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Lovell's Series of School Books.

FIFTH BOOK

OF

LESSONS,

FOR THE USE OF SCHOOLS.

Authorized by the Council of Public Instruction for Upper Canada.

Montreal:
PRINTED AND PUBLISHED BY JOHN LOVELL;
AND SOLD BY ROBERT MILLER.
Toronto:
ADAM MILLER, 62 KING STREET EAST.
1864.

This [illegible] has been compiled as a portion of the series of progressive lessons, partially developed in the preceding Books. Its object is to carry forward the instruction of the more advanced Pupils, into subjects which had been but briefly noticed, or altogether omitted in the former Numbers of the Series.

PREFACE.

THIS FIFTH BOOK OF LESSONS has been compiled as a portion of the plan of progressive Lessons, partially developed in the preceding Books. Its object is to carry forward the Instruction of the more advanced Pupils, into subjects which had been but briefly noticed, or altogether omitted in the former Numbers of the Series.

CONTENTS.

PHYSICAL GEOGRAPHY AND GEOLOGY.

HISTORY.

PHYSIOLOGY, VEGETABLE AND ANIMAL.

NATURAL PHILOSOPHY.

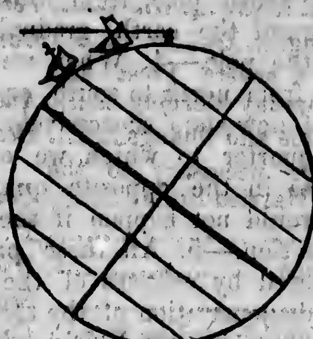
POETICAL PIECES.

FIFTH BOOK.

SECTION I.

PHYSICAL GEOGRAPHY AND GEOLOGY.

ROTUNDITY OF THE EARTH.



A GREAT variety of appearances, both on the surface of the earth, and in the heavens, prove conclusively, that the earth is a spherical or round body.—1. When we stand on the sea-shore, while the sea is perfectly calm, we perceive that the surface of the water is not quite plane, but convex or rounded; and if we are on the side of an arm of the sea, and, with our eyes near the water, look towards the opposite coast, we plainly see the water elevated between our eyes and the shore, so as to prevent our seeing the land near the edge of the water.—2. When an object is seen at a distance upon the surface of the earth, a part of its base is hid from the view. As the distance is lessened, a greater portion of the object becomes visible, and, when brought sufficiently near, the whole of it is seen. If, on the other hand, the distance is increased, the visible part of the body is continually diminished, and at last the object entirely disappears. Every person who has paid the slightest attention to the manner in which mountains, towers, and ships begin to appear and disappear, must be familiar with these facts.—3. Magellan, Drake, Anson, and other navigators, by holding an easterly or westerly course, at last arrived at the point of their departure. They thus sailed upon a line, which, in one revolution, returned into itself, ending where it began; and, therefore, the surface on which it was described must be a sphere, or must resemble a sphere. This was further confirmed by the voyages of Captain Cook towards the south pole, from which it appeared that the course round the earth gradually diminished as it approached the pole.—4. When we travel a considerable distance from north to south, or from south to north, a number of new stars successively appear in the heavens, in the quarter to which we are advancing, and many of those in the opposite quarter gradually disappear, which would not happen if the earth were a plane in that direction.—5. All these proofs are confirmed and illustrated by eclipses of the moon, which present an ocular demonstration of the earth's rotundity. An eclipse of the moon is caused by the intervention of the body of the earth between the sun and the moon; in which case, the shadow of the earth falls upon the moon. This shadow is found in all cases, and in every position of the earth, to be of a circular figure; which incontrovertibly proves, that the whole mass of land and water, of which the earth is composed, is nearly of a globular form.

It may be objected that the earth cannot be of a spherical form, as its surface presents the most irregular appearances, being in innumerable places elevated into mountains, or depressed into valleys. But these irregularities bear no greater proportion to its whole bulk than a few grains of sand to a common terrestrial globe, the highest mountains on its surface being little more than the two-thousandth part of its diameter. Some of the mountains on the surface of the moon are higher than those on the earth, and yet that body appears, both to the naked eye, and through a telescope, of a spherical figure. Equally futile is the objection, which has been improperly and ignorantly drawn from the expressions occasionally to be met with in the Bible. The object of the inspired writers who used these expressions, was not to advance a true system of natural philosophy, or to correct the popular errors of the day, in matters of mere science, but to illustrate or enforce some precept or doctrine, or to record the occurrence of some remarkable event, which could not have been done intelligibly but by adopting expressions in agreement with the opinions of the age.

On the knowledge of the spherical figure of the earth, the art of navigation in a great measure depends; and all the voyages of discovery, which have been made in later years, were undertaken in consequence of the knowledge of this fact. Had mankind remained unacquainted with this discovery, the circumnavigation of the globe would never have been attempted—vast portions of the world would have remained unknown and unexplored—no regular intercourse would have been maintained between the various tribes of the human race—and, consequently, the blessings of Divine Revelation could never have been communicated to the greater part of the Gentile world.

GENERAL VIEW OF THE GLOBE.

In looking over a map of the world, it is seen at once that the surface consists of various spaces of land, surrounded by an extensive field of water called the sea or ocean. Of these spaces of land, two are of vast extent, and on this account are termed continents. The larger of these continents includes the three divisions of Europe, Asia, and Africa, and is distinguished by the title of the Old World, from its having, till the discovery of America by Columbus, in the year 1492, been the only part of the globe with the existence of which Europeans were acquainted. The other, which includes North and South America, is named the New World.

The general direction of the land in the two continents is entirely different. In America, it is from pole to pole: in the Old World, it is from south-west to north-east; and if we keep Africa out of view, it is almost parallel to the equator. The longest straight line that can be drawn on the old continent commences on the western coast of Africa, from about Cape Verd, and extends to Behring's Strait in the north-east of Asia. It is about 11,000 miles in length. A similar line, traced along the new continent, passes from the strait of Terra del Fuego to the northern shore of North America, and is nearly 9,000 miles long. In both continents the direction of the large peninsulas is similar, almost all of them running towards the south. This is the case with South America, California, Florida, Alaska, and Greenland in the New World; and, in the Old, with Scandinavia, Spain, Italy, Greece, Africa, Arabia, Hindostan, Malaya, Cambodia, Corea, and Kamtschatka. The only exceptions to this remark are the peninsula of Yucatan in Mexico, and that of Jutland in the north-west of Europe. Both of these are directed towards the north; but they consist of plains and alluvial land, whereas the other peninsulas are more or less of a mountainous character. There is a farther resemblance between the two continents, from each being divided into two parts by an isthmus. But in the character of their outlines they differ very much; for while the coast of the Old World (excepting Africa) is broken equally on all sides by gulfs, bays, and inland seas, the New World has a series of openings on its eastern shore only. On its western side, the only inlet of any magnitude is the gulf of California.

Besides the two continents, many extensive portions of land are dispersed through the ocean, particularly the immense regions of New Holland, which occupy a space nearly as large as the whole of Europe. There are also the islands of New Guinea, Borneo, Madagascar, Sumatra, Japan, Great Britain, New Zealand, Ceylon, Iceland, Cuba, Java, and thousands of others, of different dimensions, scattered through the Pacific, the Indian, and the Atlantic Oceans, and which form a very considerable portion of the habitable regions of the globe.

The ocean surrounds the earth on all sides, and penetrates into the interior parts of many countries, sometimes by large openings, and frequently by small straits. Though it is, strictly speaking, but one immense body of water, extending in various directions, yet different names have been appropriated to different portions of it. The Pacific Ocean, divided by the equator into North and South, is inclosed between America on the east, and New Holland, the islands of Java and Sumatra, and the continent of Asia, on the west: on the north, it terminates at Behring's Strait. The seas of China, Japan, Okhotsk, &c. form parts of this ocean. The Indian Ocean lies between Africa on the west, and the peninsula of Malaya, with the islands of Sumatra, Java, &c. and New Holland, on the east, and is bounded by Persia and Hindostan on the north. The Red Sea or Arabian Gulf, the Persian Gulf, and the Bay of Bengal, are all parts of this ocean. The Southern or Antarctic Ocean is bounded on the north by a line drawn from Cape Horn to the Cape of Good Hope, thence to Van Diemen's Land, and again by the south of New Zealand to Cape Horn. These three oceans form what may be called the great South-Eastern Basin, the waters of which cover nearly half the globe. The Atlantic Ocean commences, in the south, from a line drawn from Cape Horn to the Cape of Good Hope, and is terminated on the north by the Arctic Circle. It is divided into North and South by the equator, and its branches are the Mediterranean, the North Sea or German Ocean, the Baltic, Baffin's Bay, Hudson's Bay, the Gulf of Mexico, and the Caribbean Sea. The Arctic or Northern Ocean surrounds the North

Pole, and is bounded, on the south, by the Arctic Circle, and the northern shores of the two continents. The Atlantic and Arctic Oceans may be called the Western Basin, which forms a channel between the Old and New Worlds.

The Ocean, which is thus subdivided, is spread over nearly seven-tenths of the globe; but it is remarkable how unequally the land and water are distributed. If we compare the northern and southern hemispheres, that is, the two equal parts into which the globe is divided by the equator, we shall find that, if the quantity of land in the northern hemisphere be represented by 16, the quantity in the southern will be scarcely equal to 5. Buffon and some other philosophers, therefore, asserted that a great continent must exist towards the south pole, in order to counterbalance the mass of land in the northern hemisphere; but the high southern latitudes have as yet been found to contain only a few islands. This fact, however, does not prove that there is a less mass or weight of land in the southern than in the northern hemisphere; for it is possible that the land may be only rather depressed in the south, and consequently covered by the sea.

MOUNTAINS.

Mountains are distributed in various forms and sizes through every region of the globe, and serve as a sort of connecting band to the other portions of the earth's surface. The largest mountains are generally arranged in immense chains, which extend, in nearly the same direction, for several hundreds, and even thousands of miles. The highest in the world are the Himalayas, in the north of Bengal, on the borders of Tibet. The loftiest mountain in this range is stated to be about 27,000 feet, or a little more than five miles in perpendicular height, and is visible at the distance of 230 miles. Next to the Himalayas, are the Andes, in South America, which extend more than 4,000 miles in length, from the province of Quito to the straits of Magellan. The highest summit of the Andes is Chimborazo, which is said to be 20,600 feet, or nearly four miles, above the level of the sea. The highest mountains in Europe are the Alps, which run through Switzerland and the north of Italy; the Pyrenees, which separate France from Spain; and the Dofrafeld, which divide Norway from Sweden. The most elevated ridges in Asia, are the Himalaya, Taurus, Imaus, Caucasus, Ararat, with the Uralian, Altaian, and Japanese mountains; in Africa, Mount Atlas, and the Mountains of the Moon.

In order to obtain a connected view of the loftiest and most extensive system of mountains upon the globe, we must suppose ourselves placed in New Holland, with our face turned towards the north; America will then be on the right, Asia and Africa on the left. From Cape Horn to Behring's Strait, along the western coast of America, there is an almost uninterrupted range of the highest mountains. From Behring's Strait again succeeds an enormous line passing in a south-westerly direction through Asia, leaving China and Hindostan to the south, somewhat interrupted as it approaches Africa, but still to be looked upon as continuing its course in the mountains of Persia and Arabia Felix. From Cape Guardafui in Africa to the Cape of Good Hope, there appears to be a chain which completes the view. The series of mountains which we have thus followed, is in the form of an immense irregular curve, which comprises within it the Pacific and Indian Oceans, with their innumerable islands, besides a portion of Asia, including China, the Birman dominions, and the Indian peninsula. It presents a steep face towards these oceans; while, on the other side, the land very generally slopes towards the Atlantic and Arctic Oceans.

But, though the most considerable elevations of the surface of the earth are thus formed into chains, some mountains are completely insulated, that is, are quite remote from any chain or group. Volcanos are more particularly of this kind. The term volcano is derived from Vulcan, the name which the Romans gave to their imaginary god of fire, and is applied to those mountains which send forth, from their summits or sides, flame, smoke, ashes, and streams of melted matter called lava. Upon ascending to the top of a mountain of this kind, there is found to be an immense and deep hollow, which is denominated the crater or cup. From most of the volcanos which are not extinct, there is a smoke more or less frequently arising; but the eruptions, which are discharges of stones, ashes, lava, &c., accompanied with lofty columns of fire, violent explosions, and concussions of the earth, happen at irregular and sometimes very long intervals. It seems to be a very general rule that the greater the mass and the elevation of the mountain, the less frequent and more tremendous are the eruptions. Stromboli, the small volcano on one of the Lipari islands, is almost always burning; Vesuvius has more frequent eruptions than Etna; while the immense summits of the Andes, Cotopaxi and Tungurahua, have an eruption hardly once in a century. The volcanos of America, besides the common lava and rocks, &c., cast out scorified clay, carbon, sulphur, and water, accompanied, in some instances, by fishes. The mountain of Maccaluba in Sicily, some hills near the town of Zaman in the Crimea, and a volcano which is situated towards the middle of the island of Java, in a plain abounding with salt springs, send forth eruptions of mud.

It is remarkable that, in the Old Continent, the principal chains of mountains contain no volcanos, and that islands and the extremities of peninsulas are alone the seats of these convulsions; while in the New World, the immense range which runs along the shore of the Pacific Ocean, possesses more volcanos than are to be met with in the whole of the Old Continent and its adjacent islands. No volcano has yet been discovered on the continent of Africa, but most of its groups of islands are distinguished by them. A line drawn round the great Pacific Ocean, so as to include the long range of mountains on the west of America, the Asiatic peninsula of Kamtschatka, and the islands of Sumatra and Java, will have within it by far the greatest and most extensive volcanic system on the globe. From Terra del Fuego (*the land of fire*) to the peninsula of Alaska, a complete series of volcanos may be traced. The Aleutian islands, which stretch from that peninsula to the opposite peninsula of Kamtschatka, possess several. On Kamtschatka, there are some of great violence. The islands of Japan and Formosa have several; and, beginning with Sumatra and Java, they are scattered over all that immense archipelago, which forms so remarkable a feature of the Pacific Ocean. In the Indian Ocean, the islands of St. Paul, Amsterdam, and Bourbon, have volcanos in action. The most formidable volcanos of the Mediterranean, are Etna in Sicily, and Vesuvius near the coast of Naples. Between these two mountains are the Lipari islands, all of volcanic character. The Atlantic Ocean contains several groups of this kind; Iceland has suffered frequently from the terrific eruptions of its volcanos; the Azores and the Canaries, and some of the West India islands, also experience the effects of subterranean fire. In some places, parts of the land which are covered by the waters of the ocean, are the seats of volcanos; and it has sometimes happened that new islands have been formed during submarine eruptions. Several mountains bear evident marks of having, at some very distant period, been the outlets of fires, and, on this account, they are called extinct volcanos. Altogether about 205 volcanos are known, including only those which have been active within a period to which history or tradition reaches.

THE OCEAN.

The vast body of water which surrounds the continents, and is the common receptacle of their running waters, is indispensably necessary to the support of animal and vegetable existence upon the earth. Its perpetual agitations purify the air; and the vapours which the atmosphere draws from its surface, being condensed and dispersed through the upper regions form clouds, which are the source of a constant supply of rain and moisture to the land. The ocean, also, by the facilities for communication which it offers, is the means of uniting the most distant nations, while it enables them to interchange, with mutual advantage, the productions of their several climates.

The bottom of the sea appears to have inequalities similar to those on the surface of the continents; the depth of the water is therefore extremely various. There are vast spaces where no bottom has been found; but this does not prove that the sea is bottomless, because the line is able to reach to but a comparatively small depth. If we were to found our opinion upon analogy, we might conclude that the greatest depth of the ocean is, at least, equal to the height of the loftiest mountains, that is, between 20,000 and 30,000 feet. Along the coast, its depth has always been found proportioned to the height of the shore. When the coast is high and mountainous, the sea that washes it is deep; but when the coast is low, the water is shallow. If we reckon its average depth at two miles, the ocean will contain 296 millions of cubical miles of water. We shall have a more specific idea of this enormous mass of water, if we consider that it is sufficient to cover the whole globe to the height of more than eight thousand feet; and if this water were reduced to one spherical mass, it would form a globe of more than 800 miles in diameter.

The general colour of the sea is a deep bluish green, which becomes clearer towards the coasts. This colour is thought, by some, to arise from the same cause as the azure of the sky; it is probable that the former is due to the rays of blue light being reflected in the greatest quantity from the water, and the latter to their being reflected in the greatest quantity from the particles of the air. The other colours exhibited in parts of the sea, depend on causes which are local, and sometimes deceptive. The Mediterranean in its upper part is said to have at times a purple tint. In the gulf of Guinea the sea is white; around the Maldive islands it is black;

and in some places it has been observed to be red. These appearances are probably occasioned by vast numbers of minute marine insects, by the nature of the soil, or by the infusion of certain earthy substances in the water. The green and yellow shades of the sea proceed frequently from the existence of marine vegetables at or near the surface.

The water of the sea contains several extraneous substances, in proportions varying in different places. The component parts, in addition to pure water, are commonly sulphate of soda; chloride of sodium (common salt); chlorides of calcium, magnesium, and potassium; with some organic matter. Common salt, which for salting meat is preferred to the salt of springs, is obtained by boiling the sea water so as to evaporate it. The saltness of the sea appears, with some local exceptions, to be less towards the poles than near the tropics; and, in particular places, it varies from temporary causes. The violent tropical rains have an effect in diminishing it, especially near coasts, where an increased volume of fresh water is brought down by the rivers. The Baltic is at all times less salt than the ocean, and when a strong east wind keeps out the North Sea, its waters are said to become almost fit for domestic uses. The most curious phenomenon of all, is that of springs of fresh water rising up in the midst of the sea. In the bay of Xagua, on the southern coast of Cuba, springs of this kind gush up with great force at the distance of two or three miles from the land; and others occur near Goa, on the western coast of Hindostan, and in the Mediterranean Sea, not far from Marseilles. Various theories have been advanced to account for the saltness of the ocean. Some assert the existence of vast beds of salt at its bottom. Others have supposed that the sea may have originally received all its saline particles from those existing on the surface of the earth, which were dissolved and carried down to the ocean by the action of the rivers. The most probable solution of the matter is, that it is an essential and absolute quality impressed upon it from the creation of the world by the Great Author of nature. Its presence, united to the action of the tides and waves, preserves the vast mass of waters from corruption, and at the same time gives it a specific gravity which enables it more easily to float the large bodies which move in it, or upon its surface. The bitterness which exists in sea-water, but apparently not beyond a certain depth, is with much probability considered to be owing partly to the vegetable and animal matter held there in a state of decomposition; and partly to some of the salts it contains. From the former cause some account for the luminous appearance which the sea often presents at night, particularly in summer and autumn, while others ascribe it to electricity, or to innumerable minute animals moving rapidly through the water in all directions.

Water being a bad conductor of heat, the temperature of the sea changes much less suddenly than that of the atmosphere, and is by no means subject to such extremes as the latter. It is also modified by currents, which mingle together the waters of different depths and regions, and by the neighbourhood of shallows and banks. Thus bays, inland seas, and the spaces among clusters of islands, where the action of the waves is more confined, and the water usually of less depth than at a distance from land, are the most favourable places for the production and accumulation of marine ice. It is on this account that the navigation of the Baltic is annually stopped by the ice in a latitude not more northerly than that of tracts which in the main ocean, are always open to the passage of ships. In like manner, ice extends from five to eight degrees farther from the south than from the north pole, owing, it is probable, to the almost entire absence of land near the Antarctic Circle; while the north pole is so nearly surrounded by land, that the ice of the Arctic Ocean is shut up, and cannot be carried forward to such a distance by the current, which sets towards the equator.

The ocean has three kinds of motion. The first is that undulation which is produced by the wind, and which is entirely confined to its surface. The second motion is that continual tendency which the whole water in the sea has towards the west, which is greater near the equator than towards the poles. It begins on the west side of America, when it is moderate; but as the waters advance westward, their motion is accelerated; and after having traversed the globe, they strike with great violence on the eastern shore of America. Being stopped by that continent, they rush, in the form of an impetuous current called by navigators the Gulf-stream, into the Gulf of Mexico, and thence proceed along the coast of North America, till they come to the south side of the great bank of Newfoundland, when they turn suddenly off and run down through the Azores, or Western Isles. This motion is most probably owing to the diurnal revolution of the earth on its axis, which is in a direction contrary to the current of the sea. The third motion is the tide, which is a regular swell of the ocean every 12½ hours. This motion is now ascertained to be owing to the attractive influence of the moon, and also partly to that of the sun. There is always a flux and reflux at the same time, in two parts of the globe, and these are opposite to each other; so that when our antipodes have high water, we have the same. When the attractive powers of the sun and moon act in the same direction, which happens at the time of new and full moon, we have the highest or spring tides; but when their attraction is opposed to each other, which happens at the quarters, we have the lowest or neap tides.

SPRINGS—RIVERS—LAKES.

The origin of the numerous springs that break forth from beneath the earth's surface cannot be referred to one exclusive cause. The internal reservoirs by which they are supplied are, in many cases, derived from the water which the earth absorbs from rain and melted snow, and from these reservoirs, wherever there is uneven or mountainous ground, the water flows out by minute fissures in the sides of the hills. But when we see springs rising up in plains, it is evident that they must have ascended, that is, travelled, in a direction contrary to that produced by the force of gravity, in order to reach the surface. This, no doubt, is sometimes to be attributed to water flowing under ground from distant elevations, and to the natural tendency of a liquid to find its level. But some persons believe that the rising up of springs in plains cannot always be accounted for in this manner; and have, therefore, devised other modes of explanation. Springs which suffer no diminution even from the longest continued dry weather, would appear to be derived from a source quite independent of rains and other external means of supply. They have been attributed to some vast body of water within the earth; and it has been concluded, though without sufficient reason, that many springs arise from the ocean, filtering through the pores of the earth, the salt particles being lost in the passage. Springs, which have their waters combined with mineral substances, and are, from that circumstance, called *mineral*, are very numerous, and of various kinds. *Warm* and *hot* springs are also common, especially in volcanic countries, where they are sometimes distinguished by violent ebullitions. Iceland is noted for these curious phenomena: its celebrated boiling fountain, the great Geyser, frequently throws out its contents to the height of more than a hundred feet: sometimes to twice that elevation.

Rivers are to be traced to springs, or to the gradual meltings of the ice and snow, which perpetually cover the summits of all the most elevated ranges of mountains upon the globe. The union of various springs, or of these meltings, forms rivulets; these last follow the declivity of the ground, and commonly fall, at different stages into one great channel, called a river, which at last discharges its waters into the sea, or some great inland lake. The declivities along which descend the various streams that flow into one particular river are called its *basin*; a term, therefore, which includes the whole extent of country from which the waters of the river are drawn. As mountainous regions abound in springs, we find that most rivers, more especially those of the first class, commence from a chain of mountains:

each side of a chain also has its springs, and the rivers which originate on one side flow in the opposite direction to those which rise on the other. As it is the property of water to follow the most rapid descent that comes in its way, the courses of streams naturally point out the various declivities of the earth's surface, and the line, from which large rivers flow in contrary directions will generally mark out the most elevated parts of the earth. When rivers proceed through a mountainous and rugged country, they frequently fall over precipices and form cataracts, in some cases several hundred feet in depth. The most celebrated falls in the world are those of Niagara, in North America. In the tropical regions, most of the rivers are subject to periodical overflowings of their banks, in consequence of the rains which annually fall in such abundance in these countries during the wet season. The overflow of the Nile was considered by the ancients, who were ignorant of its cause, as one of the greatest mysteries in nature, because in Egypt, where the overflow takes place, no rain ever falls. The apparent mystery is easily explained from the circumstance of the rains descending and the snow melting upon the mountains in the interior of Africa where the Nile rises. The consequent accumulation of the waters among the high grounds gradually swells the river along its whole extent, and in about two months from the commencement of the rains, occasions those yearly inundations, without which Egypt would be a desert. Rivers, in their junction with the sea, present several appearances worthy of notice. The opposition which takes place between the tide and their own currents occasions, in many instances, the collection at their mouths of banks of sand or mud, called *bars*, on account of the obstruction which they offer to navigation. Some streams rush with such force into the sea, that it is possible to distinguish for a considerable distance their waters from those of the sea. Many of the largest rivers, as the St. Lawrence and the Rio de la Plata, mingle with the ocean by means of a single outlet, while others, as the Nile, the Ganges, the Volga, the Rhine, and the Orinoco, before their termination, divide into several branches. In some of the sandy plains of the torrid zone, the rivers divide into branches, and, from the nature of the soil and the heat of the climate, are absorbed and evaporated, and thus never reach the sea.

Lakes may be classed into four distinct kinds. The first class includes those which have no outlet, and which do not receive any running water. They are usually very small; and some appear to be the craters of extinct volcanos. The second class are those which have an outlet, but which receive no running water. They have been formed by springs flowing into some large hollow: upon the water rising up to the top of the hollow, it would, of course, run over the lowest part of the edge, and thus find an outlet; and these outlets are, in some cases, the beginning of very large rivers. The third class, which embraces all those which both receive and discharge streams of water, is much more numerous than any. Though they are the receptacles of many streams from the neighbouring country, they usually have each but one outlet, which often takes its name from the principal river that runs into the lake. The largest lakes of this class are the immense bodies of water in North America, between Canada and the United States. There are five (Superior, Michigan, Huron, Erie, and Ontario), almost all like seas in extent, connected together, and having their purity maintained by means of the continual flow of water which is kept up from one to another. Their final outlet to the Atlantic Ocean is the great river St. Lawrence. Lake Baikal, in Asiatic Russia, is also remarkable for its size; it sends forth a large stream which joins the Yenisei. The fourth class of lakes comprises a very small number, but they are the most singular of all in their character. They are those which receive streams of water, and often great rivers, but have no visible outlet. The most celebrated are the Caspian Sea, Lake Aral, and the Dead Sea, all situated in the west of Asia. The Caspian is between 600 and 700 miles long, and, in one part, between 300 and 400 miles in width. It receives some very large rivers, the chief of which are the Volga, the Ural or Yaik, and the Kur. Lake Aral is much smaller than the Caspian, but possesses the same peculiarities; and, from the character of the isthmus which separates them, it is supposed that they formerly composed one body of water. They are both salt lakes, and are distinguished by marine productions; from which it has been conjectured that they must, at a very remote period, have been connected with the Black Sea. The Dead Sea is still smaller than the Lake Aral, it is also salt and exceedingly bitter.

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CHANGES IN THE SURFACE OF THE EARTH.

From the quiet and regular succession of natural events to which we are accustomed, and the repugnance we feel to the idea that it is possible for the course of nature to suffer interruption, we might, without due investigation, almost persuade ourselves that the physical features and condition of the globe possess an unchangeable character. So far, however, is this from being the case, that there is no country wherein traces are not discoverable of the violent revolutions of which the earth was formerly the theatre: and even yet it is experiencing changes of a very perceptible kind. Of the several agents which contribute to these changes water has the widest sphere of activity. Streams which descend along the flanks of elevated grounds carry along with them some portion of the materials of their respective slopes, especially when swelled into violence by rains or the melting of snows; and such as come from mountains sweep down with them even some of the fragments of rock that have been collected in the high valleys. In proportion, however, as these streams reach the more level country, and their channels become more expanded, they deposit the fragments and stones, till at last their waters convey along only particles of mud of the minutest kind. If, therefore, these waters do not run too rapidly into the sea, or the particles in question do not previously settle in some lake through which the rivers pass, the mud is deposited on the sides of their mouths, forming low grounds, by which the shores are prolonged and encroach upon the sea; and when the waves, by casting up sand upon them, assist in their increase, whole provinces are created, capable, from their rich soil, of yielding, in the highest degree, to the support of man, and of being made the seats of wealth and civilization. It has been concluded, with reason, that the greater part of Lower Egypt owes its formation to the alluvial matter brought down by the Nile, aided by the sand cast up by the sea. The Delta of the Rhone is undergoing a similar augmentation, and it would appear that the arms of that river have, in the course of 1800 years, become longer by three leagues; and that many places which were once situated on the brink of the sea, or of large pools, are now several miles distant from the water. In Holland and Italy, the Rhine and the Po, since they have been banked up by dykes, raise their beds and push forward their mouths into the sea with great rapidity. Such, indeed, has been the increase of new land formed by the latter, that the city of Adria, which there is no doubt was, at a very remote date, situated on the coast of the Adriatic, is now more than fifteen miles distant from the nearest part of it. At the same time, the river has, in consequence of embankments made to confine it, been so much raised in the level of its bottom that the surface of its waters is higher than the roofs of the houses in Ferrara; and the Adige and the Po are higher than the whole tract of country lying between them. The same cause produces the alterations perceived to be taking place in many of those lakes which are traversed by rivers. The matter brought down by the rivers easily settles in the still waters of the lakes, and the necessary result is, that the basins of the latter are gradually undergoing a diminution. Lake Erie, one of the vast bodies of water in North America, is every year becoming shallower from the influx of pebbles and earth, and the constant accumulation of reeds and shells; and the diminution of the beautiful lake of

Geneva is also said to have been considerable within the memory of man.

The formation of new islands constitutes another distinct and interesting class among the changes to which the surface of the globe is subject. Those which have been raised up by volcanic agency are comparatively few; but those of coral, which owe their origin to marine insects (of the class of zoöphytes or *plant animals*), are innumerable. Of the different coral tribes, the most abundant is that named the madarpore. It is most common in the tropical seas, and decreases in number and variety towards the poles; it surrounds, in vast rocks and reefs, many of the islands of the South Sea and Indian Ocean, and increases their size by its daily growth. The coasts of the islands of the West Indies, of those of the east of Africa, and the shores and shoals of the Red Sea, are encircled with rocks of coral. Several navigators have furnished us with accounts of the curious manner in which these formations take place; the following is extracted from Capt. Basil Hall's narrative of his voyage to the Loo-Choo islands:—

"The examination of a coral reef, during the different stages of one tide, is particularly interesting. When the tide has left it for some time, it becomes dry, and appears to be a compact rock exceedingly hard and rugged; but as the tide rises, and the waves begin to wash over it, the coral-worms protrude themselves from holes which were before invisible. These animals are of a great variety of shapes and sizes, and in such prodigious numbers, that, in a short time, the whole surface of the rock appears to be alive and in motion. The most common of the worms at Loo-Choo is in the form of a star, with arms from four to six inches long, which are moved about with a rapid motion, in all directions, probably to catch food. Others are so sluggish, that they may be mistaken for pieces of the rock, and are generally of a dark colour, and from four to five inches long, and two to three round. When the coral is broken, about high-water, it is a solid hard stone; but if any part of it be detached at a spot which the tide reaches every day, it is found to be full of worms of different lengths and colours; some being as fine as a thread, and several feet long, of a bright yellow, and sometimes of a blue colour; others resemble snails, and some are not unlike lobsters in shape, but soft, and not above two inches long. The growth of the coral appears to cease when the worm is no longer exposed to the washing of the sea. Thus, a reef rises in the form of a cauliflower, till its top has gained the level of the highest tides, above which the worm has no power to advance, and the reef, of course, no longer extends itself upwards. The other parts, in succession, reach the surface, and there stop, forming, in time, a level field with steep sides all round. The reef, however, continually increases, and being prevented from going higher, extends itself laterally in all directions. But this growth being as rapid at the upper edge as it is lower down, the steepness of the face of the reef is still preserved. These are the circumstances which render coral reef so dangerous in navigation; for, in the first place, they are seldom seen above water; and in the next, their sides are so steep, that a ship's bows may strike against the rock, before any change of soundings has given warning of the danger."

Another navigator gives the following succinct account of the manner in which, after being raised up, the coral islands gradually acquire a soil and vegetation:—"To be constantly covered with water seems necessary to the existence of the animalcules, for they do not work, except in holes upon the reef, beyond low-water mark; but the corals, sand, and other broken remnants thrown up by the sea, adhere to the rock, and form a solid mass with it, as high as the common tides reach. That elevation surpassed, the future remnants, being rarely covered, lose their adhesive property, and remaining in a loose state, form what is usually called a *Key*, upon the top of the reef. The new bank is not long in being visited by sea-birds; salt-plants take root upon it, and a soil begins to be formed; a cocoa-nut, or the drupe of a pandanus, is thrown on shore; land birds visit it, and deposit the seeds of shrubs and trees; every high tide, and still more every gale, adds something to the bank; the form of an island is gradually assumed; and last of all comes man to take possession."

The other chief agents in changing the surface of the earth are volcanos and earthquakes. The changes occasioned by the eruptions of the former are very considerable near the seat of action, but they operate over a less extensive field than either of those which have been already mentioned. The principal effect of the issue of subterranean fires is the elevation of the surface of the surrounding country; and the size of the mountains themselves must have been prodigiously increased by the matter thrown up during successive eruptions. Earthquakes appear to be brought about by the same causes as volcanic eruptions; but their action is much more tremendous than that of the latter. They are frequently accompanied by loud subterraneous noises, and are sometimes so violent, that the ground heaves up, and undulates like an agitated sea. They are felt, almost at the same instant, over a most astonishing extent; though happily, compared with this extent, their destructive ravages are confined within a small range. In those parts, which appear to be near the centre of their action, the most calamitous effects sometimes occur: whole cities are destroyed, and their inhabitants buried beneath the ruins; springs are stopped, and others gush out in new places; fissures are made in the earth; and enormous masses of rock and other materials sink down, or are detached from the mountains.

Such are the principal changes, which the surface of the globe is now undergoing. But great as they are, they could not have brought about those grand revolutions, which formerly visited the earth, and in which such multitudes of the animal race were consigned to destruction. The whole of them are insufficient to alter, in any perceptible degree, the level of the sea, still less to have occasioned an overwhelming of the land by that element. Some philosophers have endeavoured to prove that a gradual and general lowering of the level of the sea takes place, and have appealed to certain observations, which, if correct, tend to establish the fact of a diminution of the waters along the northern shores of the Baltic. But it must not be forgotten, that though in some places the ocean has retired, or sunk in level, in others it has encroached upon the land; while it is known that many harbours of the Mediterranean have preserved exactly the same level since the time of the ancients. It is plain, therefore, that all variations upon the coasts of the ocean are merely of a local kind, and that if the different accounts are balanced, we must arrive at the conclusion, that the general volume of the ocean, and perhaps even its superficial extent, suffer neither increase nor diminution.

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THE ATMOSPHERE.

The atmosphere is one of the most essential appendages to the globe we inhabit, and exhibits a most striking proof of Divine skill and omnipotence. It is now ascertained to be a compound substance, formed chiefly of two very different ingredients, termed *oxygen* and *nitrogen gas.* Of 100 measures of atmospheric air, 21 are oxygen, and 79 nitrogen. The one, namely, oxygen, is the principle of combustion. It is absolutely necessary for the support of animal life, and is one of the most important substances in nature. The other (*nitrogen*) is altogether incapable of supporting either flame or animal life. But the term *atmosphere* is also applied to the whole mass of fluids, consisting of air, vapours, electric fluid, and other matters which surround the earth to a certain height. This mass of fluid matter gravitates to the earth, revolves with it in its diurnal rotation, and is carried along with it in its course round the sun every year. It has been computed to extend about 45 miles above the earth's surface, and it presses on the earth with a force proportioned to its height and density. From experiments made with the barometer it has been ascertained, that it presses with a weight of about 15 pounds on every square inch of the earth's surface; and, therefore, its pressure on the body of a middle-sized man, is equal to about 32,000 pounds, or 14 tons avoirdupois, a pressure which would be insupportable, and even fatal, were it not equal on every part, and counterbalanced by the spring of the air within us. The pressure of the whole atmosphere upon the earth is computed to be equivalent to that of a globe of lead, 66 miles in diameter; in other words, the whole mass of the air, which surrounds the globe, compresses the earth with a force or power equal to that of five thousand millions of millions of tons. This amazing pressure is, however, essentially necessary for the preservation of the present constitution of our globe, and of the animated beings which dwell on its surface. It prevents the heat of the sun from converting water, and all other fluids into vapour; and preserves the vessels of all organized beings in due tone and vigour. Were the atmospherical pressure entirely removed, the elastic fluids contained in the finer vessels of men and other animals would inevitably burst them, and life would become extinct; and most of the substances on the face of the earth, particularly liquids, would be dissipated into vapour.

Besides these, the atmosphere possesses a great variety of other admirable properties, of which the following may be mentioned. It is the vehicle of smells, by which we become acquainted with the qualities of the food which is set before us, and learn to avoid those places, which are damp, unwholesome, and dangerous. It is the medium of sounds, by means of which knowledge is conveyed to our minds. Its undulations, like so many couriers, run for ever backwards and forwards, to convey our thoughts to others, and theirs to us, and to bring news of transactions which frequently occur at a considerable distance. A few strokes on a large bell, through the ministration of the air, will convey signals of distress, or of joy, in a quarter of a minute, to the population of a city containing a hundred thousand inhabitants. It transmits to our ears all the harmonies of music, and expresses every passion of the soul: it swells the notes of the nightingale, and distributes alike to every ear the pleasures, which arise from the harmonious sounds of a concert. It produces the blue colour of the sky, and is the cause of the morning and evening twilight, by its property of bending the rays of light, and reflecting them in all directions. It forms an essential requisite for carrying on all the processes of the vegetable kingdom, and serves for the production of clouds, rain, and dew, which nourish and fertilize the earth. In short, it would be impossible to enumerate all the advantages we derive from this noble appendage to our world. Were the earth divested of its atmosphere, or were only two or three of its properties changed or destroyed, it would be left altogether unfit for the habitation of sentient beings. Were it divested of its undulating quality, we should be deprived of all the advantages of speech and conversation, of all the melody of the feathered songsters, and of all the pleasures of music; and, like the deaf and dumb, we could have no power of communicating our thoughts but by visible signs. Were it deprived of its reflective powers, the sun would appear in one part of the sky of a dazzling brightness, while all around would appear as dark as midnight, and the stars would be visible at noon-day. Were it deprived of its refractive powers, instead of the gradual approach of the day and the night, which we now experience, at sun-rise we should be transported, all at once, from midnight darkness to the splendour of noon-day; and, at sun-set, should make a sudden transition from the splendours of day to all the horrors of midnight, which would bewilder the traveller in his journey, and strike the creation with amazement. In fine, were the oxygen of the atmosphere completely extracted, destruction would seize on all tribes of the living world, throughout every region of earth, air, and sea.

DICK.

THE WINDS.

A change in the temperature of a portion of air; an increase or a diminution of the quantity of water, which it holds in a state of vapour; in short, any circumstance which causes it either to contract or expand, destroys the equilibrium among the different parts of the atmosphere, and occasions a rush of air, that is, a *wind*, towards the spot where the balance has been destroyed. Winds may be divided into three classes: those, which blow constantly in the same direction; those, which are periodical; and those, which are variable. The permanent winds are those which blow constantly between, and a few degrees beyond, the tropics, and are called *trade-winds.* On the north of the equator, their direction is from the north-east, varying at times a point or two of the compass each way: on the south of the equator, they proceed from the south-east. The origin of them is this:—the powerful heat of the torrid zone rarefies, or makes lighter, the air of that region; the air, in consequence of this rarefaction, rises, and to supply its place, a colder atmosphere from each of the temperate zones moves towards the equator. But these north and south winds pass from regions, where the rotatory motion of the earth's surface is less, to those where it is greater. Unable at once to acquire this new velocity, they are left behind, and instead of being north and south winds, as they would be, if the earth's surface did not turn round, they become north-east and south-east winds.

The *monsoons* belong to the class of periodical winds. They blow half the year from one quarter, and the other half from the opposite direction: when they shift, variable winds and violent storms prevail for a time, which render it dangerous to put to sea. The monsoons of course suffer partial changes in particular places, owing to the form and position of the lands, and to other circumstances; but it will be sufficient to give their general directions. From April to October, a south-east wind prevails north of the equator, southward of this a south-east wind; from October to April, a north-east wind north of the equator, and a north-west between the equator and 10° of south latitude.

The *land* and *sea-breezes*, which are common on the coasts and islands situated between the tropics, are another kind of periodical winds. During the day, the air, over the land, is strongly heated by the sun, and a cool breeze sets in from the sea; but in the night, the atmosphere over the land gets cooled, while the sea, and consequently the air over it, retains a temperature nearly even at all times; accordingly, after sunset, a land-breeze blows off the shore. The sea-breeze generally sets in about ten in the forenoon, and lasts till six in the evening; at seven the land breeze begins, and continues till eight in the morning, when it dies away. These alternate breezes are, perhaps, felt more powerfully on the coast of Malabar than any where; their effect there, extends to a distance of twenty leagues from the land.

Thus, within the limits of from twenty-eight to thirty degrees on each side of the equator, the movements of the atmosphere are carried on with great regularity; but beyond these limits, the winds are extremely variable and uncertain, and the observations made, have not yet led to any satisfactory theory, by which to explain them. It appears, however, that beyond the region of the trade-winds, the most frequent movements of the atmosphere are from the south-west, in the north temperate zone. This remark must be limited to winds blowing over the ocean, and in maritime countries; because those in the interior of continents are influenced by a variety of circumstances, among which the height and position of chains of mountains are not the least important. These south-west and north-west winds of the temperate zones, are most likely occasioned in the following manner:—In the torrid zone there is a continual ascent of air, which, after rising, must spread itself to the north and south in an opposite direction to the trade-winds below: these upper currents, becoming cooled above, at last descend and mix themselves with the lower air; part of them may, perhaps, fall again into the trade-winds, and the remainder, pursuing its course towards the poles, may occasion the north-west and south-west winds, of which we have been speaking. This interchange between the heated air of the Tropics, and the cold air of the Polar regions, greatly tends to moderate the climate of each. Besides the air from the Tropics being richer in oxygen, on account of the more luxuriant vegetation decomposing a larger quantity of carbonic acid, is well calculated to supply any deficiency in the amount of this most important substance, which might occur from the barrenness of a less favoured climate.—(*See page* 224.)

Hurricanes have been supposed to be of electric origin. A large vacuum is suddenly created in the atmosphere, into which the surrounding air rushes with immense rapidity, sometimes from opposite points of the compass, spreading the most frightful devastation along its track, rooting up trees, and levelling houses with the ground. They are seldom experienced beyond the tropics, or nearer the equator than the 9th or 10th parallels of latitude; and they rage with the greatest fury near the tropics, in the vicinity of land or islands, while far out on the open ocean they rarely occur. They are most common among the West India islands, near the east coast of Madagascar, in the islands of Mauritius and Bourbon, in the bay of Bengal, at the changing of the monsoons, and on the coasts of China.

Whirlwinds sometimes arise from winds blowing among lofty and precipitous mountains, the form of which influences their direction, and occasions gusts to descend with a spiral or whirling motion. They are frequently, however, caused by two winds meeting each other at an angle, and then turning upon a centre. When two winds thus encounter one another, any cloud which happens to be between them, is of course condensed, and turned rapidly round; and all substances sufficiently light, are carried up into the air by the whirling motion which ensues. The action of a whirlwind at sea, occasions the curious phenomenon called a *water-spout.*

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AQUEOUS VAPOUR—CLOUDS AND MISTS, RAIN, DEW, SNOW, HAIL.

When water is exposed to the air, it is gradually converted into vapour, which, on account of its specific levity, ascends into the atmosphere. This vapour presents itself in various forms. When the air holds it in solution, it is invisible, just as salt dissolved in water is invisible; but when the air becomes incapable of retaining it in solution, the watery particles become visible, either in the form of clouds and mists suspended in the atmosphere, or in that of rain, dew, snow, and hail, falling to the ground.

Clouds and *Mists* differ only in this, that the former float in the air, whereas the latter extend along the ground. Water, dissolved in the atmosphere, is first, by the agency of cold, withdrawn from it in very minute particles, which being very light, remain suspended at a greater or less distance from the earth, and are kept asunder by the electrical repulsion developed during their separation from the air. When the electricity is removed *gradually*, by pointed rocks, trees, &c., or *suddenly*, during thunder storms, the rain falls. Thus we perceive another admirable means by which climates are rendered more suitable to man. The enormous evaporation which occurs in hot countries cools them by abstracting vast quantities of heat, which is imparted to colder regions when the clouds are formed, and again, when the rain descends. The height of clouds is very various. In ascending to the summits of mountains, the traveller frequently passes through a zone of clouds, and beholds the vesicular vapours of which it is composed, stretched under his feet like a vast plain covered with snow; and even on Chimborazo, the loftiest peak of the Andes, there are always to be seen, at an immense height, certain whitish clouds resembling flakes of wool. These clouds, which are perhaps many miles from the surface of the earth, have been supposed to owe their elevation to negative electricity repelling them from the ground, in the same way as mists are supposed to owe their depression to positive electricity attracting them towards it.

Rain falls from the clouds, when the vesicular vapour, of which they are composed, unites into drops. The fall of the drops of rain, after they are formed, is easily accounted for from the attraction of gravity; but the cause of the conversion of vesicular vapour into rain-drops is not better understood, than the cause of the conversion of vapour into vesicles; though it is highly probable, that electricity is an agent in the one case, as well as in the other. If the change be owing to the diminution of this fluid, we have a ready explanation of the well-known fact, that mountainous are the most rainy countries; mountains constituting so many points for drawing off the electric fluid. This supposition is further rendered very probable by the fact, that no rain falls in those regions where thunder is unknown, as in the environs of Lima, and on the coast of Peru. The quantity of rain that falls, in different regions of the globe, is very different. It is most abundant within the torrid zone, and decreases in proportion to the distance from the equator. The annual fall at Grenada, in 12° N. lat. is 126 inches; at Calcutta, in 22° N. lat. it is 81 inches; at Rome, in 41° 54″, it is 39 inches; in England, 32 inches; and at Petersburg, in lat. 59° 16″, it is only 16 inches. Even in different places in the same country, the quantity that falls is different. But the most curious fact of all, in the natural history of rain, is the difference of quantity, which is collected at different heights at the same place. In one year, a rain-gauge on the top of Westminster Abbey, received 12 inches; another on the top of a house in the vicinity received 18 inches; and a third on the surface of the ground received 22 inches.

Dew, or the moisture insensibly deposited from the atmosphere on the surface of the ground, is a well-known phenomenon. It was long supposed, that its precipitation was owing to the cooling of the atmosphere towards evening, which prevented it from retaining so great a quantity of watery vapour in solution, as during the heat of the day. But it has been recently proved, that the deposition of dew is produced by the cooling of the surface of the earth, which takes place previously to the cooling of the atmosphere. The earth is an excellent radiator of caloric, whilst the atmosphere does not possess that property in any sensible degree. Towards evening, therefore, when the solar heat declines, and after sunset, when it entirely ceases, the earth rapidly cools by radiating heat towards the skies; whilst the air has no means of parting with its heat, but by coming in contact with the cooled surface of the earth, to which it communicates its caloric. Its solvent power being thus reduced, it is unable to retain so large a portion of watery vapour, and deposits those pearly drops called dew. This view of the matter explains the reason why dew falls more copiously in calm than in stormy weather, and in a clear than in a cloudy atmosphere. Accumulations of moisture in the atmosphere not only prevent the free radiation of the earth towards the upper regions, but themselves radiate towards the earth; whereas, in clear nights, the radiation of the earth passes without obstacle through the atmosphere to the distant regions of space, whence it receives no caloric in exchange. The same principle enables us to explain the reason, why a bottle of wine taken fresh from the cellar (in summer particularly), will soon be covered with dew. The bottle, being colder than the surrounding air, absorbs caloric from it; the moisture, therefore, which that air contained, becomes visible, and forms the dew, which is deposited on the bottle. In like manner, in a warm room, or in a close carriage, the inside of the windows is covered with vapour, because the windows being colder than the breath, deprive it of part of its caloric, and by this means convert it into watery vapour. Bodies attract dew in proportion as they are good radiators of caloric; as it is this quality which reduces their temperature below that of the atmosphere. Hence we find, that little or no dew is deposited on rocks, sands, or water; while grass and living vegetables, to which it is so highly beneficial, attract it in abundance; a remarkable instance of the wise and bountiful dispensations of Providence. The same benevolent design we may observe, also, in the abundance of dew in summer and in hot climates, in which its cooling effects are so much required. The more caloric the earth receives during the day, the more it will radiate afterwards; and consequently, the more rapidly its temperature will be reduced in the evening, in comparison with that of the atmosphere. In the West Indies, accordingly, where the intense heat of the day is strongly contrasted with the coolness of the evening, the dew is prodigiously abundant. When dew is frozen the moment it falls, it gets the name of *hoar-frost*.

Snow is another of the forms which the vapours of the atmosphere assume. It consists of aqueous vapour, congealed either while falling, or when in the air previous to falling. The first crystals, produced at a great height in the atmosphere, determine, as they descend, the crystallization of aqueous particles, which, without their presence, the surrounding air would retain in a state of solution. The result is the formation of hexagonal darts, or stars of six rays, when the weather is sufficiently calm, and the temperature not too high to deform the crystals by melting off their angles; but when the atmosphere is agitated, and the snow falls from a great height, the crystals clash together, unite in groups, and form irregular flakes.

Hail, according to all appearances, is a species of snow, or of snowy rain, which has undergone a variety of congelations and superficial meltings, in its passage through different zones of the atmosphere, of different temperatures. Its formation evidently depends on electricity. It is by an electrical apparatus, that we can produce artificial hail; and it is well known, that volcanic eruptions are often followed by the fall of hailstones of enormous size.

Such are the principal circumstances which are supposed to concur in the formation of aqueous meteors. Their beneficial influence upon the earth is a point more easy to determine. We observe all nature languish, when the atmosphere retains, for too long a time, the moisture arising from the earth. Plants fade and droop; animals feel their strength failing them; man himself, breathing nothing but dust, can with difficulty procure shelter from the sultry heat, by which his frame is parched and overpowered. But scarcely have the waters of heaven descended from the clouds, when all living beings begin to revive; the fields resume their green attire; the flowers their lively tints; animals the sportive freedom of their motions, and the elements of the air their healthful equilibrium. Snow itself, whose very name alarms the natives of the tropics, is productive of real advantages in the economy of nature: it secures the roots of plants against the effects of intense cold; it serves to moisten gently those lands, from which, owing to their local situation, the rain is too soon carried off; and it paves for the inhabitant of the north, commodious and agreeable roads, along which he gaily skims in his light and nimble sledge. Hail alone, of all the aqueous meteors, never appears but as a harbinger of distress. Birds and quadrupeds instinctively conceal themselves, as soon as they have any presentiment of its coming. Man can neither foresee its approach, nor arrest its ravages; he has been able to ward off the thunderbolts of the sky, but he sees the hail destroy his corn, break his fruit trees, and shatter the very house where he dwells, without being able to prevent it.

M'CULLOCH'S *Course of Reading.*

ON THE DELUGE.

It stands on record in Scripture, that this globe was twice enveloped in water; once, when God by his work of six days, described in the first chapter of the book of Genesis, raised it up from what is usually called its chaotic state; and a second time in the days of Noah. Now, the effects of these two immersions of the earth in water are distinctly marked in the present form of it.

In regard to the first, it is a vulgar error, to which the Scripture gives no countenance, that the earth was first brought into existence when God commenced his six days' work. A more careful reading of the narrative will convince you, that this work was merely putting it in order, and fitting it for being the habitation of man.

The words of Scripture are, "In the beginning God created the heaven and the earth." This is a general announcement of what was done in the beginning; but how long antecedent to the subsequent history that beginning was, we are not informed. The narrative proceeds, "And the earth was without form and void; and darkness was upon the face of the deep, and the Spirit of God moved upon the face of the waters." This describes the condition in which the earth was, when God commenced his work of six days. How long it had been in that condition is not said. There are indications, however, in the formation of the crust of the earth itself, that it had been for a long period in that condition, and that its then chaotic state was the result of some former revolution or revolutions. Now, in perfect conformity with this history, there are evidences of the present dry land having been immersed in water, for a much longer period than its transient immersion at the deluge. For example, there are immense masses of solid rock, some at great heights in the mountains, some deep in the bowels of the earth, entirely formed of shells and other marine remains cemented together. Many of the most beautiful marbles are thus formed. In digging mines, after piercing through many strata of rocks of various descriptions, and arriving at great depths below the surface of the earth, miners come to remains of plants and of animals, that must have been formed in waters of the sea.

These, and many other phenomena, not only prove, that the globe was immersed in water, but that it must have continued in that condition, for a much longer period than the waters of the deluge remained upon it.

But there are other phenomena, which indicate, that after the earth was brought into its present form, its mountains and valleys, and rivers and seas, nearly as we now see them, it was suddenly immersed in water, which also suddenly receded. The phenomena to which I now allude, are such as fossil shells, marine plants, bones, &c. which are found in earth, or gravel, or sand,

and in other situations, which indicate a much more recent deposit, than the shells and other marine substances formed into solid rocks, already alluded to. In every part of the world, there are found indications of a submersion of the dry ground in water, much later than the formation of the mountains and valleys, and affecting the condition of the globe much more superficially. Caves, for example, have been found in countries the most distant from one another, in Europe and in New Holland, containing large quantities of bones of animals, mixed with earth or gravel, and in many cases, covered with a substance called stalagmite. In many cases, the bones belong to species of animals, that no longer exist in the countries in which they are found. Bones of elephants, hyænas, rhinoceroses, &c. have been found in Britain, and in many parts of Europe.

It seems now to be generally admitted by scientific men, that there are means of ascertaining at what distance of time a deluge covered the earth, and that the calculations founded upon them point uniformly to the time marked in the Scriptures. The following passage is from Baron Cuvier :—

"Thus, while the traditions of all nations have preserved the remembrance of a great catastrophe, the *deluge*, which changed the earth's surface, and destroyed nearly the whole of the human species, geology apprizes us, that of the various revolutions, which have agitated our globe, the last evidently corresponds to the period, which is assigned to the deluge.

"We say that, by means of geological considerations alone, it is possible to determine the date of this great event with some degree of precision.

"There are certain formations, which must have commenced immediately after the last catastrophe, and which, from that period, have been continued up to the present day with great regularity. Such are the deposits of detritus observed at the mouths of rivers, the masses of rubbish which exist at the foot of mountains, and are formed of the fragments, that fall from their summits and sides. These deposits receive a yearly increase, which it is possible to measure. Nothing, therefore, is more easy, than to calculate the time, which it has taken them to acquire their present dimensions. This calculation has been made with reference to the debris of mountains; and, in all cases, has indicated a period of about four thousand years. The same result has been obtained from the other alluvial deposits. In short, whatever has been the natural phenomenon, that has been interrogated, it has always been found to give evidence in accordance with that of tradition. The traditions themselves exhibit the most astonishing conformity. The Hebrew text of Genesis places the deluge in the year 2349 before Christ. The Indians make the fourth age of the world, that in which we now live, to commence in the year 3012. The Chinese place it about the year 2384. Confucius, in fact, represents the first King Yeo as occupied in drawing off the waters of the ocean, which had risen to the tops of the mountains, and in repairing the damage which they had occasioned."—CARLILE *on the Divine Origin of the Holy Scriptures.*

I.—MINERAL KINGDOM.

There is, perhaps, no portion of the earth's surface, of the same extent, which contains so great a variety of those mineral substances which minister to the necessities and comforts of life, as the island of Great Britain; and it would almost seem, from its internal structure, as if Providence had pre-ordained that it should be the seat of an opulent and powerful people, and one of his chief instruments for the civilization and advancement of the human race. That this is no extravagant, overstrained expression of national vanity, may, we think, be very easily made apparent, by a few reflections on the vast advantages, which the British empire itself, and, through it, the civilized world, have derived, from the circumstance of our possessing an abundance of one particular mineral under the surface of our soil. The almost inexhaustible mines of COAL, which are found in so many different parts of our island, have unquestionably been one of the chief sources of our wealth, and of our influence among the other nations of Europe. All our great manufacturing towns,—Birmingham, Leeds, Sheffield, Manchester, Glasgow, Paisley, are not only situated in the immediate vicinity of coal, but never would have existed without it. If we had had no coal, we should have lost the greater part of the wealth we derive from our metallic ores; for they could neither have been drawn from the depths, where they lie concealed, nor, if found near the surface, could they have been profitably refined. Without coal, the steam-engine would probably have remained among the apparatus of the natural philosopher. Not only did the fuel supply the means of working the machine, but the demand for artificial power, in order to raise that same fuel from the bowels of the earth, more immediately led to the practical application of the great discovery made by Watt, while repairing the philosophical instrument of Dr. Black. Before the invention of the steam-engine, the power required to move machinery was confined to the impelling force of running water, of wind, of animal and human strength,—all too weak, unsteady, irregular, and costly, to admit of the possibility of their extensive application. But the steam-engine gave a giant power to the human race, capable of being applied to every purpose, and in every situation where fuel can be found. Thus, manufactures arose, and from the cheapness with which labour could be commanded, and the prodigious increase of work done in the same space of time, their produce was so reduced in price, as to bring luxuries and comforts within the reach of thousands, who never tasted them before. New tastes thus excited, and increasing consumption, multiplied manufacturing establishments; and *their* demands led to great manufactures of machinery; competition led to improvement in the steam-engine itself, and thus, by the reciprocal action of improvement and demand, our machinery and manu factures gradually acquired that high degree of perfection, to which they are now arrived. With the improvement of the steam-engine, came the wonderful application of it to navigation, which has already, in a few years, produced such extraordinary results; and which, when combined with its farther application to wheel carriages, must, at no great distance of time, occasion a revolution in the whole state of society.

Next to coal, our IRON is the most important of our mineral treasures; and it is a remarkable circumstance, that the ore of that metal, which is so essential to the wants of man, that civilization has never been known to exist without it, should in Great Britain be placed in greatest abundance, not only in the vicinity of, but actually associated with, the coal necessary to separate the metal from the impurities of the ore, so as to render it fit for use. In Sweden, and most other countries, where iron mines exist, the ore is refined by means of wood; but no space on the surface of our island could have been spared to grow timber for such a purpose; and thus, without coal, in place of being, as we are now, great exporters of wrought and unwrought iron to distant nations, we must have depended on other countries for this metal; to the vast detriment of many of our manufactures, which mainly owe their improvement and extension to the abundance and consequent cheapness of iron.

There are extensive mines of LEAD in Derbyshire, Yorkshire, Northumberland, Lanarkshire, Dumfriesshire, and several other places in Great Britain, sufficient not only for the internal demand for that metal, but yielding a considerable amount for exportation. COPPER is produced in large quantities in Cornwall; and the same county has been celebrated for its TIN mines, for nearly two thousand years.

Coal, iron, lead, copper, and tin, are the principal minerals of our country, which, in common language, are usually associated with the idea of the produce of mines. Silver and Gold we have none, with the exception of a little of the former contained in some of the ores of lead, which is separated by refining, when in sufficient quantity to yield a profit, beyond the expense of the process; but we have some other metals, highly useful in the arts, such as zinc, antimony, and manganese.

Besides the substances above mentioned, we have many other mineral treasures of great importance still to be noticed. Of these the most valuable, perhaps, is limestone, from its use in agriculture, to meliorate the soil and increase its fertility, and from its being an indispensable ingredient in mortar for building; and there are not many parts of the island far distant from a supply of this material. Building stone is found in most parts of the country; and although we must go to Italy for the material for the art of sculpture to be employed upon, we have free-stones applicable to all the purposes of ornamental architecture, and we have many marbles of great beauty. If stones be far off, clay is never wanting to supply a substitute; and the most distant nations have their daily food served up in vessels, the materials of which, dug from our clay-pits, have given occupation to thousands of our industrious population, in our potteries and china manufactures. For our supply of SALT, that essential part of the daily sustenance of almost every human being, we are not dependent on the brine which encircles our island; for we have, in the mines and salt-springs of Cheshire and Worcestershire, almost inexhaustible stores of the purest quality, unmixed with those earthy and other ingredients, which must be separated by an expensive process, before a culinary salt can be obtained from the water of the sea.

Familiar as is almost every one of the mineral substances we have named, in the common business of life, there are many persons who have but a very imperfect idea whence they are derived, and what previous processes they undergo, before they can be made applicable to our use. In the formation of organized bodies, that is, in the structure of animals and plants, the most superficial observer cannot fail to discover a beautiful and refined mechanism; but if we cast our eyes upon the ground, and look at heaps of gravel, sand, clay and stone, it seems as if chance only had brought them together, and that neither symmetry nor order can be discovered in their nature. But a closer examination soon convinces us of that, which reasoning from the wisdom and design manifested by other parts of creation, we might beforehand have very naturally been led to expect, viz. that in all the varieties of form, and structure, and change, which the study of the mineral kingdom displays, laws as fixed and immutable prevail, as in the most complicated mechanism of the human frame, or in the motions of the heavenly bodies: and if astronomy has discovered how beautifully "the heavens declare the glory of God," as certainly do we feel assured by the investigations of geology, that the earth "showeth his handy work."—*Penny Magazine.*

II.—MINERAL KINGDOM.

The land rises from the surface of the sea in the form of islands, and of great continuous masses called continents, without any regularity of outline, either where it comes in contact with the water, or in vertical elevation, its surface being diversified by plains, valleys, hills, and mountains, which sometimes rise to the height of twenty-six thousand feet above the level of the sea. Numerous soundings in different parts of the world have shown, that the bottom of the ocean is as diversified by inequalities as the surface of the land; a great part of it is unfathomable to us, and the islands and continents, which rise above its surface, are the summits of mountains, the intervening valleys lying in the deepest abysses.

Different climates produce different races of animals, and different families of plants; but the mineral kingdom, as far as the nature of stone is concerned, is independent of the influence of climate, the same rocks being found in the polar and in the equatorial regions.

Although there is considerable diversity in the structure of the earth, it is not in any degree connected with particular zones, as far as relates to circumstances, which are external to it; nor can we say, that the wonderful action which burning mountains tell us is going on in its interior, is confined to any part of the sphere, for the volcanic fires of Iceland burn as fiercely as those that burst forth under the line. From all the observations hitherto made, there is no reason to suppose, that any unexplored country contains mineral bodies, with which we are not already acquainted; and although we cannot say beforehand of what rocks an unexamined land is likely to be composed, it is extremely improbable, that any extensive series of rocks should be found, constituting a class different from any which have been already met with in other parts of the globe.

When we dig through the vegetable soil, we usually come to clay, sand, or gravel, or to a mixture of these unconsolidated materials; and, in some countries, we shall probably find nothing else, at the greatest depths to which we are able to penetrate. But in most places, after getting through the clay and gravel, we should come upon a hard stone, lying in layers or beds parallel to each other, either of one kind, or of different kinds, according to the depth. This stone would vary in different countries, and in different places in the same country, as well in its constituent parts, as in the thickness, alternation, and position of its beds or layers. It has been ascertained by the observations of geologists, in various parts of the world, that the crust of the earth is composed of a series of such layers, distinguishable from each other by very marked characters in their internal structure. The elements, of which they are composed, are not very numerous, being for the most part the hard substance called quartz by mineralogists, of which gun-flints may be cited as a familiar example, these being wholly composed of it, and the well-known substances, clay and limestone, but these elements are aggregated or mixed up together in so many proportions and forms, as to produce a considerable variety of rocks. Besides this elementary composition, or what may be termed their *simple* structure, the greatest proportion of the rocks, that are so arranged in layers, contain foreign bodies, such as fragments of other rocks, shells, bones of land and amphibious animals, and of fishes, and portions of trees and plants. It has further been found, that these different layers or *strata* lie upon each other in a certain determinate order, *which is never, in any degree, inverted.* Suppose the series of strata to be represented by the letters of the alphabet, A being the stratum nearest the surface, and Z the lowest: A is never found *below* Z, nor under any other of the intervening letters; nor is Z ever found *above* any of the letters that stand before it in the alphabet; and so it is with all the strata represented by the other letters. It must not, however, be imagined, although this regularity *in the order* of superposition exists, that all the different members of the series always occur together; on the contrary, there is no instance where they have all been found in one place. It possibly may happen, that where C is found in a horizontal position, by going deeper all the rest would follow in succession; but this we can never know, as the thickness would be infinitely beyond our means of penetrating: and there are reasons, which render the existence of such an uninterrupted series extremely improbable. It very seldom happens, that more than three or four members of the series can be seen together;—we say *of the series*, because each member is composed of an almost infinite number of subordinate layers. This order of succession, established by geologists, has been determined by the combination of many observations made in different countries at distant points. The order of three or four members was ascertained in one place; the *upper* stratum in that place was found to be the lowest member of a second series in another place, and the *lowest* stratum at the first station was observed to be the uppermost at a third point; and, in like manner, the order of superposition was discovered throughout the whole range. Neither is it to be supposed that the strata, which lie next each other, are always so in nature; as, for instance, that, wherever G is found associated with another member, it is always either with F above it, or H below it: it very often happens that F lies upon H, G being altogether absent; and C may even be seen lying on R, the whole of the intervening members of the series being wanting Very frequently one of the lowest members of the series appears at the surface. Every one may have seen sometimes chalk, sometimes slate, lying immediately beneath the vegetable soil, or even at the surface without that scanty covering. But if a lower member of the series be seen at the surface, however deep we might go, we should never find any one of those rocks, that belong to the higher members of that series. The immense practical advantage of this knowledge of the determined order of succession will be seen at once; for if O were found to occupy the surface of the country, it would be at once known, that all search for coal in that spot would be fruitless. *Ibid.*

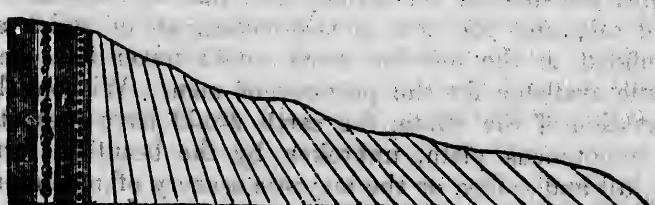
III.--MINERAL KINGDOM.

The means, by which geologists have been enabled to fix the order of superposition in the strata composing the crust of the globe, have been partly the mineral composition of each member of the series, partly their containing fragments of other rocks, but chiefly the remains of animals and plants, that are imbedded in them. They observed, that there was a class of rocks distinguished by a considerable degree of hardness, by closeness of texture, by their arrangement in slaty beds, and by possessing, when in thick masses, a glistening structure, called by mineralogists crystalline, of which statuary marble or loaf sugar may be quoted as familiar examples; and these were, even when associated with rocks of another sort, always lowest.—Above, and in contact with them, another group of strata was ob served, which, in mineral composition, had a good deal of resemblance to those below them, but contained rounded fragments of other rocks: and, when these fragments were examined, they were found to be identical with the rocks composing the lower strata. This second series was observed to be covered by another group of strata, which contained shells and corals, bodies that had never been seen in any of the lower strata. Thus it was clear, as the including substance must necessarily be formed subsequently to the pebble or shell it contains, that, previous to the formation of this third group, there had existed rocks to supply the imbedded fragments, and to contain the waters of the ocean, in which the animals that once inhabited the shells must have lived. Ascending still higher, that is, observing the strata as they lay one above another towards the surface, it was found that many were entirely composed of the fragments of pre-existing rocks, either in the form of pebbles, or of sand cemented together: that there was a vast increase in the number and variety of the imbedded shells, the latter forming very often entire beds of rock, many feet in thickness; and that the remains of plants began to appear.

In this manner certain great divisions of the strata were established, by very clear and infallible distinctive characters. But it was reserved for an English practical mineral surveyor to make a discovery, which gave a new direction to geological inquiries, and which, in the course of a few years, introduced into the science a degree of precision and certainty, that was formerly unknown. About thirty-five years ago, Mr. William Smith, of Churchill in Oxfordshire, by an extensive series of observations in different parts of England, ascertained that particular strata were characterized by the presence of certain fossil or petrified shells, which were either confined to them exclusively, or in predominating quantity, or were of rare occurrence in other strata: and he was thus enabled to identify two rocks at distant points as belonging to one stratum, when mere mineral characters would either have left him in uncertainty, or have entirely failed in deciding the question. When this discovery became known to geologists, numerous observations were made in other countries, which completely proved, that the principle was not only applicable in those places, which Mr. Smith had had an opportunity of observing, but that it held good generally, and throughout the whole series of strata, from the lowest, in which organic remains are found, to those nearest the surface. Under the direction of this guide, geologists have been enabled to discover lines of separation in the great divisions, which, as already mentioned, had been established by prior observations, pointing out distinct epochs of deposition, and revealing a succession of changes in the organic and inorganic creation, in a determinate chronological order. This more accurate knowledge of the structure of the crust of the globe is of the highest interest and importance; not only as a matter of speculative science, but as regards the practical advantages in common life, that have been derived from it.

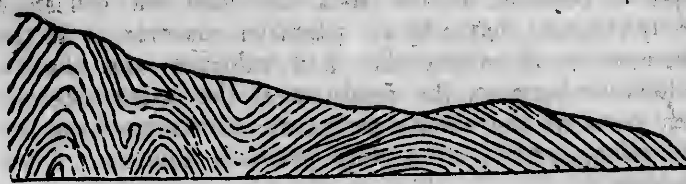
An examination of the phenomena, exhibited by the internal structure of this series of superimposed rocks, has established this farther principle—that all the strata must have been deposited on a level foundation—that is, on pre-existing ground, that was either horizontal or nearly so, at the bottom of a fluid holding their materials either in suspension, or in solution, or partly both. Now, as we know of no fluid in which this could have taken place except water, geologists have come to the conclusion, that the chief part of all the strata, however elevated they may now be above the level of the sea, were gradually deposited at the bottom of the ocean; and the remainder of them at the bottom of inland seas, or lakes. But if this be so, what mighty revolutions must have taken place to cause rocks, formed in the depths of the ocean, to occupy the summits of the highest mountains! By what known agency can so extraordinary a change of position have been effected? That the fact of elevation is indisputable, is proved by the shells imbedded in stratified rocks at the greatest elevations; and geologists, who have endeavoured to discover by what cause this change in the relative position of the rock and the sea has been brought about, have, by an attentive observation of the phenomena of earthquakes and volcanos, and the resemblance between the products of the latter and certain parts of the earth's structure, which we have yet to notice, arrived at a very probable solution of the problem.

Although the strata were originally deposited in a horizontal position, and are often found so, especially as regards the inferior members of the series, they are not uniformly so, but are frequently inclined, more or less; and they have been seen, not only at every angle of inclination, but very often in a vertical position. When a vertical section of a mountain is exposed, as is often the case in valleys or the deep bed of a river, such an appearance as that represented here is not un-



(*a*) (*b*)

common; and if the stratum *a* be composed of rounded blocks of stone surrounded by fine sand or clay, and if the stratum *b* contain a layer of shells lying parallel to the sides of the stratum, and if they be unbroken although of the most delicate texture, it is manifest, that these strata could not have been deposited in their present vertical position, but upon a level ground. Sometimes they are not only disturbed from their horizontality, but are bent and contorted in the most extraordinary way, as if they had been acted upon by some powerful force while they were yet in a soft flexible state. This appearance, very common in the slate rocks of the north coast of Devon, is shown in the diagram.



This seeming disorder and confusion is evidently a part of the order and harmony of the universe, a proof of design in the structure of the globe, and one of the progressive steps, by which the earth seems to have been prepared as a fit habitation for man. For if all the strata had remained horizontal, that is, parallel to the surface of the globe, if they had enveloped it like a shell, or to use a familiar example, had they surrounded it like the coats of an onion, it is clear that we should never have become acquainted with any other than the upper members of the series; and that the beds of coal and salt, and the ores of the metals, all of which are confined to the inferior strata, could never have been made available for the purposes of man. Without this elevation of the strata, the earth would have presented a monotonous plain, unbroken by the beautiful forms of hill and valley, or the majestic scenery of mountains. With these inequalities of the surface are intimately connected all the varieties of climates, and the diversified products of animal and vegetable life dependent thereon; as well as the whole of what may be termed the aqueous machinery of the land—the fertilizing and refreshing rains, the sources of springs, inland lakes, and the courses of rivers and brooks in their endless ramifications. Throughout all this there reigns such a harmony of purpose, that the conclusion is irresistible, that the breaking up of the earth's crust is not an irregular disturbance, but a work of design, in perfect accordance with the whole economy of nature.

We have said, that if we dig through the superficial covering of sand and clay, we usually come upon stone disposed in layers; but there are many places, where we should find a rock without any such arrangement, which would continue of the same uniform texture, and without any parallel rents dividing it into beds, however deeply we might penetrate into it. Such *unstratified rocks*, although of limited extent in proportion to the *stratified rocks*, constitute a considerable portion of the crust of the earth, and in all parts of it they generally rise above the surface in huge unshapen masses, surrounded by the stratified rocks; and sometimes they occupy districts of great extent, where none of the latter rocks can be seen. In mineral composition they are essentially different from the other class; never consisting of limestone, or sandstone, or clay, and never containing rounded pebbles, shells, or the remains of any other kind of organized matter. Their elementary constituent parts are simple mineral substances, which, although sometimes found in the stratified rocks, are always, in the rocks we now speak of, in different combinations: they are always in that particular state called crystalline; and when the parts are large enough to be distinguished, they are seen to interlace each other, and by this arrangement they form a very hard tough stone, very difficult to break into regular squared forms, or to work with the chisel, and they are very often capable of receiving a high polish. The substances most familiar to us in common life, which belong to this class of rocks, are granite, whinstone, and basalt. *Ibid.*

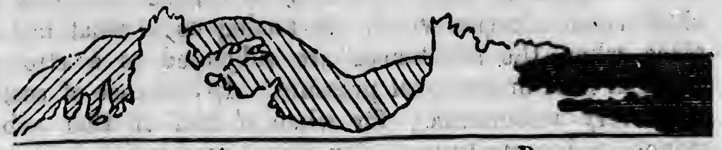
IV.—MINERAL KINGDOM.

We have shown, that the crust of the globe is composed of two great classes of rocks, one of which consists of a series of beds of stone of different kinds, lying upon one another in a certain determinate order of succession, called the *Stratified Rocks*, or the

Strata; the other of a class of stones distinguishable from the strata by peculiar mineral composition, by never containing pebbles or the remains of animals and plants, and by never being arranged in parallel layers, from which last character they have been denominated the *Unstratified Rocks*. We shall now proceed to show in what manner these two classes of rocks are associated together. It is quite evident, that the mode of formation of the two must have been totally different While the strata, by their parallel arrangement, by the pebbles of pre-existing rocks, and by the remains of living bodies which they contain, demonstrate that they must have been formed under water, by deposition *from* the surface downwards,—the whole characters of the unstratified rocks equally prove, that they must have come *to* the surface from the interior of the earth, *after* the deposition of the strata; that is, that they have been ejected among the strata from below in a melted condition, either fluid or in a soft yielding state. Geologists have come to this conclusion, from a careful examination and comparison of the unstratified rocks with the products of existing volcanos, or those burning mountains, that have thrown out streams of melted stone or lava, both in past ages, as recorded in history, and in our own time. By this comparison they have discovered a great similarity, often an identity, of composition, between the unstratified rocks and lava, and the closest analogy in the phenomena exhibited by the masses of both kinds, and in their relations to the stratified rocks, with which they come in contact.

In every case the unstratified rocks lie under the stratified. This order has never been reversed, except in cases, which have been afterwards discovered to be deceptive appearances, and where they have been protruded between strata. But it may be said, that this fact of inferiority of position is no proof of ejection from below, far less of posteriority of formation: for they might have been the foundation on which the strata are deposited. But their eruption from the interior, and that that eruption took place after the strata were formed, are proved by other evidence, as we shall presently show.

A section of the crust of the earth, where the stratified and unstratified rocks have been found associated together, has often exhibited the appearance represented by the diagram.



A and B are mountains of granite or of whinstone, with strata of limestone lying upon it. From A branches or shoots connected with the principal mass are seen to penetrate into the superincumbent strata; and in the mountain B, the granite overlies the limestone for a considerable way near the top, as if it had flowed over at that place, and lower down it has forced its way between two strata, ending like a wedge. Now, as the penetrating substance must necessarily be of subsequent formation to the body that it penetrates, it is evident, that the granite must have been formed after the limestone, although the latter rests upon it. But if any doubt remained, it would be removed by the additional fact, that the granite veins in the mountain A, contain augular fragments of limestone, identical with the strata above; and the fractured ends are seen to fit the places of the continuous stratum, from which they have been broken off.

The posteriority of the formation of the unstratified rocks to the strata is thus made evident from their relative positions; their forcible ejection from below is equally proved by the penetration of their veins or shoots into the superincumbent strata in an upward direction, often with the most slender ramifications to a great distance, and by the portions broken from the strata and enveloped in the substance of the vein. That they were ejected in a soft melted state, produced by the action of heat, is shown by the close resemblance, in mineral composition, of the unstratified rocks to the products of existing volcanos, and by remarkable changes often observed to have taken place in the strata, where they come in contact with granite and whinstone. Soft chalk is converted into a hard crystalline limestone like statuary marble; clay and sandstone are changed into a substance as hard and compact as flint, and coal is turned into *coke;* all of them changes which are analogous to what takes place, when the substances are subjected to a strong artificial heat under great pressure. In the case of coal, it is very remarkable; for when a bed of that substance, and a stratum of clay lying next to it, come in contact with whinstone, the tar of the coal is often driven into the clay, and the coal loses all property of giving flame, although, at a distance from the whinstone, it is of a rich caking quality.

We have shown, that we are enabled to fix a chronological order of succession of the strata with a considerable degree of precision; and although we have not the same accurate means of determining the relative ages of the unstratified rocks, there are yet very decisive proofs, that certain classes of them are older than others, that different members of the same class have been ejected at distinct periods, and that the same substances have been thrown up at different times far distant from each other. Granite, in veins, has never been seen to penetrate beyond the lower strata; but whinstone and the lavas of existing volcanos protrude in masses, and send out veins through all the strata: veins of one sort of granite traverse masses of another kind, and whinstone and basalt veins are not only found crossing masses and other veins of similar rocks, but even of granite. Upon the principle, therefore, before stated, that the penetrating substance must necessarily have been formed subsequently to the body penetrated, the above phenomena demonstrate successive formations or eruptions of the unstratified rocks.

