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Draft of a Book Review by Basanti Biswal and coworkers, for publication in 'Current Science'

The Structure and Function of Plastids, edited by Robert R Wise and J. Kenneth Hooper, *Advances in Photosynthesis and Respiration* (Series Editor, Govindjee), Vol. – 23, Springer, Dordrecht, The Netherlands, 2006, pp-575 + xl including color plates.

Conversion of light energy to useful chemical energy through the process of photosynthesis by tiny plastids is one of the most important events on this planet. This leads to Biomass and Bioenergy, both needed for our expanding human population. Although plastids play the major role of light harvesting, they also carry on other non-photosynthetic functions, no less important than photosynthesis. Adequate coverage of non-photosynthetic metabolism of plastids is the beauty of this book. Although different plastid forms exhibit some level of structural divergence, they possess a common architectural design; the plastids in eukaryotic cells look very different from the rest of the cellular organelles. In addition to the structure of the plastids, the book focuses on the various functions of different plastid forms.

The book includes 27 chapters, authored by 59 internationally reputed experts, from 11 countries, in different fields of plastid structure and function. The related chapters are appropriately grouped under five well-defined sections. In the beginning, Brian Gunning, Friedericke Koenig and Govindjee provide a nice historical dedication highlighting significant contributions of pioneers of research that reveals the development of our knowledge in the field.

There are 5 chapters in the section I (Plastid Origin and Development). The editors of the book Wise (USA) and Hooper (USA) have written two introductory chapters for this book. Wise describes plastid forms in different plant groups and different tissue systems, their interconversion during plant development and some features of the chloroplast, the major plastid form in green plants. Hooper, on the other hand, describes the origin and divergence of the plastid, chloroplast development and provides an overview of photosynthesis. This chapter also critically summarizes our recent knowledge in the area of synthesis of chlorophyll and its interaction with the thylakoid proteins, thylakoid biogenesis and regulation of gene expression during the development of the photosynthetic organelle. These two chapters are followed by an interesting chapter by Vothknecht and Soll (both of Germany) that tells the story of the molecular mechanism of protein transport to chloroplast, variation in the structure of protein transport machinery and the evolutionary origin of transport components. The next chapter, by Sato (Japan), deals with the origin, evolution and genomic background of the plastid diversity; this is followed by a chapter on the mechanism of plastid division by Miyagishima (USA) and Kuroiwa (Japan).

Section II (The Plastid Genome and its Interaction with Nuclear Genome), with 5 chapters, reveals the story of chloroplast biogenesis in the background of our recent knowledge of the molecular biology of chloroplast and interorganellar communication systems. This section begins with a chapter on the thylakoid proteome by van Wijk (USA) followed by that by Rochaix (Switzerland) on nucleus-chloroplast interactions.

Subsequently, Cahoon, Komine and Stern (all of USA) describe for us the features of the plastid transcription. The mechanism of signal transduction systems, which operates during communication between the nucleus and the plastids, has been discussed by Strand and Kleine (Sweden) and Chory (USA). Section II ends with a chapter authored by Merchant (USA) on metalloprotein complex, transport of metal ions and their metabolisms.

Section III (Photosynthetic Metabolisms in Plastids) consists of 4 chapters that focus on carbon metabolism of the photosynthetic organelle. Dai (USA), Hallberg & Eklund (both of Sweden) and Schurmann (Switzerland) provide an up to date knowledge of the light-dark regulation of chloroplast metabolism, with specific reference to the redox reactions associated with the thylakoids and the enzymes of the Calvin-Benson cycle. The chlororespiratory enzymes and their physiological role have been critically discussed by Nixon and Rich (both of U.K.). Then, Bartlett, Mitra and Moroney (all of USA) summarize for us the mechanism of CO₂ concentrating mechanisms. In the last chapter of this section, the transport and the partitioning of sugars are discussed by Weber (USA).

