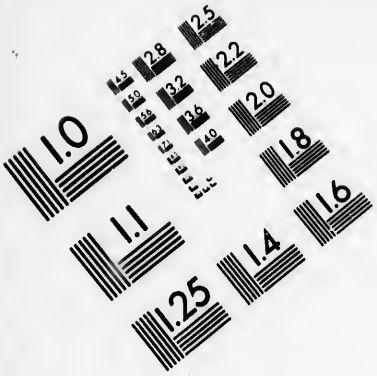

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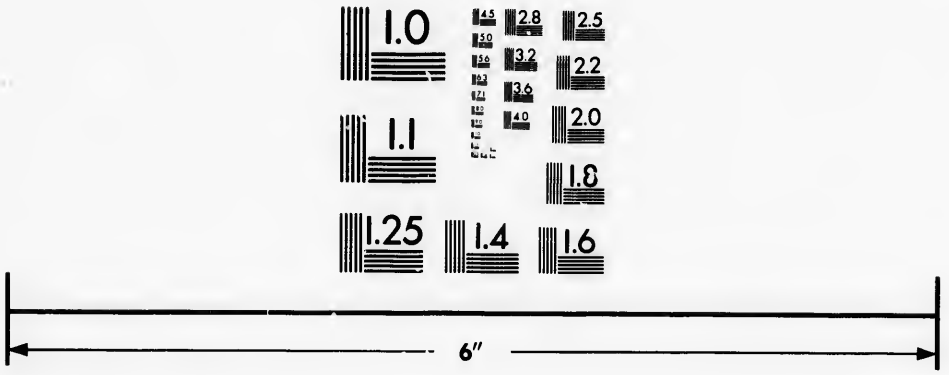

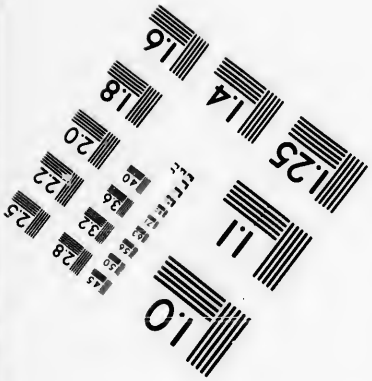

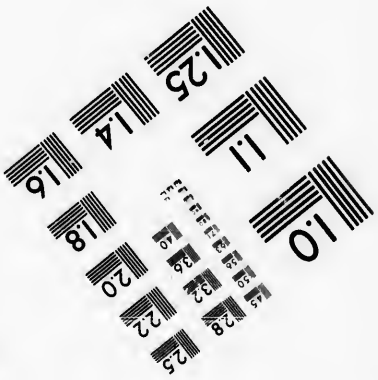

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SKETCH

OF THE

EARLY HISTORY OF ANATOMY.

BY

FRANCIS J. SHEPHERD, M.D.,
Professor of Anatomy, McGill University.

Reprinted from the Canada Medical and Surgical Journal.

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SKETCH

OF THE

EARLY HISTORY OF ANATOMY.*

By FRANCIS J. SHEPHERD, M.D.,
Professor of Anatomy, McGill University.

The origin of anatomy, like that of many other sciences, is lost in the mists of ages. The embalmers among the Egyptians must have had some rude knowledge of the human frame acquired in their process of preserving the dead, but, as they belonged to the lowest class, and were abhorred and despised on account of their occupation, what rough knowledge they may have got concerning the arrangement of the internal organs was kept secret, and so not used for the general good of the community.

It has been asserted by some that the Greeks of the time of Homer were well acquainted with anatomy, and that Homer, in describing wounds, showed an accurate knowledge of the structure of the human frame; but the fact is, that the terms used by Homer were then the common ones employed by the people, and had no exact scientific significance. In later times these same terms were used by all anatomists in special treatises on the subject, and conveyed a certain definite meaning; thus Homer's knowledge appeared much greater than it really was. Eusebius states that Athotis, a traditionary monarch of Egypt, wrote several treatises on anatomy. Hamilton, who wrote a

* Enlarged from an introductory lecture delivered before the Anatomical Class of McGill University, October 1884.

History of Anatomy and Medicine in the first quarter of this century, speaking of this tradition, quaintly remarks that "when we learn that the æra assigned to this fabulous monarch by the wild and improbable chronology of the Egyptians would carry us back to an age prior by many centuries to the formation of Adam, we can easily estimate the degree of credibility to which such a fable is entitled." Acmæon, who flourished some time before the advent of Hippocrates, paid considerable attention to anatomy, and is said to have made dissections, principally of the lower animals. Among other things, he asserted that goats breathed through their ears.

Hippocrates, who lived four or five hundred years before the Christian era, and who has been called the Father of Medicine, was the first individual who wrote a work on anatomy; his knowledge of anatomy was superficial and often most erroneous, and probably rested more on shrewd analogical conjecture than on actual observation. He, however, had a fairly accurate acquaintance with osteology. It is asserted by Pausanias that he hung a bronze model of a skeleton in the temple of the Delphian Apollo as a testimony of his own knowledge and for the instruction of posterity. It is highly improbable that he ever dissected a human body.

Diocles of Carystius, who lived a century after Hippocrates, and who is called the second Hippocrates, is said to have devoted much of his time to the study of comparative anatomy. He did not, as was the custom in those days, make a secret of his anatomical knowledge, but taught publicly, and was the first to write a manual of Dissection of Animals, an art, previous to his time, confined to a few families, and handed down from father to son by oral instruction. Diocles also wrote on Cookery, and held it to be as much a science as that of medicine—an opinion with which Plato altogether disagreed.