As the highly elevated, broken, and contorted positions of the strata are only explicable on the supposition of a powerful force acting upon them from below, and as they are seen so elevated and contorted in the neighbourhood of the unstratified rocks, it is a very legitimate inference, that the mountain chains and other inequalities on the earth's surface have been occasioned by the horizontally deposited strata having been heaved up by the eruption of these rocks, although the latter may not always appear, but be only occasionally protruded to the surface, through the rents produced by the eruptive force. The phenomena of earthquakes are connected with the same internal action, and these have often been accompanied by permanent elevations of entire portions of a country. This theory of the elevation of mountains by a force acting from the interior of the earth is not a mere inference from appearances presented by rocks, but is supported by numerous events, which have occurred repeatedly within the period of history down to our own time. In the middle of a gulf in the island of Santorino, in the Grecian Archipelago, an island rose from the sea 144 years before the Christian era; in 1427, it was raised in height, and increased in dimensions; in 1573, another island arose in the same gulf; and in 1707, a third. These islands are composed of hard rock; and in that last formed, there are beds of limestone and of other rocks containing shells. In the year 1822, Chili was visited by a violent earthquake, which raised the whole line of coast, for the distance of above one hundred miles, to the height of three or four feet above its former level. Valparaiso is situated about the middle of the tract thus permanently elevated. A portion of Cutch, near the mouth of the Indus, underwent a similar revolution in the year 1819, when a district, nearly sixty miles in length by sixteen in breadth, was raised by an earthquake about ten feet above its original level. A volcanic eruption burst out in an adjoining part of India at Bhooi, at the exact period when the shocks of this earthquake terminated. These cases must not be confounded with the production of new mountains, such as that of Jorullo, in Mexico, in the year 1759, which was raised to the height of 1600 feet above the table land of Malpais by eruptions of scoriæ and the outpouring of lava. The appearance of a new island off the coast of Sicily, in the year 1831, is another phenomenon of the latter class. It rose from a part of the sea, which was known by soundings a few years before to have been 600 feet deep, to the height of 107 feet above the water, and formed a circumference of nearly two-thirds of a mile. It was composed of loose cinders, and the part that rose above the level of the sea, was washed away in the winter of the same year; but an extensive shoal remains.

It must not be supposed, that these internal movements only took place after the whole series of strata had been deposited. There must have been long intervals between the termination of the deposition of one member of the series and the commencement of that of the stratum immediately above it; and internal movements, accompanied with disturbance of the already deposited strata, after they had come to consolidate into stone, appear to have taken place during the whole period, that the strata, from the lowest to the uppermost in the series, were deposited. The clearest evidence of this is afforded by certain appearances exhibited by the strata, in all parts of the globe, that have yet been examined. The diagram that follows represents a case of very common occurrence, and will explain our meaning. It must be borne in mind, that it is an acknowledged principle in geology, that all stratified rocks, in whatever position they are now found, must have been originally deposited horizontally.

There are here five different series of strata, *a*, *b*, *c*, *d*, *e*. Now, it is evident that the series *a* must have been first disturbed; that after its change of position, the series *b* and *c* were deposited, covering *the ends* of the strata of the series *a*. But *c* appears to have been acted upon by two forces at distant points, when thrown out of its horizontal position; for the strata dip in opposite directions, forming a basin-shaped cavity, in which the series *d* was deposited. In like manner, after the disturbance of *c*, the series *e* was deposited, covering the ends of *c*; but the internal force, which raised the beds *e* from the depths of the sea to the summit of the mountain where they are now seen, appears to have acted in such a direction, as to have carried up the whole mass without disturbing the original horizontality of the structure. It is obvious, that all the interior strata must have partaken of this last disturbance. There are, besides, numerous proofs, that there have been not only frequent elevations of the strata, but also depressions; that the same strata, which had been at one time raised above the surface of the sea, had again sunk down, preserving an inclined position; that they had formed the ground, upon which new sediment was deposited, and had again been raised up, carrying along with them the more recently formed strata. *Ibid.*

V.—MINERAL KINGDOM.

The subjects, which it is the province of the geologist to investigate, are by no means confined to questions concerning mineral substances, but embrace a wider field, involving many considerations intimately connected with the history of several tribes of animals and plants. It is not possible to give even a brief outline of the doctrines of geology without referring to the great orders and classes, into which naturalists have divided the animal kingdom. It will be necessary, therefore, before proceeding to describe the divisions of the stratified rocks, which geologists have established, and which are founded mainly upon the distinctive characters afforded by the remains of organized bodies contained in the different strata, to say a few words upon the classification of animals, in order to render the terms we must employ more intelligible to those who are unacquainted with the subject.

Animals are divided into four great branches, distinguished by the terms *Vertebrated*, *Molluscous*, *Articulated*, and *Radiated*. The FIRST DIVISION includes all those animals which are provided with a backbone; and because the similar bones, or joints, of which it is composed, are called by anatomists *vertebræ*, (from a Latin word signifying *to turn*,) the individuals that belong to this division are called *Vertebrated Animals*. It is subdivided into four classes, 1. *Mammalia*, comprehending man, land quadrupeds, and the whale tribe; that is, all animals which give suck to their young; the term being derived from *mamma*, the Latin name of that part of the body, from which the milk is drawn. 2. *Birds* of all kinds. 3. All those animals called *Reptiles* by naturalists: the word means nothing more than that they creep, but it has in common language a far more extended sense than that to which it is restricted in natural history. Frogs, serpents, lizards, crocodiles, alligators, tortoises, and turtles, are reptiles, in the sense of the word as used by naturalists. 4. *Fishes*, of all kinds, except the whale tribe, which belongs to the class *mammalia*.

The SECOND DIVISION includes tribes of animals, which have no bones; and because their bodies contain no hard parts, they are called *Molluscous Animals*, from a Latin word signifying soft. But with a few exceptions, they have all a hard covering, or shell, to which they are either attached, or in which they can inclose themselves, and be preserved from injuries, to which, from their soft nature, they would otherwise be constantly exposed. There are six classes in this division, founded on certain peculiarities of anatomical structure in the animal, but these we shall not notice; for, without a much longer description than we can enter upon, it would be a useless enumeration of hard names. It will answer our present purpose much better to say, that the animals belonging to this division may be classified according to differences in the forms of their hard covering or shells, for it is the hard parts of animals which furnish the records of their former existence; those only are preserved imbedded in the strata, all traces of the flesh or other soft parts, as far as form is concerned, having entirely disappeared. MOLLUSCOUS *Animals*, therefore, are divisible into, 1. *Univalves*, that is, animals armed with a shell or valve forming one continuous piece, such as snales and whelks. 2. *Bivalves*, or those having two shells united by a hinge, such as oysters, cockles, &c. 3. *Multivalves*, or those having more than two shells, of which the common barnacle is an example.

The THIRD DIVISION is assigned to what are called *Articulated Animals*, these having a peculiar anatomical structure, called articulations, from *articulus*, Latin for a little joint. It is subdivided into four classes; 1. *Annelides*, or those having a ringed structure, from *annulus*, Latin for ring: leeches and earth-worms are examples. 2. *Crustacea*, or those, which have their soft bodies and limbs protected by a hard coating or *crust*, which in common language we also call shell, such as lobsters, crabs, and prawns. 3. *Spiders*, which form a class by themselves. 4. *Insects*, such as flies, beetles, bees, and butterflies.

The FOURTH DIVISION comprehends a great variety of animals, which have an anatomical structure like an assemblage of rays diverging from a common point, and from which they are called *Radiated Animals*, *radius* being Latin for ray. It contains five classes, but as three of these are animals without hard parts, we may pass them over: of the remaining two, the one contains the *echini* or sea urchins; the other, the very numerous tribe called zoöphites, from two Greek words signifying animal and plant, because the animal is fixed to the ground, and builds its strong habitation in the form of a shrub, or branch, or leafy plant. Corals and sponges belong to this class; and among all the different animal remains, that are found in the strata, there is no class, which bears any proportion, in point either of frequency of occurrence, or in quantity, to this last.

The great divisions of animals, so far as the remains of species found in the strata are concerned, or, as it is termed, in a *fossil* state, are therefore briefly these:—

I. Vertebrated Animals; *Classes*—Mammalia, Birds, Reptiles, Fishes.

II. Molluscous Animals; *Classes*—Univalve, Bivalve, Multivalve Shells.

III. Articulated Animals; *Classes*—Crustacea, Insects.

IV. Radiated Animals; *Classes*—Echini, Zoöphites.

Each class is farther divisible into several *families*: each family into several *genera*; each genus into several *species*, according as greater or minor points of resemblance and difference bring individuals near to each other. There are certain other great distinctions, which it is necessary to mention, viz. that some animals eat animal food, the *Carnivorous*; others vegetable food, the *Graminivorous*; some can live both in the air and in water, the *Amphibious*. Among fishes, molluscæ, and crustacea, some live in the sea, some in fresh water, some in both; and of those inhabiting fresh water, some are peculiar to rivers, others to lakes. There are also land-shells, such as the common garden-snail. It is scarcely necessary to remind our readers, that certain species are peculiar to particular regions of the earth, being adapted by their nature to the different temperature and other peculiarities, that exist in different countries.

The number of distinguishable genera and species of fossil plants bears but a small proportion to that of fossil animal remains.

The lowest members in the order, in which the stratified rocks are placed one above another, are distinguished by the great predominance of hard slaty rocks, having a crystalline or compact texture, but chiefly by this circumstance, that they have not been found to contain any fragments of *pre-existing* rocks, or the remains of organized bodies. On this account they have been called the PRIMARY STRATA, as if formed prior to the existence of animal life, and as containing no evidence of other rocks having existed before them. That we cannot now discover animal remains in these strata is, however, no proof that they had not previously existed, because we meet with rocks containing organic remains, which are so altered by the action of heat in those parts, where they happen to have come in contact with a mass of granite or whinstone, that all traces of the organic remains are obliterated, those parts of the rocks acquiring a crystalline character analogous to what prevails in the primary strata. These last may have contained the remains of animals; but being nearest to the action of volcanic heat, they may have been so changed as to obliterate the shells and corals, by their being melted, as it were, into the substance of the crystalline rock. The absence of the fragments of pre-existing rock is a less questionable ground of distinction. From whence the materials composing these primary strata were derived, is a question, that it is not very likely any geological researches will enable us to solve; that they were in a state of minute division, were suspended in, and gradually deposited from, a fluid in a horizontal arrangement, and that they were subsequently elevated, broken, and contorted by some powerful force, prior to the deposition of the strata that lie over them, is beyond all doubt. There may also be beds of rock of great thickness, in which neither fragment nor organic remain has been found throughout a great extent of country, which nevertheless may not be primary; for if in any part of the same mass a single pebble or a single shell should afterwards be discovered, indubitably imbedded in it, one such occurrence would be as conclusive as a thousand, that a prior state of things had existed. It follows, therefore, that until the whole of an extensive district of such rocks were carefully examined, we could never be sure, that they might not one day be discovered to be of secondary origin; there is nothing in the *mineral* structure of any one stratified rock, that entitles us absolutely to say, that other rocks and living bodies could not have existed prior to its formation. But as there are large tracts of country occupied by strata, in which neither fragments of pre-existing rocks nor organic remains have yet been discovered, geologists are justified in designating them the *primary* strata; to call them *primitive*, as they used to be, and indeed still are called by some geologists, is to employ a term, which expresses much more than we are entitled to assert.

The unstratified rock, most usually associated with the primary strata, is granite, of different varieties of composition, usually lying under them in great masses, and bursting through, forming lofty pinnacles, as in the Alps, and sometimes sending forth shoots or veins, which penetrate the superincumbent strata in all directions.

Immediately above the primary strata there commences another series, very like many of the rocks below them, in respect of mineral composition, but containing the remains of shells, and some pebbles, and interstratified with thick beds of limestone, including shells and corals. These rocks are penetrated also by granite, and, in common with the primary strata, form the great depository of the metallic ores. They are, for want of a better term by which the class can be distinguished, usually called the *transition* strata, a name given by the elder geologists, because they were supposed to form a step or transition from the primitive state of the globe to the condition in which it began to be inhabited by living bodies; in strictness, they form the lowest members of the next great division of the strata, which is distinguished by the name of *the Secondary Rocks.* These will be treated of in our next section.—*Ibid.*

VI.—MINERAL KINGDOM.

The SECONDARY ROCKS comprehend a great variety of different beds of stone, extending from the primary strata to the chalk, which forms the upper or most recent member of the division.

These rocks consist of an extensive series of strata, of limestones, sandstones, and clays, all of which contain either rounded fragments of pre-existing rocks, or organic remains, or both; and each group, and all the subordinate members of the groups, are distinguishable by characters of great constancy and certainty, derived from the peculiar nature of the included fossils. They must all have been deposited in a horizontal position; but there are parts of them, which have undergone greater or less disturbance, being often thrown into a vertical position, and broken, twisted, and disturbed in the most extraordinary manner. Many of the disturbances of the lower groups took place prior to the deposition of the upper; for the latter are found lying in unconformable stratification on the ends of the former, as represented in the diagram, in page 52. They are traversed by veins, or dykes, as they are often termed, of whinstone and other unstratified rocks; and there is usually great disturbance of the strata, when these occur. The dykes are often of great magnitude, and the rock is frequently thrust in huge wedge-shaped masses, of miles in superficial dimensions and some hundred feet thick, between the regular strata. After the deposit of the secondary rocks, a remarkable change took place; for all the strata that lie above the chalk, have a totally different character from that rock, and all below it.

These have been classed together in one great division, and have been designated the TERTIARY ROCKS. Thus the whole series of strata, of which the crust of the globe is composed, is divided into the *Primary*, the *Secondary*, and the *Tertiary*. It is evident that, at the time the secondary rocks were deposited, a great part of the present continent of Europe must have been considerably lower than the present level of the sea; that when the oldest or lowest members of the series were forming, the summits of the mountain ridges of primary rocks rose as islands of different magnitudes from the bosom of the deep; that at several successive periods these islands were more elevated, and attained consequently a greater superficial extent, the newer formed strata occupying the lower levels. In the progress of this series of changes of the surface of the globe, when there were evidently occasional depressions of the land as well as elevations, there appear to have been formed basin-shaped cavities or troughs, not entirely cut off from communication with the sea, and vast estuaries, in which the tertiary strata were deposited. While the secondary strata stretch continuously for hundreds of leagues, the tertiary are found only in detached insulated spots of comparatively limited extent. In this state of the earth's surface there must have been vast inland fresh-water lakes; for we find regularly stratified deposits of great thickness full of organic remains, which exclusively belong to animals, that lived in fresh water, and to terrestrial animals and plants. Like the secondary, the tertiary rocks consist of a great variety of strata of limestones, sandstones, clays, and sands which have distinct characters, and have been united in several groups. In them we first discover the remains of land, quadrupeds, and birds; and bones of mammalia are most abundant in the beds nearest to the surface. Among all the various remains of animals and plants, that are found in the secondary rocks, from the chalk downwards, not one has been found, which is identical with any living species. Although they have characters agreeing with those, by which existing animals have been grouped together in the greater divisions of genera, families and classes; the living individuals of the same divisions have forms of structure distinct from any found in a fossil state in the secondary rocks.—But, with the tertiary strata, a new order of things commences; for, in the lowest of these, a small proportion,—about three and a half per cent. of the fossil shells cannot be distinguished from species that now exist: as we approach the higher beds the proportion always increases; and in the most recent stratum, it amounts to nine-tenths of the whole. It is not more than twenty-one years since the great division of the tertiary rocks was established. Prior to that time the peculiar characters, which separate them from the secondary strata, had been entirely overlooked,—a circumstance which marks very strongly that geology is the youngest of the sciences. The discovery was made by the celebrated Cuvier and his associate M. Brongniart, who found that the city of Paris was built in a hollow basin of chalk, that had been subsequently partially filled by vast deposits of clays, limestones, sands, and sandstones, and that there were alternations of beds, containing remains of fresh-water and terrestrial animals and plants, with others containing only the remains of marine animals.

The publication of the work of the French Naturalists led to a similar discovery in our own island, and singularly enough in the valley of the Thames; so that the capitals of France and England are both built upon these strata, so strangely neglected for so long a time, although occurring in the very spots, where the greatest numbers of scientific men are collected together in both countries. A series of tertiary strata was discovered by Mr. Webster in the Isle of Wight, having strong points of resemblance with that of the environs of Paris; and these, with some partial deposits on the coasts of Suffolk and Lancashire, constitute the whole of the tertiary rocks found in Great Britain. It was for some time supposed, that these newer strata, which were soon found not to be confined to the neighbourhood of Paris and London, extended like the secondary rocks over great tracts of country; and that there was such a degree of uniformity in their characters, that deposits widely distant from each other could be recognised as belonging to the same period in the chronological order of succession of the strata. Later observations, however, have shown, that, although possessing a general character of resemblance, they have been so much modified in their formation by local circumstances, that no two tertiary deposits, even of the same era, are alike. The discoveries of the last few years have led Geologists to establish distinct subordinate groups, as in the case of the secondary rocks; and the upper stratum of the Paris basin, which was at one time considered the most recent of stratified rocks, has been found to be inferior in the order of succession to many others, some thousand feet thick. *Ibid.*

VII.—MINERAL KINGDOM.

ORGANIC REMAINS.

We have already stated, that the stratified rocks contain the remains of animals and plants; and that beds of stone, situated many miles distant from each other, may be proved to belong to the same place, in the order of succession of the strata, by remains of organized bodies, or FOSSILS, of identical species, being found in the stone at both places. The word *Fossil*, which means anything that may be dug out of the earth, used to be applied to all minerals; but modern Geologists have conveniently restricted its application to organized bodies contained in the loose or solid beds composing the crust of the globe, and for the most part petrified; that is, converted into stone. Fossils are now always understood to be petrified remains of animals or plants, and we say, *fossil* shells, *fossil* bones, *fossil* trees, &c. We are enabled to make out, by the aid of those bodies, that a bed of limestone on the coast of Dorsetshire, another on the coast of Yorkshire, a third in the Western islands of Scotland, and a fourth in the interior of Germany, although differing perhaps in appearance, as far as the mere limestone is concerned, belong to the same age or period of formation in the chronological order of the strata.

Fossils reveal to us the important and wonderful fact that the Author of Nature had created different species of animals and plants, at successive and widely distant intervals of time, and that many of those, that existed in the earlier ages of our globe, had become totally extinct, before the creation of others in later periods: that, prior to man being called into existence, innumerable species of living beings had covered the surface of the earth, for a series of ages, to which we are unable, and probably shall ever remain unable, to fix any definite limits. We further learn, that a very large proportion of those creatures of the later periods, had become extinct, and had been replaced by the animals which now exist, before the creation of our first parents. When that great event took place, the crust of the earth had already undergone numerous changes, and we have already said, in alluding to those changes, that they appear to us to afford indisputable proofs of design; to be evidences most clear of the establishment of an order of things adapted to the predetermined nature of that more perfect creature, about to be sent as an inhabitant of the globe, to whom was to be given "dominion over the fish of the sea, and over the fowl of the air, and over the cattle, and over all the earth." We are also taught by the study of fossils, that, prior to the creation of man, there had existed a totally different condition of our planet, in so far as regards the distribution of land and water, from that which now exists; that where there are now vast continents, there must have been deep seas, and that extensive tracts of land must have occupied those parts of the globe, which are now covered by the ocean. In many parts of the interior of our continents, there must have been vast lakes of fresh water, which were drained by subsequent changes in the form of the land which bounded them, and were replaced by wide valleys, long antecedent to the existence of man. Thus, in the very heart of France, in a district along the banks of the river Allier, of which the town of Vichy may be taken as the centre, vast strata, full of fresh-water shells, prove, that there must have existed, for many ages, a lake nearly a hundred miles long, and twenty miles in average breadth. It is proved, moreover, by the nature of organic remains, that changes of CLIMATE, no less remarkable, have taken place; and that a heat equal to that now existing in the equatorial regions must have formerly prevailed in latitudes far north of our islands.

All this, so far from contradicting the Scriptures, confirms the Mosaic account of what is usually called the Creation. Moses says, In the beginning God created the heavens and the earth. How long that beginning was before the time that he wrote, he does not furnish us with the means of ascertaining; but he goes on to say, that the earth was without form and empty. All living beings, that might have been upon it previously, had been destroyed: it was in darkness and covered with water. When it was in this condition, which is usually called chaos, God said, Let there be light; and there was light; and thus the creation was commenced; for it is immediately added, that the morning and the evening were the first day.

The organized bodies which are found in a fossil state, belong to classes of animals and plants that exist on the land, or in lakes and rivers, and to those also, which are inhabitants of the sea. The latter are by far the most numerous, as might be expected would be the case, when it is considered, that the greater proportion of the strata must have been deposited at the bottom of the ocean. Of marine productions, shells and corals constitute the chief part, and for this reason, that being almost wholly composed of mineral substance, they are not liable to decay. In all cases of petrified remains of animals, it is the hard parts only that we find; the whole of the flesh and softer parts have disappeared, so much so, that, with the exceptions of some instances of fishes and amphibious animals, no trace of the external form of the living animal can be discovered; and where bones are found, it is very rarely that an entire skeleton is met with. There are fossil remains of

Among bodies belonging to the Sea.	Shells. Corals and Sponges. Radiated animals, such as Star Fish. Reptiles, resembling Crocodiles. Fishes. Cetacea, or the Whale tribe. Crustacea, such as Lobsters and Crabs. Plants.
Among bodies belonging to the Land.	Fresh-water shells, found in lakes and rivers. Land-shells, such as the Garden Snail. Quadrupeds. Reptiles. Birds. Insects. Stems of trees and wood. Smaller plants and leaves.

These several bodies are not found indiscriminately throughout the whole series of the secondary and tertiary strata; some are peculiar to the lowest beds, some to the intermediate, and some to the superior. But *all*, of whatever description they may be, *which occur in the secondary strata*, belong to species now wholly extinct. By far the greatest proportion of those found in the tertiary strata, belong likewise to extinct species. It is only in the uppermost beds that there is any very considerable number of individuals, which are identical with animals now in existence; and there they preponderate over the others.

The bones of man are not more liable to decay than those of other animals; but in no part of the earth, to which the researches of Geologists have extended, has there been found a single fragment of bone, belonging to the human species, incased in stone, or in any of those accumulations of gravel and loose materials which form the upper part of the series of strata. Human bones have been occasionally met with in stones formed by petrifying processes now going on, and in caves, associated with the bones of other animals;

but these are deposits possessing characters which prove them to have been of recent origin, as compared with even the most modern of the tertiary strata.

The Geologist may be considered as the historian of events relating to the animate and inanimate creation, previous to that period when *sacred* history begins, or the history of man, in relation to his highest destiny. Although it belongs to the Geologist to study the events that have occurred within his province during the more modern ages of the world, as well as those which are in progress in our own day, his special object is to unfold the history of those revolutions, by which the crust of the globe acquired its present form and structure. The solid earth, with its stores of organic remains, which now rises above the surface of the sea, may be compared to a vast collection of authentic records, which will reveal to man, as soon as he is capable of rightly interpreting them, an unbroken narrative of events, commencing from a period indefinitely remote, and which, in all probability, succeeded each other after intervals of vast duration. Unlike the records of human transactions, they are liable to no suspicion that they may have been falsified through intention or ignorance. In them, we have to fear neither dishonesty nor the blunders of unlettered and wearied transcribers. The mummies of Egypt do not more certainly record the existence of a civilized people in remote ages on the banks of the Nile, than do the shells, entombed in solid stone at the summit of the Alps, and Pyrenees, attest that there was a time, when the rocks of those mountains occupied the bottom of a sea, whose waters were as warm as those within the tropics, and were peopled by numerous species of animals, of which there does not now exist one single descendant.

Some scattered observations, and some fanciful theories founded upon them, show that a few of the philosophers of antiquity, and a few among the learned since the revival of letters, were not altogether unaware of the existence of these archives; but it is little more than half a century since their true value began to be understood. The cause of this is easily explained. Geology has grown out of the advanced state of other branches of knowledge. Until chemistry, mineralogy, botany, and above all, zoology, or the natural history and comparative anatomy of animals, had arrived at a considerable degree of perfection, it was impossible to comprehend the language in which these records are written. Many of the early Geologists and some even in the present day, appear indeed to find no difficulty in reading them; and when they meet with a passage which is obscure, they cut the knot, and reason upon some bold interpretation, which they arrive at by conferring upon Nature powers which she herself has never revealed to us that she has employed. But since the discovery, in recent times, by Cuvier and others, of a key to the language of these precious documents, many have been unrolled; the errors of former interpretations have been discovered; and we may now entertain a well-grounded hope, that if we cease to guess at meanings, and patiently search and compare the materials that are accessible to us, we shall arrive at such sound conclusions, that geology will be placed on as secure a basis as the most exact of the sciences.

Ibid.

VIII.—MINERAL KINGDOM.

ORGANIC REMAINS.

We find in the lowest beds of the series of the secondary strata that the organic remains consist chiefly of corals and shells, that is, of animals having a comparatively simple anatomical structure; and that as we ascend in the series, the proportion of animals of more complicated forms increases, the bones of land quadrupeds being almost entirely confined to the more recent members of the tertiary strata. From these circumstances, it is a received opinion, among certain Geologists, that the animals which were first created were of an exceedingly simple structure, and that they gradually became more complex in their frame.

Although it be true, that in the lower strata there is a large proportion of the remains of animals which possess an apparently simple structure, nothing can be more unsound than to found upon such observations a doctrine such as we have above stated. What we have at one time called simple, has again and again been afterwards found to be exceedingly the reverse, so that the term is really nothing more than an expression of our ignorance, a statement of the limit beyond which we have not yet been able to advance. The animalculæ called *Infusoria*, are living creatures, found in stagnant waters, so wonderfully minute, that they are invisible to the naked eye,—a collection of many thousand individuals occupying no greater space than the tenth part of an inch. For a long time after they were discovered by means of the microscope, they were thought to be little more than specks of animal matter endowed with locomotive powers, but the ingenious researches of Ehrenberg, a philosopher of Berlin, who employed a very powerful instrument, laid open to our wondering sight a new creation. That distinguished Naturalist has shown, that these animalculæ are provided with limbs and organs, and with a system of vessels and nerves; and even figures of their teeth accompany his curious memoir. Thus, the lowest member in the supposed graduated scale of animal structure, in place of being a simple body, is probably a very complicated piece of mechanism. Besides, corals and shells, though of most frequent occurrence, are not the only animal remains found in the lower strata, for recent observations have discovered in these rocks, the vertebræ or joints of the backbone of fishes, as well as other parts belonging to them, and even impressions of entire fish have been met with. Now, one single undoubted specimen of an animal of that description, found in such a situation, is as conclusive as ten thousand would be in overthrowing the whole doctrine, that there has been a gradual development of structure in animal life, as we ascend from the lowest to the uppermost strata.

A most curious circumstance, connected with fossils, is, the unequivocal evidence they afford of there having been formerly a completely different state of our planet with regard to climates, from that which now exists. Throughout all the strata, from the lowest member of the secondary series, up to the last layer lying immediately beneath that which, in geological language, is termed a formation of the recent period, we find, in our northern latitudes, numerous remains of animals and plants belonging to genera, which are now known to exist only in tropical climates. In the most northern part of Asiatic Siberia, at the mouth of the River Lena, which flows into the Arctic Ocean, in the 70th degree of latitude, there are vast accumulations of the bones of an extinct species of elephant, and these in such a state of preservation, that a great part of the ivory used in St. Petersburg, is brought from thence. Indeed the quantity is so great, that a Russian Naturalist has stated it as his belief, that the number of elephants now living on the globe, must be greatly inferior to those which occur in a fossil state in those parts of Siberia. The entire carcase of one of those animals was found enclosed in a mass of ice, where it must have remained incased for thousands of years; and yet, from the preservative quality of the ice, the flesh was in such a state, that, when it was disentombed by the accidental breaking up of the mass, it was devoured by the wolves and other wild animals. Moreover, it was thickly covered with hair, of which the existing species of elephants are nearly destitute; thus proving that it was of a species adapted to a cold climate. Then, as to plants, specimens of rocks have been brought from Melville Island, the remote northern land discovered in our late polar expeditions, some of which contain, imbedded in the stone, portions of plants belonging to an order now known to exist only in the warmest parts of the equatorial regions. The greatest degree of heat seems to have existed during the deposition of the inferior beds of the secondary strata; and it appears also, from the nature of the fossil plants found in these strata, that there must have existed, at the same time, a very considerable degree of moisture in the atmosphere. The heat seems to have gradually diminished, so that at last, during the deposition of the most recent of the tertiary strata, the climate of the northern hemisphere does not appear to have been very different from what it is now.

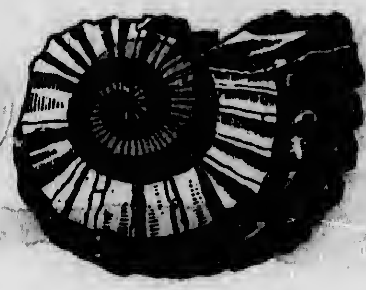
To endeavour to account for this wonderful change in the temperature of the northern latitudes, is one of the most difficult problems in the physical history of the globe, because it involves such a variety of considerations; and we know that the most important and extensive changes in the forms of organized bodies, are brought about by very nice shades of difference in the circumstances of climate and soil under which they are placed. In the early stages of geology, many theories were started: the earth was said to have been originally in a highly heated state, and to have gradually cooled; and it was maintained that during the progress of cooling, the various changes in climate took place: according to another theory, the position of the axis of the earth was at one time different from what it is now, and was so directed, that the polar regions were exposed to a much more direct action of the solar rays. But the inventors of these theories did not trouble themselves much with inquiring, whether they were in harmony with the laws which regulate the motions of the heavenly bodies; and when they were subjected to the examination of the astronomer, they could not stand the test of his severe investigations. An ingenious theory has been lately proposed by Mr. Lyell. His theory is, that all the indications of the former prevalence of warmer climates, may be accounted for by a different distribution of land and water; and we know from geological appearances, that a very different proportion of superficial land and water must formerly have existed in the northern hemisphere from that which we now find. It is not very easy to state the grounds of this theory in an abridged form; but the following explanation will perhaps convey an intelligible idea of it. Wherever there is a great expanse of water, like the sea, there is always a more uniform temperature in the adjoining countries throughout the year, less extremes of heat and cold. On the contrary, extensive tracts of land are liable to considerable vicissitudes; and hence the difference of an insular and continental climate in the same parallel of latitude. Moscow and Edinburgh are very nearly in the same latitude; but while at the latter place, there is neither extreme cold nor excessive heat, at Moscow, the cold in winter is sometimes so intense as to freeze quicksilver, and there are often days in summer as hot as at Naples. In like manner, the higher you ascend, the air becomes colder; and thus in lofty mountains, such as Ætna, the sugar-cane grows at the foot, and the lichen, or moss of Iceland, at the summit. In the lofty mountains of South America there are regions of eternal snow under an equatorial sun. If we suppose, therefore, extensive continents, lofty mountains, and numerous islands to have existed in southern latitudes, where there is now a wide expanse of sea, and an ocean to have occupied the place of northern Europe and Asia, it will be readily conceived, from the principles above stated, that very different climates would exist in the northern hemisphere from what now prevail.

All the solid strata, most abundant in *animal* remains, are either limestones, or contain a large proportion of lime in their composition. Many thick beds of clay also abound in them; but in that case, limestone, in some form or other, is generally associated with the clay. From this it has been inferred, and not without a strong semblance of probability, that animals have mainly contributed to the formation of many limestone strata, in the same way as we see them now at work forming vast limestone rocks in the coral reefs of the Pacific ocean. A reef of this sort extends for three hundred and fifty miles along the east coast of New Holland; and between that country and New Guinea the coral formations have been found to extend, with very short intervals, throughout a distance of seven hundred miles. Of all the forms of organized bodies, which are found in a fossil state, from the lowest stratum in which they occur, to those of most modern date, shells and corals constitute by far the greatest proportion. All the strata must have been deposited in seas or lakes; and it is therefore natural, that animals living in water should be most abundant. Besides, as shells and corals are not liable to decay, they remain, while the soft boneless animals, which inhabit them, perish entirely; and fish-bones, being more perishable than shells, are comparatively rare. *Ibid.*

IX.—MINERAL KINGDOM.

We have said that shells are by far the most numerous class of fossils: they are found in all formations, from the lowest stratum in which animal remains have been seen, to the most recent deposits now in progress. To a person who has made Conchology a special object of study, there appear many striking differences between those found in a fossil state, and such as now exist in our seas, lakes, and rivers; but were we to describe, or give representations, of even remarkable fossil shells, a general reader would discover, in most of them, nothing so peculiar as to arrest his attention. There is, however, one, which is so different from any thing now living, and of such common occurrence, that we are induced to give it as a good example of an extinct genus. It is called the Ammonite, or *Cornu Ammonis*, that is, Horn of Ammon, from its resemblance to those horns which are affixed to the head of the statues of Jupiter Ammon.

Here is a representation of the exterior of one of the numerous species, of which this genus is composed.



These shells are found of all sizes, from that of a few lines to nearly four feet in diameter; and above three hundred different species are said to have been observed.

The diagram here given represents the two sides of a species of crustaceous marine animal, which has

been wholly extinct from an early period in the formation of the crust of the globe; many ages may have elapsed since it ceased to exist. There are several species of the animal, which has been called *Trilobite*, from the body being composed of longitudinal divisions or lobes. It is found in the British isles, in Germany, and Sweden: and specimens have been brought from North America. In some parts of Wales the slate is so full of fragments of the animal, that millions must have swarmed on the spot.

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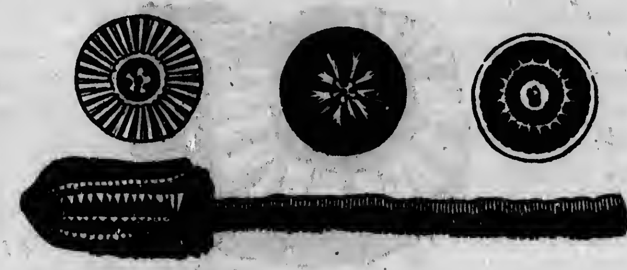
Another fossil animal which is very peculiar in its form is this called the Lily Encrinite. It resembles



that flower upon its stalk, and still more so when the several parts of which the flower-like extremity is composed, are separated and spread out; specimens of it in this state are not unfrequently met with. That stalk is not a single piece, but consists of a number of distinct joints like those of the backbone, or like a necklace of beads, on which account the fossil has been sometimes called the Necklace-form Encrinite. The stalk is perforated through its whole length, and the joints, when separated, have figured surfaces such as are represented above in the circular bodies, the figure being different at different parts of the stalk. This *family* of radiated animals, which consists of many extinct genera and species, has not wholly disappeared, like the trilobite and ammonite; living representatives of it are still found in the seas of the West Indies, and a very perfect specimen may be seen in the Museum of the Geological Society: but the lily encrinite, that branch of the family, is not only wholly extinct, but has been so ever since the period when the New Red Sandstone was deposited. It appears to have had comparatively a short existence, for it has only been found in a limestone which occurs associated with the New Red Sandstone. It is met with abundantly in that particular limestone which occupies a great extent of country in Germany; but the fossil has never been seen in England, and that kind of limestone is not found in our island.

The remains of fishes occur in almost every stratum, from the Old Red Sandstone up to the most recent deposits of fresh-water lakes. Fossil fish have been less accurately made out, as to the genera to which they belong, than any other kind of animal remains; because the Natural history of fishes is not so far advanced as that of most other departments of zoology. The great French Naturalist, Cuvier, began an extensive work on the subject; and, had he lived, much would have been done, for his master-genius threw light on every thing he touched. One of the most celebrated places for fossil fish is a hill near Verona in Italy, called Monte Bolca. Immense quantities have been found there in a very perfect state of preservation, as far as the form is concerned, but, as in most other cases, quite flattened and thin, so that they are like a painting, or engraving of a fish. These impressions are of rare occurrence, in comparison with the quantity of separate bones that are found in most strata: teeth of the shark are frequently met with, and sometimes of a size which shows them to have belonged to individuals of giant dimensions, such as are not now seen in any seas.

Ibid.

X.—MINERAL KINGDOM.

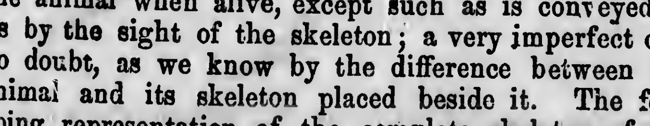
ORGANIC REMAINS.

In our last lesson, we gave some examples of remarkable species of fossil-shells, corals, and crustacea; two of these, the trilobite and the lily encrinite, belonging to genera which became extinct after the deposit of the oldest secondary strata. In the extensive series of sand-stones, lime-stones, and clays of the secondary rocks, from the coal measures up to, and including the chalk, the fossil remains of animals consist of a vast variety of shells, corals, sponges, and other marine productions of a similar description—of few kinds of crustacea, that is, animals having a crust or shell like that of the lobster or crab, a few kinds of fish, some great reptiles, and a few insects. No remains of land quadrupeds, or of the marine mammalia, or of birds, have yet been met with in chalk or any stratum under the chalk, except one supposed instance. Among the numerous animal remains that occur in the secondary strata, there is not a single species which has not been for many ages extinct; and even whole genera have totally ceased to exist.

The extinction of species is so important a fact in all that relates to the geological history of the earth, that we will, even at the risk of some repetition, endeavour, by a little popular explanation, to make clear what is meant by the term. Each particular kind or *genus* of animal usually consists of several individuals, which while they possess a common character or class of characters, have particular forms which distinguish them from each other; and such individuals constitute the *species* of a *genus*. The characters, by which geologists distinguish the relative ages of strata, in so far as animal remains are concerned, depend, not upon *genus*, but on the *species;* for while species have become extinct, one after the other in succession, the *genera* to which they belong have continued to exist from the period of the deposition of the oldest of the secondary strata to the present time. For example, the *genus* ostrea, or oyster, is found in the lime-stones which lie beneath the coal-measures; but not one of the many *species* of oyster, which are met with in almost all the strata from that lime-stone up to the chalk, is identical with any species of oyster inhabiting our present seas.

It is unnecessary for us to give the names of the marine remains, which are most abundant in the secondary strata, because even with the assistance of figures, they would convey to the general reader no clear idea of their peculiar forms, as distinguished from those of marine shells, corals, sponges, &c. now existing; but some of the marine reptiles are so extraordinary in point of form and size as to deserve a more particular notice. Of these monsters of the ancient seas, nine different genera have already been found entombed in the secondary strata, and of some of the genera there are several species. They have been called *saurians* by Geologists, from the resemblance they bear to the lizard tribe, *saura* being the Greek name for a lizard. A common green lizard is a tolerably good miniature representation of the general form of these reptiles: but a crocodile or alligator gives a still better idea of them. It must be remembered, however, that in speaking of the fossil remains of those animals, we mean only their skeletons or bones; the flesh is never converted into a fossil state. It very seldom happens, also, that the entire skeleton of any large animal is found, particularly in the strata that were deposited at the bottom of a sea, and for this reason—the bones in the living body are kept together by a cartilaginous substance or gristle, which after death putrefies, and then the several members fall asunder. Very often, too, we find only detached bones; and this may be accounted for by another circumstance attending the process of putrefaction. When that commences in a dead animal, a considerable quantity of gas is generated, which swells up the body, and, if that be in water, makes it so much lighter that it floats. In process of time the skin bursts, and the gradually loosened bones are scattered far apart. Such detached bones frequently constitute all the data, by which we are enabled to decide upon the nature of the animal; and the general reader may perhaps think that they are sufficiently scanty materials, considering the important conclusions which geologists sometimes draw from them. But the discoveries of philosophers, who have occupied themselves in comparing the anatomical structure of the lower animals with that of the human frame, and have created the interesting and beautiful department of science called Comparative Anatomy, have enabled them to establish certain fixed and invariable principles for our guidance in this curious branch of geological inquiry. This field of investigation has only been entered upon within a few years; but it has already yielded so rich a harvest, that it has established some of the most important truths connected with the past history of our planet.—The great discoverer of those general laws of the animal kingdom was the illustrious French Naturalist, the Baron Cuvier. He has shown, that there reigns such a harmony throughout all the parts of which the skeleton is composed, so nice an adaptation of the forms to the wants and habits of the animal, and such a degree of mutual subordination between one part and another in portions of the structure apparently quite unconnected, that we are enabled, by the inspection of a single bone, to say with certainty that it must have belonged to a particular kind of animal, and could not have formed a part of the skeleton of any other. Thus, if we present to a skilful comparative anatomist a small bone of the foot of a quadruped, he will not only pronounce with certainty as to the size of the animal to which it belonged, but will say what sort of teeth it must have had—whether it had horns, and whether it fed upon the flesh of other animals, or on vegetable substances. If many detached bones belonging to the same kind of animal be collected, the skill of the comparative anatomist enables him to put them together in their true places; and thus a complete skeleton has been constructed of separate fossil bones, which had belonged to several individuals of the same species. In this application of anatomy to geology we have a beautiful illustration of the intimate connexion of the sciences with each other. The discovery, in one of our stone quarries, of a few mutilated fragments of bone, imbedded in the solid rock, reveals to us the kind of animals that must have inhabited this region of the earth at the remote period when the rock was in the act of being deposited at the bottom of the sea, and tells us also that the climate was not that of the temperate zone, but of the tropics:

The most remarkable of the fossil saurians, which are found in the secondary strata, are those which have been called ichthyosaurus, plesiosaurus, megalosaurus, and iguanodon. The first of these is so called from the characters of the animal, partaking at the same time of the nature of a fish and of the lizard tribe, *ichthys* and *sauras* being two Greek words signifying fish and lizard. Its head resembles that of a crocodile, only it is much larger and sharper, its snout ending in a point, almost as acute as the beak of a bird: it has a most formidable supply of sharp conical teeth, no less than sixty in each jaw. Its head was of an enormous size, for jaws measuring eight feet in length have been found; and it was furnished with a pair of eyes of still more extraordinary proportion, for the oval hollows for that organ, in a skull in the possession of a gentleman at Bristol, measure fourteen and a half inches in their largest diameter, the size of a dish on which a tolerably good-sized turkey could be served up. The head was about a fourth of the whole length of the animal, and was joined to the body by a very short neck: the back-bone was composed of joints or *vertebræ* different from those of land animals, and similar to those of fishes; it was supplied with four paddles like those of a turtle, in the lower part of the body, and by means of these, and its very powerful tail, it must have darted very swiftly through the water. It was a most singular combination of forms, for it had the snout of a dolphin, the teeth of a crocodile, the head and breast-bone of a lizard, extremities like the marine mammalia, and vertebræ like a fish.

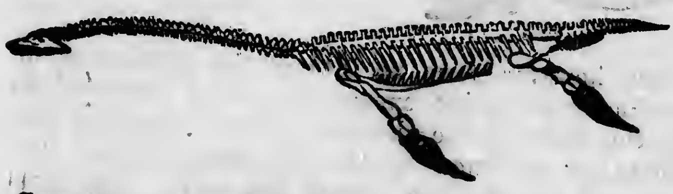


We can, however, form no idea of the appearance of the animal when alive, except such as is conveyed to us by the sight of the skeleton; a very imperfect one, no doubt, as we know by the difference between any animal and its skeleton placed beside it. The foregoing representation of the complete skeleton of the ichthyosaurus, as restored in the way we have alluded to, is given by the Rev. W. Conybeare, the eminent Geologist, to whom we are indebted for the most complete account of these fossil saurians.

Remains of the ichthyosaurus have been found in all the secondary strata, between the red sand-stone and the chalk, in many parts of England; but they are most frequently met with in the lias lime-stone, and in greatest abundance at Lyme Regis in Dorsetshire. They have also been found in several places on the continent, especially in Wurtemberg.

The *plesiosaurus* is so called from its near approach to the lizard tribe, *plesion* being Greek for *near*. It has a considerable resemblance in the body to the ichthyosaurus, but the head is much smaller, and is altogether of a different structure; but its most remarkable character is the great length of its neck. In man, all quadrupeds, and other mammalia, there are exactly seven joints or vertebræ in the neck; and so strict is the adherence to this rule, that there is precisely the same number in the short, stiff neck of the whale, and the long, flexible neck of the giraffe. Reptiles have from three to eight joints—birds many more: the swan, which has the most, is enabled to make the graceful curves of its neck by being provided with twenty-three of those separate vertebræ; but the plesiosaurus had no less than forty-one.

Mr. Conybeare, to whom we are indebted for the first description and name of the plesiosaurus, has given the following representation of this extraordinary long-necked reptile, in a restored state, in the same way as he has given us a figure of the ichthyosaurus.



Some fragments of the bones of a saurian of gigantic size were discovered by Dr. Buckland, a few years ago, in the quarry of Stonesfield, near Woodstock, in Oxfordshire. According to the opinion of Cuvier, who examined them, they must have belonged to an individual of the lizard tribe, measuring forty feet in length, and having a bulk equal to that of an elephant seven feet high. This fossil animal was distinguished by Dr. Buckland with the name *megalosaurus*, on account of its great size, *megale* being Greek for great.

A most curious discovery was made a few years ago by Dr. Buckland at Lyme Regis.

He had often remarked a number of long rounded stony bodies, like oblong pebbles or kidney potatoes, scattered on the shore, and frequently lying beside the bones of the saurians when these were discovered in the rock. He was induced to make a closer examination of them, and they turned out to be the *dung* of the saurian reptiles in a fossil state. When found along with the bones they are always under or among the ribs. Many specimens of them contained scales, teeth, and bones of fishes that seemed to have passed undigested through the body of the animal; just as the enamel of teeth and fragments of bone are found undigested in the dung of the ravenous hyæna. It was thus shown, that these great monsters of the deep fed not only on their weaker neighbours, but sometimes even on the smaller defenceless individuals of their own species; for Dr. Buckland found in one of these stones a joint of the back-bone of an ichthyosaurus, that must have been at least four feet in length. He has called the stones *coprolites*, from *kopros*, Greek for dung, and *lithos*, a stone. Since his attention was directed to the subject, he has found similar bodies in many other strata, and belonging to different animals. "In all these various formations," he says, "the coprolites form records of warfare waged by successive generations of inhabitants of our planet on one another; and the general law of nature, which bids all to eat and to be eaten in their turn, is shown to have been co-extensive with animal existence upon our globe; the *carnivora* in each period of the world's history fulfilling their destined office to check excess in the progress of life, and maintain the balance of creation." *Ibid.*

SECTION II.

HISTORY AND CHRONOLOGY.

History is the record of public events that have occurred in different ages and nations. Chronology treats of the precise dates at which these events took place. Our knowledge of *historical events* is derived chiefly from the writings of individuals; but these are aided by public records, inscriptions, coins, and other documents of a similar nature. Our knowledge of the *chronology* of these events is drawn from similar sources. History and Chronology, therefore, are intimately connected; yet they are so distinct as to suggest very different trains of investigation. History treats of the characters of the persons engaged in the events which it records, the motives which influenced them, the circumstances which led to the events, the incidents which accompanied them, the effects which resulted from them, involving considerations of the state of the nations that were engaged in them, their advancement in civilization and useful arts, and their relative position with respect to one another. The study of chronology, on the other hand, leads to the examination of the divisions of time that have prevailed in different nations, their modes of reckoning hours, days, weeks, months, years; different epochs that have been used in different ages and nations; cycles and other periodical revolutions of years; the deciphering of the devices and legends of coins and medals, the calculating of the eclipses that are mentioned in connexion with historical events; and, in short, the investigating and estimating of any notices of time that may be discovered either in natural objects, or in any record kept by men of the transactions in which they have been engaged.

The Hebrews were the only nation of antiquity, who had among them a regular chronological history. In the Sacred Scriptures, there is a chain of such history from the creation of the world till profane history assumes an authentic form. In the early portion of this history, the chronology is determined by a succession of first-born sons, accompanied by a statement of the age of each individual, at the time when his eldest son was born. In the later portion of the history, the chronology is determined by the time allotted for the continuance of the authority of a succession of judges, and afterwards of kings. There are some difficulties in adjusting this chronology, chiefly arising from variations introduced into manuscripts and translations of the Scriptures, during a long course of ages; but still, the best, perhaps the only guide to a general view of ancient chronology, is the history contained in the Sacred Scriptures. As the land in which the Israelites were placed, was in the very centre of the world's population, in the neighbourhood of the great empires that successively arose, and as it became an integral part of these empires, the history of that people is intermingled with almost all that is important in the history of our species. In reading the sacred history, there is brought before us in regular succession the sovereignties established on the banks of the Tigris and the Euphrates, and the states that rose to eminence on the eastern shore of the Mediterranean sea; the kingdoms of Egypt, Ethiopia, Syria, Assyria, Babylon and Persia, and the influence which they possessed in the affairs of men in different ages of the world. The regular chain of Jewish history and chronology is broken off at the building of the second temple, after the return from the captivity of Babylon, when the Persian monarchy was at its height: but a general view of the subsequent history of the world, marking the rise of the Grecian empire on the ruins of the Persian, its separation into several kingdoms, the advance of the Roman empire in its gigantic strides to universal sovereignty, its strength and character, its

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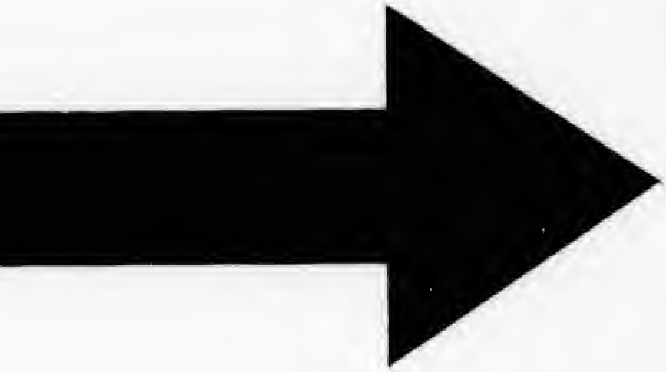

decay and overthrow, is given in the prophetic visions of a Hebrew prophet, so graphically, and in a manner so perfectly conformable to the truth of history, that when we lose the aid of Jewish history, we cannot follow a better guide than the bold characteristic sketch of subsequent events furnished by the Jewish prophecies.

The history of the world naturally divides itself into two great periods, namely, that which elapsed before the coming of the Saviour Jesus Christ into the world; and that which has elapsed since that event. The appearance of that illustrious personage on our planet was the commencement of that great revolution of mind, which has already produced such stupendous effects, and which is every day extending and strengthening its influence. It was then that those sublime views of the Deity, and that pure morality, which the nation of the Jews had received from the Scriptures, began to be diffused over the world, a process which soon changed the aspect of the Roman empire, and laid the foundation of that superior illumination and humanity, and those just conceptions of the rights and liberties of men, which distinguish Europeans from the rest of mankind, as well as all who are of their kindred in other regions of the globe. The commencement of this mighty movement is happily marked among the nations professing Christianity, by their adopting it as the fixed era, from which they date all other events either before or after it; stating the time of their occurrence by the number of years before Christ, or after Christ. We shall regard the birth of the Saviour Jesus Christ, as the great turning, or hinging point of the world's history, and view the chronology of all other events with reference to it.

Our attention, therefore, is, in the first place, to be directed to those events which took place before the birth of Jesus Christ.

The various dates and periods noted in the Hebrew Scriptures, as examined and compared by many learned men, make the duration of the world from the creation recorded in the book of Genesis, till the birth of Christ, 4004 years. For aiding the memory, this period may be conveniently divided, as follows: At the middle of this period, or two thousand years before Christ, and two thousand after the creation of the world, Abraham was born: and the call of Abraham was the commencement of that important dispensation of Providence, by which one family were separated from the rest of the world, increased to a nation, planted in a central place of the earth, that they might preserve among them the knowledge of the name, and character, and law of the true God, and ultimately diffuse it among the rest of mankind. In the middle of the period between the creation of the world and the birth of Abraham, or about the year B.C. 3017, Enoch was translated to heaven, as a token of the favour and approbation with which God regarded his devout and holy character. In the middle of the period between the birth of Abraham and the birth of Christ, or about the year, B.C. 1004, Solomon's temple was finished. This period marked the fulfilment of the promises made to Abraham in their literal sense; for then, and not till then, did his seed reign in peace and prosperity, from the great river Euphrates to the shores of the Mediterranean sea. Thus the whole period of four thousand years is divided into four parts of a thousand years each, every successive period commencing with a remarkable event, namely, the creation—the translation of Enoch—the birth of Abraham—and the completing of Solomon's temple.

These four periods, thus distinctly marked, may be further conveniently divided into eight, each of 500 years. So little is recorded respecting the first two periods of a thousand years, that it is of less importance to divide them into half thousands. We remark, however, that the first thousand years, namely, from the creation of the world to Enoch, is divided nearly equally, by the birth of Jared the fifth descendant from Adam, which was, according to the common chronology, in the year B.C. 3544. The second thousand years, namely, from Enoch to Abraham, is divided nearly equally, by the denunciation of the deluge and the commencement of the building of the ark.

The divisions of the latter two periods of a thousand years are marked by very important eras. That which intervened between Abraham and Solomon, is divided by the mission of Moses to the Israelites, their deliverance from Egypt, and the giving of the law at Mount Sinai, which is determined to the year 1491, or nearly 1500 years B.C. The last period of a thousand years, or that which intervened between Solomon and the birth of Christ, is equally divided by the building of the second temple, after the return of the Jews from the captivity of Babylon, which event is determined to the year B.C. 515. Thus the whole period from the creation of the world to the birth of Christ is divided by remarkable eras, into eight periods, of about 500 years each, as in the following table.

No.	ERAS.	Years after the Creation. A.M.	Years before Christ. B.C.
I.	CREATION.	0	4000
II.	JARED.	500	3500
III.	ENOCH.	1000	3000
IV.	NOAH.	1500	2500
V.	ABRAHAM.	2000	2000
VI.	MOSES.	2500	1500
VII.	SOLOMON.	3000	1000
VIII.	EZRA.	3500	500
IX.	JESUS CHRIST.	4000	A.

In the following chapters a succinct view of the state of the world at each of these eight eras will be given.

FIRST ERA.

The Creation.

A.M. 1.—B.C. 4004.

When man was created, he was placed in the garden of Eden, some delightful spot in the neighbourhood of the rivers Tigris and Euphrates; and a command was given to him, enforced by the penalty of death, by which command he was given to know his subjection and responsibility to the Almighty Creator. Eve was then made and brought to him, to be his wife. The fall of Adam and Eve into sin, soon follows, and their expulsion from the garden of Eden, to earn their bread by the sweat of their face; and then, in pursuance of the penalty of death which they had incurred, to return to the dust whence they were taken.

This era also is distinguished by the annunciation of a great deliverance and victory which God purposed to accomplish for man. "The seed of the woman," said he, "shall bruise the head of the serpent." This era is also marked by the sudden and awful development of that corruption, with which human nature is tainted. Cain, the first-born son of Adam, became the first murderer, imbruing his hands in the blood of his own brother, Abel.

Cain was then banished from his father's home, and, in process of time, built a city. His descendants, apparently living without God, betook themselves to various worldly avocations and amusements, to fill up that sad vacuity in their bosoms, which the want of love to God had created there. In the mean while, another son was born to Adam, whom he called Seth, and who occupied the station of Abel whom Cain slew.

Thus mankind were early separated into two classes, namely, the descendants of Cain, and the descendants of Seth.

SECOND ERA

Jared.

A.M. 500.—B.C. 3500.

At this era the families of Cain and Seth were still living separate from one another. During the period that followed, there were born Enoch, Methuselah, and Lamech, the father of Noah. Adam died at the age of 930 years. During the antediluvian periods, human life bore nearly the same proportion to a thousand, which it now does to a hundred years. It is now but about the one-tenth of what it then was.

THIRD ERA.

Enoch.

A.M. 1000.—B.C. 3000.

This era is marked by that extraordinary testimony which God bore to the holiness of Enoch's character when he removed him to heaven, without subjecting him to the universal sentence of death. This distinction conferred on Enoch, indicates that corruption was making rapid strides among men. And accordingly, in a prophecy of Enoch, recorded by the apostle Jude, he denounces the judgments of God upon the wicked; saying, "Behold, the Lord cometh with ten thousand of his saints, to execute judgment upon all, to convict all the impious among them, of all their deeds of impiety which they have impiously perpetrated, and of all the hard things which impious sinners have spoken against him." In this prophecy, there is the first intimation on record of a final day of retribution.

Towards the conclusion of the period of 500 years which followed this era, the progress of corruption was accelerated by intermarriages formed between the descendants of Cain and the descendants of Seth. "The sons of God," it is written, "saw the daughters of men that they were fair, and they took them wives of all that they chose." By this statement is probably meant that the professing worshippers of God, the family of Seth, began to intermarry with the votaries of the world, the family of Cain. The consequence of this intermixture of the two families, was the rapid and universal spread of wickedness. The children of these marriages became mighty men, men of renown. There were giants (literally fellers) on the earth in these days; and the earth was filled with violence. Thus the crime of murder, which had been specially marked by the high displeasure of God, was the very crime into which men rushed headlong, doubtless glorying in it, as it is known they did after the deluge.

"And God saw that the wickedness of man was very great upon the earth, and that every imagination of the thoughts of his heart was only evil, and that continually;" and he declared his purpose of sweeping away the godless race by the waters of a deluge; and commanded Noah to build an ark for the preservation of himself and his family.

FOURTH ERA.

The building of the Ark.

A.M. 1500.—B.C. 2500.

This era finds the whole world one scene of violence and corruption. Only Noah was found upright before God. And God, proposing to sweep away the whole race of the wicked, commanded Noah to build an ark for the preservation of himself and his family. Noah believed that God would do as he had declared, and, "moved with fear," began to build the ark according to the directions that were given to him, proclaiming, in the meantime, the catastrophe that was approaching, and warning men to repent of their sin;—for he was "a preacher of righteousness." They, however, were too intent on their own pursuits and pleasures to attend to him. "They were eating and drinking, marrying and giving in marriage, and knew not till the flood came, and took them all away." The ark being finished, Noah was directed to collect in it, pairs of all those animals that were to be preserved, and then to enter it himself and his family,—in all, eight persons. The windows of heaven were then opened, and the fountains of the great deep broken up, and the water rose, till it reached the tops of the loftiest mountains, destroying every living thing that could not subsist in the water. It then again gradually retired. This whole operation occupied only about a year;—namely, the year B.C. 2347.

The first remarkable event after the deluge, was the promise of preservation from any future deluge, and the law given to Noah, in which was pointedly prohibited the shedding of blood. At this time also liberty was given to men to eat animal food. Then followed the division of the earth among the three sons of Noah, which seems to have been done according to some rule or system. The descendants of Shem spread themselves from Mount Ararat, where the ark rested, towards the South and East; the descendants of Ham went towards the South and West, particularly occupying Africa; and to Japheth and his posterity were assigned the North and West.

Towards the latter part of this period, or about 2250 years B. C., cities began to be built, which afterwards rose to great eminence. Ashur, one of the descendants of Shem, built Nineveh on the Tigris; and Nimrod, who had addicted himself to hunting, erected a kingdom in the land of Shinar, on the banks of the Euphrates. Babel seems to have been the capital of his kingdom. On the plain of Shinar, the tower of Babel was commenced; but its completion was prevented by the interposition of God, who introduced confusion among those who were employed in building it; yet it seems to have formed the germ of the city of Babylon, that, many ages afterwards, arose to great power and splendour.

Thus, the conduct of men very soon proved, that although the deluge had given a temporary check to their wickedness, it had done nothing towards purifying the human heart, from its proud, ambitious passions. That very crime against which Almighty God had repeatedly pointed his indignation, which had brought destruction on the old world—violence and the shedding of human blood, soon began to appear in all its ferocity, and scenes of carnage commenced, which have disgraced and consumed mankind, and kept whole regions of the earth in desolation and wretchedness, till the present day.

FIFTH ERA.

Abraham.

A.M. 2000.—B.C. 2000.

At this era idolatry had made some progress. Even the family of Shem was corrupted by it. Tera, the father of Abraham and of Nachor, when he lived on the other side of the Euphrates, we are told, "served other gods." But instead of checking this evil by some awful infliction similar to the deluge, God selected a family with whom he might deposit the knowledge of himself and his will, and to whom he might give so conspicuous a station among the nations of the world, as would tend to preserve that knowledge in the world, and diffuse it among the rest of mankind. This measure he commenced by calling Abraham to leave his native country, Mesopotamia, and to reside as a stranger and a wanderer in the land of the Canaanites; a land which lay between the river Jordan and the Mediterranean sea. To Abraham, who was falling into the contagion of idolatry, he revealed himself, and maintained an intercourse with him from time to time, promising to give him a numerous posterity, while yet he had no child; to give the land in which he had come to sojourn to his posterity; and to make them a great nation, and to give them dominion from the Euphrates to the shore of the Mediterranean sea.

Abraham obeyed the call of God, and came from Mesopotamia to the land of Canaan. This land was occupied by different families descended from Canaan, the son of Ham, but to a great extent open and uncultivated, yet with some towns or cities scattered over it. The sea-coast to the southward, was in possession of the Philistines, from whom the whole country afterwards derived the name of Palestine. The valley of the Jordan, which river seems to have then flowed to the Red Sea, especially that part of the valley which lies between the mountains in the south of Palestine, and a mountainous district on the eastern side of it, seems to have been more thickly peopled, having in it several cities in the midst of a luxuriant country, of which Sodom and Gomorrah were the chief. The inhabitants of these cities had become profligate in the extreme. They were governed by kings, each city having its own king. But these kings were tributary to an empire, the centre of which was on the eastern bank of the Tigris. It is probable that the kingdom erected by Nimrod had, by this time, extended itself to the Jordan. The kings of the cities of the plain of Jordan had, about the time of the call of Abraham, rebelled against the king of Elam or Persia. And the next year, Chedorlaomer, with four confederate kings, one of whom was the king of Shinar, came upon them with an army, defeated them, and plundered Sodom and Gomorrah. They were, however, overtaken, in returning home, by Abraham, with his servants, and some of the neighbouring chiefs, and the booty recovered from them.

Egypt was then governed by a king, and seems to have retained some knowledge of the true God. Damascus was built in a beautiful valley, watered by two rivers, on the edge of the wilderness. It is called by the inhabitants of that country Sham, which renders it not improbable that it was built by Shem, the son of Noah.

Abraham had brought with him Lot, his nephew, who went down to live in the vale of the Jordan, near the city of Gomorrah. While he was there, the wickedness of that and the neighbouring cities became so intolerable, that God rained fire and brimstone upon them, and destroyed them; and, at the same time, the ground seems to have sunk, so that the Jordan, instead of flowing through the valley to the Red Sea, was arrested in its course, and formed that salt lake which is called the Dead Sea.

After this, Lot, who had been warned of the impending fate of the cities, and fled with his family, lived among the mountains, to the east of the Dead Sea, where he had two sons, Moab and Ammon, by whose descendants that district of country was afterwards peopled.

Abraham had a son by Hagar, an Egyptian woman—Ishmael, whom he sent away from him, and who took up his residence in the wilderness, between the south of Palestine and Egypt.

In his old age, Abraham had his son Isaac, who was to inherit the promises that had been made to him on leaving his own country. Isaac, before the death of his father, married his near relative Rebekah, by whom he had two sons, Esau and Jacob. Esau, or Edom, became a man of the field, and frequented Mount Seir, to the south-east of Palestine. His descendants, for many ages, occupied that district, under the name of Edomites, and more recently Idumæans.

Jacob went to Mesopotamia and married two of his near relatives Rachel and Leah, and by them, and two other wives, he had twelve sons, who became the heads of the twelve tribes of Israel.

Abraham had also children by Keturah, another wife, whom he sent away from Isaac towards the eastward. Among these was Midian, who became the head of a nation, which is frequently noticed in the subsequent history.

Jacob remained in the land of Mesopotamia for 21 years, and then returned to Canaan, where he found Isaac still living. Esau, his brother, who had addicted himself to the chase, and probably also to warfare, was at the head of 400 armed men, and resided chiefly in Mount Seir. Jacob had eleven sons at the time of his return to Canaan, and one was born to him after his return. The two youngest were sons of his favoured wife, Rachel, and were distinguished by him from his other children by particular tokens of affection. This occasioned discontent and envy in the others, which being increased, with respect to Joseph, the elder of Rachel's sons, by his fidelity in reporting their vices, and by certain dreams, which he related, that seemed to indicate an ambition of ruling over them, they seized an opportunity of his being at a distance from his father, to sell him to a company of merchants passing through the country. These merchants, who were Ishmaelites and Midianites, brought him to Egypt, and sold him there as a slave.

While he was there, the king of Egypt had a remarkable dream, which gave him uneasiness, and Joseph being informed of it, felt himself warranted, by a divine impulse, to propose to interpret it. He was accordingly brought before Pharaoh, and interpreted the dream, to signify that it indicated that there would be seven years of plenty in the land of Egypt, followed by seven years of extreme scarcity. Joseph was immediately raised to the highest rank in the kingdom of Egypt, being intrusted, during the years of plenty, with the collecting of grain for supplying the deficiency of the approaching years of famine. While he was engaged in the execution of this office, during the years of scarcity, the famine, having reached to Canaan, brought down his brethren to Egypt to purchase corn. Joseph immediately recognised them, although they did not recognise him; and after a variety of measures, the purport of which seems to have been to bring them to a sense of their guilt, he at length made himself known to them. The result was, that, on the invitation of Joseph, and also of the king of Egypt, Jacob and his whole family removed to Egypt, where he lived about seventeen years, and died.

The Israelites, being placed in a fruitful part of the country, increased, under the blessing of God, with amazing rapidity.

Egypt.—Egypt had now become a powerful kingdom. That king, who reigned in the time of Joseph, in consequence of his having obtained the command of the supply of food during seven years of extraordinary scarcity, had been enabled to make his own terms with the people. And the arrangement which he had made was, that the people should pay to him a fifth part of the produce of the land, in lieu of rent as proprietor of the land, and of taxes as head of the government. This arrangement enabled the king to maintain a powerful and well-appointed army, with abundance of horsemen and war chariots. It enabled him also to engage in those stupendous works of architecture, the remains of which are still the astonishment of the world. Egypt had also commenced the practice of embalming the bodies of the dead, by which it has been rendered so remarkable. Forty days were employed in this operation in the time of Joseph.

SIXTH ERA.

Moses.

A.M. 2500.—B.C. 1500

THE ISRAELITES.—The rapid increase of the Israelites [illegible]ered them in process of time objects of alarm to t[illegible]gyptians; a king arising who knew not Joseph, he began to adopt the most rigorous and unscrupulous measures to diminish their number. He reduced them to the most abject slavery, employing them in building cities, exacting of them exhausting and overpowering labour. But finding that they still continued to increase, he commanded that all the male children should be thrown into the river as soon as they were born, and only females preserved alive. At this time Moses was born and was preserved from the effects of this edict in consequence of having been taken under the protection of the king's daughter. His parents had placed him in a chest of bulrushes, and laid him among the flags, by the brink of the river, and Pharaoh's daughter finding him, adopted him as her own son. Thus Moses received an education which fitted him for the important office to which he was destined, as leader and governor of the Israelites. When Moses came of age, however, having been made acquainted with his descent from Abraham, Isaac, and Jacob, and having been instructed by his parents in the privileges bestowed upon their nation by the God of heaven, he relinquished his fair hopes and prospects, as an Egyptian of high, even of royal rank, and claimed his connection with the despised and persecuted Israelites. He chose "rather to suffer affliction with the people of God, than to enjoy the pleasures of sin for a season." He saw an Egyptian smiting, probably putting to death, an Israelite, and taking the part of the Israelite, he killed the Egyptian. This being discovered, he fled across the Red Sea, to the mountains which lie between the gulfs into which the Red Sea divides itself at its northern extremity, which was then called the land of Midian, doubtless in consequence of Midian, the son of Abraham, fixing his residence there. He thus obtained an opportunity of becoming acquainted with that district of country, and with the whole of the desert that lies between it and the land of Canaan. While Moses was in Midian, the Lord appeared to him and commissioned him to return to Egypt, there to call together the heads of the Israelites, and then to go to Pharaoh and demand liberty for the people to leave the land of Egypt. Moses did so. The demand was, of course, refused; but, by a series of plagues, which Moses was commissioned to inflict on the land of Egypt, the last of which was the destruction, in one night, of all the first-born sons in Egypt, Pharaoh was compelled to yield to the demand, and to let the people go. Moses accordingly led them towards the Red Sea, as if he intended going round the northern extremity of the western gulf of it; but by direction of God he turned, and encamped close by the gulf, on the western side. Pharaoh seeing the immense body of the Israelites, consisting of 600,000 men, with their wives and children, entangled in the land, and apparently within his reach, pursued them with his whole army, and came up with them as they lay encamped, unable to go forward, for the sea was in their front, or to turn either to the north or the south. In this extremity, the Lord caused the sea to divide, and directed Moses to lead the people through the bed of it. The Israelites thus passed in safety into the Arabian desert; while the Egyptian army, in attempting to follow them, were caught by the return of the sea to its usual bed, and drowned.

Moses then conducted the people to the mountainous district, where he himself had found refuge; and there the law was given to them, and their civil and ecclesiastical policy arranged. They then marched northwards towards Canaan, and were directed to enter it, but, being afraid, and refusing to go, they were condemned to wander forty years in the desert, till all the generation that came out of Egypt had died, with the exception of two persons. During their wanderings, they met with many vicissitudes, fell into many sins, suffered severe corrections; but, at length, they were led round by the south of Edom, and, after defeating two kings who attempted to withstand them, they found themselves encamped on the east side of the river Jordan, opposite to Jericho.

About this time Moses died, and Joshua succeeded to the command. He led them across the Jordan, which was miraculously divided to afford them a passage. He first took and destroyed the city of Jericho, and afterwards passed through the greater part of the land, took the cities wherever he went, extirpating, or driving out the Canaanites, and setting the Israelites in their room.

Joshua did not complete the conquest of the land, many of the natives retaining their footing in it. After his death, the people fell from time to time into idolatry, and the Canaanites, who were in the land, or the neighbouring nations, particularly the Moabites, Midianites, and Philistines, obtained power to oppress them.

During this period the Israelites were governed by judges, who succeeded Joshua; and these led them in war, and administered justice to them in peace.

In the first century, after the death of Joshua, Cushan-rishathaim, king of Mesopotamia, oppressed them for eight years, when, on their repentance, Othniel was raised up to deliver them, B.C. 1405.

The people enjoyed rest for forty years, but returning to idolatry, they were invaded and oppressed for 18 years by the king of Moab, aided by the kings of Ammon and Amalek, and on their repentance were delivered by Ehud, who slew the king of Moab, B.C. 1325.

In about 20 years afterwards, the Israelites, having returned to their idolatry, were invaded and oppressed by Jabin, king of Canaan, for 20 years. On their repentance, Barak, and Deborah, a prophetess, under the direction of God, assembled an army near Mount Tabor, on the banks of the stream Kishon, and, on their being attacked by the army of Jabin, totally defeated it, B.C. 1285. This victory gave occasion to the celebrated ode, composed by Deborah.

Another relapse into idolatry brought upon them an oppressive invasion of the Midianites, who tyrannized over them for seven years: and, when they repented, and cried to God for deliverance, Gideon routed the army of the Midianites, with 300 chosen men, B.C. 1245.

On the death of Gideon, idolatry again began to appear, and on this occasion the people were chastised by internal warfare. Abimelech, a son of Gideon by his concubine, slew all the rest of Gideon's children, and was proclaimed king by the Shechemites, but his adherents afterwards quarrelling, destroyed one another.

On a subsequent relapse into idolatry, the Philistines and Ammonites obtained power over the Israelites, and oppressed them for eighteen years. Jephtha was, on this occasion, raised up to deliver the people. He defeated the children of Ammon in a battle fought on the east side of the river Jordan, B.C. 1187. The Ephraimites quarrelled, on this occasion, with him, for not taking them to the war along with him; and he intercepted them at the fords of the Jordan, and slew of them 42,000 men.

About 33 years after this, Eli, the high priest, was judge, and during his weak government the people fell into their besetting sin. The Philistines then came upon them, overran the country, and miserably oppressed them for forty years. It was during the government of Eli that Samson performed his feats of miraculous strength. At length the Israelites were roused to resist the Philistines, and the sons of Eli brought the ark out of the tabernacle, for the purpose of inspiring the people with courage, and of terrifying the enemy; doubtless, also, with some expectation that God would not permit that sacred symbol of the covenant to be taken by the Philistines. But they were totally defeated, and the ark taken, B.C. 1116. Eli received so great a shock by this event, that he fell backwards and died.

Samuel, who had been brought up in the temple with Eli, then became judge of Israel. He was the last of the judges. His sons, being entrusted by him with the government of the kingdom, conducted themselves in the most profligate manner, so that the people demanded a king, that they might be like the nations around them. Samuel was directed by God to comply with this demand, and Saul was chosen the first king of Israel. He, however, proving unfaithful, the Lord rejected him, and chose David to be king. This choice came to the ears of Saul, who from that time pursued David with the most deadly malignity. At length, Saul and his son Jonathan, a young man of the noblest and most amiable character, were slain in battle by the Philistines, and David ascended the throne of Judah, B.C. 1055, and became king of all Israel, B.C. 1048.

David was a warlike prince, and subdued the Syrians, the Philistines, the Moabites, and Edomites, and brought that whole district of country that lies between the river Euphrates and the Mediterranean sea under tribute. After an eventful life, David died, leaving his dominions to the undisturbed possession of his son Solomon, who succeeded him, B.C. 1015.

PALESTINE.—This country had in the days of Moses become more densely peopled than it was in the days of Abraham. It was occupied by several tribes, descended from the same stock, namely, the family of Canaan, as the Hittites, Hivites, Amorites, and Jebusites. These tribes had built many strongly fortified cities, and had brought the ground into general cultivation. The cities on the sea-coast had commenced that commercial career which, for many ages, gave them much influence in the political revolutions, which mark the general history of the world.

But, in their prosperity, they had cast off all fear of the God of heaven, and had rushed, with one consent, into the most debasing idolatry. They occupied that land which God had destined for the seat of his own people; and, by the time that the Israelites had become sufficiently numerous to occupy the country, they were, by their wickedness, ripe for the fate that awaited them.

They had abundant warning given to them of the purpose of God to expel them. After the Israelites had been separated from the Egyptians by their passage through the Red Sea, they hung on the borders of Canaan for about forty years, wandering in a desert, in which no such body of people could have existed without a miracle. But the Canaanites, so far from taking warning and retiring from the country, seem to have been at the more pains to fortify themselves in it; so that when they were attacked by Joshua, they seem to have regarded themselves quite prepared by their fortresses, their armaments, and their leagues for mutual defence, to repel him.

They were, however, subdued, with amazing rapidity, but not wholly expelled nor extirpated. Considerable numbers of them remained in the land, and for many ages greatly harassed the Israelites.

In the time of David these original inhabitants of the holy land were either extirpated, or thoroughly subdued. The empire of Jabin, king of Canaan, the capital of which was Hazor, towards the north of Palestine, and which rose to its height about 300 years before the time of Solomon, seems never to have recovered the blow that it received from Deborah and Barak. The Philistines also were thoroughly and permanently subdued by David. Of the states on the coast, Tyre rose to great eminence; and the inhabitants of Tyre became celebrated for their skill in navigation and commerce. Hiram was king of Tyre in the days of Solomon, and the two monarchs seem to have lived on terms of undisturbed friendship. Hiram gave Solomon much assistance in the building of the temple, and they sent out fleets together from Ezion-Geber, on the Red Sea, for commercial purposes. The places which these fleets* visited, are not exactly known.

The nations immediately surrounding Palestine, as *Syria, Moab, Ammon, Edom*, and *Midian*, were, in the days of David, brought into subjection to his empire. Moab and Midian had, at different times, invaded and oppressed the Israelites; but they as well as Edom, were subdued by David, and did not dare to molest Solomon.

Of the more distant nations, *Mesopotamia* at one time attained to great power under Cushan-rishathaim. They invaded, and greatly oppressed Israel, for a time; but were defeated by Othniel, the son of Caleb. This seems to indicate, that the kings of those eastern countries still continued to aim at the extension of their dominion towards the westward, as they had done so early as the days of Abraham.

Of those descendants of Abraham who settled in the neighbourhood of Palestine, chiefly in what is now the peninsula of Arabia, the Ishmaelites, Midianites, and Edomites, had increased and become nations, governed by kings of their own. The Moabites and Ammonites also had become independent kingdoms. These several kingdoms formed a kind of cordon of kingdoms of the kindred of the Israelites, on the eastern and southern boundaries of the land that was allotted to them, whose language was totally different from that of the Canaanites, and also from that of Egypt.

EGYPT.—Egypt was at this time the chief seat of arts and sciences. If the book of Job was written by Moses, as is generally believed, astronomy, mineralogy, and natural history, had been cultivated to a considerable extent, and the writings of Moses manifest the most perfect simplicity, purity, and sublimity of diction. Much of these beauties of composition, doubtless, must be attributed to inspiration. Yet, observing how the natural gifts, and the acquirements of the apostles of our Lord, were wrought up with inspiration in the composition of their writings, there can be no doubt that, in the knowledge which Moses exhibits of a vast variety of subjects, which were not likely to be communicated by revelation, we have some indication of the advancement of the Egyptians of that age, in science and art.

GREECE.—The kingdom of Athens is supposed to have been founded about the time of the birth of Moses, by Cecrops; and Deucalion's flood, in Thessaly, is supposed to have taken place about the time of the mission of Moses to Pharaoh. Others think that this flood was a mere tradition of the universal deluge, and that Deucalion was Noah.

The people, who settled in Greece, appear to have been refugees from many nations; and society among them seems at this time to have been in its elements. Their most ancient traditions, chiefly respect marauding expeditions, and the destruction of cities. About 260 years before Solomon, when the Israelites were governed by Judges, an expedition was undertaken by Jason, in a ship called the Argus, having on board 50 followers, who entered the Euxine sea, and coasted along till they came to Colchis. Here Jason carried away with him Medea, the daughter of the king of Colchis. This expedition seems to have been very much like what we might expect to have taken place among the New Zealanders, or the inhabitants of Tahiti, previously to the introduction of Christianity among them. About 70 years afterwards, Paris, the son of the king of Troy, in a similar piratical expedition, carried off Helen, the wife of Menelaus, king of Sparta. Menelaus prevailed on the Grecian states to espouse his cause; and this gave rise to the celebrated siege of Troy, which ended in the total destruction of that city. It is supposed to have been in the time of David, that Cadmus introduced letters into Greece from Phœnicia; and Homer, who celebrated the siege of Troy in his poem called the Iliad, is supposed to have flourished about the time of Solomon.

SEVENTH ERA.

Solomon.

A.M. 3000.—B.C. 1000.

