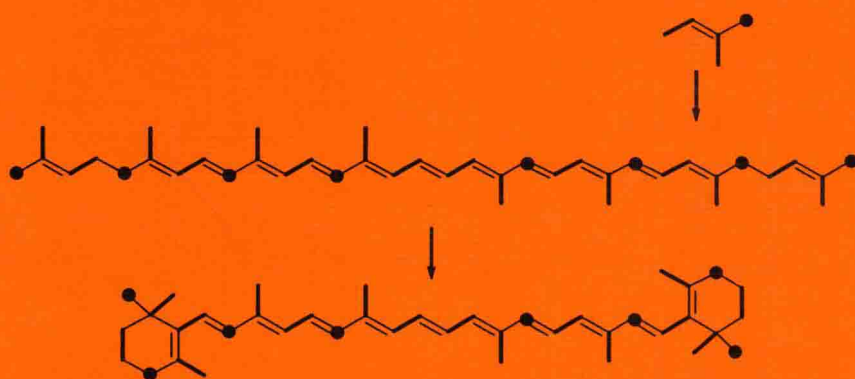


Carotenoids

Volume 3: Biosynthesis and Metabolism

Edited by G. Britton
S. Liaaen-Jensen
H. Pfander



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Preface

With Volume 3, the *Carotenoids* series moves into the area of biochemistry and biology, where much of the current interest in the carotenoid field lies. Later Volumes will cover the biological functions and actions of the carotenoids. Volume 3 concentrates on how the carotenoid molecules are formed in Nature, and utilized or modified by living organisms. Both biosynthesis and metabolism are covered. The historical development of this work is summarized in the introductory Chapter (1), in which the editors also give their views on the current state of knowledge, and their prognosis for future developments.

Carotenoids are biosynthesized in great variety by bacteria, fungi, algae and higher plants. An overview of the current state of knowledge, especially of the reactions, pathways, enzymes and regulation of carotenoid biosynthesis, is given in Chapter 2. The results of molecular genetics are now integrated into this overview. Such are the rapid advances now being made in molecular genetics that another Chapter (3) is devoted entirely to this topic, with emphasis on the practical application of these powerful techniques in the carotenoid field. Chapter 4 then describes the further biosynthetic processes by which biologically important small molecules that are structurally related to carotenoids are formed naturally from intact carotenoid molecules. The ability to accumulate carotenoids with particular structural features reflects biosynthetic capabilities, and is a useful criterion for chemosystematics, especially of algae (Chapter 5).

Animals cannot biosynthesize carotenoids *de novo*. They must obtain their carotenoids from the diet. Dietary carotenoids provide most of the vitamin A that is vital for health and development in humans and other mammals. The formation of vitamin A and the absorption, transport and deposition of carotenoids in tissues in mammals are described in Chapter 6. The diverse metabolic reactions by which dietary carotenoids undergo structural and stereochemical changes in birds, fish and invertebrate animals, and provide striking coloration in these animals, are described in Chapter 7. This metabolic activity makes carotenoids suitable molecules for use as markers to trace food chains (Chapter 8).

The philosophy of the *Carotenoids* Series is to provide practical guidance as well as detailed information, and Worked examples of some important procedures have been described in Vols. 1 and 2. Precise worked examples are not appropriate in Vol. 3. Instead, guidance on the application of some of the most important experimental procedures for studies of biosynthesis and metabolism are given in Chapter 9. Similar guidance on the application of molecular biology techniques is incorporated in Chapter 3. For all work with carotenoids, biological as well as chemical, familiarity with the general procedures for handling carotenoids and for their isolation and analysis (covered in Vol.1A), and with the analytical and spectroscopic methods dealt with in Vol.1B, is an essential prerequisite.

It is the aim of editors that the information presented and analysed by expert authors in this Volume will serve as a useful reference source, and give valuable guidance on practical strategies and procedures, as a foundation for the exciting advances that can be expected in carotenoid biosynthesis and metabolism in the next few years.

Acknowledgements

We repeat our comment from the earlier Volumes. Although we are privileged to be editors of these books, their production would not be possible without the help of a great many other people.

The dedicated work of the authors, their attention to requests and questions and their gracious acceptance of the drastic editing that was sometimes needed to avoid duplication and to meet the stringent limitations of space, is gratefully appreciated. The job of the editors and production team is made so much easier when authors provide carefully prepared manuscripts in good time.

We cannot praise highly enough the dedicated and skilful work of Christof Bircher, ably assisted by Lorenz Egli and Daniel Sarbach, in the Production Office in Bern, who, despite their busy schedules as full-time carotenoid researchers, somehow managed to find the time to produce the final camera-ready manuscript to a high professional standard. We also thank the members of the 'Pfander group' in Berne for their meticulous proof-reading.

The guidance received from Petra Gerlach and Katrin Serries and their colleagues at Birkhäuser and their efforts in finalizing publication after receipt of the camera-ready manuscripts are also much appreciated.

Finally, we again express our gratitude to Hoffmann-La Roche and BASF for the financial sponsorship without which this project would not have been possible.

George Britton
Synnøve Liaaen-Jensen
Hanspeter Pfander

Editors' Notes on the Use of This Book

The *Carotenoids* books are planned to be used with the *Key to Carotenoids*, Second Edition. Throughout the Series, whenever a known, natural carotenoid is mentioned, its number in the *Key to Carotenoids* or the *Appendix* (Vol.1A, Chapter 8) is given in bold print. Other compounds that do not appear in the *Key* are numbered separately, in italics, in sequence for each Chapter, and their formulae are shown. Note that the *Key* numbers given are those in the Second Edition of the *Key to Carotenoids* (1987). The same numbering system will also be used in the new *Handbook of Carotenoids*, now in preparation in association with the *Carotenoids* series. The numbering of compounds in the original *Key to Carotenoids* (1976) and the list in the 1971 Isler *Carotenoids* book is different.

Trivial names

The IUPAC semi-systematic names for all known naturally occurring carotenoids are given in the *Key to Carotenoids*, second Edition, and in the *Appendix* (Vol.1A, Chapter 8). Trivial names for many carotenoids are, however, well established and convenient, so the practice of using these trivial names rather than the often cumbersome IUPAC semi-systematic names will, in general, be maintained in this series. An important exception is the naming of those compounds which bear the trivial name '(prefix)-carotene'. To avoid confusion caused by the use of Greek-letter prefixes that do not correspond to the series of prefixes used to designate and groups in the IUPAC system (*e.g.* 'γ-carotene' does not contain γ end groups) the old names α-carotene, β-carotene, γ-carotene, δ-carotene and ε-carotene are abandoned according to the IUPAC recommendation, and replaced by β,ε-carotene, β,β-carotene, β,ψ-carotene and ε,ε-carotene, respectively.

Classification of organisms

Because of the biological context of this Volume, the correct classification of living organisms becomes important, especially when changes in detail occur frequently as new criteria are applied, particularly comparison of DNA sequences. It is not practical to include a classification scheme in this book. It has been the responsibility of authors to ensure that classification schemes in current usage are applied, and to ensure correlation between old and new names.

Indexing

For most purposes, reference to the List of Contents is considered sufficient to guide the reader to a particular topic. Topics/items that are obviously specific to a particular Chapter and can be located by sub-headings are not reported in the Index, *e.g.* reference to 'cDNA libraries' is clearly expected in Chapter 3. Likewise, space does not permit comprehensive listing of each mention of individual compounds. Indexing is restricted to key topics that occur, perhaps in different contexts, in more than one Chapter.

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