nerves, brain, stomach alike failing in their functions. If the lungs for only a few minutes fail in their office, the blood becomes unsuited to the living system, the brain is invaded by torpor, and all the manifestations of mind are obscured. And so when the brain suffers from any cause, whether by violence or disease, not only are all mental phenomena deranged, but the muscles become disobedient to the will, the lungs are impeded in their action, and the heart fails to circulate the blood.

Every living thing, vegetable and animal alike, has a circulating fluid out of which all the parts of their organisms are constructed, and through the medium of which all their vital processes are carried on. This in plants is known as sap, and however it may vary in color, in animals it is called blood. During winter the sap ceases to circulate in most plants, and then they appear to be dead; but when the warmth of spring returns the nutrient fluid begins to flow again and the functions of life are all renewed. In all the more highly organized animals the blood is red, but in nearly all the invertebrated families it is colorless or white, while in some mollusks it is blue, and in insects it is yellow, green, or brown. The vertebrates all have red blood except a single species of fish, the amphioxus, which differs from the rest of the family in having no brain, being a sort of connecting link between worms and the true fishes.

The blood furnishes the store from which materials are drawn for the fabrication of all the parts of the bodies of animals, and besides affords a stream into which the waste tissues of the body are emptied as it pursues the round of the circulation; for the animal organization is in a perpetual state of decay, and while every moment the organs are taking from the blood something necessary to their nourishment, they are constantly pouring into it particles which have accomplished their work and are no longer suited to the living system. The circulating mass is thus always on the verge of pollution through the natural wasting of the tissues, which goes on with a rapidity proportioned to the energy with which the functions are performed. If the removal of these effete matters is arrested for the shortest time, the blood becomes unfit for its highest offices, and before long is converted into a defiled current, carrying poison to every part. The depuration is effected by the respiratory process, and the worn-out matters are not only removed, but in the change which they undergo are made to warm the body they are about to leave.

In the lower tribes of the animal kingdom, we have seen, a nutrient fluid of a low grade meets the wants of their systems. They perform their functions on blood of a green, blue, white, or yellow color. As we rise in the scale of being the blood too rises in character. Though red in fish and reptiles, the lowest of the vertebrates, it is cold, and has fewer globules and relatively is much less in quantity than in the higher classes. Its circulation in them is slow, and may be interrupted for a great while without serious inconvenience to these cold-blooded creatures. Their nervous systems exhibitonly the rudiments of the complex structures which are met with in the mammalia. Their brains are simple in organization and in size contemptible. Reptiles and fish enjoy no independent heat, the temperature of their bodies rising and falling with that of the medium in which they live.

With the development of the nervous system, and especially of the brain, the respiratory function needs to be developed, and a more complicated circulation becomes necessary. A fish has a single heart, which sends all its blood to the gills to be aerated. The heart of a reptile is double, but the separation between the cavities is incomplete, and a portion of the blood passes at once from the right to the left side without entering the lungs, owing to which its circulating fluid is an admixture of venous and arterial blood. This is true of most reptiles; but in the alligator and in crocodiles, which stand above frogs, toads, and turtles in the scale of life, a special provision is made for supplying the brain with pure arterial blood. Before this fluid, returning from the lungs, has mingled with the general mass in the heart, arteries filled with it are sent off to the brain. The mingled arterial and venous blood supplies their muscles, and their viscera are nourished with venous blood, showing that these organs can execute their functions on a fluid quite unfit for the offices of the brain.

The renovation of the blood in the lungs is brought about by the agency of oxygen, that marvelous constituent of the atmosphere which has been well named vital air. It is to inspire oxygen that the lungs are in ceaseless motion. The first instinctive effort of the new-born child is to inhale this vital air, as the last struggle of the expiring man is to command the receding current. In the lungs the blood is brought into contact with this air, only the most delicate animal membrane intervening between them. It enters them, charged with the debris of the wasting body, of a dark purple color, and leaves them to return vitalized to the heart, of a bright scarlet hue Oxygen has mingled with it and carbonic acid has left it. For every volume of the former imbibed it is freed from a corresponding volume of the latter. The oxygen flowing in arterial blood through the system unites with the disintegrating tissues, and by oxidizing them, or burning them up, maintains animal heat. The poisonous carbonic acid resulting from this oxidation is returned to the lungs with the venous blood, and escaping through the cells is expired with the residual air.

By a law regulating the diffusion of gases, the purer the air we inspire—that is, the more nearly it is free from carbonic acid—the more readily will this gas quit the blood and pass into the air in the lungs. The air we ordinarily breathe contains about two parts of carbonic acid in every five thousand, and this without reference to the place where we may be. For though its specific gravity is much greater than that of the air, it is found in about the same proportion on the summits of mountains and in deep valleys, and is as abundant over the green fields of the country as it is in crowded cities where fires and the lungs of men are constantly sending forth streams of the heavy gas to poison the air. By the law referred to it is soon equally diffused through all the fields of the atmosphere. When air is inhaled containing not more than two parts of this gas in five thousand an equable interchange takes place between the gases, oxygen being freely absorbed and carbonic acid escaping freely at every expiration; but if we attempt to breathe an atmosphere into which carbonic acid enters more largely, the interchange is interrupted and respiration is soon embarrassed, until at last, a certain percentage having been introduced, no more can be made to enter it from the lungs. In easy natural respiration it has been ascertained that we expire every minute about thirty cubic inches of carbonic acid, but after breathing the same air over again repeatedly the quantity exhaled a minute falls to nine cubic inches, and none is exhaled at all when the proportion in the air inspired reaches ten per cent. And the exhalation seems to be more dependent upon the quantity of the gas in the air inspired than upon the amount of oxgen remaining in the lungs; for if it be removed as fast as generated, animals, it has been found, will live in an atmosphere from which nearly all the oxygen has been absorbed.

Expired air therefore is unfit for respiration. It is poisonous. It contains not less than four per cent. of the gas formed out of the decayed tissues, the deadly carbonic acid, six per cent. of which is dangerous to human life—half that quantity having proved fatal in fact—when formed at the expense of the oxygen of the air. In crowded houses the atmosphere is thus rendered foul in a short time when the doors and windows are closed. The carbonic acid in a hospital was ascertained to have increased to five times its usual proportion after the wards had been shut up all night; and in a lecture room of the Sorbonne where the class had been but a single hour the quantity was increased three times. The effect of this vitiated air upon health is not a matter of doubt. A hospital for women and children in Dublin, many years ago, became noted for the mortality of the infants born in it. One child in every six died of lock-jaw within a fortnight after birth. This started investigation, and the prevalence of this fatal disease was traced to impure air. The ventilation of the hospital was improved, and the infant mortality declined to nineteen per cent., and at last, under greater improvements, the deaths from lock-jaw were reduced to three or four a year.

My purpose, however, is not so much to show the importance of ventilation to the sick as to illustrate its bearing upon the brain, and so indirectly upon education. How by the light of physiology to place your pupils in circumstances most favorable to mental activity? this is the question which you ask science to