THE KINGDOM OF JUDAH.—*Solomon*, on his coming to the kingdom, was in possession of every thing that could contribute to the greatness and happiness of a mighty prince. His possession of the throne was undisputed—his dominions at perfect peace—his government respected by the surrounding nations, and abundance of wealth flowed into his kingdom through the means of an extensive commerce. He himself was a master of all the learning of the age, and possessed much knowledge, in which the rest of mankind did not participate. He wrote treatises, which are not now extant, on plants and on animals. He wrote many proverbs, or moral sayings, and also many poems, some of which are extant, having been embodied in the book of inspiration. He lived in the utmost magnificence and was energetic and able as a judge and a statesman. His great work was the erecting of a magnificent temple at Jerusalem, which, for many ages, was, as the tabernacle previously had been, the centre of divine worship.

Arts and sciences must have made considerable progress in the days of Solomon. The temple, which he built at Jerusalem, seems to have furnished the model for the most chaste and simple of the Greek temples, being, like the Greek temples, an oblong house, divided into an outer and inner apartment, the inner the most sacred; a portico also, supported by two pillars, with their bases, shafts, and capitals, and probably also, with an entablature and pediment, being placed in front of the principal entrance. This temple was built of stone, hewn and polished in Mount Lebanon, the wood part of it also being of timber cut in that mountain; and the whole materials for the erection of the temple were prepared there, brought by sea to

Joppa, and thence conducted over the mountains to Jerusalem; so that, when they came to be erected, no sound of any tool was heard. This, of itself, exhibits high advancement in the mechanical arts. In the art of composition, nothing can excel, for sublimity and tenderness, the Psalms of David; for terseness and force, the Proverbs of Solomon; or, for beauty and simplicity of narrative, the history of the reigns of David and Solomon. And this advancement of literature was not confined to Judea; for, if Homer flourished at this time, the Greek poetry also of that age still commands the admiration of the world, for its combined simplicity, sublimity, and elegance. Navigation also, and commerce, were cultivated to a great extent. Some have supposed, that the combined fleets of Solomon and Hiram even went round the peninsula of Africa, passing down the Red Sea, doubling the Cape, now called the Cape of Good Hope, and returning by the Mediterranean. Although none of the works of Solomon, expressly on natural history, are extant; yet from the allusions made by him, and by David his father, to natural objects, much accurate knowledge, it is obvious, must have been collected on these subjects.

The Jewish monarchy reached its highest elevation in the reign of Solomon, and it immediately began to decline. The promise made to Abraham, that a seed should be raised up to him, which should reign from the river Euphrates to the shores of the Mediterranean sea, was literally fulfilled. But no sooner had the nation attained this elevation, than it began to decline. Solomon himself, enticed by idolatrous wives, the daughters of the neighbouring princes, fell into idolatry. The Ephraimites, a powerful tribe, never seem to have been thoroughly reconciled to the reign of the house of David, which was of the tribe of Judah; and on the succession of Rehoboam, the son of Solomon, a demand was made for some relaxation in the government. This demand was answered roughly by Rehoboam, and instantly ten of the twelve tribes revolted, under the auspices of Jeroboam. Thus the Israelites were divided into two kingdoms; the one, consisting of ten tribes, called the kingdom of Israel; the other, consisting of the tribes of Judah and Benjamin, with the Levites, called the kingdom of Judah. The consequence of this division was an almost continual rivalship and warfare between the two kingdoms.

Rehoboam was the first monarch of the kingdom of Judah, as distinguished from that of Israel. He was a weak prince, and in his reign Shishach (supposed to be the same with Sesostris), king of Egypt, invaded his kingdom, and plundered Jerusalem and the temple. He reigned 17 years.

Abijah succeeded him, and reigned three years. In his reign, a battle was fought between him and Jeroboam, king of Israel, in which the latter was defeated with the loss of 500,000 men.

Asa succeeded Abijah, and reigned 41 years. He was, on the whole, a good prince. In his reign the Ethiopians, or Cushites, a people occupying the southern parts of Arabia, came up against his kingdom, with an immense army. Asa committed himself and his people to God, and then going out against the Ethiopians, totally defeated them. After this, Baasha, king of Israel, came up against him, and began to build a fortress at Ramah, on the borders of his kingdom. Asa, instead of again betaking himself to God, hired Benhadad, king of Syria, to send an army against Israel. This expedient succeeded for the time; the army of Israel withdrew, and the fortress was levelled to the ground. But God was displeased with him, and sent a prophet to rebuke him; on which he was angry, and put the prophet in prison. Soon after he became diseased in his feet. In his disease, he sought not to God, but to the physicians, and died of his disease. To Asa succeeded—

Jehoshaphat, his son, who reigned 25 years. Jehoshaphat adopted vigorous measures for purging the land from idolatry, and for instructing the people. Towards the beginning of his reign, Elijah the prophet was raised up to contend against the progress of idolatry and wickedness in Israel. Jehoshaphat joined

Ahab, the wicked king of Israel, in an enterprise against Ramoth Gilead, which was in possession of the Syrians. In this enterprise, Ahab was killed, and Jehoshaphat escaped to his own kingdom. Jehoshaphat engaged in another military expedition along with Jehoram, now king of Israel, against the Moabites; and the two kings after being in imminent danger of losing their armies and their lives from want of water, were, by applying to Elisha the prophet for directions, not only delivered, but enabled to defeat the Moabites. Jehoshaphat died in 889, B.C. and was succeeded by his son—

Jehoram.—This prince had married Athaliah, daughter of Ahab and Jezebel. On his accession, he murdered his brethren and introduced idolatry into his kingdom. Another Jehoram, son of Ahab, was, at the same time, king of Israel. In this reign the Edomites revolted from under the dominion of Judah, and never were again subdued. Jehoram was warned, by a letter from the prophet Elijah, of the judgments of God about to fall upon him; but in vain. God then brought the Philistines and Arabines against him, who broke into Judah, plundered the king's house, and took away his wives and his sons, so that he had no son left him but Jehoahaz or Ahaziah.* Still remaining incorrigible, he was smitten with violent disease, and died miserably, in the 8th year of his reign, B.C. 885.

Ahaziah, his younger son, succeeded him. He was the son of Athaliah, the daughter of Ahab, who seems to have been absent when the Philistines came and took away the other wives and children of Jehoram. Under the advice of his mother, he followed the example of the house of Ahab, in all manner of wickedness. Having entered into an alliance with Joram, king of Israel, to make war upon Hazael, king of Syria, Joram was wounded, and Ahaziah went down to

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* Ahaziah and Jehoahaz are substantially the same name, the Hebrew letters being the same, but transposed. Azariah was another name by which he was known.

Jezreel to visit him. There he was involved in one common destruction with Joram. Jehu, who had risen up against his master, finding the two kings together, slew them both, B.C. 884.

Athaliah, his detestable mother, then murdered all his children, with the exception of Joash, who was saved by Jehoshabeah, a daughter of king Jehoram, the father of Ahaziah and husband of Athaliah. Jehoshabeah, who had been married to Jehoiada, the priest, concealed Joash in the temple till he was seven years old, during which time Athaliah, the queen mother, reigned over Judah. But, in the seventh year, Jehoiada brought forward Joash to the people, who received him with joy, and Athaliah was put to death.

Joash thus began his reign, in the 7th year of his age, and reigned 40 years. He acted well during the life of Jehoiada the priest. He repaired the temple, and renewed the worship of God, which had been suspended under the influence of Athaliah and her sons. On the death of Jehoiada the priest, Joash, listening to the suggestions of the princes of Judah, left the house of God and worshipped idols. Prophets were sent to remonstrate with him; but in vain. Among these prophets was Zacharias, the son of the venerable Jehoiada, to whom he owed his life and his kingdom. He stood forward, and declared to the people, that, as they had forsaken the Lord, so he had forsaken them; on which Joash was so incensed, that he commanded him to be stoned to death, which barbarous command was executed in the court of the temple. Zacharias, when he was dying, said, "the Lord will look on it and require it;" and, accordingly, before the end of the year, the Syrians came up, destroyed all the princes, and left Joash himself dangerously ill, probably from wounds which he had received. When he was in this helpless condition, two of his own servants, an Ammonite and a Moabite, conspired against him, and murdered him on the bed on which he lay.

Amaziah succeeded Joash, and reigned 29 years. Amaziah raised a great army to make war on the

Edomites, and recover them to his kingdom. In this army he had embodied 100,000 men of the kingdom of Israel, whom he had hired for 100 talents of silver. But a prophet remonstrating with him on the sin and danger of accepting the assistance of a people whom God had forsaken, he sent back the Israelites to their own country. Amaziah then went on his expedition against the Edomites, defeated them, and treated them with great cruelty, as rebels. On his return, however, he brought their idols with him, and set them up and worshipped them. In the meanwhile, the troops that he had hired from Israel, enraged at being dismissed, came up when he was absent in Edom, and committed great ravages in Judah. This induced Amaziah to challenge the king of Israel to meet him in battle, and the challenge being accepted, a battle was fought, in which Amaziah was defeated, and taken prisoner. The king of Israel then brought him back to Jerusalem, broke down 400 cubits of the wall of the city, seized all the gold and silver that he found, and taking hostages with him, returned to Samaria. After this a conspiracy was formed against Amaziah, on which he fled to Lachish; but was overtaken and slain there, B.C. 810. To Amaziah succeeded his son—

Uzziah, in the 16th year of his age, who reigned 52 years. He was a warlike prince, and seems to have reduced war more to system than it ever had been before. He had a standing army of 307,500 men, well armed by himself, that went out to war by bands, according to the enrolment made of them. He fortified the city, and placed engines upon the walls to hurl darts and great stones upon any assailants. He attacked the Philistines and dismantled their principal fortified cities. He also succeeded in an expedition against the Arabians, and brought the Ammonites under tribute, and became celebrated for his military talents and success.

But Uzziah's prosperity proved his destruction. He became proud and self-willed, and insisted on entering into the temple to burn incense according to the custom of the monarchs of other countries, but in direct opposition to the law of God. He was resolutely withstood by a body of priests; and, becoming angry, he was struck with leprosy, and instantly hurried out of the temple to retire to a separate house, in which he lived till his death, B.C. 758.

Jotham, his son, succeeded him, and reigned well for 16 years. He followed up the defensive preparations begun by his father, by erecting forts and fortified cities in the mountains of Judah. He defeated the Ammonites, and brought them under tribute. On his death, B.C. 742—

Ahaz, one of the most profligate princes that ever reigned in Judah, succeeded, and reigned 16 years. He ran headlong into idolatry, with all its accompanying abominations. His dominions were invaded by the king of Syria, who took away a multitude of captives to Damascus. Afterwards Pekah, who had usurped the throne of Israel, defeated him with immense loss; 120,000 men being killed and 200,000 taken prisoners. The prisoners were conducted to Samaria, where it was proposed to make them slaves; but on the remonstrance of the prophet Oded, they were not only set at liberty, but clothed, treated kindly, and sent back to Judah.

After this, Ahaz, being distressed by incursions of the Edomites on one side, and Philistines on the other, and also threatened by the king of Syria, applied for help to Tiglathpileser, king of Assyria. This was readily given, as Tiglathpileser was now meditating conquest, and he grasped at the opportunity of intermeddling with the western kingdoms of Asia. He invaded Syria, took Damascus, and killed Rezin the king. But he only harrassed Ahaz by exacting gold and silver for his army. Ahaz stripped the temple and the palace of their gold and silver to pay the demand made on him. He even took the vessels out of the temple, shut it up, suspended the worship of God, and raised idolatrous altars in every corner of Jerusalem. At length, after a mischievous and disastrous reign of 16 years, he died, B.C. 726.

Hezekiah, his son, succeeded him, and reigned 29 years. He was an exemplary prince. He restored the worship of God, and made strenuous efforts to reform his kingdom. In his reign Samaria was taken by Shalmaneser, king of Assyria, and Hezekiah endeavoured to collect the remnant of the people, and bring them up to Jerusalem, there to worship God in his appointed way. Afterwards Sennacherib, who had succeeded to the throne of Assyria, came up against him with an overpowering army, demanding unconditional submission. Hezekiah having laid the matter before the Lord, the whole army of Sennacherib died in one night. Sennacherib fled, and was afterwards murdered by his own sons.

We shall here pause in the history of the kingdom of Judah, and look back to the history of other countries during the same period. One reason for this pause is, that several of the great eras in the history of the most famous nations of antiquity, belong to this century, and several of the most important, to the time of Hezekiah. Thus, the era of the building of the city of Rome, A.U.C. was the year B.C. 753. The era of Nabonassar, or rise of the Babylonian empire, was B.C. 747. The dissolution of the kingdom of Israel was B.C. 721. The first Olympiad, from which the Greeks were accustomed to compute their history, was a little earlier in this century, namely, 776 B.C. and the founding of the kingdom of Lydia still earlier, namely, B.C. 797. Besides these more remarkable eras, it may be noticed, that the first Messenian war was begun by Sparta, when Hezekiah was about seven years old, B.C. 743. To all this, it may be added, that about the close of the preceding century, the kingdom of Media, and also that of Macedonia, were founded; the former, B.C. 820, the latter, B.C. 814. The young student of history, therefore, should fix in his memory the eighth century B.C. as that in which the great kingdoms of antiquity began to be organized, and to lay the foundation of their future eminence.

ISRAEL.—We have already observed, that ten of the twelve tribes of which the whole nation of the Hebrews consisted, revolted at the commencement of the reign of Rehoboam, son of Solomon, from the family of David, and elected Jeroboam their king.

Jeroboam, finding himself elevated to the sovereign power over the larger proportion of the nation, began to fear that his newly acquired subjects might, if they went up to Jerusalem to worship at the temple, be induced to return to their allegiance to the family of David, and therefore erected two idols, one in Bethel, and the other in Dan. Before these idols he commanded the people to assemble, instead of going up to Jerusalem. This was the introduction of a corruption into that kingdom, from which it never recovered. He was in continual warfare with the kingdom of Judah, and suffered that defeat from Abijah, which has already been mentioned. He reigned 22 years, and died towards the beginning of the reign of Asa, king of Judah. He was succeeded by his son—

Nadab. Baasha conspired against Nadab, and murdered him.

Baasha then usurped the kingdom, destroyed the whole family of Jeroboam, and reigned 24 years. There was a war between him and Asa all his life, and his kingdom was invaded at the instigation of Asa, by Benhadad, king of Syria. Baasha dying, was succeeded by—

Elah, who reigned two years, when his servant, Zimri, conspired against him, and killed him.

Zimri succeeded him, but reigned only seven days; for the people did not approve of him, and called Omri, commander of the army, to the kingdom. Zimri, however, in his short reign, destroyed the whole family of Baasha. Then, Omri came against him to Tirzah, and he, seeing no hope of success or of escape, retired to the palace, set it on fire, and perished in it.

Omri succeeded; but he had a rival, called Tibni, who was followed by half of the people. Omri's party, however, prevailed; so Tibni died, and Omri reigned alone. Little is recorded of Omri, but his wickedness. In his reign, Samaria was built, which afterwards became the capital of the kingdom. He reigned 12 years, and died towards the latter end of the reign of Asa, king of Judah, leaving his crown to his son,

Ahab.—This prince is still more distinguished than his father, for his audacious wickedness. He married a heathen woman, Jezebel, daughter of the king of Zidon. He then set up the worship of Baal openly, in Samaria. It was to stem the flood of iniquity let in upon the nation by this wicked prince and his queen, that the prophet Elijah was raised up;—but nothing could arrest them in their career of wickedness. His kingdom was invaded by Benhadad, who still reigned, at Damascus, over Syria, and who seems to have subdued the neighbouring tribes, for he had thirty-two kings with him in his army. Ahab, under the direction of a prophet, was enabled to defeat this host. Next year the Syrians returned, and were again totally routed, and Benhadad forced to sue for mercy.

Ahab and his wife Jezebel, in their career of wickedness, persecuted the prophets of God, and established prophets of Baal in their stead. Ahab wished to purchase the vineyard of Naboth, one of his subjects. Naboth refused to sell it, because it was the inheritance of his father. Jezebel then contrived the murder of Naboth, which was executed, and Ahab took possession of his vineyard. For this Elijah denounced on him, his wife, and his kingdom, the terrible judgments of God. Ahab, after this, persuaded Jehoshaphat, king of Judah, to join him in a war against the Syrians, and was slain in battle, B.C. 897, having reigned 22 years.

Ahaziah, who had been associated with his father in the throne for some time before his death, now succeeded to the entire government of Israel, and reigned two years. His death was occasioned by a fall from a lattice in the upper part of his house. He was succeeded by—

Jehoram. He came to the throne, during the reign of Jehoshaphat, king of Judah, who had a son named

Jehoram associated with him in the kingdom. The king of Moab having, on the death of Ahab, withheld a certain tribute which he was accustomed to pay to the kings of Israel, Jehoram invited Jehoshaphat, king of Judah, to assist him in subduing the king of Moab. Jehoshaphat consented; and the two kings had well nigh perished with their armies by want of water, but were delivered, as has been noticed under the reign of Jehoshaphat. The king of Moab, in his extremity, offered up his eldest son as a sacrifice, to obtain deliverance from his God. It was to Jehoram that the king of Syria sent Naaman, the commander of his army, with an insolent letter to be cured of his leprosy. After this, he went to war with Hazael, king of Syria, and was wounded. He retired to Jezreel to be cured of his wounds; and while he lay there, Jehu, one of the commanders of his army, formed a conspiracy against him, and put him to death. Ahaziah, king of Judah, was slain at the same time.

Jehu succeeded, and reigned 28 years. He put to death Jezebel, and the whole family of Ahab, and massacred all the priests of Baal; but he himself continued to worship the idols which Jeroboam had set up. In his reign, Hazael, king of Syria, encroached upon the territory of Israel, taking possession of that part of it which lay to the east of the river Jordan. On the death of Jehu,

Jehoahaz, his son, succeeded him, and reigned 17 years. The Israelites persisting in their idolatry, Hazael, king of Syria, was permitted to invade the land, and to succeed in oppressing it during the whole reign of Jehoahaz. This prince dying, he was succeeded by

Joash, or *Jehoash*, his son, while Joash, the son of Ahaziah, reigned in Judah. He reigned 16 years; and, though he persevered in the hereditary idolatry of the kingdom, yet manifesting respect and attachment to Elijah the prophet, God gave him three victories over the Syrians, and enabled him to recover the cities which had fallen into their hands. Joash also defeated

Amaziah, king of Judah, and broke down part of the wall of Jerusalem, as has already been noticed under the reign of that prince. Joash died, and was succeeded by

Jeroboam, the second of that name. He reigned 41 years in Samaria. In this reign, the Israelites were still further secured from the oppression of the Syrians, and even obtained possession of Damascus and Hamath, which David had subdued. He died 784 B.C. upon which followed an interregnum of eleven years.

Jonah the prophet lived during his reign. Jeroboam was succeeded by

Zachariah, his son, who reigned wickedly six months.

Shallum conspired against him, and slew him, and usurped the throne, but reigned only one month, for

Menahem attacked him and slew him, and reigned ten years over Israel. His reign was, like those of the other kings of Israel, idolatrous, and wicked. The Assyrian kings, who had hitherto been restrained from intermeddling with Israel and Judah, now began to harass Menahem; and he, to purchase peace, gave to Pul, king of Assyria, 1000 talents of silver, equal to about £340,000. Menahem having died,

Pekahiah succeeded, and reigned ill two years.

Pekah, the son of Remaliah, an officer in his army, conspired against him, put him to death, usurped his throne B.C. 759, and reigned twenty years. Pekah made a league with Rezin, king of Assyria, against Judah; but it did not succeed. He invaded Judah in the reign of Ahaz, and gained that great victory which has already been noticed. In his reign, Tiglathpileser invaded Israel, and took possession of the country eastward of Jordan.

Hoshea formed a conspiracy against Pekah, put him to death, and usurped the throne B.C. 730, in the reign of Ahaz, king of Judah. Hoshea reigned wickedly, like the other kings of Israel. His dominions were invaded by Shalmaneser, king of Assyria. Hoshea submitted to him, and paid him tribute; but afterwards, Shalmaneser discovering that Hoshea was giving himself into the hands of So, king of Egypt, and withholding tribute from him, went up and besieged Samaria, took it, and carried the people captive to his own land, and thus put an end to the monarchy of Israel, in the year 721, B.C. after it had continued from the reign of Jeroboam I. 254 years.

We now bring down the accounts of the heathen nations to the time of Hezekiah.

Of the original inhabitants of PALESTINE, the inhabitants of TYRE, whom we found advanced in civilization, skilful in maritime affairs and commerce, still continued to rise in riches and power. The PHILISTINES also continued to be an independent people. In the reign of Joram, king of Judah, B.C. 888, they made an inroad into Judah, and carried away the wives and sons of Joram. They were, however, rapidly falling under permanent subjection to the great monarchies, that were rising up around them.

Similar observations are equally applicable to the other small states round Judah. The MOABITES and EDOMITES, at an early period of the ninth century, B.C. threw off the yoke of the Jews, by whom they were never again subdued. The Edomites, or Idumeans, elected a king, and were afterwards governed by their own kings.

Of EGYPT, little is known, from the time that elapsed between the departure of the Israelites out of it till Solomon. In the days of Solomon it was still a great kingdom and seems to have carried on a considerable trade; for it is recorded, that Solomon imported, from Egypt, horses and chariots, and linen yarn, not only for himself, but for the kings of the Hittites, and for the kings of Syria. And soon after the days of Solomon, we find Egypt performing a distinguished part in the history of the world. In the reign of Rehoboam, the son of Solomon, Shishach, supposed by some to be Sesostris, invaded Judah, laid it under tribute, and carried away the shields of gold which Solomon had made, and also much treasure, B.C. 971. At a latter period, during the reign of Hezekiah, Sabacus, or So, an Ethiopian, was king of Egypt, B.C. 725. He endeavoured to persuade Hoshea, king of Israel, to forsake his alliance with the king of Assyria, and enter into an alliance with himself. This indicates that Egypt, in the days of Hezekiah, was attempting to rival the power and influence of the Assyrian king.

SYRIA, towards the middle and end of the first century after the age of Solomon, was making conquests. Benhadad, king of Syria, or Damascus, repeatedly invaded Israel, but was ultimately defeated by Ahab. Afterwards, recovering himself, Benhadad invaded Israel and besieged Samaria; but his army fled in a panic, which God sent upon them. In a subsequent war, Ahab was slain by him in battle. In the same year, 885 B.C. Hazael, a servant of Benhadad, murdered him, usurped the throne, and raised Syria to the greatest height of power which it ever reached. He invaded Israel in the reign of Jehu, defeated him, and ravaged the kingdom. He afterwards invaded Judah, but was induced by presents, to withdraw his army. He, however, returned, and in the reign of Jehoash, sacked Jerusalem, putting to death the princes, and carrying off much plunder. Hazael died in 839 B.C. leaving the kingdom to his son Benhadad, who was the third king of that name. He was defeated by Jehoash, king of Israel, and his kingdom again brought under tribute. At a latter period, in the reign of Uzziah, king of Judah, of Pekah, the son of Remaliah, king of Israel, and of Rezin, its own king, Syria was attacked by Tiglathpileser, king of Assyria, and brought into a bondage from which it has never recovered till the present day.

ASSYRIA was now indulging ambitious projects. Pul, apparently the first who rendered Nineveh the mistress of an extensive empire, brought Israel under tribute in the reign of Menahem, B.C. 771. Tiglathpileser, who succeeded Pul, reigned 19 years at Nineveh, invaded and conquered Syria, and exacted tribute from Judah. After him Shalmaneser, in the reign of Hoshea, invaded Israel, took Samaria, and put an end to that monarchy, B.C. 721. He also made war upon Tyre, and besieged it five years, without success. Sennacherib succeeded Shalmaneser, and invaded Judah in the reign of Hezekiah, and took several towns. He was pacified for a time by the payment of a tribute, and went against Egypt. He, however, returned to besiege Jerusalem; but Hezekiah, having laid his letter and his blasphemy before the Lord, in prayer, the whole of his army were destroyed in one night. He himself fled to Nineveh, and was there murdered by two of his sons.

Babylon, having hitherto been dependent on Nineveh or Assyria, became an independent state, a short time before the reign of Hezekiah. Nabonassar, from whom the rise of the Babylonian or Chaldean monarchy is dated, came to the throne, B.C. 747, which year is called the era of Nabonassar. Merodach Baladan, one of his successors, was he who sent the insidious message to Hezekiah, for the purpose of ascertaining the state of his kingdom.

Media, also, had some time before this, thrown off the yoke of Assyria, and become an independent kingdom under Arbaces, who reigned over it 28 years. The reigns of this prince and his successors, however, for upwards of a century, are by many considered as little better than fabulous; and the rise of the Median monarchy is dated from B.C. 700, during the life of Hezekiah, when Dejoces was elected king.

In Greece, Lycurgus, while Athaliah was in possession of the throne at Jerusalem, B.C. 884, introduced his system of laws into Lacedaemon. And, in the reign of Hezekiah, the Spartans were engaged in their first ferocious and deadly struggle to enslave the Messenians, having begun it B.C. 743.

During the reign of Joash, king of Judah, and while Jehoiada the priest was yet living, B.C. 869, CARTHAGE is said to have been founded by Elisa or Dido, sister of the king of Tyre; she having, in consequence of the murder of her husband, fled to Africa.

In ITALY, Rome was built by Romulus, B.C. 753, which year is the era of the building of that city, marked by the initials, A.U.C. *Anno Urbis Conditæ.* This was in the reign of Uzziah, king of Judah. In Hezekiah's reign, the infant city was yet engaged in its contests with the neighbouring states. The rape of the Sabine virgins was in 750 B.C.

FROM HEZEKIAH TO EZRA.

THE KINGDOM OF JUDAH.—On the death of Hezekiah, he was succeeded by his son,

Manasseh.—The beginning of the reign of Manasseh was marked by extraordinary wickedness. He entered, with his whole heart, into the practices of the heathen; built idolatrous altars in the courts of the temple; made his children pass through the fire in honour of Moloch; used enchantments; dealt with a familiar spirit, and made the streets of Jerusalem flow with innocent blood. His subjects seem to have entered with him heartily into all the wickedness; so that the Lord finally denounced upon his kingdom that doom, which about half a century afterwards was executed.

Manasseh was visited with severe chastisement. The king of Assyria sent an army, which took him prisoner, and brought him to Babylon in fetters. There in his affliction he remembered the Lord God of his fathers, repented of his sin, and besought the Lord to pardon him; and the Lord heard him, and restored him to his kingdom. He then set himself to undo, as far as possible, the mischief that he had done in the former part of his reign; but the people do not seem to have entered so heartily with him into his measures of reformation, as they did into his apostasy. Although he himself was pardoned, the sentence against the nation still remained unrepealed. He died, after a reign of 55 years, B.C. 643. He was succeeded by his son,

Amon.—He followed the wicked example of the early part of his father's reign; but did not follow him in his repentance. After a reign of two years, his servants conspired against him, and murdered him. The people resented this conspiracy, put to death the conspirators, and raised to the throne his son,

Josiah, in the eighth year of his age. His character is one of the most beautiful in the whole sacred volume, and his efforts to reform the nation were the last that were made to retrieve the downward course of the kingdom. It was in the eighth year of his reign, or the 16th of his age, that he began seriously to seek the Lord God of his fathers; and in the 20th year of his age, he had begun his measures for purging his kingdom from the gross and open wickedness that had overrun it. Having banished idolatry from the land, he revived the worship of the God of Heaven in the temple at Jerusalem. In the course of purifying the temple, the book of the law was found, which seems to have been concealed from him by a sycophant priesthood; and, when he read the commands of the law, and the denunciations annexed to them, he was in deep distress, and sent immediately to inquire of the Lord respecting the book. The reply justified his apprehensions, that destruction was hanging over his kingdom; which, however, he was informed, should not come upon it in his day. The people, although to a certain extent, externally reformed, retained all their predilection for idolatry, which accordingly broke out anew on the removal of Josiah.

The occasion of his death was this. Pharaoh Necho, who reigned in Egypt, was a powerful monarch; and Babylonia, having fallen under the government of a bold ambitious prince, these two monarchs were soon involved in war with one another. Pharaoh seems to have been the assailant, for he led his army as far as the Euphrates, to besiege Carchemish. Having in his march to pass near to Judah, Josiah went out to intercept him, and would not be dissuaded from thus embroiling himself in the quarrel. The result was, that in a battle between the army of Egypt and that of Judah, Josiah was killed, after having reigned 31 years.

Immediately on his death, the people raised his younger son *Shallum*, or *Jehoahaz*, to the throne; but the king of Egypt, having, by his victory, acquired an ascendency over the kingdom of Judah, set aside this election, carried Jehoahaz to Egypt, and placed his elder brother Eliakim, whose name he changed to Jehoiakim, on the throne. He then proceeded on his expedition against Nebuchadnezzar, king of Babylon, but was defeated. Nebuchadnezzar, thus obtaining the ascendency in Judah, deposed Jehoiakim, and put him in fetters, for the purpose of carrying him to Babylon; but on his promising to hold the kingdom under him, he restored him to it. It was at this time that Daniel and his three friends, Shadrach, Meshach, and Abednego, were carried captives to Babylon; and it is from this first incursion of Nebuchadnezzar into Judah, that the 70 years' captivity of the Jews, to the first decree for their restoration, are computed.

Jehoiakim, having maintained his allegiance to Nebuchadnezzar for three years, at the end of that time revolted. The consequence was, that Nebuchadnezzar sent an army against him, which laid waste the country, took Jehoiakim prisoner, and put him to death in the year B.C. 599. On the death of Jehoiakim—

Jehoiachin (named also Coniah and Jeconiah), his son, ascended the throne; but not having obtained the consent of Nebuchadnezzar, he, after reigning three months, was set aside, and carried to Babylon. Along with him, there were taken all the gold and silver vessels, and treasures of the temple, also all the able men, and men of influence in Jerusalem, to the number of 10,000, and 8,000 artificers from the country; the poorest of the people only being left. It was in this captivity, that Mordecai and Ezekiel were taken; and Ezekiel reckons the time, in his prophecy, from this captivity, which took place in the reign of Jehoiachin.

Zedekiah, brother of the former king, Jehoiakim, was then placed on the throne by Nebuchadnezzar. Meanwhile, the king of Egypt bore, with impatience, the increasing power of Babylon, and watched for an opportunity of curtailing it. In the 8th year of the reign of Zedekiah, he made a feeble effort to revive the power and influence of his kingdom, and persuaded Zedekiah to break faith with Nebuchadnezzar, and join in an alliance with Egypt to resist him. On the revolt of Zedekiah, Nebuchadnezzar came against him; and, having laid waste the country, besieged Jerusalem. The king of Egypt came up for the purpose of relieving the city. Nebuchadnezzar raised the siege, and marched against him; but he retreated within his own territory, leaving Jerusalem to its fate. Nebuchadnezzar then returned to the siege. The city was exceedingly strong, and well calculated, from its position and fortifications, to resist the implements of warfare then in use, so that Nebuchadnezzar had no resource but to reduce it by famine. He surrounded the city with his army, to prevent all ingress or egress, and, after holding this position for about two years and a half, the distress within the city was so great, that the people were devouring one another, and women were discovered cooking and eating their own infants. At length Zedekiah made an attempt to pass through the Chaldean army, but was discovered, overtaken, and brought to Nebuchadnezzar, who treated him as a rebel, made his children be put to death before his eyes, and then caused his eyes to be put out. In the meanwhile the Chaldean army burst into the city, made a dreadful carnage among the people, burned the temple and all the principal edifices, and made slaves of all whom they did not put to the sword. Zedekiah was carried to Babylon, where he died. Thus was dissolved the kingdom of Judah, in the year B.C. 588; and it is from this captivity that the 70 years are to be reckoned to the decree of Darius Hystaspes, king of Persia, to restore the city and temple.

BABYLON.—The era of Nabonassar, who may be considered the first king of Babylon, has been determined to correspond to the year B.C. 747, or three years after the birth of Hezekiah. For some time, the history is obscure, the kings of Assyria and Babylon sometimes seeming to be the same, and sometimes different. The general current of the history seems to have been, that the kings of Babylon were at first governors for the kings of Assyria; but that, after various struggles, they rendered themselves independent. To Nabonassar succeeded several kings, little or nothing of whom is known, and whose names it is not necessary here to record. After the death of Sennacherib, king of Assyria, who invaded Judah in the reign of Hezekiah, Assarharddon succeeded him; and, during the latter part of his reign, had Babylon, as well as Nineveh, under his dominion. He came to the throne during the reign of Hezekiah, and died in that of Manasseh. He was succeeded by

Saosduchinus, of whom nothing is known. It was probably in his reign that Manasseh was restored to his kingdom. To him succeeded

Chyniladan, who is supposed, on good grounds, to have been the Nabuchadonosor of the book of Judith. If so, he occupied Palestine with his army, probably during the reign of Josiah, when that prince was yet too young to resist him. To Chyniladan succeeded

Sarac, or *Sardanapalus*.—He committed his forces in Chaldea to Nabopolassar, who rebelled against him; and, to strengthen his rebellion, invited the Medes, who had always borne the sway of the Assyrian empire with impatience, to unite with him. They did so, and the two armies besieged Nineveh. Sardanapalus, dreading the calamities that seemed to be coming upon him, retired to his palace with his wives, and, having set it on fire, was there destroyed, with his whole family and property. The allied army of Medes and Babylonians, some time afterwards, took Nineveh, and destroyed it. Nabopolassar associated his son, Nebuchadnezzar, with him on the throne, two years before he died; and, on his death, was succeeded by

Nebuchadnezzar, when Jehoiakim was on the throne of Judah. His treatment of the Jews has already been noticed. Under him the Babylonian empire, or the first of the four great monarchies, described in the prophecies of Daniel, reached its greatest height. Having established his government in the east, he attacked Pharaoh Necho, and drove him within the boundaries of his own kingdom. He then set himself to strengthen and ornament the city of Babylon. He enclosed an immense space of ground within an enormous wall, and erected hanging gardens, or gardens on elevated terraces, which have been the wonder of the world. He seems to have repaired the tower of Babel, and fitted it to be a temple for his god; and there probably he set up that golden image which the three Hebrew captives refused to worship. While these events were passing in Babylon, the nations to the west of the Euphrates were seeking an opportunity to revolt against him. The leading powers in this confederacy seem to have been Tyre and Egypt. Tyre had then become the greatest commercial city in the world, and possessed the greatest maritime power then known. Nebuchadnezzar laid siege to Tyre, but met with a most resolute and formidable enemy. For 13 years he carried on his operations against it, till the Tyrians, seeing that they were not likely to be able to hold out much longer, built a city on an island, a little way from the shore. Thither they removed all their wealth, and left to Nebuchadnezzar merely the walls and empty houses of the old city. Having thus done what he could towards chastising Tyre, he turned his army against Egypt, speedily overran it, laid it desolate and loaded himself with its booty. He then returned to Babylon, where becoming intoxicated with pride and vanity, he was struck with insanity, and, for a time, set aside from governing the kingdom. He was, however, restored, resumed the reins of government; and then he proclaimed to all his subjects the character of the one living and true God. After his restoration he lived but one year, and concluded an eventful reign of 43 years by dying, B.C. 567.

Evil Merodach succeeded him; a weak prince of profligate habits. He is supposed to have wantonly invaded Media, and laid the foundation of that hostility between the Medes and Babylonians, which proved the destruction of his kingdom. His relatives conspired against him, and put him to death.

After a struggle for the throne, in which two princes became nominally kings, and perished,

Belshazzar succeeded, who is supposed to have been the son of Evil Merodach, and the grandson of Nebuchadnezzar. He also was a week and profligate prince. In his reign, Cyrus, the Persian commander of the Median and Persian army, took the city of Babylon. Belshazzar had made a feast for his nobles, and brought in the sacred vessels of the temple at Jerusalem, to be used in the entertainment; when, in the midst of his riot, four fingers of a man's hand appeared, writing mysterious characters on the wall opposite to him. The king and his nobles were thrown into the utmost consternation, and sought for some one to interpret the writing, but no one could be found. At length the queen came in to him, and informed him of the prophet Daniel. Daniel was immediately called, and interpreted the writing to signify, that the kingdom was divided and given to the Medes and Persians. On that night the prediction was fulfilled. At the very time these things were proceeding in the palace, Cyrus had entered the city by the bed of the river; and his soldiers, assailing the palace, slew Belshazzar; and Darius, the Median, took possession of the empire.

Thus, the first of the four great monarchies, described by Daniel the prophet, fell, in the year B.C. 538, after it had existed separate from the Assyrian empire about 88 years.

THE MEDO-PERSIAN EMPIRE.—The Medes and Persians were originally two monarchies, of which the Median first rose to eminence. Previous to the time of Hezekiah, the Medes were subject to the Assyrian monarchy. On the reverse which Sennacherib met with in Judah, during that reign, it is believed that the Medes revolted, and after a time of anarchy, elected Dejoices king. He reigned 53 years, and seems to have devoted himself entirely to the internal regulation and improvement of his kingdom. He was succeeded by his son,

Phaortes, who, being a warlike and ambitious prince, attacked the Assyrian empire, under Chyniladan, or Nabuchadonosor; but was defeated, his capital city taken and destroyed, and afterwards he himself taken and slain. He was succeeded by

Cyaxares, his son.—Cyaxares recovered from the Assyrians what his father had lost. Not, however, contented with this, he was eager to revenge the death of his father, and the destruction of Ectaban by the Assyrians. He accordingly attacked and defeated the Assyrian army, and laid siege to Nineveh; but was obliged to raise the siege, in consequence of an invasion of the Scythians. Being unable to repel the Scythians by open force, he had recourse to treachery, and succeeded in having the greater part of them massacred in one night. Having freed the country of the Scythians, he resumed the siege of Nineveh, and to strengthen his hands in this enterprise he obtained the co-operation of Nabopolassar, king of Babylon. These two confederate kings took that great city, and utterly destroyed it, about 612 years B.C. After this success, the two kings directed their forces against Pharaoh Necho, and defeated him. They then separated, and Nebuchadnezzar advanced upon those western provinces of the Assyrian empire that lay to the southward, as Syria, Edom, and Palestine; while Cyaxares attacked those that lay to the northward, as Armenia, Pontus, and Cappadocia, which he subdued, with great slaughter of the inhabitants. Cyaxares is also supposed to have added Persia to his empire; although that acquisition is, by some, ascribed to his predecessor. He died in the 40th year of his reign, leaving his throne to

Astyages, his son.—Astyages married a Lydian princess, to cement the peace that had been made between that kingdom and Media; and from that marriage was born Darius, called in Scripture Darius the Mede; but called by the Greek writers, Cyaxares. Astyages, during the same year in which Darius was born, gave his daughter Mandane to Cambyses, a Persian nobleman, or, as others say, the Persian king, in marriage, and of that marriage, was born the celebrated Cyrus. Cyrus was, therefore, the nephew of Darius, and was only about one year younger than he. Astyages reigned 35 years. The only incident mentioned in his history, worthy of record, is, his repelling the unprovoked invasion of the Babylonians under Evil Merodach. In this war, Cyrus, then a young man, greatly distinguished himself. On the death of Astyages, he was succeeded by his son,

Darius, or, *Cyaxeres II.*; but Cyrus, his nephew held the command of the army under him, and conducted the military operations of his reign. It was during the reign of Darius, that Cyrus took Babylon, as already noticed; after which event Darius came to Babylon, and there, in concert with Cyrus, settled the government of his new empire. They divided it into 120 provinces, over each of which a governor was appointed. Over these governors there were three presidents, and the chief of these presidents, was the prophet Daniel, who might, therefore, be regarded as the prime minister of that vast empire. It was in this reign, when Daniel was about 80 years of age, that he was cast into the den of lions, for persevering in the worship of God, in defiance of a foolish decree which Darius had been persuaded by his courtiers to make. In about two years after the capture of Babylon, Darius died, leaving Cyrus sole monarch of the empire, B.C. 536. The Persian empire now extended from the river Indus to the shore of the Archipelago, and from the Caspian and Euxine seas, to the seas of Arabia.

Cyrus, on coming to the throne, issued a decree for the restoration of the Jews; in consequence of which, that people assembled from various parts of his empire, to the number of 42,360, exclusive of servants, amounting to 7,337, making a total of nearly 50,000 persons, and proceeded to Jerusalem. The first care of these restored captives was, to rebuild the city and temple of Jerusalem. The jealousy of the surrounding nations, especially the Samaritans, greatly retarded their operations. They could not openly oppose them, because Cyrus was avowedly their friend, and Daniel was at the seat of government to protect them. But, from the distance of the capital, these nations had it in their power to throw many obstacles in their way. Soon after this, Daniel died, at the age of 90 years; Cyrus also, soon afterwards died, in the 7th year from the restoration, and 70th of his age. He is one of the greatest men of antiquity, not in regard of his extensive conquests; but in regard to the nobleness of his character. There is, indeed, some ground to hope, that he was a convert from heathenism to the worship of the true God; and the peaceful and beneficent character of the latter part of his reign, gives additional countenance to this opinion. On the death of Cyrus,

Cambyses, his son, succeeded to the empire, a weak and profligate prince. Early in his reign, he invaded and obtained possession of Egypt, which had formerly been subdued by Nebuchadnezzar. He had a brother named Smerdis, whom, in a fit of jealousy, he caused to be killed. But, while he was absent in Egypt, a pretender to the throne appeared, who personated Smerdis, the brother of Cambyses. Cambyses marched from Egypt against him; but on mounting his horse, his own sword fell from its scabbard and wounded him on the thigh, of which wound he died.

Smerdis, the usurper, who is usually called Smerdis the Magian, because he belonged to the priesthood, which, in Persia, was called the Magi, reigned for a short time, till being detected and exposed, by a lady of high rank, whom he had married, seven of the nobles conspired against him, and slew him. The family of Cyrus being now extinct, these nobles agreed that one of themselves should be elevated to the throne. To determine which it should be, they agreed that he whose horse on a certain day should first neigh, after the rising of the sun, should be king. This seems to have been an act of adoration to the sun, which the Persians worshipped. The horse of Darius, the son of Hystaspes, one of the generals who had served under Cyrus, having first neighed, he was immediately elected king, and is known by the name of

Darius Hystaspes, and is carefully to be distinguished from Darius the Median, and also from two other princes of the name Darius, who afterwards attained to the empire. During the reign of Cambyses, and Smerdis the Magian, the enemies of the Jews contrived to prevent them from proceeding with the temple, having poisoned the minds of these princes against them. But on the accession of Darius, he, having married two of the daughters of Cyrus, and affecting to reign as his successor, was disposed to fulfil all his intentions. He, therefore, issued a new decree for the rebuilding of the city and temple of Jerusalem; and, in the 6th year of his reign, the second temple was finished, and dedicated, exactly 70 years after it had been destroyed by Nebuchadnezzar.

In the 5th year of Darius, Babylon revolted, and was besieged by him. As in the former siege by Cyrus, he was constrained to attempt to reduce it by famine; and at length became master of it by the devotedness of one of his officers. This person having cut and maimed himself, fled to Babylon, pretending that he had been so treated by Darius. He thus obtained the confidence of the Babylonians, and found an opportunity of betraying the city to Darius. Darius then began to think of extending his empire towards the west. He already possessed Egypt on the south, and Asia Minor on the north of the Mediterranean: but he proposed to himself an expedition against the Scythians who inhabited the country between the Danube and the Don, under pretence of avenging the Scythian invasion of Media, 120 years before. He accordingly crossed the Hellespont by a bridge of boats, marched through Thrace, and crossed the Danube by another bridge of boats. The Scythians retreated before him, till, finding no sustenance for his troops, he was compelled to return, having lost one half of his army. He then purposed to extend his empire eastward. In this he succeeded better, and laid India, or at least that part of it which bordered on the Indus, under tribute.

In the 18th year of his reign commenced the war between the Persians and Greeks, which brought so many calamities on both nations. A sedition, in some of the Greek Islands, of the people against their governors, led to an application to the Persian governor of Asia, from one of the parties, for assistance. This was granted, and that interference led to a hostile expedition into the Persian province of Asia Minor, the capital of which was Sardis, in which the Athenians took part. The Greeks proceeded to Sardis, which they plundered and burnt; but were compelled to retreat, and were defeated before they could reach their ships. Darious could never forget this insult on the part of Athens, and determined on an invasion of Greece. He sent an army across the Hellespont, round by Macedonia, a fleet being appointed to follow and cooperate with it. The fleet, in doubling the Cape of Mount Athos, was overtaken by a storm, and totally disabled, having lost 300 ships and 20,000 men; and the army having encamped without sufficient precaution, was attacked by the Thracians, and so roughly handled, that it was forced to return to Asia. Darius, however, was not to be diverted from his project of revenge, but fitted out another army. This he sent directly across the Archipelago to Attica. There it was met on the plain of Marathon by a small army of Athenians, under Miltiades, and totally defeated. The remains of the army escaped to the ships, and returned to Asia. Still determined upon his scheme of revenge, Darius fitted out another army, which he determined to lead in his own person; but being now an old man, he first took the precaution of settling the succession. Having done this, he died, in the 36th year of his reign, leaving his dominions, but leaving also his quarrel with the Greeks, to his son Xerxes, B.C. 486. During the reign of Darius, Ezra, the Jewish scribe, was born; but his public operations belong to a subsequent reign.

The conclusion of the reign of Darius Hystaspes brings the Persian history down to the end of the 7th period of 500 years from the creation. We now, therefore, pause, and take a brief view of the other nations of the world during the same period.

EGYPT having fallen under the dominion of the Babylonian empire, and soon after under that of Persia, from this time held the rank only of a tributary state. All the countries round Palestine were in the same circumstances.

GREECE.—It has been already mentioned, that, so far back as 884 B.C. while Athaliah reigned in Judah, Lycurgus had settled the constitution of Lacedæmon, as a monarchy, with great powers conferred on the aristocracy.

Athens was then governed by Archons, a kind of hereditary magistrates. These about 754 B.C. while Jotham son of Uzziah, was king of Judah, about the time of the building of the city of Rome, were exchanged for elective Archons, who enjoyed this office only 10 years. After about 60 years' experience of this mode of government, a further change was made, and the government placed in the hands of nine Archons, who were elected annually.

But although the legislative authority was nominally in the hands of the people, the executive was in the hands of the nobles. This gave rise to continual contests between ruling families. Some remedy was required, and Draco was called to form a code of laws, 624 B.C. His laws were so absurdly severe and sanguinary, that they could not be executed. A further time of confusion ensued, when Solon was invited to reform the constitution. He executed his task with great success, and constructed a code of laws, which forms the basis of the laws now existing in most of the kingdoms of Europe. The Romans founded their laws upon those of Solon; and, through the Romans, they have been diffused over the civilized world. Solon flourished 594 B.C. when Zedekiah was king of Judah, tributary to Nebuchadnezzar, and about the time of the birth of Cyrus, afterwards king of Persia.

The constitution of Sparta was highly aristocratical; that of Athens was continually becoming more democratical. In nearly all the Greek republics, there was a perpetual struggle between the nobles and the people, the former looking to Lacedæmon as their protector, the latter to Athens. Athens itself was agitated by similar conflicts between the nobles and the people. In the course of these struggles, Pisistratus, a popular leader, seized the Acropolis, and reigned over the city as a king, for 33 years, although his reign was twice interrupted. He was succeeded by his sons Hipparchus and Hippias; but they becoming tyrannical, first one was killed, and then the other was forced to retire from the city. He fled to Darius Hystaspes, who now reigned in Persia. After the expulsion of Hippias, the old disputes between the aristocracy and democracy were renewed. Isagoras was banished, and applied to Sparta for aid, which readily granted it. The Athenians were thus threatened with a war with Sparta, and applied to Persia for help; but they received a haughty reply, requiring them to subject themselves to Darius. In the meanwhile, Hippias had prevailed on the Persian governor of Asia Minor to espouse his cause, and to insist on his being reinstated in the government of Athens. This the Athenians peremptorily refused to comply with, and thenceforward regarded themselves as at war with Persia.

Soon after this, Darius sent heralds into Greece, demanding earth and water, as tokens of subjection; which demand was indignantly rejected by Sparta and Athens. While matters were in this precarious state between Persia and Greece, the Athenians were led to take part in that expedition into Asia Minor, which has been already noticed, in which Sardis was burned. Then followed the invasion of Greece by Darius, in which his army was defeated, at Marathon, by Miltiades, the Athenian general.

ROME.—According to ancient traditions, which are the only authority extant for the history of Rome, at its commencement, Rome was founded, B.C. 757. It was, for the two first centuries of its existence, a monarchy, and the chief occupation of its kings and citizens, was fighting, and gradually subduing the neighbouring states, or incorporating them into their body politic by treaties. The first king was

Romulus, the founder of the city, who reigned 30 years. Having collected a number of loose persons together, all males, he procured wives for them, by inviting the neighbouring tribe, called Sabines, to a religious festival, and there directing his men to seize upon the women. This created a war, which ended in the two nations being incorporated in one. Having subdued several of the other tribes, he was killed by his senators, B. C. 717. After an interregnum, he was succeeded by

Numa Pompilius, who was of a pacific disposition, and gave his attention chiefly to the internal regulation of his kingdom. To him succeeded

Tullus Hostilius, B. C. 660, who reigned 32 years, while Manasseh was king of Judah. In his reign was the celebrated battle between the Horatii and the Curiatii. The Albans and the Romans were at war for superiority, when it was agreed to leave the matter to the event of a battle, to be fought between three chosen men on each side. Three brothers, on each side, were chosen, when the Roman champions proved victorious. Tullus Hostilius is said, by some to have been killed by lightning, with his whole family; by others, he is said to have been murdered by Ancus Martius, who succeeded him.

Ancus Martius came to the throne, B.C. 638, during the reign of Josiah in Judah. He was a warlike prince, and subdued the Latins, and several other neighbouring tribes. He died, leaving two sons, the eldest only fifteen years of age; he left them to the care of Tarquin, the son of a merchant of Corinth. Tarquin took advantage of the youth and inexperience of his pupils to obtain the throne for himself.

Tarquin came to the throne, B.C. 609, about the time that Josiah was killed by Pharaoh Necho. His reign was occupied in repelling the invasions of the neighbouring states, and subduing them. He greatly strengthened and beautified the city, and constructed those celebrated aqueducts, for draining and cleansing it, that were accounted among the wonders of the world. Tarquin reigned 38 years, and was assassinated in his palace by the sons of Ancus Martius, whom he had originally deprived of the kingdom. He was succeeded by

Servius Tullius, his son-in-law, B.C. 572, during the reign of Nebuchadnezzar, king of Babylon. He reigned 44 years. He was a politic prince, and, with much sagacity, introduced important changes into the constitution. Till his reign all Roman citizens, rich or poor, had contributed equally to the funds of the city. Servius proposed to ease the poor, by laying the burden chiefly on the rich; but at the same time to give more power to the rich. This he accomplished by a dexterous distribution of the people into classes and centuries. Servius had under his care two sons of Tarquin, the former king. One of these, Tarquin, to whom he had given his daughter in marriage, formed a conspiracy to obtain the throne, in which he was at first disappointed, but was afterwards successful. Servius was murdered, it is said, at the instigation of his own daughter.

Tarquin II. surnamed the Proud, succeeded him, B.C. 529, and reigned 25 years. He proved a most despotic and cruel tyrant. At length, in consequence of an outrage committed by him upon Lucretia, a Roman lady, he was deposed, and Rome became, from that time, a republic, B.C. 505. This was in the reign of Darius Hystaspes

CARTHAGE had been founded by the Phœnicians, on the coast of Africa, about the time of the foundation of the city of Rome, or a little before that era. Like the people from whom they sprang, the Carthaginians were a maritime people, and early became acquainted with the gold mines in Spain, from which their city acquired great wealth. Little is known of their ancient history. It appears that they were formidable by sea in the time of Cyrus and Cambyses, kings of Persia. In the year B.C. 503, which was during the reign of Darius Hystaspes, they entered into treaty with the Romans. The treaty related chiefly to matters of navigation and commerce; but from it, we learn, that the whole island of Sardinia, and part of Sicily were then subject to Carthage, and that a spirit of jealousy had already begun to manifest itself between the two republics. Till this time, the Carthaginians had paid tribute to the original African tribes for the ground on which their city stood. They now attempted to free themselves from this tribute; but, notwithstanding their power, they did not succeed. They were obliged to conclude a peace, one of the articles of which was, that the tribute should be continued.

EIGHTH ERA.

Ezra.

A.M. 3500.—B.C. 500.

This era finds the whole western part of Asia, from the Indus to the shores of the Archipelago, and also Egypt, under the dominion of the kings of Persia.

Profane history has now begun to assume a precise and authentic form; and many documents are still extant, besides the Sacred Scriptures, which shed a clear and steady light on the affairs of men at this era.

JUDEA was now a tributary kingdom, the history of which is involved in that of Persia, and the monarchies which succeeded the Persian. We, therefore, commence this period with

PERSIA.—At the conclusion of the former era, B.C. 500, Darius Hystaspes was on the throne of Persia, and we noticed his history till his preparation for a second invasion of Greece, which, however, he did not live to accomplish. He died, leaving

Xerxes, his son, as his successor. The first care of Xerxes was to prosecute the invasion of Greece, for which preparations were made by his father. To prevent the Greeks from receiving assistance from their colonies in the west, he entered into a treaty with the Carthaginians, by which they undertook to attack the Greek settlements in Sicily. He then proceeded with his army to Greece. He took the same route which Darius had taken on his invasion of Scythia, crossing the Hellespont, as he did, by a bridge of boats into Thrace, and passing along the head of the Archipelago through the southern part of Macedonia. He then turned southward towards Attica, but was withstood at the straits of Thermopylæ (a narrow pass in the southern part of Thessaly, between the mountains and the sea), by Leonidas, with 300 Spartans, and as many other Greeks as made up the whole number to 4000. This little company, aided by the nature of the ground, arrested the progress of the whole Persian army for two days, till a Greek betrayed it, by leading a Persian detachment across the mountains. The Greeks seeing themselves menaced with an attack on their rear, retired, with the exception of Leonidas, and the remains of his 300 Spartans, who kept their ground till they were overpowered and cut to pieces. The Persian army then proceeded southward to Athens. The Athenians retired to their ships, and placed their wives and children, for protection, in cities on the opposite side of the Peloponnesus. Meanwhile the Persian and Greek fleets were assembled near to one another. The Persian occupied the Athenian port of Phalerus, and the Greek fleet under the command of Themistocles, the neighbouring straits of Salamis. There the Persians determined to attack them; but the narrowness of the straits rendering it impossible for their huge armament to act in concert, the Greeks contrived to throw it into confusion, and utterly destroyed it. The shattered remains of this fleet retired to the opposite shore of Asia.

Xerxes, seeing his fleet destroyed, and fearing that the Greeks would sail for the Hellespont, and interrupt his return to Asia, fled thither; and finding his bridge of boats broken by storms, was under the necessity of crossing the strait in a small fishing boat.

While Xerxes was suffering these disasters in Greece his confederates in the west were equally unsuccessful. Hamilcar, the Carthaginian general, was surprised and slain in his camp by Gelo, the Sicilian king, and his fleet and army totally destroyed.

After the departure of Xerxes for Greece, Mardonius retired with the army to Thessaly, and then returning next year, and finding the Athenians still determined not to submit, burned whatever remained of the city, and committed all manner of excesses. But the Greeks of the Peloponnesus had collected an army, and were marching towards the Isthmus of Corinth, by which they threatened his communication with Thrace and Asia, and he retired to Bœotia. There the Greek army, commanded by Pausanias, king of Lacedæmon, and Aristides, the Athenian general, followed him, and came up with him near the city of Platæa; where the Persian army was totally routed, and cut to pieces, with the exception of 40,000 men, whom Artabazus, a Persian general, foreseeing how the battle was likely to issue, withdrew early from the field, and brought to Byzantium, where they re-crossed the Hellespont into Asia.

On the same day with the battle of Platæa, the combined Greek fleet attacked and destroyed the Persian fleet at Mycale, a promontory on the coast of Asia. The Persian ships were drawn up on the shore, surrounded by a rampart, and defended by a land army: but the Greeks forced the rampart, and burned the ships. Thus ended the celebrated expedition of Xerxes against Greece; and in consequence of those victories, the Greeks were delivered from any further invasions from Persia, or the east.

Xerxes, on the defeat of his armies, retired from Asia, and took refuge in Susa, the Persian capital. There he gave himself up to the greatest licentiousness. In the meanwhile, the Greeks were prosecuting the war against him with vigour and success, and depriving him of his possessions. Cimon, the Athenian commander, in one day destroyed a fleet, said to be equal to that which had been destroyed by Salamis, and defeated an army equal to that which was defeated at Platæa. At length Artabanes, the captain of his guard, formed a conspiracy against him, and put him to death. B.C. 465.

Artaxerxes, surnamed Longimanus, who is believed to have been the Ahasuerus of the Book of Esther succeeded him. He secured himself on the throne by putting to death Artabanes, and defeating his partisans. He then celebrated a great feast, on which occasion it was, that Vashti, the queen, was repudiated; and Esther, a Jewess, made queen in her stead. Towards the beginning of his reign, the Egyptians revolted from him, being aided by a fleet and army of Athenians. Artaxerxes sent an army against it; but it was defeated with great slaughter, and the remnant of it shut up and besieged in Memphis. Artaxerxes sent another army to raise the siege, in which he succeeded, having defeated the revolters.

In the 17th year of Artaxerxes and 458 B.C. Esra, the Jewish priest and prophet, now in captivity, obtained, probably through the interposition of Esther, an ample commission to return to Jerusalem, with as many Jews as chose to accompany him. Ezra immediately addressed himself to the work of bringing into order the little community over which he presided. He revived the rites and ceremonies of the Jewish church, according to the prescribed order; he settled and arranged the canon of Scripture, and transcribed the Old Testament from the old Hebrew character, which had fallen into disuse, into the present Hebrew, or Chaldee character. This did not change in any respect the words of Revelation. It was not a greater alteration than writing or printing the Bible in the present Roman character instead of the black letter, which was in use when our present translation was made. He also arranged, or as some think, established the synagogue service. Whilst Ezra was engaged in these important works, Nehemiah was serving as cup-bearer to Artaxerxes; and intelligence having reached him, that the walls and gates of Jerusalem were still in ruins, he was deeply affected, and procured, probably through the influence of Esther also, liberty to repair to Jerusalem and to do whatever was necessary for completing the defences of the city. He arrived about eleven years after Ezra. Having made considerable progress in restoring the city and polity of the Jews, he returned at the appointed time to Persia; but almost immediately came back to Jerusalem a second time, when he found that abuses had again begun to appear. The sabbath was openly violated, and many of the leaders of the people had married heathen wives: and he set himself, with renewed vigour, to correct these abuses. While these important operations were in progress at Jerusalem, under the direction of Ezra and Nehemiah, the celebrated Peloponnesian war commenced between the Spartans and Athenians. Artaxerxes, although he was solicited by both parties for aid, seems to have declined taking either side. He sent an ambassador to Sparta; but before his return, Artaxerxes himself had died, B.C. 424. On his death, the succession to the kingdom was contested. Xerxes, his son, mounted the throne, but reigned only forty-five days, being murdered by his brother *Sogdianus*. Sogdianus attempted to get another of his brothers into his power, whose name was *Ochus*, whom his father had made governor of Hyrcania, but Ochus suspecting his brother's intention, raised an army, came against him, defeated and slew him, after he had reigned only six months and fifteen days. Thus he established himself on the throne, and took the name of Darius. He is that prince whom historians call

Darius Nothus.—In his reign, Egypt revolted from Persia, and successfully defended itself during the life of Darius and the lives of some of his successors. In his reign also the temple of Samaria was built to rival that at Jerusalem, which increased the enmity between the two nations. Darius Nothus sent his son Cyrus as governor to Asia Minor, and he gave such assistance to the Lacedæmonians in their war with Athens, as enabled them to defeat the Athenian fleet, and to put an end to the war. Darius Nothus died about the time of the conclusion of the Peloponnesian war, B.C. 405.

Artaxerxes, surnamed by the Greeks, Mnemon, succeeded him; but Cyrus, his brother, who commanded in Asia Minor, instigated by an ambitious and unprincipled mother, laid a plot to wrest the empire from him. The plot was discovered, but by the influence of his mother, he was pardoned, and sent back to his government. But here again he employed the opportunity which he enjoyed of having intercourse with the Greeks, to form another conspiracy against his brother. He hired a mercenary Greek army, and with it, and such other troops as he could raise in Asia, he marched against Artaxerxes. The two brothers met with their armies, at Cunaxa, in the province of Babylon, where Cyrus was defeated and slain. The Greek troops had remained unbroken, and now had no resource but to attempt a retreat to their own country, in the face of a victorious enemy. Their general, Clearchus, fell by treachery into the hands of the Persians, and was slain; and the command devolved on the celebrated Xenophon, whose history of the retreat of the 10,000

Greeks to the shores of the Euxine, and thence to Greece, is one of the most instructive and interesting military histories extant.

A new war breaking out with Sparta, which since the conclusion of the Peloponnesian war, had ruled Greece with a rod of iron, the Spartans invaded Asia Minor, and the Persian forces being unable to arrest their progress, Conon, an Athenian exile, advised Artaxerxes to place a fleet at his disposal. This advice was adopted, and Conon, having organized a powerful conspiracy against the Spartans, came up with their fleet at Cnidus, and totally defeated it. He then obtained liberty to repair to Athens, and restore the fortifications of the city, which soon became as formidable as ever. The Spartans were thus reduced to the necessity of making peace with the Persians.

The latter years of the life of Artaxerxes were embittered by dissensions in his own family. He died in the 94th year of his age, and the 46th of his reign, B.C. 359. On his death,

Ochus, his son, succeeded him, having cleared his way to the throne by the murder of those of his brothers who rivalled him in the succession. These murders he soon followed up by an indiscriminate massacre of all the royal family, without distinction of sex, age, or character. On his accession, the western provinces revolted, but returned to their allegiance. Egypt had never been thoroughly subdued since the last revolt. Nectanebus was now king of that country. Ochus marching into Egypt, lost a large proportion of his army in the quicksands of Lake Sorbonis. He, however, succeeded in driving Nectanebus out of the kingdom. Nectanebus was the last native king of Egypt; that fine country having, from that day till the present, been under the dominion of foreigners. But while Ochus was in the midst of his success, he was laying the foundation for his own destruction. He had a favourite servant named Bagoas, an Egyptian, who accompanied him; and Ochus, not satisfied with subduing Egypt, insulted its religion, killed the sacred bull, and gave its flesh to his attendants. Bagoas determined to revenge this insult, and at length succeeded in poisoning Ochus.

Arses, the youngest of the king's sons, was raised to the throne by Bagoas; but not finding him sufficiently compliant, Bagoas poisoned him also, B.C. 338. He then brought forward a descendant of Darius Nothus, named Codomanus, and placed him on the throne. Codomanus took the name of

Darius Codomanus.—Fearing that he might be treated by Bagoas, as Ochus and Arses had been, he put Bagoas to death, and thus secured himself on the throne. But the Persian empire was now hastening to its ruin. The affairs of Greece had by this time fallen under the undisputed direction of the king of Macedon, and Alexander, the son of Philip, had combined the whole strength of its various tribes, in a long threatened enterprise against that great, but ill-compacted empire. The events that led to the downfall and death of Darius, belong rather to the history of Greece than of Persia. We merely mention here, that Alexander passed over to Asia at the head of the Greek army, and defeated the forces of the Persians, in several battles, the last of which was near Arbela. Darius, after this defeat, fled to Ecbatana, the capital of Media. On Alexander's approach, he retired to Bactria, and was there murdered by Bessus, the Governor of that province. Thus fell Darius Codomanus, and with him the Persian empire, B.C. 330, after it had existed, from the taking of Babylon, 209 years.

We shall here pause, as we did at the reign of Hezekiah, and bring down the history of the other nations to the time of Alexander; when the whole political aspect of the world underwent a mighty revolution.

GREECE.—It has already been noticed, under the history of Persia, that Xerxes succeeding Darius, attempted to carry into effect his father's schemes of revenge, and invaded Greece with an immense armament which was totally destroyed in the different battles of

Salamis, Platæa, and Mycale. After these victories, the Greeks continued still to carry on the war with Persia, chiefly by descents on their coasts, till peace was concluded, in the reign of Artaxerxes, the son of Xerxes.

The Spartans were at this time, the acknowledged leaders of the Greek confederacy, but their king, Pausanias, carrying himself proudly and contemptuously to the allies, they put themselves under the patronage of Athens. From this time the Athenians held the decided ascendency at sea, and over those Greek states and colonies which were approached by sea. At first, they used their influence with equity and moderation; but gradually feeling their strength, they became more haughty in their conduct, and more dictatorial in exacting the service of their allies. The result was, that the allies of the Athenians eventually became subjects, from whom the Athenians regularly exacted tribute: but they were impatient subjects, and ready to avail themselves of any opportunity to emancipate themselves.

The Spartans eyed the growing power of Athens with jealousy, and were prepared to embrace the first plausible occasion of going to war with it. Such an occasion was not long wanting. The government of Athens was yearly becoming more democratical, and the management of the affairs of the state falling under the influence of demagogues; these, to obtain influence, or retain it, were under the necessity of proposing popular measures. Cimon, the son of the celebrated Miltiades, himself a great military leader, attained to the chief influence in Athens; and being a man of immense property, he secured his popularity by spending it freely among the people. Others, who followed him, had not the same means of bribing them; but they, to supply this defect, proposed to the people to take for themselves, the same indulgences out of the public treasury. They voted to themselves money for attending on the great councils of the nation. This naturally threw the power over public affairs into the hands of the most worthless of the people, whose ear was always open to whatever proposals their orators might make, for the purpose of pampering their idleness, or feeding their vanity; and that orator, who flattered them most, was sure to be the most popular, and to have most power. In these circumstances, nothing could exceed the folly, or the flagitiousness of many of the measures adopted by the Athenians. Thus corrupted, they became idle and dissolute; and were under the necessity of supporting themselves by exactions made on other states. This roused the impatience and enmity of their allies; and the Lacedæmonians, on the watch for an excuse to attack them, soon found one in the discontent of the Athenian subjects.

These were the circumstances that led to the celebrated Peloponnesian war, which, for nearly thirty years, raged in Greece, with an animosity, a reckless barbarity, and regardlessness of public faith, scarcely to be paralleled in the history of any other country. On the one side were ranged all the states of Peloponnesus, except Argos and Achaia, which were neutral; and all the states of northern Greece, except Thessaly and Acarnania. On the other, the Athenians had with them the islands and maritime towns. At the head of the Peloponnesian party, was Lacedæmon, which was one of the most oligarchical states in Greece; yet, such had been the oppressive conduct of republican Athens to all those states that were under its power, that the Lacedæmonians were enabled to represent the war as one waged by them for the liberties of Greece. The war was carried on, at first, by inroads of the Peloponnesians into Attica, which the Athenians, unable to resist, retaliated, by descents on the coast of Peloponnesus. Pericles, an able statesman and general, was at the head of the Athenian affairs at the commencement of the war; but, in the second year of it, he died, and then the government fell into the hands of men of an inferior description. This war between the great patron of oligarchy on the one side, and of democracy on the other, kindled strife and civil war in many of those states of Greece, in which the parties were nearly balanced. The oligarchical parties manœuvred to bring their states into connexion with Lacedæmon, that they might govern through means of their influence, and the democratic parties wished, for a similar reason, to be connected with Athens. In some of these civil contests, particularly in that which took place in Corcyra, the scenes of treachery and cold deliberate cruelty were hideous beyond description.

Several times, when one of the parties was reduced to straits, overtures of peace were made, but rejected by the opposite party; till, in the tenth year of the war, a temporary peace was concluded. It was, however, only a breathing time; and the struggle soon recommenced. At this time, the affairs of Athens were considerably under the influence of a young man, one of the most remarkable characters of Grecian history—Alcibiades. He was of noble birth, of great wealth, great talents, most accomplished address; but artful, ambitious, profligate, and utterly destitute of principle. He was a pupil of the celebrated philosopher, Socrates, who flourished at this time. Alcibiades, impatient of the narrow sphere of warfare in which the Athenians were engaged, prevailed on them to attempt a foreign conquest in Sicily, holding out to them many plausible reasons for the enterprise. He was put in chief command; but the people were jealous of him. He had enemies at home, who plotted against him in his absence. One result was, that he was removed from the head of the armament, and forced into exile; the next result was, that the expedition totally failed, and its failure involved the ruin of the Athenian fleet and army. The Athenians made powerful efforts for the maintenance of their influence and their liberty, and might probably have succeeded in recovering their prosperity, had not the commander of their fleet permitted himself to be surprised in the harbour of Ægospotamos, in the Hellespont, by the Lacedæmonian fleet, under Lysander; when the Athenian fleet was totally destroyed. This sealed the fate of Athens. The Greek fleet sailed to the unhappy city, blockaded it, and at length, compelled the Athenians to surrender.

They then proceeded to demolish the walls, which operation was conducted to the sound of musical instruments—as if celebrating the recovery of the liberties of Greece. They also changed the constitution, and, instead of a republic, put it under the command of thirty of the aristocracy; who are usually known by the designation of the thirty tyrants. These thirty oligarchists soon abused their power so much, that they forced into exile a large proportion of the influential citizens; and the people, submitting with reluctance to their oppressors, the exiles, under Thrasybulus, secretly assembled, obtained possession first of the port, and afterwards the city, and proclaimed anew the democratical constitution, B.C. 401. In the following year, Conon obtained a fleet from Artaxerxes Mnemon, the Persian monarch, with which he defeated the Lacedæmonian fleet; and, afterwards sailing for Athens, he rebuilt the walls, and thus raised Athens to nearly its former greatness. It was at this time that the Greek mercenaries engaged themselves in the service of Cyrus, the brother of Artaxerxes, to dethrone that monarch; in which expedition Cyrus was killed, and the Greeks, under Xenophon, performed their celebrated retreat. Meanwhile, the contests between the oligarchies and the democracies of the Greek states were proceeding with their usual violence. In the midst of one of these struggles in Thebes, two men of singular talents attained to the chief influence; placed their city, for a time, at the head of the affairs of Greece; and permanently changed the relative position of its different parties. These were Epaminondas, and Pelopidas. The democratic party being predominant in Thebes, a war broke out between them and Lacedæmon, in which Epaminondas, by a change in the usual mode of conducting battles, totally defeated the Spartan army with inferior force. The first of those battles, which broke the power of Sparta, was fought at Leuctra, B.C. 371. Epaminondas afterwards invaded the Laconian territory, ravaged the country, and built a city in the neighbourhood of Sparta, which he called Messini, and gave it to the Messenians, whom the Spartans had kept for several centuries in the most rigorous bondage. This proved an effectual curb on the power and prosperity of Lacedæmon. The war still continuing, Epaminondas again entered the Peloponnesus, and again defeated the Lacedæmonians, near Mantinea, B.C. 361. Thus the Spartans were deprived of that preponderating influence, which they had exerted over the affairs of Greece, for nearly 500 years; but Epaminondas was himself killed at that battle; and, with him, vanished the power of Thebes.

Meanwhile, Macedon, hitherto scarcely known in Grecian history, was rising to power and eminence. Philip came to the throne, B.C. 360. The situation of parties in Greece furnished him with a favourable opportunity of interfering with its affairs. By a series of able manœuvres, partly military, and partly diplomatical, he gradually extended his influence, till he was elected general of the combined Greek army. It was to resist his growing influence, that the celebrated Demosthenes exerted his unexampled eloquence. At length Athens and Macedon came into direct conflict with one another; and the result was, that the Athenian army was defeated at Chæronea. This battle, which annihilated for ever the independence of the Greek states, was fought, B.C. 338.

Philip was now the first potentate of Greece, and began almost immediately to make preparations for invading Persia with the united Greek army. But, in the midst of his preparations, he was assassinated by a young Macedonian of rank, leaving his crown and his enterprise to his son Alexander.

On *Alexander's* coming to the throne, his first care was to establish his authority in Greece. Some symptoms of resistance to him were manifested in Athens and Thebes; but he suddenly appeared in the heart of Greece with an army, and crushed all opposition. Thebes held out against him; but a skirmish taking place between his troops and the Thebans, before the walls of the city, which brought on a general engagement, the Thebans were defeated and fled. The troops of Alexander following closely, entered the city along with them; and the soldiers, finding themselves within the city without any control, and many of them belonging to cities over which the Thebans had domineered with the utmost pride and insolence, began an indiscriminate massacre, and ultimately levelled the city to the ground—murdering, or making slaves of all the inhabitants. This execution struck terror into the rest of Greece; and enabled Alexander to carry forward his scheme of the invasion of Persia, without interruption.

Alexander then crossed the Hellespont, B.C. 334, into Asia Minor. There he was met by the Persian troops, whom he defeated at the passage of the Granicus; and thus cleared his way to the possession of the whole of Asia Minor. After arranging the affairs of Asia Minor, he proceeded towards Syria, and crossing Mount Taurus, encountered the Persian army, under Darius Codomanus, at Issus, and totally defeated it. He then proceeded along the sea-coast of Syria, possessing himself of the various towns on his route. He was resisted by Tyre, but after a siege of two years, took it by storm, and destroyed it. He then proceeded to Egypt, which fell easily into his hands; and there he founded the city of Alexandria. Having settled the affairs of Syria and Egypt, he proceeded eastward towards Persia, where the Persian king had been preparing an army to resist him. The two armies met at Gaugamela, near Arbela, on the east of the Tigris; where the Persian army was again defeated, and thus the fate of Asia was decided. Darius fled to Ecbatana, and afterwards to Bactria, where he was assassinated.

Alexander then took possession of Babylon. He afterwards occupied himself in subduing some of the neighbouring tribes. He crossed the Indus, and gained some victories over the people that inhabited these regions. But here his soldiers mutinied, refusing to accompany him further, so that he was under the necessity of returning westward. He came to Babylon, where he died of fever, supposed by some to have been occasioned by poison, B.C. 323.

ROME.—From the time that Rome became a republic, its history, for several centuries, is occupied chiefly by dissensions, similar to those in Greece, between the patricians or nobles, and the plebeians or people, and by wars for supremacy with the neighbouring states. The general tendency of the movements that were taking place in the city, was towards a democracy. The patricians had assumed to themselves the exclusive government of the people; but the people, as they came to understand their importance and weight, gradually vindicated their own rights. In one of these contests, an army in the field deserted the consuls, and encamped in the vicinity of Rome; and the patricians were reduced to the humiliating necessity of proposing terms to the plebeians.

The chief incident of importance, in this part of Roman history, is the invasion of the Gauls. Brennus had attacked one of the northern states, that were in treaty with the Romans. The Romans interposed for the assistance of their allies. The Gauls and Romans came to a battle, near the city of Rome. The Roman army was entirely defeated, the city taken and burned, and the Capitol, or citadel, closely besieged. The Romans were constrained to purchase the retreat of the Gauls (B.C. 385,) by giving them 1000 pounds of gold. This was during the reign of Artaxerxes Mnemon, king of Persia. It was not till the year 266, B.C. that the Romans were masters of all Italy.

CARTHAGE.—This city was still growing in opulence and power. It was busily engaged in attempting to make conquests—the chief object of its military operations being Sicily. The object of the Carthaginians was to obtain possession of that island; but in that they never succeeded. The sea-coasts of Sicily were colonized by Greeks; and they, partly by their superior military tactics, and partly by obtaining aid from Greece, frustrated every attempt of Carthage, powerful as she was, to enslave them.

FROM THE DEATH OF ALEXANDER, B.C. 323, TO THE BIRTH OF CHRIST.

Alexander, having died a young man, left no children capable of assuming the government of his empire. This circumstance immediately led to cabals and intrigues among his principal officers—the object of which was, to secure, each for himself, as great a share of the empire as possible. At first, an attempt was made to erect a government in the name of one of Alexander's children, with one of the Macedonian generals for his protector; the provinces being distributed among other generals, as governors. The central government, however, wanted strength to keep the governors in subordination. Every one soon sought not only to make himself an independent prince, but to seize on his neighbour's territory. Then followed a scene of confusion, of treachery, and of bloodshed, such as the world has scarcely ever witnessed. One of the first results was, that the whole family of Alexander were successively murdered. Olympias, his mother, the wife of Philip, perished by the hand of the executioner. At length, after nearly all of the generals of Alexander had fallen in battle, or had been murdered, the result of the struggle was the partition of the empire into four kingdoms, as predicted by Daniel the prophet. To Ptolemy Lagus were allotted Egypt, Lybia, Arabia, Cœlo-Syria, and Palestine. To Cassander, the son of Antipater (whom Alexander had left in Greece, to watch over his interests there), were allotted Macedonia and Greece. To Lysimachus, Thrace, Bithynia, and some other Asiatic provinces; and to Seleucus, all the other parts of Asia, as far as India. But, although these four kingdoms were thus formed out of Alexander's empire, there was no cessation of hostilities. On the contrary, there were almost perpetual wars among them, till they were all swallowed up by the Roman empire.

SYRIA.—The arrival of Seleucus at Babylon, B.C. 312, to take possession of the eastern provinces of Alexander's empire, after having been obliged by Antigonus to fly to Egypt, is called the era of the Seleucidæ, which word means the descendants of Seleucus; and was the era which was long in use in the east for computing time.

Seleucus was a prince of great talent, and much beloved by his subjects, for his great clemency. He was at war with Antigonus, as soon as he came to the throne; and at length succeeded in defeating and slaying him in battle, at Ipsus. He and Lysimachus were now the only surviving generals of Alexander. When both were about seventy years of age, they went to war with one another, and Lysimachus was slain. Soon afterwards, Seleucus himself was treacherously murdered. Seleucus built many cities, 16 of which he named Antioch after the name of his son, the most celebrated of which was Antioch in Syria on the Orontes; several he named Seleucia, from his own name, and several Apamia, from the name of his wife. Seleucus was succeeded by

Antiochus Soter, who reigned 19 years, and was succeeded, B.C. 261, by his son,

Antiochus II. or *Theos.*—Having divorced his wife, Laodice, for Berenice, daughter of Ptolemy, king of Egypt; and on the death of Ptolemy, having put away Berenice, and taken back Laodice; the latter, to secure herself from further disgrace, poisoned him, and raised her son, Seleucus, to the throne, B C. 246.

Seleucus II. or *Calinicus*, with his wicked mother, then put Berenice and her son to death; which so enraged her brother, Ptolemy, that he invaded the dominions of Seleucus, and getting Laodice into his hands, put her to death. Seleucus embarked in an expedition into Parthia, where he was defeated, taken prisoner, and after four years' captivity, died. He was succeeded by

Seleucus III. or *Ceraunus*, who after reigning one year, was poisoned by two of his officers.

