be invaluable to an employer of labor, as well as to pedagogues. This coefficient can also be used to make a comparison between an individual working under his own guidance, i. e., a man who is being "left alone" and the same individual when subjected to the influence of various stimuli, such as admonitions, curses, prayers, the hope of reward, the fear of punishment, or the artistic delight in achievement. Perhaps this explains the well known popular assumption that only an expert in profanity makes a good mule driver.

A decrease in energy can be made by successive compressions of a dynamometer, by Mosso's ergograph, or with the dynamograph invented by Professor Charles Henry of the Sorbonne. Fatigue can also be tested by a decrease of rapidity in certain simple movements, as for example, in the so-called tapping test. This see-sawing produced by steadily increasing fatigue and by spurts of energy designed to make up for the loss causes the descending curve which indicates a fatigue to be very irregular in character, showing individual variation.

The dynamometer consists of a metal spring which is compressed by the hand. Its defect consists in its hardness and stiffness which produce pain, which tends to inhibit the effort. Mosso's ergograph is far better. In this a weight is lifted by the repeated contraction of the middle finger, which wears a ring attached to a string which runs over a pulley, the weight being at the other end of the string. The weight used must be neither too large nor too small, 3 to 4 kg. being best. The proper rhythm is one contraction of the finger every 2 seconds; a slower rate permits the finger to rest, so that according to Maggiora's ergogram a rhythm of 10 seconds prevents fatigue. Too fast a rhythm, on the other hand, tends to produce cramp. The defect of the ergograph consists in the impossibility of maintaining a sufficient degree of immobility in the arm to prevent coöperation by fresh muscles of arm and shoulder.

Professor Henry's dynamograph represents a distinct improvement. Here the work is done by compressing a rubber bulb filled with mercury communicating with a manometer. Since the mercury is not rigid the effort causes no pain. The surface of the mercury bears a float connected with a registering device. The bulb must be squeezed rather slowly to prevent the mercury from rising above the float.

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A NEW THEORY CONCERNING THE NATURE OF THE PHENOMENA OF LIFE.

BY FELIX REGNAULT.

OUR knowledge has now reached such a degree of advancement that we are enabled to regard the phenomena of life from a new viewpoint. This consists in regarding the living being as consisting of two substances, one of which is actually living while the other is organic in nature.

The living substance may be termed the "energiade"; in this class are included the nucleus, the protoplasm, and certain intracellular elements. The energiades manufacture organic products. Some of them remain intracellular, while others are pericellular and still others are extracellular. Among these latter are those which are architectural in character.

It is not true as stated in the classic definition that a tissue is formed simply by the union of cells having a similar constitution; it comprises also an organic product. Tissues are divided into three classes according to the quantities which they contain of this product, as follows:

1. The tissues having numerous and contiguous cells with a not very abundant intermediate organic product. Examples of such tissues are the epithelium and the endothelium.

In these tissues the cell has an important functional rôle while the organic products has a secondary rôle.

2. The tissues composed of rare and isolated cells immersed in an abundant organic product. Certain lower organisms, such as the volvox are composed of cells of the same kind united by an abundant gelatinous substance. Among the higher creatures the conjunctive cartilaginous and osseous tissues are formed in this manner. The cells of these tissues are specialized in the production of the aforesaid organic products and have no other rôle. The organic product has an important functional rôle. The grafts of these products succeed well upon condition that the cells which they enclose are killed. These dead cells are then replaced by the cells of that part of the body which acts as the host for the grafted piece and these cells readily invade the organic product.

3. Tissues constituted exclusively by the organic product. The latter proceeds from a pericellular or an intracellular secretion which is liberated by the death of the energiades. Examples of such tissues are the vascular canals of wood among plants and the epidermis among animals. Finally, such a tissue is sometimes produced by an extracellular secretion, such as the shell of mollusks.

In every tissue an effort must be made to distinguish between that portion which is the truly living substance and that portion which is merely the organic product. There are cases in which this distinction is very difficult to make.

The corpuscles of the blood are living to begin with, while they exhibit a nucleus, and are erythroblasts. They continue to remain living in the batrachians among whom they retain their nucleus. But in the higher mammals they lose the nucleus and are formed solely of hemoglobin and then become merely an organic product.

The muscular substance is derived from protoplasm; from the point of view of embryologists it is to be regarded as an organic product. Protoplasm has long been regarded as the vital principle par excellence. But today it has diminished in importance, while the nucleus has increased in significance. However, the habit has continued of considering protoplasm to be a living substance as well as a nucleus. However, the properties, movement and excitability of protoplasm can be explained by physico-chemical laws. When separated from the nucleus it perishes; by itself it is incapable either of assimilation or of reproduction. Contrary to the nucleus it possesses an incomplete vital energy; to all appearance it is capable of acquiring the vital energy of the nucleus but incapable of producing that energy.

The laws which govern the phenomena of life are a subject of debate. Some authorities accept the animist theory, others that of the unicists, and still others, finally, that of the vitalists. In these discussions we ought to make a distinction between the organic products, which necessarily obey physico-chemical laws and the energies. It is quite possible that the latter produce a special form of energy which differs from other forms of physical energy as much as electricity differs from heat or from light.

Conclusion.—Living organisms may be regarded as composed of two substances, the living substance or energies and the organic product. These two substances form tissues in which they exist in variable quantities; the tissues may be classified by taking as a basis the quantity of organic products which they contain.

Certain substances which are commonly regarded as being living are in reality organic products: such are the corpuscles of the blood and the sarcolemma of the muscles. It is possible that protoplasm itself is merely an organic product of the nucleus—in any case it possesses an incomplete vital energy which it acquires from the nucleus.

While the organic products are governed by physico-chemical laws, it is easy to believe that the energiades produce a special form of energy which is peculiar to life.—Presented by Dr. Ch. Richet before the French Society of Biology in Paris at the Session held December 6, 1919.