gists this book provides an excellent basis for the management of wild sheep. There can be no doubt that *Mountain Sheep* will prove of considerable value to all those interested in mammalian behavior, ecology, and evolution. It will stand as the definitive text on wild sheep for many, many years.

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Atmospheric Modeling

Numerical Weather Prediction. GEORGE J. HALTINER. Wiley, New York, 1971. xviii, 318 pp., illus. $10.95.

Numerical weather prediction is the forecasting of a state of the atmosphere from a known initial state by solving the hydrodynamic equations governing atmospheric phenomena. The idea of such forecasting is old. However, although the basic principles of atmospheric dynamics have long been known, their successful application for the prediction of large-scale motion in the atmosphere awaited the construction in the last two decades of sophisticated numerical models of the atmosphere based on theoretical and observational studies of the characteristics of atmospheric motions. The development of electronic computers and the system of the meteorological observation have also contributed to the success.

In this book, the physical and mathematical considerations which have been and should be taken into account for successful development and integration of an atmospheric model are well described. In the atmosphere there are many modes of wave motions and oscillations. One should know the behavior of each mode of waves and its role in the prediction of the large-scale field of the atmosphere. In many models, the primitive equations are simplified so that only the factors that are primarily important for the change in the meteorologically significant waves are retained. Such an approximation can be made systematically by means of scale analysis. It may be desirable that the simplified system satisfy some integral constraints regarding vorticity and energy which are fulfilled by the primitive equation system. Understanding of the growth of large-scale waves as a result of the instability of the atmosphere is also important for proper modeling. Numerical integration schemes have to be formulated carefully so that both linear and nonlinear computational instabilities can be avoided. The aforementioned important subjects in this field have been discussed sporadically in various journals in many years. It is good that they are now treated in a single book. This book will be useful and handy for the numerical modelers in the field of dynamic meteorology in general, and the methodology summarized in it will be full of suggestions for scientists working with numerical models in other fields.

There are underdeveloped areas in numerical weather prediction. One problem concerns the atmospheric waves in the tropics. Another important problem is how to incorporate the ensemble effect of cumulus convection into a large-scale model. Those are briefly mentioned and some parameterization schemes of convections are explained, but the so-called convective adjustment method which is currently used with success in some big models is not introduced.

A question that may naturally arise is the limit of deterministic prediction—how far ahead and how accurately can one compute the future state of the atmosphere? An answer to this question cannot be found in this book. If the problem of predictability had been included I would have enjoyed reading the book more. At any rate, I welcome its publication.

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Chemical Exchanges

Bioinorganic Chemistry. A symposium, Blacksburg, Va., June 1970. RAYMOND DESSY, JOHN DILLARD, and LARRY TAYLOR, Eds. American Chemical Society, Washington, D.C., 1971. x, 436 pp., illus. $14. Advances in Chemistry Series, vol. 100.

These lectures on bioinorganic chemistry will be useful to chemists who seek examples of biological problems (nitrogen fixation, metal ion effects on nucleic acid structure, metalloenzymes, heme proteins, and other metalloproteins such as ferredoxins or ceruloplasmin) to which to apply knowledge of inorganic chemistry and techniques such as nuclear magnetic, electron paramagnetic, and proton magnetic resonance and complex kinetic analysis. Correspondingly, a biologist may find approaches that are more useful than the analyses usual in enzymology (enzyme isolations, cofactor and intermediate identification, and kinetic and inhibitor studies). These analyses are becoming analogous in value to the descriptive observations of anatomists or embryologists in a time when cellular and molecular approaches can be taken; though useful and important, they are not sufficient to open up new concepts.

One is impressed with the probable truth of what several of the authors imply: that inorganic chemistry is far more important to biology than has thus far been recognized in biological dogma and training, and may turn out to be as important as the organic side. Thus the curious political separations and territorial antagonisms of inorganic, organic, and physical chemists, biochemists, biological chemists, and biologists gradually have been diminished by the logic of the chemical and biological questions themselves. A chemist (Williams) now expresses his excitement at the reasonable way in which certain ions have been selected through evolution for special roles.

The volume reflects a continually increasing interest among protein chemists and enzyme mechanists in probing the mechanisms of inorganic ion catalytic groups and inorganic reactions, in contrast to a preoccupation with kinetics, protein structure, and mechanisms of reactions involving organic molecules. Chemists (some of whom may be in awe of enzymes or may not believe in them) may be stimulated by descriptions (such as that given by Breslow in this volume) of the development of model compounds for enzymes, not only for the inherent interest of enzymes but as they point the way toward the development of selective catalysts.

Some of the articles (Caughey's, for example) are fairly concise presentations largely of the authors' own work. Some (such as that by Williams) are rambling, enthusiastic, and speculative. Authors were motivated to spend more time in model building, speculation, commentary on the importance of problems, and prediction of useful approaches (as do, for example, Williams and Rabinowitz) than a scientist usually feels allowed to do in preparing a review.

The book will be a useful addition to biochemistry and chemistry libraries—more so to the latter, for much of the material in it is already available

in the former. Considering the financial state of science, it is interesting that several of the authors indicate the potential medical or social value of research on their subjects. This may contribute to the motivation of researchers tackling biological problems.