Antiochus, surnamed the Great, succeeded him.

His reign was a continued series of wars with the neighbouring princes, particularly Ptolemy Philopator, king of Egypt, and Arsaces, king of Parthia, which led to no important or permanent result. His reign is remarkable for having first given occasion to the Romans to interfere in the affairs of the east. Ptolemy, king of Egypt, dying and leaving a son only five years old, to succeed him, Antiochus formed a conspiracy with Philip, king of Macedon, to seize on his dominions. Upon this, the Alexandrians sent to Rome for protection, which was readily granted; and Antiochus was required, on the authority of the Roman republic, to desist from his attempt on Egypt. Antiochus, afterwards, on the advice of Hannibal, the celebrated Carthaginian general, made war with the Romans: but was ultimately defeated, and was obliged to purchase peace on the most ignominious terms. Antiochus, was afterwards slain, when he was attempting to rob the temple of Jupiter at Elymais.

Seleucus IV., surnamed *Philopator*, succeeded him, B.C. 187. After a reign of twelve years, he died, leaving his throne to

Antiochus IV., surnamed *Epiphanes*, one of the most blood-thirsty and barbarous tyrants, that ever disgraced any throne. The Romans, now in effect, gave laws to Syria, so that when Antiochus hesitated about obeying some of the commands of the Senate, the Roman ambassador drew a circle round him, and insisted on receiving an answer before he should leave that spot. It was this prince, who, by his outrageous persecution of the Jews, drove them to exasperation; and stirred up that successful resistance of his authority, which is recorded in the two books of Maccabees. In the midst of this Jewish war, he went on an expedition to the east. In his absence, his generals were defeated by the Jews; on which, he hastened back to revenge himself upon them; but died miserably on his journey.

After his death, the Syrian throne fell a prey to a succession of usurpers and impostors, who rapidly followed one another, and whose names it is not necessary to record The last of them was *Antiochus Asiaticus*. In his reign, Pompey, the Roman general, overran his dominions and reduced Syria to a Roman province, B.C. 65.

EGYPT.—*Ptolemy Lagus*, afterwards *Soter*, who obtained as his share of Alexander's empire, Egypt and the neighbouring countries, reigned 39 years. He greatly embellished the city of Alexandria, which he made the capital of his dominions. He was, like Seleucus I. the best of his race. He died about 284 years B.C. and was succeeded by

Ptolemy Philadelphus.—The most important events of the reign of this prince were, his founding the celebrated Alexandrian library; his causing the Sacred Scriptures of the Jews to be translated into Greek, which translation is still extant, under the name of the Septuagint Version, from the tradition that seventy persons were employed in executing it; and his opening a port on the western side of the Red Sea, by which he drew the commerce of the east from Tyre, to Alexandria, his capital. He was the first Egyptian king, who entered into an alliance with the Romans.

Ptolemy Euergetes.—This name, which signifies benefactor, was given to him by the Egyptians, because he restored to them the idols, which had been carried away by Cambyses into Persia. In a war with Antiochus Theos, king of Syria, he proved successful; and greatly enlarged his dominions towards the east. He also extended his kingdom southward, on both sides of the Red Sea, even to the straits of Babelmandel. He died in the 27th year of his reign, B.C. 221. During these reigns, the Jews enjoyed, at Alexandria, the same privileges with the Macedonians; and this induced great multitudes of that nation to settle there. Ptolemy Euergetes was succeeded by

Ptolemy Philopator, who began his reign by the murder of his brother Magas; and then gave himself up to universal licentiousness. His kingdom fell into confusion, and continued so till his death, B.C. 204.

The Jews were threatened in this reign with extirpation, for refusing to worship the Egyptian idols; but were, as their historians say, miraculously preserved, and restored to their privileges.

Ptolemy Epiphanes succeeded him, when he was an infant, of five years old. Scipio had just defeated the Cathaginians, and forced them to humiliating terms of peace; and the young king was, as has already been mentioned, threatened by the kings of Syria and Macedon; but the Alexandrians placed him under the protection of the Romans. Ptolemy, on coming of age, by his mal-administration, drove the Egyptians into rebellion. He, however, crushed the rebellion; and after having granted terms of peace to the revolted nobles, put them all to death. He was soon after poisoned, B.C. 181, and thus left his dominions to

Ptolemy Philometer, a child of six years old, under the tuition of his mother Cleopatra. In a war, which he had with the kings of Syria, towards the beginning of his reign, he was made prisoner; and this induced the Alexandrians to raise his brother,

Ptolemy Physcon to the throne.—Ptolemy Philometer, however, recovered his liberty; and the two brothers at first united in opposition to Antiochus Epiphanes, who was seeking an opportunity of availing himself of the distracted state of the kingdom, to obtain possession of it. Antiochus then proposed to invade Egypt; but was prevented from doing so, by the intervention of the Romans. Philometer was one of the best of that race; and Physcon, one of the very worst. Under the sanction of the Romans, Philometer reigned in Egypt, and Physcon in Libya and Cyrene. Philometer was slain in battle with Demetrius king of Syria, and Cleopatra, his queen, attempted to secure the kingdom for her son: but Physcon making pretensions to it, he married her, and then murdered her son in her arms. The remainder of his reign was a continual series of the most revolting crimes. He died, B.C. 117, and was succeeded by

Ptolemy Lathyrus.—Cleopatra, mother of Lathyrus, attempted to govern him and the kingdom at the same time; but finding him not sufficiently tractable, she instigated the Alexandrians to drive him from the throne, and to place his younger brother, Alexander, upon it. He, finding his mother's dictation insupportable, caused her to be murdered. He was then driven from the throne by the people, who would not have a matricide for their king; and Lathyrus was recalled. Thebes was one of the cities which had rebelled against Lathyrus, and it continued to resist him; but, after a three years' siege, he took it, and gave it up to plunder and devastation: so that it never afterwards recovered its former influence and splendour. On the death of Lathyrus, he was succeeded by

Alexander II. under the protection of the Romans, among whom he had lived. The Alexandrians had, in the meantime, chosen Cleopatra for their sovereign; and on the arrival of Alexander, it was agreed that he should marry her. This was done, but nineteen days afterwards, he murdered her; and afterwards continuing to perpetrate the most horrible crimes, the people rose up against him, and obliged him to flee for protection to Pompey, the celebrated Roman general. He soon afterwards died, leaving all his rights to the Roman people, declaring them to be the heirs of his kingdom.

Ptolemy Auletes was heir to the throne; and endeavoured to obtain possession of the kingdom, by the consent of the Roman Senate, among whom he expended large sums of money. After many disappointments, he at length obtained the crown, and held it for four years. On his death, he left a son and two daughters under the tuition of the Roman people. One of these daughters was the celebrated Cleopatra, who makes so conspicuous a figure in the civil wars of Rome. With Cleopatra ended the race of the Ptolemies, who had reigned over Egypt for the space of 294 years. Egypt then became a province of the Roman empire.

In the other two kingdoms, namely, THRACE and MACEDON, into which Alexander's empire was divided, no events affecting the general history of the world took place, except such as were connected with the history of Rome, till they were both swallowed up in that all-absorbing empire. We therefore proceed to give a brief view of the history of

ROME, from the age of Alexander, till the advent of the Saviour of the World. The last and most formidable enemy that the Romans met with, in their wars to obtain the sovereignty of Italy, was Pyrrhus, king of Epirus. He was brought into Italy by the Samnites and Tarentines, to assist them against the Romans; and it was not till after a six years' war, that the Romans were able to expel them. Pyrrhus was killed at the siege of Argos, B.C. 272; after which, the unsubdued states of Italy submitted to Rome.

Soon after this, the Romans were engaged in the first war with the Carthaginians; usually called the first Punic War, from the Carthaginian name, Pœni, or Phœni, which they had, as being descended from the Phœnicians. This war was occasioned by the Carthaginians having possession of part of Sicily, and grasping at possession of the rest. The Mamertines, having been defeated by Hiero, king of Syracuse, and reduced to great distress, had resolved to surrender the city of Messina to him; when Hannibal, the Carthaginian general, obtained possession of it by stratagem. The Mamertines called in the assistance of the Romans; and thus brought Rome and Carthage into direct collision. The war continued 24 years; and ended in the Romans obtaining possession of Sicily, and forcing the Carthaginians to conclude a peace on very disadvantageous terms.

The interval between the first and second Punic Wars, was occupied in subduing some tribes of Italy that had revolted; and also in taking possession of Corsica, Sardinia, and Malta. The second Punic War was purposely provoked by the younger Hannibal, now general of the Carthaginian army. He found a pretext for attacking Saguntum, a city in alliance with Rome. The Romans remonstrated, but in vain; and war was the consequence. Hannibal, having taken measures for securing Africa and Spain, crossed the Pyrenees, and then continued his march to the Rhone. This he passed, in the face of some opposition from the Gauls; and then, scaling the Alps with his army, he descended into the plains of Italy. There, by a series of able measures, military and diplomatic, he maintained himself for 16 years; defeated the Romans in several pitched battles,—namely, at Ticinium, at Trebia, at Thrasymene, and at Cannæ; and brought Rome itself into the most imminent danger. Had he been supported by his country, as its interests required, he might probably have turned the scale permanently in its favour. But an envious faction at home refused him the necessary supplies; and, for a considerable time, he could do little more in Italy, than maintain his ground. At length Scipio, the Roman General, after defeating the Carthaginian forces in Spain, passed over to Africa, and threatened Carthage itself. Hannibal was then recalled to defend his native city. He left Italy with regret, and contrary to his own judgment. He encountered Scipio at Zama; but his army, consisting chiefly of mercenaries, was unequal to the army which Scipio commanded, and was defeated, B.C. 196. Peace was then made on terms for Carthage still more humiliating.

The Romans, however, were not satisfied with humbling this rival republic. It was a favourite maxim with some of their statesmen, that Carthage should be overturned. An opportunity soon occurred of renewing hostilities. The Carthaginians were anxious to avoid war, and made many extraordinary concessions; but nothing would satisfy the Romans. They proposed that Carthage should be destroyed, and a city to accommodate the inhabitants, built 10 miles inland. This proposal drove the Carthaginians to despair, and they determined to resist to the uttermost. The city was besieged; the people defended themselves with the greatest resolution; but, being betrayed by one of their own citizens, the city was taken by storm, and destroyed B.C. 146.

The manner in which the Romans were led to interfere in the affairs of Egypt, on the accession of Ptolemy Philometer, has already been related.

Similar causes led to their interference in the affairs of Greece. After the death of Pyrrhus, king of Epirus, the Macedonian kings resumed their authority over Greece. An effort was made by a confederacy among the Greek states, called the Achæan league, to assert their liberties; but, in consequence of their mutual jealousies, and want of good faith, they never shook off the shackles, in which Philip, the father of Alexander, had bound them. At length, the ambition of the Macedonian king, induced him first to enter into a league with Hannibal, and afterwards to engage in an enterprise against Egypt, which was under the protection of the Romans. These aggressions, together with an application for protection from Athens, induced the Senate to declare war against Macedon, B.C. 200. This contest lasted four years, when Philip, having been defeated by the Consul Flaminius, agreed to peace. Philip died B.C. 179, being in the interval between the second and third Punic Wars, and during the reign of Antiochus Epiphanes, king of Syria. Perseus, his son, succeeded him, and immediately began to make preparation for war with Rome. The Romans, anticipating him, sent an army against Macedon. Perseus at first defeated the Romans; but was ultimately defeated by the Consul, Paulus Æmilius. When the Romans first defeated Philip, they proclaimed freedom to Greece; and the infatuated Greeks exulted as if they were really free. They seem to have forgotten that, by receiving their freedom from Rome, they put it in the power of Rome to take it away. Accordingly, in the same year that the Romans destroyed Carthage, their Consul Mummius destroyed Corinth; and reduced Greece to the rank of a Roman province, B.C. 146.

Not long after this, a contest commenced between the patricians and plebeians, which ended not, till it had effected the ruin of the republic. Tiberius Gracchus, a tribune, proposed to revive the Agrarian or Sempronian law, by which no citizen was permitted to hold above 500 acres of conquered lands. This attempt so irritated the senators, that during the tumult of an election, they assassinated Gracchus, and 300 of his partisans. His brother Caius Gracchus, when tribune, made a similar attempt; and on his return to a private station, was persecuted to death. Thus was begun, by the senators, that system of persecution, which very soon fell most heavily upon themselves. In the meanwhile, however, the republic continued to be successful in its foreign wars; and country after country was annexed to the empire by conquest, or by treaties, or by the bequests of sovereign princes.

The next important transaction, in which the Romans were engaged, was the war against Jugurtha, king of Numidia. He had come to the throne by the murder of his uncle's sons, Hiempsal and Adherbal. An appeal was made to the Romans against the treachery and oppressions of Jugurtha; and they made war on him, and ultimately took him prisoner, and brought him to Rome; where he was strangled in the prison. In this war, the celebrated Marius first distinguished himself.

The Cimbri and Teutones, threatening to cover Italy with desolation, Marius was sent against them, and defeated them with immense slaughter.

But the ambition and revengeful spirit of Marius brought innumerable calamities upon the republic. He proposed again the execution of the Agrarian law, relative to the lands recently recovered from their enemies. This produced the social war,—so called, because it was a war of the Italian states upon Rome, provoked by the operation of the Agrarian law. It lasted three years: and, after a slaughter of more than 300,000 men, the Senate succeeded in putting a stop to it, by granting, in part, the demands of the allies, B.C. 87.

The next important war in which the Romans were engaged, was that with Mithridates, king of Pontus. This prince obtained possession of Phrygia, by bribing one of the Roman generals. He was driven out of it, by Sylla; and this expulsion laid the foundation of determined enmity to the Romans. He proved one of the most formidable enemies they ever had. He was, however, subdued, and forced to sue for peace. But this war was the occasion of more disastrous consequences to the state, than the resistance of Mithridates. Sylla and Marius contended for the privilege of conducting the war, which was likely to prove lucrative. Marius gained the popular interest, and was appointed to the command; but Sylla marched to Rome, with six legions, proscribed Marius, and eleven of his adherents, who fled. Sylla, now deeming himself secure, returned to prosecute the war with Mithridates; but Marius returned to Rome, massacred great numbers of citizens and distinguished senators, and abrogated the laws of Sylla. Marius then caused himself to be elected consul with Cinna; but survived his election only sixteen days.

Italy, on Sylla's return, became the theatre of civil war; in which Carbo the Consul, and the younger Marius were slain. Sylla, every where victorious, entered Rome in triumph, trampled on the laws, proscribed 80 senators, and several thousands of citizens, and gave up his enemies to military execution. Julius Cæsar, who was nephew of Marius, narrowly escaped the carnage, while Pompey was a zealous partisan of Sylla. Sylla died, B.C. 78.

The civil war still continued; and also a servile war against about 40,000 rebel slaves raged. Pompey so much distinguished himself in these wars, that he was vested with the supreme command of the Roman army, and sent against Mithridates, king of Pontus, whom he subdued; and carrying the war beyond Pontus, he subdued Armenia, Syria, and Palestine. From these conquests, he returned to Rome, B.C. 63.

Meanwhile, Julius Cæsar was signalizing himself in the west. Returning in triumph from Spain, he found Rome divided into two factions; the one attached to

Pompey, the other to Crassus, who was the richest of the citizens. These men, Cæsar had the address to unite, and to bring to an agreement to form a triumvirate with him, the object of which was, to divide the government among themselves. They accordingly partitioned the provinces among them: Pompey taking Spain; Crassus, Syria; and Cæsar, Gaul.

Crassus, on entering his province, made war on Parthia; and was defeated, and slain. This broke up the triumvirate; for Pompey and Cæsar, coming into direct collision, a contest immediately arose, who should be at the head of the state. Pompey had chief influence in the Senate; Cæsar among the soldiers. Cæsar marched to Rome, and forced Pompey to retire. Pompey went to Greece, where he raised an army to withstand Cæsar. Thither Cæsar followed him: and, encountering him at Pharsalia, totally defeated him. Pompey fled to Egypt, where he was treacherously murdered. Cæsar, after this battle, overran Egypt, Syria, and Pontus, and then returned to Rome. Pompey's party was not yet extinct: one portion of it was in Africa. Thither Cæsar went, and defeated it. Another part of it, was in Spain: thither he next led his army, and overthrew it. He then returned to Rome, where he was greeted by the acclamations of the citizens; but, almost immediately afterwards, was assassinated in the senate-house, at the foot of Pompey's statue.

His death rekindled the flames of war. The Senate had its interests to promote; Antony, master of the horse, had his; and Octavius, Cæsar's sister's grandson, then only 18 years of age, had views and interests different from both. After a series of intrigues and treacheries, a second triumvirate was formed, consisting of Octavius, who had assumed the name of Cæsar Octavianus, Antony, and Lepidus. The temporary alliance between these three, was founded upon a proscription of the enemies of each: and 300 Senators and 2000 Knights being included in this proscription, it soon filled Rome with bloodshed and terror. The triumvirate then proceeded to subdue the conspirators against Cæsar. The contest was decided in Greece; the last decisive battle being fought at Philippi. After the death of the conspirators, the triumvirs divided the Roman empire among them. Antony, by this partition, went to Egypt, to govern the Eastern kingdoms. There he met with the notorious Cleopatra, and was so fascinated by her, that he ceased from that time to attend to his own interests with energy. Meanwhile Octavianus, whose unceasing aim was to centre the supreme power in his own person, easily found means to undermine Lepidus, to deprive him of all authority, and force him into banishment, where he died in obscurity. He then contrived to quarrel with Antony. The pretence was the insult which Antony had offered to his sister, whom he had married, and then deserted for Cleopatra. The war was decided by a naval engagement at Actium, in which Antony was defeated. He fled to Egypt, whither Octavianus followed him; and, finding it impossible to retrieve his affairs, he put himself to death. Cleopatra, also, after a fruitless attempt to gain Octavianus, caused herself to be bitten by an asp, and died. Octavianus thus became sole monarch of the Roman empire, B.C. 27,—and received from the senate, the title, Augustus, by which title he is usually known. Augustus, having firmly fixed himself in the sovereign authority, his ferocious character seems greatly to have softened; and he employed himself sedulously in promoting the welfare of his empire. It was in the 23rd year of the reign of Augustus Cæsar, when the empire was in profound peace, that the Saviour of the World was born at Bethlehem. The Christian era began four years later. The reason of this was, that the birth of the Saviour was not used as an era for the computation of time, till some centuries afterwards; and, in computing the time backwards, a mistake was made of four years; so that his birth really took place in the year of the world, 4000; although, in consequence of this error, the Christian era corresponds to the year of the world 4004.

JUDEA.—The only country besides Rome, whose affairs, during this period, it is necessary to notice, is Judea. After the death of Alexander, the Jews fell under the dominion alternately of the Egyptian and Syrian kings, as the one or the other were able to take possession of Palestine. Judea was, consequently, during this period, almost constantly the theatre of war. Antiochus Epiphanes, on his accession to the throne of Syria, B.C. 175, being much in want of money, received an offer of 350 talents from Jason, the brother of the high priest, on condition that he should be made high priest instead of Onias, and that Onias should be confined for life at Antioch. This contract was completed. Jason entered on the office, and being a zealous admirer of Greek customs, he suspended the worship of God in the temple, and gave himself up to Paganism. Jason was afterwards supplanted, in the same manner, by Menelaus, another brother, who offered 300 talents more, for the high-priesthood. A report afterwards, reached Jerusalem, that Antiochus was dead. The people could not refrain from expressing their joy, which coming to the ears of Antiochus, he entered the city, and put to death, it is said, 40,000 of the inhabitants, and sold as many more for slaves. Some years afterwards, Antiochus having been mortified by the Romans, resolved to wreak his vengeance on the Jews, and sent his General with the most sanguinary orders to put an end to their religion. A scene of carnage then commenced that has hardly any parallel in history, till the people were driven to desperation; when a priest named Mattathias collected a small body of resolute men, and, after many struggles, succeeded in driving the Syrian army beyond the borders of the kingdom. He was succeeded by his son, the renowned Judas Maccabæus, who defeated the Syrians in five pitched battles, and baffled all their attempts to recover Palestine. Antiochus was in Persia, whilst this revolution was taking place in Judea. Mad with rage, he hastened back, breathing out slaughter and destruction against the Jews, when he was seized with a mortal disease, and died at Tabæ, a town on the frontiers of Persia and Babylonia. The Syrian Generals renewed the war, and were defeated repeatedly by Judas, who was at length slain in battle, B.C. 161, and was succeeded by Jonathan, his brother. Jonathan, conducted the affairs of the nation with the same prudence and success, till he was treacherously murdered. He was succeeded in the command by his brother, Simon; who, after governing wisely, for some years, was murdered by Ptolemy, who had married his daughter. Simon was succeeded by his son,

John Hyrcanus, who took the title of King. He was the first king, after the captivity; and in his reign, the nation rose to greater prosperity than it had enjoyed at any period since the restoration. On his death, B.C. 107, he was succeeded by

Aristobulus, his eldest son, who proved a tyrant and a murderer. After a short reign, he was succeeded by

Alexander Jannæus, B.C. 105, who made some conquests to the eastward of Jordan. Returning from his conquests and triumphs, he gave himself up to luxury and dissipation; and brought upon himself diseases, of which he died. He was succeeded by

Alexandra, his wife, B.C. 78, during the contests of Mithridates, king of Pontus, against the Roman power. In her reign, the Pharisees having obtained her ear, rose to influence, and persecuted the party that was opposed to them. She died B.C. 70, and was succeeded by

Hyrcanus, her eldest son; who, in three months, was driven from the kingdom by

Aristobulus, his younger brother. It was in the contest between these two brothers, that Antipater, an Idumæan proselyte, and the father of Herod, the first of that name, came into notice. Under pretence of supporting the cause of Hyrcanus, he contrived to ingratiate himself with the Romans, and, after Jerusalem was taken by Pompey, B.C. 63, in the war that ensued between Cæsar and Pompey, Antipater found an opportunity of obtaining the favour of the former, and the result was, that

Herod, his son, was made King of Judea, by Mark Antony, B.C. 40. He became one of the most furious blood-thirsty tyrants, whose names stain the page of history. He had married the daughter of Hyrcanus, through whom his family enjoyed all its dignity and influence. Becoming jealous of the rank which she possessed independently of him, he caused her and all her family to be put to death. After he was firmly settled on the throne, he set himself to beautify his dominions. He rebuilt Samaria; calling it Sebaste, in honour of Augustus Cæsar. He built a stately palace on Mount Zion: he also built the city of Cesarea; which name was given to it also in honour of Augustus. But his most celebrated work was the rebuilding of the temple at Jerusalem, on a scale of great magnificence. It was towards the close of his reign, that the Lord Jesus Christ was born at Bethlehem; on which occasion he caused all the infants in Bethlehem, under the age of two years, to be massacred in cold blood, in the hope that the new-born Messiah would perish among them. He soon after died himself, in extreme torture, leaving his dominions divided among his four sons, who, from their inheriting a fourth part of the kingdom, were called Tetrarchs. One of these sons was that Herod, tetrarch of Galilee, who put to death John the Baptist, and who derided our blessed Lord, when he was sent to him by Pilate, the Roman Governor. Archelaus had Judea for his province; but, incurring the enmity of his subjects, they accused him at Rome, and ultimately procured his banishment. Judea was then made a Roman province, and continued to be so till the destruction of Jerusalem; except for a few years, during which by the favour of Caligula and Claudius, that Herod reigned, who put to death the apostle James, and imprisoned Peter; and who, after a vain-glorious speech, was smitten with the diseases of which he died. Agrippa and Bernice, before whom Paul pleaded his cause, while Festus was

Roman Governor, were also of the same family. Agrippa reigned however, not over Judea, but over some of the neighbouring districts.

MODERN HISTORY.

That portion of the history of the world, which followed the birth of the Lord Jesus Christ, may fitly be called Modern History; because the institutions of the empire of Rome, which then had reached its height, still continue to influence the western world; and particularly, because that great revolution of religion, and generally of the human mind, which then commenced, has continued to advance; and, in the present day, is proceeding with unabated, or rather renewed, vigour.

This portion of history, like that which preceded it, from the creation of the world, might also be regarded as distributed into periods of 500 years, by remarkable eras. The first period of 500 years, after the Christian era, is marked pretty nearly by the reign of Justinian, and the fall of the western empire. The second period is marked by the reign of William the Conqueror, and the settlement of the Gothic nations. The third is marked by the discovery of America, the fall of the eastern empire, and the Reformation. These divisions, however, do not suggest the leading revolutions in the history of the world, since the birth of Christ. We rather, therefore, adopt the following eras, as our resting points. The dates are given in round numbers. I. The era of Constantine, marked by the toleration of Christianity, and the division of the Roman territory into the Eastern and Western empires, A.D. 300. II. The rise of Mahomet, A.D. 600. III. The Crusades, A.D. 1100. IV. Charles V. of Germany, and the discovery of America, A.D. 1500. And V. Bonaparte and the French Revolution, A.D. 1800.

A.D.	ERAS.	Century.	PRINCIPAL PERSONS OR EVENTS IN EACH CENTURY.
0 to 100	JESUS CHRIST.	1st	Jesus Crucified under Tiberius, Emperor, A.D. 33. Jerusalem destroyed by Titus, A.D 70. Persecution of Christians.
101 to 200		2nd	Trajan, Emperor. Antoninus Pius, Emperor. Persecution of Christians.
201 to 300		3rd	Pertinax, Emperor. Dioclesian, Emperor. Persecution of Christians.
301 to 400	CONSTANTINE.	4th	Persecution ceases, A.D. 313. Constantinople built, and Empire divided.
401 to 500		5th	Rome plundered by Alaric the Goth, A.D. 410. Attila, king of the Huns. Western Empire overturned by Odoacer, A.D. 476.
501 to 600		6th	Justinian, Emperor of the East. Belisarius. Narses defeats the Goths in Italy.
601 to 700	MAHOMET.	7th	Mahomet's flight, or Hegira, A.D. 622. Caliphate established. Saracenic conquests.
701 to 800		8th	Saracens defeated, and their progress stopped by Pepin, king of France. [Charles Martel. Charlemagne, Western Empire revived.
801 to 900		9th	England united in one Monarchy. Danes invade England. Alfred.
901 to 1000		10th	Normans establish themselves in France. Hugh Capet, king of France.
1001 to 1100	CRUSADES.	11th	Canute, first Danish king of England. William the Conqueror, king of England, 1066. Crusades commence, A.D. 1095.
1101 to 1200		12th	Henry II. of England, receives the submission of the Irish Kings. Saladin, Sultan of Egypt, A.D. 1193.
1201 to 1300		13th	Magna Charta, signed by King John, 1215. Zengis Khan overruns Asia. Rise of Ottoman Empire.
1301 to 1400		14th	Battle of Bannockburn, 1314. Tamerlane overruns Asia. Henry IV. usurps the English throne.
1401 to 1500		15th	Printing invented, A.D. 1440. Constantinople taken by the Turks, A.D. 1453. America discovered, A.D. 1492.
1501 to 1600	CHARLES V.	16th	Henry VIII. king of England. Reformation. Elizabeth. Defeat of Spanish Armada.
1601 to 1700		17th	Louis XIV. king of France. Charles I. king of England, beheaded, A.D. 1649. William and Mary, king and queen of Gt. Britain.
1701 to 1800	BONAPARTE.	18th	Peter the Great, of Russia. Unit. States of America acknowledged, A.D. 1783. Louis XVI. king of France, beheaded, A.D. 1793.
		19th	Union of Great Britain and Ireland. South American Republics separate from Spain. Abolit. of Slave Trade, A.D. 1806, of Slavery 1834.

At the birth of Jesus Christ, nearly the whole of that territory that had been successively occupied by the Babylonian, the Persian, and Grecian monarchies, was under the dominion of the city of Rome, now itself governed by a despotic monarch, retaining, indeed, the forms of a republic, but really under the absolute government of a military chief. And besides the territory of the former monarchies, this great empire now included under its sway those western countries, Spain, France, Holland, or Batavia, as far as Britain, which were scarcely known to history, even at the latest of the former eras. It was, with the single exception of Palestine, pagan. That country was inhabited by the Jews; who derived their religion with more or less purity, from the Scriptures of the Old Testament.

FIRST ERA.

Birth of Jesus Christ.

FIRST CENTURY.

After the birth of the Saviour of the world, Augustus continued to govern the empire with much good judgment and clemency, attending to its internal order and prosperity, and to its protection from foreign invasion. Towards the end of his reign he adopted his step-son, Tiberius, and appointed him his successor in the empire. He died, A.D. 14, in the seventy-sixth year of his age, and the forty-first of his reign.

Tiberius succeeded him, a man naturally of dark suspicious temper—a disposition which was fostered by the circumstances in which he was placed—till he became a torment to himself, and a scourge to all who fell within his reach. In the 12th year of his reign, he retired to the Island of Capreæ, opposite to Naples, which he has rendered infamous by his cruelties, and his abominable debaucheries. In this retreat he remained issuing his murderous edicts, till the 23rd year of his reign, and 78th of his age; when he was seized with illness, and in that state, was put to death by one of his attendants. Previous to his death, he had appointed Caligula his successor, who seems to have recommended himself to him chiefly by his profligacy. It was in the 18th year of the reign of Tiberius, that the Lord Jesus Christ was crucified.

Caligula succeeded him, but was remarkable for nothing but his extravagant vices. His cruelty, his rapacity, his profligacy, and his licentiousness, were without bounds, till the injuries which he inflicted on the citizens of every rank, became intolerable. A conspiracy was formed to murder him, which proved successful, in the 4th year of his reign, and the 29th of his age. When Caligula was slain, no successor had been named; the Senate met, and some of the Senators proposed to avail themselves of the opportunity of re-establishing the liberty of the city and empire: but they were opposed by the populace and the soldiery, who preferred to the government of a Senate, the largesses and the shows by which the Emperors sought to secure their favor. The soldiers and the populace, therefore, were resolved to have an Emperor; and some of them passing round the palace, found Claudius, the uncle of Caligula, a man about 50 years of age, who had been known chiefly by his imbecility:—him they took upon their shoulders, and proclaimed Emperor.

Claudius began, as most of the Emperors did, to reign well. He paid great attention to the making of aqueducts, roads, bridges, harbours, and other works of public utility; but, partly under the influence of an infamous woman, his wife, and partly through suspicions and fears to which his exalted rank exposed him, he became jealous and cruel, and a multitude of persons of the first families in Rome fell a sacrifice to his apprehensions. At length his wife, becoming apprehensive for her own safety, caused him to be poisoned, after he had reigned 13 years, A.D. 54. In the reign of Claudius, Britain was invaded a second time by the Romans. They were resisted by Boadicea, a British Queen; but her army was totally defeated, and the Britons deprived of the power, and, as it would appear, the inclination to resist. He was succeeded by

Nero, son of Agrippina, the second wife of Claudius. He, too, began to reign well, but afterwards rushed with such headlong fury into every species of wickedness, as to eclipse the enormities even of Tiberius, Caligula, and Claudius. The first indication which he gave of the native cruelty of his heart, was the ordering his mother Agrippina to be executed, and coolly observing, when he saw her dead body, that he never had thought his mother was so handsome a woman. The whole of his future life was divided between the most frivolous occupations, and the perpetration of cruelties—the recitals of which make the soul to shudder. Chariot-driving was his favourite amusement. He also valued himself upon his skill in music, and even condescended to appear as a public performer. But on the other hand, his thirst for blood was insatiable.

During his reign, a great part of Rome was burned; and most historians attribute to him the conflagration. To remove the odium of it from himself, he attributed it to the Christians, who were then beginning to attract attention; and upon that pretence commenced an inhuman persecution against them. Some of them were covered with the skins of wild beasts, and in this disguise, devoured by dogs; some were crucified, and others burned alive. It was in this persecution that Paul was imprisoned the second time, as mentioned in his second epistle to Timothy, and in all probability suffered death. Peter also, it is generally believed, suffered about the same time.

Seneca, the celebrated philosopher, had been his tutor; and Nero, having taken up some suspicion that he was accessary to a conspiracy against him, sent him an order to die; which order Seneca obeyed. Lucan, the poet also, the nephew of Seneca, received a similar order, for the same cause, and obeyed it. Nero murdered his wife, Octavia, that he might marry an infamous woman, named Poppæa, and her he afterwards killed by a kick, while she was in a state of pregnancy.

For thirteen years was he permitted thus to outrage human nature, till at length the empire was roused to rid itself of such a monster. Servius Galba, who was at that time Governor of Spain, and much revered both by the soldiery and the citizens, accepted an invitation that was given to him to march an army towards Rome. When Nero heard that Galba had declared against him, he gave himself up for lost. He made one or two efforts to put himself to death, but his courage always failed him. He at length fled out of the city, to the country house of one of his freedmen. There again he purposed to put himself to death, but dared not, till he heard that the senate had decreed that he should be put in the pillory, and scourged to death, and that the soldiers were actually in pursuit of him for that purpose. Then, by the assistance of an attendant, he gave himself a mortal wound with a dagger, and expired, just as the soldiers who pursued him burst into his apartment.

Galba succeeded him, and soon found that, being raised to the throne by the army, it required more steadiness of purpose and of conduct than he could command to keep the soldiers in subordination. In his attempts to do so he rendered himself unpopular, and furnished an opportunity for Otho, who had been a favourite of his, and who expected to succeed him, to attempt to undermine and depose him. In this Otho succeeded:—the soldiers bore him on their shoulders to the Forum, where they found Galba, and put him to death.

Otho, accordingly, succeeded to the throne, but did not possess long his newly acquired dignity. Other Commanders of armies, finding that the throne was at the disposal of the soldiery, began to aspire to that dangerous elevation. Vitellius, who commanded the army in Germany, persuaded his soldiers to proclaim him Emperor, and immediately marched towards Rome. Otho went to meet him; and, after a desperate conflict of several days, in which the two armies, felt that they were contending for the disposal of the whole Roman world, fought with great obstinacy and fury. At length

Otho was defeated, and soon afterwards killed himself having reigned three months and five days.

Vitellius was then declared Emperor by the Senate. He entered Rome as a town that he had taken by conquest, and immediately gave himself up to the indulgence of all kinds of luxury and profusion, and rendered himself proverbial for his gluttony. By these degrading practices, as well as by his cruelties, he too soon became unpopular; and the legions of the east availed themselves of the opportunity of declaring their general Vespasian Emperor. When the first army from the east entered Italy, Vitellius sent one of his Generals to meet it, but he being defeated, Vitellius proposed to resign the empire to Vespasian, on condition of his life being spared, and a sufficient revenue allotted for his support. Other circumstances, however, occurred to induce him to attempt to defend himself in the city. Vespasian's Commander laid siege to the city, forced his way into it, slaughtered a large proportion of the army of Vitellius, and at length some of the soldiers, finding Vitellius himself hid in an obscure corner, put a halter round his neck, killed him by blows, and then dragged his body through the streets and cast it into the Tiber.

Vespasian was now declared emperor by the Senate, A.D. 70. He was a man of rather low extraction, his father having been a collector of taxes. His name being Flavius Vespasian, his accession to the empire is sometimes regarded as the commencement of a new dynasty called the Flavian, as distinguished from the Julian, which preceded it. When the way to the empire opened to him, he was engaged in subduing the Jews who had revolted; and being under the necessity of coming to Rome, he left his son, Titus, to conduct the Jewish war.

Vespasian was not tainted with the vices of the preceding Emperor. He was a man of rather austere manners. He set himself steadily to reform the profligacy of both the citizens and the army, and was respected by both. His government is not charged with any public vice except avarice, and even that, perhaps, on not very sufficient grounds.

The most remarkable event of his reign was the destruction of the city of Jerusalem, and dispersion of the Jews. This event took place A.D. 69. The open country and provincial towns had been subdued by Vespasian, and the Jews made their last stand in the city of Jerusalem. That city was strongly fortified and defended with the utmost obstinacy. The Jews in the city were divided into two factions that were in deadly hostility with one another. The two factions, however, one keeping possession of the city, and the other of the temple, united in the defence against the Romans; and the city was so strong that Titus felt himself under the necessity of calling a council of his officers, when it was determined to surround it with a trench, and thus reduce it by famine. In the meanwhile, however, the operations for assaulting the city went on without relaxation; and at length the besiegers forced their way into it, when a scene of unexampled carnage ensued. Titus attempted to save the temple, but in vain. The city and temple were burned to the ground, every wall thrown down, and the ground on which it stood ploughed up and sowed with salt as the emblem of perpetual desolation. Thus was the prediction of our Lord fulfilled, that not one stone of the temple should be left on another.

Vespasian and Titus then entered Rome in triumph. A triumphal arch was erected for the occasion, which still stands almost entire. On this arch are sculptured some of the scenes of the Jewish war, and among others the Roman soldiers bearing in the triumph, the table of show bread, the silver trumpets, and the golden candlestick with seven branches. Vespasian also built a prodigious amphitheatre, capable of holding 80,000 spectators seated, and 20,000 standing, which still remains almost entire, and is known by the name of the Coliseum. Twelve thousand Jewish captives were employed in its erection. Vespasian reigned in all ten years, and died of a natural disease, leaving his son Titus to succeed to the empire.

Titus ascended the throne A.D. 79, and has been held up to all ages as a Prince possessing almost every virtue. It is to be observed, however, that he reigned only two years and two months, and that most of the Roman emperors began their reigns well. Had Nero himself reigned so short a time, he too would have been set forth as an example of every thing amiable and great. In the first year of his reign, A.D. 80, eruptions of Mount Vesuvius took place, by which the city of Herculaneum was overwhelmed in a torrent of lava, and Pompeii buried under an immense mass of ashes. These towns were discovered in the beginning of the last century, Herculaneum in 1713, and Pompeii 40 years afterwards; and from their ruins have been collected some of the most interesting remains of antiquity.

Towards the latter end of the reign of Vespasian, Agricola had been sent to Britain; and, in the reign of Titus he succeeded in bringing the southern part of the island under the dominion of the empire. After a reign of two years and two months, Titus was seized with a violent fever, of which he died, not without the suspicion of having been poisoned by his brother Domitian.

Domitian succeeded him, A.D. 81, and, at first, he, too, reigned well, but soon became one of the most degraded and detestable of the Roman Emperors. His character was a compound of arrogance, cruelty, and licentiousness. Agricola's success in Britain filled him with envy; he recalled him, and that General dying soon after, it is suspected that Domitian procured his death by poison. Men were daily put to death for the most trivial causes. In his reign, the second persecution of the Christians took place, when the Apostle John was banished to the island of Patmos, and there wrote his Apocalypse, or book of Revelations. The governor of Upper Germany revolted from him; but prematurely:—he was defeated and slain. At length his wife Domitia, having discovered that her name was inserted in his tablets to be destroyed, and also the names of several officers about the palace, headed a conspiracy against him, by which he was put to death.

His death was regretted only by the soldiery, whose favour he had taken care to secure by frequent and large distributions of money among them. The Senate immediately began to load his memory with reproach, and proceeded, before the soldiers had an opportunity of making an appointment of their own, to name his successor, so that on the very day of his death, Nerva was chosen to the empire, A.D. 96.

Nerva was an amiable but somewhat imbecile man. The people, however, had been so much accustomed to be governed by the most furious tyrants, that they regarded his gentle reign with rapture. Nerva recalled all the Christians who had been banished from Rome during the former reign. Finding the soldiery disposed to dictation and tumult, and his own strength decaying, for he was about 65 years of age when he was called to the throne, he wisely, overlooking his own family, chose Ulpius Trajan to succeed him; and, about three months after this, he died, having reigned only one year and four months. Nerva was the first foreigner that ever reigned in Rome.

Trajan accordingly succeeded him, A.D. 98. He was a Spaniard by birth, and at the time of his adoption by Nerva, was governor of Upper Germany. He had been the pupil of the celebrated Plutarch the Biographer. He was a man of great vigour, both of body and mind, and proved a warlike and energetic Prince. The barbarous nations that lay upon the outskirts of the empire were now becoming troublesome and dangerous. The Dacians that inhabited the country to the north of the Danube, invaded the empire. Trajan marched against them, defeated them, erected a bridge across the Danube which consisted of 22 arches, the ruins of which remain till the present day, and reduced Dacia to the condition of a province of the Roman empire.

Trajan, however, led away by the prejudices that existed against the Christians, permitted them, about the ninth year of his reign, to be furiously persecuted; and many of them were put to death by popular tumults, and by judicial proceedings. After some time, however, being satisfied that they were an unoffending people, he put a stop to the persecution. In his reign, the Jews made a fanatical insurrection against the government of Rome, in all parts of the empire, expecting that some signal deliverance would be sent to them from God. They took advantage of the absence of Trajan, in an expedition to the east, to massacre all the Greeks and Romans whom they could get into their power, perpetrating the most revolting cruelties. Their crimes, however, only recoiled upon themselves, and brought upon them a terrible retribution from the enraged army and populace of the empire.

In the east, Trajan extended the limits of his empire; but, on returning towards Rome, he was seized in the city of Seleucia with apoplexy, of which disease he died after a reign of 19 years, A.D. 117. A splendid column was erected to his memory during the reign of his successor, which still continues to be one of the most interesting ornaments of modern Rome.

SECOND CENTURY.

Adrian, his nephew, was chosen to succeed him.—The character of his government was totally different from that of Trajan. He was a man of peace, and adopted every method to promote and maintain peace. He was one of the most remarkable of the Roman emperors for the variety of his endowments: and, although his private character was stained with many faults, his public acts seem to have been dictated by sound policy. The barbarians still continuing their irruptions into the empire, had adopted the method of watching the absence of the Roman armies to make their incursions, and retiring before them when they came to drive them back. Adrian, finding that according to this mode of warfare, the bridge which Trajan built was at least as convenient for his enemies as for himself, destroyed it. His mode of obtaining peace in the eastern part of the empire, was an act of more questionable policy. He purchased the barbarians off by large sums of money; which could only encourage them to meditate new invasions.

He gave orders for the rebuilding of Jerusalem, which work was performed with great expedition, by the assistance of the Jews; but that infatuated people being enraged by the privileges which were granted to the Pagan worshippers in their renovated city, fell upon the Romans and Christians that were dispersed through Judea, and mercilessly put them to the sword. Adrian sent a powerful army against them, which subdued them, but not till after two years of warfare, during which 1000 towns were demolished, and nearly 600,000 men killed in battle. Adrian banished all Jews from Judea, and forbade them, on pain of death, to come within view of it.

Adrian spent a considerable part of his time in travelling through the empire. Among other places, he visited Britain; and, for the better security of the southern parts of this province, he built a wall of earth and stone across the island, between the river Eden, in Cumberland, and the Tyne, in Northumberland, some portions of which can still be traced. After 13 years, spent in striving to regulate the empire, and reform abuses in it, he returned to Rome, with the intention of ending his days there: and while there, he introduced many wise regulations into the city, particularly the restraining of masters from putting to death their slaves without trial, and preventing slaves from being tortured to discover the murder of their masters.

As he advanced in age, he became subject to great bodily pain, so that he ardently desired to die, and requested those around him to despatch him; none however could be found to engage in so dangerous a service, and he was permitted to die naturally, after a reign of nearly 22 years, A.D. 138. He was succeeded by

Antoninus, who, partly from his attachment to the idol-worship of the empire, and partly from his tenderness to Adrian while he was dying, has obtained the name of *Pius*. His character stands high for justice and moderation, and generally for primitive strictness of morals.

No regular account of the transactions of his reign has come down to us; but his general policy was rather to preserve the bounds of the empire, than to extend them. He was wont to say, after Scipio, that he would rather save one citizen, than kill a thousand enemies. He died of fever, at the age of 75, having reigned 23 years. On his death-bed he confirmed an adoption of Marcus Aurelius, which he had previously made, and nominated him as his successor.

Marcus Aurelius, who also took the name of *Antoninus,* accordingly succeeded to the empire; but associated with him Lucius Verus. Marcus Aurelius is frequently called *Antoninus Philosophus,* and is thus distinguished from his predecessor, Antoninus Pius. He is justly regarded as one of the best of the Roman emperors. Verus was almost a contrast to him in all the features of his character, being dissolute and ignorant; yet they seem to have conducted the affairs of the empire in uninterrupted amity.

When Antoninus came to the throne, he was urged by the Pagan priests and others to persecute the Christians; but he received that proposal with indignation; and, on the contrary, interposed his authority for their protection. During his reign the empire was visited with several heavy calamities. An inundation of the Tiber destroyed a vast multitude of cattle, and caused a famine in Rome. This famine was followed by an invasion of the Parthians, and about the same time the Celti made an irruption into Gaul and Rhætia. Verus went against the Parthians, defeated them and drove them out of Mesopotamia. About the same time a pestilence ran over the empire, making dreadful havoc of the inhabitants. The Marcomanni, another German tribe, began to take up arms against the Romans. The two Emperors marched to meet them, but Verus died by the way. In the conflict that ensued, the Romans were defeated with great slaughter. The Emperor made vigorous preparations for renewing the war; but his army being blocked up by the Quadi, a German tribe, an incident happened which has given rise to many contradictory statements. The Roman army were in danger of perishing with thirst, and the enemy assailed them in that condition, when suddenly a copious rain fell, which refreshed the Romans, while, at the same time, a storm of thunder and hail beat in the faces of the assailants, and enabled the Romans to overcome them. The Pagan writers ascribe this interposition to magicians: the Christians ascribe it to the prayers of a body of Christians who were in the army, chiefly in the 12th legion, from which that legion obtained the name of the thundering legion. Soon after this Avidius Cassius revolted, but was killed by a centurion. In A.D. 179, the Marcomanni again invaded the empire. Antoninus went against them and obtained a victory over them; but died before he had completed the war, A.D. 180. During his reign, the Roman rampart which ran between the Forth and the Clyde in Scotland, known vulgarly by the name of Graham's Dyke, was built. Antoninus was succeeded by

Commodus, his son, a weak and dissolute prince, who has made himself remarkable only for his licentiousness, cruelty, and injustice. After a reign of 13 years, he was assassinated by a conspiracy of the members of his household. He was succeeded by

Pertinax, A.D. 192, who had previously been nominated to the empire. He was of low birth, and had risen to eminence by his military virtues and talents. He reigned but three months; after which, he was murdered by the soldiery. The prætorian soldiers then set up the empire for sale; and it was purchased by a weak but rich man, named

Didius Julianus. Didius had amassed his money by avarice; and, continuing to manifest an avaricious disposition, he soon became unpopular with the soldiers; and Severus, an African by birth, induced the army, which he commanded, to proclaim him emperor. Severus immediately marched towards Rome, and Didius was slain.

Severus succeeded him, A.D. 194, having overcome two other competitors for the throne. His reign was energetic, but cruel. He went against the Parthians, who were then invading the frontiers of the empire, and overcame them,—compelled the submission of the King of Armenia, and destroyed several cities in Arabia Felix. He entered Rome in triumph; a splendid triumphal arch having been erected to receive him, which is still in good preservation. The Roman subjects in Britain being harassed and in danger of being destroyed by the northern inhabitants, he went thither, drove back the Caledonians, and built a wall across the island between the Solway Frith and the German Ocean. He did not long survive his successes in Britain, but died at York, after an active though cruel reign of about 18 years.

THIRD CENTURY.

Caracalla and *Geta*, the sons of Severus, being acknowledged as Emperors by the army, A.D. 211, began to manifest their hatred of one another even before their arrival at Rome. Caracalla, at length, resolving to govern alone, rushed into Geta's apartment, followed by a troop of ruffians, and murdered Geta in his mother's arms. He then became one of the most execrable tyrants that ever disgraced the empire. He even outdid Nero and Domitian in his barbarities; till Macrinus, the Commander of the forces in Mesopotamia, was roused to get rid of him, and employed a person to assassinate him, after he had reigned six years. The soldiers then fixed upon

Macrinus as Emperor, not knowing the part which he had taken in the assassination of Caracalla. He was permitted to reign little more than one year, when, having been defeated by some seditious legions of his own army, he was pursued and killed.

Heliogabalus, a boy of about 14 years of age, was then called to the throne by the army. His whole reign was a compound of effeminacy, prodigality, and cruelty. At length, after four years, the soldiers became tired of him, mutinied, pursued him into his palace, dragged him out, murdered him, and threw his body into the Tiber. Heliogabalus was succeeded by

Alexander, his cousin german. He was a prince of great energy, strict justice, and great humanity. Although but 16 years of age when he was called to the empire, he was one of the most accomplished and able of the Emperors. In his reign, the Germans began to pour, in immense swarms, into the empire. They passed the Rhine and the Danube, and threw Italy itself into extreme consternation. The Emperor resisted them in person, and drove them back; he was, however, cut off by a mutiny among his own soldiers, after a reign of 13 years.

Maximin, who had been the chief promoter of the sedition against Alexander, was then chosen Emperor. He was a man of great stature, strength, and courage. He had, by his extraordinary personal qualifications, attracted the notice of the Emperor Severus, who introduced him into his body guard; and from that station he rose to the throne itself. The leading feature of his character was brutal ferocity, which his elevation gave him ample means of indulging. He, however, carried on his military operations with great vigour, and defeated the Germans in several battles. His cruelties provoked several attempts to destroy him, none of which succeeded, till the soldiers, having gained over his guards, entered his tent while he was asleep, and slew both him and his son, after a reign of three years. After him

Pupienus and *Balbienus* reigned A.D. 238, but disagreeing between themselves, they were both slain by the soldiers. After the murder, the soldiers, passing along the street, met

Gordian, whom they declared Emperor on the spot, A.D. 238. He was a youth 16 years of age, and of good dispositions and abilities. The army, however, soon began to be dissatisfied, and their complaints were artificially fomented by one Philip an Arabian. Philip succeeded in having himself associated in the empire with Gordian; and when he found his authority sufficiently strong, he ordered Gordian to be slain.

Philip then became Emperor, and associated his son with him, A.D. 243, a boy of six years of age. The army, however, soon revolted in favor of Decius Julianus, his General, when Philip was put to death, and

Decius became Emperor, A.D. 248. He was a man of talent and moderation, and seemed for a time, to retard the fall of the empire. He was killed, after a reign of two years and a half, by an ambuscade of the enemy. He was a furious persecutor of the Christians.

Gallus, who had betrayed the Roman army, had sufficient address to get himself proclaimed Emperor, A.D. 251. He was the first that agreed to pay an annual tribute to the Goths to induce them to cease from disturbing the empire. Gallus wished for relief from foreign enemies, that he might give himself up to indulgence. Meanwhile, however, he permitted the Pagans to wreak their malice on the Christians, who were becoming very numerous. A pestilence raged throughout the empire with great fury in his reign. At length his general Æmilianus revolted from him, and Gallus and his son were slain in the battle that ensued. The senate refused to acknowledge Æmilianus, and an army that was stationed near the Alps chose

Valerian, their Commander, to succeed to the throne A.D. 253. He seemed to set about reforming the state with vigour, but the Persions invading Syria, Valerian was taken prisoner, and suffered an imprisonment of seven years, in which he was treated with every indignity. When Valerian was taken prisoner,

Gallienus his son proposed to avenge the insult, and was chosen Emperor, A.D. 259. But it soon appeared that he was more intent on the indulgences than the labours of royalty; and set himself down to a life of ease and luxury. At this time, there were no less than 30 competitors for the throne, who are sometimes absurdly called the 30 tyrants, in reference to the Athenian rulers after the Peloponnesian war. One of these aspirants to the throne had taken possession of Milan. Gallienus was obliged to march against him, but was slain during the expedition, by his own soldiers.

Flavius Claudius was named to succeed him, A.D.

263, a man of energy and talent, having done excellent service against the Goths; but after a great victory over these unwearied enemies, he was seized with a fever, of which he died. Upon his death

Aurelian was acknowledged by all the states of the empire. He was a man of great courage and personal strength, and rapid in his military movements. One of the most noted events of his reign was his subduing and taking prisoner Zenobia, the queen of Palmyra. Longinus, the celebrated author of the treatise on the Sublime, was Secretary to Zenobia, and he was by Aurelian's orders put to death. This Emperor's severities were at length the cause of his destruction. His own Secretary having been threatened by him, formed a conspiracy against him, which succeeded, and he was slain, having reigned five years. After some time, the senate chose

Tacitus, a man of 75 years of age, to succeed him, A.D. 275. He was a man of great merit; no way ambitious of the honours that were offered to him. He began with moderation; but after reigning six months, he was seized with fever and died. After his death his half brother attempted to succeed, but being defeated by Probus, he killed himself.

Probus was then declared Emperor; he was bred a soldier, and was noted for his determined bravery. During his reign, every year produced new calamities to the empire, by the incursions of enemies. These he repelled with great energy, being every where victorious, till, as he was marching to Greece, he was slain by his mutinous soldiers. He was succeeded by

Carus, A.D. 282, who associated with him his two sons Carinus and Numerian. Several nations in the west having revolted, he sent his son Carinus against them, and advanced himself against his eastern enemies. He defeated them, but was struck dead by lightning, after having reigned about 16 months. In the midst of the tumult and the attempts of Numerian and Carinus to secure the empire that was occasioned by the death of the Emperor,

Dioclesian, one of the ablest Generals of his day, was chosen, A.D. 284. In his time, the northern barbarians having discovered the want of discipline and energy in the Roman legions, poured down in swarms on the devoted territory. The Scythians, Goths, Sarmatians, Alani, Cursii, and Quadi, assailed it along the whole northern frontier. Dioclesian had chosen Maximian as his colleague, and afterwards took two other colleagues, Constantius Chlorus and Galerius, with the title of Cæsars. These Emperors gained many victories over the barbarians, but without the slightest effect in putting a stop to their incursions.

Dioclesian has rendered himself notorious by the most furious and persevering persecution of the Christians, which they were ever called to endure; but, in his effort to crush them, he was as much disappointed, as in his attempts to subdue and restrain the barbarians. At length, being threatened with a civil war, Dioclesian and Maximian resigned the empire, and on the same day, both retired into private stations. Dioclesian lived in his palace near Salona, amusing himself in the cultivation of his garden till he died, either by poison or insanity. After the resignation of Dioclesian and Maximian,

Constantius Chlorus and *Galerius*, the two Cæsars, were universally acknowledged as their successors Galerius immediately began to take measures for ultimately centering the sole government in himself; but his arrangements were rendered abortive by the elevation of Constantine, the son of Constantius Chlorus. Constantius died at York, A.D. 306, having appointed his son Constantine as his successor. Galerius died soon afterwards, and his government was distributed between Licinius and Maximian. There were now, therefore, four Emperors, Maxentius and Maximian, who had entered into a secret treaty with one another, Constantine and Licinius, who were naturally led to associate for mutual defence against their rivals.

Maxentius was in possession of Rome, and a steadfast supporter of Paganism. Constantine marched against him, and during his march he made a public profession of Christianity. Most of his army, it is said, were

Christians; and his profession of Christianity, not merely attached them the more to him, but procured for him many adherents in all parts of the empire. Maxentius was defeated, and drowned in his flight while attempting to cross the Tiber. Maximian, who governed in the east, marched against Licinius, but was also defeated, and soon afterwards died.

SECOND ERA.

Constantine.

At this era, the Roman empire still retained its ascendency; but its armies had lost much of their energy. They had been pampered and ruined by success, and had taken into their own hands the appointment of the Emperors. Constantine having built Constantinople, constituted it the capital of the eastern portion of the empire, and thus rent the empire into two parts. He also became professedly a Christian; and his accession drew multitudes into the church, many of whom, in all probability, knew little of Christianity, beyond the name.

FOURTH CENTURY.

Constantine and *Licinius* thus remained undisturbed possessors of the Roman world. It was not, however, likely that both would be satisfied with only a share of sovereignty, and accordingly, a contest soon arose, which terminated in favour of Constantine.

Constantine thus having become sole Monarch, adopted measures for establishing Christianity as the religion of the empire, which was effected, as it would appear, without much difficulty. The battle had already been fought in the diffusion of the truth; so that a large number of his subjects were already professing Christians.

Another important change introduced by this Emperor was his building Constantinople, and constituting that city the capital of the empire, and removing thither with his whole court. This measure ultimately caused a division of the empire into the western and eastern; the capital of the one being Rome, and that of the other Constantinople. This result was hastened by his dividing his empire among his three sons. Constantine died, A.D. 337, and was succeeded by his three sons,

Constantine, *Constantius*, and *Constans*. The weakness produced by this division encouraged the enemies of the empire, who had been restrained by the power and vigour of Constantine, to take up arms. The most remarkable and dangerous of these enemies was Sapor, king of Persia. He was vigorously opposed by Constantius, but with various success, till both parties being wearied with the struggle, and new enemies to each appearing, they concluded a peace.

In the meanwhile, Constantine attempted to dispossess his brother Constans of his dominions, but perished in the attempt. Constans governed so tyrannically, that he provoked an insurrection, headed by Magnentius, who commanded the veteran troops of the west. Constans was unprepared for this insurrection, and fled, but was overtaken and put to death. Magnentius had now to contend with Constantius, the other brother. A decisive battle was fought near the town of Mursa, on the river Drave, and the army of Magnentius defeated, and almost extirpated. This battle was decisive, not only of the fate of Magnentius, who afterwards put himself to death, but of the empire itself. So many well disciplined veterans, as were lost on that fatal day, could never be replaced; and never again did an Emperor command an army such as that which fell on the plains of Mursa.

Constantius thus became Monarch of the whole Roman empire. But the emergencies of the state compelled him to nominate an associate. Gallus and Julian his cousins, nephews of Constantine the Great, had been kept in confinement from their childhood. Gallus was now called forth to be associated with Constantius; but conducting himself indiscreetly, he alarmed the jealousy of Constantius, and was put to death. His brother Julian was then chosen, who conducted the affairs of the western empire with much ability. Constantius became jealous of him also, and demanded some of his troops, under pretence that reinforcements were required in the east. The troops refused to march, and Julian, after some delay, sanctioned their disobedience. A civil war was averted by the death of Constantius, when

Julian became Emperor A.D. 361. He had been educated in Christianity, but had a strong bias towards the Pagan religion and philosophy. While he was a subject, he continued to profess Christianity, or at least not openly to deny it; but when he attained to supreme power, he openly embraced Paganism. From this circumstance he has acquired the name of *the apostate*. He did not, however, persecute the Christians. He had observed that persecution only increased their numbers. He therefore attacked them by more subtle means,—by fomenting quarrels among them, by discountenancing them, by encouraging and favouring Pagans, and by reviving the Pagan worship, which had fallen into disuse, in all its splendour; also by arguing against Christianity in his writings and conversations. For the purpose of providing such an argument, he attempted to rebuild the temple at Jerusalem; but could not succeed. The most respectable writers of his age attribute the defeat of this attempt to a miraculous interposition, which interrupted the workmen, so that they did not dare to proceed with the work. But whether the interposition was miraculous or not, it is agreed on all hands, that the attempt was made by Julian, a Monarch of the Roman empire, and that it failed.

The Persians were at this time carrying on war against the Romans with vigour, and Julian marched to oppose them. On his way, he revived the Pagan worship wherever he went, consulted the ancient oracles respecting the event of his enterprise, and was uniformly assured of success. Full of hope and confidence, inspired by these assurances, he marched towards Persia, crossed the Euphrates and Tigris, and penetrated some way into the enemy's territory But the Persians had laid waste the country on his line of march, and he was at length compelled to retreat. The Persian horse now harassed him continually. It was in vain that the Romans were victorious in every encounter, the enemy only retired to renew the assault, till, at length, Julian, in his eagerness to repulse one of these attacks, was mortally wounded, and died the same evening, having reigned only twenty months. The army, reduced to great straits, chose

Jovian, an able commander, to succeed him, A.D 363. When Jovian was thus raised to the throne, he and his army were in imminent danger of perishing by famine. Unexpectedly the Persians sent proposals of peace, upon the condition that the Romans should restore five provinces which had been taken from them in the reign of Dioclesian. To these conditions Jovian agreed, and this was the first permanent dismemberment of the empire. Jovian did not live to return to Rome, or even to Constantinople; but was found dead in his bed on his way thither. At Antioch, however, he had revoked all the laws that Julian had made against Christianity.

Valentinian was chosen Emperor, and then named his brother Valens as his colleague. The empire being assailed on all sides by the barbarians, the two Emperors divided the empire between them, Valentinian receiving, as his share, the western, and Valens the eastern part of it. The Goths, in the reign of Valens, advanced up to the very suburbs of Constantinople, defeated and killed the Emperor, and then laid siege to Adrianople, but were repulsed with great slaughter After their repulse, great numbers of them were cut to pieces by the Saracens, who had come to the aid of the Romans. Valentinian continued to make head against the barbarians who invaded his part of the empire, till A.D. 375, when he died in the 12th year of his reign. At his death he was succeeded in the west by

Gratian, and the western empire being at this time without any Emperor, he obtained the sovereignty of that also. He was immediately engaged in conflict with the barbarians, who threatened the empire with destruction. Finding himself pressed on all sides, he chose *Theodosius* as his partner, and committed the east to his care. Theodosius was an able General, and of generous dispositions. He was a decided favourer of Christianity, and did much towards the abolition of idolatry, destroying the idols and temples of the heathens. While Theodosius was employed in combating the barbarians in the east, Gratian was attacked by a usurper in the west named Maximus. Gratian had previously given his brother Valentinian (known as Valentinian II.) a portion of his dominions. Maximus succeeded in putting Gratian to death, and then attacked Valentinian. Valentinian fled to Theodosius, who espoused his quarrel, attacked and defeated Maximus, took him prisoner, and put him to death. Valentinian II. was afterwards murdered by a General of his army, and Eugenius raised to the throne. Theodosius attacked and defeated him, and he was afterwards beheaded by his own soldiers. Theodosius, who is sometimes called the Great, divided his empire between his two sons, Honorius and Arcadius, allotting the west to Honorius, and the east to Arcadius. He died soon afterwards of dropsy.

Honorius and *Arcadius* succeeded him, A.D. 395. Honorius was a weak prince, utterly incapable of contending with the hordes of furious barbarians that were pouring in on the empire. He had, however, an able general named Stilicho. The celebrated Alaric was at this time king of the Goths. He ravaged Greece and invaded Italy, where he was defeated by Stilicho, who was hailed as the deliverer of Italy. Honorius retired to the inaccessible fastnesses of Ravenna, to be secure from the assaults of the barbarians, and the efforts of his General were confined to the defence of Italy; it being utterly impossible to protect the more distant provinces. A most formidable invasion now threatened Rome by Rodogaisus or Rodogast, at the head of an immense host of Germans of different tribes. They laid siege to Florence, which was reduced to the last extremity, when Stilicho appeared for its deliverance. He introduced supplies into the city, surrounded the besieging army with a trench and rampart, and reduced it by famine to a fragment of what it originally was. The wretched remnant of it was forced to surrender at discretion, and sold for slaves. Stilicho was thus hailed a second time as the deliverer of Italy.

Honorius, however, was exposed to a worse enemy than the barbarians, namely, his own jealousy and weakness. Stilicho, after all his services, was accused of corrupt motives, and put to death. This opened Italy to the Goths, and Alaric, a Gothic king professing Christianity, descended upon Rome itself. He was at first induced to spare the city by a large ransom, but afterwards he assailed it, took and plundered it, massacring many of the inhabitants.

In the eastern empire, nothing worthy of being noticed in this brief narrative is recorded, from the reign of Constantine, till the end of this century.

X

FIFTH CENTURY.

Alaric had taken and plundered Rome, A.D. 410, and Honorius died, A.D. 423. It is not necessary to give the names of the different nominal Emperors of the west, who assumed that title, during the early part of this century. None of them ever possessed the real government of the empire, almost every province of it being now in full possession of the barbarian tribes that had invaded it. At length, when a youth, called in derision, Augustulus, who had been raised to the nominal rank of Emperor by his father Orestes, a general of the Roman army, was in possession of the title of Emperor, Italy was invaded by Odoacer, a Goth. Odoacer defeated, took, and slew Orestes, went to Ravenna and took Augustulus; but spared his life in consideration of his youth, and appointed him a liberal maintenance. He then went to Rome, which readily submitted to him, and he immediately caused himself to be proclaimed King of Italy. Thus the very name of the empire of the west was obliterated. Britain had long been abandoned by the Romans. Spain was held by the Goths and Suevans. Africa by the Vandals. The Burgundians, Goths, Franks, and Alans, had erected several governments in Gaul, and at length Italy itself, as we have just seen, was enslaved by a barbarian, whose family, country, and nation can scarcely be traced.

In the east the empire was attacked by the most formidable enemy it had yet encountered; Attila, king of the Huns, a Tartar race who had come from the great wall of China, spreading blood and desolation over their track. Attila called himself the scourge of God, and boasted that grass never grew where his horse had trodden. He afterwards advanced westwards to Gaul. His empire is supposed to have been the most extensive ever acquired in one reign; his authority being acknowledged over the north of Asia and Europe, from the shores of the Pacific nearly to the shores of the Atlantic. It was, however, greater in territorial extent than in population and importance. Aœtius, the Roman prefect of Gaul, who had induced the Kings of the Goths and Franks to make common cause with the empire against Attila, met him near Chalons-sur-Marne, and defeated him with the loss of 200,000 men. But Attila though defeated was not subdued; he sent a threatening message to the Emperor, and received in reply a defiance. He then resolved to raise all his forces and invade Italy, and actually penetrated as far as Milan, which he took. Such was the terror that his approach occasioned, that many of the inhabitants took refuge among the canals and marshes that were at the extremity of the Adriatic Gulf, and there gave origin to the city of Venice. Attila was dissuaded by the

Pope from advancing upon Rome. Acetius compelled him to pass into Gaul, and there Thorismond, king of the Goths, gave him as signal a defeat as he had formerly received from Acetius.

In 476 a great conflagration took place in Constantinople in which 120,000 books were consumed. Towards the end of this century, the Ostro Goths, or Eastern Goths, erected a kingdom within the limits of the eastern empire, as the Visi Goths, or Western Goths, had done in the west.

SIXTH CENTURY.

The western empire is now at an end. In the eastern empire the chief object worthy of attention during this century is the reign of Justinian. He came to the throne, A.D. 527. The first enemy that he had to encounter, was the Persian Monarch. This monarch, although successful in one battle, was routed afterwards by the celebrated Belisarius. The war, however, was continued, with various success for many years. During this war, one of the greatest civil tumults, recorded in history, took place at Constantinople. It began with different factions in the Circus, but ended in open rebellion. One party went so far as to proclaim a new Emperor and seemed to carry every thing before them till Belisarius, who had been recalled from the Persian war, came upon the rebels when they were assembled in the Circus, attacked and slew 30,000 of them, and effectually quelled the rebellion.

Justinian now turned his arms against the Vandals in Africa, and the Goths in Italy, both of which provinces his able generals Belisarius and Narses recovered out of the hands of these barbarians. In A.D. 558, Justinian purchased peace with the Persians by paying a large sum of money. The same year a body of Huns having passed the Danube, marched towards Constantinople, and came within 18 miles of the city. The indefatigable and faithful Belisarius went out against them with comparatively a handful of men, and put them to flight. This was his last exploit. On his return to Constantinople, he was disgraced, stripped of his employments, and confined to his house, on pretence of being party to a conspiracy against the emperor.

Justinian thus, by the talent and bravery of his Generals, seemed to revive the ancient grandeur of the Roman empire. But he is scarcely less celebrated for the different digests of the laws which were executed under his auspices, and which have been of the most essential use in arranging the jurisprudence of the different kingdoms of Europe. He also founded the Church of Saint Sophia at Constantinople, which has been converted by the Turks into a Mahometan mosque, and is still regarded as a master piece of architecture. Justinian died, A.D. 565, in the 83rd year of his age, and the 39th of his reign.

THIRD ERA.

Mahomet.

At this era the Western division of the empire was no more. Barbarian tribes, from the north and east, had burst in upon it, and were in possession of much of its territory: and Rome itself was governed by a lieutenant, sent by the Emperor of Constantinople. In A.D. 600, Mahomet was preparing to propagate that celebrated imposture, which has obtained possession of so large a portion of the human race.

SEVENTH CENTURY.

This century is remarkable for the rise of the Mahometan imposture, which produced important results in the history of the world, during this and the succeeding period. Mahomet was born towards the close of the previous century; but did not commence his system of imposition till about A.D. 620. In A.D. 623, his efforts to disseminate his doctrine began to attract the attention of the magistrates of Mecca, and they conceived that he should be punished with death, as a disturber of the public peace. Mahomet fled to Medina, and from that circumstance his followers have adopted this year as the era from which they date all events, which is known by the name of the Hegira, or flight. Mahomet first established his doctrine in Arabia. His countrymen were previously Pagans, but had received sufficient knowledge of Christianity to render manifest to them the absurdities of Paganism. Mahomet artfully made such modifications on the Jewish and Christian doctrines and forms of worship, as to accommodate them to the habits and propensities of the Arabs, and also to establish his own personal sanctity and authority. After persuading some of his countrymen, and, through them, compelling others, to receive him as the prophet of God, he entered upon a regular system of conquest, which was followed up by his successors under the name of Caliphs. They overran Syria, Persia, Egypt, and Asia Minor, and ravaged the Greek empire; besieged Constantinople, but did not succeed in taking it. They spread themselves along the whole southern shore of the Mediterranean, crossed over to Spain, and entered Gaul, but were defeated and driven back by Charles Martel. They, however, established a splendid kingdom in the south of Spain, and maintained their ground there till near the time of the Reformation, when they were finally driven out by Ferdinand and Isabella, in the fifteenth century. After the Christian era, towards the beginning of the seventh century, the Saxon heptarchy was established in England, and the various barbarian tribes that had settled themselves in the Roman empire began to assume the form of regular states and kingdoms.

EIGHTH CENTURY.

Towards the beginning of this century, Pepin, mayor of the palace of the French kings, became possessed of the royal authority, and dying, was succeeded by his son, Charles Martel.

This century is remarkable chiefly for the effectual check that the Saracens received from Charles Martel in France, which has already been mentioned by anticipation. In the great battle which was fought between Tours and Poitiers, historians state that 375,000 men were slain, among whom was the Saracen General.

Pepin, son of Charles Martel, assumed, after his death, not only the authority, but the title and prerogatives of sovereignty. Pepin was succeeded by his son Charles, usually called Charlemagne, or Charles the Great, who makes the most conspicuous figure in the history of Europe towards the end of this, and the beginning of the following century. His dominions extended over France, Germany, and the northern parts of Italy; and he was invested by the Pope with imperial dignity, and crowned as the founder of a new empire of the west. But his chief honour consisted in the encouragement which he gave to literature and learned men throughout his dominions. He founded the University of Paris, and various other seminaries; and his attention to government, and the general improvement of his subjects, would have done honour to any Monarch in the most enlightened ages of the world.

NINTH CENTURY.

Charlemagne dying, A.D. 814, was succeeded by his son Louis, surnamed Le [illegible]bonnaire.

This century is noted in English history by the invasions of the Danes, and the reign of Alfred, who, whether he be considered in his public or private character, deserves to be ranked among the greatest and best of monarchs. The early part of his reign was most calamitous, in consequence of the incessant invasions and ravages of the Danes. He himself was reduced to the necessity of wandering about in disguise. He, however, succeeded in defeating them repeatedly, and checking for a time their incursions. Like Charlemagne, he gave every encouragement to learning that his means enabled him. He founded the University of Oxford, and composed more books than most men have done whose whole time has been devoted to study. In A.D. 890 he promulgated a code of laws, which are justly considered as the foundation of the common law of England. He died at the age of 51, A.D. 900.

TENTH CENTURY.

This century is chiefly remarkable for the almost total extinction of literature and civilization throughout Europe. The light of antiquity had perished amidst the violent agitations that followed the breaking up of the Roman empire, and the light of modern science and literature had not yet been kindled. The world presents over its whole surface one field of contention and bloodshed, with scarcely any object sufficiently prominent to deserve attention, or to excite interest. It is the very midnight of the dark ages.

ELEVENTH CENTURY.

This century is nearly as barren of important events as the preceding. It is, however, interesting in the history of England and Scotland. During the early part of this century, the Danes, still continuing their invasions, at length succeeded in placing their king, Canute, on the throne of England; and the Norwegian king having, in the absence of Canute, attacked Denmark, Canute returned to his native country, invaded Norway, onquered and deposed the King, placed himself on the hrone, and thus became the sole monarch of the three ingdoms, Denmark, England, and Norway. Canute, n his death, was succeeded in the throne of England, y two of his sons; the one following the other; after hom the Saxon line resumed the sovereignty.

But another enemy, destined to supersede both of hese dynasties, was now advancing to power, namely, he Normans, who had settled themselves on the west oast of France. Towards the middle of the century, William, Duke of Normandy, invaded England, defeatng Harold, King of England, at Hastings, ascended the nglish throne, and originated a dynasty of Norman ings, that for many ages reigned in England.

In the west, the Turks were rising into power. They ere of Tartar descent, and having been called in by e King of Persia to assist him in his wars, they soon, nder Tangrolipix, their leader, made themselves masters f Persia. Although they were Mahometans, they scruled not to attack the caliphate, and overthrow it. They so invaded the Greek empire, ravaged its territories, t did not, till a period considerably later, make themlves masters of Constantinople.

FOURTH ERA.

The Crusades.

At this era, the empire of the Saracens, or the aliphate, which had arisen out of the imposture of ahomet, had been broken up into many independent ngdoms, all professing the Mahometan religion. A w power, namely, the Turkish, had also sprung up the bosom of the Caliphate; and was now in posseson of Asia Minor, Syria, and some provinces to the stward. The Turks also were Mahometans. Palesne and Jerusalem were thus in possession of the emies of Christianity.

TWELFTH CENTURY.

Ever since the rise and rapid extension of Mahometanism, Jerusalem and Palestine, localities that were endeared to Christians by so many interesting associations, were in the hands of enemies of Christianity. Towards the end of the previous century, the western church had been aroused by the preaching of Peter the Hermit, to the disgrace of permitting infidels to retain possession of the holy city and holy sepulchre, and all the other sacred localities. And already an army, called a crusade, from its marching under the banner of the cross, had advanced into Syria. The first of the armies that went upon this expedition, being without arrangement, or generals possessed of military skill, and necessarily plundering the country in their route, were massacred, or perished, with the exception of about 20,000 men, before they reached Constantinople; and these, crossing into Asia, were met by the Turkish army, and totally defeated. That army was followed by one better organised, under the command of Godfrey of Bouillon, who defeated the Turks in several battles, and at length succeeded in taking Jerusalem, which the crusaders held for nearly a century. Godfrey was elected king of Jerusalem A.D. 1098. These crusades were repeated from time to time for about 150 years, till seven armies had found their graves in the plains and mountains of the east. But although these expeditions proved abortive in regard to the immediate object of them, namely, the rescuing of Jerusalem from the power of the infidels, they produced a beneficial effect on the state of Europe. They carried off many of the more turbulent spirits, and left a breathing time to the various kingdoms of the west; during which many towns rose to eminence and power, and the supreme civil authorities were strengthened. They also introduced into Europe a taste for elegance and refinement. Many of the crusaders returning from the east, where some remains of the civilization and polish of the Greeks, and of the Roman empire, still lingered, brought along with them a relish for more polished manners than those to which they had been accustomed at home. Hence it is, that almost immediately after the crusades, ancient literature and the fine arts began to be cultivated sedulously in Europe.

The connexion also of warlike operations with Christianity, however incongruous the admixture may appear, had the effect of infusing more of humanity and upright generous principle into the operations of war, than the ancient Pagan empires and states had any conception of. It was probably from this cause that the institution of chivalry arose, by which a race of warriors was reared who cultivated the highest principles of honour, and whose aim and pride it was to relieve the oppressed, particularly women, and even children, who might be in captivity, or exposed to insult or injury. It is thus that we seldom or never hear, in modern times, of such scenes of unmingled atrocity, such deadly treachery, such extensive and cold-blooded massacres, as we read of in every page of ancient history.

It was towards the end of this century that Henry II. of England first invaded Ireland, and obtained the homage of the Irish kings.

THIRTEENTH CENTURY.

The crusades still continued till the middle of this century; the last, which totally failed, having been undertaken by Louis IX. king of France, called Saint Louis, in A.D. 1270. This century is chiefly remarkable for the conquests of Zengis Khan, a chief of the Mogul, or Mongul Tartars, in the east. He overran the empire of the Saracens, took Bagdad, and put an end to that empire. Towards the end of this century the Moguls subdued China, and then established a Tartar government, which has continued till the present day. Othman, also, at the head of Turks, founded the Ottoman empire. Edward I. of England, about the close of this century, attempted to bring the Scottish monarchy under his authority.

FOURTEENTH CENTURY.

The commencement of this century is marked by the Scotch achieving their independence at the battle of Bannockburn, which was fought A.D. 1314. Towards the middle of the century Edward III. of England invaded France, and gained several victories, which led to no permanent result. Towards the end of the century, another Tartar leader, Timour Beg, known usually by the name of Tamerlane, overran the middle and west of Asia, carrying desolation and destruction wherever he went. He laid the foundation of the Mogul empire in Hindostan. Delhi was taken by him A.D. 1398. In this century the dawn of literature becomes manifest in Europe. Petrarch, Boccaccio, and Froissart, on the continent; Geoffry Chaucer in England; and Abulfeda, an Arabian geographer and historian flourished.

FIFTEENTH CENTURY.

In this century commenced that conflict, known in history by the name of the Reformation, which resulted in many of the kingdoms of Europe separating from the church of Rome. John Huss in Bohemia, Jerome of Prague, and Wickliffe in England, took the lead in disseminating the doctrines of the Reformation.

In the history of England, the early part of this century is marked by the attempt of Henry V. to obtain possession of the crown of France, by availing himself of the distracted state of this country. For a time he seemed to succeed in his enterprise; but the English were ultimately repulsed and driven back by the enthusiasm of a peasant girl, named Joan of Arc, who believed that she was called by heaven to achieve the deliverance of her country, and who infused into the armies of France a portion of her own enthusiasm. She was taken, and basely condemned and executed by the English General.

But that act of imbecile revenge rather hastened the expulsion of the English from France than retarded it. In the succeeding reign commenced the wars between the houses of York and Lancaster, in which a large portion of the English nobility were extirpated.

In the east the Turks, under Mahomet II. besieged Constantinople, and, after an obstinate siege, succeeded in taking it, A.D. 1453, the Greek Emperor being slain, fighting sword in hand in the breach. This put an end to the eastern empire.

The latter part of the century will ever be celebrated over the whole world by the discovery of America by Christopher Columbus, A.D. 1492.

FIFTH ERA.

Charles V.

