blem of secretion as far as we may. Supply a liver cell with blood, and it makes bile; supply a cell of the stomach's glands with blood, and it makes or "secretes" gastric juice. The "properties of protoplasm" is a phrase that means much or little, according as we are wise or heedless of life's acts and wonders. He who is heedless will be apt to say there is no mystery after all; he will urge that living protoplasm, because it lives, discharges these functions, and that there is an end of the matter. But he who is wise will not rest here. He will seek to know *why* one bit of protoplasm makes bile, and *why* another makes saliva. He will regard with wonder the fact that all forms of protoplasm appear essentially similar to all scientific tests. He will look below the surface, and see in the adaptations of this one substance to many and varied ends, another proof of the great contention of modern science—that, after all, the evolution of life's ways and works is as discernible in a study of "secretion," and "cells," as in the growth of the complex animal from the simple egg, or of the flower and its variety from the primitive germ that precedes fruition.

THE BLOOD.

When the voice of ancient authority declared the blood of the body to be its "life," the statement was one which the experience of everyday life seemed fully to support. The physiologist of to-day will not quarrel seriously with the ancient rendering. He knows the impossibility of defining this mystic "life" of ours, which appears now as diversity in unity, and then as unity amidst variety of the most complex kind. He also knows that many other parts or components of the body might with equal justice be named the "life"—at least, in the sense in which the blood has been so termed. The top of the spinal cord (or *medulla oblongata*, as this part of the nervous axis has been named) might, perhaps, with greater force than the blood, be named the "life," since we can lose a pint or two of blood and recover perfectly from the depletion, while a prick with a pin in the medulla would cause instant death. Similarly, the heart might quite appropriately be named the "life," in the sense of the absolute necessity of its action for the continuance of the circulation. The "breath," also, is the "life" in a very plain and unmistakeable sense, since interference with the breathing function means primarily death to the blood itself. But when we consider that the blood-flow is incessant, that it travels to all parts of the body, and that its failure means deprivation of food to the tissues, as well as the want of heat-production, we can readily enough find ample justification for the words of ancient wisdom with which we open this paper.

What is blood? An important question this, and one which may be answered in at least three ways—firstly, *physically*; secondly, *chemically*; and thirdly, *microscopically*. Let us, firstly, endeavour to ascertain the *physical characters* of blood, or those which blood exhibits when regarded merely as a particular kind of fluid. To the naked eye, blood appears of a bright red colour as it flows in the arteries—that is, when it is pure; whilst it is of a purple colour when, in an impure state, it circulates through the veins. Microscopically, as we shall presently see, blood is not really red in hue, but owes its colour to the numerous red bodies (or *corpuscles*) which float in it. Blood is feebly alkaline in its reaction, and this alkaline character decreases from the time of the removal of the blood from the body, and until it clots or "coagulates."

When drawn from the body, blood "clots." From two to five or six minutes suffice for this action. At first, the blood appears as a red jelly; but ultimately, the clot sinks to the bottom of the vessel, leaving a straw-coloured liquid above. Blood thus practically analyses itself before our eyes, into a solid part, the *clot*, and a liquid part, the *serum* or *plasma*. The clot consists of the *corpuscles* or *globules* of the blood (most of them *red*, hence the character of the clot) entangled in a substance called *fibrin*. The liquid, or *plasma*, is the normal liquid or fluid part of the blood itself. This fluid, the microscope shows us, is as clear as water, and owes its apparently red colour, as already remarked, to the red globules that float in it. It is owing to a few of these red corpuscles remaining suspended in the plasma, that the liquid part of the blood in the "clot" seems to be straw-coloured. If we whip up or switch the blood with a bundle of twigs, just after it has been shed, no clotting takes place. In such a case, we whip out from the blood the fibrin which entangles the red corpuscles, and which adheres in strings or shreds to the twigs.

The *chemical composition* of the blood may be very shortly dealt with. A fluid which is supplied to every part of the body, and from which each organ or tissue derives the materials wherewith to renovate and repair its substance, might reasonably enough be expected to present us with a fluid epitome of the entire frame. And so, in truth, do we find blood to exhibit a composition of wide and generalised character. We discover, for instance, that blood contains about 784 parts of *water per* 1,000; it is rich in *albumen*; it contains *fatty matters*; it has a complex list of minerals, such as common salt, chloride of potass, phosphates of lime and magnesium, carbonate of sodium, etc., and it shows on analysis, colouring matter, gases, and a number of substances derived from the waste of the body. Another fashion of showing the chemical composition of blood, brings out its elementary constitution as follows: Carbon, 57·9; hydrogen, 7·1; nitrogen, 17·4; oxygen, 19·2; ashes, 4·4. From such an estimate, we see that blood contains material adapted for supplying all the tissues of the body in the reparative work which is incessantly being performed.

Under the *microscope*, a thin film of human blood is seen to consist of a clear liquid—the *plasma*—in which float two kinds of bodies. These are the *red* and *white corpuscles* or "globules," as they are often popularly named. The blood derives its red colour from the immense number of corpuscles which float in its liquid. The white globules are less numerous; about one white corpuscle existing to 400 or 500 red ones. The microscope enables us to see in between the globules, and thus to perceive the clear liquid. To the naked eye, conversely, the blood appears uniformly red, because the globules are so numerous, and because we cannot perceive the liquid in which they float. Each red corpuscle of man measures in breadth about 1-3200th of an inch, and in thickness about 1-10,000th of an inch. In shape it is biconcave, or hollowed on either side, and is coloured red by a substance called *hæmoglobin*. It is this substance which is affected by the *oxygen* we breathe into the blood, and by the *carbonic acid gas* the body and tissues at large excrete into the blood. The *white corpuscles* of man's blood measure in diameter, each, about the 1-2500th of an inch. Each contains a central particle, the *nucleus*. It appears to be this nucleus which, when liberated from the outer part of the white corpuscle and coloured red, *becomes a red corpuscle*. The red corpuscles of the blood are thus derived from the white ones.

The white corpuscles of the blood are known to possess the curious property of exhibiting movements similar to those seen in the *amœba*-animalcule. These corpuscles (like the *amœba*) can also absorb particles of solid matter, as the animalcule in question takes its food. The white corpuscle is, therefore, a particle of *living protoplasm*, possessing a vitality independent, in a measure at least, of that seen in the body of which it forms part. It is, indeed, a curious fact to ponder over, that rolling about in our veins and arteries; now worming through the walls of blood-vessels into our tissues, and now contracting and expanding their substance, are myriads of minute living specks which, although, part and parcel of our composition, are closely related in structure and life to the animalcules of the pool.

Miscellaneous Notes.

At a Meeting of the Physical Society Berlin, Dr. Konig reported on two optico-physiological researches, which he had carried out in consequence of his optical studies with the leucoscope. In the first he has, with the aid of a special apparatus, examined a number of colour blind persons as to the position in the spectrum of their so called "neutral" point. According to the Young-Helmholtz theory, it is known, there are three primary colours (red, green, and violet), each of which produces its special colour sensation, while all combined give the impression of white. The sensibility for the three primary colours is so distributed over the spectrum that their curves in great part coincide on the abscissa of wave lengths, and therefore mixed colour sensations occur everywhere, while the maxima of the separate curves occur at the places of brightest red, green, and violet respectively. In the case of the colour blind one curve is wanting, and the two remaining ones have therefore a point of section where their ordinates are the same. Hence the eye must at this part have the impression of white or grey. For finding this neutral point in the spectrum, an apparatus served, in which the telescope of a spectroscope was so arranged