PART IV.

AGGREGATION OF CELLS INTO COMPOUND ORGANISMS.

CHAPTER X.

AGGREGATION OF CELLS INTO COLONIES AND COMPOUND ORGANISMS.

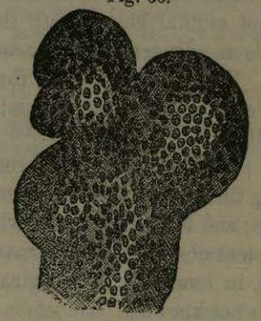
SOME of the cells, when formed, do not remain solitary, each one living by itself, but numbers of them aggregate together, into colonies, or societies, in which all the individuals live their own independent lives, but all together form one community.

Fig. 33.

Fig. 34.

Fig. 35.

Fig. 36.



FIGURES 33, 34, 35, 36.—*Different Forms of Coral Branches.*

The spots, stars, and finger-like projections are the separate Polypes, all united to one main stem.

Instances of this are found in the *Corals*, a mass of which consists of the lime-built cases of a number of distinct polypes, all united, just as bricks are in a wall. Each one, however, lives by itself, and for itself alone, in its own cell, coated with lime. The animal itself is soft and jelly-like. The separate polypes act together,

in this way,—they form conjointly the internal skeleton, or framework, usually like the branch of a tree, on which they all live, each one separately in its own cell. Such an arrangement may be called the first approach toward the formation of a society.

The *Sponges* also exhibit somewhat similar habits. A ball of sponge is only a mass of animals somewhat like amœbas, all quite independent, all nutrifying themselves like other amœbas, and in no way vitally connected with each other. They, however, act together so far as to form a common framework, or skeleton, on and in which they live, like so many separate people in a tenement house.

What we call a sponge is one of the common skeletons cleansed of the jelly-like inhabitants, and of the lime which had served to somewhat harden it.

The difference between the corals and sponges is this: the corals form a common skeleton of lime only, while in many of the sponges it is more or less an animal substance, and sometimes quite horny. There are sponges, however, that form lime skeletons, and they nearly always have a lime or silex center, somewhat like an incipient backbone.

For a long time both corals and sponges were thought to be plants, and even till quite lately the sponges were considered as much vegetable as animal. They are now, however, by general consent, classed as animals. Many of them, nevertheless, contain a green-colored substance, apparently identical with chlorophyl, the green-colored matter found in the leaves of plants.

The stony skeletons of the sponges, and other allied beings, are the most beautiful and regularly formed objects that can be conceived, and their varieties are endless. Many of them are microscopic; others large enough to be seen by the naked eye. They are often visible in the clear interior of the flints found in the English chalk, which when polished make beautiful ornamental stones.

In some very simple cellular organisms the separate beings merely hang or stick together, in bunches, more or less large, each one being still quite independent.

Simple and unimportant as this kind of union may seem, it is still an advance on detached single-cell life, where each one lives and dies by itself, and where there is no kind of mutual help. Both the coral and the sponge, humble though they be, have made an advance, and are nearer to the higher animals than the *gregarinas*, or *amœbas*. They show us one of the first steps in that process of *evolution* by which all the higher animals, man himself included, have been produced from the simple single cell.

Cells propagate, either by forming a new brood inside, and then bursting and scattering them, or by dividing themselves into bits, or by budding, as will be shown elsewhere; and the rapidity with which this is done is amazing. It has been stated, by competent observers, that as many as *sixty-six millions* of new cells are formed in a minute, in some cases, all originating from a single parent; but how far this can proceed is not known.

It is supposed by some, that each cell, when it begins this astounding rate of propagation, starts with a certain amount of force, which can carry it only so far, and that when this original force is exhausted, the propagation of new cells ceases. If this be so, it follows that every *family* of cells has its limit of duration, and must, sooner or later, come to an end. In the simplest single-cell beings, as soon as a new brood is formed, it is scattered far and wide, each individual living and dying independently by itself, so that the fate of the family cannot be followed step by

step in each of its members. When we ascend higher however, all the family originated by one cell have a tendency to hang together, more or less, either in strings, chains, cones, or regular-formed bodies. Probably the coral and sponge societies start in this way, from one parent originally.