This era finds the Greek or Byzantine empire extinct, and the Turks in possession of Constantinople and of Greece, to the shores of the Adriatic, with the most considerable islands. Further to the eastward, a great empire had been established by the Mogul Tartars; which had, particularly under two chiefs, Zengis Khan and Timour Beg, or Tamerlane, embraced a larger extent of territory, than any of the great empires of antiquity; but which, at this era, was broken up into a number of independent sovereignties. China was under the dominion of a Tartar dynasty.

The kingdoms of Europe were assuming that form, which, with the exception of late modifications, they still retain. Spain was then one of the most warlike countries in Europe.

Literature had begun to advance, with a steady and rapid pace, over Europe. The art of printing had been discovered about the year 1440, and was now beginning to assume that influence over human affairs, which has been so wonderfully developed in the present day. Statuary, painting, and architecture, had reached their highest excellence in Italy, under Leonardo da Vinci, Michael Angelo, Raphael, Titian, Correggio, and others.

But the most remarkable, as well as the most important, feature in this era, was the discovery of America, by Columbus; by which discovery a new world, that had been hid from the inhabitants of that portion of the globe which we have hitherto been contemplating, was unfolded to their wondering gaze, and opened to their spirit of discovery and enterprise—opened, also, alas! to their cupidity and cruelty. This event took place in 1492.

This age, so fertile in great events, was also the age of the Reformation; in which the Protestant churches separated from the church of Rome; an event which still continues to influence the political affairs of Europe.

SIXTEENTH CENTURY.

In the beginning of this century the eyes of all Europe were turned towards the newly discovered continent of America and its islands, till their attention was called off by a new object of a different description, namely, the dissemination of the doctrines of the Reformation, followed by the struggle for civil liberty that immediately ensued. The crowned heads of Europe regarded the introduction of any political or religious doctrines into their dominions, without their consent, as a dangerous encroachment on their power and prerogative; and, aided by many of the clergy and aristocracy of the day, attempted to crush every such tendency to innovation. Hence arose wars, persecutions, proscriptions, and massacres, scarcely less revolting than those which stain the pages of ancient pagan history.

Towards the commencement of this century, Charles, king of Spain, was elected Emperor of Germany, and being an able and ambitious prince, he made use of his vast power to attain to supreme influence in Europe. He was steadily resisted by Francis I. of France. After an active enterprising reign, in the latter part of which he met with many disappointments, he at length resigned his crown, and retired into private life.

This century is celebrated in English history, chiefly by the reign of Elizabeth, the attempt of Philip of Spain to subdue England, and the total destruction of his fleet, which he had boastingly called the Invincible Armada.

SEVENTEENTH CENTURY.

This century is marked by the struggle for civil liberty in England with the Kings of the Stuart family. Charles I. had imbibed higher ideas of royal prerogative than the people were disposed to submit to; and after various attempts on his part to establish an independent undefined right of taxation, which was steadily resisted, the contest broke out into a civil war, and the result was, that Charles was defeated and beheaded, and a kind of republic established, with a Protector, who, in fact, possessed all the authority of royalty. On the death of Cromwell, the Protector, the people of England were disposed to return to their former monarchical government, and Charles II. the son of the former Charles, was restored to his hereditary dominions. On his death, James, his brother, succeeded him; but manifesting a disposition to exercise the absolute authority which had been claimed by the first Charles, he was forced to abdicate the throne; and William, Prince of Orange, who had married the eldest daughter of James and was also his nephew, was called to it. This revolution led the way to those struggles for liberty which have since taken place in America and Europe, and which have not yet subsided.

On the Continent of Europe, this century is celebrated for the wars waged by Gustavus Adolphus, the Swedish Monarch, against the emperor of Germany. Gustavus baffled the ablest generals of the empire, gained several battles, till, at the battle of Lutzen, A.D. 1632, he was slain, although his troops gained the victory. This century is also celebrated for the reign of Louis XIV.

of France, which may be regarded as the Augustan age of French literature.

In the east of Europe, the Turks were pressing upon the Christian states. Their armies had advanced to the neighbourhood of Vienna, where they were defeated by John Sobieski, king of Poland.

While the southern parts of Europe were thus occupied, a power was rising in the north, which was destined to produce important changes in its social state. Russia, which had scarcely been felt or even heard of in European politics, till towards the beginning of the eighteenth century, now began to emerge from its obscurity. This empire may be said to owe its existence, under Divine Providence, to the extraordinary enterprise of Peter, more justly called the Great, than many of those who have obtained that title, and who ascended the throne of Russia A.D. 1682. The measures which he adopted for raising his country to eminence, were not conquest; but the introduction into his dominions of civilization, and of the arts and sciences. By these means he rendered available the resources of his vast territory; and his successors, following up his plans, with the addition of direct efforts to enlarge their territory, the Russian empire has assumed a more commanding and formidable position, than any single state now in Europe.

In Asia, the Tartars again overran China, and commenced a new Tartar dynasty on the throne of that vast empire.

EIGHTEENTH CENTURY.

The commencement of this century finds England and several of the states of Europe combined to resist the ambitious projects of Louis the Fourteenth. And the Duke of Marlborough, General of the forces of the allies, gained several great victories over the armies of France, which ultimately led to the peace of Utrecht. The attention of Europe was also directed to the war of

Frederick the Third, king of Prussia, with the German Emperor, for the possession of Silesia: and the rise of the Prussian kingdom to influence. Also to the wars of Charles the Twelfth, king of Sweden, against Russia, which ended in his defeat and death. Towards the middle of the century, Britain was disturbed by a rebellion which arose in the highlands of Scotland, the object of which was to replace the family of Stuart on the throne, but which was frustrated by the total defeat of the rebel army at Culloden, A.D. 1746.

While Europe was thus occupied with her own internal causes of jealousy and dissension, a new power was rising on the other side of the Atlantic, destined to produce the most important effects on the political condition of the world. Amidst the agitation and contentions on the subject of religion in England, during the reign of Charles I. and II., many of the English emigrated, carrying with them high ideas of religious and political liberty. To these were added a colony a little to the southward, consisting partly of persons convicted of crimes, and sentenced to transportation. Under favourable circumstances for increasing, the colonists did increase with unexampled rapidity, and soon began to feel that they were able to support themselves without aid from the parent country. The consequence was, that they became impatient of the right claimed by the British legislature to tax them without their consent. This was the very claim on account of which their forefathers had resisted Charles, and for the establishment of which they had been driven from their native country. The British government most unwisely pressed their claims, till they drove the settlers in America into open revolt. A war ensued, in which the Americans were aided by the French, and the result was, that they achieved their independence, the northern and southern states uniting together in one federal republic.

The European nations were not inattentive spectators of the struggle between Britain and her colonies. The French soldiers who had been employed in assisting the American revolters, returned to France strongly imbued with the principles of civil liberty, and much predisposed to resist the despotic authority of their own monarchs. Accordingly, almost immediately after the termination of the Anglo-American war, a revolution began in France, which did not end, till the reigning family of France, like that of England in the former century, was driven from the throne. France, for a short season, became a republic, and commenced a system of encroachment on the neighbouring states, the results of which belong to the history of the following century.

In Asia, the most important, and to Europeans, the most interesting object during this century, is the gradual rise of the British empire in India. In consequence of the superiority of the British navy, when any war broke out between Britain and any of the other powers of Europe, she was immediately able to take possession of their foreign colonies or settlements. She thus gradually superseded the Danes, the Dutch, the Portuguese, and the French, in India and the adjacent islands; and, partly by a train of events over which she had no control, and partly by able measures, military and diplomatical, she gradually extended her authority and influence over a vast territory in India and the Asiatic islands.

SIXTH ERA.

French Revolution.

This era finds Napoleon Bonaparte, a native of Corsica, wielding the government of France, as the head of a triumvirate, with the title of First Consul; and, in consequence of a series of victories, possessing the chief influence in Europe. Britain, his great opponent, is mistress of the sea, and possesses a large empire in India, the West Indies, and Canada, with many important colonies, and military stations in various parts of the world. Spain and Portugal are in possession of extensive empires in South America. Three new important states have risen since the former era, namely, the United States of America, formed of British settlers; Holland, which had formerly belonged to the crown of Spain; and Russia, which has arisen, from a state of barbarism, to a place among the civilized nations of Europe. Prussia, also, from being an electorate of the German empire, has become an independent kingdom; and Austria has acquired extensive territories. On the other hand, Poland has been partitioned between Russia, Prussia, and Austria, by a series of acts of the basest treachery and violence. Further to the east, the Turkish empire still exists, but weak and obviously sinking to its dissolution. Still further to the east, Russia is encroaching on the more southern states of Asia, and is now conterminous with China and Persia. In Hindoostan, the Mogul empire exists but in name; its territory being nearly all in the hands of the British, or under British influence.

NINETEENTH CENTURY.

The French republicans had, at the close of the former century, entered on a career of conquest and aggrandizement, and having taught the people to regard military exploits as the glory of France, laid open their republic to be subverted by any military leader of sufficient talent to command the admiration of the nation. Such a leader soon appeared in Napoleon I., a Corsican, and a subaltern officer in the French army. He entered with all his natural enthusiasm into the revolutionary sentiments of the day; and, by his military skill, soon rose to eminence, and so dazzled the people by what they were taught to regard as the glory of his exploits, that he attained to the chief power in the republic, which he soon overturned, and was crowned emperor.

As he rose by his military talent, he could maintain his ground only by the same means. He carried forward the system of national aggrandizement which the republic had commenced, till the greater part of Europe was, directly or indirectly, under his control. Meanwhile England offered to him a determined resistance, and, by her naval power, at once confined him to the continent of Europe, and obtained possession of a large proportion of the commerce of the world. The powers of Europe had been repeatedly roused to resist the encroachments of Bonaparte, but in vain; till he broke the power of his own arm, by a mad attempt to conquer Russia. The Russians retired before him. He advanced as far as Moscow, which the Russians evacuated and burned. The winter was approaching; he could neither maintain himself in Moscow, nor advance further. He was at length compelled to retreat, surrounded and harassed by the unbroken armies of Russia, and an inveterately hostile population. Winter assailed him in all its rigour, and the consequence was, that of nearly half a million of men, whom he had led into Russia, but a few thousands found their way back to their own country.

The European powers saw this to be a fit opportunity for regaining their own authority and influence, and assailed Bonaparte on every side. He continued to offer a vigorous and dexterous resistance, till, overpowered by numbers, he was subdued, and forced to resign the crown. He was permitted to retire to the island of Elba, in the Mediterranean. From that island he very soon issued, marched to Paris, was hailed by the French soldiery, and reinstated in the empire. The other powers of Europe were again leagued against him, and began to assemble their armies on the northern frontier of France. He marched against them, dispersed the Prussians, but was almost immediately afterwards met by the British army at Waterloo, and there defeated, A.D. 1815. The result was, that he again resigned the crown, surrendered himself to a British ship of war, was sent to confinement to St. Helena, where he remained till he died, A.D. 1821. The Bourbons were then recalled to the throne of France.

This century has already also been distinguished by the rise of several independent States in South America. The colonies of Spain and Portugal, which had long been impatient of the rigorous control exercised over them, finding that the convulsions of Europe opened a favourable opportunity of attaining to independence, promptly availed themselves of it, and successfully resisted all attempts of the parent country to maintain authority over them.

There are three features of this period, which must not be overlooked.

The first is the rapid advancement of science, and of the useful arts. Mathematics have been carried to an extent, and have attained to a power and facility of investigation, of which the ancients formed no conception. Astronomy, by the aid of Mathematics and of Optics, has opened up the system of the universe; subjected the various heavenly bodies to weight and measurement; and accounted with mathematical precision, not only for all the phenomena known to the ancients, but for ten thousand other phenomena, that have been discovered by the more powerful instruments which Optics have placed at her disposal. Mental phenomena, also, and all departments of knowledge, that relate to the direction and cultivation of the understanding, have been investigated on the principles of sound philosophy; and many important practical truths have been established. Natural History, in all its branches, has been cultivated with a zeal and success altogether unprecedented. New subjects of investigation have been opened and pursued to a surprising extent. The sciences of Political Economy and of Chemistry may be regarded as the creations of this period; and Geology is only yet attaining to the form and consistency of a science. Geography, also, has explored the surface of our planet in almost every direction. And along with the increase of knowledge, have come increase of human power, and addition to human comfort and convenience. Machinery, in every department of labour, has been carried to great perfection. The invention of the Steam-engine has placed a power to which it would be difficult to assign limits, at the disposal of men; and this mighty instrument has been applied to manufactures, and latterly to water and land carriage, with the most gratifying results. The more delicate machines, too, such as clocks and watches, although not the invention of this last period, have been brought to a high perfection in it; and the recent discovery of gas-light has added much to the comfort and safety of cities and towns. The power of intellect, that is still employed in improvements in every department of art, is unexampled in the history of mankind.

The second feature of this period, to which we have alluded, is the great progress that has been made in translating the Sacred Scriptures, into the various languages of the world. The Scriptures had been previously translated at different times, into most of the languages of Europe, and had existed from a very early period in Syriac, Arabic, and Coptic; but a great addition to such translations, chiefly into eastern languages and dialects, belongs to the present period. Men of different nations have thus been furnished with opportunities of becoming acquainted with each others' languages; and of learning to act on similar principles to a greater extent than has ever before been witnessed. And when this fact is connected with the amazing facilities for communication among the different nations of the world that are now in progress, it is impossible to form any conception of what may be the result.

The third remarkable feature of this period, is the abolition, first of the slave trade, and afterwards of slavery in the British colonies. A traffic in human beings from the west coast of Africa, to the American continent and islands, early commenced. The cupidity of the European settlers in the New World, impelled them to seek for labourers to cultivate the land, to work the mines, and otherwise to render their new acquisitions profitable, before a sufficient population had grown up on the soil for these purposes. With this intent, they sent their ships to the coast of Africa, to get, as they could, men, women, or children, and convey them across the Atlantic, to the European settlements. The prosecution of this nefarious traffic created a mass of human misery, partly in Africa, partly during the middle passage, and partly in America, such as scarcely had at any former period been known: and it is humiliating to think, that the agents and abettors of this traffic were natives of countries professing to have adopted the benign principles of Christianity.

The zeal of a few benevolent individuals was chiefly instrumental in opening the eyes of the British public to the enormous crimes, to which they were rendering themselves parties, by sanctioning the slave trade, and by the condition of the slaves in the British West India islands. The result was, that the nation was roused to indignation at the fearful recitals, and became determined to wash its hands of the foul stain. And after a determined struggle against the parties interested, humanity triumphed, and first the slave trade, and afterwards slavery itself was abolished. The manner, in which this last act of justice was effected, is, perhaps, unique in the history of the world. The British nation purchased the freedom of the slaves from their masters, subjects of the empire, and advanced to them twenty millions of pounds sterling, to set the wretched captives at liberty.

SECTION III.

INTRODUCTION TO VEGETABLE PHYSIOLOGY.

The first distinction to be attended to between minerals, and beings endowed with life is, that the latter are formed with organs adapted to fulfil the several functions for which they were destined by nature. These organs differ, not only in form and structure, but more or less in the materials of which they are composed: organized beings are generally of a smooth surface, rounded, and irregular; whilst minerals are rough, angular, and, in their crystalline state, of geometrical regularity.

One of the principal functions these organs have to perform, is nutrition. Unorganized matter may be enlarged or diminished, either by mechanical or chemical changes; minerals may be augmented by the addition of similar particles, or by chemical combinations with substances which are dissimilar; but they have no power to convert them into their own nature. Organized bodies, on the contrary, are increased in size, by receiving internally, particles of matter, of a nature different from their own, which they assimilate to their own substance.

Let us now proceed to inquire, what is the principal distinction between the two classes of organized beings—the animal and the vegetable creation.

Animals are provided with a cavity, called a stomach in which they deposit a store of food, whence they are continually deriving nourishment. This organ is essential to animals, as they are not constantly supplied with food: they find it not always beneath their feet; they must wander in search of it; and were they not provided with such a store-house, in which to lay it up, they would be frequently in danger of perishing.

Vegetables have no stomach; they do not require such a magazine, since they find a regular supply of nourishment at the extremity of their roots. The food of plants is not of a complicated nature, like that of animals; but consists of the simplest materials—water, and the solid and gaseous matter contained within it.

The second distinction between the animal and vegetable creation is, that the latter are not endowed with sensibility.

Some ingenious experiments have, however, been recently made, which tend to favour the opinion that plants may be endowed with a species of sensibility; and seem to render it not improbable, that there may exist in plants something corresponding with the nervous system in animals. There are certain vegetable poisons, which are known to destroy life in animals, not by affecting the stomach, but merely by acting on the nervous system. These poisons were administered to different plants, either by watering them with, or steeping the roots in, infusions of these poisonous plants. The universal effect was, to produce a sort of spasmodic action in the leaves, which either shrunk, or curled themselves up; and, after exhibiting various symptoms of irritability, during a short time became flaccid, and the plant, in the course of a few hours, died. When we see plants thus acted upon by vegetable poisons, which are known to be incapable of destroying the animal fibre, or of injuring the frame, but through the medium of the nerves, we may be led to suppose, that certain organs may exist in plants, with which we are totally unacquainted, and which bear some analogy to the nervous system in animals.

It is certain that some plants possess a power of irritability or contractibility. There are some flowers, such as those of the barberry, whose stamens will bend and fold over the pistil, if the latter be pricked with a needle; and there is one instance of a plant the leaves of which move without any assignable cause; this is the *hedysarum gyrans*, which grows only on the banks of the Ganges. It has three leaflets on each footstalk, all of which are in constant irregular motion. The leaves of the sun-dew, near the root, are covered with bristles, bedewed with a sticky juice. If a fly settles on the upper surface of the leaf, it is at first detained by this clammy liquid, and then the leaf closes, and holds it fast, till it dies. Plants in general, turn their leaves towards the light; and, when growing in a room, they spread out their branches towards the window, as if they were sensible of the benefits they derive from light and air.

Plants appear also to be susceptible of contracting habits. The mimosa, or sensitive plant, if conveyed in a carriage, closes its leaves, as soon as the carriage is put in motion; but after some time, it becomes accustomed to it, the contraction ceases, and the leaves expand.

Plants, which are brought from the southern hemisphere, faithful to the seasons of their native country, make vain attempts to bud and blossom, during our frosty winter; and seem to expect their sultry summer at Christmas.

These, and many other phenomena, exhibited by plants, do not permit us positively to say, that plants are wholly devoid of sensibility; but the evidence against that opinion is so strong, as to amount almost to proof. Had Providence endowed plants with the sensations of pleasure and of pain, it would, at the same time, have afforded the means of seeking the one, and of avoiding the other. Instinct is given to animals for that express purpose, and reason to man; but a plant rooted in the earth, is a poor, patient, passive being: its habits, its irritability, and its contractibility, all depending on mere physical causes.

The properties of plants may be separated into two classes: first, those which relate to their structure; such as their elasticity, their hygrometric power: these properties may continue after death. Secondly, those which relate to their vitality; such as contractibility; which, consequently, can exist only in the living state.

The elementary organs of vegetables are of three kinds. First, the cellular system; consisting of minute cells, of an hexagonal form, apparently closed and separated by their partitions, somewhat similar to the construction of a honeycomb. These cells in plants are marked by small spots, which have been conjectured to be apertures, through which fluids are transmitted from one cell to another; but these marks are so minute, as to render it hazardous to venture on deciding for what purpose they are designed.

The vascular system forms the second set of elementary organs. It consists of tubes, open at both ends: they are always situated internally. The organs of plants are so extremely small, that, though aided by the most powerful microscope, it is frequently difficult to examine the structure of their parts, with a sufficient degree of accuracy, to be able to ascertain their functions. It has long been a disputed point, whether the sap ascends through the vascular or the cellular systems of organs; the latest opinion is, that it passes through neither; but that it rises through the interstices which separate the different cells.

The third system of elementary organs, is the tracheæ; so called from their conveying air both to and from the plant; they are composed of very minute elastic spiral tubes. Air is so essential an agent, in promoting the nourishment and growth of plants, that it is scarcely less necessary to their existence, than to that of animals.

The whole of the vegetable kingdom consists of masses of these several elementary organs, with the exception of fungi, mosses, and lichens, whose vessels are all of a cellular form; they have no vascular system whatever; and this affords a strong argument against the passage of the sap through the vascular system.

The layers of wood, which are seen in the stem or branch of a tree cut transversely, consist of different zones of fibres, each the product of one year's growth.

The bark consists of three distinct coats, the cuticle, the cortex, and the liber or inner bark; of these, the cuticle is that which is external. It covers the leaves and flowers, with the exception of the pistils and anthers, as well as the stem and branches. The cuticle of a young shoot, after it has been for some time exposed to the atmosphere, becomes opaque, dries, and being distended by the lateral growth of the branches, splits, and after a year or two, falls off. A second membrane is then formed, by the desiccation of the external part of the cellular integument; but it differs from the former, in being thicker, and of a coarser texture. This envelope is distinguished from the former by the name of epidermis.

ROOTS.

The root not only supports the plant by fixing it in the soil, but affords a channel for the conveyance of nourishment. At the extremity of each fibre of a root, there is an expansion of the celullar integument, called spongiole, from its resemblance to a small sponge; being full of pores, it absorbs the water from the soil. There are pores in every part of a plant, above ground, but they are almost wholly for the purpose of exhalation. The roots have no pores, except in the spongioles at the extremities. It would be useless for them to be furnished with evaporating pores, since they are not exposed to the atmosphere, where alone evaporation could take place.

The tendrils of vines, and of other climbing plants which serve to fix them against a wall, or the trunk of a tree, cannot be considered as roots; since, though they answer the purpose of sustaining the plant, they are unable to supply it with nourishment. But there are some parasitical plants, such as the mistletoe, which, having no immediate communication with the earth, strike their fibres into the stems or branches of a tree, and derive their nourishment from this richly prepared soil: yet, as the absorption in this case is not carried on by the regular mode of spongioles, their fibres are not denominated roots.

The spongioles act only by capillary attraction, and suck up moisture, just as a lump of sugar absorbs the water into which it is dipped. As a proof of this it has been shown, that if roots, saturated with moisture, be transplanted into very dry earth, the latter will absorb the moisture from the roots.

Absorption does not immediately cease upon the death of a plant, as the blood ceases to circulate upon the expiration of animal life; but when the vessels, through which the fluid should pass, have lost their vital energy, that susceptibility of irritation and contraction, which enabled them to propel the fluid upward, ceases, and it can no longer ascend into the roots, but remains stagnant in the spongioles, which soon become saturated. Disease and putrefaction follow; and that nourishment, which was designed to sustain life, now serves only to accelerate disorganization. The fluid is, however, still performing the part assigned to it by the Creator, for if it be necessary to supply living plants with food, it is also necessary to destroy those which have ceased to live, in order that the earth may not be encumbered with bodies become useless, and that their disorganized particles may contribute to the growth of living plants. Thus, the putrefaction of leaves, straw, &c. which reduces the bodies to their simple elements, prepares them to become once more component parts of living plants.

Botanists distinguish several kinds of roots. The *radix fibrosa*, or fibrous root, is the most common in its form: it consists of a collection or bundle of fibres. The roots of many grasses, and most annual herbs, are of this description. The couch-grass is an example of the *radix repens*, or creeping-root. If an attempt be made to eradicate such roots, a succession of bunches of fibres are met with, springing from an apparent root which grows horizontally, and appears to be endless. This long horizontal fibre is, however, not a root, but a subterraneous branch, for it has no spongioles; the real roots are the small bundles of fibres which spring from it. Such a root is very tenacious of life, as any portion, in which there is an articulation, will grow. The ox-eye, whose strong penetrating roots strike deep into the earth, furnishes an example of the *radix fusiformis*, or spindle-shaped. It is also called the tap-root, from its tapering so considerably towards the end. The *radix bulbosa*, or bulbous-root, such as that of the lily, the hyacinth, or the onion, is improperly so called, for the tufts of fibres, pendant from the bulb, are the roots. The bulb constitutes the stem of the plant. The potato belongs to the class of tuberous, or knotted roots, which are of various kinds, comprehending all such as have fleshy knobs, or tumours. In all cases they are to be considered as reservoirs of nourishment, which enable the plant to sustain the casual privations of a barren or dry soil.

The root of the *orchis* is deserving of notice, from its singularity. It consists of two lobes, somewhat similar to the two parts into which a bean is divided. One of these perishes every year, and another shoots up on the opposite side of the remaining lobe. The stem rises every spring from between the two lobes, and since the new lobe does not occupy the same place as its predecessor, the orchis every year moves a little onwards.

The duration of roots is either annual, biennial, or perennial. To the first belong plants the existence of which is limited to one season, such as barley, and a vast number of garden or field flowers. The biennial root produces, the first season, only herbage, and the following summer, flowers and fruits, or seed; after which it perishes. To the perennial belong plants which live to an indefinite period, such as trees and shrubs.

STEMS.

Every plant has a stem through which the sap circulates, and from which the leaves and flowers spring. This stem is not always apparent: it is sometimes concealed under ground, sometimes disguised under an extraordinary form: the stem of the tulip, for instance, is contained within the bulb, which is commonly, but improperly, called its root; that of the fern is subterraneous. The functions of the root and stem are totally different: the former merely sucks up nourishment from the soil, and transmits it to the leaves; the latter is supplied with organs to distribute it, variously modified, to the several parts of the plant, the leaves, the flowers, &c.

The stems of plants are divided into two classes; those which grow internally, hence called *endogenous;* they are also called *monocotyledons,* from their seed having only one cotyledon, or lobe; and those which grow externally, called *exogenous,* or *dicotyledons,* from their seed having two lobes.

There is a third class, denominated *acotyledons,* which have no cotyledons, and no vascular system, such as fungi, lichens, &c.

The date, the palm, and the cocoa-nut tree, the sugar-cane, and most of the trees of tropical climates, belong to the monocotyledons, or endogenous plants. Their stems are cylindrical, being of the same thickness from the top to the bottom. Their mode of growth is this: a hollow stem shoots up to a certain height, and there stops; layer after layer grows in the interior of this hollow stem, till at length a period arrives when the outer coats are so hardened and distended, as to yield no longer, the stem has then attained its full growth in horizontal dimensions, and offers a broad, flat, circular surface to view, which has scarcely risen in height above the level of the ground. In this stage it resembles the stump of the trunk of a tree, which has been cut down. The following Spring, there being no room for a new layer of wood to extend itself horizontally, it shoots up from the centre of the stem vertically; fresh layers every year successively perforate this central shoot, till it becomes hard, compact, and of the same horizontal dimensions as the base; the second period of growth is then complete.

The leaves and fruit of this class of plants grow from the centre of the last shoot, and form a sort of cabbage at the top of the tree, on cutting off which, the tree perishes.

Endogenous plants have no real bark, the external coats of wood are so much hardened as to render such a preservation unnecessary. When an European wood-cutter begins to fell a tree of this description, he is quite astonished at its hardness. "If I have so much difficulty with the outside," says he, "how shall I ever get through the heart of the wood?" But as he proceeds, he finds, that, contrary to what he has been accustomed to, it gets softer. This circumstance renders it very easy to perforate them, and makes them peculiarly appropriate for pipes, for the conveyance of water, and such like purposes.

These plants have usually no branches. Corn, and all gramineous plants, the lilaceous tribe of flowers, and bulbous roots, are all endogenous. Some of these send forth shoots, but they are not from the stem, but from a knot or ring upon the stem. The sugar-cane, which grows in this manner, is the largest of the gramineous plants.

The structure of the exogenous plants, or dicotyledons, to which the trees of our temperate climes belong, is much more complicated.

The stem is composed of two separate parts: the one ligneous, the other cortical, in other words, it is formed of wood and bark.

The wood consists, in the first place, of the pith, a soft medullary substance, which occupies the centre of the stem, and is almost always of a cylindrical form. This soft, pulpy body, does not grow or increase in size with the tree, but retains the same dimensions it originally had in the young stem.

The first layer, surrounding the central pith, grows freely during a twelvemonth, but the following year it is enclosed by a new layer; being, by the pressure of this layer, prevented from extending laterally, it makes its way where there is no pressure; that is to say, vertically. When during the third year, a third layer surrounds and compresses the second, this, in its turn, escapes from the bondage by rising vertically. This process goes on year after year, so that the stem grows in height, at the same time that it increases in thickness. This mode of growing renders the form of the stem conical, the number of layers diminishing as the stem rises.

These layers of wood attain a state of maturity, when they become so hard by continued pressure, as to be no longer susceptible of yielding to it. Previous to this period, the layers bear the name of *alburnum*, signifying white wood, for wood is always white, until it reaches this degree of consistency. The length of time requisite to convert the alburnum into perfect wood, varies from five to fifty years, according to the nature of the tree.

The vegetation of the bark is precisely the inverse of that of the wood; that is to say, it is *endogenous*, its layers growing internally: the new soft coat of bark, therefore, lies immediately in contact with the new soft layer of wood. The outer coats of bark, when they become too hard to be further distended by the pressure of the internal layers, crack, and becoming thus exposed to the injury of the weather, fall off in pieces: it is this which produces the ruggedness of the bark in some trees. The other layers, as they become external, and exposed to the same sources of injury, experience the same fate.

It has long been a disputed point, what part of the stem the sap rises through; some have maintained the opinion, that it ascended through the pith: others, that it rose through the bark, but they have both been proved to be wrong. By colouring the water, with which the plant was watered, it has been traced within the stem, and found to ascend almost wholly in the alburnum, or young wood, and particularly in the latest layers.

THE FUNCTIONS OF LEAVES.

If the leaves of a tree be stripped off, the fruit comes to nothing, which is exemplified every year in gooseberry bushes, the leaves of which have been devoured by caterpillars; and though the fruit trees of warm climates, partly naturalized with us, grapes and peaches, for instance, ripen their fruit sooner, perhaps, if partially deprived of their leaves; yet if that practice be carried too far, the fruit perishes. The white mulberry, indeed, cultivated in the south of Europe, for the food of silkworms only, bears wonderfully the loss of its foliage three or four times a year.

These facts have led some to think, that leaves were merely a clothing, or a protection against cold and heat. Though this is undoubtedly true, still it is a very small part of the use of leaves.

That leaves give out moisture, or are organs of insensible perspiration, is proved, by the simple experiment of gathering the leafy branch of a tree, and immediately stopping the wound at its base, with wax, or any other fit substance, to prevent the effusion of moisture in that direction. In a very short time, the leaves droop, wither, and are dried up. If the same branch, partly faded, though not dead, be placed in a very damp cellar, or immersed in water, the leaves revive, by which their power of absorption is also proved.

The great annual sun-flower is said to have lost by perspiration, 1 lb. 14 oz. weight, in the course of twelve hours, in a hot dry day. In a dry night, it lost about three ounces; in a moist night, scarcely any alteration was observable; but in a rainy night it gained two or three ounces. The cornelian cherry is most remarkable in this respect: the quantity of fluid which evaporates from its leaves, in the course of twenty-four hours, is said to be nearly equal to twice the weight of the whole shrub.

The perspiration of aquatic plants seems to be remarkably copious. Of these some grow constantly immersed in water. Their leaves are peculiarly vascular, and dry very quickly in the air, withering in a few minutes after exposure to it. Other aquatics float with only the upper surface of their leaves exposed to the air, which surface is so contrived, that water will scarcely remain upon it. These leaves, though extremely juicy, dry with great rapidity, as does every part of the plant, when gathered. It is probable that they imbibe copiously by their under sides, and perspire by their upper.

Light has a very powerful effect upon plants. The green colour of the leaves is owing to it, so that plants raised in the dark, are of a sickly white; and it is well known that the blanching of celery is effected by covering the plant, so as to exclude the light.

Light acts beneficially upon the upper surface of leaves, and hurtfully upon the under side; hence, the former is always turned towards the light, in whatever situation the plant may happen to be placed. Plants, in a hot-house, present the fronts of their leaves to the side where there is most light, not to the quarter where most air is admitted, or to the flue in search of heat. It has been found, that vine leaves turn to the light, even when separated from the stem, if suspended by a thread.

Nor is this effect of light peculiar to leaves alone. Many flowers are equally sensible to it, especially the compound radiated ones, as the daisy, sun-flower, marigold, &c. In their forms, Nature seems to have delighted to imitate the radiant luminary, in the absence of whose beams, many of them do not expand their blossoms at all. The stately annual sun-flower displays this phenomenon more conspicuously, on account of its size: the flower follows the sun all day and returns, after sunset, to the east, to meet his sun-beams in the morning. A great number of leaves, likewise, follow the sun in its course. A clover field is a familiar instance of this.

The chemical actions of light, heat, and the component parts of the atmospheric air, upon leaves, are now tolerably well understood. It is agreed, that in the day time, plants imbibe, from the atmosphere, carbonic acid gas (which is a compound of oxygen and carbon), that they decompose it, absorb the carbon, as matter of nourishment, which is added to the sap, and emit the oxygen. The burning of a candle, or the breathing of animals, in a confined space, produces so much of this gas, that neither of these operations can go on beyond a certain time; but the air so contaminated, serves as food for vegetables, the leaves of which, assisted by light, soon restore the oxygen, or, in other words, purify the air again. This beautiful discovery shows a mutual dependence of the animal and vegetable kingdoms, and adds another to the many proofs we have of the wisdom, and wonder-working power of the Creator of all things.

In the dark, plants give out carbonic acid, and absorb oxygen; but the proportion of the latter is small, compared to what they exhale by day, as must likewise be the proportion of carbonic acid given out; else the quantity of carbon added to their substance, would be but trifling, especially in those climates, in which the proportion of day to night is nearly equal, and which, notwithstanding, we know to be excessively luxuriant in vegetation.

There can be no question of the general purpose, answered to the vegetable constitution by these functions of leaves. But when we attempt to consider, how the peculiar secretions of different species, and tribes of plants are formed; how the same soil, the same atmosphere, should, in a leaf of the vine, or sorrel, produce a wholesome acid, and in that of a spurge, or manchineel, a most virulent poison;—how sweet, and nutritious, herbage should grow, among the acrid crow-foot, and aconite:—we find ourselves totally unable to comprehend the existence of such wonderful powers in so small, and, seemingly, simple an organ, as the leaf of a plant. The agency of the vital principle alone can account for these wonders, though it cannot, to our understandings, explain them. The thickest veil covers the whole of these processes; and so far have philosophers hitherto been from removing this veil, that they have not even been able to approach it. All these operations, indeed, are evidently chemical decompositions and combinations: but we neither know what these decompositions and combinations are, nor the instruments in which they take place, nor the agents by which they are regulated.

The vain-glorious Buffon caused his own statue to be inscribed, "a genius equal to the majesty of nature;" but a blade of grass was sufficient to confound his pretensions. *Sir J. E. Smith.*

THE SAP.

The sap of trees may be obtained by wounding a branch, or stem, in Spring, just before the buds open; or in the end of Autumn, though less copiously, after a slight frost, yet not during the frost. It has always been observed to flow from the young wood, or alburnum, of our trees; not from the bark. A branch of the vine, cut through, will yield about a pint of this fluid, in the course of twenty-four hours. The birch also affords much sap. It flows equally upward and downward, from a wound.

This great motion, called the *flowing* of the sap, which is to be detected principally in the Spring, and slightly in the Autumn, is, therefore, totally distinct from that constant propulsion of it going on in every growing plant.

This *flowing* of the sap has been thought to demonstrate a circulation; because, there being no leaves at the time to carry it off by perspiration, it is evident that, if it were at these periods running up the sap vessels, it must run down again by other channels. But as soon as the leaves expand, its motion is no longer to be detected. The effusion of sap from plants, when cut or wounded, is, during the greater part of the year, comparatively very small. It is thought, therefore, that this *flowing* of the sap, is nothing more than a facility of the sap to run, owing to the peculiar irritability of the vegetable body, at that period; and that it runs only when a wound is made—being naturally at rest till the leaves open, and admit of its proper and regular conveyance.

As soon as the leaves expand, insensible perspiration takes place, very copiously, chiefly from those organs; but also, in some degree, from the bark of the young stem and branches. The perspiration of some plants is very great. The large annual sun-flower is said to perspire about seventeen times as fast as the ordinary perspiration of the human skin.

The sap, in its passage through the leaves and bark, becomes quite a new fluid, possessing the peculiar flavour and qualities of the plant; and not only yielding woody matter for the increase of the vegetable body, but furnishing various secreted substances more or less numerous and different among themselves. These, accordingly, are chiefly found in the bark. In herbaceous plants, the stems of which are only of annual duration, the perennial roots frequently contain these fluids, in the most perfect state; nor are they, as such, confined to the bark, but deposited throughout the substance, or wood, of the root, as in rhubarb and gentian.

Gum, or mucilage, a viscid substance, of little flavour or smell, and soluble in water, is a very common secretion. When superabundant, it exudes from many trees, in the form of large drops, as in the plum, cherry, and peach trees, and different species of the *mimosa*, or sensitive plants, one of which yields the gum arabic, others the gum senegal, &c.

Resin is a substance soluble in spirits, as the turpentine of the fir and juniper. Most vegetable exudations partake of a nature between resin and mucilage, being partly soluble in water, partly in spirits; and are therefore called gum-resins. The more refined and volatile secretions, of a resinous nature, are called essential oils; and are often highly aromatic and odoriferous. One of the most exquisite of these is afforded by the cinnamon bark. They exist, in the highest perfection, in the perfumed effluvia of flowers, some of which, capable of combination with spirituous fluids, are obtainable by distillation, as those of the lavender and rose.

Acid secretions are well known to be very general in plants. The astringent principle is a species of acid; it may be derived from various sources—for instance the tanning from the oak, willow, &c. An acid is found united with even the sugar, in the sugar cane.

Sugar, more or less pure, is very generally found in plants. It abounds in various roots, as the carrot, beet, and parsnip; and in many plants of the grass or cane kind, besides the famous sugar cane.

It is curious to observe not only the various secretions of different plants, by which they differ from each other in taste, smell, qualities, and medical virtues, but also their great number, and striking difference, frequently in the same plant. Of this, the peach tree affords a familiar example. The gum of this tree is mild and mucilaginous: the bark, leaves, and flowers abound with a bitter secretion, than which, nothing can be more distinct from the gum. The fruit is replete, not only with acid, mucilage, and sugar, but with its own peculiar aromatic and highly volatile secretion, on which its fine flavour depends. How far are we yet from understanding the vegetable body, which can form, and keep separate, such distinct and discordant substances!

The odour of plants is, unquestionably, a volatile, essential oil. Its general nature is evinced by its ready union with spirits or oil, not with water.

To all the foregoing secretions of vegetables, may be added those, on which their various colours depend.

We can but imperfectly account for the green, universal in their herbage; but we may gratefu acknowledge the beneficence of the Creator, in clothi the earth with a colour the most pleasing, and the le fatiguing to the eye. We may be dazzled with t brilliancy of a flower garden, but our eyes repose leisure on the verdure of a grove or meadow.

Abridged from Sir J. E. Smith.

THE FLOWER.

The flower consists of several parts.

The *calyx*, or flower cup, forms the external inte ment which protects the bud, before it expands: consists of several parts, called *sepales*, resembli small leaves, both in form and colour. These sep are, in general, more or less soldered together; so times so completely, as to form a cup apparently of piece.

Above and within the calyx, rises the *corolla*, wh is the coloured part of the flower. It is composed several petals, either separate or cohering, so a form a corolla of one single piece: in the latter c the flower is called *monopetalous*. When the pe first burst from the calyx, and expand in all t beauty, they still serve to protect the central parts the flower. They are at first curved inwards, form a concavity around the delicate organs which occ the centre. This not only shelters them from ternal injury, but reflects the sun's rays upon th like a concave mirror; thus rearing them, as it w in a hot-house. When these parts are full grown, artificial heat being no longer necessary, and admission of light and air, being not only safe advantageous, the petals expand; leaving the inte organs exposed to the free agency of these elements.

At the base of the petals is generally situated

...n, called the nectary. This is the store whence ... bee derives honey.

...he most important parts of the flower are those ...ans which occupy the centre. It is here that the ...d, which is to propagate the plant, is lodged, in a ...sel called the *ovary*, or seed-vessel. From its ...mmit rises a little threadlike stalk, called a *style;* ...ich, at its extremity, supports a small, spongy sub...nce, denominated the *stigma*. These three parts ...m a whole, which bears the name of *carpel*.

Immediately surrounding the pistils, are situated the ...*mens;* each of which consists of a slender filament, ...porting a little bag, or case, called an *anther*, ...d with pollen, which is a species of dust or powder. ...e anthers, when ripe, burst; and, being more ...vated than the stigma, shed their pollen upon it; ...hout which no seed can be perfected.

...n some vegetables the stamens are in one flower, ... the pistils in another; in others, the stamens and ...ils are upon separate plants. In these cases the ...len is conveyed from the one to the other, by means ...he wind, or by winged insects, which, in penetrating, ...means of their long and pliant proboscis, within the ...sses of the corolla, in order to obtain the nectar, ...r their downy wings with the pollen. This un...ded burden they convey to the next flower on which ... alight; and in working their way to the nectary, ... rubbed off and falls on the stigma. Every insect, ...ever ephemeral, every weed, however insignificant, ... its part assigned in the great system of the ...verse.

...n Persia, very few of the palm and date trees, under ...ivation, have stamens, those having pistils being ...erred, as alone yielding fruit. In the season of ...ering, the peasants gather branches of the wild ...n trees, whose blossoms contain stamens, and spread ...n over those which are cultivated, so that the pollen ...es in contact with the pistils, and fertilizes the ...er.

...here were two remarkable palm-trees in Italy. The ... situated at Otranto, had no stamens; the other at Brindisi, which is about forty miles distant, had no pistils; consequently, neither of those trees bore seed. But when, after the growth of many years, they not only rose superior to all the trees of the neighbouring forests, but overtopped all the buildings which intervened, the pollen of the palm-tree at Brindisi was wafted by the wind, to the pistils of that of Otranto; and, to the astonishment of every one, the latter bore fruit.

THE SEED.

The seed, from which the future plant proceeds, is the sole end and aim of all the parts of fructification. It consists of several parts, the most essential of which is the *embryo*, or germen, called by Linnæus, *corculum*, whence the life and organization of the future plant originate.

The *cotyledons*, or seed lobes, are immediately attached to the embryo, of which they form, properly speaking, a part. They are commonly two in number, and, when the seed has sufficiently established its root, generally rise out of the ground, and form a kind of leaves. *Hilum*, the scar, is the point by which the seed is attached to its seed-vessel, or receptacle, and through which alone nourishment is imparted for the perfecting of its internal parts; it is also the point through which the radical is protruded in the first stage of germination.

There is no part of the vegetable kingdom, which offers so many striking proofs of admirable contrivance as the seed. The care which Providence has bestowed upon it is astonishing.

Independently of the innumerable means which are adopted for maturing and protecting the organs, on which the production of the seed depends, and which form part of the system of provision for perfecting it—

ndependently, too, of the countless contrivances, some ighly artificial, for the immediate purpose of perfecting ,—the mode in which this organ is *preserved* after it is atured, evinces consummate care and wisdom. Some-imes it is packed up in a capsule, a vessel composed of ugh and strong coats; sometimes, as in stone-fruits nd nuts, it is closed in a strong shell, which again is nclosed in a pulp; sometimes, as in grapes and berries, is plumped overhead in a glutinous syrup, contained ithin a skin or bladder; at other times, as in apples nd pears, it is embedded in the heart of a firm fleshy ubstance; or as in strawberries, pricked into the sur-ce of a soft pulp. These, and many other varieties, xist in what are called fruits. In pulse, and grain, and rasses;—in trees, and shrubs and flowers,—the variety f the seed-vessels is incomputable. We have the eeds, as in the pea-tribe, regularly disposed in parch-ent pods, which completely exclude the wet; the pod so, not seldom, as in the bean, lined with a fine down istended like a blown bladder; or we have the seed nveloped in wool, as in the cotton plant; lodged, as in nes, between the hard and compact scales of a cone; barricadoed, as in the artichoke and thistle, with ikes and prickles; in mushrooms, placed under a nthouse; in ferns, within slits in the back part of the af; or, which is the most general organization of all, e find them covered by a strong close tunicle, and tached to the stem, according to an order appropriated each plant, as is seen in several kinds of grain and of asses.

Equally numerous and admirable are the contrivances r *dispersing* seeds. Who has not listened, in a calm d sunny day, to the crackling of furze-bushes, caused the explosion of their little elastic pods, or watched e down of innumerable seeds floating on the Summer eeze, till they are overtaken by a shower, which oistening their wings, stops their further flight, and the same time accomplishes its final purpose, by im-ediately promoting the germination of each seed in e moist earth?

How little are children aware, as they blow away the seeds of the dandelion, or stick burs in sport on each others' clothes, that they are fulfilling one of the great ends of nature.

The awns of grasses answer the same purpose.

Pulpy fruits serve quadrupeds and birds as food, while their seeds, often small, hard and indigestible, pass uninjured through the intestines, and are deposited, far from their original place of growth, in a condition perfectly fit for vegetation.

Even such seeds as are themselves eaten, like the various sorts of nuts, are hoarded up in the ground, and occasionally forgotten, or carried to a distance, and in part only devoured.

The ocean itself serves to waft the larger kind of seeds from their native soil to far distant shores.

M'CULLOCH'S *Course of Reading.*

ANIMAL LIFE.

Living bodies are usually divided into the Animal and Vegetable kingdoms. It may seem at first sufficiently easy to make the distinction between an animal and a plant; and, as long as we confine our views to the higher orders of animated beings, there is no room for doubt. But when we descend in the scale to the radiated animals, which present no distinct nervous system, no organs of sensation, no observable mode of communication with the external world; it then becomes necessary to inquire more accurately into the peculiar points, which should decide us to arrange them under the one class, or the other. Perhaps the most certain of these, is the presence of a digestive organ. Cuvier mentions three other marks of distinction, which however are by no means so general. They are, the presence of nitrogen, as one of the chemical components of all animal bodies; the existence of a circulation; and respiration. Nitrogen, it is true, exists in all animal bodies, but all vegetables, likewise, contain it, and some in considerable quantities, as the extensive classes of *fungi* and *cruciformia;* in *cafein,* a principle extracted from coffee, there is actually a greater amount of it, than in most animal substances. Circulation is not found to exist in the lowest class of animals. As for respiration, the leaves of plants so exactly resemble, in their action, the lungs of animals, that they are now familiarly spoken of by Vegetable Physiologists as respiratory organs.

What life *is,* we know not; what life *does,* we know well. Life *counteracts the laws of gravity.* If the fluids of our bodies followed the natural tendency of fluids, they would descend to our feet, when we stood, or to our backs, when we lay. The cause, why they do not, may be referred immediately to the action of the heart and vessels; but it is evident, that they derive that power from life.

Life *resists the effects of mechanical powers.*—Friction, which will thin and wear away a dead body, actually is the cause of thickening a living one. The skin on a labourer's hand is thickened and hardened, to save it from the effects of constant contact with rough and hard substances. The feet of the African, who, without any defence, walks over the burning sands, exhibit always a thickened covering; and a layer of fat, a bad conductor of heat, is found deposited between it, and the sentient extremities of the nerves.—Pressure, which thins inorganic matter, thickens living matter. At tight shoe produces a corn, which is nothing more than a thickened cuticle. The same muscle, that with ease raised a hundred pounds when alive, is torn through by ten when dead.

Life *prevents chemical agency.* The body, when left to itself, soon begins to putrefy; the several parts of which it is composed, no longer under the influence of a higher controlling power, yield to their chemical affinities; new combinations are formed; ammonia, sulphuretted, with carburetted hydrogen, and other gases are given off, and nothing remains but dust. This never happens during life.

Life *modifies the power of heat.* Beneath a tropical sun, or within the arctic circle, the temperature of the human body is found unaltered, when examined by the thermometer. Some have exposed themselves to air, heated above the point at which water boils; yet a thermometer, placed under the tongue, stood at the usual height of about 98°; and the sailors, who, under Captain Parry, wintered so near the north-pole, when examined in the same way, constantly afforded the same results.

Finally, life *is the cause of the constant changes that are going forward in our bodies.* From the moment that our being commences, none of the materials, of which we are composed, continue stationary. Foreign matter is taken in, and, by the action of what are termed the assimilating functions, becomes part of our composition; while, on the other hand, the materials, of which our frame had been built up, being now unfit any longer for the performance of the necessary duties, are dissolved, as it were, into a liquid or gaseous form, conveyed by the absorbents from the place which the new matter comes to occupy, and finally expelled from the system.

PERCEVAL B. LORD.

THE INTEGUMENTS.

The integuments form that substance, which covers every part of the surface of the body. They constitute what is termed the hide, in various animals, and consist of three parts; the *scarf-skin*, a *mucous net work* below, and the *true skin.*

The scarf-skin, or cuticle, which is intended to protect the parts beneath, and to preserve their sensibility, is itself insensible. A blister will raise the cuticle, and render it apparent. Strong work will harden it, as in the hands of labouring people; and, after many severe complaints, the scarf-skin peels off, just as it does in some animals, as serpents, which cast their skin at certain periods.

The scarf-skin has in it numerous minute holes or pores, by means of which perspiration is effected, and through which the air issues.

The color of the scarf-skin varies very little in the different races of mankind: even in the negro it is very little darker than in the European. The seat of colour is, in fact, a very thin layer of soft substance, which is interposed between the scarf-skin and the cutis, or true skin, and is termed the mucous net-work. In the negro it is of a very dark colour: and the colouring matter is capable of being communicated to water. The true skin, and the parts below, are of the same colour, both in whites and blacks.

There are five principal varieties of colour in the human species, and all of them dependent on the different shades of the mucous coat: the first is the European, or white; the second is the Mongolian yellow, or olive; the third is the American red, or copper colour; the fourth is the Ethiopian, or black; the fifth is the Malay brown, or tawny.

The true skin constitutes the organ of touch. This power exists in the greatest degree at the ends of the fingers, in slight elevations of the skin, called papillæ. The immediate organs of sensation are, however, small white threads, called nerves, which are more or less immediately derived from the brain, and these are diffused very plentifully over the ends of the fingers, and particularly over the papillæ, which, by this means are calculated to communicate minute impressions with great accuracy.

Most animals have, independently of the general diffusion of sensibility over the surface, some particular part which possesses the sense of touch in a pre-eminent degree. The nose or snout is a very common organ for this purpose, in many animals; and in the elephant, large and unwieldy as it appears, the extremity of the trunk is provided with an organ, as small and delicate as the human finger, and capable of taking hold of very small objects, as needles or pins, with great facility.

Some animals have an exceedingly thick epidermis or scarf-skin, as the elephant and hippopotamus. Thos that live in the air, have their cuticle dry and horny; fish, on the contrary, have it mucous, or oily, so as to prevent injury by the action of the water upon it. Some animals, as has already been observed with regard to serpents, cast their cuticle once a year, and this in so perfect a way, that even the rotundity of the eye is discoverable in the exuviæ. The greater part of silk-worms, and of the caterpillars of butterflies, cast off their cuticles seven times, and some insects even ten times, before they pass into a state of chrysalis.

There is a peculiarity in the attachment of the skin of the frog and toad to the body, which is not found in other animals. It is only adherent at a few points; being in other respects a loose bag inclosing the body; whereas, in most animals, it is closely adherent to the muscular surface beneath.

THE BONES.

The bones form, as it were, the foundation of the body; and, besides being a basis or ground-work for the soft parts, are intended to inclose and support some organs, which are of the first importance in the animal frame.

The skull or cranium, which contains the brain, is fixed at the top of the vertebral column, or bones of the back: in the centre of these bones, is a hollow space, destined for the reception of the spinal marrow, a substance which is a prolongation of the brain, and resembles it a good deal in nature and function.

At a little distance from the skull commence the ribs, which are all fixed behind to the bones of the back, and the greater number to the breast-bone before. Their curvature forms a cavity, which is called the chest, and contains the heart and lungs.

At the lower part of the vertebral column is placed a firm, thick, strong, and irregular, bony structure, called the hips, which encircle a sort of hollow space termed the pelvis or basin.

At the upper part of the ribs, are the shoulder blades, into which the upper extremities are articulated or jointed; and at the lower part of the pelvis are articulated the lower extremities.

The form, magnitude, and mode of junction of bones vary, according to the design which they are intended to serve. Where strength is required, with flexibility at particular parts, we have bones, like those of the arm and leg, of firm texture, with joints at certain intervals. In the hand and foot, there is, by means of the numerous joints of the fingers and toes, and the mechanism of the wrist and ancle, a facility given to the various important actions of the hand, and to the more limited motions of the foot.

In the back, great solidity is required, and the motion in any one part of it is very small. In some of the joints, the power of motion is in all directions, as in the shoulder and hip; while in the elbow and knee, there is only the power of bending or extending them.

The joints which compose the shoulder and hip are of the description which is called, in mechanics, the ball and socket. The bone of the arm is attached to the shoulder blade, which is connected with the breast bone, by the intervention of the collar bone, or clavicle.

The ends of bones are covered with a gristly substance, called *cartilage*, which, together with the oil, or synovia, as it is called, which is secreted in every joint, prevents them being injured by the constant friction to which they are exposed.

The bones, hard and substantial as they appear, were originally nothing more than soft pulp, contained within a membraneous covering, which gradually became harder, and, at the proper period, acquired solidity sufficient for all the purposes of life. The younger a person is, the greater is the quantity of jelly; and in old people there is a much larger proportion of ossified matter. Some fish have their bones composed entirely of cartilage, as the shark, skate, sturgeon.

In some animals the bony structure is on the outside of the body, as in all the testaceous tribes, which are enclosed in one or more shells; as the oyster, snail, whilk, &c.; and also in the crustacea, which comprise the crab, lobster, shrimp, &c.

In the crustaceous, as well as in the testaceous, there is a power of renewing the shell in case of injury, which in the former, not only extends to the shell, but likewise to the limb itself. Lobsters and crabs, are sometimes, after thunder-storms, found to be entirely without their claws, which require some time for reproduction. The jar communicated to the water, and perhaps terror on the part of the animal, have the singular effect of making these animals throw off their claws. The effect seems to be voluntary, for some of the younger of these animals will drop their claws, on an attempt to take them, even though they have not been touched. In these animals, the blood-vessels have the power of secreting the matter of the shell. Crabs and lobsters lose their shell annually, and seek retirement till the new shell is sufficiently consolidated; being aware of their defenceless state at such times.

MARKS OF DESIGN IN THE HUMAN BODY.

I challenge any man to produce, in the joints and pivots of the most complicated, or the most flexible machine that was ever contrived, a construction more artificial, or more evidently artificial, than that which is seen in the vertebræ of the human neck. Two things were to be done. The head was to have the power of bending forward and backward; and, at the same time of turning itself round upon the body to a certain extent. For these purposes, two distinct contrivances are employed. First, the head rests immediately upon the uppermost part of the vertebræ, and is united to it by a *hinge-joint*; upon which joint, the head plays freely forward and backward. But then the rotatory motion is unprovided for: therefore, secondly, to make the head capable of this, a farther mechanism is introduced; not between the head and the uppermost bone of the neck, where the hinge is, but between that bone and the next underneath it. This second, or uppermost bone but one, has what anatomists call a process, viz. a projection, somewhat similar in size and shape to a tooth; which tooth entering a corresponding hole or socket in the bone above it, forms a pivot or axle upon which that upper bone, together with the head which it supports, turns freely in a circle. Thus are both motions perfect without interfering with each other. When we nod the head, we use the hinge-joint, which lies between the head and the first bone of the neck; when we turn the head round, we use the tennon and mortise, which runs between the first bone of the neck and the second. No one can here doubt of the existence of counsel and design.

The spine, or back-bone, is a chain of joints of very wonderful construction. It was to be firm, yet flexible: *firm*, to support the erect position of the body; *flexible*, to allow of the bending of the trunk in all degrees of curvature. It was further also to be a pipe for the safe conveyance from the brain of the spinal marrow; a substance not only of the first necessity to action, if not to life, but of a nature so delicate and tender, so susceptible of injury, as that any unusual pressure upon it is followed by paralysis, or death. Now the spine was not only to furnish the main trunk for the passage of the medullary substance from the brain, but to give out, in the course of its progress, small branches, which being afterwards indefinitely subdivided, might, under the name of nerves, give, to every part of the body, the power of feeling and motion. The same spine was also to serve another purpose, not less wanted than the preceding, viz. to afford a basis for the insertion of the muscles, which are spread over the trunk of the body, in which trunk there are not, as in the limbs, cylindrical bones to which they can be fastened. The spine had likewise to furnish a support for the ends of the ribs to rest upon

How admirably is all this accomplished! The spine is composed of a great number of bones (in man, of twenty-four), joined to one another, and compacted by broad bases. The breadth of the bases upon which the parts seeerally rest, and the closeness of the junction, give to the chain its firmness and stability; the number of parts, and consequent frequency of joints, its flexibility. This flexibility varies in different parts of the chain; is least in the back, where strength more than flexure is wanted; greater in the loins, which it was necessary should be more supple than the back; and greatest of all in the neck, for the free motion of the head. In order to afford a passage for the descent of the spinal marrow, each of these bones is bored through in the middle in such a manner, as that, when put together, the hole in one bone falls into a line, and corresponds with the holes in the two bones contiguous to it. By which means, the perforated pieces, when joined, form an entire, close, uninterrupted channel; at least, while the spine is upright, and at rest. But as a settled posture is inconsistent with its use, a great difficulty still remained, which was, to prevent the vertebræ shifting upon one another, so as to break the line of the canal as often as the body moves or twists. But the vertebræ, by means of their processes and projections, and of the articulations which some of them form with one another at their extremities, are so locked in and confined as to maintain, in the surfaces of the bones, the relative position nearly unaltered; and to throw the change and pressure produced by flexion, almost entirely upon the intervening cartilages, or gristle, the springiness and yielding nature of whose substance admits of all the motion which is necessary, without any chasm being produced by a separation of the parts. For the medullary canal giving out in its course a supply of nerves to different parts of the body, notches are made on the upper and lower edge of each vertebra; two on each edge. When the vertebræ are put together, these notches, exactly fitting, form small holes through which the nerves issue out in pairs, in order to send their branches through every part of the body, and with an equal bounty to both sides of the body.

The structure of the spine is not in general different, in different animals. In the serpent tribe, however, it is considerably varied; but with strict reference to the convenience of the animal. For, whereas in quadrupeds the number of vertebræ is from thirty to forty, in the serpent, it is nearly one hundred and fifty: whereas in men and quadrupeds the surfaces of the bones are flat, and these flat surfaces laid one against the other, and bound tight by sinews; in the serpent, the bones play one *within* the other, like a ball and socket, so that they have a free motion upon one another in every direction; that is to say, in men and quadrupeds, firmness is more consulted; in serpents, pliancy.

PALEY'S *Nat. Theology.*

THE MUSCLES.

The muscles are distinct portions of flesh, capable of contraction and relaxation. They are composed of fibres of two kinds; the one soft and irritable, of a red colour, from the blood that is in them: these generally constitute the body of the muscle; whilst the other sort are found, for the most part, in the extremities, and are of a harder texture, and of a white glistening colour: if these are formed into a round, slender cord, they are called tendons. What we commonly term flesh, as the lean of meat, is the substance of the muscles. The fibres of which they are composed are exquisitely fine.

The muscles are generally attached to the bones, by means of tendons, and are so artfully situated, that whatever motion the joint annexed is capable of performing, the muscle is adapted to produce it. The knee, and the elbow, furnish examples of this agreement. Both being hinge joints, formed to move backwards or forwards, the muscles belonging to them are placed parallel to the bone, so as, by their contraction or relaxation, to effect that motion, and no other. The shoulder and the hip joints, by their construction, admit a sort of sweeping or circular action, and are accordingly supplied with muscles adapted to it.

A joint unfurnished with suitable muscles would be motionless; muscles deprived of the joint, would be unavailing. They are necessary to each other; and their union displays the highest marks of wisdom and goodness

The red colour of the muscular or fleshy parts of animals is owing to innumerable blood vessels that are dispersed through their substance. When we soak the fibres of a muscle in water, it becomes white. The blood vessels are accompanied by nerves; and they are both distributed so abundantly in the fleshy parts, that in endeavouring to trace the course of the blood vessels in a muscle, the muscle would appear to be formed altogether by their ramifications; and in an attempt to follow the branches of its nerves, they would be found to be equally numerous.

When a muscle is in action, the fibres become shorter, and the body swells. Experiments show that the nerves, and a regular supply of blood, are essential to this contraction; and that it is regulated by the mind, at least in the voluntary muscles, viz. those muscles that move the limbs, or any other part dependently upon our will: but there are others, called the involuntary muscles, which operate without even our consciousness of the action that is continually going on within us; such is the heart, which is itself a muscle: and the muscular fibres that occasion the necessary motions of the stomach and the intestines.

Most muscles have others opposed to them, which act in a contrary direction, and are called antagonists. Some of these act in succession, as when one muscle, or one set of muscles, bends a limb, another extends it; one elevates a part, another depresses it; one draws it to the right, another to the left. By these opposite powers the part may be kept in a middle direction, ready to obey when called to act.

Four hundred and forty-six muscles have been described, and their uses ascertained. It has been said that not less than a hundred are employed every time we breathe: yet we draw our breath every moment, without considering, or even being sensible of the vast and complicated apparatus that is necessary to effect it. The least impediment to our breathing, throws us into the greatest distress; but how little do we value the inestimable blessing, till disease or accident makes us sensible of its enjoyment.

The exquisite and delicate management of different parts of the frame claims our highest admiration; but our wonder is greatly increased, when we consider, that it performs its different functions for fifty or sixty years together, with very little diminution of its power. What hinge could the most skilful workman contrive, that might be used as often as our elbow-joint is, for so long a term, without being disordered or worn out? Have we not here a strong proof of the vast superiority of the works of God, to the most ingenious contrivances of man?

Those important faculties of sight and hearing, which are of so much use, and which procure us so many enjoyments, depend upon muscles so extremely small, that they must be magnified to be visible. In the tongue the muscles are very numerous, and so implicated with one another, that the nicest dissectors cannot trace them; yet they are so arranged, that they never interfere with each other, nor interrupt the various offices of speaking and swallowing. In the other parts of the body, the same admirable economy is preserved. The muscles are every where diffused; they lie close to each other, in layers, as it were, over one another, after crossing, sometimes passing through, and even imbedded in one another, yet each at perfect liberty to perform its peculiar office, without interrupting the power of its neighbour.

The action of muscles is often required where their situation would be inconvenient. In such a case, the body of the muscle is placed in some commodious position at a distance, and communicates with the point of action by means of slender tendons, or strings, resembling wires. If the muscles, which move the fingers had been placed in the palm or back of the hand, they would have enlarged it to a clumsy and very inconvenient thickness. They are, therefore, disposed in the arm, and even up to the elbow; from this position they act by long tendons, strapped down at the wrist by ligaments, beneath which they pass to the fingers. The same artful arrangement is observed in the muscles that give motion to the toes, and many of the joints of the foot. Instead of swelling and distorting the foot, they form a graceful enlargement of the calf of the leg. The variety in the figure of the muscles, according to their situation and office, is likewise beautifully contrived: some have double, some triple tendons; others none: in some places, one tendon belongs to several muscles; in other places, one muscle to several tendons.

One set of muscles enables us to move a certain part one way, and a different set enables us to move it another way. That we have the power to frown, smile, cough, breathe, to lift up or close our eye-lids, raise or bend our heads, stoop, incline to one side or the other, move our fingers or toes, raise or depress our limbs, walk or sit down, speak, or sing, swallow, open or shut our mouths, or perform any action whatever, we owe to particular muscles, which are appointed to set that part in motion.

Surely no one can be acquainted with the art and wisdom so wonderfully displayed in the structure of the human body, without acknowledging that there is a God, and that the work is his: for nothing short of infinite intelligence, could have produced any thing so complicated and so perfect.

THE TEETH.

The functions of circulation and of respiration are carried on by means of organs situated in a cavity which is called the chest, or thorax. The organs which are concerned in the preparation of the food, and in nutrition, lie in a cavity beneath, called the cavity of the abdomen. The chest is occupied chiefly by the heart and the lungs; the abdomen by the stomach, the intestines, the liver, the spleen, and the pancreas or sweet-bread. These two cavities are separated by a partition, called the diaphragm, or midriff, which is partly of a fleshy, and partly of a membraneous nature, and readily gives way, by its laxity, to the alternate expansion and contraction of the chest in the action of breathing, to which its muscular power eminently contributes. The stomach is connected with the mouth, by means of a long tube, which is called the œsophagus, or gullet, by means of which, it receives the food from the mouth.

The first action, to which the food is subjected, is mastication, or chewing, and for this purpose, most animals are provided with teeth. When there are no teeth, other resources are provided in the stomach itself, for that sort of preparation which it is necessary that the food should undergo, previous to digestion. Birds have no teeth; and with various other animals, as fish, and serpents, the teeth seem to be adapted only to prevent the escape of that prey which is swallowed whole.

The nature of the teeth depends on the nature of the food which the animal is designed to use; namely, whether it is animal, vegetable, or of a mixed nature. By the inspection of the teeth, therefore, we are able to form an opinion as to some of the most material habits of the animal. The teeth which first exhibit themselves, are called milk, deciduous, or temporary teeth, from their being intended to continue only a few years. Those which supply their places when they are shed, are, from their never being shed, called permanent.

The teeth in man are composed of two parts; a bony, which constitutes the body of the tooth, and is very similar to real bone, and a bright, smooth, thin external covering, called the enamel. The part which is out of the jaw, is called the crown and neck: while the fangs, or roots, are planted deep in the jaw. There is a small cavity in the body of the tooth, which descends in the form of a small tube into the fangs, and contains the vessels and nerves, which were employed in the original formation, and subsequently in the nutrition of the tooth. This is the structure of the teeth in the omnivorous and carnivorous animals; but in the graminivorous, the enamel descends into the body of the tooth, and by forming several perpendicular layers, enables the tooth to resist the attrition necessary in mastication; if there were only one layer of enamel, it would be soon worn off. Between the teeth of the omnivorous, and carnivorous animals there is also a difference. In the carnivorous, the teeth fit into each other very nicely; whereas in the omnivorous, there is a certain latitude of motion permitted, for the operation of grinding the food.

The *temporary* teeth, in the human race, are twenty in number, and are divided into three kinds; the front, called also incisors, or cutting teeth, of which there are eight, namely, four in each jaw; the canine teeth, called dog teeth, or cuspidate, which are four in number, one on each side of the incisors, and are of a pointed or conical form; and the grinders, or molares, which amount to eight, being two back teeth, above and below, on each side. The *permanent* teeth are thirty-two in number. These are, as in the temporary, eight incisors, and four cuspidate; two bicuspidate, or two-pointed, next to the cuspidate on each side, amounting to eight; and three molares on each side, above and below, making twelve, of which the four hindermost are denominated *dentes sapientiæ*, or teeth of wisdom, from their not appearing till adult age. The cause of this increase of teeth, is, that there is a very great disproportion between the magnitude of the jaw, in the young and adult; and as the teeth, from their nature and mode of growth, do not admit of any increase of size, it was necessary, when the jaw became larger, that not only a supply of larger teeth, but additional teeth should be given.

Many of the carnivorous animals are beasts of prey, and their teeth are part of their natural weapons of attack. The tusks, or canine teeth, are, in such animals, and indeed in some others, as the hog, very formidable instruments of offence.

Cattle and sheep, whose front teeth are confined to biting the grass, have them sharp, and the enamel of these teeth covers their outside only, as in man; but neither cattle nor sheep have incisors, in the upper jaw. In horses, where both the front teeth and the molares are employed as grinders, the enamel is distributed through the body of the tooth, in both descriptions of teeth, in the same way as in graminivorous animals.

There is a very curious difference in the disposition of the enamel in the African and Asiatic elephant, which is worth notice. In the African, it is always in the form of transverse lozenges, which touch each other in the middle of the tooth; in the Asiatic, it is in the form of transverse flattened ovals; and this difference is so constant, that it may be always known, by a slight inspection, whether the tooth has belonged to the one or the other of these species.

In the shark, whose teeth are spear-shaped, and very sharp, notched at the edges, and covered with enamel, several ranges of them are formed and continually forming in the jaw, to supply such as are broken or torn away. The same is the case in a species of skate, which has teeth of a similar kind, and is apt to have them injured, by breaking the shells of lobsters, crabs, &c. which are its chief food. There is also, a singular power of renewal in the teeth of venomous serpents. These animals are distinguished by having a sharp, hollow tooth, or fang, in the upper jaw, on each side, the base of which communicates with a poison gland situated below the eye. This tooth, in ordinary circumstances, lies flat: but it is capable of being erected; and then, either on biting, or by the action of the same muscles which erect it, the poison gland is pressed upon, and a minute portion of the poison forced through the hole of the tooth into the wound. The poison fang is very apt to get entangled and broken; but there is a provision for its supply, in the germs of future fangs, which exist as pulp, in little bags in the jaw: the new fangs become ossified, and assume the office of the old ones.

THE DIGESTION.

During the action of chewing, the food is mixed with the saliva or spittle. The food is then carried backwards into the pharynx, which is a sort of pouch at the back part of the mouth, from which it immediately descends, into the œsophagus, or gullet, at the extremity of which is the stomach, into which the food is deposited.

We may here mark a wonderful contrivance. The passage from the mouth, to the windpipe, lies immediately before the passage to the stomach: we might suppose that the food would pass into the first opening, viz. the passage to the windpipe, before it reached its own proper passage.—And this would be the case, were it not that there is a little valve standing erect before the passage to the windpipe, which the food in its way to the gullet, presses down, and thus closes the anterior opening of the gullet. Were this passage left open, we would be in danger of being choked by every morsel we endeavoured to swallow.

The stomach is a kind of membraneous bag, not very unlike the bag of a bag-pipe, lying across the body, and having two openings: the upper, towards the left side, by which it receives food from the gullet, called the cardia; and the lower, on the left side, called the pylorus or janitor, by which the food passes into the intestines. Its inner surface consists of a soft membrane, called the mucous, or villous coat, which is carried through the whole alimentary canal; its middle coat is muscular, and, by means of this coat, the stomach has the power of emptying its contents; its outer is a membraneous covering, common to the stomach, intestines, and all the other organs contained in the cavity of the abdomen. At the pylorus is a contraction, which prevents the too ready passage of the food downwards. Between its coats are various small glands which secrete, and pour into the stomach, a fluid called the *gastric juice*, which dissolves the substances taken into the stomach, converts them into a uniform, greyish pulpy mass, called *chyme*, and thus fits them for becoming nourishment. Digestion is totally independent of any pressure which is exercised by the coats of the stomach, for it has been found that if portions of food were placed in silver balls, and these swallowed, such portions would be dissolved.

When food has undergone the change which it is meant to suffer in the stomach, it passes through the pylorus or lower orifice, into the intestines. When the food has passed into the intestines, it receives the *bile*, which is a secretion from the liver; and the *pancreatic juice*, which is the secretion of the pancreas, or sweetbread. By the mixture of these substances, the food is so far altered in its nature as to be capable of affording *chyle*, which is a fluid like milk. This fluid is taken up by small vessels, called *lacteals*, spread upon the surface of the intestines. These lacteals, uniting together, convey their contents into one of the large blood-vessels of the body, and thus supply the means of nourishment to the whole system. That part of the food which cannot afford nourishment, is carried off as excrementitious matter.

All carnivorous animals have stomachs of the same kind: and in them the digestive organs are of the more simple kind, as animal food is more easily converted into chyle. Many birds not only take in portions of gravel to assist their digestion; but, as they have no teeth, and can divide their food in but a very imperfect manner with their bills, the gizzard is given them for the purpose of doing so. The gizzard is a muscle in the stomach with two bodies, called therefore the digastric, calculated to press any substance very strongly between the two parts of which it consists. But as the gizzard could not perform the whole of the duty at once, there is a bag, or enlargement of the gullet given to many birds, called the crop, which is situated in the front of the chest, at some distance from the gizzard. In this the hard and dry food is macerated; it is then let into the gizzard, where it is bruised and divided, and mixed with the gastric juice, which is secreted by glands near the entrance of the gizzard; and thus the changes are produced upon the food, which fit it for nourishment.

The crop, in such birds as have it, is principally to be viewed as a repository, in which the food is first softened, and then transferred to the gizzard. But in all birds of the dove kind, and it is supposed in parrots, macaws, and cockatoos, the crop, both in the male and female, is endowed with the power of secreting a fluid, which coagulates into a whitish curd, and is employed to feed the young for two or three days after hatching. It is then found to be mixed with some of the common food; and as the pigeon grows older, the proportion of common food is increased; so that by the time it is eight or nine days old, and able to digest common food, the secretion of the food in the old bird ceases.

In some of the crustaceous animals, as the lobster and crab, the division of the food is accomplished by means of teeth placed in the stomach. These teeth are of the molaris or grinding shape, and are one on each side. Immediately behind them, is a single projecting tooth, which answers the purpose of preventing the food from passing on till it is sufficiently divided. The stomach of these animals is also lined with a hard substance, similar to the external coat, so that it is never collapsed: and it is a curious circumstance, that this coat, as well as the hard covering of the teeth, is parted with, when these animals cast their shells. The tooth-like processes at the entrance of the mouth, which are sometimes represented as teeth, are nothing more than a kind of pincers, to grasp the food, and convey it into the mouth.

Teeth are likewise met with in some of the worm tribe; and such is also the case with various insects, particularly the Cape grasshopper, and mole cricket.

The most curious apparatus for the conversion of vegetable food into nourishment, is that which belongs to the cow, the sheep, the deer, the camel, and other animals which usually chew their cud. In these animals there are four stomachs, which are concerned in digestion. The first stomach receives the food after a slight mastication; thence it goes into the second, called the *honey-comb*; and when it has been macerated for some time, it is carried up into the mouth. It is then chewed, and passes into the third stomach, or *many-plies*, whence it goes into the fourth, or *real*, the proper digesting stomach, where its conversion into chyme is completed. The animal seems to have the power of sending the food at once into the second, third, or fourth; and this they do according to the facility with which the different kinds of food may be digested. For instance, cows in the north of Scotland, and the Hebrides, are occasionally fed on fish, which does not require a second mastication, and is therefore received at once into the third stomach; and calves, when fed on milk, receive it into the fourth stomach. In the camel, the second stomach consists of cells, and is solely appropriated to the reception of water. By means of a curious muscular structure the orifices of these cells are closed, and the water preserved from being mixed with the food. It is this peculiar structure, which in the camel, dromedary, and lama, fits them to live in sandy deserts, where the supplies of water are so precarious. Bruce mentions that four gallons were taken out of the stomach of a camel, during one of his journeys in the desert, when there was much distress for want of water.

THE HEART.

The heart is the grand reservoir of the blood, whence it flows through the arteries to the utmost extremities of the body, and is conveyed back again by the veins. This organ is situated in the thorax, or chest, between the two lobes of the lungs. In man it is placed almost cross-wise.—The base, or broad part, is directed towards the right side, and the point towards the left. It is securely inclosed in a membraneous sack, or pouch, which contains a fluid that gives smoothness to its surface, and ease to its motions. The substance of the heart is entirely fleshy, or muscular. Its basis, from which the great blood vessels originate, is covered with fat, and it has two hollow appendages, called auricles. Within, it is divided into two cavities, or ventricles, separated from each other by a fleshy partition. The use of these ventricles and auricles is to circulate the blood through the whole body, by means of the power of contraction and enlargement which the heart possesses from its numerous fibres, that surround it in a spiral direction. When these fibres are contracted, the sides of the muscular cavities are necessarily squeezed together, so as to force out of them any fluid which they may contain. By the relaxation of the same fibres, the cavities become dilated, and of course prepared to admit any fluid which may be poured into them. The great trunks, both of the arteries, which carry out the blood, and of the veins, which bring it back, are inserted in these cavities. By dilating the fibres, which anatomists call *diastole*, the cavity of the ventricles is opened to receive the blood from the auricles: on the contrary, when the ventricles are contracted, which is called *systole*, the auricles are expanded; and by this alternate action, they carry on the wonderful operation of supplying with blood the most distant parts of the body.

The blood, which has been ejected from the auricles and ventricles, is prevented from returning, by valves, or little doors, placed between the auricles and ventricles, and at the mouths of the great arteries. These valves open inwards, but not in the contrary direction; of course when the blood has passed through them the valves close, and a return is thus rendered impossible.

You may perceive, by this account, that there is a continual exchange of the blood that fills the heart. It is no sooner emptied into the arteries, than it is filled again from the veins; and this contraction and dilatation succeed each other with great rapidity; and by its re-action causes that beating at the wrist, and other parts, that is called the pulse.

It is supposed that the quantity of blood contained in the body amounts to between 25 and 35 pounds;

and that about two ounces pass on from the heart at each pulsation. In this way, at 70 pulsations in a minute, 140 ounces will pass through the heart in a minute, or 8400 ounces in an hour. Hence the whole quantity of blood contained in the body, supposing it to be 25 pounds, will pass through the circulation in about three minutes, or about 20 times in an hour, or 480 times in a day. When we consider the same process in the larger species of animals, it strikes the mind still more forcibly. Dr. Hunter dissected a whale; and he relates that the aorta, which is the principal artery of the body, measured a foot in diameter. Ten or fifteen gallons of blood are thrown out of the heart at a stroke; what then must be the quantity of blood circulating through the whale in a day!

The structure of the heart, and the circulation of the blood, seem to be conducted on the same principles in man and in quadrupeds. We have just seen that in the whale it is similar; and probably in fishes in general. The circulation of the blood, as it appears in the newt, a species of lizard, when seen through a good microscope, will illustrate what we have said on this subject. The bodies of these animals, when very young, are so transparent, that the blood may be seen to flow briskly through every part, even into the toes, and to return from them. The newt has three small fins, near the head, which are divided like the leaves of a polypody or fern; and in every one of these branches, the blood may be traced, running to the end through the artery, and conveyed back again, by a vein of the same size with the artery, and laid in the same direction. In this part may be seen above thirty channels of blood running at once, like the divided streams of a great river, diffusing life and vigour.

Some insects have several hearts. If silk worms be examined, when full grown, there will be perceived a chain of hearts, running the whole length of their bodies; whilst many amphibious animals, frogs for example, have but one ventricle to the heart.

The chief distinction between the arteries and veins is this, that the arteries convey the blood from the heart; the veins carry it back again. In order to effect this purpose, the veins are continued from the extremities of the arteries, and, in general, every artery is accompanied by its corresponding vein.

