Book Reviews

Protein Synthesis

Ribosomes. Papers from a meeting, Cold Spring Harbor, N.Y., 1973. M. NOMURA, A. TISSIÈRES, and P. LENGYEL, Eds. Cold Spring Harbor Laboratory, Cold Spring Harbor, N.Y., 1974. xii, 930 pp., illus. $32. Cold Spring Harbor Monograph Series.

The study of protein synthesis has become in the past few years a problem in enzymology. We think we know what goes into (or onto) the ribosome and what comes out, we can identify several functional states of the system that we believe to be intermediates in a cycle (or several cycles), and we understand in principle the nature of the information-transducing system by which the ribosome translates the genetic code from polynucleotide into polypeptide language. This level of understanding of protein synthesis carries enormous biological insight. But it is not entirely satisfying because of the conspicuous blur in the picture where the ribosome itself is concerned and the large number of still unanswered questions about the ribosome and its complexity. And it would be most surprising if there are no further interesting surprises as we attempt to deal with these complexities.

With the separation and characterization of all of the 58 or so molecular components of the (bacterial) ribosome and the advent of techniques by which ribosomes can be reassembled in vitro from dissociated and separated RNA and proteins, it has become possible to extend the resolution of our understanding of protein synthesis from the 200-Å level of a few years ago to 30 Å (the approximate diameter of an average globular ribosomal protein) or so. Progress in that direction is the subject of this book, which, in 39 well-integrated review articles by some 68 authors, successfully pulls together a very large body of diverse data on the structure, function, and assembly of the ribosome, constituting an early stage in the development of ribosome enzymology. What is most striking about this book is, first, the overall coherence, which may be spurious, of all the data and, second, the very small ratio of answers to questions.

Representative of the apparent agreement among diverse experiments is a topographical model of the small ribosomal subunit from *Escherichia coli*, presented by Traut *et al.*, in which each of 20 proteins is represented by a styrofoam ball and the RNA is left out altogether. The model is based on physical data, assembly mapping and reconstitution studies, and chemical cross-linking experiments—the efforts of many laboratories. When it is systematically compared with data on functional properties of the proteins and results of other studies, overall the consistency is quite impressive, with functionally related proteins repeatedly being found grouped together. While it may be premature, since much more relevant information can probably be obtained rather quickly, the model serves two useful functions in that it summarizes and correlates many data and it makes predictions that can be tested. What it does not do is give us any immediate insight into the mechanism of protein synthesis.

There are many more unanswered questions. A basic one is the question of the function of ribosomal RNA. Since the realization that ribosomal RNA is not the genetic message there has been no good explanation for the fact that about two-thirds of the mass of the ribosome is RNA and that the ribosome is the only known ribonucleoprotein enzyme. Views presented in this book (to overstate them somewhat) range from that of Nomura and Held, that the RNA is a cheap filler the purpose of which is to give the particle overall dimensions sufficient to interact with 80-Å-long transfer RNA molecules, to that of Kurland, that the interesting functions are assigned to RNA, with the bulk of the proteins there only to hold the RNA in a proper conformation. Nearly all the functional studies presented in this book have been limited to the proteins, for operational reasons. As Kurland suggests, the fact that one RNA molecule encompasses the whole of each subunit and cannot easily be subdivided for functional studies, whereas the proteins are many, small, localized in the ribosome structure, and separable, has dictated the experimental preoccupation with the proteins and accounts for the relative scarcity of functional assignments to the large RNA's. And indeed this idea seems to be borne out by the fact that the smaller 5*S* RNA appears at least as interesting functionally as any of the proteins. But proteins are so much more intelligent than RNA that we cannot avoid a bias in their favor.

Since these studies are in such an early stage of development, the question arises, as it did for the editors of the book, whether at this time it is wise to canonize current concepts by making them the subject of a monograph in this prestigious series. In spite of the danger that some of the material will find its way into textbooks, I believe this book is extremely useful in several respects. Even with the great simplification achieved by the introduction of a uniform nomenclature of ribosomal proteins, the literature in this field has become so complex as to be utterly bewildering to the outsider and difficult to correlate even for those directly concerned. By bringing together, summarizing, comparing, and digesting masses of fragmentary publications this book makes the field accessible to outsiders (though its 900-odd pages are still formidable to the merely curious) and helps ribosome researchers to frame their questions and design critical experiments.

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Colored Substances in Animals

The Significance of Zoochromes. ARTHUR E. NEEDHAM. Springer-Verlag, New York, 1974. xx, 430 pp., illus. $26.20. Zoophysiology and Ecology, vol. 3.

The subject matter of this volume is, as the title indicates, the colored substances in animals. Unlike previous authors of comparable volumes, who have emphasized the chemistry and taxonomic distribution of such substances, Needham has chosen to deal primarily with their functional significance. In the context of the book, he prefers the terms "biochrome" and "zoochrome" to "pigment," which he would confine to use in art and industry. He uses "biochrome" to refer to "a specific chemical substance with a coloured molecule, synthesised by living organisms," and "zoochrome" to refer to a biochrome that is "found in the bodies of animals." The term "pigment" is so well entrenched in the scientific literature, however, that an effort to replace it may prove futile.

Zoochromes have interested humans for many centuries. Even Aristotle described

the color changes of some animals in his book *History of Animals*. The present book goes far beyond a mere discussion of integumentary zoochromes. It deals with all the colored molecules that occur in animals, including the carotenoids, fuscins, quinones, bilins, porphyrins, melanins, ommochromes, purines, pterins, isoalloxazines, and hemocyanins.