In still higher organisms, as in the vertebrate animals, all the cells produced from the one primitive parent cell are held together by a single integument, or skin. The *egg*, from which every such animal is produced, is the primitive parent cell, from which are produced the millions of other cells that finally form the full-grown body. None of these are thrown off till the new individual is fully developed; then some of them are *specialized*, and thrown off in the form of eggs, or sperm, to begin the formation of other new beings in the same way.

It is just the same with a plant, which starts from a single cell, in the form of a seed or bulb, and this by ceaseless multiplication forms continually new cells, which build up the perfect plant; and when complete, some of the cells are specialized into seeds or bulbs, to form other new plants, just as some of the animal cells are specialized into eggs, or sperm.

In the plant, however, as in some of the lowest animals, a piece of the perfected body may be cut off, as a small branch, for instance, and, being planted, will grow into a new plant just as a seed or bulb would do. This branch is, in fact, only a cluster of cells, which can go on propagating, in proper conditions, just as if still attached to the parent body.

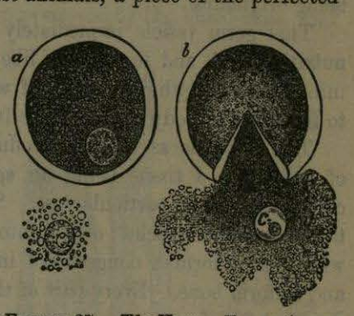


FIGURE 37.—*The Human Egg, or Ovum.*

a represents the parent cell, containing the primitive germ, or vesicle, as seen in the female ovary. *b* shows the parent cell ruptured, as it is when fully ripe, and the germ vesicle escaping, surrounded by the nutritious granules, by which it first begins to nutrify itself, and develop. *c* is the germinal vesicle. HERE, THEN, IS THE FUTURE MAN, IN HIS FIRST STAGE, *much magnified.*

The question has been asked, however, if this continued division, and redivision, in the case of a plant grown from a seed or bulb, could go on forever. Many physiologists say no, but that it must come to an end some time, because as the original cell, the seed, started with only a certain stock of force, this must in time be exhausted, and then its final descendants will no longer have the power to continue propagation.

In this way they account for the enfeeblement, and dying out, of many kinds of trees and plants once vigorous and healthy. Many varieties of fruits, formerly well known, have been so extensively propagated by budding and grafting, that the power of reproduction—so these men say—has been all expended, and they are now fast becoming extinct. Every bud, or graft, it must be borne in mind, is, in reality, only a continuation of the parent tree, and not a new start from a parent cell, or seed.

Observation has not been as yet long enough continued, nor systematic enough, to settle this point; but it certainly seems reasonable to suppose that there is a limit to the duration of a family derived by continual re-propagation from one original parent; and that it is necessary, in the course of time, to get a new start from a seed or egg; that is, a primal germ.

In the higher animals, of course, nothing of the kind has to be considered, because they are all propagated singly, each one from a new cell or germ, and cannot be multiplied by subdivision.

A century ago, owing to the ravages of syphilis, it was common for men to lose their noses, and those who could afford it paid poor men to consent to having a new one cut from some part of their bodiés, and grafted upon the mutilated face. The operation was usually successful, but great consternation was caused by some one suggesting that if the poor man died first, the nose taken from his body would die at the same time. *Hudibras* alludes to this in his well-known lines—

> "And when the date of Knock was out,
> Off dropt the sympathetic snout."

It is needless, perhaps, to say that the fear was groundless.

Every animal, high and low, starts from a simple cell, and begins its life like a simple *monad*. In the monad, however, the primitive stock of force carries its future development only to a certain extent, and in a certain way, while in the higher animal it is capable of carrying it farther, and in a different way.

Man, for instance, begins life as a little vesicle, or bag of fluid—a simple *cell*—as all other animals do. In his first stage, or beginning, man is shown in the preceding figure, which represents the female ovum, or egg, from which every human being originates.