That we may clearly understand the subject before us, let us suppose two trees united to each other by the extremities of their branches at the top, and their trunks terminating at the same point at the bottom; each being hollow from the roots to the tips of the smallest twigs, and filled with a fluid which circulates incessantly from one through the other. Let us imagine this, and we shall have a tolerably correct idea of the circulation of the blood through the vessels of the human body. Four large vessels, from which all the rest proceed, pass out from the base of the heart; two of these are arteries, and the other two veins. The aorta is the principal artery, that distributes the main stream of the blood through innumerable ramifications, to all parts of the body; it arises from the left ventricle of the heart. The pulmonary artery originates from the right ventricle, and enters the lungs, where its branches are spread out on the air-vessels: by this means the blood is acted upon by the air which we inhale, and undergoes a certain change which is essential to our well-being. All the veins, which bring the blood from the upper extremities, and from the head and heart, pass into a large vein called the descending *vena cava*; those veins, which bring the blood from the lower extremities, pass into another large vein, called the ascending *vena cava*. These two large veins unite as they approach the heart, and open by one common orifice into the right auricle. The return of the blood is promoted by the action of the muscles, the pulsation of the arteries, and the valves which are formed in the veins. These valves are so nicely adapted to their design, that they admit the blood to flow from the extremities, but oppose its returning back towards them.

The circulation of the blood was first ascertained by Harvey, A.D. 1628; by the aid of the microscope it may be very plainly observed in the web of a frog's foot.

RESPIRATION.

In forming the organs of respiration in the higher orders of animals, the Creator has had two great objects in view: the one, that of forming the voice; the other, that of completing the changes which are requisite for adapting the blood to the functions, which it is intended to perform in the animal economy.

The organs of respiration consist of the *larynx*, the *trachea*, or windpipe, and the *lungs*. The larynx is the projecting part, which you can see and feel at the upper part of the throat. It is the commencement of the windpipe, and is the organ in which the voice is formed. The windpipe is the tube which is connected with this, and is divided first into two, and then into smaller branches, called bronchia, which at last terminate in small cells, that form the minute structure of the lungs. These organs can only be considered as subservient to the more immediate functions of respiration. There are other parts, which are necessary for carrying on the mechanical process of admitting and ejecting the air from the lungs, and these in man and quadrupeds are principally a very large and strong muscle, called the diaphragm, which separates the cavity of the abdomen from the thorax; and various small muscles which lie between the ribs.

The mechanism employed in dilatation and expansion is exceedingly simple. The contraction of the diaphragm forces down the abdominal viscera, and thus enlarges the cavity of the chest downwards, while the action of the muscles between the ribs raises them, and produces an expansion in another direction. The necessary effect of this increase of size is, that the air rushes into the windpipe, to supply the void which would otherwise occur; and when the diaphragm and intercostal muscles cease to act, and become relaxed, the elasticity of the cartilaginous parts of the chest, but more particularly the tendency of the muscles of the abdomen to recover themselves, have the effect of diminishing the cavity in the chest, and of thus forcing out from the lungs, the air which has been received by inspiration. The alternate dilatation and contraction of the chest, which thus takes place, constitutes the act of respiration, which is partly dependent on the will, and partly independent of it. The lungs are of a light, spongy texture, one in each cavity of the chest, capable of swimming in water, separable into sub-divisions called lobes, and covered with a membrane called the *pleura*, which doubles back, and lines the cavity of the chest, as the peritoneum does the cavity of the abdomen. The lungs are very largely supplied with blood-vessels, of which some appear to be destined for the nourishment of the organ; but by far the principal part convey the blood from the right side of the heart, in order that it may, after minute division, and diffusion over the air cells, be exposed to the influence of the external air, and be carried back to the heart in a proper state for nourishing the body.

The blood which passes from the right side of the heart into the lungs, is of a dark red colour. After circulating through the lungs, it becomes of a florid red, and has then been rendered fit for nutrition. In this progression through the lungs, it has been freely exposed to the air of the atmosphere, which is continually received and thrown out, by the alternate actions of inspiration and expiration.

Atmospheric air is composed of about twenty-one parts by measure of oxygen, or the respirable part; and seventy-nine parts of azote, called also nitrogen, or the unrespirable part, with a small portion, not exceeding two per cent. of carbonic acid gas. When an animal is confined in a certain quantity of atmospheric air, a part of the oxygen disappears, and an augmented quantity of carbonic acid gas is found to have been produced. Now, it is supposed by Physiologists, that part of the oxygen is absorbed by the blood, giving it its florid red colour, and is carried through the body, that by its union with other elements it may form a species of *diffused* combustion. This preserves a more uniform temperature than if the animal heat were produced only in the lungs, which are at a considerable distance from the extremities, and are not united with them by substances well calculated to transmit heat. The remainder changes the venous blood in the lungs, by abstracting carbon, and forming carbonic acid; this may be easily shown by passing the air from the lungs through lime water, which will become turbid by the formation of carbonate of lime.

Physiologists have differed very much as to the quantity of air taken in at each inspiration. It would appear, however, that about forty cubic inches of air are taken in at an ordinary inspiration; and if we suppose that we respire sixteen times in a minute, we shall respire, during the twenty-four hours, 921,600 cubic inches, or 533 cubic feet of air. This is an immense consumption of oxygen; and it may seem extraordinary, that, considering the prodigious demands on the atmosphere, by the many millions of human beings who inhabit the earth, and the countless numbers of animals which require a constant supply of air, the oxygen should not be consumed, and the air itself contaminated. God, however, has wisely provided for the removal of what is noxious, from air, and for the supply of what is wholesome. Carbonic acid gas, which animals produce in respiration, and which likewise originates from fermentation and combustion, is capable of being absorbed by water. It is also, in certain circumstances, taken in by plants, of which it forms a part of the food, so that there is no danger of any deleterious superabundance. Plants, likewise, when exposed to the rays of the sun, exhale oxygen, which seems to arise from the decomposition of the absorbed carbonic acid gas, the carbon forming a part of the substance of the plant, and the oxygen, which had been united with it, being thrown out.

The influence, exercised by respiration, in the animal economy, is pretty much the same in all animals; but the mode, which we have described, principally applies to man and quadrupeds. In birds, there are some important modifications; in fish the air is applied to the blood in the gills, through the medium of the water; in amphibious animals, the principal characteristic is, that the whole of the blood does not circulate through the lungs, and that they can bear the interruption of respiration without injury; but in the insect tribe, and most of the inferior animals, there are various tubes, or tracheæ, which ramify over the body, and open externally by apertures, or stigmata, as they are called, by means of which the air is received and expelled: so that we witness over the whole creation, an admirable accordance to the modes, for the support of life and health which God has thought fit to adopt.

The peculiarities, in the functions of respiration in birds, are exceedingly curious. In this class of animals, the lungs are small, flattened, and lie close to the breast, but there is no diaphragm, and there is no alternate expansion of the lungs, as in mammalia. In them, the lungs have several openings, by means of which they communicate with various air-bags, or cells, which fill the whole of the cavity of the body from the neck downwards. These cells are filled by air which passes into, and out of them, through the lungs, and which, in its passage, produces those changes on the blood circulating through the lungs, which are necessary for the health of the animal. By admitting different quantities of air into these cells, and also into the bones, which are hollow, for the purpose of admitting air into them from the lungs, birds have the power of increasing or diminishing their specific gravity, so that they can, not only walk on the earth, but soar in the heavens, in all the varieties of density of atmosphere, which a greater or smaller proximity to the earth necessarily occasions. No strength of wing could poise a terrestrial animal in air, unless there were the power of admitting air into the inmost recesses of the body, as happens in birds; and this has been so carefully attended to in them, that the cells extend even among the muscles of the body, where they are particularly large in the soaring animals, as the eagle, hawk, stork, and lark. Those birds that pounce and those that dive, are enabled to do so with great velocity, by suddenly compressing their body, which drives air out, and increases their specific gravity. The barrels of the quills in birds, too, are hollow, and contain air; and it is said, that it is in some measure owing to the power of diminishing or increasing the contained quantity, that the turkey, bulfinch, &c. are able to produce the quick and voluntary erection of their plumage. We may mention here, that the power which birds have of admitting a large quantity of air into their bodies, enables them to keep up a much stronger, and more continued current of air through the larynx, than any other animal can do; and gives them, therefore, a volume of voice, which is very great, compared with their small dimensions.

In fishes, as already stated, the air is applied to the gills through the medium of the water. The gills are covered with a large flap, or operculum, which is edged with a fringe which can be accurately applied to the part beneath, so as entirely to shut up the slit, or opening into the gills. When the animal breathes, that is, when it wishes water to be applied to the gills, it acts with the muscles of this flap so as to render it convex; this cannot be done, it is clear, without producing a vacuum under the flap; and as the animal is in water, and there is an opening in the mouth which communicates with the gills, the water rushes in among the gills, filling up the space made by the changed form of the flap, and thus applying itself to the minute ramifications of blood-vessels diffused over the gills. When the air contained in this water is no longer equal to its purpose, the water passes away through the air-opening at the edge of the operculum, which the animal has the power of making; and by a repetition of the process, a fresh supply of water is obtained, and the function of respiration kept up. Fish could not live in water from which the air has been expelled by boiling; and when a small pond is frozen over, the fish die unless an opening is made to admit the air.

There is, in fish, a part of structure somewhat analogous to the air-cells in birds, namely, the *air-bladders*, or *swimming-bladders*, which are given to them, as the cells are to birds, for the purpose of increasing, or diminishing their buoyancy. These bladders are placed close to the back-bone; they vary in size, shape, and number; and are wanting, or very small, in such fish as are generally confined to the lowest depths. They form what is called the sound of fish; a part which gourmands prize highly. When the air-bladder is ruptured, the animal loses the power of raising itself, and lies on its back, from the additional weight given to that part of the body, by the removal of the air. The air, in the air-bladders of fish, cannot be admitted and thrown out at pleasure, as in the case of birds. The air is procured from the vessels circulating in the membrane which composes the air-bladders; these vessels having the power of secreting air. The air-bladder is ordinarily full, and is then capable of being acted upon, and compressed, either by the abdominal muscles, or by a muscular structure peculiar to this organ; and thus the air is condensed pursuant to the will of the animal, and an alteration made in the specific gravity accordingly.

It is a curious fact that the nature of the air varies very much, according to the depth which fish generally inhabit. Those which live in shallow water, have azote, with a very small proportion of oxygen. As the depth increases so does the oxygen; and after the depth of 150 feet, the average proportion is as much as 70 per cent., while the mean result afforded by fish caught at less depth, is only 29 per cent. Pike, carp, roaches, and perch, which are fresh-water, and therefore shallow-water fish, have only from 3 to 5 per cent. of oxygen.

There is a curious mode of respiration employed by frogs, toads, chameleons, and some others of the amphibious tribe, which is, that the animal, instead of breathing through its mouth, keeps its mouth shut, receives air through its nose, and by means of the muscles of the jaws forces it into the lungs, from which it is returned, through the nostrils, by the action of the muscles of the abdomen—there being no diaphragm. With this conformation, those animals would be suffocated if their mouths were kept open.

SECTION IV.

INTRODUCTION TO NATURAL PHILOSOPHY.

Natural Philosophy, in its most extensive sense, has for its province the investigation of the laws of matter; that is, the properties of matter; and it may be divided into two great branches. The first and most important (which is sometimes called *Natural Philosophy*, by way of distinction, but more properly *Mechanical Philosophy*) investigates the sensible motions of bodies. The second investigates the constitution and qualities of all bodies, and has various names, according to its different objects. It is called *Chemistry*, if it teaches the properties of bodies with respect to heat, combination with one another, weight, taste, appearance, and so forth; *Anatomy* and *Animal Physiology*, if it teaches the structure and functions of living bodies, especially the human;—for, when it treats of the functions of other animals, we term it *Comparative Anatomy*. It is called *Medicine*, if it teaches the nature of diseases, and the means of preventing them, and of restoring health: *Zoology*, if it teaches the arrangement or classification, and the habits of the different lower animals: *Botany*, including *Vegetable Physiology*, if it teaches the arrangement or classification, the structure and habits of plants: *Mineralogy*, including *Geology*, if it teaches the arrangement of minerals, the structure of masses in which they are found, and of the earth composed of these masses. The term *Natural History* is given to the three last branches taken together; but chiefly, as far, as they teach the classification of different things, or the observation of the resemblances and differences of the various animals, plants, and ungrowing substances in nature.

Here we may make two observations. The *first* is, that every such distribution of the sciences is necessarily imperfect; for one runs unavoidably into another. Thus, Chemistry shows the qualities of plants with relation to other substances, and to each other: and Botany does not overlook those same qualities, though its chief object be arrangement. So Mineralogy, though principally conversant with classifying metals and earth, yet regards also their qualities in respect of heat and moisture. So Zoology too, beside arranging animals describes their structures like Comparative Anatomy. In truth, all arrangement and classification depend upon noting the things in which the objects agree and differ; and among these things in which animals, plants, and minerals agree or differ, must be considered the anatomical structure of the one, and the chemical qualities of the other. Hence, in a great measure, follows the *second* observation, namely, that the sciences mutually assist each other. Thus, arithmetic and algebra aid geometry, and the purely mathematical sciences aid mechanical philosophy; mechanical philosophy, in like manner, assists chemistry and anatomy, especially the latter: and chemistry very greatly assists physiology, medicine, and all the branches of natural history.

The first great head, then, of natural science, is mechanical philosophy; and it consists of various subdivisions, each forming a science of great importance. The most essential of these, which is indeed fundamental, and applicable to all the rest, is called *Dynamics*, from the Greek word signifying *power* or *force*. It teaches the laws of motion in all its varieties. The application of dynamics to the calculation, production, and direction of motion, forms the science of *Mechanics*, sometimes called *Practical Mechanics*, to distinguish it from the more general use of the word, which comprehends every thing that relates to motion and force.

The application of dynamics to the pressure and motion of fluids, constitutes a science, which receives different appellations according as the fluids are heavy and liquid, like water, or light and invisible like air. In the former case it is called *Hydrodynamics*, from the Greek words signifying *water* and *power;* in the latter *Pneumatics*, from the Greek words signifying *breath* or *air.* And hydrodynamics, is divided into *Hydrostatics*, which treats of the weight and pressure of liquids, from the Greek words for *balancing of water*, and *Hydraulics*, which treats of their motion; from the Greek word for several musical instruments played with *water* in *pipes.*

Library of Useful Knowledge.

GENERAL PROPERTIES OF BODIES.

There are certain properties, which appear to be common to all bodies, and are hence called the *essential properties of bodies:* These are, *Impenetrability*, *Extension*, *Figure*, *Divisibility*, *Inertia*, and *Attraction.*

Impenetrability is the property, which bodies have of occupying a certain space, so that, where one body is, another cannot be, without displacing the former;—for two bodies cannot exist in the same place at the same time. A liquid may be more easily moved than a solid body; yet it is not the less substantial, since it is impossible for a liquid and a solid to occupy the same space at the same time. For instance, if a spoon be put into a glass full of water the water will flow over to make room for the spoon.

Air is a fluid differing in its nature from liquids, but no less impenetrable. If we endeavour to fill a phial by plunging it into a basin of water, the air will rush out of the phial in bubbles, in order to make way for the water.

If a nail be driven into a piece of wood, the nail penetrates between the particles of the wood, by forcing them to make way for it; for not a single atom of the wood remains in the space which the nail occupies.

Extension. A body which occupies a certain space, must necessarily have extension; that is to say, *length*, *breadth*, and *depth*: these are called the dimensions of extension, and they vary extremely, in different bodies. The length, breadth and depth of a box, or of a thimble, are very different from those of a walking stick or of a hair.

Height and depth are the same dimensions; if you measure a body, or a space, from the top to the bottom, it is called the depth, if from the bottom upwards, it is called height. Breadth and width are also the same dimensions.

The limits of extension constitute *figure* or shape; a body cannot be without form, either symmetrical or irregular.

Divisibility is a susceptibility of being divided into an indefinite number of parts. Take any small quantity of matter, a grain of sand, for instance, and cut it into two parts; these two parts might be again divided, had we instruments sufficiently fine for the purpose; and if, by pounding, grinding, or any other method, we carry this division to the greatest possible extent, yet not one of the particles will be destroyed, and the body will continue to exist, though in this altered state. A single pound of wool may be spun so fine as to extend to nearly a hundred miles in length.

The melting of a solid body in a liquid, also affords a very striking example of the extreme divisibility of matter; when you sweeten a cup of tea, for instance, with what minuteness the sugar must be divided to be diffused throughout the whole of the liquid. Odoriferous bodies afford an example of the same thing. The odour or smell of a body is part of the body itself, and is produced by very minute particles or exhalations, which escape from odoriferous bodies, and come in actual contact with the nose.

When a body is burnt to ashes, part of it *appears* to be destroyed; the residue of ashes, for instance, is very small compared to the coals which have been consumed. In this case, that part of the coals, which one would suppose to be destroyed, goes off in the form of smoke, which, when diffused in the air, becomes invisible. But we must not imagine that what we no longer see no longer exists. The particles of smoke continue still to be particles of matter, as much so as when more closely united in the form of coals. No particle of matter is ever destroyed; this is a fact which must constantly be remembered. Every thing in nature decays and corrupts in the lapse of time. We die, and our bodies moulder to dust; but not a single atom of them is lost.

It should be observed, that when a body is divided, its surface or exterior part is augmented. If an apple be cut in two, in addition to the round surface there will be two flat surfaces; divide the halves of the apple into quarters, and two more surfaces will be produced.

Though divisibility is very often included among the essential properties of matter, chemistry teaches us that the ultimate elements of bodies are incapable of further division; yet they are material substances.

Inertia expresses the resistance which native matter makes to a change of state. Bodies appear to be not only incapable of changing their actual state, whether it be of motion or rest; but to be endowed with a *power of resisting* such a change. It requires force to put a body which is at rest in motion: an exertion of strength is also requisite to stop a body which is already in motion. The resistance of a body to a change of state is, in either case, called its inertia. In playing at cricket, for instance, considerable strength is required to give a rapid motion to the ball; and in catching it we feel the resistance it makes to being stopped. Inert matter is as incapable of stopping of itself, as it is of putting itself in motion. When the ball ceases to move, therefore, it must be stopped by some other cause or power, which you will understand better after we have treated of the next and last general property of bodies.

Attraction is the general name under which we may include all the properties by which atoms of matter act on each other, so as to make them approach or continue near to one another. Bodies consist of infinitely small particles of matter, each of which possesses the power of attracting or drawing towards it, and uniting with any other particle sufficiently near to be within the influence of its attraction. This power cannot be recognized in minute particles, except when they are in contact, or at least appear to be so: it then makes them stick or adhere together, and is hence called the *attraction of cohesion.* Without this power solid bodies would fall to pieces, or rather crumble to atoms.

The attraction of cohesion exists also in liquids; it is this power which holds a drop of water suspended at the end of the finger, and keeps the minute watery particles, of which it is composed, united. But as this power is stronger in proportion as the particles of bodies are more closely united, the cohesive attraction of solid bodies is much greater than that of fluids. It is owing to the different degrees of attraction of different substances, that they are hard or soft; and that liquids are thick or thin. The term *density* denotes the degree of closeness and compactness of the particles of a body; the stronger the cohesive attraction, the greater is the density of the body, whether it be solid or liquid. In philosophical language, however, density is said to be that property of bodies, by which they contain a certain quantity of matter, under a certain bulk or magnitude. *Rarity* implies a diminution of density, thus we should say, that mercury or quicksilver was a very dense fluid; ether, a very rare one. We judge of the density of a body by the weight of it; thus we say, that metals are dense bodies, wood, comparatively a rare one.

Capillary attraction is an interesting variety of the attraction of cohesion. In tubes of small bore, liquids rise a certain height within them, from the cohesive attraction between the particles of the liquid and the interior surface of the tube. The smaller the bore, the higher will the liquid rise. All porous substances, such as sponge, bread, linen, &c. may be considered as collections of capillary tubes. If you dip one end of a lump of sugar into water, the water will rise in it, and wet it considerably above the surface of that into which you dip it. Capillary attraction probably contributes to the rise and circulation of the sap in the bark and wood of vegetables.

Attraction of gravitation differs from that of cohesion, inasmuch as the latter influences the *particles* of bodies at *imperceptible* distances, whereas the former acts upon *masses*, and at *any* distance, however great. Let us take, for example, a very large body, and observe whether it does not attract other bodies. What is it that occasions the fall of a book when it is no longer supported? You will say that bodies have a natural tendency to fall. That is true; but that tendency is produced by the attraction of the earth. The earth being much larger than any body on its surface, draws to it every other, which is not supported.

Attraction being mutual between two bodies, when a stone falls to the earth, the earth should rise part of the way to meet it. But when, on the other hand, you consider that attraction is in proportion to the mass of the attracted and attracting bodies, you will no longer expect to see the earth rising to meet the stone. There are, however, some instances, in which the attraction of a large body has sensibly counteracted that of the earth. If a man, standing on the edge of a perpendicular side of a mountain, hold a plumb line in his hand, the weight will not fall perpendicularly to the earth, but incline a little toward the mountain.

If the air did not impede the fall of bodies, attraction would make them all descend with equal velocity. It may be objected, that since attraction is proportioned to the quantity of matter which a body contains, the earth must necessarily attract a heavy body more strongly, and consequently bring it to the ground more rapidly than a light one. In answer to this, it must be observed that bodies have no natural tendency to fall any more than to rise, so that the force which brings them down, must be in proportion to the quantity of matter it has to move. Thus a body consisting of a thousand particles of matter, requires ten times the force or attraction to bring it to the ground, in the same space of time, that a body consisting of only a hundred particles does.

There are some bodies which do not appear to gravitate: smoke and steam, for instance, rise instead of fall, but it is still gravity which produces their ascent. The air nearer the earth being heavier than smoke, steam, or other vapours, not only supports these light bodies, but, by its own tendency to sink below them, forces them to rise. The principle is just the same as that by which a cork, if forced to the bottom of a vessel of water, rises to the top as soon as it is set at liberty. Balloons ascend upon the same principle, the materials of which they are made, are heavier than the air, but the air with which they are filled is considerably lighter; so that, on the whole, the balloon is lighter than the air which is near the earth, and consequently rises.

ON THE LAWS OF MOTION, AND THE CENTRE OF GRAVITY.

The science of Mechanics is founded on the laws of motion; it will therefore be necessary to explain these laws before we examine the mechanical powers. Motion consists in a change of place. A body is in motion whenever it is changing its situation with regard to a fixed point. Now, as one of the general properties of bodies is inertia, it follows that a body cannot *move* without being *put* into motion. The power which puts a body into motion is called *force;* the stroke of the hammer is the force which drives the nail; the exertion of the horse in pulling, that which draws the carriage. Gravitation is the force which occasions the fall of bodies, cohesion that which binds the particles of bodies together, and heat a force which drives them asunder. When a body is acted on by a single force, the motion is always in a straight line, and in the direction in which it received the impulse.

The rate at which a body moves is called its *velocity;* and it is one of the laws of motion, that the velocity of the moving body is proportional to the force, by which it is put in motion. The velocity of a body is called *absolute*, if we consider its motion, without any regard to that of other bodies. When, for instance, a horse goes fifty miles in ten hours, his velocity is five miles an hour. It is termed *relative*, when compared with that of another body which is itself in motion. Thus a man asleep in a ship under sail, remains at rest relatively to the vessel, though he partakes of its absolute motion. If two carriages go along the same road, their relative velocity will be the difference of their absolute velocities.

The motion of a body is said to be *uniform*, when it passes over equal spaces in equal times. It is produced by a force having acted on a body once, and having ceased to act, such as the stroke of a bat on a cricket-ball. It may be said, that the motion of the ball is neither uniform nor in a straight line. In answer to this objection, you must observe that the ball is inert, having no more power to stop than to put itself in motion; if it fall, therefore, it must be stopped by some force superior to that by which it was projected; and this force is gravity, which counteracts and finally overcomes that of projection. If neither gravity nor any other force opposed its motion, the cricket-ball, or even a stone thrown by the hand, would continue to proceed onwards in a right line and with a uniform velocity. We have no example of perpetual motion on the surface of the earth; because gravity, the resistance of the air or friction, ultimately destroys all motion. When we study the celestial bodies, we find that nature abounds with examples of perpetual motion, and that it conduces as much to the harmony of the system of the universe, as the prevalence of it would be destructive of all stability on the surface of the globe.

Retarded motion is produced by some force acting on a body in a direction opposed to that which first put it in motion, and thus gradually diminishing its velocity.

Accelerated motion is produced, when the force which puts a body in motion, continues to act upon it during its motion, so that its velocity is continually increased. Let us suppose, that the instant a stone is let fall from a high tower, the force of gravity were annihilated: the stone would nevertheless descend; for a body, having once received an impulse, will not stop, but move on with a uniform velocity. If, then, the force of gravity be not destroyed, after having given the first impulse to the stone, but continue to act upon it during the whole of its descent, it is easy to understand that its motion will be thereby accelerated. It has been ascertained, both by experiment and calculations, that bodies descending from a height by the force of gravity, fall about sixteen feet in the first second of time, three times that distance in the next, five times in the third second, seven times in the fourth, and so on, regularly increasing according to the number of seconds during which the body has been falling. Thus the height of a building, or the depth of a well may be known, by observing the length of time which a stone takes in falling from the top to the bottom. If a stone be thrown upwards, it takes the same length of time, ascending that it does in descending. In the first case, the velocity is diminished by the force of gravity; in the second, it is accelerated by it.

The *momentum* of bodies is the force or power, with which one body would strike another. The momentum of a body is measured by the product of its weight and velocity. The quicker a body moves, the greater will be the force with which it will strike against another body; and we know also, that the heavier a body is, the greater is its force; therefore the whole power or momentum of a body is composed of these two properties. It is found by experiment, that if the weight of a body be represented by the number 3, and its velocity also by 3, its momentum will be nine.

The *reaction* of bodies is the next law of motion to be explained. When a body in motion strikes another body, it meets with resistance; the resistance of the body at rest will be equal to the blow struck by the body in motion; or in philosophical language, action and reaction will be equal and in opposite directions. Birds, in flying, strike the air with their wings, and it is the reaction of the air which enables them to rise or advance forwards.

If we throw a ball against a wall, it rebounds; this return of the ball is owing to the reaction of the wall against which it struck, and is called *reflected motion.*

Compound motion is that produced by the action of two forces. If a body be struck by two equal forces, in opposite directions, it will not move. But if the forces, instead of acting on the body in opposition, strike it in two directions inclined to each other, at an angle of 90 degrees, it will move in the diagonal of a square; thus [Fig. 1,] if the ball A be struck by equal forces at x and at y, the force x would send it towards B, and the force y towards C: and since these forces are equal, the body cannot obey one impulse rather than the other, yet as they are not in direct opposition, they cannot entirely destroy the effect of each other; the body will therefore move, but, following the direction of neither, it will move in a line between them, and reach D in the same space of time that the force x would have sent it to B, and the force y would have sent it to C. Now, if two lines be drawn from D to join B and C, a square will be produced, and the oblique line e, which the body describes, is the diagonal of a square. Supposing the two forces to be unequal [Fig 2] that x, for instance, is twice as great as y; then x will drive the ball twice as far as y, consequently the line A B will be twice as long as the line A C; the body will in this case move to D; and if the lines be drawn from that point to B and C, the ball will move in the diagonal of a rectangle.

Fig. 1.

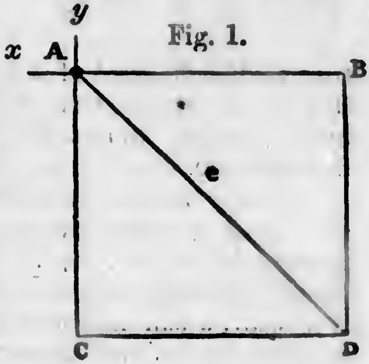
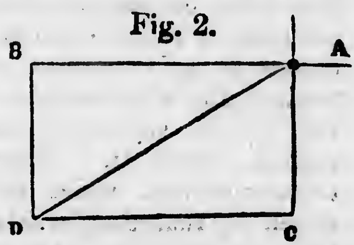
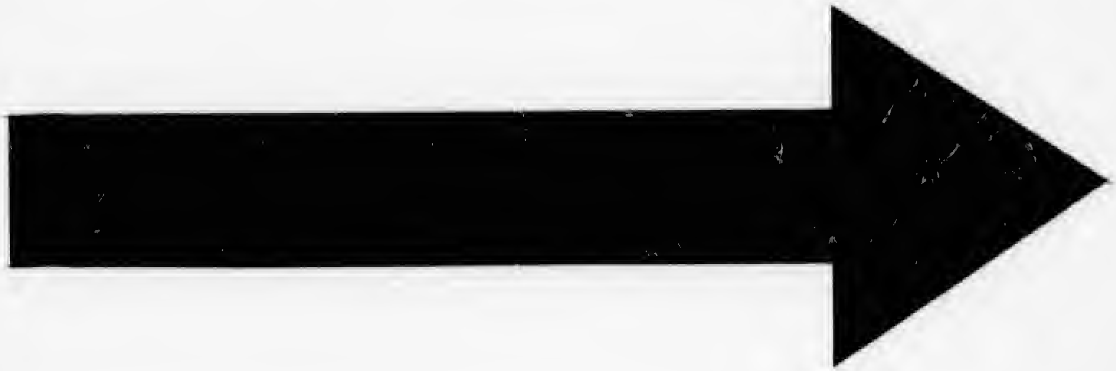


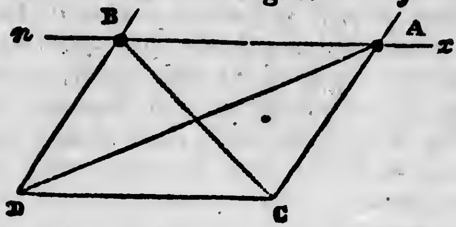
Fig. 2.





Let us now suppose the two forces to be unequal, and not to act on the ball in the direction of a right angle, but in that of an acute angle. The ball will move [Fig. 3] from A to D in the diagonal of a parallelogram, A B D C. Forces acting in the direction of lines forming an obtuse angle will also produce motion in the diagonal of a parallelogram. For instance, if the body set out from B instead of A, and be impelled by the forces *m* and *n*, it will move in the dotted diagonal B C.

Fig. 3.



Circular motion is produced by the action of two forces on a body, by one of which it is projected forward in a right line, whilst by the other it is continually directed towards a fixed point. For instance, if I whirl a ball fastened to my hand with a string, it is acted on by two forces, and has a circular motion; one of the forces is that which I give it, which represents the force of projection, the other force is the string which confines it to my hand. If during its motion the string were suddenly to break, the ball would fly off in a straight line, and this, because it would then be acted on by only one force; for, as we have said, motion produced by one force is always in a right line. The point or line, to which the motion of a body is confined, is called the *centre* or *axis* of motion. This centre or axis remains at rest, whilst all the other parts of the body move round it: when a top is spun, the axis is stationary, whilst every other part is in motion round it. There is one circumstance in circular motion, which must be carefully attended to; which is, that the further any part of a body is from the axis of motion, the greater is the velocity. The force, which confines a body to a centre, round which it moves, is called the *centripetal* force; and the force, which impels a body to fly from the centre, is called the *centrifugal* force. In circular motion these two forces balance each other.

If a ball be thrown in a horizontal direction, it is acted upon by three forces, viz. the force of projection; the resistance of the air through which it passes; and the force of gravity which finally brings it to the ground. Bodies thus projected describe a curve line in their descent. If the forces of projection and of gravity both produced uniform motion, the ball would move in the diagonal of a parallelogram: but the motion produced by the force of projection alone is uniform, that produced by gravity is accelerated; and it is this acceleration which makes it fall in a curve instead of a straight line. The curve line which a ball describes, if the resistance of the air be not taken into consideration, is called in geometry a *parabola*.

The middle point of a body is called its *centre of magnitude*, that is, the centre of its mass or bulk.

The *centre of gravity* is the point about which all the parts of a body exactly balance each other, in every position of the body; if therefore this point is supported, the body will not fall. When a boat is in danger of being upset, it is dangerous for the passengers to rise suddenly; this is owing to their raising the centre of gravity. When a man stands upright, the centre of gravity of his body is supported by the feet. If he lean to one side he will no longer stand firm. A rope-dancer performs all his feats of agility, by dexterously supporting his centre of gravity; whenever he finds himself in danger of losing his balance, he shifts the heavy pole which he holds in his hands, in order to throw the weight towards the side that is deficient; and thus by changing the situation of the centre of gravity, restores his equilibrium. A person carries a single pail of water with great difficulty, owing to the centre of gravity being thrown on one side; but two pails, one hanging on each arm, are carried with much greater facility, because they balance each other.

When two bodies are fastened together, they are to be considered as forming but one body. If the two bodies be of equal weight, the centre of gravity will be in the middle of the line which unites them; but if one be heavier than the other, the centre of gravity will be proportionably nearer the heavy body than the light one.

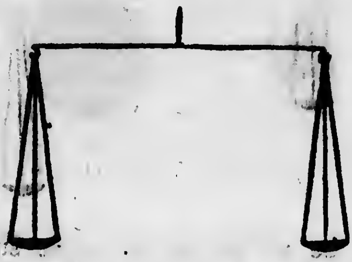
ON THE MECHANICAL POWERS.

There are six mechanical powers, viz. the *lever*, the *pulley*, the *wheel* and *axle*, the *inclined plane*, the *wedge* and the *screw*. One or more of these enters into the composition of every machine.

In order to understand the power of a machine, there are four things to be considered. *Firstly*, the power that acts; this consists in the effort of men or horses, of weights, springs, steam, &c. *Secondly*, the resistance which is to be overcome by the power. The effect of the power must always be superior to the resistance, otherwise the machine could not be put in motion. For instance, were the resistance of a carriage equal to the strength of the horses employed to draw it, they would not be able to draw it. *Thirdly*, we are to consider the centre of motion, or, as it is termed in mechanics, the *fulcrum*, which means a prop. And *lastly*, the respective velocities of the power, and of the resistance.

THE LEVER.

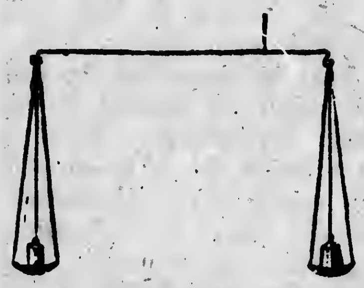
The *lever* is an inflexible rod or beam, that is to say, one which is not supposed to bend in any direction. For instance, the steel rod, to which a pair of scales is suspended, is a lever, and the point by which it is suspended, called the prop or fulcrum, is also the centre of motion. The two parts of a lever, divided by the fulcrum, are called its arms. Now, both scales being empty, they are of the same weight, and consequently balance each other. We have stated that if two bodies of equal weight are fastened together, the centre of gravity will be in the middle of the line that connects them; the centre



of gravity of the scales must, therefore, be in the middle between them, as the fulcrum is, and, this being supported, the scales balance each other.

You recollect, that if a body be suspended by that point in which the centre of gravity is situated, it will remain at rest in any position indifferently; which is not the case with this pair of scales, for when we hold them inclined, they instantly regain their equilibrium. The reason of this is, that the centre of suspension, instead of exactly coinciding with that of gravity, is a little above it. If, therefore, the equilibrium of the scales be disturbed, the centre of gravity moves in a small circle round the point of suspension, and is therefore forced to rise; and the instant it is restored to liberty, it descends and resumes its situation immediately below the point of suspension, when the equilibrium is restored. It is this property which renders the balance so accurate an instrument for weighing goods. If the scales contain different weights, the centre of gravity will be removed towards the scale which is heavier, and being no longer supported, the heavier scale will descend. If the lever be taken off the prop, and fastened on in another point, that other point then becomes the fulcrum. In this case the equilibrium is destroyed; the longer

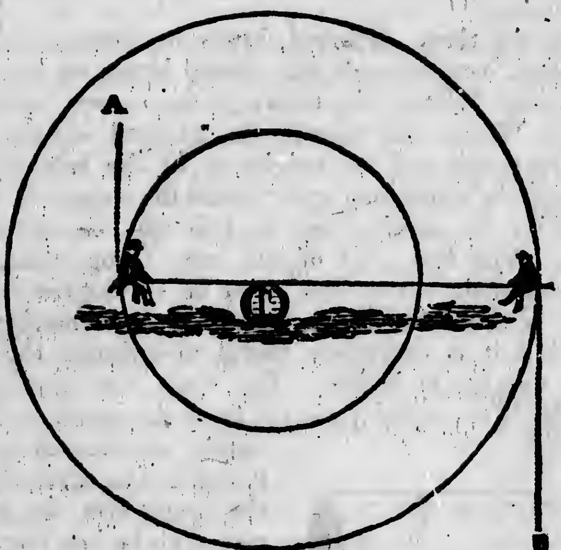
arm of the lever is heaviest, and descends. The centre of gravity is not supported, because it is no longer immediately below the point of suspension. But if we can bring the centre of gravity immediately below that point, as it is now situated, the scales will again balance each other. Thus if a heavy weight be placed in the scale suspended to the shorter arm of the lever, and a lighter one into that suspended to the longer arm, the equilibrium will be restored.



It is not, therefore, impracticable to make a heavy body balance a light one; and by this means an imposition in the weight of goods is sometimes effected. An ingenious balance, called a steelyard, has been invented, on the principle that a weight increases in effect in proportion to its distance from the fulcrum.

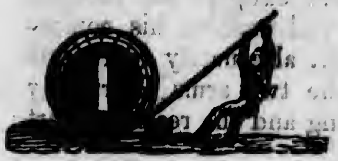
When a lever is put in motion, the longer arm, or acting part of the lever, must move with greater velocity than the shorter arm, or resisting part of the lever, because it is further from the centre of motion. When two boys ride on a plank drawn over a log of wood, the plank becomes a lever, the log which supports it the fulcrum, and the two boys, the power and the resistance at each end of the lever. When the boys are of equal weight, the plank must be supported in the middle to make the two arms equal; if they differ in weight, the plank must be drawn over the prop, so as to make the arms unequal, and the lighter boy must be placed at the extremity of the longer arm, in order that the greater velocity of his motion may compensate for the superior gravity of his companion, so as to render their momentums equal. But we know, that the action of the power must be greater than the resistance in order to put a machine in motion. For this purpose each boy at his descent touches the ground with his feet; and the support he receives from it diminishes his weight, and enables his companion to raise him; thus each boy alternately represents the power and the weight, and the two arms alternately perform the function of the acting and the resisting part of the lever.

A lever in moving, describes the arc of a circle, for it can move only around the fulcrum or centre of motion.



It would be impossible for one child to rise perpendicularly to the point A, or for the other to descend in a straight line to B; they each describe arcs of their respective circles; and it may be judged from the different dimensions of the circle how much greater the velocity of the little child must be than that of the bigger one. Enormous weights may be raised by levers of this description, for the longer the acting part of the lever is in comparison to the resisting part, the greater is the effect produced by it; because the greater is the velocity of the power compared to that of the weights.

We have all seen a heavy barrel or tun rolled over



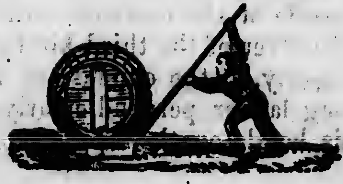
by thrusting the end of a strong stick beneath it and resting it against a log of wood, or any other object which can give it support, near the end in contact with the barrel. The stick, in this case, is a lever, the support, the prop or fulcrum; and the nearer the latter is to the resistance, the more easily will the power be able to move it.

There are three different kinds of levers; in the *first*, which comprehends the several levers we have described, the fulcrum is between the power and the weight. When the fulcrum is situated equally between the power and the weight, as in the balance, the power must be something greater than the weight, in order to move it; for nothing can in this case be gained by velocity. The two arms of the lever being equal, the velocity of their extremities must be so likewise. The balance is therefore of no assistance as a mechanical power, but it is extremely useful to estimate the respective weights of bodies. But when the fulcrum, F, of a lever is not equally distant from the power and the

weight, and that the power, P, acts at the extremity of the longer arm, the power may then be less than the weight, W, its deficiency being compensated by its greater velocity; as we observed in describing the *see-saw*. Therefore, when a great weight is to be raised, it must be fastened to the shorter arm of a lever, and the power applied to the longer arm. But, if the case will admit of putting the end of the lever under the weight, no fastening will be required, as you may perceive by stirring the fire. The poker is a lever of the first kind: the point, where it rests against the bars of the grate, whilst stirring the fire, is the fulcrum; the short arm, or resisting part of the lever, is employed in lifting the weight, which is the coals; and the hand is the power, applied to the longer arm, or acting part of the lever. A pair of scissors is an instrument composed of two levers, united in one common fulcrum; the point at which the two levers are screwed together, is the fulcrum; the handles to which the power of the fingers is applied are the extremities of the acting part of the levers; and the cutting parts of the scissors are the resisting parts of the levers: therefore, the longer the handles, and the shorter the points of the scissors, the more easily will they cut. Thus, when pasteboard, or any hard substance is to be cut, that part of the scissors nearest the screw or rivet is used. Snuffers, and most kinds of pincers, are levers of a similar description, the great force of which consists in the resisting part of the lever being very short in comparison of the acting part.

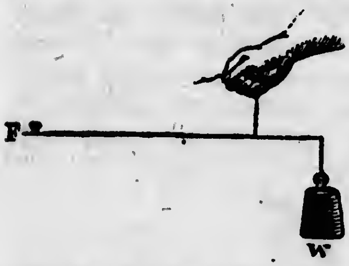
In levers of the *second* kind, the weight, instead of being at one end, is situated between the power and the fulcrum. In moving it, the velocity of the power must necessarily be greater than that of the weight, as it is more distant from the centre of motion. We may sometimes see a barrel moved

by means of a lever of the second kind, as well as by one of the first. The end of the stick that is thrust under the barrel rests on the ground, which becomes the fulcrum; the barrel is the weight to be moved, and the power the hands applied to the other



end of the lever. In this instance there is an immense difference in the length of the arms of the lever, the weight being almost close to the fulcrum, and the advantage gained is proportional. The most common example that we have of levers of the second kind is in the doors of our apartments; in these the hinges represent the fulcrum; the hand, the power applied to the other end of the lever; and the door, or rather its inertia, is the weight which occupies the whole of the space between the power and the fulcrum. Another very common instance is found in an oar; the blade is kept in the same place by the resistance of the water, and becomes the fulcrum, the resistance is applied where the oar passes over the side of the boat: and the hands at the handle are the power. Nut-crackers are double levers of this kind: the hinge is the fulcrum; the nut-crackers the resistance, and the hands the power.

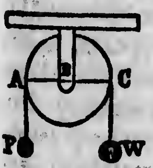
In levers of the *third* kind, the fulcrum is also at one of the extremities, the weight or resistance at the other, and the power is applied between the fulcrum and the resistance. Thus the fulcrum, the weight, and the power, each in its turn, occupies some part of the lever between its extremities. But in this third kind of lever, the weight being further from the centre of motion than the power, the difficulty of raising it, instead of being diminished is increased. Levers of this description are used when the object is to produce great velocity. The aim of mechanics, in general, is to gain force by exchanging it for time; but it is sometimes desirable to produce great velocity by an expenditure of force. The treadle of the common turning lathe affords an example of a lever of the third kind employed in gaining time, or velocity, at the expense of force. A man, in raising a long ladder perpendicularly against a wall, cannot place his hands on the upper part of the ladder; the power,



therefore, is necessarily placed nearer the fulcrum than the weight, for the hands are the power, the ground the fulcrum, and the ladder the weight, which, in this, as well as in the door, may be considered as collected in the centre of gravity of the ladder, about half way up it, and consequently beyond the point where the hands are applied. This kind of lever is employed in the structure of the human frame. In lifting a weight with the hand, the lower part of the arm becomes a lever of the third kind; the elbow is the fulcrum; the muscles which move the arm, the power; and as these are nearer to the elbow, than the hand is, it is necessary that their power should exceed the weight to be raised. It is of more consequence that we should be able to move our limbs nimbly, than that we should be able to overcome great resistance; for it is comparatively seldom that we meet with great obstacles, and when we do, they can be overcome by art.

THE PULLEY.

The *pulley*, which is the second mechanical power we are to examine, is a circular flat piece of wood or metal, with a string running in a groove round it, by means of which a weight may be pulled up. Thus pulleys are used for drawing up curtains, the sails of a ship, &c. When the pulley is fixed, it gives no mechanical advantage. If P. represent the power to raise the weight W, it is evident that the power must be something greater than the weight in order to move it. A fixed pulley is useful, therefore, only in altering the direction of the power; and its most frequent practical application is to enable us to draw up a weight by drawing down the string, connected with the pulley. But a movable pulley affords mechanical assistance. The hand which sustains the cask by means of the



cord D E, passing round the movable pulley A C, does it more easily than if it held the cask suspended to a cord without a pulley; for the fixed hook H, to which one end of the cord is fastened, bearing one-half of the weight of the cask, the hand has only the other half to sustain.

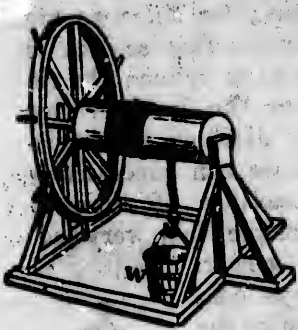
Now, it is evident, that the hook affords the same assistance in raising, as in sustaining the cask, so that the hand will have only one-half of the weight to raise. But observe, that the velocity of the hand must be

double that of the cask; for in order to raise the latter one inch, the hand must draw the two strings (or rather the two parts, D and E, into which the string is divided by the pulley) one inch each; the whole string being shortened two inches, while the cask is raised only one. Thus the advantage of a movable pulley consists in dividing the difficulty. Twice the length of string, it is true, must be drawn, but one-half the strength is required which would be necessary to raise the weight without such assistance; so that the difficulty is overcome in the same manner as it would be by dividing the weight into two equal parts, and raising them successively. The pulley, therefore, acts on the same principle as the lever, the deficiency of strength of the power being compensated by superior velocity; and it is on this principle that all mechanical power is founded. In the fixed pulley, [p. 281,] the line A C may be considered as a lever, and B the fulcrum: then the two arms A B and B C being equal, the lever will afford no aid as a mechanical power; since the power must be equal to the weight in order to balance it, and superior to the weight in order to raise it. In the movable pulley you must consider the point A as the fulcrum; A B, or half the diameter of the pulley, as the shorter arm; and A C or the whole diameter, as the longer arm. It may, perhaps, be objected to pulleys, that a longer time is required to raise a weight with their aid than without it. That is true, for it is a fundamental law in mechanics, that what is gained in power is lost in time; this applies not only to the pulley, but to the lever and all the other mechanical powers. It would be wrong, however, to suppose that the loss was equivalent to the gain, and that we derived no advantage from the mechanical powers; for since we are incapable of augmenting our strength, that science is of wonderful utility which enables us to reduce the resistance or weight of any body to the level of our strength. This we accomplish, by dividing the resistance of a body into parts, which we can successively overcome; and if it require a sacrifice of time to attain this end, you must be sensible how very advantageously it is exchanged for power.

The greater the number of pulleys connected by a string, the more easily the weight is raised; as the difficulty is divided amongst the number of strings, or rather of parts, into which the string is divided by the pulleys. Several pulleys thus connected form what is called a system, or tackle of pulleys. You may have seen them suspended from cranes to raise goods into warehouses, and in ships to draw up sails. Here both the advantages of an increase of power and change of direction are united; for the sails are raised up the masts by the sailors on deck, from the change of direction which the pulleys effect; and the labour is facilitated by the mechanical power of a combination of pulleys. Pulleys are frequently connected, as described, both for nautical and a variety of other purposes; but, in whatever manner pulleys are connected by a single string, the mechanical power is the same in its principle. When there are two, three, &c., strings the effect is greater, but the apparatus is more complicated, and its applicability is more limited.

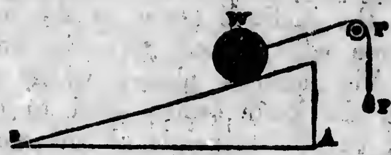
THE WHEEL AND AXLE.

The third mechanical power is the *wheel and axle.* Let us suppose the weight w to be a bucket of water in a well, which is to be raised by winding the rope, to which it is attached, round the axle; if this be done without a wheel to turn the axle, no mechanical assistance is received. The axle without a wheel is as impotent as a single fixed pulley, or lever, whose fulcrum is in the centre; but add the wheel to the axle, and you will immediately find the bucket is raised with much less difficulty. The axle acts the part of the shorter arm of the lever, the wheel that of the longer arm. The velocity of the circumference of the wheel is as much greater than that of the axle, as it is further from the centre of motion; for the wheel describes a large circle in the same space of time that the axle describes a small one, therefore the power is increased in the same proportion as the circumference of the wheel is greater than that of the axle. If the velocity of the wheel were twelve times greater than that of the axle, a power nearly twelve times less than the weight of the bucket would be able to raise it.



THE INCLINED PLANE.

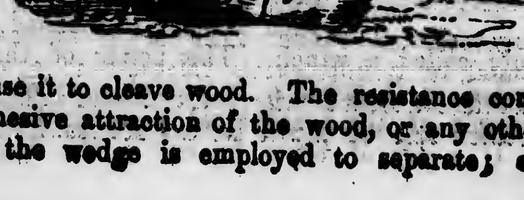
The fourth mechanical power is the *inclined plane.* This is nothing more than a slope, or declivity, frequently used to facilitate the drawing up of weights. It is not difficult to understand, that a weight may with much greater ease be drawn up a slope than it can be raised the same height perpendicularly. But in this, as well as the other mechanical powers, the facility is purchased by the loss of time; for the weight, instead of moving directly from A to C, must move from B to C, and as the height of the plane is to its length, so is the



power to the weight which it is intended to raise. Thus, if a pulley be fixed at F, so that the string from F to W may be parallel to B C, and a string fixed to the weight W were connected with another weight P; then if P bear the same proportion to W that the line A C does to the line B C, the two weights will balance each other, a considerable portion of the weight W being supported by the plane B C, and only the residue by the power P.

THE WEDGE.

The *wedge*, which is the next mechanical power, is composed of two inclined planes. Woodcutters some-

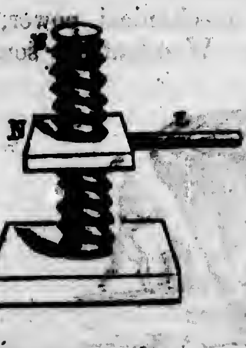


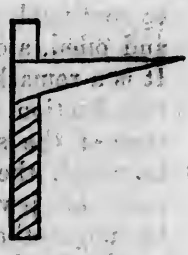
times use it to cleave wood. The resistance consists in the cohesive attraction of the wood, or any other body which the wedge is employed to separate; and the advantage gained by this power is in the proportion of half its width to its length. The wedge, however, acts principally by being struck, and not by mere pressure; the proportion stated, is that which expresses its power when acting by pressure only.

All cutting instruments are constructed upon the principle of the inclined plane, or the wedge. Those that have one edge sloped, like the chisel, may be referred to the inclined plane; whilst the axe, the hatchet, and the knife (when used to chop or split asunder) act on the principle of the wedge. But a knife cuts best when drawn across the substance it is to divide, as it is used in cutting meat; for the edge of a knife is really a very fine saw, and therefore acts best when used like that instrument.

THE SCREW.

The *screw*, which is the last mechanical power, is more complicated than the others. It is composed of two parts, the screw and the nut. The screw S is a cylinder, with a spiral protuberance coiled round it, called the thread; the nut N is perforated to contain the screw; and the inside of the nut has a spiral groove, made to fit the spiral thread of the screw; just like the lid of a box which screws on. The handle which projects from the nut is a lever, without which, or something equivalent, the screw is never used as a mechanical power. The nut, with a lever L attached to it, is commonly called a winch. The power of the screw, complicated as it appears, is referable to one of the most simple of the mechanical powers, the inclined plane. If a slip of paper be cut in the form of an





inclined plane, and wound round a pencil, which will represent the cylinder, it will describe a spiral line corresponding to the spiral protuberance of the screw. The nut then ascends an inclined plane, but ascends it in a spiral instead of a straight line. The closer the thread of the screw, the more easy is the ascent; but the greater are the number of revolutions the winch must make; so that we return to the old principle, what is saved in power is lost in time. The power of the screw may be increased, also, by lengthening the lever attached to the nut; it is employed either for compression or to raise heavy weights. It is used in cider and wine presses, in coining, in book-binding, and for a variety of other purposes.

All machines are composed of one or more of the six mechanical powers we have examined. One more remark must be made relative to them, which is, that friction in a considerable degree diminishes their effect. Friction is the resistance which bodies meet with in rubbing against each other. There is no such thing as perfect smoothness or evenness in nature. Polished metals, though they wear that appearance, more than any other bodies, are far from really possessing it; and their inequalities may frequently be perceived through a good magnifying glass. When, therefore, the surfaces of two bodies come into contact, the prominent parts of the one will often fall into the hollow parts of the other, and occasion more or less resistance to motion. In proportion as the surfaces of bodies are well polished, the friction is diminished; but it is always considerable, and it is usually computed to destroy one-third of the power of a machine. Oil or grease is used to lessen friction; it acts as a polish by filling up the cavities of the rubbing surfaces, and also prevents them from being so immediately in contact, which makes them slide more easily over each other. It is for this reason that wheels are greased, and the locks and hinges of doors oiled. In these instances, the contact of the rubbing surfaces is so close, and the rubbing so continual, that, notwithstanding their being polished and oiled, a considerable degree of friction is produced. It is a remarkable circumstance, that there is generally less friction between two bodies of different substances than of the same. It is on this account that the holes in which the spindles of watches work, are frequently made of jewels; and that when two cog-wheels work in one another, the cogs of the one are often made of wood, and the other of metal.

There are two modes of friction; the one occasioned by the sliding of the flat surface of a body, the other by the rolling of a circular body. The friction resulting from the first is much the more considerable; for great force is required to enable the sliding body to overcome the resistance which the asperities of the surfaces in contact oppose to its motion, and it must be either lifted over, or break through them; whilst, in the other kind, the friction is transferred to a smaller surface, and the rough parts roll over each other with comparative facility. Hence it is, that wheels are often used for the sole purpose of diminishing the resistance of friction. When, in descending a steep hill in a carriage, we fasten one of the wheels, we decrease the velocity of the carriage, by increasing the friction, that is to say, by converting the rolling friction of one of the wheels into the dragging friction; and when casters are put to the legs of a table, the dragging is converted into the rolling friction.

A fly-wheel, which is a large heavy wheel attached to the axis of one of the principal wheels of the machinery in steam-engines and other large machines, acts in the first instance as a heavy weight to impede their free and uncontrolled motion. However paradoxical this mode of improving machinery may appear, it is, nevertheless, of great advantage. The motion of a machine is always more or less variable. Whether the power consists in wind, water, steam, or the strength of animals, it cannot be made to act with perfect regularity, nor can the work which the machine has to perform be always uniform. Yet in manufactures, and most cases in which machinery is employed, uniformity of action is essentially requisite, both in order to prevent injury to the machine, and imperfection in the work performed. The fly-wheel answers this purpose, by regulating the action of the machine; by its *inertia* it diminishes the effect of increased action, and carries on the machine with uniform velocity when the power transiently slackens; thus, by either checking or impelling the action of the machine, it regulates its motion so as to render it tolerably uniform. It is not difficult to understand the manner in which a fly-wheel acts.—The vast number of particles of which it consists may lose, or gain, taken as a *whole*, a considerable quantity of *motion*, without their being, *individually*, much affected; that is, without the fly-wheel, or—by consequence—the machinery with which it is connected being *sensibly* retarded or accelerated. Thus it is in reality a magazine in which motion is hoarded up, when it is not wanting, or is injurious—ready, however, to be given out again precisely at the moment it is required.

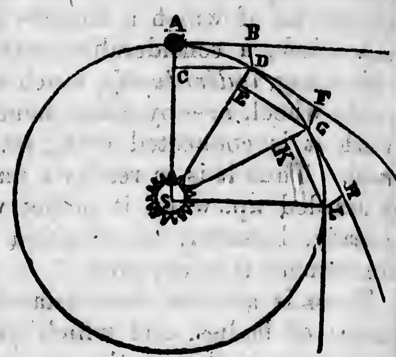
There is another circumstance which diminishes the motion of bodies, and which greatly affects the power of machines; this is the resistance of the medium in which a machine is worked.

All fluids, whether of the nature of air, or of water, are called mediums: and their resistance is generally proportioned to their density; for the more matter a body contains, the greater the resistance it will oppose to the motion of another body striking against it. It is, therefore, more difficult to work a machine under water than in the air. If a machine could be worked in *vacuo*, and without friction, it would be perfect; but this is unattainable. A considerable reduction of power must, therefore, be allowed for the resistance of the air.

ASTRONOMY.

THE EARTH'S ANNUAL MOTION.

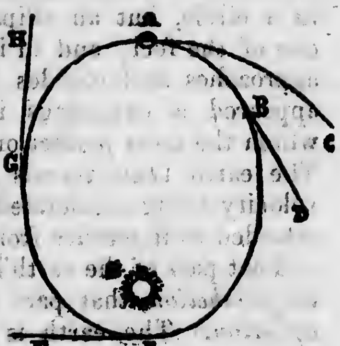
In attempting to give some general notions on Astronomy, we shall not begin by entering into an explanation of the system of the celestial bodies, but select that portion which is most interesting to us, the earth, and when we have formed a distinct idea of the part which it performs in the general system, we shall be able to form some conception of the grandeur and immensity of the universe. Let us suppose the earth at its creation to have been projected forwards. We know, from the laws of motion, that if no obstacle impeded its course it would proceed interminably in the same direction, and with a uniform velocity. Let A represent the earth, and S the sun. We shall suppose the earth arrived at the point in which it is represented in the figure, having a velocity which would carry it on to B in the space of one month; whilst the sun's attraction would bring it to C in the same space of time. Reasoning upon the laws of uniform motion we might hastily conclude that the earth would move in the diagonal A D of the parallelogram A B D C, as a ball struck by two forces will do. But the force of attraction is continually acting upon our terrestrial ball, and producing an incessant deviation from a course in a straight line, and thus converts it into a course in a curve line.



Let us detain the earth a moment at the point D, and consider how it will be affected by the combined action of the two forces in its new situation. It still retains its tendency to fly off in a straight line; but a straight line would now carry it away to F, whilst the sun would attract it in the direction D S. In order to know exactly what course the earth will follow, another parallelogram must be drawn in the same manner as the first; the line D F describing the force of projection, and the line D S that of attraction; and it will be found that the earth will proceed in the curve line D G drawn in the parallelogram D F G E; and if we go on throughout the whole of the circle, drawing a line from the earth to the sun, to represent the force of attraction, and another at a right angle to it, to describe that of projection, we shall find that the earth will proceed in a curve line passing through similar parallelograms till it has completed the whole of the circle. The attraction of the sun is the centripetal force, which confines the earth to a centre; and the impulse of projection, or the force which impels the earth to quit the sun and fly off, is the centrifugal force.

We have described the earth as moving in a circle, merely to render the explanation more simple, for in reality the centripetal and centrifugal forces are not so proportioned as to produce circular motion; and the earth's orbit or path round the sun is not circular, but elliptical or oval.

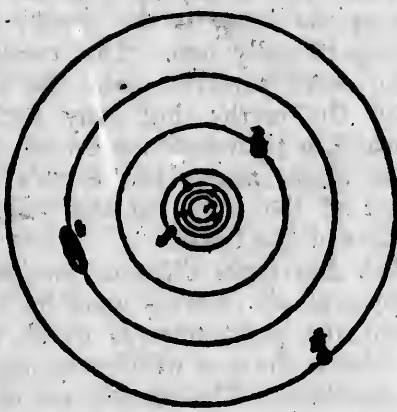
Let us suppose that when the earth is at A, its projectile force does not give it a velocity sufficient to counterbalance that of gravity, so as to enable these powers conjointly to carry it round the sun in a circle; the earth instead of describing the line A C, as in the former figure, will approach nearer the sun in the line A B. Under these circumstances it will be asked, what is to prevent our approaching nearer and nearer the sun till we fall into it; for its attraction increases as we advance towards it. There also seems to be another danger. As the earth approaches the sun, the direction of its motion is no longer perpendicular to that of attraction, but inclines more nearly to it. When the earth reaches that part of its orbit at B, the force of projection would carry it to D, which brings it nearer the sun, instead of bearing it away from it; so that



being driven, by one power, and drawn by the other towards this centre of destruction, it would seem impossible for us to escape. But with God nothing is impossible. The earth continues approaching the sun with an accelerated motion till it reaches the point F, when the projectile force impels it in the direction E F. Here then the two forces act perpendicularly to each other, and the earth is situated as in the preceding figure, yet it will not revolve round the sun in a circle, for the following reasons. The centrifugal force increases with the velocity of the body; or, in other words, the quicker it moves the stronger is its tendency to fly off in a right line. When the earth arrives at F its accelerated motion will have so far increased its velocity and consequently its centrifugal force, that the latter will prevail over the force of attraction, and draw the earth away from the sun till it reaches G. It is thus that we escape from the dangerous vicinity of the sun; and as we recede from it, both the force of its attraction, and the velocity of the earth's motion diminish. From G, the direction of projection is towards H, that of attraction towards S, and the earth proceeds between them with a retarded motion, till it has completed its revolution. Thus the earth travels round the sun, not in a circle, but an ellipsis, of which the sun occupies one of the foci, and in its course the earth alternately approaches and recedes from it, so that what at first appeared a dangerous irregularity, is the means by which the most perfect order and harmony are produced. The earth, then, travels on at a very unequal rate, its velocity being accelerated as it approaches the sun, and retarded as it recedes from it.

That part of the earth's orbit nearest the sun is called its *perihelion*, that part most distant from the sun its *aphelion*. The earth is about three millions of miles nearer the sun at its perihelion than at its aphelion. Some are surprised to learn that during the height of our summer, the earth is in that part of its orbit which is most distant from the sun, and that it is during the severity of winter that we are nearest to it. The difference, however, of the earth's distance from the in summer and winter, when compared with its al distance from the sun, is but inconsiderable, for ree millions of miles sink into insignificance in comrison of 95 millions of miles, which is our mean stance from the sun. The change of temperature, ising from this difference, would in itself scarcely be sible, and it is completely overpowered by other uses which produce the variations of the seasons; t the explanation of these must be deferred, till we ve made some further observations on the heavenly dies.

PLANETS.



The *planets* are celestial bodies which revolve round e sun, on the same principle as the earth. They e divided into primary and secondary. Those, which volve immediately round the sun, are called primary. any of these are attended in their course by smaller anets, which revolve round them: these are called condary planets, satellites, or moons; such is our oon, which accompanies the earth, and is carried with round the sun. The sun is the general centre of traction to our system of planets; but the satellites volve round the primary planets, on account of their greater proximity. The force of attraction is not only proportional to the quantity of matter, but to the degree of proximity of the attracting body. The power of attraction diminishes as the squares of the distance increase; so that a planet, situated at twice the distance at which we are from the sun, would gravitate four times less than we do. The more distant planets, therefore, move slower in their orbits, for their projectile force must be proportioned to that of attraction. This diminution of attraction, by the increase of distance, also accounts for the motion of the secondary round the primary planets, in preference to the sun; for the vicinity of the primary planets renders their attraction stronger than that of the sun. But since attraction between bodies is mutual, the primary planets are also attracted by their satellites. The moon attracts the earth, as well as the earth the moon; but as the latter is the smaller body, her attraction is proportionally less. The result is, that neither does the earth revolve round the moon, nor the moon round the earth; but they both revolve round a point, which is their common centre of gravity, and which is as much nearer the earth's centre of gravity than that of the moon, as the weight of the former exceeds that of the latter.

The earth then has three different motions; it revolves round the sun,—it revolves upon its axis,—and it revolves round the point towards which the moon attracts it; and this is the case with every planet which is attended by satellites. The planets act on the sun in the same manner as they are themselves acted on by their satellites; but the gravity of the planets (even when taken collectively) is so trifling, compared with that of the sun, that they do not cause it to move so much as one-half of its diameter. The planets, therefore, do not revolve round the centre of the sun, but round a point at a small distance from its centre, about which the sun also revolves. The sun likewise revolves on its axis. This motion is ascertained by observing certain spots which disappear and reappear regularly at stated times.

Mercury is the planet nearest the sun; his orbit is consequently contained within ours; but his vicinity to the sun occasions his being nearly lost in the brilliancy of his rays; and when we do see this planet, the sun is so dazzling, that very accurate observations cannot be made upon him. He performs his revolution round the sun in about eighty seven days, which is consequently the length of his year; the time of his rotation on his axis is not accurately known; his distance from the sun is computed to be 37 millions of miles, and his diameter 3,224 miles.

Venus, the next in the order of the planets, is 68 millions of miles from the sun; she revolves about her axis in 23 hours and 21 minutes, and goes round the sun in 224 days 17 hours. The diameter of Venus is 7,687 miles. The orbit of Venus is within ours; during nearly one-half of her course we see her before sun-rise, when she is called the morning star; in the corresponding part of her orbit, on the other side, she rises later than the sun. We cannot then see her rising, as she rises in the day time; but she also sets later; so that we perceive her approaching the horizon after sun-set; she is then called Hesperus, or the evening star.

The *Earth* is next to Venus. At present we shall only observe that we are 95 millions of miles distant from the sun—that we perform our annual revolution in 365 days, 5 hours, and 49 minutes,—and are attended in our course by a single moon.

Mars comes next. He can never be between us and the sun, like Mercury and Venus. His distance from the sun is 144 millions of miles, he turns on his axis in 24 hours and 39 minutes; and he performs his annual revolution in about 687 of our days: his diameter is 4,189 miles. Then follow four very small planets—*Juno*, *Ceres*, *Pallas* and *Vesta*, which have been recently discovered, but whose dimensions and distances from the sun have not been very accurately ascertained.

Jupiter is next in order. This is the largest of all the planets; he is about 490 millions of miles distant from the sun, and completes his annual period in nearly twelve of our years, he revolves on his axis in about ten hours; he is about 1,400 times as large as our earth, his diameter being 89,170 miles. He is attended by four moons.

Saturn comes next, whose distance from the sun is about 900 millions of miles. His diurnal rotation is performed in ten hours and a quarter; his annual revolution is nearly thirty of our years; his diameter is 79,000 miles. This planet is surrounded by a luminous ring, the nature of which astronomers are much at a loss to conjecture; he has seven moons.

Georgium Sidus, or *Uranus*, or *Herschel* (for all these names have been given to this planet) is the last. It was discovered by Dr. Herschel in 1791. It is attended by six moons. It is the most distant planet from the sun that has yet been discovered; being at a distance of no less than 1800 millions of miles from that luminary. Its diameter is about 35,000 miles. It takes about 83 years and a half to complete its revolution round the sun.

Comets are supposed to be planets. The reappearance of some of them at stated times proves that they revolve round the sun; but in orbits so eccentric, and running to such a distance from the sun, that they disappear for a great number of years. They are distinguished from the other celestial bodies, by their ruddy appearance, and by a long train of light called the tail. The length of these tails is often many millions of miles. Some comets have been ascertained to move in long narrow ellipses or ovals, round the sun, from which it has been inferred, perhaps hastily, that they all do so. The number of comets which have occasionally been seen within the limits of our system, since the commencement of the Christian era, is about 500, of which the paths of 98 have been calculated.

FIXED STARS.

The ancients, in order to recognize the fixed stars, formed them into groups, to which they gave particular names. In order to show their proper situations in the heavens, they should be painted on the *internal* surface of a hollow sphere, from the centre of which they might be viewed. We should then see them as they appear to be situated in the heavens. The twelve constellations, called the Signs of the Zodiac, are those which are so situated, that the earth, in its annual revolution, passes directly between them and the sun. They occupy a complete circle, or broad belt, in the heavens. Hence, a right line, drawn from the earth, and passing through the sun, would reach one of these constellations; and the sun is said to be in that constellation in which such a line would terminate. The circle in which the sun appears to move, and which passes through the middle of the Zodiac, is called the Ecliptic.

We have no means of ascertaining the distance of the fixed stars. When therefore they are said to be in the Zodiac, it is merely implied that they are situated in that direction, and that they shine upon us through that portion of the heavens which we call the Zodiac. Whether the apparent difference of the size and brilliancy of the stars proceeds from various degrees of remoteness or of dimension, is a point which astronomers are not able to ascertain. Considering them as suns, we know no reason why they should not vary in size, as well as the planets belonging to them.

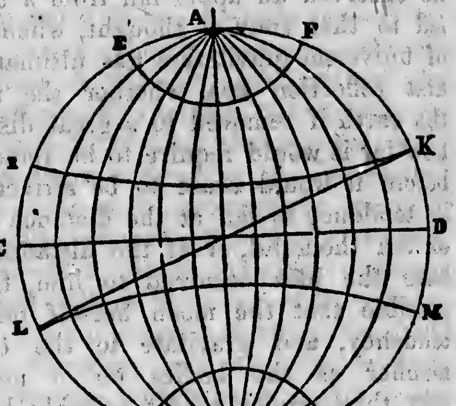
It may, perhaps, be objected to this system of the universe, that it is directly in opposition to the evidence of our senses, to which, it is plain and obvious, that the earth is motionless, and that the sun and stars revolve round it. But our senses sometimes deceive us. When sailing on the water with a very steady breeze, the houses, trees, and every object appear to move, whilst we are insensible of the motion of the vessel in which we sail. It is only when some obstacle impedes our motion, that we are conscious of moving; and were you to close your eyes while sailing on calm water, with a steady wind, you would not be sensible of your motion; for you could not feel it, and you could see it only by observing the change of place of objects on shore. So it is with the motion of the earth: every thing on its surface, and the air that surrounds it, accompanies it in its revolution—it meets with no resistance, therefore, we are insensible of motion. The apparent motion of the sun and stars affords us the same proof of the earth's motion, that the crew of a vessel have of their motion, from the apparent motion of the objects on shore. Imagine the earth to be sailing round its axis, and successively passing by every star, which, like objects on land, we suppose to be moving, instead of ourselves. Persons who have ascended in balloons, tell us that the earth appears to sink beneath the balloon, instead of the balloon rising above the earth. What an immense circuit the sun and stars would make daily, were their apparent motions real! Why should these enormous globes traverse such an immensity of space, merely to prevent the necessity of our earth revolving on its axis? The motion produced by the revolution of the earth on its axis is about thirteen miles and a half in a minute to an inhabitant of London. A person at the equator moves much quicker, and one situated near the poles much slower, since they each perform a revolution in twenty-four hours. But in performing its revolution round the sun, every part of the earth moves with an equal velocity; and this velocity is no less than a thousand miles a minute.

In ancient times, the earth was supposed to occupy the centre of the universe; and the sun, moon, and stars to revolve round it. This was the system of Ptolemy; but since the beginning of the sixteenth century, that system has been discarded, and the solar system, such as we have described, was established by the celebrated Astronomer Copernicus, and his followers, and is thence called the Copernican system. But the theory of gravitation, the discovery of the source whence this beautiful and harmonious arrangement flows, we owe to the genius of Newton, who lived at a much later period.

During the prevalence of the plague, in the year 1665, Newton retired into the country to avoid the contagion. When sitting one day in his orchard, he observed an apple fall from a tree, which it is said led to that train of thought, whence his grand theory of universal gravitation was ultimately developed. His first reflection was, whether the apple would fall to the earth if removed to a great distance from it; then how far it would require to be removed from the earth, before it would cease to be attracted; would it retain its tendency to fall at the distance of a thousand miles, or ten thousand, or at the distance of the moon—and here the idea occurred to him, that it was not impossible that the moon herself might have a similar tendency, and gravitate to the earth in the same manner as the bodies on or near its surface, and that this gravity might possibly be the power which balanced the centrifugal force implied in her motion in her orbit. It was then natural to extend this idea to the other planets, and he considered them as gravitating towards the sun, in the same manner as the moon gravitates towards the earth. Who would imagine that the simple circumstance of the fall of an apple would have led to such magnificent results? It is the mark of superior genius to find matter for observation and research in circumstances which, to ordinary minds, appear trivial, because they are common, and with which they are satisfied, because they are natural, without reflecting that nature is our grand field of observation—that within it is contained our whole store of knowledge: in a word, that to study the works of nature, is to learn to appreciate and admire the wisdom of God.

THE TERRESTRIAL GLOBE.

As the earth is the planet in which we are most particularly interested, we shall explain the effects resulting from its annual and diurnal motions; but for this purpose it will first be necessary to make you acquainted with the *artificial* terrestrial globe. This globe, or sphere, represents the earth. The line AB which passes through its centre, and on which it turns, is called its axis; and the two extremities of the axis are the poles, distinguished by the names of the north and the south pole. The circle CD, which divides the globe into two equal parts between the poles, is called the equator, or equinoctial line; that part of the globe to the north of the equator is the northern hemisphere; that part to the south of the equator, the southern hemisphere. The small circle EF which surrounds the north pole, is called the arctic circle; GH, surrounding the south pole, the antarctic circle. There are two intermediate circles, between the polar circles and the equator, that to the north, IK, called the tropic of Cancer; that to the south, LM,



called the tropic of Capricorn. Lastly, the circle LK, which divides the globe into two equal parts, crossing the equator, and extending northward as far as the tropic of Cancer, and southwards as far as the tropic of Capricorn, is called the Ecliptic. The delineation of the ecliptic on the terrestrial globe may convey false ideas; for the ecliptic is an imaginary circle in the heavens, passing through the middle of the Zodiac, and situated in the plane of the earth's orbit. In order to understand the meaning of the earth's orbit, let us suppose a smooth, thin, solid plane cutting the sun through the centre, extending out as far as the fixed stars, and terminating in a circle which passes through the middle of the zodiac. In this plane the earth moves in its revolution round the sun; it is therefore called the plane of the earth's orbit; and the circle in which this plane cuts the signs of the zodiac is the ecliptic.

The spaces between the several parallel circles on the terrestrial globe are called zones; that which is comprehended between the tropics is distinguished by the name of the torrid zone; the spaces, which extend from the tropics to the polar circles, the north and south temperate zones; and the spaces, contained within the polar circles, the frigid zones.

The several lines which are drawn from one pole to the other, cutting the equator at right angles, are called meridians. When any one of these meridians is exactly opposite the sun, it is mid-day, with all places situated on that meridian; and with the places situated on the opposite meridian, it is consequently midnight. To places situated equally distant from these two meridians, it is six o'clock. If they are to the east of the sun's meridian, it is six o'clock in the afternoon, because the sun will have previously passed over them; if to the west, it is six o'clock in the morning, and the sun will be proceeding towards that meridian.

Those circles which divide the globe into two equal parts, such as the equator and the ecliptic, are called great circles—to distinguish them from those which divide it into two unequal parts, as the tropic and polar circles, which are called small circles. All circles are divided into 360 equal parts, called degrees; and these degrees into 60 equal parts, called minutes. The diameter of a circle is a right line drawn across it, and passing through the centre; the diameter is equal to a little less than one-third of the circumference, and consequently contains a length equal to nearly 120 degrees. A meridian, reaching from one pole to the other, is half a circle, and therefore contains 180 degrees; and the distance from the equator to the pole is half of a meridian, or a quarter of the circumference of a circle, and contains 90 degrees.

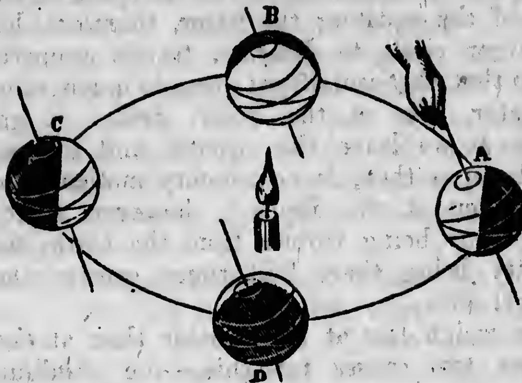
Besides the usual division of circles into degrees, the ecliptic is divided into twelve equal parts, called signs, which bear the names of the constellations through which this circle passes in the heavens. The degrees, measured on the meridians from north to south, or from south to north, are called degrees of latitude; those measured from east to west on the equator, or any of the lesser circles parallel to it, are called degrees of longitude. These lesser circles are called parallels of latitude; because being everywhere at the same distance from the equator, the latitude of every point contained in any one of them is the same.

The degrees of longitude must necessarily vary in length according to the dimensions of the circle on which they are reckoned: those, for instance, at the polar circle, will be considerably smaller than those at the equator. The degrees of latitude, on the contrary, never vary in length; the meridians, on which they are reckoned, being all of the same dimensions. The length of a degree of latitude is 60 geographical miles, which is equal to 69½ English statute miles. The degrees of longitude at the equator would be of the same dimensions as the degrees of latitude, were the earth a perfect sphere; but its form is not exactly spherical, being somewhat protuberant about the equator, and flattened towards the poles. This form proceeds from the superior action of the centrifugal power at the equator. The revolution of the earth on its axis gives every particle a tendency to fly off from the centre. This tendency is stronger or weaker, in proportion to the velocity with which the particle moves. Now, a particle situated near one of the polar circles makes a rotation in the same space of time as a particle of the equator; the latter, therefore, having a much larger circle to describe, travels proportionably faster, so that the centrifugal force is much stronger at the equator than at the polar circle: it gradually decreases as we leave the equator and approach the poles, where, as there is no rotatory motion, it entirely ceases. Even at the Equator, however, there is no danger of our being thrown from the earth, the force of gravity being there 288 times greater than the centrifugal force.

Bodies weigh less at the equator than at the poles. There are two causes for this,—the diminution of gravity at the equator, it being at a greater distance from the earth's centre than the poles,—and the increase of the centrifugal force; which, as it tends to drive bodies from the centre, must necessarily decrease the power of gravity.

THE SEASONS.

We shall now explain the variation of the seasons, and the difference of the length of the days and nights in those seasons—both effects resulting from the same cause. In moving round the sun, the axis of the earth is not perpendicular to the plane of its orbit; in other words, its axis does not move round the sun in an upright position, but slanting or oblique. This you will understand more clearly, if you carry a small globe round a candle which is to represent the sun.—You must consider the ecliptic drawn on the small globe as representing the plane of the earth's orbit; and the equator, which crosses the ecliptic in two places, shows the degree of obliquity of the axis of the earth in that orbit, which is nearly 23½ degrees. The points in which the ecliptic intersects the equator are called nodes. The globe at A is situated as it is in



the midst of summer, or what is called the summer solstice, which is on the twenty-first of June. The north pole is then inclined towards the sun, and the northern hemisphere enjoys much more of his rays than the southern. The sun now shines over the whole of the north frigid zone, and notwithstanding the earth's diurnal revolution, it will continue to shine upon it as long as it remains in this situation, whilst the south frigid zone is at the same time completely in obscurity.

