cellent *Coastal and Submarine Morphology* (1958) and may disappoint specialists in morphogenic processes, but the volume will be of value to most geomorphologists, many geologists, college students in earth sciences, and interested laymen. It presents both sides of many controversial questions and in some cases skillfully avoids commitments of preference. Its above-average figures and plates appear at appropriate places in the text. In early chapters an impression may be created that the "classical" ideas of W. M. Davis, F. P. Gulliver, and D. W. Johnson are regarded too seriously, but in subsequent discussions they are subordinated to modern concepts. The author's familiarity with coasts of western Europe and North America is evident, although the one or two well-chosen examples given for most coastal features are heavily weighted in favor of those occurring in Australia.

The emphasis on Australia is welcome because the continent exhibits such a diversity in coastal types. It spans tremendous contrasts in tidal ranges, has an adequate variety of rocks, and its climates include both arid and humid varieties extending from tropical rain forest in the north to Mediterranean in the southwest and cool maritime in Tasmania. Much of the coast is exposed to the high, persistent swell of the Southern Ocean, while wave energy is comparatively low in the lee of the Great Barrier Reef and coasts of the relatively shallow Timor and Arafuta seas. It is probably true that in diversity of coastal features Australia ranks second only to South America among continents.

A thoughtfully selected bibliography includes more than 250 references. Its value is somewhat weakened because nearly all refer to literature in English. Books or articles in Japanese, French, Italian, German, and Russian for the most part are neglected.

If succeeding volumes in the series are as informative as *Coasts* they deserve space on the earth science shelves of all libraries as well as in faculty and student collections. The smallest continent not only is characterized by many unique and inadequately known geomorphological features but in addition has developed a research community with many original insights that should become better known in other parts of the world.

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Evidence and Speculation on How Life Began

The Origin of Life. J. D. BERNAL. World, Cleveland, Ohio, 1967. xvi + 345 pp., illus. $12.50.

Genesis and Evolutionary Development of Life. A. I. OPARIN. Translated from the Russian edition (Moscow, 1966) by Eleanor Maass. Academic Press, New York, 1968. x + 206 pp., illus. $9.50.

Biochemical Predestination. DEAN H. KENYON and GARY STEINMAN. McGraw-Hill, New York, 1969. xviii + 302 pp., illus. Cloth, $12.50; paper, $4.95.

Casual observation shows that living organisms originate within their mothers, in eggs, or, spontaneously, in decaying organic matter. While it is no surprise that these conclusions are in part correct, it should be recognized that a long and important chapter in the history of biology is concerned with the experiments leading to the final rejection of the third possibility. It was only after the work of Pasteur and Tyndall had proved that life is no longer arising spontaneously in the nonliving world that the problem of origins in its contemporary form became acute.

During the latter half of the 19th and the beginning of the 20th century Pasteur's work was often misunderstood. Pasteur had shown that the spontaneous generation of living organisms is not a common event. It was not generally recognized that the possibility still remained that the evolution of life had required an enormous amount of time and had occurred only once, early in the history of the earth. This misunderstanding led to the widespread acceptance of the semimystical view that life is necessarily as old as matter. A few more perceptive scientists, while interpreting correctly Pasteur's work, believed that nothing useful could come of studies of the origins of life and doubted at least the wisdom of those who undertook them.

Two publications, one by Oparin (1924) and the other by Haldane (1929), mark the beginning of the modern approach to the subject. (Bernal's book includes both of these historically important works in full, as appendices.) Each author, independently, made the critical point that early in the history of the earth the atmosphere must have been reducing and hence have permitted the synthesis of organic compounds. This prediction was subsequently confirmed by Miller and others. Oparin also introduced at that time the notion that organic colloids, coacervates, played a key role in the further evolution of life; this controversial hypothesis has dominated his thinking up to the present time.

In his latest book, Oparin presents for the general reader his present views on the origins of life. The first chapter is a delightful history of the subject, but I regret that as an admirer of Oparin's earlier books I was disappointed by much of what follows. Oparin deals first with the origins of the earth's atmosphere and, more particularly, with the synthesis of very simple organic compounds within it. The central problem of the synthesis of more complex organic monomers such as sugars, amino acids, purines, pyrimidines, and nucleotides and of their condensation to polymers is treated in a brief 24 pages; the coverage is neither selective nor critical. The remaining three chapters deal with coacervates and with hypotheses concerning later stages in the evolution of life. The emphasis is too much on speculation and too little on experiment.

It is well known that Bernal has read nearly everything, and hence it is not surprising that his book is encyclopedic in character. In it one does not find many formulae, mathematical or chemical, but rather a consistent and almost always reasonable qualitative discussion of all topics related, however peripherally, to the origins of life. Turning the pages at random I came on the following section headings: Thickening the Primitive Soup; Coenzymes and Nucleic Acids; Microtubules and Cilia; The Principle of Self-Assembly; Panspermia; Civilization in Outer Space; The Coacervate Hypothesis; Criticisms of Spiritual Explanations of Life; Generalized Crystallography. I recommend this book to those who want a general account of the subject; it is not for the student who wants to know the facts and to draw his own conclusions from them.