It is with the appearance of Aristotle, the preceptor of Alexander, that we must first date the systematic cultivation of the science of anatomy. To him, without doubt, should be awarded the credit of having founded Comparative Anatomy. Many of his admirers, without much reason, claim for him an

intimate knowledge of human anatomy; that he dissected animals is no doubt true, and also that he had a marvellously accurate knowledge of marine animals, but to say that he was a profound anatomist is absurd, and is not substantiated by what we find in his writings. For instance, in his writings he states that the kidney of man resembles that of the ox (which consists of many reniform bodies), and is not smooth like the sheep, that the human uterus is double, that the back part of the skull is empty, that the brain is without blood, and many other things equally absurd. His knowledge of osteology was also limited. He asserted that man had no astragalus (a bone in man forming the keystone of the arch of the foot), "neither," he says, "have many-toed animals, nor solid-footed animals." Now this bone is never absent in mammalian animals with limbs, and it is evident that Aristotle never looked for it, but asserted that these animals were without it on theoretical grounds alone, for in one of his works, "*De partibus Animalium*," he gives elaborate reasons why certain animals have no astragaloid bones. He also stated that the bones of the lion had no marrow, and that the necks of wolves and lions consisted of a single bone and had no flexibility. These points he could easily have made clear by actual examination. He, like Hippocrates, thought that nerves, ligaments and tendons were the same thing; he gave, however, a fairly accurate description of the great blood-vessel, the aorta, and distinguished the windpipe from the gullet; he also had some acquaintance with the structure of the larynx, and knew that the ear and throat communicated. No doubt Aristotle, for his time, was a good comparative anatomist, and some of his observations are valuable, but he so mixed up his facts with fiction that it is not easy to separate the one from the other. He was the first to write a treatise on Comparative Anatomy.

Plato, although he did not study anatomy practically, frequently refers to it in his writings. His references represent, no doubt, fairly well the condition anatomy and physiology had reached in his time, for all philosophers were supposed to know much of physic, under which anatomy was included, but sup-

position and assertion are so substituted for facts that his anatomy appears nearly altogether fanciful and imaginary.

The name of Praxagoras of Cos, the last of the family of the Asclæpiadæ (B.C. 341), has been handed down as the individual who distinguished the arteries from the veins, and who first asserted that the arteries were air-tubes (hence the name *ἀρτηρία*), an opinion which was held for several hundred years by his successors, and to which I shall refer later on.

Up to this time all knowledge of anatomy had been acquired from the dissection of the lower animals, but we now enter upon a new era of great and rapid progress in anatomical knowledge.

In the division of the empire which took place on the death of Alexander (323 B.C.), Egypt fell to the lot of Ptolemy Soter. He and his successors, Philadelphus and Euergetes, ardently encouraged the study of letters and the sciences. At Alexandria, a great library was established and a school of philosophy founded.* Alexandria, under the fostering care of the Ptolemies, soon outstripped its many rivals not only in literature and science, but in wealth and commerce. Learned Greeks, glad to escape from the dissensions of their native states, flocked to Alexandria, where they were sure, not only of protection, but of a hearty welcome; thus whilst the rest of the civilized world, distracted by intestine troubles and ravaged by frequent foreign wars, was fast sinking into a state of semi-barbarism, the Egyptian Greeks, protected by the wise and peaceful government of the Ptolemies, not only kept alive the flame of literature and science, but added not a little to its volume. The Alexandrian School of Medicine, participating in the general prosperity and advance, attained a renown far exceeding that of any school which had previously existed, attracted pupils from all parts, and produced many emi-

* Ptolemy founded the Museum (or University) of Alexandria, which was an establishment for the cultivation of literature and science. To it were attached botanical and zoological gardens for the purpose of practical study. One of the most important features of the Museum was its public library, which was supported with the greatest liberality; whenever manuscripts of acknowledged merit were offered for sale, they were immediately purchased, and the whole known world was ransacked for curious and useful MSS. The list of teachers in the Alexandrian school includes such names as Euclid in Geometry, Strabo and Eratosthenes in Geography, Archimedes in Physics, Hipparchus and Ptolomæus in Astronomy, and Erasistratus and Herophilus in Anatomy and Physic.

nent physicians. Among these were two who did more than any previous individuals to advance the science of anatomy. These men were Erasistratus and Herophilus. They both wrote large works on anatomy, which are, unfortunately, lost, but from which Galen, Oribasius, and others quote extensively. Herophilus and Erasistratus were probably the first who ever dissected the human body, for Philadelphus and Eurgetes gave orders that the bodies of all criminals should be handed over to the School of Anatomy for dissection. Thus at this early period, when the dissection of a human body was looked upon with horror and as an act of desecration, the enlightened and far-sighted Ptolemies, in spite of vulgar prejudices and religious scruples, enabled the School of Medicine of Alexandria to make a great stride forwards in learning, knowledge and reputation. It is said that Herophilus dissected 700 bodies, and that both he and Erasistratus made a common practice of opening living bodies in order to discover the origin of life. Tertullian, a learned father of the Church, who lived at the end of the second century, charges Herophilus with this crime; he says, "Herophilus, that physician, or rather butcher, who dissected 600 men in order to find out nature, who hated man in order to learn the structure of his frame, could not by these means come to a more perfect knowledge of his internal structure, since death produces a great change in all parts so as to render the appearance after death different from what it was before, especially since they did not die a natural death, but expired amidst all the agonies to which the curiosity of the anatomist was pleased to subject them." Celsus, who lived about 20 B.C., also says that Herophilus and Erasistratus vivisected human beings; he mentions it incidentally, as if it were a well-known fact, and does not appear at all shocked at such a proceeding. It is very probable that these anatomists did occasionally vivisect a criminal, since human life in those days was considered of little value, and the people were accustomed to see criminals cruelly tortured before being put to death, so that *vivisection* would, perhaps, be regarded with less horror than *dissection* of a dead body. It is the custom of historians to attribute these charges against Herophilus and Erasis-

tratus to blind and ignorant superstition, and to utterly repudiate them as unworthy of belief, but for the reasons given above the story seems to me a very probable one.