Let the earth now set off from its position in the summer solstice, and carry it round the sun: observe, that the axis must be always inclined in the same direction, and the north pole point to the same spot in the heavens. There is a fixed star situated near that spot, which is hence called the North Polar star. The earth at B has gone through one quarter of its orbit, and is arrived at that point at which the ecliptic cuts or crosses the equator, and which is called the autumnal equinox. The sun now shines from one pole to the other. At this period of the year, the days and nights are equal in every part of the earth; but the next step she takes in her orbit involves the north pole in total darkness, whilst it illumines that of the south. This change was gradually preparing as the earth moved from summer to autumn. The instant the earth passes the autumnal equinox, the long night of the north pole commences, and the south pole begins to enjoy the light of the sun. As the earth proceeds in her orbit, the days shorten and the nights lengthen throughout the northern hemisphere, until it arrives at the winter solstice, on the 21st of December, when the north frigid zone is entirely in darkness, and the southern enjoys uninterrupted day-light. Exactly half of the equator, it will be observed, is enlightened in every position, and consequently the day is there always equal to the night.

Observe, that the inhabitants of the torrid zone have much more heat than we have, as the sun's rays fall perpendicularly on them, while they shine obliquely on the temperate, and almost horizontally on the frigid zone; for during their long day, the sun moves round at no great elevation above their horizon, without either rising or setting.

To a person placed in the temperate zone, the sun's rays will shine neither so obliquely as at the poles, nor so vertically as at the equator; but will fall upon him more obliquely in autumn and in winter than in summer. Therefore, the inhabitants of the earth between the polar circles and the equator will not have merely one day and one night in the year, as happens at the pole; nor will they have equal days and equal nights, as at the equator, but their days and nights will vary in length at different times of the year, according as their respective poles incline towards or from the sun, and the difference will be greater in proportion to their distance from the equator.—During the other half of her orbit, the same effect takes place in the Southern hemisphere, as what we have just remarked in the Northern. When the earth arrives at the vernal equinox, D, where the ecliptic again cuts the equator, on the 22d of March, she is situated with respect to the sun, exactly in the same position as in the autumnal equinox; excepting that it is now autumn in the

Southern hemisphere, while it is spring time with us: for the half of the globe, which is enlightened, extends exactly from one pole to the other. On the two days of the equinox the sun is visible at both poles; but only half of it is seen from either, the other half being concealed by the horizon.

ON THE MOON AND ECLIPSES.

Let us now turn our attention to the moon. This satellite revolves round the earth in the space of twenty-seven days eight hours, in an orbit nearly coinciding with the plane of the earth's orbit, and accompanies us in our revolution round the sun. Her motion, therefore, is of a complicated nature; for, as the earth advances in her orbit, whilst the moon goes round her, the moon proceeds in a sort of progressive circle.

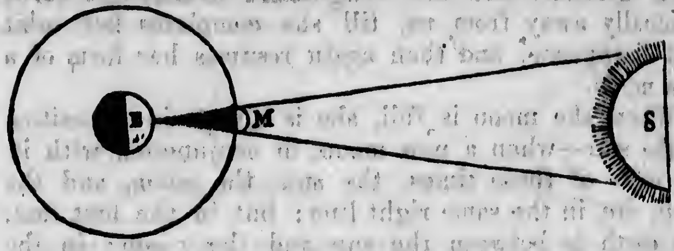
The moon always presents the same face to us, by which it is evident that she turns but once upon her axis, while she performs a revolution round the earth; so that the inhabitants of the moon have but one day and one night in the course of a lunar month. Since we always see the same hemisphere of the moon, the inhabitants of that hemisphere alone can see the earth. One half of the moon, therefore, enjoys our light every night, while the other half has constantly nights of darkness; and we appear to the inhabitants of the moon under all the changes, or phases, which the moon exhibits to us.

When the moon is in the same direction from us as the sun, we cannot see her, as her dark side is towards us; but her disappearance is of very short duration, and as she advances in her orbit we perceive her under the form of a new moon. When she has gone through one-sixth of her orbit, one quarter of her enlightened hemisphere will be turned towards the earth, and she will then appear horned. When she has performed one quarter of her orbit, she shows us one half of her enlightened side. She next appears gibbous; and after that full. As she proceeds in her orbit she becomes again gibbous, and her enlightened hemisphere turns gradually away from us, till she completes her orbit and disappears; and then again resumes her form of a new moon.

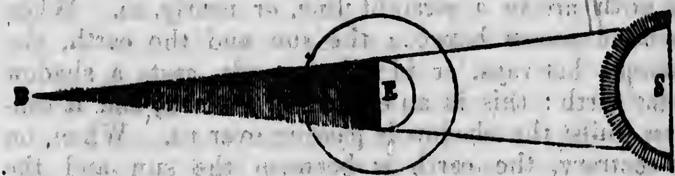
When the moon is full, she is always in opposition to the sun—when a new moon, in conjunction with it. At each of these times, the sun, the moon, and the earth are in the same right line; but in the first case, the earth is between the sun and the moon: in the second, the moon is between the sun and the earth. An eclipse can only take place when the sun, moon, and earth are in a straight line, or nearly so. When the moon passes between the sun and the earth, she intercepts his rays, or in other words, casts a shadow on the earth: this is an eclipse of the sun, and it continues whilst the shadow is passing over us. When, on the contrary, the earth is between the sun and the moon, it is we, who intercept the sun's rays, and cast a shadow on the moon: she then disappears from our view, and is eclipsed.

Why, it may be asked, have we not a solar and a lunar eclipse every month? Because the planes of the orbits of the earth and moon do not exactly coincide, but cross or intersect each other; and the moon generally passes either on one side or the other, when she is in conjunction with, or in opposition to, the sun; and therefore does not intercept the sun's rays, or produce an eclipse: for this can only take place, when the earth and moon are in conjunction near those parts of their orbits which cross each other (called the nodes of their orbits), because it is then only that they are both in the same plane, and in a right line with the sun. A partial eclipse takes place when the moon, in passing by the earth, does not entirely escape her shadow. When the eclipse happens precisely at the nodes, they are not only total, but last for some length of time.

When the sun is eclipsed, the total darkness is confined to one particular spot of the earth, as the moon's



shadow is not large enough to cover the earth. The lunar eclipses, on the contrary, are visible from every

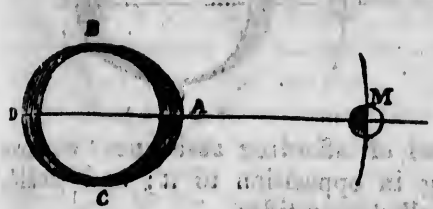


part of the earth, where the moon is above the horizon.

THE TIDES.

The tides are produced by the attraction of the moon The cohesion of fluids being much less than that of solid bodies, they more easily yield to the power of gravity, in consequence of which, the waters immediately below the moon are drawn up in a protuberance, producing a full tide, or what is commonly called high-water, at the spot where it happens. According to this theory, you would imagine we should have full tide only once in twenty-four hours—that is, every time that we are below the moon—while we find that we have two tides in the course of twenty-four hours, and that it is high-water with us and with our antipodes at the same time.

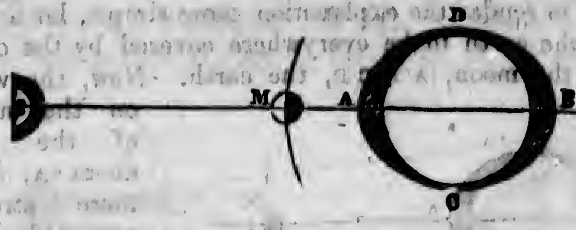
This opposite tide is rather more difficult to explain than that which is drawn up beneath the moon. In order to render the explanation more simple, let us suppose the earth to be everywhere covered by the ocean. M is the moon, A B C D, the earth. Now, the waters on the surface of the earth about A, being more strongly attracted than in any other part, will be elevated, the attraction of the moon at B and C, being less; but still it will be greater there than at D, which is the part most distant from the moon. The body of the earth will therefore be drawn away from the waters at D, leaving a protuberance similar to that at A; so that the tide A is produced by the waters receding from the earth, and the tide D by the earth receding from the waters.



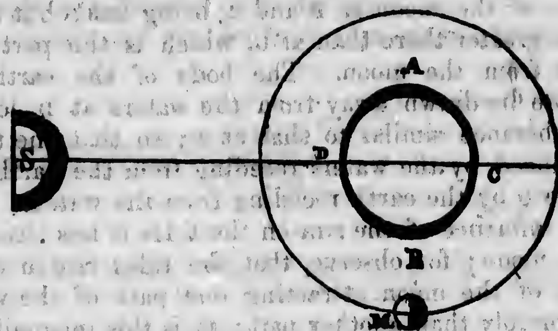
The influence of the sun on the tides is less than that of the moon; for observe, that the tides rise in consequence of the moon attracting one part of the waters more forcibly than another part; it is this inequality of attraction which produces full and ebb tides. Now the distance of the sun is so great, that the whole globe of the earth is comparatively but as a point, and the difference of its attraction for that part of the waters most under its influence, and that part least subject to it is but trifling; and no part of the waters will be much elevated above, or much depressed below their general surface by its action. The sun has, however, a considerable effect on the tides, and increases or diminishes them as it acts in conjunction with, or in opposition to, the moon.

The moon is a month in going round the earth; twice during that time, therefore, at full and at change, she is in the same direction as the sun. Both then act conjointly on the earth, and produce very great tides, called spring-tides, as represented at A and B;

but when the moon is at the intermediate part of her



orbit, the sun, instead of affording assistance, weakens her power by acting in opposition to it; and smaller tides are produced, called neap-tides.



Since attraction is mutual between the moon and the earth, we produce tides in the moon; and these are more considerable, in proportion as our planet is larger. Neither the moon nor the earth in reality assumes an oval form, for the land which intersects the water destroys the regularity of the effect. The orbit of the moon being nearly parallel to that of the earth, she is never vertical but to the inhabitants of the torrid zone; in that climate, therefore, the tides are greatest, and they diminish as you recede from it and approach the poles; but in no part of the globe is the moon immediately above the spot where it is high tide. All matter, by its inertia, offers some resistance to a change of state; the waters, therefore, do not readily yield to the attraction of the moon, and the effect of her influence is not complete until some time after she has passed the meridian.

The earth revolves on its axis in about twenty-four hours: if the moon were stationary, therefore, the same part of our globe would, every twenty-four hours, return beneath the moon; but as during our daily revolution the moon advances in her orbit, the earth must make more than a complete rotation in order to bring the same meridian opposite the moon: we are about three-quarters of an hour in overtaking her. The tides, therefore, are retarded, for the same reason that the moon rises later, by three-quarters of an hour every day. This, however, is only the average amount of the retardation. The time of the highest tide is modified by the sun's attraction, and is between those of the tides which would be produced by the separate action of the two luminaries. The action of the sun, therefore, makes the interval different on different days, but leaves the average amount unaffected.

ON THE MECHANICAL PROPERTIES OF FLUIDS.

The science of the mechanical properties of fluids is called Hydrostatics. A fluid is a substance which yields to the slightest pressure.

Fluids are divided into two classes, distinguished by the names of liquids, and elastic fluids or gases, which latter comprehends the air of the atmosphere, and all the various kinds of air with which chemistry makes us acquainted. We shall confine our attention at present to the mechanical properties of liquids or non-elastic fluids.

Water, and liquids in general, are little susceptible of being compressed, or squeezed into a smaller space than that which they naturally occupy. This is due to the mutual repulsions of their particles, which, rather than submit to compression, force their way through the pores of the substance which confines them, as was shown by a celebrated experiment, made at Florence many years ago. A hollow globe of gold was filled with water, and on its being submitted to great pressure, the water was seen to exude through the pores of the gold, which it covered with a fine dew. But more recent experiments, in which water has been confined in strong iron tubes, &c., prove that it is susceptible of compression.

Liquids have spaces between the particles, like solid bodies, but they are too minute to be discovered by the most powerful microscope. .The existence of spaces in liquids can be ascertained by dissolving solid bodies in them. If we melt some salt in a glass full of water, the water will not overflow, and the reason probably is, that the particles of salt will lodge themselves between the particles of the liquid, so that the salt and water together will not occupy more space than the water did alone. If we attempt to melt more salt than can find room within these pores, the remainder will subside to the bottom, and, occupying the space which the water filled before, oblige the water to overflow. A certain proportion of spirit of wine may also be poured into water without adding to the bulk, as the spirit will introduce itself between the particles of water.

Fluids show the effects of gravitation in a more perfect manner than solid bodies; the strong cohesive attraction of the particles of the latter in some measure counteracting the effect of gravity. In a table, for instance, the strong cohesion of the particles of wood enables the four slender legs to support a considerable weight. Were the cohesion so far destroyed as to convert the wood into fluid, no support could be afforded by the legs; for the particles no longer cohering together, each would press separately and independently, and would be brought to a level with the surface of the earth.

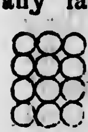
This deficiency of cohesion is the reason why fluids can never be formed into figures, or maintained in heaps; for though it is true the wind raises water into waves, they are immediately afterwards destroyed by gravity. Thus liquids always find their level. The definition of the equilibrium of a fluid is, that every part of the surface is equally distant from the point to which gravity tends; that is to say, from the centre of the earth. Hence the surface of all fluids must partake of the spherical form of the globe, and bulge outwards. This is evident in large bodies of water, such as the ocean; but the sphericity of small bodies of water is so trifling as to render their surfaces apparently flat.

The equilibrium of fluids is the natural result of their particles gravitating *independently* of each other; for when any particle of a fluid accidentally finds itself elevated above the rest, it is attracted down to the level of the surface of the fluid, and the readiness with which fluids yield to the slightest pressure, will enable the particle by its weight to penetrate the surface of the fluid and mix with it. But this is the case only with fluids of equal density, for a light fluid will float on the surface of a heavy one, as oil on water; and air will rise to the surface of any liquid whatever, being forced up by the superior gravity of the liquid. The figure here represents an instrument called a level, which

is constructed upon the principle of the equilibrium of fluids. It consists of a short tube, A B, closed at both ends, and containing a fluid and a bubble of air; when the tube is not perfectly horizontal the fluid runs to the lower end, which makes the bubble of air rise to the upper end, and it remains in the centre only when the tube does not incline on either side. It is by this means that the level of any situation, to which we apply the instrument, is ascertained.

Solid bodies, therefore, gravitate in *masses*, the strong cohesion of their particles making them weigh altogether, while every particle of a fluid may be considered as a separate mass, gravitating independently. Hence the resistance of a fluid is considerably less than that of a solid body. The particles of fluids acting thus independently, press against each other in every direction, not only downwards but upwards, and laterally or sideways; and in consequence of this equality of pressure, every particle remains at rest in the fluid. If you agitate the fluid, you disturb this equality, and the fluid will not rest till its equilibrium be restored.

Were there no lateral pressure, water would not flow from an opening on the side of a vessel; sand will not run out of such an opening, because there is scarcely any lateral pressure among the particles. Were the



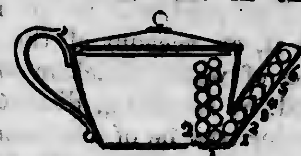
particles of fluids arranged in regular columns, there would be no lateral pressure, for when one particle is perpendicularly above the other, it can only press it downwards; but as it must continually happen that a particle passes between two particles beneath, these last suffer a lateral pressure; just as a wedge driven into a piece of wood separates

the parts laterally. The lateral pressure is the result, therefore, of the pressure downwards, or the weight of the liquid above; and consequently the lower the orifice is made in the vessel, the greater will be the velocity of the water rushing out of it. The

annexed figure represents the different degrees of velocity with which a liquid flows from a vessel furnished with three stopcocks at different heights. Since the lateral pressure is entirely owing to the pressure downwards, it is not affected by the horizontal dimensions of the vessel, which contains the liquid, but merely by its depth; for as every particle acts independently of the rest, it is only the column of particles immediately above the orifice that can weigh upon and press out the liquid.

The pressure of fluids upwards, though it seems in direct opposition to gravity, is also a consequence of their pressure downwards. When, for example, water is poured into a tea-pot, the water rises in the spout to a level with that in the pot. The particles of water at the bottom of the pot are pressed upon by the particles above them; to this pressure they will yield, if there is any mode of making way for the superior particles, and as they cannot descend, they will change their direction, and rise in the spout.

Suppose the tea-pot to be filled with columns of particles of water similar to those described in the figure annexed, the particle 1 at the bottom will be pressed laterally by the particle 2, and by this pressure be forced into the spout, where, meeting with the particle 3, it presses it upwards, and this pressure will be continued from 3 to 4, from 4 to 5, and so on, till the water in the spout has risen to a level with that in the pot.

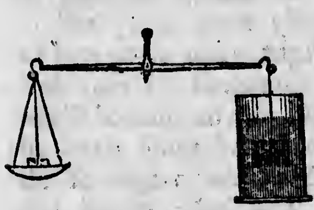


SPECIFIC GRAVITY.

The specific gravity of a body means simply its weight compared with that of another body of the same size. When we say that substances, such as lead and stones, are heavy, and that others, such as paper and feathers, are light, we speak comparatively; that is to say, that the first are heavy, and the latter light, in comparison with the generality of the substances in nature. Mahogany is a heavy body when compared to many other kinds of wood, but light when compared to stone. Chalk is a heavy body compared to coal, but light if compared to metal. Thus our notions of light and heavy are vague and undefined, and some standard of comparison is required, to which the weight of all other bodies may be referred. The body which has been adopted as a standard of reference is distilled water. When the specific gravity of bodies is to be estimated, it is necessary simply to weigh the body under trial in water. If a piece of gold be weighed in a glass of water, the gold will displace just as much water as is equal to its own bulk; a cubic inch of water must make way for a cubic inch of gold. The bulk alone is to be considered, the weight having nothing to do with the quantity of water displaced; for a cubic inch of gold does not occupy more space, and therefore will not displace more water, than a cubic inch of ivory, or any other substance that will sink in water.

The gold will weigh less in water than it did out of it, on account of the upward pressure of the particles of water, which in some measure supports the gold, and, by so doing, diminishes its weight. If the body under trial be of the same weight as the water in which it is immersed, it will be wholly supported by it; if it be heavier, the water will offer some resistance to its descent; and this resistance will in all cases be the same to bodies of equal bulk, whatever be their weight. All bodies of the same size, therefore, lose the same quantity of their weight when completely immersed in water. A body weighed in water loses as much of its weight as is equal to that of the water it displaces; so that were this water put into the scale to which the body is suspended, it would restore the balance.

When a body is weighed in water, in order to ascertain its specific gravity, it may either be suspended to a hook at the bottom of the basin of the balance, or, taking off the basin, suspended to the arm of the balance. Now, supposing that a cubic inch of gold weighed nineteen ounces out of water, and lost one ounce by being weighed in water, the cubic inch of water it displaces must weigh that one ounce; consequently gold would be nineteen times as heavy as water.

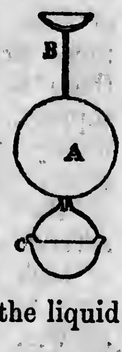


The specific gravity of a body lighter than water cannot be ascertained in the same manner. If a body were absolutely light, it would float on the surface, without displacing a drop of water; but bodies have all some weight, and will, therefore, displace some quantity of water. A body lighter than water will not sink to a level with the surface of the water, and therefore will not displace so much water as is equal to its bulk, but a quantity equal to its weight. A ship sinks to some depth in water, and the heavier it is laden the deeper it sinks, the quantity of water it displaces being always equal to its weight. This quantity cannot, however, afford a convenient test of its specific gravity, from the difficulty of collecting the whole quantity of water displaced, and of measuring the exact bulk of the body immersed.

In order practically to obtain the specific gravity of a body which is lighter than water, a heavy one, whose specific gravity is known, must be attached to it, and they must be immersed together: the specific gravity of the lighter body may then be easily calculated.

Bodies which have exactly the same specific gravity as water, will remain at rest in whatever situation they are placed in water. If a piece of wood, by being impregnated with a little sand, be rendered precisely of the weight of an equal bulk of water, it will remain stationary in whatever part of a vessel of water it be placed. If a few drops of water be poured into the vessel (so gently as not to increase their momentum by giving them velocity,) they would mix with the water at the surface, and not sink lower.

The specific gravity of fluids is found by means of an instrument called an hydrometer. It consists of a thin glass ball, A, with a graduated tube, B, and the specific gravity of the liquid is estimated by the depth to which the instrument sinks in it; for the less the specific gravity of the fluid, the further will the instrument sink in it.—There is a smaller ball, C, attached to the instrument below, which contains a little mercury; but this is merely for the purpose of equipoising the instrument, that it may remain upright in the liquid under trial.



The weight of a substance, when not compared to that of any other, is perfectly arbitrary; and when water is adopted as a standard, we may denominate its weight by any number we please; but then the weight of all bodies tried by this standard must be signified by proportional numbers. If we call the weight of water, for example, 1, then that of gold would be 19; or, if we call the weight of water 1000, that of gold would be 19,000. In short, the specific gravity indicates how much more or less a body weighs than an equal bulk of water.

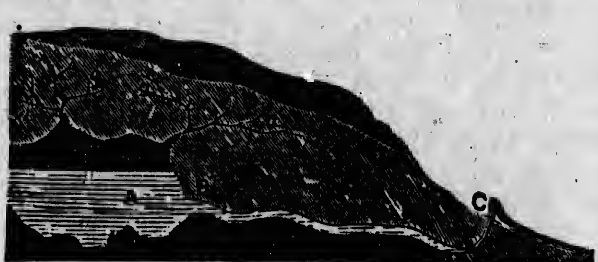
SPRINGS, FOUNTAINS, &c.

The water belonging to our globe exists in various states. It is the same water which successively forms seas, rivers, springs, clouds, rain, and sometimes hail, snow, and ice. When the first rays of the sun warm the surface of the earth, the heat, by separating the particles of water, transforms them into vapour, which, being lighter than the air, ascends into the atmosphere. The atmosphere diminishing in density as it is more distant from the earth, the vapour which the sun causes to exhale, not only from seas, rivers, and lakes, but likewise from the moisture on the land, rises till it reaches a region of air of its own specific gravity, and there it remains stationary. By the frequent accession of fresh vapour, it gradually accumulates, so as to form those large bodies of vapour which we call clouds; and these at length, becoming too heavy for the air to support, fall to the earth in the form of rain. If the watery particles retained the state of vapour, they would descend only till they reached a stratum of air of their own specific gravity; but during their fall, several of the watery particles come within the sphere of each others' attraction, and unite in the form of a drop of water. The vapour, thus transformed into a shower, is heavier than any part of the atmosphere, and consequently descends to the earth. Observe, that if the waters were never drawn out of the earth, vegetation would be destroyed by the excess of moisture; if, on the other hand, the plants were not nourished and refreshed by occasional showers, the drought would be equally fatal to them. Were the clouds constantly in a state of vapour, they could never fall to the ground; or were the power of attraction more than sufficient to convert the vapour into drops, it would transform the cloud into a mass of water, which, instead of nourishing, would destroy the produce of the earth. We cannot consider any part of Nature attentively without being struck with admiration at the wisdom it displays: we cannot contemplate these wonders without feeling our hearts glow with admiration and gratitude towards their bounteous Author.

Water, then, ascends in the form of vapour, and descends in that of rain, snow, or hail, all of which ultimately become water. Some of this falls into the various bodies of water on the surface of the globe, the remainder upon the land.—Of the latter, part re-ascends in the form of vapour, part is absorbed by the roots of vegetables, and part descends into the bowels of the earth, where it forms springs. The only difference between rain and spring water consists in the foreign particles which the latter meets with and dissolves in its passage through the various soils it traverses. Spring water being more pleasant to the taste, and more transparent, is commonly supposed to be more pure than rain water. Excepting distilled water, however, rain water is really the most pure we can obtain: it is this which renders it insipid, whilst the various salts and different ingredients dissolved in spring water, give it a species of flavour, without in any degree affecting its transparency; and the filtration it undergoes through gravel and sand in the bowels of the earth cleanses it from all foreign matter which it has not the power of dissolving.

When rain falls on the surface of the earth, it continues making its way downwards through the pores and crevices in the ground. Several drops meet in their subterraneous passage, unite, and form a little rivulet: this, in its progress, meets with other rivulets of a similar description, and they pursue their course together in the interior of the earth, till they are stopped by some substance which they cannot penetrate; for though we have said that water under strong compression penetrates the pores of gold, when acted upon by no other force than gravity, it cannot make its way even through a stratum of clay. This species of earth, though not remarkably dense, being of great tenacity, will not admit the passage of water. When, therefore, it encounters any substance of this nature, its progress is stopped, and the pressure of the accumulating waters forms a bed, or reservoir.

The next figure represents a section of the interior of a hill or mountain. A is a body of water such as has been described, which, when filled up as high as B (by the continual accession of waters it receives from the ducts or rivulets *a, a, a, a,*) finds a passage out of the



cavity; and, impelled by gravity, runs on, till it makes its way out of the ground at the side of the hill, and there forms a spring, C. The spring, during its passage from B to C, rises occasionally, upon the same principle that water rises in the spout of a tea-pot, but it cannot mount above the level of the reservoir, whence it issues; it must, therefore, find a passage to some part of the surface of the earth that is lower or nearer the centre than the reservoir.—Water may thus be conveyed to every part of a town, and even to the upper stories of the houses, provided that it be originally brought from a height superior to any to which it is conveyed.

Reservoirs of water are seldom formed near the summit of a hill, for in such elevated situations there can scarcely be a sufficient number of rills to supply one; and without a reservoir there can be no spring. In such situations, therefore, it is necessary to dig deep wells, in order to meet with a spring; and then it can rise in the well only as high as the reservoir whence it flows.

When reservoirs of water are formed in very elevated situations, the springs which feed them descend from higher hills in the vicinity. There is a lake on the very summit of Mount Cenis which is supplied by the spring of the higher Alps surrounding it.

A syphon is an instrument commonly used to draw off liquids from large casks or other vessels which cannot be easily moved. It consists simply of a bended tube. If its two legs are of equal length, and filled with liquid, if held perfectly level though turned downwards, the liquid will not flow out, but remain suspended in the tube; for there is no pressure of the atmosphere above the liquid, while there is a pressure from below upon the open ends of the tube; and so long as this pressure is equal on both ends, the liquid cannot flow out; but if the smallest inclination be given to the syphon, so as to destroy the equilibrium of the water, it will immediately flow from the lower leg. When syphons are used to draw off liquids, the legs are made of unequal length, in order to render the pressure of the liquid unequal; the shorter leg is immersed in the cask, and the liquid flows out through the longer. To accomplish this, it is however necessary to make the liquor rise in the shorter leg, and pass over the bended part of the tube, which is higher than the level of the liquor in the cask. There are two modes of doing this; one is, after immersing the shorter leg in the liquor to be drawn off, to suck out the air of the tube from the orifice of the longer leg; then the liquor in the cask, which is exposed to the pressure of the atmosphere, will be forced by it into the tube which is relieved from pressure. As

long as the tube continues full, no air can gain admittance; the liquor will, therefore, flow on till the cask is emptied. The other mode is to fill the syphon with the liquor, then stopping the two ends with the fingers, immerse the shorter leg in the vessel, and the same effect will follow. In either case, the water in the highest part of the syphon must not be more than about 32 feet above the reservoir; for the pressure of the atmosphere will not support a greater height of water.

The phenomena of springs which flow occasionally, and occasionally cease, may often be explained by the principle of the syphon. The reservoir of water which supplies a spring may be considered as the vessel of liquor to be drawn off, and the duct the syphon, having its shorter leg opening in the reservoir, and its longer at the surface of the earth whence the spring flows; but as the water cannot be made to rise in the syphon by either of the artificial modes which we have mentioned, the spring will not begin to flow till the water in the reservoir has risen above the level of the highest part of the syphon: it will then commence flowing upon the principle of the equilibrium of fluids; but it will continue upon the principle of the syphon; for, instead of ceasing as soon as the equilibrium is restored, it will continue flowing as long as the opening of the duct is in contact with the water in the reservoir. Springs which do not constantly flow are called intermitting, and are occasioned by the reservoir being imperfectly supplied.

ON THE MECHANICAL PROPERTIES OF AIR.

We shall now examine the second class of fluids, distinguished by the name of aëriform, or elastic fluids, the principal of which is the air we breathe, which surrounds the earth, and is called the atmosphere. There is a great variety of elastic fluids, but they differ only in their chemical, not in their mechanical properties; and it is the latter we are to examine. There is no attraction of cohesion between the particles of elastic fluids, so that the expansive power of heat has no adversary to contend with but gravity; any increase of temperature, therefore, expands elastic fluids prodigiously, and a diminution proportionally condenses them. The most essential point in which air differs from other fluids is by its spring or elasticity: that is to say, its power of increasing or diminishing in bulk, according as it is less or more compressed—a power of which liquids are almost wholly deprived.

The atmosphere is thought to extend to about the distance of 45 miles from the earth; and its gravity is such, that a man of middling stature is computed to sustain the weight of about 14 tons. Such a weight would crush him to atoms, were it not that air is also contained within our bodies, the spring or elasticity of which counterbalances the weight of the external air, and renders us insensible of its pressure. Besides this, the equality of pressure on every part of the body enables us more easily to support it; when thus diffused, we can bear even a much greater weight, without any considerable inconvenience. In bathing we support the weight and pressure of the water, in addition to that of the atmosphere; but this pressure being equally distributed over the body, we are scarcely sensible of it· whilst if the shoulders, the head, or any particular part of the frame were loaded with the additional weight of a hundred pounds, we should feel severe fatigue. On the other hand, if the air within a man met with no external pressure to restrain its elasticity, it would distend his body, and at length bursting the parts which confine it, put a period to his existence. The weight of the atmosphere, therefore, so far from being an evil, is essential to our existence. When a person is cupped, the swelling of the part under the cup is produced by taking away the pressure of the atmosphere; in consequence of which the internal air distends the part.

A column of air reaching to the top of the atmosphere, and whose base is a square inch, weighs 15 lbs.

when the air is heaviest. The rule that fluids press equally in all directions applies to elastic fluids as well as to liquids: therefore, every square inch of our bodies sustains a pressure of 15 lbs. and the weight of the whole atmosphere may be computed by calculating the number of square inches on the surface of the earth, and multiplying them by 15.

The weight of a small quantity of air may be ascertained by exhausting the air from a bottle, and weighing the bottle thus emptied. Suppose that a bottle six cubic inches in dimension, weighs two ounces; if the air be then introduced, and the bottle re-weighed, it will be found heavier by nearly two grains, showing that six cubic inches of air (at a moderate temperature) weigh about two grains. In estimating the weight of air, the temperature must always be considered, because heat, by rarefying air, renders it lighter. The same principle indeed applies, almost without exception, to all bodies. In order to ascertain the specific gravity of air, the same bottle may be filled with water, and the weight of six cubic inches of water will be nearly 1667 grains: so that the weight of water to that of air, is about 833 to 1.

A barometer is an instrument which indicates the state of the weather, by showing the weight of the atmosphere. It is extremely simple in its construction, and consists of a glass tube, A B, about three feet in length, and open only at one end. This tube must first be filled with mercury, then stopping the open end with the finger, it is immersed in a cup, C, which contains a little mercury. Part of the mercury which was in the tube now falls down into the cup, leaving a vacant space in the upper part of the tube, to which the air cannot gain access. This space is, therefore, a perfect vacuum; and consequently the mercury in the tube is relieved from the pressure of the atmosphere, whilst that in the cup remains exposed to it; therefore the pressure of the air on the mercury in the cup supports that in the tube, and prevents it from falling; thus the

equilibrium of the mercury is destroyed only to preserve the general equilibrium of fluids. This simple apparatus is all that is essential to a barometer. The tube and the cup or vase are fixed on a board, for the convenience of suspending it; the board is graduated for the purpose of ascertaining the height at which the mercury stands in the tube; and the small movable metal plate serves to show that height with greater accuracy. The weight of the atmosphere sustains the mercury at the height of, on an average, about 29½ inches; but the exact height depends upon the weight of the atmosphere, which varies much according to the state of the weather. The greater the pressure of the air on the mercury in the cup, the higher it will ascend in the tube. The air, therefore, generally is heaviest in dry weather, for then the mercury rises in the tube, and consequently that in the cup sustains the greatest pressure; and thus we estimate the dryness and fairness of the weather by the height of the mercury. We are apt to think the air feels heavy in bad weather, because it is less salubrious when impregnated with damp. The lungs, under these circumstances, do not play so freely, nor does the blood circulate so well: thus obstructions are frequently occasioned in the smaller vessels, from which arise colds, asthmas, agues, fevers, &c.

As the atmosphere diminishes in density in the upper regions, the air must be more rare upon a hill than in a plain; and this difference may be ascertained by the barometer. This instrument is so exact in its indications, that it is used for the purpose of measuring the height of mountains, and of estimating the elevation of balloons. Considerable inconvenience is often experienced from the thinness of the air in such elevated situations. It is sometimes oppressive, from being insufficient for respiration; and the expansion which takes place in the more dense air contained within the body is often painful: it occasions distension, and sometimes causes the bursting of the smaller blood-vessels in the nose and ears. Besides, in such situations, the body is more exposed both to heat and cold; for though the atmosphere is itself transparent, its lower regions abound with vapours and exhalations from the earth, which float in it, and act in some degree as a covering, which preserves us equally from the intensity of the sun's rays and from the severity of the cold.

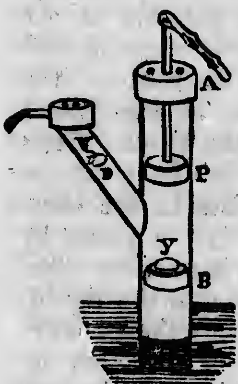
Now, since the weight of the atmosphere supports mercury in the tube of a barometer, it will support a column of any other fluid in the same manner; but as mercury is the heaviest of all fluids, it will support a higher column of any other fluid; for two fluids are in equilibrium, when their heights vary inversely as their densities: as, for instance, if a cubic foot of one fluid weighs twice as much as a cubic foot of the other, a column of the first ten feet in height will weigh as much as a column of the other twenty feet in height.—Thus the pressure of the atmosphere, which will sustain a column of mercury of thirty inches, is equal to sustaining a column of water about thirty-four feet in height. The weight of the atmosphere is, therefore, as great as that of a body of water surrounding the globe of the depth of thirty-four feet; for a column of air of the height of the atmosphere is equal to a column of water of thirty-four feet, or one of mercury of twenty-nine inches, each having the same base.

The common pump is constructed on this principle. By the act of pumping, the pressure of the atmosphere is taken off one part of the surface of the water: this part therefore rises, being forced up by the pressure communicated to it by that part of the water on the surface of which the weight of the atmosphere continues to act. The body of a pump consists of a large tube or pipe, whose lower end is immersed in the water which it is designed to raise. A kind of stopper, called a piston, is fitted to this tube, and is made to slide up and down it, by means of a metallic rod fastened to the centre of the piston.

The various parts of a pump are here delineated. A B is the pipe or body of the pump; P the piston; V a valve, or little door in the piston, which, opening upwards, admits the water to rise through it, but prevents its returning; and *y* a similar valve in the body of the pump. When the pump is in a state of inaction, the two valves are closed by their own weight; but when, by drawing down the handle of the pump, the piston ascends, it raises a column of air which rested upon it, and produces a vacuum between the piston and the lower valve, *y*; the air beneath this valve, which is immediately over the surface of the water, consequently expands, and forces its way through it; the water then, relieved from the pressure of the air, ascends into the pump. A few strokes of the handle totally exclude the air from the body of the pump, and fill it with water, which, having passed through both the valves, flows out at the spout. Thus the air and the water successively rise in the pump on the same principle that the mercury rises in the barometer. Water is said to be drawn up into a pump by suction; but the power of the suction is no other than that of producing a vacuum over one part of the liquid, into which vacuum the liquid is forced by the pressure of the atmosphere on another part. The action of sucking through a straw consists in drawing in and confining the breath, so as to produce a vacuum, or at least to lessen materially the quantity of air, in the mouth: in consequence of which, the air within the straw rushes into the mouth, and is followed by the liquid, into which the lower end of the straw is immersed. The principle is the same; and the only difference consists in the mode of producing a vacuum. In suction, the muscular powers answer the purpose of the piston and valves. The distance from the level of the water in the well to the valve in the piston ought not to exceed thirty-two feet, otherwise the water would not be sure to rise through that valve, for the

weight of the air is sometimes not sufficient to raise a column of mercury more than twenty-eight inches, or a column of water much more than thirty-two feet; but when once it has passed that opening, it is no longer the pressure of air on the reservoir which makes it ascend—it is raised by lifting it up, as you would raise it in a bucket, of which the piston formed the bottom. This common pump is, therefore, called the sucking and lifting pump, as it is constructed on both these principles.

The forcing pump consists of a forcing power added to the sucking part of the pump. This additional power is exactly on the principle of the syringe: by raising the piston, the water is drawn up into the pump; and by making it descend, it is forced out. The large pipe, A B, represents the sucking part of the pump, which differs from the lifting pump only in its piston, P, being unfurnished with a valve, in consequence of which the water cannot rise above it. When, therefore, the piston descends, it shuts the valve *y*, and forces the water (which has no other vent) into the pipe, D; this is likewise furnished with a valve, V, which, opening outwards, admits the water, but prevents its return. The water is thus first raised in the pump, and when forced into the pipe, by the alternate ascending and descending motion of the piston, after a few strokes of the handle to fill the pipe, whence the water issues at the spout.



ON OPTICS.

Optics is one of the most interesting branches of Natural Philosophy; it is the science of vision, and teaches us how we see objects. In this science, bodies are divided into *luminous*, *opaque*, and *transparent*. A luminous body is one that shines by its own light—as the sun, the fire, a candle, &c. But all bodies that shine are not luminous; polished metal, for instance, when it shines with so much brilliancy, is not a luminous body, for it would be dark if it did not receive light from a luminous body; it belongs, therefore, to the class of opaque, or dark bodies, which comprehend all such as are neither luminous nor will admit the light to pass through them; and transparent bodies are those which admit the light to pass through them, such as glass and water. Transparent or pellucid bodies are frequently called mediums; and the rays of light which pass through them are said to be transmitted by them. Light, when emitted from the sun, or any other luminous body, is projected forwards, in straight lines, in every possible direction; so that the luminous body is, not only the general centre whence all the rays proceed, but every point of it may be considered as a centre which radiates light in every direction. A ray of light is a single line of light projected from a luminous body; and a pencil of rays is a collection of rays proceeding from any one point of a luminous body.

Philosophers are not agreed as to the nature of light. Some maintain the opinion that it is a body consisting of detached particles, which are emitted by luminous bodies, in which case the particles of light must be inconceivably minute; since, even when they cross each other in every direction, they do not interfere with each other. Others suppose it to be produced like sound, by the undulations of a subtile fluid diffused throughout all known space. In some respects, light is obedient to the laws which govern bodies; in others, it appears to be independent of them. Thus, though its course corresponds with the laws of motion, it does not seem to be influenced by those of gravity; for it has never been discovered to have weight, though a variety of experiments have been made with a view of ascertaining that point. We are, however, so ignorant of the intimate nature of light, that we shall confine our attention to such of its properties as are well ascertained.

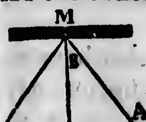
To return then to the examination of the effects of the radiation of light from a luminous body;—since the rays are projected in straight lines, when they meet with an opaque body through which they are unable to pass, they are stopped short in their course; for they cannot move in a curve line round the body. The interruption of the rays of light by the opaque body produces, therefore, darkness on the opposite side of it; and if this darkness fall upon a wall, a sheet of paper, or any object whatever, it forms a shadow; for shadow is nothing more than darkness produced by the intervention of an opaque body, which prevents the rays of light from reaching an object behind it.

If the luminous body, A, be larger than the opaque body, B, the shadow will gradually diminish in size till it terminates in a point; if smaller, the shadow will continually increase in size, as it is more distant from the object which projects it.

The shadow of a figure, A, varies in size, according to the distance of the several surfaces, B, C, D, E, on which it is described.

Now what becomes of the rays of light which opaque bodies arrest in their course, and the interruption of which is the occasion of shadows? This leads to a very important property of light, *Reflection*.

When rays of light encounter an opaque body, which they cannot traverse, part of them are absorbed by it, and part are reflected, and rebound as an elastic ball which is struck against a wall. Light, in its reflection, is governed by the same laws as solid perfectly elastic bodies. If a ray of light fall perpendicularly on an opaque body, it is reflected back in the same line towards the point whence it proceeded; if it fall obliquely, it is reflected obliquely, but in the opposite direction, the angle of incidence being equal to the angle of reflection. If the shutters be closed, and a ray of the sun's light admitted through a very small aperture, and reflected by a mirror, on which the ray falls *perpendicularly*, but one ray is seen, for the ray of incidence and that of reflection are both in the same line, though in opposite directions, and thus are confounded together. The ray, therefore, which appears single, is in fact double, being composed of the incident ray proceeding to the mirror, and the reflected ray returning from the mirror. These

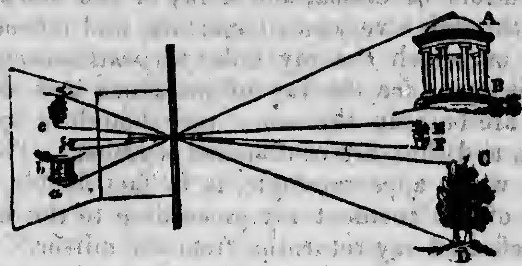


may be separated by holding the mirror, M, in such a manner that the incident ray, A B, shall fall obliquely upon it; then the reflected ray, B C, will go off in another direction. If a line be drawn from the point of incidence, B, perpendicularly to the mirror, it will divide the angle of incidence from the angle of reflection, and these angles will be equal.

It is by reflected rays only that we see opaque objects. Luminous bodies send rays of light immediately to our eyes; but the rays which they send to other bodies are invisible to us, and are seen only when reflected or transmitted by those bodies to our eyes.

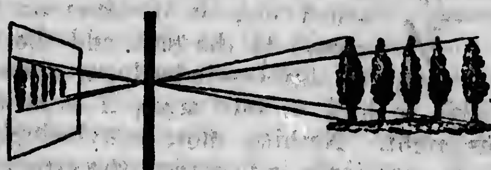
Let us now examine by what means the rays of light produce vision. They enter at the pupil of the eye, and proceeding to the retina, an expansion of the optic nerve, which is situated at the back of the eye-ball, they describe the figure, colour, and (with the exception of size) form a complete representation of the object from which they proceed. If the shutters be closed, and a ray of light admitted through a small aperture, a picture may be seen on the opposite wall similar to that which is delineated on the retina of the eye; it exhibits a picture in miniature of the garden, and the landscape would be perfect were it not reversed. This picture is produced by the rays of light reflected from the various objects in the garden, and which are admitted through the hole in the window shutter. It is called a camera obscura, (*dark chamber*,) from the necessity of darkening the room in order to exhibit it.

The rays from the glittering weathercock at the top



of the building A, represent it at *a*; for the weathercock being much higher than the aperture in the shutter, only a few of the rays, which are reflected by it in an obliquely descending direction can find entrance there. The rays of light moving always in straight lines, those which enter the room in a descending direction will continue their course, in the same direction, and will, consequently, fall upon the lower part of the wall opposite the aperture, and represent the weathercock reversed in that spot, instead of erect in the uppermost part of the landscape; and the rays of light from the steps, B, of the building, in entering the aperture, ascend, and describe them in the highest instead of the lowest part of the landscape; whilst the rays proceeding from the part which is to the left, describe it on the wall to the right. Those which are reflected by the walnut-tree, C D, to the right, delineate its figure in the picture to the left, *c d*. Thus the rays, coming in different directions, and proceeding always in straight lines, cross each other at their entrance through the apertures; those from above proceed below, those from the right go to the left, those from the left towards the right; thus every object is represented in the picture as occupying a situation the very reverse of that which it does in nature, excepting the flower-pot, E F, which though its position is reversed, does not change its situation in the landscape, for being immediately in front of the aperture, its rays fall perpendicularly upon it, and consequently proceed perpendicularly to the wall, where they delineate the object. It is thus that the picture of objects is painted on the retina of the eye. The pupil of the eye, through which the rays of light enter, represents the aperture in the window-shutter; and the image delineated on the retina is exactly similar to the picture on the wall.

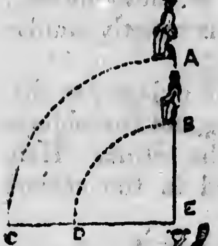
The different apparent dimensions of objects, at different distances, proceed from our seeing, not the objects themselves, but merely their image on the retina. Here is represented a row of trees, as viewed in the camera



obscura; the direction of the rays from the objects to the image is expressed by lines. Observe that the ray which comes from the top of the nearest tree, and that which comes from the foot of the same tree, meet at the aperture, forming an angle of about twenty-five degrees; this is called the angle of vision, being that under which we see the tree. These rays cross each other at the aperture, and represent the tree inverted in the camera obscura. The dimensions of the image are considerably smaller than those of the object, but the proportions are perfectly preserved. The upper and lower ray from the most distant tree, form an angle of not more than twelve or fifteen degrees, and an image of proportional dimensions. Thus two objects of the same size, as the two trees of the avenue, form figures of different sizes in the camera obscura, according to their distance, or, in other words, according to the angle of vision under which they are seen.

In sculpture we copy Nature as she really exists; in painting we represent her as she appears to us—that is to say, we do not copy the objects, but the image they form on the retina of the eye.

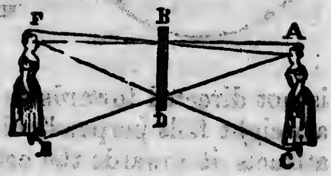
We cannot judge of the velocity of a body in motion unless we know its distance; for, supposing two men to set off at the same moment from A and B, to walk each to the end of their respective lines C and D, if they perform their walk in the same space of time, they must have proceeded at a very different rate; and yet to an eye situated at E, they will appear to have moved with equal velocity, because they will both have gone through an equal number of degrees, though over a very unequal length of ground.—Sight cannot be implicitly relied on; it deceives us both in regard to the size and the distance of objects—indeed our senses would be very liable to lead us into error, if experience did not set us right. Nothing more convincingly shows how requisite experience is to correct the errors of sight, than the case of a young man who was blind from his infancy, and who recovered his sight at the age of fourteen, by the operation of couching. At first he had no idea either of the size or distance of objects, but imagined that everything he saw, touched his eyes; and it was not till after having repeatedly felt them, and walked from one object to another, that he acquired an idea of their respective dimensions, their relative situations, and their distances.



Since an image is formed on the retina of each of our eyes, it would seem that we ought to see objects double. In fact, however, we do not; and perhaps the best solution which has been offered of the difficulty is this, that the action of the rays on the optic nerve of each eye is so perfectly similar, that they produce but a single sensation; the mind, therefore, receives the same idea from the retina of both eyes, and conceives the object to be single. Besides, each eye refers the object to exactly the same place, from which we unconsciously conclude that there can be but *one* object. Persons afflicted with a disease in one eye, which prevents the rays of light from affecting it in the same manner as the other, frequently see double.

The image of an object in a looking-glass is not inverted, because the rays do not enter the mirror by a small aperture, and cross each other, as they do at the orifice of a camera obscura, or the pupil of the eye.

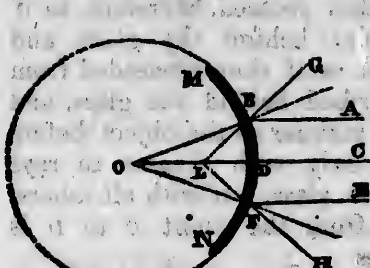
When a man views himself in a mirror, the rays from his eyes fall perpendicularly upon it, and are reflected in the same line; they proceed, therefore, as if they had come from a point behind the glass, and the same effect is produced as if they proceeded from an image of the object described behind the glass, and situated there in the same manner as the object before it. This is not the case only with respect to rays falling perpendicularly on the glass, but with all others. —Thus, a ray proceeding from the point C to D is reflected to A, and arrives there in the same manner as if it had proceeded from E, a point behind the glass, at the same distance from it as C is in front of it.



A man cannot see himself in a mirror if he stand to the right or to the left of it, because the incident rays falling obliquely on the mirror will be reflected obliquely in the opposite direction, the angles of incidence and reflection being equal.

There are three kinds of mirrors used in optics; the plane or flat, which are the common mirrors, convex mirrors, and concave mirrors. The reflection of the two latter is very different from that of the former.

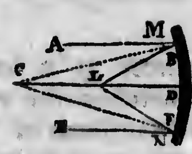
The plane mirror which, as we have seen, does not alter the direction of the reflected rays, forms an image behind the glass exactly similar to the object before it; for it forms an image of each point of the object at the same distance behind the mirror, that the point is before it; and these images of the different points together make up one image of the whole object. A convex mirror has the property of making the reflected rays diverge, by which means it diminishes the image; and a concave mirror makes the rays converge, and, under certain circumstances, magnifies the image. Let us begin by examining the reflection of a convex mirror, when this is formed by a portion of the *exterior* surface of a sphere. If several parallel rays fall upon it, that ray only which, if prolonged, would pass through the centre, or axis of the mirror, is perpendicular to it. In order to avoid confusion, we have drawn only three parallel lines, AB, CD, EF, to represent rays falling on



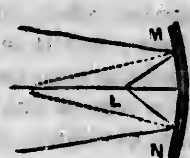
the convex mirror, MN; the middle ray, you will observe, is perpendicular to the mirror, the others fall on it obliquely.—The three rays being parallel would all be perpendicular to a flat mirror; but no ray can fall perpendicularly on a spherical mirror, which is not directed towards the centre of the sphere, just as a weight falls perpendicularly to the earth when gravity attracts it towards the centre. In order, therefore, that rays may fall perpendicularly to the mirror at B and F, the rays must be in the direction of the dotted lines which meet at the centre, O, of the sphere, of which the mirror forms a portion.

Now let us observe in what direction the three rays AB, CD, EF, will be reflected. The middle ray falling perpendicularly on the mirror will be reflected in the same line; the two others falling obliquely, will be reflected obliquely to G and H, for the dotted lines are perpendiculars, which divide their angles of incidence and reflection, or they will proceed as if they came from the point L; and since we see objects in the direction of the reflected ray, we shall see an image, answering to that which would be produced by a body placed at L, which is the point at which the reflected rays, if continued through the mirror, would unite and form an image. This point is equally distant from the surface and centre of the sphere, and is called the imaginary focus of the mirror. A focus is a point at which rays unite:—the focus to which parallel rays converge is called the *principal* focus. In the present case the focus is called an *imaginary* focus, because the rays only appear to unite there, or rather proceed after reflection in the same direction as if they came from behind the mirror, from that point; for they do not pass through the mirror, since they are reflected by it.

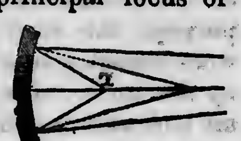
A concave mirror is formed of a portion of the *internal* surface of a hollow sphere, &c., and its peculiar property is to make the rays of light converge. If three parallel rays, A B, C D, E F, fall on the concave mirror, M N, the middle ray will be reflected in the same line, being in the direction of the axis of the mirror, and the two others will be reflected obliquely as they fall obliquely on the mirror.



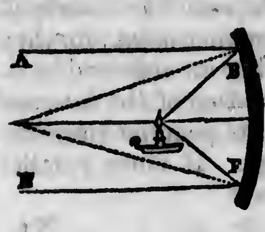
The two dotted perpendiculars divide their angles of incidence and reflection; and in order that these angles may be equal, the two oblique rays must be reflected to L, where they will unite with the middle ray. Thus when any number of parallel rays fall on a concave mirror, they are all reflected to a focus; for in proportion as the rays are more distant from the axis of the mirror, they fall more obliquely upon it, and are more obliquely reflected; in consequence of which they come to a focus in the direction of the axis of the mirror; and this point is not an imaginary focus (as with the convex mirror), but the true focus at which the rays unite. If rays fall convergent on a concave mirror, they are sooner brought to a focus, L, than parallel rays; their focus is therefore nearer to the mirror M N. Divergent rays are brought to a more distant focus than parallel rays,



where the focus is at L; but the principal focus of mirrors, either convex or concave, is equally distant from the centre and the surface of the sphere. If a metallic concave mirror of polished tin be exposed to the sun, the rays will be collected into a very brilliant focus; and a piece



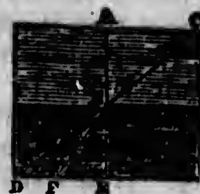
of paper held in this focus will take fire; for rays of light cannot be concentrated without accumulating a proportional quantity of heat; hence concave mirrors have obtained the name of burning mirrors.



If a burning taper be placed in the focus, the ray which falls in the direction of the axis of the mirror will be reflected back in the same line; but two other rays, drawn from the focus, and falling on the mirror at B and F, will be reflected to A and E.—Therefore the rays which proceed from a light placed in the focus of a concave mirror fall divergent upon it, and are reflected parallel; it is exactly the reverse of the former figure, in which the rays fell parallel on the mirror, and were reflected to a focus. In other words, when the incident rays are parallel, the reflected rays converge to a focus; when the incident rays proceed from the focus, they are reflected parallel; this is a very important law of optics.

ON REFRACTION AND COLOURS.

Refraction is the effect which transparent mediums produce on light in its passage through them. Opaque bodies reflect the rays, and transparent bodies transmit them; but it is found that if a ray, in passing from one medium into another of different density, fall obliquely, it is turned out of its course. The power which causes the deviation of the ray is not fully understood; but the appearances are the same as if the ray (supposing it to be a succession of moving particles, which is for this purpose the most convenient way of considering it) were attracted by the denser medium more strongly than by the rarer. Let us suppose the two mediums to be air and water; when a ray of light passes from air into water, it appears to be more strongly attracted by the latter. If then a ray, AB, fall perpendicularly on water, the attraction of the water acts in the same direction as the course of the ray; it will not, therefore, cause a deviation, and the ray will proceed straight on to E; but if it fall obliquely as the ray C B, the water will attract it out of its course. Let us suppose the ray to have reached the surface of a denser medium, and that it is there affected by its attraction. If not counteracted by some other power, this attraction would draw it perpendicularly to the water at B, towards E; but it is also impelled by its projectile force, which the attraction of the denser medium cannot overcome; the ray, therefore, acted on by both these powers, moves in a direction between them, and instead of pursuing its original course to D, or being implicitly guided by the water to E, proceeds towards F, so that the rays appear bent or broken.



If a shilling be placed at the bottom of an empty teacup, and the teacup at such a distance from the eye that the rim shall hide the shilling, it will become visible by filling the cup with water. In the first instance, the rays reflected by the shilling are directed higher than the eye, but when the cup is filled with water, they are refracted by its attraction, and bent downwards at quitting it, so as to enter the eye. When the shilling becomes visible by the refraction of the ray, you do not see it in the situation which it really occupies, but an image of it higher in the cup; for as objects always appear to be situated in the direction of the rays which enter the eye, the shilling will be seen in the direction of the refracted ray at B. The manner in which an oar appears bent in water is a similar effect of refraction. When we see the bottom of a clear stream, the rays which it reflects, being refracted in their passage from the water into the air, will make the bottom appear more elevated than it really is, and the water will consequently appear

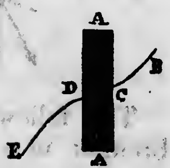
more shallow. Accidents have frequently been occasioned by this circumstance; and boys who are in the habit of bathing should be cautioned not to trust to the apparent shallowness of water, as it will always prove deeper than it appears.

The refraction of light prevents our seeing the heavenly bodies in their real situation. The light they send to us being refracted in passing into the atmosphere, we see the sun and stars in the direction of the refracted ray. If the sun were immediately over our heads, its rays falling perpendicularly on the atmosphere would not be refracted, and we should then see it in its true situation. To the inhabitants of the torrid zone, where the sun is sometimes vertical, its rays are then not refracted. There is, however, another obstacle to see the heavenly bodies in their true situation, which affects them in the torrid zone as well as elsewhere. Light is about eight minutes and a half in its passage from the sun to the earth, therefore, when the rays reach us, the sun has quitted the spot he occupied on their departure; yet we see him in the direction of those rays, and consequently in a situation which he had abandoned eight minutes and a half before. In speaking of the sun's motion, we mean his apparent motion, produced by the diurnal rotation of the earth, for the effect being the same, whether it be our earth or the heavenly bodies which move, it is more easy to represent things as they appear to be, than as they really are. The refraction of the sun's rays by the atmosphere renders the days longer, as it occasions our seeing an image of the sun, both before he rises and after he sets; for below the horizon he still shines upon the atmosphere, and his rays are thence refracted to the earth. So likewise we see an image of the sun before he rises, the rays that previously fall upon the atmosphere being reflected to the earth.

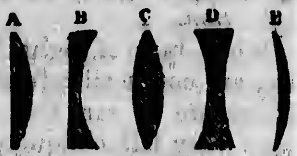
If light radiating from a luminous body continues to pass through a medium of the *same* density its direction remains unchanged; but if it passes from one medium to another of a *different*, its direction becomes different; and the angle formed by lines representing the former and latter directions makes what is called the *angle of refraction.*

When rays of light fall perpendicularly on a surface they are not at all refracted—the exceptions to this rule, if any, are so rare that they need not be noticed. But when they fall obliquely on the surface of the second medium, if they pass from a less to a more dense medium they are turned *towards*, if from a more to a less dense medium, they are turned *from* a perpendicular to that surface. If, however, they fall very obliquely they are reflected, instead of being refracted. If the density of the medium gradually increase they will describe a curve; as, for instance, when they pass through the atmosphere. When the two opposite surfaces of a medium are parallel, the direction of the ray is changed, but after passing the medium it becomes parallel to its former path. Thus in passing through a pane of glass; the rays suffer two refractions, which being in contrary directions, produce nearly the same effect as if no refraction had taken place.

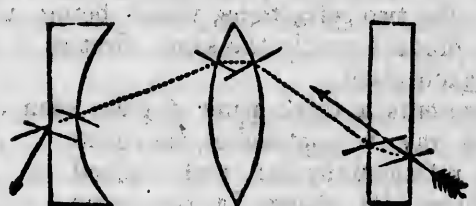
A A represents a thick pane of glass seen edgeways. When the ray B approaches the glass at C it is refracted by it; and, instead of continuing its course in the same direction, it passes through the pane to D; at that point, returning into the air, it is again refracted by the glass, but in a contrary direction, and in consequence proceeds to E. Now the ray B C and the ray D E being parallel, the light does not appear to have suffered any refraction; for if a ray of light passes from one medium into another, and through that into the first again, the two refractions being equal and in opposite directions, no sensible effect is produced; for the direction is the same, and the little space by which the ray is thrown to one side, is necessarily less than the thickness of the medium, and the thickness of a pane of glass is too little to be worth considering. But this is the case only when the two surfaces of the refracting medium are parallel to each other; if they are not, the two refractions may be made in the same direction, and may cause the rays to come to a focus at a point beyond the medium.



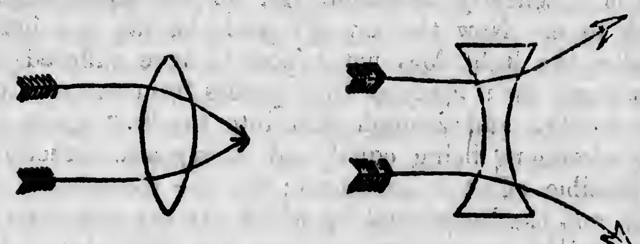
Lenses are of various forms as here represented. A is called a plano-convex, from having one side flat, and the other rounded; B is a plano-concave, having one side hollow; C is a double-convex, and has both sides rounded; D is a double-concave, with both sides hollow; E is a meniscus, (so called from its moon shape), and has one side convex, and the other concave. The property of those which have a convex surface is to collect rays of light to a focus; and those which have a concave surface to disperse them.



The following diagram will give some idea of the manner in which light is affected by being transmitted through media of greater densitv and bounded by plane, convex, or concave surfaces:



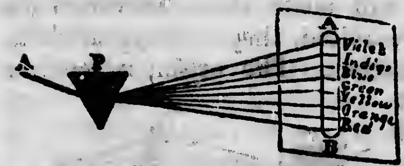
The following will show how parallel, &c., rays are brought to a focus by convex, or made to diverge by concave lenses:



It is evident that convergent rays become more convergent with convex lenses, and divergent rays more divergent with concave lenses.

We shall next explain the refractions of a triangular piece of glass called a prism. The sides are flat; it

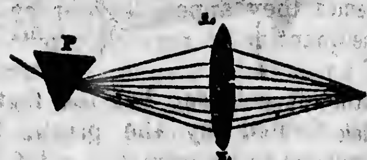
cannot, therefore, bring the rays to a focus, nor can its refraction be similar to that of a flat pane of glass, because it has not two sides parallel. The refractions of the light, on entering and on quitting the prism, are both in the same direction.* On entering the prism P, the ray is refracted from B to C, and on quitting it, from C to D. If the window-shutters be closed, and a ray of light, admitted through a small aperture, fall upon a prism, it will be refracted, and a spectrum, A B, representing all the colours of the rainbow will be formed on the opposite wall. It is difficult to conceive how a piece of white glass can produce such a variety of brilliant colours; but the fact is, that the colours are not formed by the prism, but existed in the ray previous to its refraction; for the white rays of the sun are composed of coloured rays, which when blended together, appear colourless or white.



Sir Isaac Newton, to whom we are indebted for the most important discoveries respecting light and colours, was the first who divided a white ray of light, and found it to consist of an assemblage of coloured rays, which formed an image upon the wall, such as is exhibited, in which are displayed the following series of colours—red, orange, yellow, green, blue, indigo, and violet. Now a prism separates these coloured rays by refraction. It appears that the coloured rays have different degrees of refrangibility; in passing through the prism, therefore, they take different directions, according to their susceptibility of refraction. The violet rays deviate most from their original course; they appear at one end of the spectrum, A B. Contiguous to the violet are the indigo rays, being those which have somewhat less refrangibility; then follow, in

* This will at once appear, as in the case of the lens, by drawing perpendiculars to the surface of the prism where the ray enters and quits it.

succession, the blue, green, yellow, orange, and lastly, the red, which are the least refrangible of the coloured rays. The union of these colours, in the proportions in which they appear in the spectrum, produces in us the idea of whiteness. If a card be painted in compartments with these seven colours, and whirled rapidly on a pin, it will appear white. But a more decisive proof of the composition of a white ray is afforded by re-uniting these coloured rays, and forming with them a ray of white light. This can be done by letting the coloured rays, which have been separated by a prism, fall upon a lens, which will make them converge to a focus; and when thus re-united, they will appear white, as they did before refraction. The prism, P, separates a ray of white light into seven coloured rays; and the lens, LL, brings them to a focus at F, where they again appear white. Thus by means of a prism and a lens, we can take a ray of white light to pieces, and put it together again.



This division of a ray of white light into different colours, being caused by the unequal refrangibility of the different coloured rays, must take place, more or less, whenever the ray suffers refraction. Thus the rainbow, which exhibits a series of colours so analogous to those of the spectrum, is formed by the refraction of the sun's rays in their passage through a shower of rain, every drop of which acts as a prism, in separating the coloured rays as they pass through it.

A body appears to be of the colour which it reflects; as we see it only by reflected rays, it can appear but of the colour of those rays. Thus grass is green, because it absorbs all except the green rays; it is, therefore, these only which the grass and trees reflect to our eyes, and which make them appear green. The sky and flowers, in the same manner, reflect the various colours of which they appear to us: the rose, the red rays; the violet, blue; the jonquil, the yellow, &c. If any one should imagine that these are the permanent colours of the grass and flowers, he would be mistaken. Whenever we see those colours the objects must be illuminated; and light, from whatever source it proceeds, is of the same nature, composed of the various coloured rays, which paint the grass, the flowers, and every coloured object in nature. Objects in the dark have no colour, or are black, which is the same thing. We can never see objects without light. Light is composed of colours, therefore, there can be no light without colours; and though every object is black, or without colour in the dark, it becomes coloured as soon as it becomes visible.

Bodies which reflect all the rays are white; those which absorb them all are black. Between these extremes they appear lighter or darker, in proportion to the quantity of rays they reflect or absorb. A rose is of a pale red: it approaches nearer to white than black, it therefore reflects rays more abundantly than it absorbs them. Pale-coloured bodies reflect all the coloured rays to a certain degree, which produces their paleness, approaching to whiteness; but one colour they reflect more than the rest; this predominates over the white, and determines the colour of the body. Since, then, bodies of a pale colour in some degree reflect all the rays of light, in passing through the various colours of the spectrum, they will reflect them all with tolerable brilliancy, but will appear most vivid in the ray of their natural colour. The green leaves, on the contrary, are of a dark colour, bearing a stronger resemblance to black than to white: they have, therefore, a greater tendency to absorb than to reflect rays. Blue often appears green by candle-light, because this light is less pure than that of the sun; and when refracted by a prism, the yellow rays predominate: and as the admixture of blue and yellow forms green, the superabundance of yellow gives to blue bodies a greenish hue.

The sun appears red through a fog, owing to the red rays having a greater momentum, which gives them power to traverse so dense an atmosphere. For the same reason the sun generally appears red at rising and setting: as the increased quantity of atmosphere which the oblique rays must traverse, loaded with the mists and vapours which are usually formed at those times, prevents a large proportion of the other rays from reaching us. The colour of the atmosphere, commonly called the sky, is blue;—now since all the rays traverse it in their passage to the earth, it would be natural to infer that it should be white; but we must not forget that we see none of the rays which pass from the sun to the earth, excepting those which meet our eyes; and this happens only if we look at the sun, and thus intercept the rays, in which case, we know it appears white. The atmosphere is a transparent medium, through which the sun's rays pass freely to the earth; but when reflected back into the atmosphere, their momentum is considerably diminished, and they have not all of them power to traverse it a second time. The momentum of the blue rays is least; these, therefore, are the most impeded in their return, and are chiefly reflected by the atmosphere; or it may be that, without any question of momentum, the colour which the particles of air most readily reflect is blue—just as grass reflects the green, or a rose the red rays. This reflection is performed in every possible direction; so that wherever we look at the atmosphere, some of these rays fall upon our eyes; hence we see the air of a blue colour. If the atmosphere did not reflect any rays, though the objects on the surface of the earth would be illumined, the skies would appear perfectly black. This would not only be very melancholy, but it would be pernicious to the sight, to be constantly viewing bright objects against a black sky.

When bodies change their colour, as leaves which wither in autumn, or a spot of ink which produces an iron-mould on linen, it arises from some chemical change, which takes place in the internal arrangement of the parts, by which they lose their tendency to reflect certain colours, and acquire the power of reflecting others. A withered leaf thus no longer reflects the blue rays: it appears, therefore, yellow, or has a slight tendency to reflect several rays which produce a dingy brown colour. An ink-spot on linen at first absorbs all the rays; but exposed to the air, it undergoes a chemical change, and the spot partially regains its tendency to reflect the yellow rays; and such is the colour of the iron-mould.

ON THE STRUCTURE OF THE EYE.

The body of the eye is of a spherical form. It has two membraneous coverings; the external one, *aaa*, is

called the sclerotica: this has a projection in that part of the eye which is exposed to view, *bb*, which is called the cornea, because, when dried, it has nearly the consistence of very fine horn, and is sufficiently transparent for the light to obtain free passage through it. The second membrane which lines the cornea, and envelopes the eye, is called the choroid, *cc*: this has an opening in front, just beneath

the cornea, which forms the pupil, *dd*, through which the rays of light pass into the eye. The pupil is surrounded by a coloured border of fibres, called the iris, *ee*, which by its motion, always preserves the pupil of a circular form, whether it be expanded in the dark, or contracted by a strong light.

The construction of the eye is so admirable, that it is capable of adapting itself, more or less, to the circumstances in which it is placed. In a faint light the pupil dilates so as to receive an additional quantity of rays; and in a strong light it contracts, in order to prevent the intensity of the light from injuring the optic nerve. The eyes suffer pain, when, from darkness, they suddenly come into a strong light; for the pupil being dilated, a quantity of rays rush in before it has time to contract. And when we go from a strong light into obscurity, we at first imagine ourselves in total darkness; for a sufficient number of rays cannot gain admittance into the contracted pupil to enable us to distinguish objects; but in a few minutes it dilates, and we clearly perceive what was before invisible. The choroid, *cc*, is covered with a black substance, which serves to absorb all the rays that are irregularly reflected, and to convert the body of the eye into a more perfect camera obscura. When the pupil is expanded to its utmost extent, it is capable of admitting ten times the quantity of light that it does when most contracted. In cats, and animals, which are said to see in the dark, the power of dilatation and contraction of the pupil is still greater; it is computed that their pupils may receive one hundred times more light at one time than at another.—Within these coverings of the eye-ball are contained three transparent substances, called humours. The first occupies the space immediately behind the cornea, and is called the aqueous humour, *ff*, from its liquidity and its resemblance to water. Beyond this is situated the crystalline humour, *gg*, which derives its name from its clearness and transparency: it has the form of a lens, and refracts the rays of light in a greater degree of perfection than any that have been constructed by art: it is attached by fibres, *mm*, to each side of the choroid. The back part of the eye, between the crystalline humour and the retina, is filled by the vitreous humour, *hh*, which derives its name from a resemblance it is supposed to bear to glass or vitrified substances. The membraneous coverings of the eye are intended chiefly for the preservation of the retina, *ii*, which is by far the most important part of the eye, as it is that which receives the impression of the objects of sight. The retina consists of an expansion of the optic nerve, of perfect whiteness; it proceeds from the brain, enters the eye at *n* on the side next the nose, and is finally spread over the interior surface of the choroid. The rays of light which enter the eye by the pupil, are refracted by the several humours in their passage through them, and unite in a focus on the retina.

Rays proceed from bodies in all possible directions. We must, therefore, consider every part of an object which sends rays to our eyes as points from which the rays diverge, as from a centre. Divergent rays, on entering the pupil, do not cross each other; the pupil, however, is sufficiently large to admit a small pencil of them; and these, if not refracted to a focus by the humours, would continue diverging after they had passed the pupil, would fall dispersed upon the retina, and thus the image of a single point would be expanded over a large portion of the retina. The divergent rays from every other point of the object would be spread over a similar extent of space, and would interfere and be confounded with the first, so that no distinct image could be formed on the retina. The refraction of the several humours unites the whole of a pencil of rays, proceeding from any one point of an object, in a corresponding point on the retina, and the image is thus rendered distinct and strong.

That imperfection of sight which arises from the eyes being too prominent, is owing to the crystalline humour being too convex; in consequence of which it refracts the rays too much, and collects them into a focus, before they reach the retina. From this focus, the rays proceed diverging, and consequently form a very confused image on the retina. This is the defect of short-sighted people; and it is remedied by bringing the object nearer to the eye; for the nearer an object is brought to the eye the more divergent the rays fall upon the crystalline humour, and consequently do not so soon converge to a focus. This focus, therefore, either falls upon the retina, or at least approaches nearer to it, and the object is proportionally distinct. The nearer, therefore, an object is brought to the crystalline or to a lens, the further the image recedes behind it. But short-sighted persons have another resource for objects which they cannot permit to approach their eyes. This is to place a concave lens before the eye, in order to increase the divergence of the rays, the effect of a concave lens, being exactly the reverse of a convex one. By the assistance of such glasses, therefore, the rays from a distant object fall on the pupil as divergent as those from a less distant object; and, with short-sighted people, they throw the image of a distant object back as far as the retina. Those who suffer from the crystalline humour being too flat, apply an opposite remedy: that is to say, a convex one to make up for the deficiency of convexity of the crystalline humour. Thus elderly people, the humours of whose eyes are decayed by age, are under the necessity of using convex spectacles; and when deprived of that resource, they hold the object at a distance from their eyes, for the more distant the object is from the crystalline, the nearer the image will be to it. These two opposite defects are easily comprehended; but the greatest difficulty remains, namely, how any sight can be perfect; for, if the crystalline humour be of a proper degree of convexity to bring the image of distant objects to a focus on the retina, it will not represent near objects distinctly; and if, on the contrary, it be adapted to give a clear image of near objects, it will produce a very imperfect one of distant objects. Now to obviate this difficulty, and adapt the eye either to near or to distant objects, power is given to us to increase or diminish in some degree the convexity of the crystalline humour, and also to project it towards, or draw it back from the object, as circumstances require. In a young, well-constructed eye, the fibres to which the crystalline humour is attached, have so perfect a command over it, that the focus of the rays constantly falls on the retina, and an image is formed equally distinct both of distant objects and of those which are near. We cannot, however, see an object distinctly if we bring it very near to the eye, because the rays fall on the crystalline humour too divergent to be refracted to a focus on the retina. The confusion, therefore, arising from viewing an object too near the eye, is similar to that which proceeds from a flattened crystalline humour; the rays reach the retina before they are collected to a focus.

We conclude this subject with the following beautiful observations on the eye from the pen of Addison:

Our sight is the most perfect and most delightful of all our senses. It fills the mind with the largest variety of ideas; converses with its object at the greatest distance, and continues the longest in action without being tired, or satiated with its proper enjoyments. The sense of feeling can indeed give us a notion of extension, shape, and all other ideas that enter at the eye, except colours; but at the same time it is very much straitened and confined in its operations, to the number, bulk, and distance of its particular objects. Our sight seems designed to supply all these defects, and may be considered as a more delicate and diffusive kind of touch, that spreads itself over an infinite multitude of bodies, comprehends the largest figures, and brings within our reach some of the most remote parts of the universe.

It is this sense which furnishes the imagination with its ideas. We cannot, indeed, have a single image in the fancy that did not make its first entrance through the sight; but we have the power of retaining, altering, and compounding those images, which we have once received, into all the varieties of picture and vision that are most agreeable to the imagination; for by this faculty a man in a dungeon is capable of entertaining himself with scenes and landscapes more beautiful than can be found in the whole compass of nature.

A beautiful prospect delights the soul, as much as a demonstration; and a description in Homer has charmed more readers than a chapter of Aristotle. Besides, the pleasures of the imagination have this advantage, above those of the understanding, that they are more obvious, and more easy to be acquired. It is but opening the eye, and the scene enters. The colours paint themselves on the fancy with very little attention of thought or application of mind in the beholder. We are struck, we know not how, with the symmetry of any thing we see, and immediately assent to the beauty of an object, without inquiring into the particular causes and occasions of it.

A man of polite imagination is let into a great many pleasures, that the vulgar are not capable of receiving. He can converse with a picture, and find an agreeable companion in a statue. He meets with a secret refreshment in a description, and often feels a greater satisfaction in the prospect of fields and meadows, than another does in the possession. It gives him, indeed, a kind of property in every thing he sees, and makes the most uncultivated parts of nature administer to his pleasures; so that he looks upon the world, as it were, in another light, and discovers in it a multitude of charms, that conceal themselves from the generality of mankind.

SECTION V.

ON ELECTRICITY.

The word Electricity denotes a peculiar state, of which all bodies are susceptible, and which is supposed to depend upon the presence of a substance called the electric fluid. Some of its phenomena were known to the ancients, particularly those attractions and repulsions which a piece of amber, after being rubbed, exhibits, with regard to hairs, feathers, and other light bodies; and it was from its power of drawing light substances to it when rubbed, that the Greeks gave amber the name *elektron*, which is the origin of the word Electricity. Thales, who lived six centuries before the Christian era, was the first who observed the electrical properties of amber; and he was so struck with the appearances, that he supposed it to be animated. Mr. Boyle is supposed to have been one of the first persons who got a glimpse of the electrical light, or who seems to have noticed it, by rubbing a diamond in the dark. Sir Isaac Newton was the first who observed, that excited glass attracted light bodies on the side opposite to that on which it is rubbed.

An electric is any substance, which being excited or rubbed by the hand, or by a woollen cloth, or other means, has the power of attracting light bodies. If a piece of sealing-wax be rubbed briskly with the sleeve of your coat, a silk handkerchief, &c., for some time, and then held near hair, feathers, bits of paper, or other light bodies, they will be attracted; that is, they will jump up and some of them will adhere to the wax. If a tube of glass, or small phial, be rubbed in a similar manner, it will answer much better. If this operation be performed in the dark, something luminous will be seen, which is called the *electric matter or fluid;* and all bodies that we are acquainted with have more or less of it in them; though it seems to lie dormant till it be put into action by rubbing. The air, and every thing, is full of this fluid, which appears in the shape of sparks; the rubbing of the glass with the hand collects it from the hand, and the glass, having now more than its natural share, parts with it to any body that may be near enough to receive it. The substance rubbed, and that with which it is rubbed, are always found to be oppositely electrified—the one body having more and the other less than its natural share; indeed one kind of Electricity is never obtained without, at the same time, the productions of the other. Those bodies which have been called Electrics, will not convey electricity from one body to another, and, therefore, they are termed NON-CONDUCTORS. The most remarkable are—glass, and all vitreous substances, precious stones, resins, amber, sulphur, baked wood, wax, silk, cotton, wool, hair, feathers, paper, white sugar, air, oils, metallic oxides, all dry vegetable substances, and all hard stones. Those bodies, which, when rubbed ever so much, do not exhibit electricity, are called Non-Electrics. They convey electricity from one body to another, and, therefore, are denominated CONDUCTORS; they are as capable of having electricity developed upon them by friction as those bodies which have been called "electrics," but it is conducted away as fast as it is produced. Some of them conduct electricity much better than others. The principal conductors are the metals, charcoal, all fluids except dry airs and oils, most saline substances, and stony substances. Woollen and silk, when wet, will, by means of the water, conduct electricity.

When a body has more than its natural quantity of this fluid, it is said to be electrified positively, or *plus*; and when it has less than its natural quantity, it is said to be electrified negatively, or *minus*. When bodies are electrified either of these ways, they repel each other; but if some be electrified *plus*, and others *minus*, they mutually attract; or if one body be electrified *plus*, and the other not electrified in either way, they also attract each other.