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Biological Compounds

Aspects of Terpenoid Chemistry and Biochemistry. Proceedings of a Phytochemical Society symposium, Liverpool, Apr. 1970. T. W. GOODWIN, Ed. Academic Press, New York, 1971. xiv, 442 pp., illus. $24.50.

Terpenoids and Steroids. Vol. 1. A Review of the Literature Published between Sept. 1969 and Aug. 1970. K. H. OVERTON and seven others. Chemical Society, London, 1970. xii, 558 pp., illus. £11. A Specialist Periodical Report.

Perhaps I am getting old, but I regret to find lately as I peruse new technical books that the trend is simply toward cramming more and more facts onto each page; a consequence of this is that the books are more difficult and far less enjoyable to read. Regrettably, this is the case for the two volumes under review. The purpose of these volumes is identical—to review the literature of their subject. The first volume covers a four-year span; the second comprises coverage of only 12 months.

Goodwin's volume consists of 12 contributions by researchers in various disciplines from Europe and the United States. A record of the first symposium, entitled *Terpenoids in Plants*, was reviewed by me in 1967 (*Science* **158**, 1558). In four years, sufficient new material became available to warrant another symposium on essentially the same topic, and, surprisingly enough, there is little actual overlap in the material presented at the two symposiums. Of the two new works, the symposium proceedings is the more readable, some effort having been made by the editor and the various contributors to move from sentence to sentence with the hope that the reader will stay with it.

The book places emphasis on the insect hormones and carotenoids. Pfiffner's chapter enlarges one's appreciation of the nature and multifaceted role of the juvenile hormones in insects. Nonexperts in this field, such as this reviewer, must stumble through mountains of tongue-twisting words to follow the text, but the fascination of the subject sweeps one along. Rees adds an additional chapter on the ecdysones, the insect moulting hormones. Goodwin's interest in the carotenoids is evident in that over one-fourth of the book is devoted to various topics of carotenoid chemistry and biochemistry. Recently, several C_{50} carotenoids have been isolated and their structures determined. A thought-provoking aspect of this is that to date these C_{50} compounds have been found only in bacteria and especially in Gram-positive, aerobic forms. All are nonphotosynthetic.

After reading Francis's chapter on monoterpene biosynthesis one can only remark yet again how little we know of the function and relationship of the monoterpenes to the overall physiology of the plant—and we must wait still longer to find the answers.

Overton's book is simply heavy going. Its deadpan presentation of the facts make it difficult and dreary reading. The "editor" considers himself as a "senior reporter" and his seven associates as more simply "reporters," and that's exactly what they do—report. Although the book offers little interpretation or evaluation of the reported research, the coverage appears to be thorough and accurate. The plenitude of structural formulas should prove quite useful to workers in the field.

The space is divided about equally between terpenoids and steroids. The first part of the book is further divided into chapters based on structural and biogenetic relationships—covering monoterpenoids, sesquiterpenoids, and so on—and biosynthesis of terpenoids and steroids. The second part consists of only two chapters, on steroid properties and reactions and steroid synthesis.

Both volumes contain excellent line drawings and have clear, well-executed printing. The indexes of both seem quite complete and are easy to use. If one accepts these books not as works to enjoy but simply (and to me with some distaste) as "reference works," then one can get on with using them as I presume they were intended to be used.

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Developmental Sequences

Changing Syntheses in Development. A symposium, Albany, N.Y., June 1970. MEREDITH N. RUNNER, Ed. Academic Press, New York, 1971. xiv, 272 pp., illus. $13.50. *Developmental Biology*, supplement 4.

The major questions posed in this book are the traditional questions of development biology: how cells become different from one another during embryogenesis, how they organize into identifiable organs, and how, once differentiated, they respond to external stimuli. These problems are approached and discussed at levels ranging from the molecular biology of gene transcription, to cell dependence upon or response to hormones, to electron microscopic studies of cell and tissue organization. In spite of the diversity of the systems and approaches presented, the articles are related by the unifying theme implicit in the title of the book: they all stress sequential developmental events, whether at the biochemical, the cellular, or the morphological level.

Several of the papers present systematic descriptions of the developmental events and are valuable contributions for the information they contain. A few of the authors develop models in an effort to explain the changes they observe. Flickinger, for example, presents a provocative and speculative argument for the role of redundant nucleotide sequences during early amphibian embryogenesis. He suggests that most "DNA-like" RNA from very early embryos is transcribed from more redundant, evolutionarily old DNA sequences and that restriction of embryonic competence results from a restriction of transcription of these sequences as they become late-replicating. Bernfield and Wessells have neatly combined cytochemical and other biochemical studies with observations from light and electron microscopy to help elucidate the forces involved in the formation and maintenance of salivary gland epithelial structure. They find two independent factors, a mucopolysaccharide-protein complex at the epithelial surface and organized microfilaments, that appear to play a requisite role.

The most basic form of cell differentiation is the transition from germ cell to somatic cell. *Volvox*, a colonial flagellate, consists of only these two cell types, although the reproductive cells may be asexual, male, or female.