Herophilus, whether the charge against him of vivisecting human beings be true or not, was an able physician, an accomplished anatomist, and a learned man. Galen says of him, "He was an accomplished man in all branches of physic, excelling particularly in anatomy, which he learned, not from the dissection of beasts alone, as physicians usually do, but principally from that of men." He discovered the lacteals and the pulmonary artery, and described correctly the liver and organs of generation; he also described the blood-vessels, and a large blood cavity in the skull is, to this day, called the "Torcular Herophili." It is said that he was the first one who operated for cataract by removing the crystalline lens. Gabriel Fallopius, one of the most distinguished anatomists of the 16th century, said that he would almost as soon think of contradicting the Gospel as the authority of Herophilus.

Erasistratus is supposed to have been a contemporary of Herophilus, and to have flourished in the reign of Seleucus (B.C. 300). He was an able anatomatist, and accurately described, for the first time, various parts of the human frame, as the brain, nerves, valves guarding the orifices of the heart, etc. He it was who first divided the nerves into motor and sensory. He believed that the arteries carried air and the veins blood, also that the only use of respiration was to fill the arteries with air. This has been addueed by some as evidenee that he had never viviseeted human beings, for had he done so, say his defenders, he must neeessarily have found out that the arteries were full of blood, but, as I shall show later on, this argument can have no weight.

Erasistratus was much opposed to bleeding and purgatives, and treated his patients solely by diet and regimen. He condemned strongly complex prescriptions, and, in fact, left everything to nature; he might with truth be called an "expectant physician." Herophilus, it is said, held opinions in physic diametrically opposed to those of Erasistratus, and believed in actively interfering with disease.

From the time of these two anatomists to that of Celsus little was done to keep alive the science of anatomy. Celsus, who lived towards the end of the last century before the Christian era, gives in his works, which are valuable repositories of the medical and surgical knowledge of his time, fairly accurate anatomical descriptions, but he himself does not seem to have done any original work in anatomy.

The first Roman anatomist whose name has been handed down to us is Marinus, who, according to Galen, described the muscles accurately, and also mentions the mesenteric glands. Soon after Marinus, Ruffus of Ephesus, a Greek physician, appeared. He vivisected animals and devoted himself to physiology and comparative anatomy; he made some discoveries regarding the abdominal viscera, and especially the uterus.

Of all the physicians of antiquity, none attained to so great a fame as Claudius Galenus of Pergamus. His reputation is deservedly great, for none did so much as he to advance the knowledge of physic. He was born A.D. 130, and was educated by his father Nicon, a mathematician of repute, as well as an architect and astronomer. Nicon early initiated his son into the mysteries of Aristotle's philosophy, but Galen also studied philosophy in the schools of the Stoics, Academics, Peripatetics and Epicureans. With the exception of the Epicureans, whose doctrines he utterly repudiated, he is said to have taken from each what he thought to be the most important part of their systems. At the age of seventeen he began the study of medicine; he soon outstripped his teachers, and early exhibited proofs of the greatest ability. His renown spreading abroad, he was brought to Rome by the Emperor Aurelius, and in that city he practiced till his death at the age of 90 years. Over his contemporaries he acquired great ascendancy, and held the same position in the medical world that Aristotle held in the world of general science. For hundreds of years after his death his doctrines and opinions held sway, and his sayings were regarded as oracular. Few ventured to oppose his tenets, and up to the 16th century all the medical books were merely commentaries explanatory of Galen's work. If any one advanced

a new theory as to disease, or stated what he believed to be a new fact, it was quite sufficient to show that it was opposed to the opinion of Galen, to bring down shame and disgrace upon the heretical innovator. Although Galen studied, among other places, at Alexandria, it is very probable that his knowledge of anatomy was gained chiefly from the dissection of animals whose structure was supposed to come nearest to man, hence his anatomy is not always the most correct.

Previous to Galen's time, it was thought the arteries carried vital spirits or pneuma, and so convinced were the ancients of this "physiological fact" that, although they were fully aware that when an artery was wounded it bled, they used all their ingenuity and powers of reasoning to explain how it was that a tube containing air *should* bleed when cut. They held that the air first escaped through the wound and then blood came from the veins by communicating channels, to fill the vacuum. Galen fully exposed the absurdity of this belief, and, by experiments on animals, showed that the puncture of an artery by the finest needle immediately gave rise to hemorrhage, and that no discharge of vital spirits took place. He also placed ligatures on the arteries at two points, and demonstrated that the portion of the artery between the two ligatures contained only blood. The Alexandrian anatomists said: "Nature could not have made two kinds of vessels, both intended to contain blood." But Galen replied: "You might as well say that the several stomachs of ruminating animals were not all intended as the recipients of the food, but that one was meant for solids, one for liquids, and one for spirits; they are all the recipients of the same thing, but each, nevertheless, has its separate use. So it is with arteries and veins." (Galen's *Opera Omnia*, Vol. IV, p. 722; quoted by Dalton.) Galen could not explain why two sets of vessels existed to carry blood, but he knew both contained blood, and this he satisfactorily proved by experiment. He did not, as was then (and is now) too commonly the case, start a theory and endeavor to make the facts dove-tail into it, but founded all his theories on experiment and observation, as every true philosopher should. It is very improbable that there were any opportunities

at Rome for dissection of human bodies; for Galen advises students to visit Alexandria in order to study the human skeleton, and not to trust to book descriptions. It is evident Galen himself had few opportunities of studying even the human skeleton, for he expresses great delight and astonishment on one occasion when on his travels he had the opportunity of examining a skeleton which had been exposed by the washing away of the earth which had covered it.

Galen added but little to our knowledge of human anatomy, yet by his researches and arrangement he brought together all that was known up to that time, digested and systematized it, and made it the basis of a medical education. He was a good comparative anatomist, and most of his original descriptions are derived from the dissection of monkeys. His style is clear and correct, and there is not so much confusion as is seen in the authors preceding him. Many of the names he gave to different parts of the body, especially those about the brain, are retained to the present day.