There are some fishes which possess the extraordinary faculty of being able, at pleasure, to communicate shocks, like those of an electric battery or galvanic pile, to any animal that comes in contact with them. They are called the *torpedo*, the *gymnotus electricus*, and the *silurus Indicus*. The most remarkable of these is the Gymnotus Electricus or Electric Eel, which is frequently found in the marshes and stagnant pools of Guiana, and other countries of South America. The shocks they give are exceedingly severe; and Humboldt mentions a road which has been totally abandoned, because the mules, in crossing a wide ford, were, by these violent attacks, often paralysed and drowned. Even the angler on the bank was not exempt from danger, the shock being conveyed along his wetted rod and fishing line. The Electric Eel is sometimes twenty feet long. The electricity of all those fishes is exerted by them only when they please, and of course only while they are alive. After the animal has discharged its electrical matter, the next shock is weaker; and when the animal is exhausted, it has lost all the power of producing any effect for some time.

There is no longer any doubt that the cause of thunder is the same with that which produces the ordinary phenomena of electricity. The resemblance between them is indeed so great, that we cannot believe thunder itself to be any other than a grander species of electricity.

GALVANISM.

Galvanism is so intimately connected with electricity, that it may be considered as a branch of that science. It was first accidentally discovered in the chemical laboratory of M. Lewis Galvani, Professor of Anatomy in the University of Bologna, upon the following occasion. The lady of the Professor, being of a delicate habit, was occasionally supported by soup made from frogs as a restorative. Some of these animals, skinned for that purpose, were lying upon a table in the laboratory of the Professor, in which stood an electrical machine. One of the assistants, in experiment, by accident brought the point of the scalpel near the crural nerves of a frog recently killed, lying not far from the conductor; the muscles of the limb were instantly set in motion, being agitated with strong convulsions. By a long series of new experiments, the law of nature, as far as respects the influence of this principle, was investigated, of which mere accident had at first afforded him a glimpse only. Galvani published a treatise on the subject, addressed to the Institute of Bologna, in the year 1791. On the appearance of this work, the universal attention of the Philosophers of Europe was arrested. This discovery was made at a time when something more than hypothesis was necessary to satisfy the mind of the inquisitive inquirer after scientific truth. To this desire may be referred the almost innumerable experiments which were made in every district of Europe, in consequence of this publication; by which means the science became considerably enriched by the addition of a great variety of new facts, by contemporaries and successors, insomuch that it is said, the labours of Galvani, the original discoverer, bear but a comparatively small proportion to what have been since adduced for its illustration.

Galvani found that, by the mere agency of a metallic substance, where he had no reason to suspect the presence of electricity, the limbs of a recently killed frog were convulsed; and having ascertained the fact by a number of experiments, he in the course of his inquiries found, that the convulsions or contractions were produced only when *dissimilar* metals were employed. It was now inferred that electricity is not only produced by the friction of bodies, but even by the mere contact of certain substances. At the same time it was admitted, that these substances must have some chemical agency or action upon each other, and that the effect produced seems to be proportionate to the degree of chemical action. The following well known facts were now supposed to be explained by this science. Porter, taken from a pewter pot, has always been held by connoisseurs in that liquor to be better than when taken from China or glass: this was now said to arise from a certain decomposition effected by means of the liquor in the vessel—the porter, and the saliva on the under lip coming in contact with the metal. Pure mercury retains its metallic splendour a long time, but its amalgam with tin, &c. is almost immediately oxydated or tarnished. Inscriptions of very ancient date, on pure lead, have been found in a perfect state, while others of modern times, made on compound metals, are corroded and scarcely legible. Works of metal, whose parts are soldered together by means of other metallic substances, soon tarnish, or are oxydated about the places in which the different metals are joined. So likewise is the copper on ships, which is fastened on by means of iron nails. Zinc also may be kept a long time under water, with scarcely any change; but if a piece of silver touch the zinc while under water, there will be very soon a sensible oxydation. Take a piece of zinc and place it under the tongue, and lay a piece of silver as big as half a crown on the tongue, and no particular taste will be observed; but bring the outer edges of the metals together, and a very disagreeable taste will be perceived, which is said to arise from the decomposition of the saliva, a watery fluid. The same thing may be noticed with a guinea and a piece of charcoal. These facts have been thus explained, and the theory generally admitted: — The *conductors* of electricity, however they may differ from each other in their conducting powers, may be divided into two classes. The *first* class, which are denominated the *dry* and more perfect conductors, consist of metallic substances and charcoal: the *second* class, called also imperfect conductors, are water, acids, &c. From these, or some of them, all *Galvanic Circles*, as they are named, are formed.

Hitherto this influence or agent had been chiefly investigated with reference to its operation on animal substances. Hence its popular name was for a long time, *animal electricity:* but it being soon found that its agency was more extensive, that it possessed powers not indicated by this denomination, and that of course the retention of this name would lead to error, the word *Galvanism* was adopted in its stead. This extension of the Galvanic principle was connected with new discoveries, and improvements from various quarters; these, however, for a considerable time, were generally small, and unimportant in their nature. But among all the recent discoveries in *Galvanism*, that made by Professor Volta, in 1800, is most remarkable in its nature, and most interesting in its relations. Volta set out with the idea, contrary to that of Galvani, that the electricity did not belong to the animal, but to the different metals employed. Galvani was not likely to produce any greater effect than what could be obtained by two pieces of metal, because he believed the electricity to be in the animal. Volta was led to the discovery of the battery, by combining a number of pieces of metal together, because he was persuaded that the electricity was in the metals or fluids employed. These repeated combinations obtained the name of Galvanic, or more properly, Voltaic batteries: and the science itself is usually denominated, from the discoveries resulting from these batteries, *Voltaism.*

The simplest galvanic apparatus consists of a set of tumblers, containing water slightly mixed with nitric or sulphuric acid, which are connected by bent wires with a piece of zinc at one end, and a piece of copper at the other; connect the tumblers by placing these in them all in the same order—one metal in the first and last, and both metals in each intermediate one:—touching the first copper and the last zinc with the fingers, will occasion a shock.

The pile is made thus; take twenty or thirty pieces of zinc, each as large as a penny. Get as many pieces of copper about the same size, and also as many pieces of paper or cloth, which are to be dipped in a solution of salt and water. In building up the pile place zinc, paper, copper, &c. constantly in the same order until the whole be finished. The sides of the pile may be supported with rods of glass, or varnished wood, fixed in the board on which it stands. The following experiments may then be performed:—

Having wet both hands, touch the lower part of the pile with one hand, and the upper part with the other; a slight shock of electricity will be felt as often as one hand is removed. If the hand be brought back, a similar shock will be felt. Put a basin of water near the pile, and put the left hand into it, holding a wire, the one end of which touches the top of the battery or pile; then put the end of a silver spoon between the lip and the gum, and with the other end of the spoon touch the lower part of the pile; a strong shock is felt in the gum and in the hand. Take the left hand from the water, but still keep hold of the wire, and then perform the last experiment in the same manner, and a shock will be felt in the gum only. Hold a silver spoon in one hand, and touch with it the battery at the lower part, then touch the upper part with the tongue, the bitter taste is extreme. In performing the above experiments, if, instead of the two ends of the pile, the one end and the middle of it be touched, the sensations will not be nearly so strong.

The Galvanic trough is a very powerful apparatus; it is composed of zinc and copper plates placed in pairs, so that all those of one metal lie toward the same end. The end plates have connecting wires; and when the trough is filled with water, impregnated with nitric or muriatic acid, and the points of the wires brought together, the action is remarkably powerful; any number of troughs may be united and made to act at once. In this way substances have been decomposed on which the strongest fires had no effect.

Modern research has considerably augmented our knowledge of Galvanism. It was, after some time, discovered that the efficiency of a Galvanic Circle depends on its being formed of three bodies, two of which have a powerful effect on each other, but neither of them, if possible any, on the third. Hence perfectly pure zinc, or (what answers extremely well) zinc amalgamated with mercury, platina, and dilute acid; or charcoal, zinc, and acid, form batteries which are very effective, and which from their long continued actions are called *constant* batteries; indeed the zinc in them is not at all acted upon by the acid in which it is immersed, unless when connected with the platina, &c., by means of a wire or some other conductor; and then only to an extent proportioned to the goodness of the conductor which connects them.

Galvanic action is now applied to a very interesting and useful purpose, which is called the *Electrotype* process. This enables us with great facility, and the most perfect exactness to copy medals, engraved copper plates, &c., and to cover almost any substance with gold, silver, copper, &c. In its simplest form it may be illustrated by a small Galvanic battery, consisting of a vessel of unglazed porcelain, within which is a piece of zinc immersed in dilute sulphuric acid, and outside of it a plate of copper immersed in a solution of blue vitriol (sulphate of copper); when the zinc and copper are connected together by a wire, &c., the former will be gradually dissolved, and the latter covered with fine copper deposited from the blue vitriol.

The experiment will be more perfect, when a *generating* cell (a constant battery) and a *decomposing* cell are used. Let us suppose the generating cell to consist of amalgamated zinc, platina, and dilute sulphuric acid; and the generating cell to be a vessel containing a solution of blue vitriol, in which a plate of copper and the medal intended to be copied are immersed, without being in contact. When the zinc of the generating cell is connected with the medal, and its platina with the plate of copper, the medal will in a few hours be covered with a plate of pure copper, whose thickness will depend on the time used in forming it, &c., and which being removed from the medal, and placed instead of it in the generating cell, will constitute a matrix, and be covered with copper, thus affording a copy of the medal, than which nothing can be more exact. The same matrix will, it is evident, be sufficient for the production of an indefinite number of copies.

MAGNETISM, &c.

The production of magnetism by electricity is another of the important results which have arisen from our increased knowledge of Galvanism.

Almost every one knows that property of the magnet which causes it to attract iron and a few other substances. This attractive power may be communicated temporarily to soft iron, and permanently to steel, either by the natural magnet (the loadstone) or the artificial (a magnetized bar of steel). If a magnet be suspended freely it will arrange itself *north* and *south;* that is, one *pole* or extremity will point almost north, and the other in the opposite direction. This *directive* power, as it is called, is what makes the mariner's compass so useful to the navigator. By its aid he may traverse the pathless ocean, during the darkest night, in the utmost security; and yet it consists merely of a needle (a small bar of steel magnetized) balanced on a fine point, so that it can move in every direction over a circular card, marked with 32 divisions (called *points*), in its circumference.

If a bar of steel is carefully balanced on a point, and then magnetized by rubbing it to a magnet, or by any other means—except in a part of the earth just midway between the magnetic poles—it will no longer remain in equilibrio, but will form an angle with the horizon, which is called the angle of *dip*. Hence to make the needle of the mariner's compass assume and preserve a horizontal position, we are obliged to render one end of it heavier than the other. We have already said that the needle does not, when left to itself, point *due* north and south; the angle it makes with a horizontal line lying in the meridian of the place is called the angle of *variation* of that place. It is to be remarked that this angle is not always the same even at the same place. Both "dip" and "variation" arise from that cause which makes the needle point to the magnetic poles, namely, the earth being a great magnet and acting as such on the needle. We may illustrate both dip and variation by placing a magnetized bar of steel under the needle, in such a way as that it will occupy the same positions with reference to it, as the magnetic axis (a line passing through the magnetic poles) occupies.

It only remains to show why the earth acts towards the needle as if it were a great magnet. The earth is what is called an electro-magnet; that is, one formed by the circulation of electrical currents around it. The connection between electricity and magnetism was long known; but that electricity circulating around the needle will cause it to be deflected from its ordinary position, and that the same current passing round a bar of iron would magnetize it, are facts which constitute a recent and very important discovery.

The currents which produce the magnetism of the earth are due to the enormous evaporation from its surface, and to the constant change of temperature caused by revolution on its axis, which exposes different parts of it in succession to the sun's rays.—Electricity developed during *change* of temperature has been designated *thermo-electricity*.

We are not to suppose that only ferruginous substances (although the best for the purpose), or even metals alone, are capable of being magnetized by means of electricity.

We may illustrate the most interesting facts in electro-magnetism by covering copper wire with worsted, cotton, or some other bad conductor of electricity, and then coiling it round a bar of iron. On connecting the extremities of the wire-coil or *helix*, as it is termed, respectively, with the plates of a Galvanic circle, the iron bar will be found to be highly magnetic. It is necessary to cover the wire with some non-conducting substance, or the electricity instead of traversing the *length* of it, and so passing *round* the iron, would pass directly from one part of the wire to another, selecting, as electricity always does, the shortest path.

The *helix* is capable not only of producing magnetism in iron, but also electricity in another helix placed around or intertwined with it; and it is found, whether used by itself, or in combination with another, to give to the electricity derived from a *single* Galvanic circle an intensity which could scarcely be obtained from the combination of a very great number of circles—the zinc of one being connected with the copper or platina of the next; which is the mode of arrangement required, when we desire to give to Galvanic electricity a greater or less degree of intensity; that is a capability of producing mechanical or physiological effects, and the power of traversing bad, or imperfect conductors.

CALORIC.

Heat, strictly speaking, is the name of a sensation, though it is customary to speak of the heat of the sun, or the heat of the fire, just as readily as of the heat which these bodies are capable of exciting. It was with a view of avoiding the confusion which arose from thus confounding the cause and effect, that modern chemists adopted the new word *caloric*, to denote the principle which produces heat.

The nature of caloric is not yet well understood, it being still doubtful whether it be a material substance, or a mere property of matter. It is generally regarded, however, as a fluid of great tenuity which pervades the whole system of nature.

Caloric is produced in various ways; by *combustion*—by *friction*,—by *percussion*,—by *the mixture of two or more substances*, as when sulphuric acid is poured upon water or magnesia—by electricity and galvanism. But the principal source of caloric is the sun.

Caloric is either latent or free. All bodies are supposed to contain caloric, but when it is neither perceptible by the senses, nor affects the thermometer, it is termed *latent heat;* if by any means we can ascertain its presence, it gets the name of *free caloric*. Free caloric always tends to diffuse itself equally; in other words, when two bodies are of different temperatures, the warmer gradually parts with its caloric to the colder, till they are both brought to the same temperature. Thus, when a thermometer is applied to a hot body it receives caloric, when to a cold one it gives to it part of its own caloric; and this giving and receiving goes on until the thermometer and the body arrive at the same temperature. Cold is merely a diminution of heat. When you lay your hand on a marble table you indeed feel it cold, but the cold you experience consists merely in the loss of caloric that your hand sustains whilst its temperature is being brought to an equilibrium with the table. If you lay a piece of ice upon the same table, you will find that a contrary effect will take place, the ice will be melted by the caloric which it abstracts from the marble.

The facility with which caloric enters or leaves bodies, depends much on the nature of the body; some species permitting the passage of caloric through them with ease, and others with much difficulty. Those substances which permit caloric to pass readily through them, are called good conductors; thus metals and liquids are good conductors; but silk, cotton, wool, wood, &c. are bad conductors. For example, if we put one end of a poker into the fire, the other end will soon become hot, but this will not happen with a piece of wood of the same length, and under the same circumstances. A person may stand so near the fire, as to make the metal buttons on his coat too hot to touch, whilst the temperature of the cloth will be apparently scarcely altered. When there is occasion to hold any metallic instrument, we take care that the part by which it is to be held shall not be made of metal, but of wood or bone. Good conductors of heat would evidently form bad clothing. The object of clothing is to intercept the heat, and preserve the body as much as possible at a uniform temperature. In cold weather, the temperature of the atmosphere being lower than that of the body, clothing formed of non-conductors prevents the too rapid escape of heat from the body to the surrounding air; and, in very hot weather, it answers a contrary purpose,—preventing the too rapid communication of heat to the body. Animals are clothed in fur, wool, feathers, &c. all non-conductors; and man borrows his clothing, in a great degree, from them.

One of the most remarkable properties of caloric is the repulsion which exists among its particles. Hence it happens, that when this principle enters into a body, its first effect is to remove the integrant molecules of the substance to a greater distance from one another. The body, therefore, becomes less compact than before, occupying a greater space, or, in other words, expands. Now this effect of caloric is manifestly in opposition to cohesion—that force which tends to make the particles of matter approximate, and which must be overcome before any expansion can ensue. It may be expected, therefore, that a small addition of caloric will occasion a small expansion, and a greater addition of caloric, a greater expansion; because in the latter case, the cohesion will be more overcome than in the former. It may be anticipated, also, that whenever caloric passes out of a body, the cohesion being then left to act freely, a contraction will necessarily follow; so that expansion is only a transient effect, occasioned solely by the accumulation of caloric. It follows, moreover, from this view, that caloric must produce the greatest expansion in those bodies, the cohesive power of which is least; and the inference is fully justified by observation. Thus the force of cohesion is greatest in solids, less in liquids, and least of all in aëriform substances; while the expansion of solids is trifling, that of liquids much more considerable, and that of elastic fluids far greater. It may be laid down as a rule, the reason of which is now obvious, that all bodies are expanded by heat, and that the expansion of the same body increases with the quantity of caloric which enters it.

INTRODUCTION TO CHEMISTRY.

Chemistry is the science which makes known to us the nature and properties of all bodies, whether these bodies be simple or compound—solid, liquid, or aëriform.

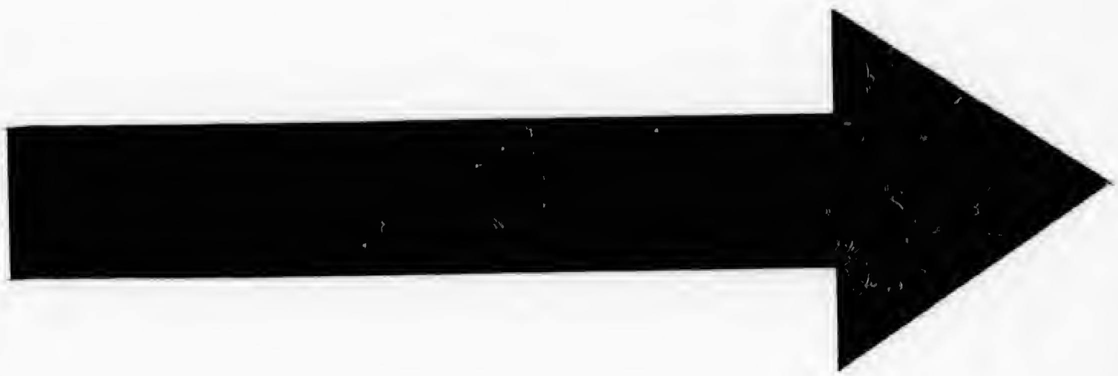
The importance of the science of chemistry is evident from the following considerations. In acquiring a knowledge of the constitution of the atmosphere, in investigating the changes to which it is subject, the variations of temperature, the laws of winds, dew, rain, hail, and snow, chemistry is our principal, our only satisfactory guide. These remarkable changes—changes, which, because familiar, do not produce any emotion in the mind, though in themselves truly wonderful—are chemical operations on a magnificent scale, and can only be explained on chemical laws.

In examining the various objects which compose the mineral, vegetable, and animal kingdoms, chemistry is essentially requisite for the successful prosecution of our inquiries.

In the art of extracting metals from their ores, in purifying and combining them with each other, almost all the processes are purely chemical. The arts of glass and porcelain-making—of tanning, soap-making, dyeing, and bleaching—depend entirely upon chemistry; and all the processes of baking, brewing and distilling, and most of the culinary arts, are chemical operations.

The transformations of chemistry, by which we are enabled to convert materials apparently useless into important objects of the arts, are opening up every day sources of wealth and convenience unknown to former ages. Who, for instance, would have conceived that linen rags were capable of producing *more than their own weight* of sugar, by the agency of one of the cheapest and most abundant acids—the sulphuric?—that dry bones could be a magazine of nutriment, capable of preservation for many years, and ready to yield up their sustenance in the form best adapted to the support of life, on the application of steam, or of an acid at once cheap and durable?—that sawdust itself is susceptible of conversion into a substance bearing no remote analogy to bread; and though certainly less palatable than that of flour, yet no way disagreeable, and at once wholesome, digestible, and highly nutritive?

Chemistry makes us acquainted with many facts, of which, without it, we must have remained in ignorance. How wonderful that the diamond should be made of



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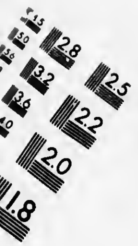

the same material with coal; that the most part, by bulk, of water should be an inflammable substance; that acids should be almost all formed of different kinds of air; and that one of those acids, the strength of which can dissolvé almost any of the metals, should be made of the same ingredients with the common air that we breathe.

If we consider chemistry purely as a science, we shall find no study which presents more interesting subjects of research, and none which affords more striking proofs of the wisdom and beneficence of the Creator of the universe. In all the singular and surprising changes which everywhere present themselves, the more closely we examine them, the more we shall admire the simple means by which they are accomplished, and the intelligent design and perfect wisdom displayed in them.

CHEMICAL AFFINITY.

That property of matter which occasions the combination of heterogeneous bodies, is the cause of the principal phenomena of chemistry, and is, therefore, called chemical affinity or attraction. It is also sometimes termed electric attraction, and the attraction of composition, to distinguish it from cohesive or aggregative attraction.

Chemical attraction may be defined to be that energy, in consequence of which different kinds of matter unite to form compounds, having properties often dissimilar from those of their component parts, so that the result of chemical combination can only be ascertained, at least in the first instance, by experiment. Thus, if iron filings be dissolved in sulphuric acid, or as it is commonly called, oil of vitriol, a substance will be produced which bears no kind of resemblance to either of its component parts, it is called by chemists sulphate of iron, and vulgarly, copperas, or green vitriol—a greenish, semi-transparent crystallized substance, having nothing of the appearance of the metal, nor of the sour taste of the acid. Acetic acid, or the acid of vinegar, in the same manner dissolves copper, and constitutes with it the blue efflorescent salt called verdigris. Caustic vegetable alkali (caustic potash) is a deliquescent substance, which, as its name implies, corrodes flesh; and sulphuric acid is a liquid which, when concentrated, acts much in the same manner on flesh; but from the union of these bodies, so destructive to animal matter, results the chemical compound, sulphate of potash, a salt which, whether solid or dissolved in water, does not act on the skin, and may be swallowed with safety. Sometimes two liquids or gaseous bodies, by their union form a solid compound. Thus, the gas that rises from spirit of hartshorn, called by chemists ammonia, and muriatic acid gas, if mixed together in an empty jar, become condensed into a white saline solid, called muriate of ammonia, or sal ammoniac.

The phenomena of chemical attraction are regulated by the following laws:

1. This attractive force is exerted in different degrees by different bodies.

2. It operates only on very minute particles of bodies; and hence chemical action is promoted by previous solution, trituration, or other mechanical methods of division and intermixture.

3. When bodies combine, an alteration of temperature generally takes place, sometimes with the exhibition of light.

4. Bodies which have an attraction for each other are always found to display opposite states of electricity.

5. All bodies are composed of certain atoms or molecules, and chemical combination consists of the union of one or more atoms of one of the uniting bodies, with some determinate number of atoms of the other uniting body.

6. Chemical attraction takes place in three different modes:—1. When one simple body is presented to another for which it has an affinity, a union takes place, and a compound is formed. 2. If a simple body, A, be presented to a compound, B C, and if A have a stronger affinity for B than C has, the compound B C will be decomposed, and a new compound A B, will be formed. 3. If a compound A B be presented to

another compound, C D, though neither A nor B would alone decompose C D, yet a mutual decomposition may take place between the two compounds, and occasion the formation of two new compounds A D and C B. The first and second modes of attraction are styled instances of simple affinity, or simple elective attraction; and the last mode is styled compound affinity, or compound elective attraction.

7. All compounds, when they enter into union with other bodies without being decomposed, act in the same manner as simple bodies.

Book of Science.

ON SIMPLE BODIES.

According to the ancient philosophers, the simple bodies or elementary principles from which all the varieties of matter are composed, were but four, namely, fire, air, earth, and water. This notion, after having for ages formed a part of the creed of the learned, has been completely exploded by the light of modern science.

Some of the alleged elements of the older chemists are now known to have existed only in imagination, and others are ascertained to be by no means simple substances: thus air is found to consist principally of two different elastic fluids or gaseous bodies, which may be separated by various processes, and exhibited apart from each other. Water also has been ascertained to be a compound which may be analyzed or decomposed, so as to produce two distinct kinds of gas, which may be separately collected, and when again mixed together in proper proportions, may be made to form water by their union.

Other bodies formerly esteemed simple, have yielded to the analytical processes of modern chemistry; but there is a certain number of substances, which have hitherto resisted all attempts at further decomposition, and which, therefore, in the present state of the science, must be ranked as simple substances. Their number is not very great, amounting to about fifty-five, and it is not unlikely that the future researches of chemists may demonstrate some of these bodies to be compounds. At the same time, it is probable that additions may be made to the class of elementary substances, in consequence of future discoveries—several of those now admitted into this class having become known to us but very recently.

Some of these elementary bodies are widely and abundantly dispersed throughout the three kingdoms of nature, either alone or in a state of composition, while others appear to be of very rare occurrence, or at least have hitherto been met with only in small quantities, and in few situations. The whole of the elementary substances may be arranged in two divisions; the first comprehending those which are not of a metallic nature, the entire number of which, now known, amounts to only thirteen; the remaining forty-two elementary bodies are all regarded as metals, though some of them exhibit properties differing considerably from those which characterize gold, silver, mercury, lead, iron, and other bodies, to which the designation of metals was originally applied.

The following are the thirteen non-metallic elementary substances: oxygen, chlorine, iodine, bromine, fluorine, hydrogen, nitrogen, carbon, boron, silicon, phosphorus, sulphur, selenium. *Book of Science.*

ON SIMPLE BODIES, CONTINUED.

Oxygen is one of the most important of the elementary bodies. In a simple state, it is obtained only in the form of gas. It is an exceedingly abundant body; the air of the atmosphere contains one-fifth, and water is resolvable into a mixed gas, one-third of which, by bulk, is oxygen, and the remainder hydrogen. It also exists in most natural products—animal, vegetable, and mineral. Oxygen gas is, like common air, colourless, invisible, tasteless, inodorous, and elastic. But it is heavier than common air, in the proportion of 11½ to 10. It is a powerful supporter of combustion; that is to say, when any inflamed body, as a lighted candle, is put into it, it burns very vigorously—much more so than when in common air; indeed it is owing to the oxygen it contains that common air supports combustion at all. Its presence is also necessary for the continuance of animal life. We cannot breathe air which has been deprived of its oxygen.

Hydrogen is known only in the state of gas, and is sometimes called inflammable air. It is the lightest of all bodies that can be weighed. It is one of the ingredients which forms water—from which it can be easily procured. Hydrogen gas, when pure, possesses all the mechanical properties of common air. It does not support combustion, though it is itself one of the most combustible of all bodies; for if a lighted candle be put into a vessel containing hydrogen, the candle will be instantly extinguished, while the gas itself will be inflamed. It is not fit for respiration, for animals which breathe it die almost instantaneously. If pure oxygen and hydrogen be mixed together, and the mixture set fire to, it explodes with great violence, and forms water. Hence we see the origin of the term hydrogen, which literally signifies the water-former. Hydrogen gas is, on account of its greater levity, employed to fill balloons.

Nitrogen, called also azote, is a gaseous body, rather lighter than common air; of which it forms four-fifth parts, the remaining one fifth being oxygen. It has neither colour, smell, nor taste. It does not support combustion, nor is it combustible itself, for if a lighted candle be put into a vessel containing nitrogen, it is instantly extinguished, and the gas itself does not take fire, as is the case with hydrogen. Nitrogen is fatal also to animal life; any animal put into it dies in a very short time.

ON SIMPLE BODIES, CONTINUED.

CARBON.

When wood is heated to a certain degree in the open air, it takes fire, and forms whilst burning, water and carbonic acid gas, till the whole of it is consumed. A small portion of ashes is the sole residue. But if the wood be heated to redness in close vessels, so that the atmospheric air cannot have free access to it, a large quantity of gaseous and other volatile matters is expelled, and a black, hard, porous substance is left, called *charcoal.*

Charcoal may be procured from other sources. When the volatile matters are driven off from coal, as in the process of making coal gas, a peculiar kind of charcoal, called *coke,* remains in the retort. Most animal and vegetable substances yield it, when ignited in close vessels. Thus a very pure charcoal may be procured from starch or sugar, and from the oil of turpentine or spirit of wine, by passing their vapour through tubes heated to redness. When bones are made red hot in a covered crucible, a black mass remains, which consists of charcoal mixed with the earthy matters of the bone. It is called ivory black, or animal charcoal.

Carbon is the name given to the pure inflammable part of charcoal, of which substance the diamond is only a variety in a pure crystallized state; for pure charcoal and diamond, when treated in the same manner, produce precisely the same results. Carbon is insoluble in water, and infusible by the most intense heat, provided air be excluded. Animal and vegetable oils are composed almost entirely of carbon and hydrogen. The same may be observed of gum, sugar, and starch. These bodies, however, contain oxygen.

Charcoal absorbs the odoriferous and colouring principles of most animal and vegetable substances. When coloured infusions of this kind are digested with a due quantity of charcoal, a solution is obtained, which is nearly if not quite colourless. Tainted flesh may be rendered sweet and eatable by this means, and foul water may be purified by filtering through charcoal.

Sulphur occurs as a mineral production in some parts of the earth, particularly in the neighbourhood of volcanoes, as in Italy and Sicily. It is commonly found in a massive state; but is sometimes met with in a crystallized form. It is procured abundantly in combination with several metals, such as silver, copper, antimony, lead, and iron. It is obtained in large quantities by exposing the common iron pyrites to a red heat in close vessels.

Sulphur is well known under the name of brimstone. It is a brittle solid body, of a greenish yellow colour, emits a peculiar odour when rubbed, and has little taste. It is insoluble in water; but if poured into it when liquified it retains its softness, and is in this state employed for taking impressions from seals and medals.

Phosphorus was discovered about the year 1669, by Brandt, an alchemist of Hamburgh. It is a semitransparent yellowish matter, of the consistency of wax. It is procured, in general, by the decomposition of bones. It is exceedingly inflammable. Exposed to the air at common temperatures, it undergoes a slow combustion; it emits a dense white smoke, which has the smell of garlic, appears luminous in the dark, and is gradually consumed. On this account, phosphorus should always be kept under water. On account of its very combustible nature, it requires to be handled with great caution; gentle pressure between the fingers is sufficient to kindle it. It burns rapidly, emitting a splendid white light, and causing an intense heat.

Chlorine was discovered in 1770. It is a substance of much importance, being, in combination with other substances, extensively used in the arts. Chlorine is a yellowish-green coloured gas, which has an astringent taste, and a disagreeable odour. It is one of the most suffocating of the gases, exciting great irritability in the wind-pipe, even when considerably diluted with air. When strongly and suddenly compressed, it emits both heat and light—a character which it possesses in common with oxygen gas. Under considerable pressure it assumes the form of a limpid liquor of a bright yellow colour. Chlorine is a supporter of combustion. If a lighted taper be plunged into chlorine gas, it burns with a small red flame, and emits a large quantity of smoke. Phosphorus takes fire in it spontaneously. Several of the metals, such as tin, copper, arsenic, antimony, and zinc, when introduced into chlorine in the state of powder, or in fine leaves, are suddenly inflamed. Chlorine, though formerly called an acid, possesses no acid properties. It has not a sour taste, nor does it redden the blue colour of plants, which nearly all acids do. One of the most important properties of chlorine is its bleaching power. All animal and vegetable colours are speedily removed by chlorine; and when the colour is once discharged, it can never be restored. Chlorine, however, cannot bleach unless water be present. Chlorine is useful also for the purposes of fumigation, and is used to purify the air in fever hospitals. The infection of the small-pox is also destroyed by this gas, and matter that has been submitted to its influence will no longer generate that disease.

Iodine is a substance much resembling chlorine in some of its properties. It may be procured by drying and powdering common sea weed, and heating it with sulphuric acid and peroxide of manganese: a violet coloured vapour rises, which, if received in a cool vessel, will condense on its sides, and will form scaly crystals, of a somewhat metallic lustre. These crystals are the substance: from the violet colour of its vapour it is called *iodine*. It has the property of forming a beautiful blue colour, when mixed with a little powdered starch, diffused through cold water; hence iodine and starch are used as tests of the presence of each other. Iodine stains the fingers yellow, but not permanently. Like chlorine, it destroys vegetable colours, though not so powerfully. Iodine is used in medicine: in small doses it increases the appetite; but in large doses, or continued too long, it produces remarkable emaciation.

To these simple non-metallic bodies we might add bromine, selenium, boron, fluorine (the base of fluor spar), and silicon (the base of flint). But as they are of less importance, and as the nature of some of them is still a subject of dispute with chemists, we shall omit the consideration of them for the present.

SECTION VI.

TRUE LIBERTY.

True Liberty was Christian, sanctified,
Baptized, and found in Christian hearts alone.
First-born of Virtue! daughter of the skies!
Nursling of Truth divine! sister of all
The Graces, Meekness, Holiness, and Love:
Giving to God, and man, and all below,
That symptom show'd of sensible existence,
Their due unask'd; fear to whom fear was due;
To all, respect, benevolence, and love.
Companion of Religion; where she came,
There Freedom came; where dwelt, there Freedom dwelt;
Ruled where she ruled, expired where she expired.
"He was the freeman whom the truth made free;"
Who first of all the bands of Satan broke;
Who broke the bands of Sin; and for his soul,
In spite of fools, consulted seriously;
In spite of fashion, persevered in good;
In spite of wealth or poverty, upright;
Who did as Reason, not as Fancy bade;
Who heard Temptation sing, and yet turned not
Aside; saw Sin bedeck her flowery bed,
And yet would not go up; felt at his heart
The sword unsheathed, yet would not sell the truth;
Who, having power, had not the will to hurt;
Who blush'd alike to be, or have a slave;
Who blush'd at nought but sin, feared nought but God;
Who, finally, in strong integrity
Of soul, 'midst want, or riches, or disgrace,
Uplifted calmly sat, and heard the waves
Of stormy folly breaking at his feet;

Now shrill with praise, now hoarse with foul reproach,
And both despised sincerely; seeking this
Alone—the approbation of his God,
Which still with conscience witness'd to his peace.

This, this is freedom, such as angels use,
And kindred to the liberty of God.
First-born of Virtue! daughter of the skies!
The man, the state in whom she ruled, was free;
All else were slaves of Satan, Sin, and Death.

POLLOCK.

THE CORAL INSECT.

Toil on! toil on! ye ephemeral train,
Who build in the tossing and treacherous main,
Toil on,—for the wisdom of man ye mock,
With your sand-based structures and domes of rock;
Your columns the fathomless fountains lave;
And your arches spring up to the crested wave;
Ye're a puny race, thus boldly to rear
A fabric so vast in a realm so drear.

Ye bind the deep with your secret zone;
The ocean is seal'd, and the surge a stone;
Fresh wreaths from the coral pavement spring,
Like the terraced pride of Assyria's king;
The turf looks green where the breakers roll'd;
O'er the whirlpool ripens the rind of gold;
The sea-snatch'd isle is the home of men,
And mountains exult where the wave hath been.

But why do you plant, 'neath the billows dark,
The wrecking reef for the gallant bark?
There are snares enough on the tented field,
'Mid the blossom'd sweets that the valleys yield;
There are serpents to coil, ere the flowers are up!
There's a poison-drop in man's purest cup,

There are foes that watch for his cradle-breath,
And why need ye sow the floods with death?

Ye build,—ye build,—but ye enter not in,
Like the tribes whom the desert devour'd in their sin;
From the land of promise ye fade and die,
Ere its verdure gleams forth on your weary eye;
As the Kings of the cloud-crown'd pyramid
Their noteless bones in oblivion hid;
Ye slumber unmark'd 'mid the desolate main,
While the wonder and pride of your works remain.

SIGOURNEY.

SNOW.

The keener tempests rise; and fuming dun,
From all the livid East or piercing North
Thick clouds ascend, in whose capacious womb
A vap'ry deluge lies, to snow congeal'd.
Heavy they roll their fleecy world along,
And the sky saddens with the gather'd storm.
As thus the snows arise, and foul and fierce
All winter drives along the darken'd air,
In his own loose-revolving fields the swain
Disaster'd stands; sees other hills ascend,
Of unknown, joyless brow, and other scenes,
Of horrid prospect, shag the trackless plain;
Nor finds the river nor the forest, hid
Beneath the formless wild, but wanders on
From hill to dale, still more and more astray,
Impatient, flouncing through the drifted heaps,
Stung with the thoughts of home; the thoughts of home
Rush on his nerves, and call their vigour forth
In many a vain attempt. How sinks his soul!
What black despair, what horror fills his heart!
When, for the dusky spot which fancy feign'd
His tufted cottage, rising through the snow

He meets the roughness of the middle waste,
Far from the track and bless'd abode of man;
While round him night resistless closes fast,
And ev'ry tempest, howling o'er his head,
Renders the savage wilderness more wild:
Then throng the busy shapes into his mind,
Of cover'd pits, unfathomably deep,
A dire descent! beyond the pow'r of frost;
Of faithless bogs; of precipices high,
Smooth'd up with snow; and what is land unknown,
What water of the still unfrozen spring,
In the loose marsh or solitary lake,
Where the fresh fountain from the bottom boils.
These check his fearful steps, and down he sinks
Beneath the shelter of the shapeless drift,
Thinking o'er all the bitterness of death,
Mix'd with the tender anguish nature shoots
Through the wrung bosom of the dying man,
His wife, his children, and his friends unseen.
In vain for him th' officious wife prepares
The fire fair blazing, and the vestment warm,
In vain his little children, peeping out
Into the mingling storm, demand their sire,
With tears of artless innocence. Alas!
Nor wife, nor children, more shall he behold,
Nor friend, nor sacred home. On ev'ry nerve
The deadly winter seizes, shuts up sense,
And o'er his inmost vitals creeping cold,
Lays him along the snows, a stiffen'd corpse,
Stretch'd out, and bleaching in the northern blast.

THOMSON.

BENEFITS OF AFFLICTION.

The path of sorrow, and that path alone,
Leads to the land where sorrow is unknown.
No traveller ever reached that blessed abode,
Who found not thorns and briers in his road.

The world may dance along the flowery plain,
Cheered as they go by many a sprightly strain;
Where nature has her mossy velvet spread,
With unshod feet they yet securely tread:
Admonished, scorn the caution and the friend,
Bent all on pleasure, heedless of its end.
But He, who knew what human hearts would prove,
How slow to learn the dictates of His love,
That hard by nature, and of stubborn will,
A life of ease would make them harder still,
In pity to the souls his grace designed
To rescue from the ruin of mankind,
Called for a cloud to darken all their years,
And said, "Go spend them in a vale of tears."
  O balmy gales of soul-reviving air!
O salutary streams that murmur there!
These, flowing from the fount of grace above;
Those breathed from lips of everlasting love.
The flinty soil, indeed, their feet annoys,
Chill blasts of trouble nip their springing joys;
An envious world will interpose its frown,
To mar delights superior to its own;
And many a pang, experienced still within,
Reminds them of their hated inmate, Sin.
But ills of every shape, and every name,
Transformed to blessings, miss their cruel aim;
And every moment's calm that soothes the breast,
Is given in earnest of eternal rest.
  Ah, be not sad, although thy lot be cast
Far from the flock, and in a boundless waste!
No shepherds' tents within thy view appear,
But the chief Shepherd even there is near.
Thy tender sorrows and thy plaintive strain,
Flow in a foreign land, but not in vain;
Thy tears all issue from a source divine,
And every drop bespeaks a Saviour thine—
So once in Gideon's fleece the dews were found,
And drought on all the drooping herds around.

COWPER.

PROCRASTINATION.

Be wise to day; 'tis madness to defer;
Next day the fatal precedent will plead,
Thus on, till wisdom is pushed out of life!
Procrastination is the thief of time;
Year after year it steals, till all are fled,
And to the mercies of a moment leaves
The vast concerns of an eternal scene.
If not so frequent, would not this be strange?
That 'tis so frequent, this is stranger still,
Of man's miraculous mistakes this bears
The palm, "That all men are about to live,"
For ever on the brink of being born:
All pay themselves the compliment to think
They one day shall not drivel, and their pride
On this reversion takes up ready praise;
At least their own; their future selves applaud,
How excellent that life they ne'er will lead!
Time lodged in their own hands is Folly's vails;
That lodged in Fate's, to wisdom they consign;
The thing they can't but purpose, they postpone.
'Tis not in folly not to scorn a fool;
And scarce in human wisdom to do more.
All promise is poor dilatory man,
And that through every stage. When young, indeed,
In full content we sometimes nobly rest,
Unanxious for ourselves, and only wish,
As duteous sons, our fathers were more wise,
At thirty, man suspects himself a fool;
Knows it at forty, and reforms his plan;
At fifty chides his infamous delay,
Pushes his prudent purpose to resolve;
In all the magnanimity of thought
Resolves and re-resolves; then dies the same.
  And why? Because he thinks himself immortal.
All men think all men mortal but themselves;
Themselves, when some alarming shock of fate
Strikes through their wounded hearts the sudden dread,

But their hearts wounded, like the wounded air,
Soon close; where, past the shaft, no trace is found.
As from the wing no scar the sky retains,
The parted wave no furrow from the keel—
So dies in human hearts the thought of death:
Even when the tender tear which nature sheds
O'er those we love, we drop it in their grave.

YOUNG

TASTE.

What then is taste, but these internal powers,
Active, and strong, and feelingly alive
To each fine impulse? A discerning sense
Of decent and sublime, with quick disgust
From things deform'd, or disarranged, or gross
In species? This, nor gems, nor stores of gold,
Nor purple state, nor culture, can bestow;
But God alone, when first his active hand
Imprints the secret bias of the soul.
He, mighty Parent! wise and just in all,
Free as the vital breeze, or light of heaven,
Reveals the charms of nature. Ask the swain
Who journeys homeward from a summer day's
Long labour, why, forgetful of his toils
And due repose, he loiters to behold
The sunshine gleaming as through amber clouds,
O'er all the western sky; full soon, I ween,
His rude expression and untutor'd airs,
Beyond the power of language, will unfold
The form of beauty smiling at his heart.
How lovely! how commanding! But though Heaven
In every breast hath sown these early seeds
Of love and admiration, yet in vain,
Without fair culture's kind parental aid,
Without enlivening suns, and genial showers,
And shelter from the blast, in vain we hope
The tender plant should rear its blooming head,

Or yield the harvest promised in its spring.
Nor yet will every soil with equal stores
Repay the tiller's labour; or attend
His will obsequious, whether to produce
The olive or the laurel. Different minds
Incline to different objects; one pursues
The vast alone, the wonderful, the wild;
Another sighs for harmony, and grace,
And gentlest beauty. Hence, when lightning fires
The arch of heaven, and thunders rock the ground,
When furious whirlwinds rend the howling air,
And ocean, groaning from its lowest bed,
Heaves his tempestuous billows to the sky;
Amid the mighty uproar, while below
The nations tremble, Shakspeare looks abroad
From some high cliff superior, and enjoys
The elemental war. But Waller longs,
All on the margin of some flowery stream,
To spread his careless limbs amid the cool
Of plantain shades, and to the listening deer
The tale of slighted vows and loves disdain'd
Resound soft-warbling all the live-long day:
Consenting Zephyr sighs; the weeping rill
Joins in his plaint, melodious; mute the groves;
And hill and dale with all their echoes mourn,
Such and so various are the tastes of men.

AKENSIDE.

DETACHED PIECES.

Now, my co-mates, and brothers in exile,
Hath not old custom made this life more sweet
Than that of painted pomp? Are not these woods
More free from peril than the envious court?
Here feel we but the penalty of Adam,
The season's difference; as the icy fang
And churlish chiding of the winter's wind,
Which, when it bites and blows upon my body,

Even till I shrink with cold, I smile, and say—
This is no flattery; these are counsellors,
That feelingly persuade me what I am.
Sweet are the uses of adversity;
Which, like the toad, ugly and venomous,
Wears yet a precious jewel in its head;
And, this our life, exempt from public haunts,
Finds tongues in trees, books in the running brooks,
Sermons in stones, and good in every thing.

SHAKSPEARE.

What you do
Still betters what is done. When you speak sweet,
I'd have you do it ever: when you sing,
I'd have you buy and sell so, so give alms,
Pray so; and for the ordering your affairs,
To sing them too. When you do dance, I wish you
A wave o' the sea, that you might ever do
Nothing but that; more still—still so,
And own no other function: each your doing
So singular in each particular,
Crowns what you are doing in the present deeds,
That all your acts are queens.

SHAKSPEARE

Let me play the fool
With mirth and laughter; so let wrinkles come,
And let my liver rather heat with wine,
Than my heart cool with mortifying groans.
Why should a man, whose blood is warm within,
Sit like his grandsire cut in alabaster?
Sleep when he wakes, and creep into the jaundice
By being peevish? I tell thee what, Antonio,
(I love thee, and it is my love that speaks,)
There are a sort of men whose visages
Do cream and mantle like a standing pond,

And do a wilful stillness entertain,
With purpose to be dressed in an opinion
Of wisdom, gravity, profound conceit,
As who should say, I am Sir Oracle,
And when I ope my lips, let no dog bark!
I'll tell thee more of this another time;
But fish not with this melancholy bait
For this fool's gudgeon, this opinion.
Come, good Lorenzo, fare you well a while;
I'll end my exhortation after dinner.

SHAKSPEARE.

A fool,—a fool!—I met a fool i' th' forest—
A motley fool;—a miserable varlet!—
As I do live by food, I met a fool,—
Who laid him down and basked him in the sun,
And railed on Lady Fortune in good terms,
In good set terms, and yet a motley fool.
Good-morrow, fool, quoth I: No, sir, quoth he,
Call me not fool, till heaven hath sent me fortune:
And then he drew a dial from his poke;
And looking on it with lack-lustre eye,
Says, very wisely, It is ten o'clock:
Thus may we see, quoth he, how the world wags:
And after one hour more 'twill be eleven;
And so from hour to hour, we ripe and ripe,
And then from hour to hour, we rot and rot,
And thereby hangs a tale. When I did hear
The motley fool thus moral on the time,
My lungs began to crow like chanticleer,
That fools should be so deep-contemplative;
And I did laugh, sans intermission,
An hour by his dial. O noble fool!
A worthy fool! Motley's the only wear.

SHAKSPEARE.

Seems, madam! nay, it is: I know not seems.
'Tis not alone my inky cloak, good mother,
Nor customary suits of solemn black,
Nor windy suspiration of forced breath;
No, nor the fruitful river in the eye,
Nor the dejected 'haviour of the visage,
Together with all forms, modes, shows of grief,
That can denote me truly: these indeed seem,
For they are actions that a man might play;
But I have that within which passeth show,
These but the trappings and the suits of woe.

SHAKSPEARE.

Why get thee gone! horror and night go with thee.
Sisters of Acheron, go hand in hand,
Go dance around the bower, and close them in;
And tell them that I sent you to salute them.
Profane the ground, and for the ambrosial rose
And breath of jessamine, let hemlock blacken,
And deadly nightshade poison all the air:
For the sweet nightingale, may ravens croak,
Toads pant, and adders rustle through the leaves.
May serpents winding up the trees let fall
Their hissing necks upon them from above,
And mingle kisses—such as I would give them.

YOUNG.

Why have those banished and forbidden legs
Dared once to touch a dust of England's ground?
But more than why—why have they dared to march
So many miles upon her peaceful bosom;
Frightening her pale-faced villagers with war,
And ostentation of despised arms?
Comest thou because the anointed king is hence?
Why, foolish boy, the king is left behind;
And in my loyal bosom lies his power.

Were I but now the lord of such hot youth,
As when brave Gaunt, thy father, and myself,
Rescued the Black Prince, that young Mars of men,
From forth the ranks of many thousand French;
Oh, then, how quickly should this arm of mine,
Now prisoner to the palsy, chastise thee,
And minister correction to thy fault.

SHAKSPEARE.

Many are the sayings of the wise,
In ancient and in modern books enrolled,
Extolling patience as the truest fortitude;
And to the bearing well of all calamities,
All chances incident to man's frail life,
Consolatries writ
With studied argument, and much persuasion sought,
Lenient of grief and anxious thought;
But with the afflicted in his pangs their sound
Little prevails, or rather seems a tune
Harsh and of dissonant mood from his complaint;
Unless he feels within
Some source of consolation from above,
Secret refreshings that repair his strength,
And fainting spirits uphold.

MILTON.

ON MILTON'S BLINDNESS.

When I consider how my light is spent,
  Ere half my days in this dark world and wide,
  And that one talent which is death to hide,
  Lodged with me useless, though my soul more bent,
To serve therewith my Maker, and present
  My true account, lest he returning chide;
  "Doth God exact day-labour, light denied?"
  I fondly ask; but Patience, to prevent

That murmur, soon replies, God doth not need
 Either man's work, or his own gifts; who best
 Bear his mild yoke, they serve him best; his state
Is kingly, thousands at his bidding speed,
 And pass o'er land and ocean without rest,
 They also serve who only stand and wait.

MILTON.

CAPTAIN BOBADIL'S METHOD OF DEFEATING AN ARMY.

I will tell you, sir, by way of private and under seal, I am a gentleman, and live here obscure and to myself; but were I known to his Majesty and the Lords, observe me, I would undertake, upon this poor head and life, for the public benefit of the state, not only to spare the entire lives of his subjects in general, but to save the one-half, nay three-fourths of his yearly charge in holding war, and against what enemy soever. And how would I do it think you?—Why thus, sir:—I would select nineteen more to myself, throughout the land: gentlemen they should be; of good spirit, strong and able constitution. I would choose them by an instinct that I have. And I would teach these nineteen the special rules; as, your Punto, your Reverso, your Stoccata, your Imbroccata, your Passada, your Montonto, till they could all play very near, or altogether, as well as myself. This done, say the enemy were forty thousand strong. We twenty would come into the field, the tenth of March, or thereabout, and we would challenge twenty of the enemy; they could not in their honour refuse us. Well—we would kill them: challenge twenty more—kill them: twenty more—kill them: twenty more—kill them too. And thus would we kill every man his ten a day—ten a day, that's ten score: ten score—that's two hundred: two hundred a day—five days a thousand—forty thousand—forty times five—five times forty—two hundred days, kill them all by computation. And this I will venture my poor gentleman-like carcase to perform (provided there be no treason practised upon us) by fair and discreet manhood; that is, civilly—by the sword.

BEN JONSON.

THE POST ARRIVES IN THE VILLAGE.

Hark! 'tis the twanging horn! o'er yonder bridge,
That with its wearisome but needful length
Bestrides the wintry flood, in which the moon
Sees her unwrinkl'd face reflected bright,
He comes, the herald of a noisy world,
With spatter'd boots, strapp'd waist and frozen locks
News from all nations lumb'ring at his back,
True to his charge the close packed load behind,
Yet careless what he brings, his one concern
Is to conduct it to the destined inn;
And having dropp'd th' expected bag, pass on.
He whistles as he goes, light-hearted wretch,
Cold, and yet cheerful; messenger of grief
Perhaps to thousands, and of joy to some;
To him indifferent whether grief or joy.
Houses in ashes, and the fall of stocks,
Births, deaths, marriages, epistles wet
With tears that trickled down the writer's cheeks
Fast as the periods from his fluent quill,
Or charg'd with am'rous sighs of absent swains,
Or nymphs responsive, equally affect
His horse and him, unconscious of them all.
But oh, th' important budget! ushered in
With such heart-shaking music, who can say
What are its tidings; have our troops awak'd?
Or do they still as if with opium drugg'd,
Snore to the murmurs of th' Atlantic wave?
Is India free? and does she wear her plum'd
And jewell'd turban with a smile of peace;

Or do we grind her still? The grand debate,
The popular harangue, the tart reply,
The logic, and the wisdom, and the wit,
And the loud laugh—I long to know them all;
I burn to set th' imprison'd wranglers free,
And give them voice and utterance once again.
Now stir the fire, and close the shutters fast,
Let fall the curtains, wheel the sofa round;
And while the bubbling and loud hissing urn
Throws up a steamy column, and the cups
That cheer not to inebriate, wait on each,
So let us welcome peaceful ev'ning in.
Not such his ev'ning, who with shining face,
Sweats in the crowded theatre, and squeez'd
And bor'd with elbow points through both his sides
Outscolds the ranting actor on the stage.
Nor his who patient stands till his feet throb
And his head thumps, to feed upon the breath
Of patriots, bursting with heroic rage,
Or placemen, all tranquillity and smiles.
This folio of four pages, happy work!
Which not e'en critics criticise, that holds
Inquisitive attention, while I read,
Fast bound in chains of silence, which the fair,
Though eloquent themselves, yet fear to break,
What is it but a map of busy life,
Its fluctuations, and its vast concerns?
Here runs the mountainous and craggy ridge
That tempts ambition. On the summit, see
The seals of office glitter in his eye;
He climbs, he pants, he grasps them. At his heels,
Close at his heels a demagogue ascends,
And with a dext'rous jerk soon twists him down
And wins them, but to lose them in his turn.
Here rills of oily eloquence in soft
Meanders lubricate the course they take.
The modest speaker is asham'd and griev'd
T' engross a moment's notice; and yet
Begs a propitious ear for his poor thoughts,
However trivial all that he conceives.

Sweet bashfulness! it claims at least this praise:
The dearth of information and good sense
That it foretells us, always comes to pass.
Cataracts of declamation thunder here;
The forests of no-meaning spread the page
In which all comprehension wanders lost;
While fields of pleasantry amuse us there
With merry descants on a nation's woes.
The rest appears a wilderness of strange
But gay confusion—roses for the cheeks
And lilies for the brows of faded age,
Teeth for the toothless, ringlets for the bald,
Heaven, earth, and ocean plunder'd of the sweets,
Nectareous essences, Olympian dews;
Sermons, and city feasts, and fav'rite airs,
Æthereal journeys, submarine exploits,
And Katerfelto,* with his hair on end
At his own wonders, wond'ring for his bread.

COWPER.

REPORT OF AN ADJUDGED CASE, NOT TO BE FOUND IN ANY OF THE BOOKS.

Between Nose and Eyes a strange contest arose,
The spectacles set them unhappily wrong;
The point in dispute was, as all the world knows,
To which the said spectacles ought to belong.
So the Tongue was the lawyer, and argued the cause,
With a great deal of skill, and a wig full of learning,
While chief baron Ear sat to balance the laws,
So famed for his talent in nicely discerning.
In behalf of the Nose, it will quickly appear,
And your lordship, he said, will undoubtedly find
That the Nose has had spectacles always in wear,
Which amounts to possession, time out of mind.
Then holding the spectacles up to the Court—

* Katerfelto, a celebrated juggler.

Your lordship observes they are made with a straddle,
As wide as the ridge of the nose is; in short
Designed to sit close to it, just like a saddle.
Again would your lordship a moment suppose
('Tis a case that has happened and may be again)
That the visage or countenance had not a Nose,
Pray who would or who could wear spectacles then?
On the whole it appears, and my argument shows,
With a reasoning the Court will never condemn,
That the spectacles plainly were made for the Nose,
And the Nose was as plainly intended for them.
Then shifting his side, as the lawyer knows how,
He pleaded again in behalf of the Eyes;
But what were his arguments few people know,
For the Court did not think they were equally wise:
So his lordship decreed, with a grave solemn tone,
Decisive and clear, without one *if* or *but*—
That whenever the Nose put his spectacles on,
By day-light or candle-light—Eyes should be shut.

COWPER.

THE DESERTED WIFE.

He comes not—I have watched the moon go down,
But yet he comes not.—Once it was not so:
He thinks not how these bitter tears do flow,
The while he holds his riot in that town.
Yet he will come and chide, and I shall weep,
And he will wake my infant from its sleep,
To blend its feeble wailings with my tears!
Oh, how I love a mother's watch to keep,
O'er those sleeping eyes, that smile which cheers
My heart, though sunk in sorrow fixed and deep.
I had a husband once who loved me—now,
He ever wears a frown upon his brow,
And feeds his passion on a wanton's lip,
As bees from laurel flower a poison sip!
But yet I cannot hate—O! there were hours,

When I would hang for ever on his eye,
And Time, who stole with silent sadness by,
Strew'd, as he hurried on, his path with flowers.
I loved him then, he loved me too—my heart
Still finds its fondness kindle if he smile.
The memory of our loves will ne'er depart!
And though he often sting me with a dart,
Venom'd and barb'd, and waste upon the vile
Caresses, which his babe and mine should share;
Though he should spurn me, I will calmly bear
His madness—and should sickness come, and lay
Its paralysing hand upon him, then
I would, with kindness, all my wrongs repay,
Until the penitent should weep and say
How injured and how faithful I had been.

PERCIVAL.

GERTRUDE OF WYOMING.

On Susquehanna's side, fair Wyoming!
Although the wild flower on thy ruin'd wall,
And roofless homes, a sad remembrance bring
Of what thy gentle people did befal,
Yet thou wert once the loveliest land of all
That see the Atlantic wave their morn restore.
Sweet land! may I thy lost delights recal,
And paint thy Gertrude in her bowers of yore
Whose beauty was the love of Pennsylvania's shore.

Delightful Wyoming! beneath thy skies,
The happy shepherd swains had nought to do,
But feed their flocks on green declivities,
Or skim perchance thy lake with light canoe,
From morn till evening's sweeter pastime grew,
With timbrel, when beneath the forest's brown,
Thy lovely maidens would the dance renew,
And aye those sunny mountains half way down,
Would echo flageolet from some romantic town,

Then where of Indian hills, the daylight takes
His leave, how might you the flamingo see,
Disporting, like a meteor on the lakes,
And playful squirrel on his nut-grown tree;
And every sound of life was full of glee,
From merry mock-bird's song, or hum of men,
While hearkening, fearing nought their revelry,
The wild deer arch'd his neck from glades, and then,
Unhunted, sought his woods and wilderness again.

And scarce had Wyoming of war or crime
Heard, but in trans-atlantic story rung,
For here the exile met from every clime,
And spoke in friendship every distant tongue,
Men from the blood of warring Europe sprung,
Were but divided by the running brook;
And happy where no Rhenish trumpet sung,
On plains, no sieging mine's volcano shook,
The blue-eyed German changed his sword to pruning-hook.

Here was not mingled in the city's pomp
Of life's extremes, the grandeur and the gloom,
Judgment awoke not here her dismal tromp,
Nor seal'd in blood a fellow-creature's doom,
Nor mourn'd the captive in a living tomb.
One venerable man beloved of all,
Sufficed, where innocence was yet in bloom,
To sway the strife that seldom might befal;
And Albert was their judge in patriarchal hall.

How reverend was the look, serenely aged,
He bore, this aged Pennsylvanian sire,
When all but kindly fervours were assuaged,
Undimm'd by weakness' shade or turbid ire!
And though, amidst the calm of thought entire,
Some high and haughty features might betray
A soul impetuous once, 'twas earthly fire,
That fled composure's intellectual ray,
As Ætna's fires grow dim before the rising day.

CAMPBELL.

LINES WRITTEN IN A SEVERE FROST AND STRONG HAZE, ON SUNDAY MORNING.

How drear and awful is this solitude !
Nature herself is surely dead, and o'er
Her cold and stiffened corse a winding sheet,
Of bright unsullied purity, is thrown.
How still she lies ! she smiles, she breathes no more.
Yon drooping elm, whose pale and leafless boughs
O'erhang the stream, hath wept itself to death.
The stream that once did gaily dance and sing
The live-long day, now, stiff and silent, lies
Immovable—congeal'd to glittering shingles,
'Tis beautiful in death ! That grove, which late
Did woo the merry stream with ceaseless music,
From morn till eve, with notes of thousand songsters,
And all the night with those melodious strains,
With which lone Philomela tells her love,
Now silent stands a bleached skeleton.
The sky itself is shrouded; now no more
The rosy blush of health, the glow of rapture,
Or cheerful smile of peace her face illumines;
One sickly vivid hue is spread o'er all.
The veil of air wont not to hide, but show
With mild and softening azure tint more sweet
The beauteous aspect of the varying heaven,
Is now become a foul and dense disguise.
The sun, that glorious source of warmth and light,
Arrested in his course, flares through the dun
And turbid atmosphere, as if expiring.
Nought else appears—it seems as though this spot
Were all creation, and myself the sole
Survivor. Oh ! how awful thus to find
Myself alone with God—to know and feel
That his all-seeing, his all-searching eye,
Surveys my inmost thoughts! How little, now,
Appear the mighty joys, the hopes and fears,
Pursuits and pleasures of a transient world!
A world wherein, till now, like other men,

I've toiled and grieved, with many anxious cares,
But where I too have loved and been beloved,
With more of happiness than oft is found
In this probationary state. With Him
Who gave me all, and day by day, hath still,
With kind parental care my life preserved,
To stand alone is awful, but not dreadful.
Nay, sure, 'tis more than earthly bliss, here, thus
To hold communion with my heavenly Father.
Witness this heart, with gratitude o'ercharged,
Which pleads and presses to present its thanks:
Witness these tears which thus uncall'd obtrude,
And half congeal'd, fall to the frozen earth,
An humble offering at the throne of grace:
Witness the sweet, serene, and holy calm,
At once bespeaking and befitting for
The presence of my Maker; semblance faint
Of happiness to come, when bliss supreme
Shall be the portion of these ransom'd saints,
Who through eternity shall join to raise
Loud hallelujahs to their heavenly King.

ANONYMOUS.

ON THE EFFECTS OF TIME AND CHANGE.

Of chance or change O let not man complain,
Else shall he never, never cease to wail;
For, from the imperial dome, to where the swain
Rears the lone cottage in the silent dale,
All feel the assault of Fortune's fickle gale;
Art, empire, earth itself, to change are doomed;
Earthquakes have raised to heaven the humble vale,
And gulfs the mountain's mighty mass entombed,
And where the Atlantic rolls, wide continents have
bloomed.

But sure to foreign climes we need not range,
Nor search the ancient records of our race,
To learn the dire effects of time and change,
Which in ourselves, alas! we daily trace.

Yet at the darkened eye, the withered face,
Or hoary hair I never will repine:
But spare, oh time, whate'er of mental grace,
Of candour, love, or sympathy divine,
Whate'er of fancy's ray or friendship's flame is mine.

BEATTIE.

MUTUAL FORBEARANCE, NECESSARY TO THE HAPPINESS OF THE MARRIED STATE.

The Lady thus address'd her spouse—
What a mere dungeon is this house!
By no means large enough; and was it,
Yet this dull room, and that dark closet,
Those hangings, with their worn out graces,
Long beards, long noses, and pale faces,
Are such an antiquated scene,
They overwhelm me with the spleen.
Sir Humphrey, shooting in the dark,
Makes answer quite beside the mark;
No doubt, my dear; I bade him come,
Engag'd myself to be at home,
And shall expect him at the door,
Precisely when the clock strikes four.
You are so deaf, the lady cried,
(And rais'd her voice, and frown'd beside,)
You are so sadly deaf, my dear,
What shall I do to make you hear!
Dismiss poor Harry! he replies,
Some people are more nice than wise;
For one slight trespass all this stir!
What if he did ride, whip, and spur?
'Twas but a mile—your fav'rite horse
Will never look one hair the worse.—
Well I protest, 'tis past all bearing!
Child, I am rather hard of hearing!
Yes truly—one must scream and bawl,
I tell you, you can't hear at all.
Then with a voice exceeding low,
No matter if you hear or no.

Alas! and is domestic strife,
That sorest ill of human life,
A plague so little to be fear'd,
As to be wantonly incurr'd;
To gratify a fretful passion,
On every trivial provocation?
The kindest and the happiest pair
Will find occasion to forbear,
And something every day they live
To pity, and perhaps forgive.
But if infirmities that fall
In common to the lot of all,
A blemish, or a sense impair'd,
Are crimes so little to be spar'd,
Then farewell all that must create
The comfort of the wedded state.
Instead of harmony, 'tis jar
And tumult, and intestine war.
The love that cheers life's latest stage,
Proof against sickness and old age,
Preserv'd by virtue from declension,
Becomes not weary of attention;
But lives when that exterior grace,
Which first inspired the flame decays.
'Tis gentle, delicate, and kind,
To faults compassionate or blind,
And will with sympathy endure
Those evils it would gladly cure:
But angry, coarse, and harsh expression,
Shows love to be a mere profession,
Proves that the heart is none of his,
Or soon expels him if it is.

COWPER.

THE CONVICT SHIP.

Morn on the waters! and purple and bright
Bursts on the billows the flashing of light;
O'er the glad waves, like a child of the sun,
See the tall vessel goes gallantly on.

Full to the breeze she unbosoms her sail,
And her pennon streams onward like hope in the gale;
The winds come around her, in murmur and song,
And the surges rejoice as they bear her along,
See she looks up to the golden edged clouds,
And the sailor sings gaily aloft in her shrouds.
Onward she glides amid ripple and spray,
Over the waters, away and away!
Bright as the visions of youth ere they part,
Passing away, like a dream of the heart!
Who, as the beautiful pageant sweeps by,
Music around her, and sunshine on high,
Pauses to think amid glitter and glow,
Oh! there be hearts that are breaking below!

Night on the waves! and the moon is on high,
Hung like a gem on the brow of the sky,
Treading its depths in the power of her might,
And turning the clouds, as they pass her, to light;
Look to the waters! asleep on their breast,
Seems not the ship like an island of rest?
Bright and alone on the shadowy main,
Like a heart-cherished home on some desolate plain,
Who, as she smiles in the silvery light,
Spreading her wings on the bosom of night,
Alone on the deep, as the moon in the sky,
A phantom of beauty, could deem with a sigh,
That so lovely a thing is the mansion of sin,
And souls that are smitten, lie bursting within?
Who, as he watches her silently gliding,
Remembers that wave after wave is dividing
Bosoms that sorrow and guilt could not sever,
Hearts that are parted and broken for ever?
Or dreams that he watches, afloat on the wave,
The death-bed of hope, or the young spirit's grave?

'Tis thus with our life, as it passes along,
Like a vessel at sea, amid sunshine and song,
Gaily we glide in the gaze of the world,
With streamers afloat, and with canvas unfurled;

All gladness and glory to wondering eyes,
Yet chartered by sorrow and freighted with sighs:
Fading and false is the aspect it wears,
As the smiles we put on, just to cover our tears,
And the withering thoughts that the world cannot know,
Like heart-broken exiles lie burning below,
Whilst the vessel drives on to that desolate shore,
Where the dreams of our childhood are vanish'd and o'er.
T. K. HERVEY.

CHRISTIAN BENEVOLENCE.

Wouldst thou from sorrow find a sweet relief?
Or is thy heart oppressed with woes untold?
Balm wouldst thou gather for corroding grief?
Pour blessings round thee like a shower of gold.
'Tis when the rose is wrapt in many a fold
Close to its heart the worm is wasting there
Its life and beauty; not when, all unroll'd,
Leaf after leaf, its bosom, rich and fair,
Breathes freely its perfumes throughout the ambient air.

Some high or humble enterprise of good,
Contemplate till it shall possess thy mind,
Become thy study, pastime, rest, and food,
And kindle in thy heart a flame refined.
Pray Heaven for firmness thy whole soul to bind
To this thy purpose—to begin, pursue,
With thoughts all fixed, and feelings purely kind.
Strength to complete, and with delight review,
And grace to give the praise where all is ever due.

No good of worth sublime will Heaven permit
To light on man as from the passing air;
The lamp of genius, though by nature lit,
If not protected, pruned, and fed with care,
Soon dies, or runs to waste with fitful glare;
And learning is a plant that spreads and towers
Slow as Columbia's aloe, proudly rare,
That 'mid gay thousands, with the suns and showers
Of half a century, grows alone before it flowers.

Beware lest thou from sloth that would appear
But lowliness of mind, with joy proclaim
Thy want of worth; a charge thou couldst not bear
From other lips without a blush of shame,
Or pride indignant; then be thine the blame,
And make thyself of worth; and thus enlist
The smiles of all the good, the dear to fame;
'Tis infamy to die and not be miss'd,
Or let all soon forget that thou didst e'er exist.

Rouse to some work of high and holy love,
And thou an angel's happiness shall know—
Shall bless the earth while in the world above,
The good begun by thee shall onward flow,
In many a branching stream, and wider grow,
The seed that in these few and fleeting hours,
Thy hands unsparing and unwearied sow,
Shall deck thy grave with amaranthine flowers,
And yield thee fruit divine in heaven's immortal bowers.

WILCOX.

THE LAST MINSTREL.

The way was long, the wind was cold;
The Minstrel was infirm and old;
His withered cheek, and tresses gray,
Seemed to have known a better day;
The harp, his sole remaining joy,
Was carried by an orphan boy;
The last of all the Bards was he,
Who sung of Border chivalry.
For well a day! their date was fled,
His tuneful brethren all were dead;
And he neglected and oppress'd,
Wished to be with them and at rest.
No more on prancing palfrey borne,
He carolled, light as lark at morn;
No longer courted and caressed,
High placed in hall, a welcome guest,

He poured, to lord and lady gay,
The unpremeditated lay;
Old times were changed, old manners gone,
A stranger filled the Stuart's throne,
The bigots of the iron time
Had called the harmless art a crime.
A wandering Harper, scorned and poor,
He begged his bread from door to door,
And tuned, to please a peasant's ear,
The harp, a king had loved to hear.
He passed where Newark's stately tower
Looks out from Yarrow's birchen bower;
The minstrel gazed with wishful eye,
No humbler resting place was nigh;
With hesitating step, at last,
The embattled portal arch he passed,
Whose pond'rous grate and massy bar
Had oft rolled back the tide of war,
But never closed the iron door
Against the desolate and poor.
The duchess marked his weary pace,
His timid mien, and reverend face,
And bade her page the menials tell,
That they should tend the old man well;
For she had known adversity,
Though born in such a high degree;
In pride of power and beauty's bloom,
Had wept o'er Monmouth's bloody tomb!

SCOTT.

THE MORAL CHANGE ANTICIPATED BY HOPE

Hope, when I mourn with sympathising mind,
The wrongs of fate, the woes of human kind,
Thy blissful omens bid my spirit see
The boundless fields of rapture yet to be;
I watch the wheels of Nature's mazy plan,
And learn the future by the past of man.
Come bright improvement! on the car of Time,
And rule the spacious world from clime to clime,

Thy handmaid arts shall every wild explore,
Trace every wave, and culture every shore.
On Erie's banks where tigers steal along,
And the dread Indian chants a dismal song,
Where human fiends on midnight errands walk,
And bathe in brains the murderous tomahawk.
There shall the flocks on thymy pastures stray,
And shepherds dance at summer's opening day;
Each wandering genius of the lonely glen,
Shall start to view the glittering haunts of men,
And silent watch, on woodland heights around
The village curfew as it tolls profound.
Where barbarous hordes on Scythian mountains roam,
Truth, Mercy, Freedom, yet shall find a home;
Where'er degraded nature bleeds and pines,
From Guinea's coast to Sabir's dreary mines,
Truth shall pervade the unfathomed darkness there,
And light the dreadful features of despair—
Hark! the stern captive spurns his heavy load,
And asks the image back that heaven bestowed;
Fierce in his eye, the fire of valour burns,
And as the slave departs, the man returns.

CAMPBELL.

THE SNOW FLAKE.

"Now, if I fall, will it be my lot
To be cast in some low and lonely spot,
To melt, and to sink unseen or forgot?
  And then will my course be ended?"
'Twas thus a feathery snow-flake said,
As down through the measureless space it strayed,
Or, as half by dalliance, half afraid,
  It seemed in mid air suspended.

"O, no," said the Earth, "thou shalt not lie,
Neglected and lone, on my lap to die,
Thou pure and delicate child of the sky;
  For thou wilt be safe in my keeping:

But, then, I must give thee a lovelier form;
Thou'lt not be a part of the wintry storm,
But revive when the sun-beams are yellow and warm,
And the flowers from my bosom are peeping.

"And then thou shalt have thy choice to be
Restored in the lily that decks the lea,
In the jessamine bloom, the anemone,
Or aught of thy spotless whiteness;
To melt and be cast in a glittering bead,
With pearls that the night scatters over the mead,
In the cup where the bee and the firefly feed,
Regaining thy dazzling brightness.

"Or wouldst thou return to a home in the skies,
To shine in the Iris, I'll let thee arise,
And appear in the many and glorious dyes
A pencil of sunbeams is blending.
But true fair thing, as my name is Earth,
I'll give thee a new and vernal birth,
When thou shalt recover thy primal worth,
And never regret descending!"

"Then I will drop," said the trusting flake;
"But bear in mind that the choice I make
Is not in the flowers nor the dew to awake,
Nor the mist that shall pass with the morning;
For things of thyself they expire with thee,
But those that are lent from on high, like me,
They rise and will live, from thy dust set free,
To the regions above returning

"And if true to thy word, and just thou art,
Like the spirit that dwells in the holiest heart,
Unsullied by thee, thou wilt let me depart,
And return to my native heaven;
For I would be placed in the beautiful bow,
From time to time, in thy sight to glow,
So thou mayst remember the flake of snow,
By the promise that God hath given."

GOULD.

TO A WATERFOWL.

Whither midst falling dew,
While glow the heavens with the last steps of day,
Far through their rosy depths dost thou pursue
Thy solitary way?

Vainly the fowler's eye
Might mark thy distant flight to do thee wrong,
As darkly painted on the crimson sky,
Thy figure floats along.

Seek'st thou the plashy brink
Of weedy lake or marge of river wide,
Or where the rocking billows rise and sink
On the chafed ocean side.

There is a power whose care
Teaches thy way along that pathless coast—
The desert and illimitable air—
Lone wandering, but not lost.

All day thy wings have fanned,
At that far height, the cold, thin atmosphere:
Yet, stoop not, weary, to the welcome land,
Though the dark night is near.

And soon that toil shall end;
So shalt thou find a summer home, and rest,
And scream among thy fellows; reeds shall bend
Soon o'er thy sheltered nest.

Thou'rt gone, the abyss of heaven
Hath swallowed up thy form; yet on my heart
Deeply hath sunk the lesson thou hast given,
And shall not soon depart.

He who from zone to zone
Guides through the boundless sky thy certain flight,
In the long way that I must tread alone,
Will lead my steps aright.

BRYANT.

THE BLIND MOTHER.

Gently, dear mother, here:
The bridge is broken near thee, and below
The waters with a rapid current flow—
Gently, and do not fear;
Lean on me, mother—plant thy staff before thee,
For she who loves thee most is watching o'er thee.

The green leaves as we pass
Lay their light fingers on thee unaware,
And by thy side the hazel clusters fair,
And the low forest grass
Grows green and lovely, where the wood paths wind,
Alas, for thee, dear mother, thou art blind.

And nature is all bright;
And the faint grey and crimson of the dawn,
Like folded curtains from the day are drawn;
And evening's dewy light
Quivers in tremulous softness on the sky—
Alas, dear mother, for thy clouded eye!

And the kind looks of friends
Peruse the sad expression in thy face,
And the child stops amid his bounding race,
And the tall stripling bends
Low to thine ear with duty unforgot—
Alas, dear mother, that thou see'st them not!

But thou canst hear—and love
May richly on a human tongue be poured,
And the slight cadence of a whispered word
A daughter's love may prove;
And while I speak thou knowest if I smile,
Albeit thou dost not see my face the while.

Yes—thou canst hear—and He
Who on thy sightless eye its darkness hung,
To the attentive ear like harps hath strung
Heaven, and earth, and sea!
And 'tis a lesson in our hearts to know,
With but one sense the soul may overflow!

ANONYMOUS.

SONG FOR MAY-DAY.

It is May! it is May!
And all earth is gay,
For at last old Winter is quite away;
He linger'd a while in his cloak of snow,
To see the delicate primrose blow;
He saw it, and made no longer stay—
And now it is May! it is May!—

It is May! it is May!
And we bless the day
When we first delightfully so can say.
April had beams amid her showers,
Yet bare were her gardens, and cold her bowers;
And her frown would blight, and her smile betray—
But now it is May! it is May!

It is May! it is May!
And the slenderest spray
Holds up a few leaves to the ripening ray;
And the birds sing fearlessly out on high,
For there is not a cloud in the calm blue sky,
And the villagers join in their roundelay—
For, O! it is May! it is May!

It is May! it is May!
And the flowers obey
The beams which alone are more bright than they:
Up they spring at the touch of the sun,
And opening their sweet eyes, one by one,
In a language of beauty they seem all to say—
And of perfumes!—'tis May! it is May!

It is May! it is May!
And delights that lay
Chill'd and enchained beneath Winter's sway,
Break forth again o'er the kindling soul;
And soften and soothe it, and bless it whole;
Oh thoughts more tender than words convey
Sigh out—It is May! it is May!

ANONYMOUS.

THE SILENT GLEN.

This silent glen, this silent glen,
  Oh how I love its solitude!
Far from those busy haunts of men,
  Far from the heartless multitude;
No eye save nature's sovereign beam;
No breath, but heaven's, to break the dream;
No voice, but yonder babbling stream,
  Dares on the ear intrude.

The peace—the peace of graves is here;
  O that it would but last!
But man lives like the waning year,
  Till joy's last leaf is past:
His bliss, like autumn plants, of power
To flourish for a transient hour,
Ere the bud ripens to a flower,
  Dies on the wintry blast.

Yon alder tree—see how she courts
  The zephyrs as they stray;
Yet every breeze with which she sports
  Scatters a leaf away:
So man will wreaths of pleasure crave,
Though with each flower a thorn she gave,
And the last leaves him in the grave
  To coldness and decay!

How fearfully that hollow blast
  Raved round the mountains hoar;
Ruffled the wave, in fury pass'd
  The heath—and was no more!
Such is the fame of mortal man—
In pride and fury it began,
Yet sooner even than life's brief span,
  The empty noise was o'er.

And even to those for whom is spread
  Joy's banquet richly crown'd,
This world is but a gorgeous bed,
  Where in fast slumber bound,

Pomp's gaudy trappings spread beneath,
They dream away life's fleeting breath,
Till night comes closing in, and death
  Draws his dark drapery round.

HENRY NEELE.

WHO IS MY NEIGHBOUR?

Thy neighbour? It is he whom thou
  Hast power to aid and bless,
Whose aching heart or burning brow
  Thy soothing hand may press.

Thy neighbour? 'Tis the fainting poor,
  Whose eye with want is dim,
Whom hunger sends from door to door;
  Go thou and succour him.

Thy neighbour? 'Tis that weary man,
  Whose years are at their brim,
Bent low with sickness, cares, and pain.
  Go thou and comfort him.

Thy neighbour? 'Tis the heart bereft
  Of every earthly gem;
Widow and orphan, helpless left:—
  Go thou and shelter them.

Thy neighbour? Yonder toiling slave
  Fettered in thought and limb,
Whose hopes are all beyond the grave
  Go thou and ransom him.

Oh, pass not, pass not heedless by;
  Perhaps thou canst redeem
The breaking heart from misery:
  Oh share thy lot with him.

ANONYMOUS.