Book Reviews

Biochromes

Carotenoids. OTTO ISLER, HUGO GUTMANN, and ULRICH SOLMS, Eds. Birkhäuser, Basel, 1971. 932 pp., illus. 118 Sw. Fr. Chemische Reihe, vol. 23.

Of the conservatively estimated 4×10^{10} metric tons of organic matter produced annually by the world's greatest biochemical factory, that is, marine single-celled plants, about 0.01 percent, or several hundred million tons, consists of newly synthesized carotenoids, of which the major proportion are typical algal xanthophylls. These conspicuous yellow, orange, or red fat-soluble biochromes, synthesized by all green plants and by many achlorophyllous species, are virtually ubiquitous also in animals, through nutritional channels. They have always attracted the active attention of growers, and increasing numbers of chemists, biochemists, and biologists, dating back into the 19th century, have been concerned with them, but the past quarter-century has seen approximately a quadrupling in the number of individually recognized carotenoids, which today exceeds 300. Our increasing knowledge has called for another comprehensive book to follow T. W. Goodwin's volume on the comparative biochemistry of these compounds published in 1954 and the one published in 1965 under his editorship which contains the chemistry and biochemistry of plant pigments.

This volume, memorializing the late Paul Karrer, involves a total of 17 expert authors and is an amply gratifying response, addressed particularly to chemists but with far-reaching usefulness also to many biochemists and chemically trained biologists. Thorough treatment, with wide citations of older and of most recent literature, relating to the occurrence, distribution, chemistry, biosynthesis, metabolism, functions, and uses of the carotenoids attests to the scientific popularity these naturally occurring compounds have attained, and the deep and extensive coverage of the field, truly constituting a grand tour, will evoke enthusiastic welcome from the many who have been awaiting an authoritative assimilation on the central topic.

A brief general introduction, a review of historical features of researches on carotenoids, and a listing of carotenoids and some nomenclatural rules are followed by information on the natural occurrence and distribution of the numerous chemical classes of these compounds. A number of beautiful colored plates depict the natural appearance of carotenoids in plants and animals, their application to foods, some characteristic crystalline forms, and a typical absorption spectrum. Omission of the red-skinned apples, purple-skinned grapes, and dark-purple-skinned eggplant fruit (each of which manifests pigmentation by water-soluble anthocyans rather than by carotenoids) would have rendered one plate more exclusively factual. Indeed, the named specimens could profitably have been replaced by such examples as the lycopene-red flesh of a ripe, opened watermelon and the orange-colored skin or flesh of other cucurbits such as pumpkin or crookneck squash.

The chemical isolation and reactions of the many molecular species of carotenoids, and the application of spectroscopic methods and stereochemical studies to their characterization, receive expert attention. A treatment of purely chemical studies on total synthesis in vitro, applying to an extensive range of known representative compounds, occupies 250 pages.

A survey of biosynthesis refers to many diversified processes occurring in tissues of higher plants, algae, fungi, and photosynthetic and nonphotosynthetic bacteria, and to periods of fruit-ripening and of green-leaf senescence, wherein esterified xanthophylls seem to outlast not only chlorophylls but carotenes as well. Ketonization of dietary carotenoids, for example in certain crustaceans, is given some notice here and is treated further in a succeeding chapter dealing with metabolism of carotenoids in animals. Some gratifying and refreshing discussion refers also to carotenoproteins, which may exhibit many different colors, notably in skin, carapace, ovaries (including eggs), and other tissues of numerous invertebrates. The spectral characteristics and high molecular weights of some of these chromoproteins are recorded, and brief consideration to the subject invites further study concerning the possible function of these complexes.

In view of the extensive volume of cited literature, including some titles of 1971 publication, it may surprise some readers to encounter no reference to the arresting discovery, reported in 1970, of astaxanthin chemically bonded to and within the pigmented calcareous skeletons of certain hydrocorals, nor recognition of another 1970 report showing the metabolic derivation of echinenone, and notably of canthaxanthin, from dietary β-carotene in (American) flamingos.

With respect to the functions of carotenoids, there are cited records of their possible or established role as accessory pigments or cofactors in photosynthesis, protoprotective factors in some circumstances, and elsewhere the roles they play in taxes, tropisms, inhibition, stimulation, reception, or periodism, all associated with incident blue light. Stabilization of proteins and of membranes, regulation of reproductive processes, and other miscellaneous functions are also considered.

The structural specificity, metabolic origins from full-length precursors, general metabolism, and function in visual processes are discussed with reference to the A vitamins. Consideration is given to their usefulness in preserving the integrity of integumentary and mucous surfaces and in the normal function of nervous, skeletal, reproductive, and respiratory systems, and to the vital seriousness of vitamin A deficiencies in animals, notably in neglected children.