With Galen's death anatomical science declined—nay, was almost extinguished. For many centuries the men that followed him looked upon anatomy as a completed science, and Galen's works on the subject were regarded as sacred and infallible. It is strange that in ancient times all the great names in anatomy are those of Greeks, the Romans, though rich in soldiers, statesmen, poets and orators, never produced any one who was great in physic or any of the sciences.

With the fall of the Roman Empire and rise of Christianity, all learning, especially that having its origin in Greece, declined, for it was thought by the Christians to be the cause of all heresies. Anatomy suffered with the rest, principally owing to the prejudice which existed against the dissection of the human body. Dr. William Hunter, in a lecture delivered over a hundred years ago, remarks that "when faith was thought to be all that was worth acquiring, and prayer almost our only duty, there was an end of liberal education and every ingenious inquiry."

From the second to the eighth century but little progress was made in anatomy. The names of writers in anatomy during this

period are those of mere compilers, such as Oribasius, Meletius, Theophilus, and Soranus; the last mentioned appears to have dissected the human subject, but he added nothing to what was already known.

About this time, what little of science and learning there was in Europe was transferred to Asia; this transference of learning and science from the West to the East is coincident with the capture of Alexandria, which was then one of the chief seats of learning. There the Saracens were first brought into contact with the literature of Europe. When the Northern Vandals overran Europe, they drove from it all that remained of learning and culture, and ignorance was universal. A few monks and quacks practised the healing art in a rude way, but anatomy was altogether neglected. The lamp of science was kept feebly burning by the Saracens, who, although at first despising learning, later encouraged it. The philosophers of the West found refuge in Asia, and were protected by the wise rulers of the Saracens.

It has been for ages a common belief that at the capture of Alexandria its huge library was committed to the flames by the conquerors, and all its treasures, both literary and scientific, destroyed. The only authority for this story is Abulpharagius, who flourished about the middle of the 13th century, nearly six hundred years after the capture of the city. He relates that John Philiponus, the celebrated peripatetic philosopher, requested Amrou, the Saracen General, to spare the celebrated library of the Ptolemies. The General referred the matter to the Caliph Omar, who replied, "If these writings of the Greeks agree with the Koran, they are useless and need not be preserved; if they disagree, they are pernicious, and ought to be destroyed." Abulpharagius goes on to state that the library, in conformity with this decision, was destroyed, and that the books furnished the Arabs with sufficient fuel to heat the baths of the city for six months. Now, in the various histories of the siege and capture of Alexandria, written soon after the event, no mention is made of the destruction of the library. Besides, it is well known that the destruction of such treasures would be utterly repug-

nant to the Mohammedan precepts, which distinctly declare that religious books of Jews and Christians should never be committed to the flames, and that works of profane science may be lawfully applied to the use of the faithful. In addition to this, the Saracens took a great interest in medicine, and it is even said that the prophet himself wrote a book of medical aphorisms. So it is most unlikely that the Saracens would destroy the numerous works on that science which were contained in the library. Again, it is well known that Alexandria preserved its reputation as a school of science for a considerable period after its change of masters. Possibly part of the library was destroyed previous to the capture of the city by the mob of Christians led by Archbishop Theophilus in A.D. 391, and the rest was gradually dispersed in various directions, as happened after the destruction of Constantinople. (*Hamilton, History of Medicine.*) The Saracens ardently encouraged the study of medicine; the Caliph Almansor, the founder of Bagdad, offered large premiums to the translators of Greek works into Syriac and Arabic; schools, hospitals and libraries were established in Bagdad, Cordova,* Seville, and other cities. At one time Bagdad has as many as 6,000 students. Soon a race of learned Arabians arose, who did much to preserve what had, up to that time, survived the sanguinary conflicts and destructive fires of the dark ages. In the department of medicine, chemistry and pharmacy are most indebted to the Arabians, and many terms employed by them are yet in use, as alcohol, syrup, julep, etc. Little or no progress was made in anatomy, as, owing to the strict rules of Islam, which declared him defiled who touched a dead body,† dissection was never practised; nevertheless, they deserve credit for having preserved Galen's works, and in this way prevented anatomy from being altogether a lost science. Some anatomical terms remain as the only trace that anatomy was once in the keeping of the Arabians.

* Alhakem established an academy at Cordova which was frequented by all the Christians of the West. In the 10th century the library contained 224,000 volumes: and in the 12th century 70 public libraries existed in the parts of Spain subject to the Moors.

† The Mussulman faith taught that the soul did not take wing at once, but clung to the body after death, crept from limb to limb, and afterwards took refuge in the chest.

The era of Saracen learning extends to the end of the 13th century, when the empire, which was already showing signs of decay, was overthrown by the Ottoman. The Turks, despising learning, destroyed all the schools and abolished every kind of study in Bagdad, and from this time Europe again became the seat of the little learning that survived. There, the study of the Greek authors was encouraged, and a taste for literature and art was rapidly developed. The University of Bologna now begins to attract notice as a school of literature, medicine and law; in the 13th century it had over 10,000 students in attendance on its classes. In the early part of the 14th century, the chair of Medicine, which included anatomy, was filled by Mondino di Luzzi, called the Restorer of Anatomy; his is the first name of note in anatomy following Galen's. Mondino, in 1315, was fortunate enough to get Royal permission to dissect the body of an unclaimed female subject, the first human subject which had been legally dissected for more than a thousand years. One can well imagine the excitement which must have existed in the old University when it was announced that on a certain day a human body was to be publicly dissected. With what feelings of awe even students and physicians, who had never witnessed such a desecration of the dead, must have regarded the sight, and how such a mutilation of the sacred bodies of the dead would have aroused the animosities and prejudices, not only of the common people, but even the most highly cultured. Mondino himself was not entirely free from these prejudices and superstitions, since he declined to open the head and examine the brain in fear of committing mortal sin. (*Fisher.*)