This germ vesicle immediately begins, by osmose, to suck in the surrounding nutritive fluid, and to develop, like any other cell, and finally divides and subdivides into millions of other cells, all of which are appropriated, in the process of growth, to forming the body of the future full-grown man.

The new cells as they are produced are formed into what are called the *tissues* of the body—a tissue being an aggregation of cells, modified or specialized in a certain way, for a particular use. Some of them, for instance, form into threads, or fibers, as in the muscles; others into pipes or tubes, as in the nerves and blood-vessels; while others form a congeries of interlaced cavities, which become filled with lime, and so form bone. Every part of the future body, in short, is built up of cells, produced at first from the multiplication, or division, of the primitive parent cell.

A man is, in fact, an aggregation of cells, as is a coral or sponge, only, in his case, they are so vitally united, and interact so in concert for a common purpose, that, conjointly, they form a compound organism, having an independent life of its own. This larger life, however, is really a result of the combined forces of all the individual cell lives of which it is composed, and each of which still lives its own little life as an independent being.

It is the same as in a working steam-engine, where every particle of wood, iron, coal, and water possesses, through all its workings and changes, its own individual power and properties (or *life*), while all together form the compound life, the *engine*.

The engine has no power that did not exist before it was made, in the material it is composed of, or in that which works it. Nor has man any powers but what exist in the cells of which he is composed, and which, primarily, existed also in the inorganic elements of which they are made.

The newly developing being remains connected with the parent organism till its own structure is so far perfected that it can begin to live by itself; then, its organs being so far perfected that it can form new cells from the food which it takes, for a while it simply grows, or increases, and afterward maintains itself in equilibrium, till the time comes when the power of cell formation and assimilation ceases, and then it dies.

The growth of a man, and his after-maintenance, are effected from the blood, a

peculiar fluid that circulates in his veins and arteries, and which is derived chiefly from the food he eats.

Blood consists, mainly, of a large number of little vesicles floating in a clear liquid, which is albuminous or protoplasmic, and contains also several salts and other inorganic ingredients. In it is found the material of the body, but not in a proper form for assimilation. By the action of the cells, this crude material, which is only digested food, is sorted and recombined into true protoplasm, suitable for nourishing every part of the body.

There are two kinds of cells in the blood,—one globular and colorless, dotted with little grains; the other flattened, with no dots, and filled with a deep-red fluid. Each of these cells is a distinct individual, with a life of its own, but all co-operate together to support the life of the compound being in whose vessels they circulate.

The various changes required in this protoplasmic fluid, to fit it for nutrition, are effected by these cells, by the action of osmose, and if they are deficient in number or activity, those changes do not fully take place. The individual then becomes feeble and loses flesh,—he has *poor blood*. The life of a man depends, therefore, on the life of these little cells in his blood.

Such is the power of selection and combination possessed by the blood-cells, that they can form true protoplasmic material out of any other albuminous fluid, as well as out of the true blood fluid. In many cases of great hemorrhage or extreme exhaustion, it is well known that blood from other and healthier bodies can be transfused into the veins of the sufferer, and life and strength be restored. It is not so well known however that, in case blood cannot be obtained, *milk* may be used; and many cases are on record where life has been saved by injecting it into the veins. Even weak infusions of many farinaceous matters will serve the same purpose, after great loss of blood.

In such cases the blood vesicles select the needed material from the milk, or other albuminous fluid, the same as they would do from the true blood fluid.

Nothing shows more clearly than this that man is but an aggregate of cells, and that his life is the sum of all their lives. While they live, he lives; when they die, he dies, and his powers, whatever they may be, are but the sum of their powers combined.