The 12th and final chapter, including lists of natural carotenoids and 815 references, will perhaps be the most widely consulted part of this substantial volume, for it provides the commoner or trivial names, one or more descriptive chemical designations, consonant with current nomenclatural practices, and structural and empirical formulas for each of 273 carotenoids of known structure and appends coded references relating to further information to be found in cited literature. The chapter lists alphabetically also the names of 110 carotenoids whose structures re-

main unknown or are insufficiently established for inclusion in the first group. There also is an alphabetical list of 57 obsolete names not always ascribable to a single specific carotenoid but useful in searching the older literature. There remains in this chapter one desideratum. The value of the painstakingly assembled and listed information on known carotenoids could have been substantially enhanced had there been appended, for each entered compound, just a few diagnostic or characteristic data, such as the maximum wavelength values in reference solvents, partitional behavior, perhaps crystalline habit from specific solvents, and melting point. Such addenda could follow somewhat the forms and sequences in which carotenoids are presented in Rauen's *Biochemisches Taschenbuch* (Springer-Verlag, 1964). Such additional information might have added to the total space given to the list by 20 percent—or only about 1 percent of the book—and the increase would have been more than compensated for by the increase in the book's usefulness both at the desk and near the laboratory bench.

Dedicated as it is "to all scientists in the field of carotenoids," this volume will amply serve that wide fraternity for a long time to come. It belongs within ready reach of all such students and in all scientific libraries.

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Secretory Processes

Subcellular Organization and Function in Endocrine Tissues. A symposium, Bristol, England, Apr. 1970. H. HELLER and K. LEDERIS, Eds. Cambridge University Press, New York, 1971. xxiv, 1012 pp., illus. $37.50. Memoirs of the Society for Endocrinology, No. 19.

Results from different experimental approaches (biochemistry, physiology and pharmacology, and electron microscopy) are beginning to yield a coherent picture of the secretory process in endocrine systems which liberate peptides and monoamines. The planners of the symposium that gave rise to this volume wisely limited the scope of the meetings to a consideration only of tissues which secrete these hormones. In so doing, they have provided a comprehensive and valuable study of the dynamics of synthesis, transport, storage, and release of these hormones, and of the morphology of subcellular structures involved. Most of the contributions are current research papers rather than reviews; experimenters in the field will therefore find the book to be a stimulating source of methods as well as experimental ideas, references, and unanswered questions. Of the few review papers that are included, most are of the contributors' recent work, rather than exhaustive studies of the entire field.

The experimental separation of the stages from synthesis of the hormones to stimulus-release coupling is one of the difficult problems in analyzing the process of secretion. In this volume (as in the field as a whole), the most successful analyses of various stages are made on the neurohypophysis, beta cells of the pancreas, and monoamine-secreting cells. The incorporation of radioactive label is followed biochemically in the neural lobe (the coordinated synthesis of neurophysins and active peptides is demonstrated) and by electron microscope autoradiography (unfortunately presented here without micrographs) in the beta cells. Transport of newly synthesized hormones and granules, and disruption of this process, are traced in all three systems. The conclusion that rates of transport are rapid, and possibly crucial in maintaining the supply of releasable hormone, is an important one. The biochemical maturation of granules is discussed for several of the systems. There is now evidence for more heterogeneity of granules than is indicated by the simple distinction between those in a "readily releasable pool" and those "in storage." A great many data are presented on the nature of granule contents and the mechanism of binding of hormones (for example, the probable occurrence of high-molecular-weight aggregates of adenosine triphosphate and catecholamines), but in many cases the role of the binding proteins remains obscure.

Experiments on hormone release in the adenohypophysis, as described in this book, are somewhat less satisfying. Some experiments in vitro are complicated by high leakage rates. The conclusion of some workers that there is no calcium requirement for release must be squared with contrary results of other workers on the same system and with the general importance of calcium in the release of other peptidic hormones. Geschwind's important paper outlines clearly the many steps that may be involved in the release process in the adenohypophysis as well as other secretory tissue. It is possible that many of the agents tested for effects on "release" (for example, metabolic inhibitors, factors affecting adenyl cyclase) actually alter processes several steps removed from the actual coupling between stimulus and release.

Other papers deal with pineal, urophysis, parathyroid, and "tissue hormones," and the last 200 pages are devoted to round table discussions. In most cases, the formal contributions to this latter section consist of brief and concentrated descriptions of recent experimental results. Because of the abridged nature, or absence, of introduction, methods, figures, and references, parts of this section may be of less interest and value to those who are not already familiar with the particular problem under consideration.

Several of the electron microscopic studies included in this volume merit special mention. Even to those who have been skeptical about the possibility of interpreting dynamic processes on the basis of micrographs, the paper by Farquhar is particularly striking. Her interpretations of many stages of synthesis and release of several adenohypophysial hormones, and of the destruction of excess granules, are firmly based on physiological manipulations. The contribution of Douglas's group provides impressive microscopic evidence for exocytosis as a release pathway for neurohypophysial peptides, although the failure to demonstrate an effect of a potent releasing stimulus is still disappointing. Microscopic evidence for the electron-lucent microvesicles by uptake from the cell membrane after hormone release is also presented. The latter, coupled with the centrifugation studies on intact nerve endings reported by Livingstone and Lederis, suggests that the term "synaptic vesicles," as applied to the microvesicles of peptide neurosecretory cells, may finally be laid to rest.

In view of the size of the volume and the obviously tightly scheduled nature of the meetings, it is perhaps unfair to criticize the organizers for deciding not to include a session on invertebrate neurosecretion. While studies of the biochemistry, packaging, and release of invertebrate peptide hormones are still of a preliminary sort, important parallels to the situation in vertebrates have already been uncovered. The evidence for exocytosis and the origin of microvesicles from electron microscopic studies is, if anything,