8. Sex-characters segregate at the second (the 'reduction') maturation division. For eggs which develop without fertilization and without a second maturation division contain both the male and the female characters, the former recessive, the latter dominant. But, in normally parthenogenetic species, eggs which undergo a second maturation division and then develop without fertilization are always male. In such species the female character regularly passes from the egg into the second polar cell; in dicœcious animals *either* sex-character may remain in the egg.

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SCIENTIFIC BOOKS.

Die Biogenhypothese. Eine kritisch-experimentelle Studie über die Vorgänge in der lebendigen Substanz. By MAX VERWORN. Jena, Gustav Fischer. 1903. 8vo. Pp. 114.

To consolidate the ideas which are presenting themselves more or less obtrusively to the minds of all workers in the biological sciences, and to give them concrete expression, is an accomplishment of no little importance, and it is this which Professor Verworn has attempted in propounding his Biogen-theory. Biogen is the special constituent of protoplasm whose decomposition and recomposition are the basis of the phenomena which we recognize as life, and the paper now under review is an examination into the nature of vital phenomena and an endeavor to deduce from this examination what the general composition and structure of the biogen molecules must be.

In its essence Verworn's theory differs but slightly from that advanced by Pflüger many years ago; it does differ, however, in its details. For it recognizes the similarity of the chemical processes taking place in the cell to those manifested during the action of an enzyme, accepting the prevalent view that an enzyme acts as a catalyzing agent and that the action of a catalyzer is the formation of a labile intermediate product which instantly decomposes, restoring the catalyzer to its original condition. Enzymes exist in the living substance which are capable of bringing about complicated syntheses and have the power of producing by their activity additional quantities of themselves; such phenomena demand the assumption that even in the molecules of the enzyme metabolism occurs and the biogen molecule may be regarded as something similar to such an enzyme.

Assuming this idea as a foundation, what may be predicated concerning the special composition of the biogen molecule? It is well known that an increase in the amount of oxygen increases, and a diminution of it diminishes, the irritability of the living substance, and Professor Verworn believes that it has been established by his own observations and those of his pupils on strychninized frogs that this phenomenon depends upon an increase in the lability of the biogen molecules in the presence of oxygen, and a diminution of it in the absence of that substance. If this be true, then it may be assumed that there is in the biogen molecule a chemical group which reacts readily with oxygen, and, since the functional activity of muscle, for instance, is associated, as Hermann demonstrated long ago, with the formation of non-nitrogenous products of decomposition, it may be supposed that the reacting group is a carbohydrate group, or, perhaps, on account of its affinity for oxygen, a carbon group of the type of a carbohydrate with a terminal aldehyde group.

But in addition there must also be a nitrogenous group in the molecule, since a continuous nitrogenous catabolism is going on in the tissues, and that this group is probably of the benzol type is shown by the formation of aromatic decomposition products, such as tyrosin, indol, phenol, skatol, etc., as the result of the digestion or putrefaction of albumen compounds. For the building up of a complicated organic compound a benzol group presents many possibilities, and Verworn supposes that such a group forms the center of a biogen molecule and that the carbohydrate

group is a side chain associated with it. Further, he supposes that the central group has attached to it another side chain which acts as the receiver and transmitter of the oxygen, and consists of a nitrogenous or iron compound, since certain compounds of either of these elements readily combine with oxygen and yield it up again. A biogen molecule may, then, be pictured as composed of an oxygen receptor and translator, consisting of a nitrogen or iron group, and oxidation material represented by a carbohydrate group with certain aldehyde-like peculiarities, both these groups being united as side chains to a benzol nucleus.

In such a molecule two varieties of destructive change may occur: what may be termed functional dissociation, affecting only the carbohydrate side chain, and destructive decomposition, which affects the entire molecule. The latter process necessarily impairs or destroys the activity of the molecule, and is compensated for by the synthetizing powers of the unaltered biogens which, acting on the products of digestion, build up additional molecules by a process of polymerization.

It is believed that there is no evidence of the existence of biogens in the cell nucleus, although this structure, directly or indirectly, contributes to the maintenance of the metabolism of the cytoplasm. The active molecules are located exclusively in the cytoplasm, which also contains reserve supplies of nutrition and of oxygen, the latter being in composition, and it is also supposed that there is present normally a greater or less amount of material, produced by the action of the cell enzymes, and of such a nature that it can at once be employed in the restitution of the biogen molecules.

Such is, in outline, the biogen theory, and having expounded it, Professor Verworn proceeds to apply it to the explanation of certain physiological phenomena. He points out that two changes may be recognized as causes in the diminishment of a response to stimuli: (1) A diminution or suppression of the lability of the molecules and (2) a diminution or suppression of the supply of restitution material. The characteristic symptom of the first of these causes is a gradual rise in strength of the minimal stimulus during the development of the phenomenon, while that of the second is the occurrence during its development of constantly increasing intervals during which the tissue fails to respond to the stimulus. On this basis a distinction, already drawn on somewhat similar lines by an American physiologist, is made between *fatigue* and *exhaustion,* the latter being regarded as due to the imperfect restitution of the molecules, while the former is the result of an impairment of their lability, owing to an accumulation in the tissues of catabolic substances which act as narcotics. For it is claimed that the effect of narcotics in general is an inhibition of the lability of the biogens.

It would carry us too far to follow the author into his application of the theory to the explanation of the phenomena of the self-regulation of metabolism, of rhythm and of the source of muscular energy. Suffice it to say that these subjects are treated with the same clearness and suggestiveness as distinguish the remainder of the paper. Professor Verworn is careful to insist that his theory claims merely the rank of a working hypothesis, and, viewed in this light, it should serve a purpose in stimulating further investigation. Its similarity to Pflüger's hypothesis has been already noted; indeed, it might be characterized as Pflüger's theory expressed with greater precision and combined with an idea borrowed from Ehrlich's well-known theory of immunity. One may question the advisability of substituting the single chemical compound biogen for the more complex protoplasm as the material basis of vital energy, and it may be claimed that the assumed structure of the biogen molecule is altogether too schematic; but, nevertheless, it will be admitted that the paper is full of interest and suggestion, and even though the future may show the theory to be futile, it must be remembered, as the author points out, that 'for the development of human intellectual life a fertile error has infinitely greater value than an unfertile fact.'

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