

able to follow most, if not all, of the discussion. In addition, many interesting side comments are made throughout the book. Finally, some useful appendixes on spinors, quantization of constrained systems, and other basic topics are provided.

I have very few criticisms of the book, and only one worthy of mention. I would have benefitted from more discussion of the difficulties and pitfalls of the proposed approach to quantization, particularly via the loop variables approach. Specifically, since one does not expect to have an easy time giving an exact formulation of any nonlinear field theory (much less general relativity), it should be expected that severe difficulties will arise when one attempts to specify precisely the choice of Hilbert space and specify a consistent regularization scheme for the operators representing the observables of interest. There is barely any mention of these issues in the book, and certainly not sufficient discussion to convey a clear impression of the nature of the difficulties that ultimately would have to be confronted in order to convert the loop quantization approach into a rigorously defined theory.

In summary, this book is very successful in achieving its goal of giving a clear, up-to-date introduction to the approach to canonical quantum gravity pioneered by Ashtekar. It is essential reading not only for anyone who intends to do research on this approach but also for anyone at the level of an advanced graduate student or beyond who is interested in broadening his or her perspectives on the theory of quantum gravity.

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Photosynthesis

The Photosynthetic Apparatus. Molecular Biology and Operation. LAWRENCE BOGORAD and INDRA K. VASIL, Eds. Academic Press, San Diego, CA, 1991. xxviii, 495 pp., illus. \$139. Cell Culture and Somatic Cell Genetics of Plants, vol. 7B.

With recent refinements in the techniques for the transformation of photosynthetic organisms it has become possible to interrupt or delete genes of choice and to introduce site-directed point mutations. Researchers are thus now in a position to probe the roles of individual subunits of the protein complexes that constitute the photosynthetic apparatus and to understand how individual amino acids contribute to the redox and kinetic properties of

the constituent proteins.

Bogorad and Vasil in the chapters they have solicited for this volume attempt to provide the biochemical, functional, and molecular biological framework for appreciating some of the contributions that the transformation techniques as well as random mutagenesis have made to our understanding of photosynthesis. Though with one exception the chapters are concerned with oxygenic photosynthetic organisms, there are also references to the homologous polypeptides, enzymes, and pigment molecules present in the photosynthetic bacteria.

Three chapters, by Vermaas and Ikeuchi, Chitnis and Nelson, and Widger and Cramer, deal with the redox complexes of the oxygenic electron transport chain. That on photosystem II is the most detailed, with an extremely thorough discussion of primary and secondary electron transport function of the reaction center, integrating kinetic and structural information. The authors show an appreciation of recent controversies and give a critical reading of a vast array of information assembled in an intelligible manner. The chapter on photosystem I touches on a wide variety of topics of interest having to do with structure, regulation, and evolution. The chapter on the cytochrome b_6/f complex is a useful comparative anatomy of this complex and its homologs, stressing structural similarities and topology.

The chapter by Jagendorf, McCarty, and Robertson is a delight to read, containing an equilibrated balance of functional, structural, and genetic information on ATPase-ATP synthase from higher plants, cyanobacteria, mitochondria, and bacteria. This chapter brings together in a complementary fashion information on mutants, cross-linking, and chemical modification, enabling the reader to appreciate the discussion of opposing models of ATPase function.

The chapter by Bryant on cyanobacterial phycobilisomes is among the most detailed, with emphasis on the gross structure, roles, stoichiometry, and location of individual subunits. It includes an extensive discussion of operon structure and the consequences of interposon mutagenesis, of which the author is one of the prime practitioners. This chapter is so thorough that that by Tandeau de Marsac on chromatic adaptation, itself a thorough effort on light control of differentiation and pigment gene expression, inevitably retreads some of the same ground. Another chapter on light regulation, this time in chloroplasts by Link, is well written, with a good introduction to control sites for gene expression in plastids and an emphasis on chloroplast differentiation in C4 plants. Another form of plastid differentiation to amyloplasts and chromoplasts is described

in an interesting chapter by Kobayashi.

Two general chapters on oxygenic and anoxygenic photosynthesis are included. In trying to touch on many aspects at once these somewhat sacrifice depth and coherence and contain some errors. Chlorophyll and carotenoid biosynthesis, Rubisco assembly, and nuclear-plastid interactions are also represented in separate chapters.

A listing of chloroplast protein-coding genes toward the end of the book is useful for referencing sequences but could have been improved by identification of the gene products. The subject index is not very useful, and the book lacks an author index. However, the bibliographies associated with each chapter are for the most part extensive and current through 1989 and include titles of papers.

This volume brings together a diverse sampling of the photosynthetic world. Some recent work on site-directed mutagenesis of the reaction centers and cytochrome bc_1 complex of the purple non-sulfur photosynthetic bacteria, much of it illustrative of the power of molecular biology for the probing of function, would have been a welcome addition. Also unrepresented is much fine recent work on transport of proteins into the chloroplast and thylakoid. But the topics that are represented receive for the most part thorough treatment, and the reader is directed to reviews that fill the gaps. Those interested in the topics covered will undoubtedly find themselves enlightened, whether they be neophytes or more mature photosynthesizers.

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Books Received

Advanced General Relativity. John Stewart. Cambridge University Press, New York, 1991. viii, 228 pp., illus. \$49.50. Monographs on Mathematical Physics.

Bilharzia. A History of Imperial Tropical Medicine. John Farley. Cambridge University Press, New York, 1991. xii, 359 pp., illus. \$59.50. Cambridge History of Medicine.

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The Elements. John Emsley. 2nd ed. Clarendon (Oxford University Press), New York, 1991. viii, 251 pp., illus. \$49.95; paper, \$22.50.

Food. Fact and Fictions. Ralph I. Freudenthal and

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