Non-photosynthetic metabolism in plastids is covered in Section IV, that includes 6 chapters. The chapters on the synthesis of chlorophyll by Willows (Australia) and on the carotenoids by Cuttriss, Mimica, Pogson and Howitt (also of Australia) cover biosynthesis and regulation of these pigments associated with thylakoid membranes. The next 4 chapters review several specific aspects of chloroplast metabolism which have been ignored in many earlier published text books on plastids. The chapters on the synthesis of lipids by Dormann (Germany) and amino acids in plastids by Lancien and Lea (UK) and Azevedo (Brazil) focus on specific metabolic reactions, the enzymes involved in the synthesis of lipids and amino acids, and their interlink with other cellular metabolic path ways. The subsequent two chapters of this section deal with the specific role of sulfur and of calcium in chloroplast metabolism. Pilon-Smits and Pilon (both of USA) have written a chapter on the biosynthesis of sulfur compounds, their biosynthetic pathways and function in the plastids, and Johnson, Shingles and Ettinger (all of USA) describe calcium fluxes across the plastid membrane and their light-dark regulation.

Section V, the last section of the book, comprises 7 chapters that cover the area of plastid differentiation, its response to environmental factors, and the features of plastids harbored in animals. The first two chapters critically discuss the transformation of plastids during fruit ripening and leaf senescence. Bouvier and Camara (both of France) describe the changes in fruit plastids with particular reference to carbohydrate and carotenoid metabolism. On the other hand Krupinska (Germany) highlights the dismantling of chloroplast structures and subsequent transformation of the photosynthetic organelle to gerontoplast. Although a research monograph with details of molecular mechanism of transformation of chloroplast to gerontoplast has been published by U.C. Biswal, B. Biswal and M.K. Raval (Chloroplast Biogenesis from Proplastid to Gerontoplast, Springer, 2003), the present chapter updates the knowledge in this field. The next two chapters are very unique in character. Rumpho, Dastoor and Manhart (all of USA) and Lee (South Korea) summarize the characteristic feature of kleptoplasty, a process that helps some animals harbor functional chloroplasts from photosynthetic organisms; this makes the heterotrophic animals photoautotrophic! This chapter is followed by that authored by Funes (Germany) and Perez- Martinez, Reyes-Prieto and

Gonzalez-Halphen (all of Mexico) on apicoplast, another fascinating organelle believed to be derived from the chloroplast. The nature of its plastid like DNA, expression of the genome and its physiological role in apicomplex are discussed there. Although our knowledge in these two fascinating plastids is still limited, this chapter provides a new dimension to photosynthesis research that needs further attention. The last three chapters describe the responses of the plastid to environmental factors like gravitation, light and oxygen. Palmieri and Kiss (both of USA) describe gravitation responses, Sato and Kadota (Japan) describe light responses, whereas Logan (USA) discusses oxygen responses. Light induced chloroplast movements, mediated by different photo-receptors, and molecular mechanism of the receptors' action, have been reviewed earlier in advanced level books in Plant Physiology.

This is the first book in the *Advances in Photosynthesis and Respiration* series (of Govindjee) that comprehensively describes the complete story of plastids that includes their diversity, origin, evolution, interconversion, different physiological functions, communicating systems with other cellular organelles and their responses to various environmental factors. The chapters covering these areas provide the most recent and relevant information.

A complete Table of Content of this book is available at: < <http://www.life.uiuc.edu/govindjee/References/Volume%2023%20By%20Chapter.htm> >. Members of the ISPR (International Society of Photosynthesis Research; web site: < <http://www.photosynthesisresearch.org/> >) receive 25 % discount.

Although most of the book succeeds in providing a broad view of the structure and function of plastids to students and researchers in chemistry and biology, some of the chapters of the book are specifically designed for advanced students in the fields of photosynthesis, molecular biology, biochemistry and plant physiology. Several chapters are highly suited for use as text book materials for courses in Plant Physiology. We recommend this book to all the major biology libraries of the universities and research institutions in the World.