Martianus, physician to Frederick II. of Naples, induced that monarch to grant permission to allow a public lecture on the actual subject at least once in five years. All the physicians and surgeons in the neighborhood were commanded by Frederick to attend these demonstrations. At these lectures the professor sat on a high chair, with the subject in front of him, and surrounded by his pupils. He demonstrated the various structures as they were laid bare with a huge broad-bladed knife or razor by the barber who was employed for that purpose. An engrav-

ing of such a scene forms the frontispiece of some of the editions of Mondino's Anatomy. It is said that Mondino dissected two female subjects, and shortly afterwards published a description of the human body, illustrated by rude engravings. The title of the book was "*De omnibus humani corporis interioribus membris Anathomia.*" This work was very little different from that left by Galen—in fact, most of the errors of the latter were perpetuated. The Government undertook the publication of Mondino's Anatomy, and the statutes of the University of Padua prohibited the use of any other anatomical text-book. Mondino's Anatomy existed in manuscript alone for 150 years, and first appeared in type in 1578, twelve years after the introduction of printing into Italy. It went through numberless editions, and for more than 200 years was looked upon as an authority. It is quite a small book of 175 pages, and gives a most superficial and crude description of the various parts of the body. It is full of inaccuracies, the arrangement is confused, and the meaning often obscure, still it was the best work in anatomy which had up to that time appeared. The first chapter shows how man differs from the animals; one difference is that man has no tail, "because, being naturally erect, he rests himself by the sitting posture, and a tail would interfere with his sitting down." His reasons for the erect posture are amusing. "First, man is erect because he is of a lighter, more spirituous, and aërial character; secondly, he contains a greater quantity of heat, which is naturally lifted upwards; thirdly, he has, among all animated creatures, the most perfect form, which he shares in common with the angels and the intelligences which rule the universe; and fourthly, the sense of sight, through which most of our intelligence comes, needs to be placed at the highest point of the body, like the sentinel on the watch-tower." (*Dalton.*) Mondino divided the body into three cavities: the upper (head), containing the animal members; the middle (thorax), containing the spiritual or vital members; and lower (abdomen), containing the natures. His description of the heart is singularly correct, and he seems to have had some notion of the uses of the valves, for he calls them *ostiola*, or little doors.

From the time of Mondino to the 16th century, there is little to relate about the progress of anatomy; during that period most of the anatomists were blind followers of Galen, and learned nothing by actual observation. There were one or two exceptions, men who worked diligently and observed closely, though their opportunities were few and their minds still somewhat obscured by the mysteries of the Arabian school. Among these were Matthew de Gradibus, who first accurately represented the ovaries, and Achillini of Bologna, who discovered the small bones of the ear and also gave an accurate description of the brain and intestines.

Leonardi da Vinci, the great painter, was one of the first who gave an impetus to the study of anatomy by the introduction of anatomical drawings. He not only made drawings of human anatomy, but carefully and accurately described and figured the various parts of the anatomy of the horse whilst modelling his gigantic equestrian statue of Francesca Sforza. His anatomical drawings are still extant, and are very correct.*

With the 16th century, we come to a period in which anatomy made marvellous progress, more than it had made for fourteen hundred years previously, and many good anatomists were produced. Early in the century, James Berenger of Carpi was professor of anatomy at Padua and afterwards at Bologna. He is said to have dissected over one hundred bodies, and made not a few discoveries. He correctly described the heart and great blood-vessels, brain, ear and larynx, and gave a very clear account, illustrated by woodcuts, of the abdominal muscles.

Berenger, although a celebrated anatomist, is better known as the introducer of mercurial inunction in the treatment of syphilis, a disease which at this period was spreading with great rapidity in Europe, and which was then of the most virulent type. The whole of Europe was alarmed, and Berenger's discovery lessened to a great degree the severity of the disease and calmed the fears of the people. By the use of his remedy he accumulated an immense fortune, which he left, on his death, to his patron, the Duke of Ferrara. At one time Berenger had to leave Spain because he was accused, as Vesalius was after

* Some are at Windsor Castle, others at the South Kensington Museum, London.

him, of opening a living body in order to observe the movements of the intestines.

The French School of Anatomy arose in the early part of the 16th century, and all anatomical students are familiar with the names of the great men of that school—names such as Dubois (Sylvius), Etienne, the discoverer of the canal in the spinal cord, and others. It is a curious fact that the French anatomists knew nothing of what had been done in Italy by Mundino and his successors, but followed Galen closely and had a remarkable admiration for ancient authorities. They rarely dissected human bodies, but contented themselves with such lower animals as dogs, cats, pigs, etc.

One of the most independent observers and investigators who lived during the first half of the 16th century is Michael Servetus, a Spanish physician. He was educated in medicine in the University of Paris under the assumed name of Michael Villeneuve. Servetus soon quarrelled with the Faculty in Paris, owing to the peculiar views held by him regarding astrology and divination. He early developed a taste for controversial theology, and discussed various theological questions with the leading Reformers, among others, Calvin, whose hatred he soon aroused. When Servetus published anonymously his great work, "*Christianismi Restitutis*," which was alleged to contain heretical doctrines, he afforded Calvin the long sought-for opportunity of condemning him as a blasphemer and heretic and most cruelly consigning an innocent and eminent man of science to the flames. It is in this condemned work we find the first clear account of the circulation of the blood through the lungs—that is, its transfer from the right to the left side of the heart, through the lungs. It is not announced as a new and important discovery, but is merely mentioned incidentally in this theological work addressed not to scientific men but to the Reformers and Schismatics. This is a clear proof that the importance of the discovery, which paved the way for Harvey's greater discovery of the systemic circulation, was not at that time realized.

The greatest anatomist of the 16th century, and perhaps the greatest the world has ever seen, is Andreas Vesalius.

