IUPAB Biophysics Series
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Photosynthesis
Physical mechanisms and chemical patterns

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Photosynthesis

Physical mechanisms and chemical patterns

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To B. J. Clayton, wife and colleague

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FOREWORD

The origins of this series were a number of discussions in the Education Committee and in the Council of the International Union of Pure and Applied Biophysics (IUPAB). The subject of the discussions was the writing of a textbook in biophysics; the driving force behind the talks was Professor Aharon Katchalsky, first while he was president of the Union, and later as the honorary vice-president.

As discussions progressed, the concept of a unified text was gradually replaced by that of a series of short inexpensive volumes, each devoted to a single topic. It was felt that this format would be more flexible and more suitable in light of the rapid advances in many areas of biophysics at present. Instructors can use the volumes in various combinations according to the needs of their courses; new volumes can be issued as new fields become important and as current texts become obsolete.

The International Union of Pure and Applied Biophysics was motivated to participate in the publication of such a series for two reasons. First, the Union is in a position to give advice on the need for texts in various areas. Second, and even more important, it can help in the search for authors who have both the specific scientific background and the breadth of vision needed to organize the knowledge in their fields in a useful and lasting way.

The texts are designed for students in the last years of the standard university curriculum and for Ph.D. and M.D. candidates taking advanced courses. They should also provide a suitable introduction for someone about to begin research in a particular field of biophysics. The Union is pleased to collaborate with the Cambridge University Press in making these texts available to students and scientists throughout the world.

Franklin Hutchinson, Yale University
Watson Fuller, University of Keele
Lorin J. Mullins, University of Maryland
Editors

PREFACE

The aim of this book is to introduce students of science to the methods and present state of research in photosynthesis. As befits a monograph on a topic in biophysics, physicochemical aspects of the subject are emphasized. The treatment of metabolic and physiological areas is confined to the earlier phases of ATP formation and carbon assimilation. The treatment of physical aspects is weighted heavily toward bacterial photosynthesis because the photosynthetic bacteria have afforded exceptional opportunities in elucidating physical mechanisms.

Part I describes major developments from about 1650 to 1960, emphasizing the chemical nature of photosynthesis and the roles of chlorophylls and other pigments. Part II reviews our present knowledge of the structures and components of photosynthetic tissues in relation to their function. Part III deals with the photochemistry of photosynthesis, and with the patterns of chemical events, principally electron and proton transfer, that follow the photochemistry. Part IV treats the relationships of electron and proton transport to ATP formation, and the metabolic patterns of carbon assimilation. The epilogue exposes major areas of confusion and ignorance and indicates potentially fruitful directions of research, including the development of photosynthetic systems for solar energy conversion.

This book can provide the framework for a course on photosynthesis suitable for undergraduate or postgraduate students. To meet this purpose it includes digressions into physics and chemistry, as needed for a basic understanding of the subject. These digressions can of course be passed over by the reader who is familiar with their content; they are mainly descriptive rather than analytical. I have tried to impart a knowledge of photosynthesis at the level of contemporary research; nevertheless, a student will be sufficiently prepared if he understands physics, chemistry, and biology at the level of introductory college courses for science majors. The reader will detect some redundancy in widely separated parts of the book. This is deliberate and is based on the premise that a cyclical return to some topics will help to consolidate an overall grasp of a subject as multifarious and complex as photosynthesis. The treatment is detailed and comprehensive so that students and

mature investigators can visualize concretely what is required and involved in a career of research in photosynthesis.

Annotation has been restricted to a few references to specific experiments, plus a set of suggested readings at the end of each chapter. These readings are listed in the order of appearance of relevant material in the text.

I am indebted to Drs. W. L. Butler, R. E. McCarty, W. W. Parson, K. Sauer, and A. Vermeglio for valuable suggestions and critical comments on parts of this book.

R. K. C.