SCIENCE

Biophysics

THE rise of biophysics is an expression of the fact that, more and more, physically trained scientists are becoming ensnared in problems involving living matter. It is, after nuclear physics, one of the most significant developments of modern science. Physics for many reasons has long been concerned primarily with inanimate matter. But we are now faced with the tragic realization that a large measure of understanding and control of our physical environment, intellectually satisfying and wealth-producing though it is, has not only failed to define the living state but has engendered human problems that endanger continuity of life itself. This is one of the most compelling reasons why physical science is moving toward a greater preoccupation with the animate half of nature.

Had biophysics developed a century ago it would probably soon have taken the form of a highly organized, if fragmentary, inquiry into the physics of biological material. But physics has lost much of its former universality, and it is not surprising that the emerging biophysics is amorphous and episodic, and may never acquire that unified elegant expression which made classical physics so aesthetically satisfying to the scientific intellect of its day. Nonetheless, biophysics already has its fundamental aspect and its workaday fields of application.

The oldest of these is in fact a branch of physiology. In part experimental and in part a mathematical biophysics, it seeks to account for the form and behavior of biological structure by means of the mechanics, optics, and electricity of classical physics. Its contributions to the mechanics of respiration and blood flow, and to our knowledge of how a nerve acts or an eye functions, are well known.

Physics now provides many radiations besides light and heat to which living matter may be exposed, and research into their generally injurious effects is building a second chapter of biophysics. They are useful in the control of disease, and their analysis throws some light on vital processes; we all know that knowledge of these effects is needed as protection against the destructive agents that man has himself called into being.

Physics cannot be satisfied until it has interpreted the properties of matter in terms of its atomic and molecular composition. The molecules of living matter have a complexity not found in inanimate nature. New methods for dealing with them lead to a third kind of biophysics which seeks, in combination with biochemistry, to understand properties of organic matter in terms of the atomic make-up, the reactions, and the arrangements of these giant molecules.

Underlying biophysics is a search for a scientifically adequate definition of the term *alive*. All interpretations of nature use intuitive concepts which mark the present limits of our intellectual perception; and *alive* involves such a concept. Its scientific indefiniteness is immediately apparent when, for instance, we ask if viruses are alive. Information that will make our definition more precise is coming from many sources, but there is a widespread feeling that the study of viruses—those denizens of a seeming twilight zone between the living and the nonliving—can supply much of it.

Evidently biophysics in its essence is more than either the use of physical tools by the biologist or the application of physical precision of thought to problems of biology. Law in physics has been established with the aid of simple systems manipulated by the experimenter. Although many of the attributes of living matter can be analyzed through such systems, life is a coordinated activity of entire organisms never fully under the experimenter's control. The alteration in physical thinking needed to deal with this situation may prove to be the most important consequence of our growing concern with living matter.

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SCIENCE, founded in 1880, is published each Friday by the American Association for the Advancement of Science at the Business Press, 10 McGovern Ave., Lancaster, Pa. Entered as second-class matter at the Post Office at Lancaster, Pa., January 13, 1948, under the Act of March 3, 1879. Acceptance for mailing at the special rate postage provided for in the Act of February 28, 1925, embodied in Paragraph (d-2) Section 34.40 P. L. & R. of 1948.

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Annual subscriptions, $7.50; single copies, $.25; foreign postage, outside the Pan-American Union, $1.00; Canadian postage, $.50. Special rates to members of the AAAS.

The AAAS also publishes THE SCIENTIFIC MONTHLY. Subscription rates on request.