Vesalius revolutionized the teaching of anatomy, and a new epoch of anatomical progress dates from the publication, in 1542, of his great work, "*De Humani Corporis Fabrica.*"* For fourteen hundred years previous to his time, anatomists and physicians reverently bowed before the shade of the great Claudius Galenus, and accepted all his statements as inspired. Vesalius had no sympathy with this feeling of the old school of anatomists, and was one of the first to throw off this yoke of authority which so long encumbered them. He asserted that theory should be based solely on experiment, and observation and anatomy on actual dissection. When only 28 years of age, he published his great work, and in it he, without any respect for authorities of previous ages, exposed and corrected numerous errors which had been perpetuated since the time of Galen. He denied that Galen could not be wrong, and utterly scouted the idea of his inspiration, which had been held by medical men for so many centuries. The publication of his great work called forth an angry storm of abuse, the author was denounced as a dangerous man, and was accused of licentious criticism,† as William Hunter says, "The spirit of opposition and emulation was perfectly aroused; and Sylvius in France, Columbus, Fallopius and Eustachius in Italy, who were all in high anatomical reputation about the middle of the 16th century, endeavored to defend Galen at the expense of Vesalius. In their disputes they made appeals to the human body, and thus in a few years our art was greatly improved." Vesalius was undoubtedly a man of great genius. He had a wonderful capacity for work, and a profound knowledge of the human body. He is spoken of as a man who was "a fluent speaker and master of an admirable style," and also an "ornament to the 16th century and the admiration of the following ones."

Vesalius was born at Brussels on the 30th of April, 1514,

* The University of Basle still possesses a skeleton prepared by Vesalius when he came to Basle from Padua for the purpose of seeing his great work, "De Humani Corporis Fabrica," through the press of Io. Oporinus. The skeleton is that of a man named Jacob Karrer, beheaded whilst Vesalius was in Basle, and who furnished the great anatomist an opportunity of instructing the students at Basle in a new anatomy not then to be learnt from books.

† Even his old friend and teacher, Dubois (Sylvius), denounced him.

and was the son of the apothecary to the Archduke Charles, afterwards Charles V. He developed a passion for anatomy at a very early age, for while yet at school he amused himself dissecting rats, dogs, moles and cats. He studied at Louvain, then went to Cologne and Montpelier, and thence to Paris, where he studied anatomy under Sylvius. Here he remained three years, and by his great dexterity and success in dissection, and intense application, he soon equalled, if he did not surpass, his master. He was frequently invited by both professors and students to give public demonstrations in anatomy.

Vesalius also studied under Johann Winther, the well-known anatomist who first accurately described the pancreas, and was for his numerous scientific acquirements ennobled by Charles V. Whilst in Paris, the war between Francis and Charles V. broke out, so Vesalius went to the low countries and served as physician and surgeon from 1535 to 1537. At the end of the latter year he travelled to Italy, and was made professor of anatomy at Padua at the age of 24. Here he remained till 1543. Whilst professor at Padua he published his great work (1542). In 1544 Charles V. appointed him chief-physician to the Court, and when that prince abdicated in 1555, Vesalius continued in the same position under Philip II. It was here he established his reputation and passed the most brilliant portion of his life. In 1564 there died under his care a Spanish nobleman, and not knowing the cause of death, he asked permission of the relatives to make a post-mortem examination; this was granted him, and on opening the body it is said that some of his assistants perceived that the heart was still beating. The patient's friends were immediately informed, and being naturally indignant at the circumstance, denounced Vesalius to the Inquisition. He was tried and condemned to death by this tribunal, but the king interfered and would not allow the sentence to be carried out, and Vesalius was ordered to make a pilgrimage to the Holy Land to atone for his supposed crime. Whilst passing through Venice he was appointed to the chair of anatomy at Padua, vacant by the death of Fallopius. He accepted the appointment, but had to complete his pilgrimage before entering on his

duties. But, alas! his evil destiny still pursued him, and he never more set his foot on Italian soil, for on his return from Palestine, the vessel in which he sailed was wrecked on the island of Zante. Vesalius escaped to land, but died miserably soon after from hunger and exhaustion in the 50th year of his age (1564). Thus perished one of the greatest anatomists the world has ever known; he must ever excite our respect by his extensive knowledge and wonderful powers of observation. Considering the crude state of anatomy when Vesalius appeared upon the scene, and the perfection at which it had arrived when he left it, we may well wonder how it was possible that the energy and genius of one man could have accomplished so much in so short a time. His great work, which might still be referred to with advantage by modern anatomists, was published, as I have already stated, when its author was only 28 years of age.

Vesalius' anatomical works were long looked upon as authorities, and were translated into many languages, including English. His great work was illustrated by John of Calcar, a pupil of Titian's, whose pictures, it is said, were often mistaken by good judges for those of his master.

The last edition appeared in 1725, and was edited by Boerhaave and Albinus, the latter a great anatomist, as his works testify.

Vesalius had accomplished so much by his originality, independence, and disregard for ancient authority, that others, stimulated by his example, were also encouraged to throw off the trammels of the old divinities of medicine and observe for themselves. Many able anatomists now came to the front, some of whom obtained great celebrity. Such men were Eustachius of San Severino, Fallopius (a pupil of Vesalius), Colombo, Aranzi, Varolius, and many others.

Eustachius, who was a contemporary of Vesalius, though not entitled to the same great reputation, was styled the founder of anatomy. He was a devoted follower of Galen, and blamed Vesalius much for abusing so great a man. He also charged Vesalius with describing in his work a dog's kidney in place of a human one, a fault similar to that with which Vesalius charged

Galen. Eustachius was the first to accurately describe the internal ear and the tube from the throat to the ear, which is still called the Eustachian tube. He, also, was the first to describe the thoracic duct, which he saw in the horse. He discovered the supra-renal capsules, and described many other structures accurately for the first time. In his finer dissections he used magnifying glasses, and separated complicated parts by injection and maceration. Eustachius published a few works in his lifetime, but, from want of means, his anatomical plates, which were ready in 1552, were not published, but remained in the Papal Library till 1714, when, having been accidentally found, they were published by Lancisi. Lauth observes that if Eustachius had been able to publish them himself, anatomy would have advanced much more rapidly, as many of the discoveries afterwards made by observers in the 18th century were anticipated in this work of Eustachius. The last edition appeared in 1790, and even as late as 1830 his plates were much valued for their anatomical exactness. Eustachius was professor of anatomy in the University of Rome, and died there in 1574.