Every part of the body, bone, muscle, brain, hair, nails, and skin, all are composed of cells more or less modified. Some of them are fixed (as those of the bones, for instance), or change but very slowly. Others, especially those of the brain and nerves, are all the time in a state of rapid change, and so are those of the blood. The more active any part of the body

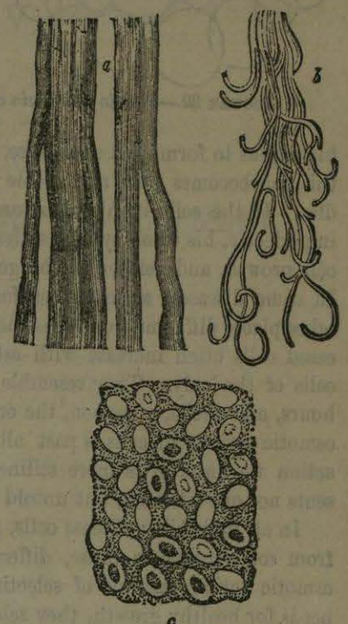


FIGURE 38.—*Cells of Different Kinds.*

a and *b* show cells formed into fibers, as in muscle, or cartilage. *c* shows the cells in bone; these cells are all filled with plastic or solid matter, to make them firm, or unyielding.

is, the more rapidly do its component cells become disorganized and die, and new ones take their place.

In fact, it is upon this rapid change that activity depends; the consumption of cell material, and its constant formation, resembling the fire in the engine, by which the steam is produced. Muscular motion rapidly uses up the muscle cells, and new ones have to be supplied from the blood. *Thought* and *emotion* consume cell matter, in the *brain*, still faster, and the blood has to circulate in it with a rapidity proportionate to the work it performs.

In the next cut is shown the cells in the *brain* of a cat. These are all globular, and soft, being filled only with fluid. At *a* and *b*, some of these cells are shown separately, each with its nucleus.

The skin is simply a layer of flattened cells, and even the claws, nails, and horns of animals are formed from them; the liver, kidneys, and all other secreting glands, are but clusters of cells, each cluster specialized for its particular purpose.

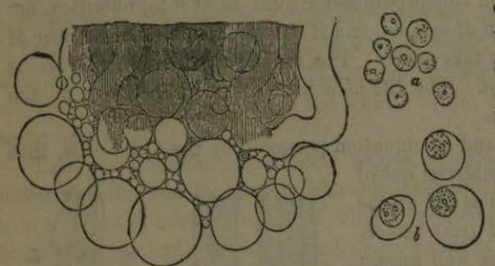


FIGURE 39.—*Cells in the Brain of a Cat.*

It will be readily seen from the above explanation, that the *cell* is the foundation of the man, and that even when he is full grown, his life and active usefulness depend entirely upon the ability of his organs to form, and assimilate, new cell material. If he then make too little of this, he becomes poor and feeble; and if the depreciation be carried too far, he dies. If the cells in his blood are deficient in number, or perform their functions imperfectly, his whole system suffers. Debility and disease both come from deranged cell growth, and neither can be got rid of till the cell action again becomes perfect. In some diseases, as in cancer for instance, a morbid or unusual growth of cells takes place, different from those normally existing in the system; and these new diseased cells often increase with astonishing rapidity, at the expense of the proper cells of the body. They resemble those fungus cells which often spring up in a few hours, and choke, or poison, the ordinary vegetation of the place they grow in. The osmotic activity of cells is past all conception. Compared with it, the most rapid action we know of is mere stillness, and it is incessant. A man, therefore, represents not one life only, but untold millions of lives!

In all probability disease cells, as those of cancer above referred to, have become, from some unknown cause, different in structure from healthy ones, and in their osmotic action, instead of selecting that material from the blood which the body needs for healthy growth, they select hurtful material.

It is highly probable that those who suffer from cancer, if they have children, will transmit to them a tendency to this abnormal cell formation, and in this way perpetuate the dire disease. The same may be said of many other diseases, and the first practical step toward getting permanently rid of them will be for people so afflicted not to propagate. In future and wiser ages, I have no doubt, this will be attended to. In fact we do attend to it now, in the *lower animals*, but neglect it in *man!*

PART V.

EVOLUTION.

ORGANIC AND EMBRYONIC DEVELOPMENT.