PREFACE

In the two decades since the last comprehensive work on plant peroxisomes appeared[1] the scientific approaches employed in the study of plant biology have changed beyond all recognition. Development of techniques such as plant transformation, confocal microscopy, PCR and high throughput DNA sequencing has led to an explosion of information and an opportunity to do experiments that were beyond the wildest dreams of the founders of our subject. A major investment by public funding bodies in Europe, the US and Japan, as well as commercial enterprises, has led to the production of research tools that were unthinkable even a few years ago. We have the complete genome sequence of a dicot (*Arabidopsis thaliana*) and a draft sequence of a monocot (rice). EST projects are well advanced for many other crop species. The development of various post genomic technologies such as proteomics, transcriptomics and metabolomics, and the relative ease of identifying mutants by forward and reverse genetics, raises the prospect of knowing the function of every gene in Arabidopsis in just a few years time, and being able to apply this knowledge to more economically important species. The accelerating pace of plant research is leading us to appreciate that peroxisomes have many more roles than the earliest described metabolic functions in lipid mobilisation and photorespiration, vital though these functions are. Many researchers are finding, and no doubt will continue to find, that their favourite protein, metabolic pathway or physiological response is in, or in some way connected to, peroxisomes. In animals defects in peroxisome formation and function results in multi-system defects and often death. It is becoming apparent that peroxisomes and peroxisome functions are no less important for normal plant development. It, therefore, seemed timely to produce a book which would seek to draw together the current state of knowledge of the field, as a convenient starting point for anyone who wants to know about plant peroxisomes.

The first section of the book surveys the functions of plant peroxisomes. The first chapter by Beevers provides a personal historical perspective of those pioneering early studies and provides a link between the past and the present. Hooks, Smith and Cornah, and Reumann provide comprehensive reviews of fatty acid oxidation, the glyoxylate cycle and the photorespiratory pathway,

[1] Huang, A.C., Trelease, R.N. and Moore, T.S. (ed) (1983) Plant Peroxisomes. New York:Academic Press

integrating older observations with new data arising from mutants, genome and EST sequences about gene families, expression and function. Verma addresses the important functions of root nodule peroxisomes in nitrogen fixation in tropical legumes. Heinze and Gerhardt lead us through the immense complexities of catalase function and biogenesis with multiple genes regulated at different levels giving rise to a wide range of isoforms to defend plants against oxidative stress. The role of peroxisomes as both a source of reactive oxygen species and ROS related signal molecules and as a first line of defence against these potentially harmful species is addressed by Del Rio and co-workers. Donaldson surveys the composition and function of the peroxisome membrane. The compartmentalization of pathways such as photorespiration between organelles necessitates the intra-compartment movement of many molecular species. To what extent the peroxisome membrane is responsible for compartmentalization and to what extent supra-molecular assemblies of the pathway enzymes serves to confine intermediates (metabolite channelling) is still a matter of active debate. This question is addressed by Reumann in the context of the glycolate and glycerate pathways of photorespiration, and by Smith and Cornah in the context of the glyoxylate cycle, as well as more generally by Donaldson. Despite our comparative lack of knowledge of the peroxisome membrane it is clear that it has important functions in transport of metabolites and proteins as well as in ROS metabolism. The section ends with a chapter by Hayashi and Nishimura that describes several peroxisome-deficient mutants including those that are disrupted in specific aspects of peroxisome metabolism and peroxisome biogenesis. These studies highlight the contribution that the genetic approach is now making to our understanding of the physiological relevance of these processes and the mechanisms underlying peroxisome biogenesis and protein import.

The second section deals with peroxisome biogenesis and protein import in detail. Trelease provides a thoughtful discussion on the origin and differentiation of peroxisomes, still a topic of some controversy within the field, and then reviews our limited knowledge of the targeting and insertion of peroxisome membrane proteins. Mullen considers the targeting and import of peroxisome matrix proteins and Charlton and Lopez-Huertas conclude this section with a chapter on genes required for peroxisome biogenesis in other organisms and their counterparts in plants. This survey leads them to consider whether the components for peroxisome biogenesis are universal.

The final section considers the potential to exploit our growing knowledge of peroxisome biogenesis and function for biotechnological ends. Alscher

considers the possibilities for engineering plant peroxisomes to increase plant resistance to stress. Rylott and Larson address the problem of futile cycling through β-oxidation as a potential barrier to increased yields of novel oils in transgenic plants. Poirier reviews use of peroxisomes as a compartment for the synthesis of biodegradable plastics and other novel biopolymers.

It has been a pleasure for us to work with colleagues from 9 countries and 3 continents during the preparation of this book. We as editors have learned an enormous amount from reading and discussing the various contributions with the authors whom we thank for contributing their time and enthusiasm to the project. We hope that you the reader will find it stimulating and informative.

ALISON BAKER AND IAN A. GRAHAM, DECEMBER 2001.