Fallopius, a pupil of Vesalius, was professor of anatomy, first at Pisa and afterwards at Padua. He accurately described various parts about the ear, which still bear his name.* He paid great attention to the organs of generation (as the "Fallopian tube" testifies), and published a large work on anatomy in 1561, which went through many editions.

Columbus was also a pupil of Vesalius, and described the circulation of the blood from the right to the left side of the heart six years after Servetus. He is supposed by many to have first taught it to Servetus.

The name of Cesalpinus (1519-1603) is more interesting to physiologists than anatomists, as it is identified with the circulation of the blood. Although a contemporary of Vesalius, he outlived him fifty years. Not knowing what had been done previously by Servetus and Columbus, he rediscovered the pulmonic circulation, and was the first to use the words "circulation

* Aqueductus Fallopii, which transmits the facial nerve, and the Hiatus Fallopii for the petrosal nerve.

of the blood." He no doubt had some vague idea of the circulation, but his descriptions show by their obscurity that he did not fully comprehend, not merely the systemic circulation, afterwards discovered by Harvey, but the pulmonary circulation so accurately described by Servetus and Columbus. From the very obscurity of his language, which may be made to mean anything, his admirers in Italy to-day call him the discoverer of the circulation of the blood, and have quite recently erected a monument in his honor, in the inscription on which they give him all the credit for this great discovery and brand Harvey as a plagiarist.

There were several other noted anatomists who flourished in this century, and who have left their impress on anatomy and anatomical nomenclature. Among these I might mention Aranitius, professor of anatomy at Bologna, Varolius of Bologna, who is known for his researches on the anatomy of the brain, Coiter of Groningen, distinguished for his work on the cartilages, and others of lesser note.

We now approach near the time when that great discovery, the *circulation of the blood*, was in the air, and on the brink of which discovery men hovered "without effecting it." Their minds were so obscured by the theories of centuries that they could not divest themselves entirely of the incubus. Such unmeaning terms as *vital spirits*, *animal spirits*, etc, are so mixed up with their descriptions, that it is difficult for a modern to understand exactly what they mean. The puzzle to them was, first, how the blood got from the right to the left side of the heart. For centuries it was believed that the left side of the heart received air from the lungs by the pulmonary artery, which, when mixed with blood, became "spirituous blood." This blood was supposed to pass through invisible pores, in the division between the right and left sides of the heart. The circulation through the lungs was discovered, as I have above remarked, by Servetus and Columbus, but the greater systemic circulation —that is, the circulation of blood from the heart through the arteries and back again by means of the veins to the heart— was not discovered for many years after (1619). Cesalpinus,

as we have seen, had only the most vague notions of this circulation, although he was the first to use the term.*

The next step forwards was the demonstration, by Hieronymus Fabricius ab Aquapendente, of the valves of the veins. Fabricius, who was a pupil of Fallopius, and afterwards succeeded him as professor of anatomy at Padua, first publicly showed the venous valves in 1574. At that time the blood was believed to go from the heart, through the veins, to the extremities, so Fabricius failed to arrive at the correct solution of the use of the valves. He held that they retarded the flow of the blood and prevented over-distension.

Fabricius and his successor, Julius Casserius, may be regarded as the last of those illustrious Italian anatomists who established anatomy on a solid scientific basis, and paved the way for the great discovery of the circulation.

Fabricius had for his pupils the immortal Galileo and William Harvey, to whom Aquapendente, no doubt, demonstrated the valves in the veins, and so prepared the way for his later discovery regarding the influence of the valves on the direction of the blood current. The Italians are now claiming that not only did Harvey plagiarize from the works of Cesalpinus, as related above, but was actually taught the circulation of the blood by Fabricius ab Aquapendente, notwithstanding the fact that the published works of the latter show his actual knowledge of the circulation to have been most obscure. Still we must regard Aquapendente as the man who inspired Harvey, who, without his teaching, would probably never have made his immortal discovery.

William Harvey was born in 1578, and received his early education at Cambridge. In 1598 he went to Padua, and graduated as Doctor of Medicine in 1602. On his return to

* Hamilton (History of Medicine, 1830) says the true theory of the circulation was known to Plato, and quotes a passage from Timæus, as follows: "But they (the Gods) established the heart, which is both the fountain of the veins, and the blood which is vehemently impelled through all the members of the body in a circular progression." The author offers the following curious remarks regarding this passage: "Can we suppose," he says, "that this was one of those scattered fragments of divine revelation to man in his state of primæval innocence and simplicity, which were gradually obliterated with the other traces of his celestial origin."

London, full of new thoughts and theories on the circulation of the blood, he entered into general practice, and some years after was appointed lecturer on anatomy to the College of Physicians. At the College he lectured on "the motion of the heart and the circuit of the blood," and illustrated his lectures by dissections and experiments. He taught his new doctrines as early as 1619, though he did not publish his work "*De Motu Cordis*" till 1628. This work is a very clear exposition of his doctrine, and free from the obscurity and ambiguity of the works which had before been published on the subject. Harvey never could find the direct connection between the arteries and veins which Galen declared existed, but believed the blood was transmitted from the arteries to the veins by means of the porosity of the organs. The finding of the capillaries, which connect the arteries and veins, was a later discovery, when the means of research became better and more accurate.

It would be useless for me to try and describe all the important anatomical discoveries which took place in the 17th century, or to give, even shortly, an account of the great anatomists of that period. The anatomical canvas is crowded with celebrated men, such as Van Horn, professor of anatomy at Leyden, Aselli, who discovered the lacteals whilst demonstrating the nerves in the living dog, De Graaf, who discovered the Graafian vesicle in the ovary, etc. The names of De la Boe, Pauli, Wesling, Highmore, and Pecquet are all connected with discoveries in the lacteal and lymphatic systems. The honor of discovering the difference between the lacteals and lymphatics is divided between Jollyffe, an Englishman, and Rudbeck, a Swede. Further discoveries in these systems are associated with the names of Bartholini, Wharton, Blaes, Nuck, and Swammerdam.

