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PREFACE

THIS VOLUME is a partial record of the First National (U.S.A.) Conference on Biophysics. It contains papers submitted by invitation of the Program Committee or editors, papers submitted by the authors and selected by the editors, and all abstracts which were submitted for presentation at the conference. The rule of not rejecting any abstract for any reason was adhered to, though sometimes with difficulty; as a result this book represents a truly composite view of the frontiers of biophysics as seen by more than 200 investigators, a view that could not be matched by any work of a single or a few persons.

As there is nothing in biology or in physics which may not find a place in biophysical research, the topics presented cover a major portion of all biology and medicine. Clear lines of demarcation have yet to be formed between biophysics and cellular physiology, psychophysics, and chemical cytology—to name just some of the bordering and overlapping disciplines. However, a large fraction of the total effort is concentrated, at this time, in a few areas, and these areas have certain characteristic features.

Much of biophysics consists in the application of physicists' methods and instruments to biologists' problems. This area is a moving frontier zone: as soon as a physical method is worked out to a degree where its application no longer requires the special training of a physicist or the special facilities of a physics laboratory, it ceases to be part of biophysics and becomes just plain biology. Thus, at this time, X-ray microscopy is biophysics, and routine light microscopy is biology.

Not all of the physicist's skills involve instruments. One major skill in which, as a rule, physicists are better trained than most biologists is that of forming concepts and of applying mathematical treatment. Many biophysicists are very much interested in thus treating biology. For this it is necessary to have deep understanding of both the abstract methods used and the biological problems treated. Such understanding is not easily achieved by verbal communication between physicists and biologists if both have only average training. Special study is needed, on either side, to reach a thorough understanding of the other side's problems.

The most effective study method is, for the physicist, to acquire a working knowledge of one branch of biology, and vice versa. This seems to be the basic principle of current biophysics curricula. Once a person has a working knowledge of the physical and biological methods needed to deal with a particular problem, he will tend to investigate it by himself. In this way, much biophysics becomes simply biology done by physicists, or by biologists with special training in some parts of physics. The combination of a biologist's problems with a physicist's approach has yielded some excellent results, and some that are rather regrettable; examples of both kinds are on view in this very volume.

There is another problem area, quite different in origin from the application of physics to biology but also unquestionably belonging to biophysics: the study of the effect of physical agents upon living things. This includes both normal physical stimuli (the biophysics of perception) as well as agents which do not operate under physiological conditions—e.g. large amounts of ionizing radiation, high accelerations. Here, again, the physicist is called upon if the control and measurement of the physical agent studied involves special skill and instrumentation. This area, too, is a moving frontier zone: it is a matter of record that as soon as the effects of some physical agent become fairly well known, its students tend to turn to the use of the agent as an analytic tool to study the nature of the living reactant. Radiation biology offers conspicuous examples of this trend. Thus, again, what starts as biophysics tends to become biology.

The question arises whether there are areas in biophysics besides these shifting zones which are defined by particular difficulties rather than by particular interests. Are there major coherent problem areas which are new to the physicist (other than new applications of well-known techniques) and equally new to the biologist (other than new approaches to well-known problems)? The answer is a tentatively affirmative one; there seem to be a few fields which, while not radically new, are in a state of rapid development, a development in which people who call themselves biophysicists take an important part. Some of these evolving fields are characterized by impressive coordination of physical with anatomical, chemical, mathematical, and psychological methods in the analysis of well-characterized biological phenomena; such fields are the study of perception; the study of membranes, nerves, and muscles; the newer branches of genetics. Another new development is largely conceptual: the establishment of systems analysis as a special discipline, with roots

in probability theory, statistical mechanics, and some modern branches of engineering science, such as network analysis and synthesis, cybernetics, information theory. Then there is the new field of molecular biology, with a methodology which is still in full development, concerned with a class of objects that seem to have unique physical characteristics and important biological functions. If molecular biology is defined as the study of the characteristic biological macromolecules, the way in which they are formed from ordinary molecules, and the way in which they, in turn, are organized in the formation of virus and organelles, then it accounts for more than half the contributions to this volume.

The present volume can fulfill an important function in acquainting a wide public with the present state of biophysical research in this country. In order to fulfill this function it must be read—preferably from cover to cover. To make it readable, the editor had to forego the simple and safe alphabetical sequence in order to group papers and abstracts by topics. Of course, there is no linear arrangement that does justice to all the varied relations between papers, and no grouping of topics which accounts equally well for all relations between topics. The present arrangement was arrived at after several attempts; it is necessarily subjective, and apologies are extended to all authors who feel that their papers have been misplaced.