Biochemical Predestination, despite its title, is a thoroughly professional book on the origins of life. It presents the best detailed account of the subject that I have read. The authors, perhaps because they never knew the bad old days, are not too concerned with the legitimacy of their subject but, writing as laboratory scientists, describe the relevant experiments and attempt to interpret them. After a brief historical introduction and a discussion of the special character of experimental work related to the origins of life, Kenyon

and Steinman treat in considerable depth the geological evidence leading to the conclusion that living organisms had already evolved on earth 3 billion years ago. They then discuss the history of the earth at even earlier times (4.5 to 3 $\times$ 10^9 years ago) and deduce the probable conditions existing when life began. There follow two long and detailed chapters on the prebiological synthesis of organic monomers and on condensation reactions giving polypeptides, polynucleotides, and other polymers. Clearly the authors share the reviewer's prejudice that this is the central problem at the present time. These chapters will be most useful to anyone beginning research in the area. The final chapters of this valuable book deal briefly with the evolution of more complex organization and present a general review in the form of a discussion and prognosis.

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Prospects for the State of an Art

Future Goals of Engineering in Biology and Medicine. Proceedings of an international conference, Washington, D.C., Sept. 1967. JAMES F. DICKSON, III, and J. H. U. BROWN, Eds. Academic Press, New York, 1969. xvi + 360 pp., illus. $16.

In light of recent concern with medical care and costs, biomedical instrumentation, the use of computers for diagnosis and hospital housekeeping, artificial organs and transplants, and electronic devices in general, a discussion of the present position and future direction of efforts in biomedical technology was needed. This book is a compilation of the formal presentations and discussions from a conference, sponsored by the National Institute of General Medical Sciences, at which about 45 people apparently knowledgeable on such subjects as biomathematics, prostheses, heart surgery, brain research, engineering, and systems and operations analysis were convened to "assess the start of the art in some key areas [and] identify unique opportunities . . ." for contributions that engineering sciences might make to biology and medicine. This collection of papers reflects both the range of topics that the scope of the conference entailed and the technical interests of the presenters. In the main, the papers are general descriptions of what the authors believed to be of most importance in their respective fields. Whether the authors were wise in their selections can be decided by experts in the different areas. It would be presumptuous for a single reviewer to attempt to assess the scientific or technical merits of all the papers presented. A number of ideas seem to be common to many of the papers, and these will be discussed briefly here.

Most of the speakers concluded that significant progress in biomedical engineering will occur only if multidisciplinary teams of specialists are formed and if sufficient funds are available to support the required research. Impediments to the formation and funding of such teams were noted by a few of the speakers. For example, some commented that the National Institutes of Health lack the personnel to evaluate proposals submitted to organize and support multidisciplinary teams or the projects proposed by such teams. In consequence, others suggested the establishment of one or several nonprofit organizations to evaluate proposals, allocate funds, and evaluate the results and implications of the work performed. Others suggested that NIH exert more effort to hire the required personnel or that a special organization within the government be established to manage a well-funded program. One such organization discussed, which has since been established in the Department of Health, Education, and Welfare, is the Center for Health Services Research and Development. The center will be "concerned with applying new technology in the delivery of health services and will have direct mechanisms for the demonstration of the results of research."

As might be expected, many of the speakers lamented the inadequacy of the universities in producing medico-engineering specialists. In part, I think, the rationale for this lament is similar to that of the complaints about NIH; that is, the universities also consist of enclaves of specialists who do little to encourage the development of specialties other than their own. Along the same lines, most medical schools and organized medicine seem to resist encroachments on the medical arena by nonphysicians. Clearly exceptions exist, but in the main the curricula of medical schools and training hospitals are determined by physicians oriented toward private practice. If the orientation of the schools is to be changed, some of the speakers seemed to imply that no small problem may be to encourage physicians to abandon or forego lucrative private practices for laboratory research, which all agree is needed.

To engineers interested in improving or providing instrumentation the papers presented are likely to be of little interest because the state of the art of biomedical instrumentation is not described in any detail. Indeed, the speakers seem to disagree as to which medical conditions warrant intensive research and development effort. For example, Bertil Jacobson suggests that too much effort has been and is being exerted toward correction of late pathological conditions in which irreversible changes have already occurred. (That the point is well taken is evidenced by the recent heart-transplant operations and the reported reasons for the patients' deaths.) Rather, research should be directed toward the detection and correction of the precursors of disease.

A deficiency of the book may be that some of the speakers cite no references although their presentations have provocative aspects which some readers may wish to explore more closely.

In general the book, especially the discussion section, is well worth reading because it provides an overview of the research and planning going on in some areas of biology, medicine, and engineering. For readers interested in the politics of health research, some of the flavor of the then-ongoing political discussions is imparted also. However, with the arrival of the new administration in 1969, the political orientation is likely to have changed.

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Correction. In a recent listing of Books Received, Loren Eiseley's **The Unexpected Universe** (Harcourt, Brace and World, New York, 1969; $5.75) was erroneously described as a reprint of a 1964 edition. It is a new book, of which only small portions have previously appeared. The chapter titles are: "The ghost continent," "The unexpected universe," "The hidden teacher," "The star thrower," "The angry winter," "The golden alphabet," "The invisible island," "The inner galaxy," "The innocent fox," and "The last Neanderthal."