From 1650, anatomists began to study the human frame more minutely, and organs and tissues were more closely investigated. Glisson's name is associated with the liver, Wharton's, Wirsung's and Steno's with the glands and their ducts, and Willis' with the brain and nervous system.

One of the most distinguished anatomists of the 17th century was Thomas Willis, who, with Wren, Millington, and Lower, made

some remarkable discoveries in the nervous system. Willis was the first to number the cranial nerves, and the circle of blood-vessels at the base of the brain is called after him, the "circle of Willis." The 17th century has a great number of Englishmen among its celebrated anatomists. The 16th century, with the exception of Harvey, produced no English anatomist of note. Those who wrote works on anatomy were mere copyists, and their books are of little value.

About the middle of the 17th century, magnifying glasses were first made much use of in the prosecution of anatomical investigations. Malpighi, with whose name the use of the first simple microscope is associated,* very greatly advanced our knowledge of minute anatomy, or histology, as it is now called. He it was who first laid the foundation of this, now separate, science. In this he was ably seconded by Leewenhock of Holland. The circulation was now first actually seen in the transparent parts of animals; the blood corpuscles were discovered by Leewenhock. Malpighi first demonstrated that thin tubes or capillaries intervened between the veins and arteries, and not, as was supposed by Harvey and previous anatomists, cells and spongy substance. Leewenhock discovered the presence of scales in the cuticle, corpuscles in the milk, and spermatozoa in the seminal fluid.

I can only mention such names as Ruysch, Albinus, Brunner, Peyer, Duvernay, Cowper, Wrisberg, Vieussens, Meibomius, Spigelius, Valsalva, Santorinus, and Morgagni, all men of note, and who, in no small degree, advanced the science of anatomy. The three last in the above list especially, were remarkably accurate in their descriptions, and in this respect fully a century in advance of their contemporaries. Winslow, who flourished at the beginning of the 18th century, was a native of Denmark, and settled in Paris, where he became not only a naturalized Frenchman, but a convert to Catholicism. He was the first to write an anatomy divested of physiological details and stripped of fanciful hypotheses. His method of description and arrange-

* Hooke and Nehemiah Grew first employed the microscope for the minute examination of plants and animals about 1650.

ment is that on which nearly all anatomical works written since have been modelled. Some have described the appearance of his work as a beginning of a new era in anatomical progress.

The end of the last century and the beginning of this was rich in anatomists of repute, men who did much to make anatomy a science. Such men are Monro, Cheselden, Douglas, John and Wm. Hunter, Cruikshank, Camper, Bell, Zinn, Meckel, Scarpa, Blumenbach, Cuvier, Haller, Buffon, Dumas, Lamarc, and others of lesser note.

From the first quarter of the 19th century up to the present time the march of progress has been steady. Anatomy has become more philosophic, and the methods of teaching and investigation have become more scientific. Human anatomy is now regarded as forming a small, but important, part of one majestic whole. Many men are now laboring where few were formerly found, and laboring, too, with the advantage of all modern methods of research and the great light which has been thrown on the science by their predecessors.

In schools where formerly one subject was dissected in two years, hundreds are used for anatomical purposes, and the whole field is open to the humblest worker. As much information may be (I don't say is) obtained from one subject, owing to modern methods of preservation and injection, as would formeriy be obtained from a dozen. The student of to-day has many advantages which were denied a century or two ago to even the most renowned. Formerly it was a red-letter day when a subject was obtained, and it was dissected and demonstrated by men of reputation to a select few, who greatly prized the long sought-for opportunity, and considered themselves to be among the fortunate to be so favored. In Italy, in former times, one subject a year, who must have suffered the death penalty, was allowed to each school. The difficulty of securing bodies for dissection was great, even as late as the 17th century. Cortesius, a professor of anatomy at Bologna, could not finish a work on Practical Anatomy he had begun, because of the scarcity of subjects; he had only two opportunities in twenty-four years of dissecting human bodies, "whereas," he says, "I expected to have done

so once every year, according to the custom of the famous academies of Italy."

Besides being the basis of a sound medical education, anatomy has other claims of a much broader character; if we study it in the light of our present knowledge, it not only enables us to cultivate scientific habits of thought, but opens up for us fresh fields of inquiry, and puts us in the way of at least partially solving many problems concerning the origin of man and the line of his descent. Thus have morphology and development added a new interest to a subject which was once considered dry and, perhaps, somewhat disagreeable. It is a great mistake to suppose that human anatomy is a subject which has reached its finality; a knowledge of what has been done of late years easily proves this. A few years only have passed since the topography of the cerebral convolutions has been fully described and the origin of the optic nerve traced to the medulla. The position of the internal organs has only quite recently been accurately determined by means of frozen sections of the body, first introduced by the Russian surgeon Piragoff. In fact, every day anatomists are, by their discoveries, placing new problems before the physiologists to solve. "Every year," says Turner, "adds to our knowledge of form and structure and the relations they bear to function, and fresh light is being continually thrown on the mechanism of the human frame." Human anatomy, without the assistance of comparative, cannot be properly studied; the ideas of an anatomist who only knows the human body are as narrow as those of an explorer of a large river who is satisfied with investigating one of its tributaries, or of a botanist who is acquainted with only one order of plants. His range of knowledge being limited, his ideas must be necessarily so; besides, to the pure human anatomist, much interest in the study of his subject is lost, and the explanation of the existence of rudimentary organs, variations, and anomalies is not attempted or even thought of. Anatomy, however, studied in the light of modern science, teaches not only what we have been, and are, but also indicates, faintly perhaps, what the distant future has in store for us.