After a brief introductory chapter, there is a detailed chapter explaining the physical basis of color in molecules. The subsequent chapters concern themselves mainly with the functions of the many zoochromes in such processes as photoreception, camouflage, protection against radiation, oxidation and reduction, oxygen transport, and reproduction and development. In addition, there are interesting chapters on such topics as the genetic basis of chromogenesis, pathological states involving zoochromes, and zoochromes and evolution.

In the introductory chapter, Needham comments that because of the multiplicity of functions that biochromes serve many biologists are as yet disinclined to recognize what he refers to as "a discrete science of biochromatology." This book presents a strong case for such recognition.

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Thermal Biology

Temperature and Life. H. PRECHT, J. CHRISTOPHERSEN, H. HENSEL, and W. LARCHER, Eds. Springer-Verlag, New York, 1973. xx, 780 pp., illus. $54.70. Second edition of *Temperatur und Leben* (1955).

This is the long-awaited second edition of the authoritative book *Temperatur und Leben*. The second edition is in English and the translation is excellent throughout. Because the first edition was a bible for workers entering the field of thermal biology, this edition demands close attention.

The new book unfortunately is merely a compilation of relevant literature on microorganisms (two contributors), plants (seven contributors), poikilothermic animals (four contributors), and homoiothermic animals (three contributors). The bulk of the book suffers from a lack of either a synthetic or an analytical approach to the literature. In places it is reduced to a catalog, which makes it pedestrian reading. In most chapters coverage of the literature is complete up to 1972, and in one case work published in 1973 is included in footnotes.

The chapters, and in some cases sections of the same chapter, are largely independent of each other, and little or no attempt is made to integrate material on similar subjects in different sections. It is irritating to find such topics as frost resistance and cold injury in plants dealt with at a variety of levels by several different contributors. The chapters on plants, with the exception of the one by Gates, are the weakest. This may in part reflect current knowledge about the temperature relations of plants, which seems to be still at a very descriptive level. In my view that part of the book would have been improved by a more rigorous editorial policy.

I regret that more space could not be found for the excellent work on cryobiology, which surely deserves more than half a page. This is a field in which many exciting advances have been made, particularly in studies of the mode of action of cryoprotectants and on freezing injury, work that demands to be included. Furthermore, I cannot believe that nothing of significance has been published in this field since 1960, the most recent reference quoted. A similar criticism can be leveled at the section on the effect of temperature on spermatogenesis, where much of the significant literature since 1950 has been ignored. At least the publications from the laboratories of Lacy, Steinberger, and Clegg should have been included. It is also disappointing that the interesting observation by Edwards that maternal hyperthermia produces developmental abnormalities in the fetus is left out of the section on temperature and development.

Students will find the chapter by Gates most useful, and Precht's cautions regarding experimental procedure in thermal physiology are most instructive, though they would have been more pungent had they been illustrated by examples. At a time when more and more workers are studying the effect of temperature on enzyme kinetics, the contribution by Havsteen is most welcome. Surely, though, this was the place to discuss the significant contributions by Hochachka and his colleagues to our understanding of the mechanisms involved in capacity acclimation in terms of thermal modulation of enzyme activity. In fact, one of the most disappointing aspects of the book is that the opportunity to seek explanations for the observed effects of temperature on living organisms at a fundamental level is not taken. Accounts of effects of temperature on cells, cell organelles, and enzymes are scattered throughout the book. It seems a great pity that the proposed chapter by Lumper on physical and chemical aspects (to be published separately) was not included instead of the repetitive material in existing chapters. In my view the greatest omission is the recent spate of research on the effect of temperature on membranes, particularly on membrane fluidity and phospholipid model membranes. A chapter that included, for example, the elegant studies of Bangham, Chapman, and van Deenen on model membranes, together with the work of Fox, Overath, and McElhaney on bacteria, of Kemp, Hazel, and Raison on mitochondria and chloroplasts, of Charnock, Grisham, Papahadjopoulous, and Hokin on the Na^+–K^+ adenosine triphosphatase, of Eletr, Inesi, and Sreter on sarcoplasmic reticulum, and of Wunderlich on *Tetrahymena*, could have integrated these related studies and made the workers in these various fields less isolated from each other. The type of work done by Willis on tissues from hibernators might also have been included.

I found the index deficient. The publishers should consider presenting a supplementary index with the Lumper contribution, as well as an author and a species index. These addenda would make this a valuable reference text, particularly for new workers in the field.

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Theory of Statistical Mechanics

Nonequilibrium Statistical Thermodynamics. D. N. ZUBAREV. Translated from the Russian edition (Moscow, 1971) by P. J. Shepherd. P. Gray and P. J. Shepherd, Transl. Eds. Consultants Bureau (Plenum), New York, 1974, xx, 490 pp. $25. Studies in Soviet Science.

This text deals with the formal theory of equilibrium and nonequilibrium statistical mechanics. The treatment is at a level appropriate for a second-year graduate course. Zubarev's discussion is uniformly clear, and his development of the material is interspersed with a number of particularly illuminating remarks. The approach is formal in the sense that no attempt is made to supplement the discussion with either illustrative examples based on soluble models or a comparison of theory and experiment. These omissions tend to give the book a somewhat dry quality. In addition, we note that, although the date of the original Russian edition is given as 1971, most of the material in the text was already classical a decade earlier. Thus, some of the most important recent developments in statistical physics (for example, long time tails in transport phenomena and the theory of mode-mode coupling near critical