Physical Concepts in Biology

Philosophy of Science

HENRY OSBORN TAYLOR, in *Human Values and Verities* (Macmillan):

With the crumbling of the old entities and the new rivalry among mathematical postulates, the foundations of physical theory are shaken. As for the biological sciences, their ultimate basis must lie in physics, and be shaken by the changes in physical theory, even as the flora and fauna of the earth's surface are disturbed by subterranean tremors. Yet plants and animals go on their ways heeding little of what is taking place beneath the soil, and biologists worry as little as possible about relativity and nuclei and electrons. They have troubles of their own from the complexity and trickery of living organisms, the unlooked-for behaviour of the phenomena of life.

It may be that biology has its own postulates, superimposed on those of physics. Biologist, as well as physicist, contents himself with seeking the *how* without looking beyond what Claude Bernard called *"la cause prochaine ou les conditions d'existence des phénomènes."* Doubtless today "invariable antecedent" or some other non-committal phrase would be substituted for the word "cause". As a general postulate the biologist might insist upon that which the same clear-seeing Frenchman called the absolute principle of determinism which he asserted no biologist could doubt—*"un principe scientifique absolu. Ce principe est le déterminisme des phénomènes qui est absolu aussi bien dans les phénomènes des corps vivants que dans les corps bruts."* This word has a rather different philosophical meaning in English, but I think the French savant meant by it that a given antecedent or condition or *cause prochaine* inevitably issues in the same resulting phenomenon. It seems to me a precise and specific statement of the fundamental scientific postulate or belief in an invariable or rational order in nature. It amounts to a claim that biology is or may become a precise science, like physics or chemistry. This is what biologists are working for. Yet a more instructed realization of the perplexing and unexpected conduct of organisms has since Bernard's time driven the worker to contemplate the possibility of more than one interpretation of his experiment. He might hesitate to affirm so unequivocally the unqualified determinism of organic phenomena.

There may be other biological postulates or imperfect inductions that apply only to living organisms. For example, Harvey's *omne vivum ex ovo* and Virchow's *omnis cellula e cellula* (1855). The first may need qualification, since the growing organism takes much into its substance which could scarcely be said to come *ex ovo*. No exception might be taken to the second but that it dates from a time when the cell was imagined to be a homogeneous body, and of course cytologists are now trying to state specifically how the parts of the succeeding cells come from the corresponding parts in the parent.

There may be still another general biological conviction that every living organism has some quality besides its physical or chemical constituents, even though that quality be but a pattern or configuration. A living thing is not simply the sum of its tangible components. The succeeding and apparently related phenomena of a living organism conduce to the continuation of its existence and functioning. There is no need to endow such phenomena with purpose. With reason most biologists reject the crude term of vitalist. But they might well refuse to be called mechanists just because they work along the ways of physics and chemistry.

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The Egg as a Physical System

Biology

SIR WILLIAM B. HARDY, in *Colloid Symposium Monograph* (Chemical Catalog Co.):

Let us in conclusion consider the ovum as a physical system. Its potentialities are prodigious and one's first impulse is to expect that such vast potentialities would find expression in complexity of structure. What do we find? The substance is clouded with particles but these can be centrifuged away, leaving it optically structureless but still capable of development.

On the surface of the egg there is a fine membrane, below it fluid of high viscosity, next fluid of relatively low viscosity, and within this, the nucleus which is, in the resting stage, merely a bag of fluid enclosed in a delicate membrane. How shall sources and sinks of energy be maintained in a fluid composed largely of water? They undoubtedly are there for the egg is a going concern, taking in oxygen and maintaining itself by expenditure of energy.

Clearly the ovum is possible only as a paradox. It is no pangenetic structure—a mosaic of all the parts to which it will give origin. Tristram Shandy's theory is false. To play its part it can only be the simplest form of living matter, but its simplicity is neither that of a machine nor of a crystal but of a nebula. Gathered into it are units relatively simple but capable by their combinations of forming a vast number of dynamical systems into which they fall as the distribution of energy varies. After all, a nebula holds within itself the beginnings of a history more complex even than that of an ovum and yet, so far as structure is concerned, it is but a simple affair!

The more there is known about living matter the more there is revealed a curious simplicity. Sheeman finds skin transmuted to brain or brain to skin, but the agent which effects the change appears to be a chemical substance probably of quite ordinary character. You may lead living matter as you may a donkey with a carrot—but you have to choose the carrot with some care.

Biology halts on the mechanical side because it needs the services of men who are at once real physicists and real biologists — both faculties being within the same brain. Biochemistry has made its great advances because it has been served of late by men who are both real chemists and real biologists.

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