HENRY QUASTLER

Brookhaven National Laboratory
January 1958

FOREWORD

FROM TIME to time the need for an organization of biophysicists, whether formal or informal, has been in the minds of those whose work combines physical and biological methods. There was little interest in a more formal organization before World War II. Afterward, interest accumulated, probably in an exponential manner, until about the year 1955, when several active strides were taken in that direction. All of these are not known to the writer, but some of them can be listed. They are as follows: In September 1955, a meeting at Tufts College, in connection with the American Physiological Society meetings, organized by Dr. W. A. Selle. Also in September 1955, a small conference, "The Careers and Training of Biophysicists," was sponsored by the Biophysics Department of Yale University and held at its Hartford House. These exploratory operations were followed by a more formal session on the occasion of the meetings of the American Institute of Physics in New York at the Hotel New Yorker, January 31, 1956, under the chairmanship of Dr. Selle. Prior to this meeting, Drs. W. J. Fry and H. P. Schwan had devoted some time and effort to considering the process of a formal organization of biophysicists.

At this New York meeting, which was very important in that it represented the first open meeting with this kind of interest in mind, a large and inclusive steering committee was named and asked to meet in Atlantic City with the Federation on April 18, 1956.

In due course the Atlantic City meeting was held under the chairmanship of Dr. S. A. Talbot, where it was voted to organize and hold a national conference on biophysics and a Committee of Four was appointed to set it up. The same Committee of Four, which is now responsible for this volume, is submitting this short foreword.

At both the New York and Atlantic City meetings the question of a biophysics society was brought up. In both cases, a motion for its immediate formation was defeated. It was quite apparent that there was a rising interest in such a society; but a somewhat conservative attitude of approach, which seems to be characteristic of biophysicists, was evident right from the start.

The Committee of Four appointed an advisory Committee of Thirteen which met with it at the Barbizon Plaza on May 26, 1956, to organize further details for the meeting being planned at Columbus, Ohio. After another meeting on June 7, 1956, a proposal for financial support to the conference was submitted to the Air Force for consideration.

In short order, funds were granted by the United States Air Force Office of Scientific Research, largely because of the understanding and wisdom of Colonel A. P. Gagge, and the whole mechanism of setting up a program was able to get under way. Under the approved contract, some funds were provided for publication of these proceedings as well as—even more important—funds to assist in travel for those attending the conference.

The purpose of the Columbus conference, then, was to represent biophysical research as broadly as possible, thereby defining in a practical way what biophysics is in the minds of those who identify themselves with it. To fulfill this aim, invitations to attend and contribute short papers were sent to over 1,500 scientists, suggested by twenty-two organizations concerned with biophysical research and its bordering fields. From the 225 papers received and presented, about a third were selected for publication in full by an Editorial Committee. The abstracts of the remainder are also included, to complete the *Proceedings* of the 1957 *Biophysical Conference* and show the scope of the program.

An outstanding feature of this conference was a series of invited papers, presenting syntheses of representative areas of biophysical thought. The privilege of publishing these outstanding papers is appreciated by the sponsors and the Planning Committee.

Among those who worked vigorously to make the conference a success were Dr. H. P. Schwan, chairman of publicity, and Dr. R. B. Stacy, chairman of local arrangements. The success, and in fact the whole development, of the biophysics society owes a great deal to these two men.

The conference actually became a reality in Columbus, Ohio, March 4, 1956. In concluding this short foreword, we reproduce verbatim the remarks made by Dr. K. S. Cole at the beginning of the meetings.

> Last Spring, after considerable rumbling, some minor explosions, and not a little bickering, a Committee of Four was designated to organize a biophysics meeting with an ulterior motive of finding out if there was such a thing as biophysics and, if so, what sort of thing this biophysics might be.

In the ominous quiet that followed, your committee realized that it didn't know how to organize any meeting—much less one for an unknown *number* of unknown *people* in unknown *places* working on unknown *problems* in unknown *fields*. So it called for advice and assistance and both were given most effectively and with an outstanding generosity—by the Advisory Committee, by the Air Force, by the Publicity Committee, by the Columbus Committee, and by this hotel, and especially by the invited speakers, the contributors of papers, and the rest of you to whom it has been important to attend this Conference.

And so now the four of the committee can welcome all of you—from our oldest friends to our newest colleagues—to *your* conference, and I have the privilege of voicing that welcome. But I also have the opportunity to indulge one of the objectionable characteristics associated with gray hairs—to reminisce! Thirty-five years ago at Cornell I asked my teacher, F. K. Richtmyer, "What is a biophysicist?" and he said, "Darned if I know, but I'll tell you something that I think is biophysics." That was the beginning of the path I have followed ever since.

And now at this Conference, I suggest that we may say with George Wald that life is part of the physics of our universe and consequently, of course, biophysicists are those who do this physics. And so for the Committee of Four I say, "Here is your conference—and we hope you like it."

E. C. POLLARD
FOR THE COMMITTEE OF FOUR

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