

The structure of PS II is followed by a section on 'Molecular dynamics of photosynthesis' in Part V of the book. This part includes four chapters. Chapter 22, written by Laura M. Barter, David R. Klug and Rienk van Grondelle, reviews our current understanding of energy trapping mechanisms, rate-limiting steps in energy transfer, and charge separation and its regulation. This is followed by a review on the role of carotenoids in photo-protection under adverse environmental conditions in Chapter 23, by Barry J. Pogson, Heather M. Rissler and Harry A. Frank. In Chapter 24, Vladimir Shinkarev discusses the unique flash-induced oscillatory processes which lead to oxygen production from water. On the basis of current knowledge on energetic and kinetic aspects of photosynthetic water oxidation, Warwick Hillier and Johannes Messinger discuss the mechanism of oxygen production in Chapter 25. The black box of 'the oxygen clock' is finally being opened before our very eyes.

Part VI of the book on the 'Assembly and biodynamics of photosystem II' includes four chapters. This part discusses the processes involved in sustaining PS II functions *in vivo*. In Chapter 26, G. Charles Dismukes, Gennady M. Ananyev and Richard Watt discuss the assembly of manganese cluster in the presence of light. This is followed by a review on the mechanisms and regulation of photo-inactivation and recovery of D1 protein by light in PS II in Chapter 27 by Wah Soon Chow and Eva-Mari Aro. Chapter 28 discusses the regulation of transcription and translation of gene expression of the *PS II* genes, Kenichi Yamaguchi, Stephen P. Mayfield and Mamoru Sugita. Chapter 29 covers protein import and post-translational modifications of PS II proteins, by Steven M. Theg and Lan-Xin Shi.

Part VII of this volume discusses the comparison of PS II with artificial and other natural systems. Chapter 30 in this section reviews the origin and evolutionary aspects of oxygen evolution by PS II, by G. Charles Dismukes and Robert E. Blankenship. In Chapter 31, Gary W. Brudvig and Marten Wikstrom compare the PS II to the cytochrome oxidase of mitochondria. Two totally opposite reactions are catalysed by these enzymes: the process of water oxidation/oxygen production by PS II and oxygen reduction/water production by cytochrome c oxidase. In Chapter 32, the point of focus is

on the models and experimental evidences for evolutionary development of PS II from purple bacteria to higher plants, by Laszlo Kalman, JoAnn C. Williams and James P. Allen. This provides evidence that PS II development was a unique one-time event in the history of the earth. The next two chapters (33 and 34) provide experimental details of mimicking photosynthesis in *de novo* proteins and artificial systems. These are by Brian R. Gibney and Cecilia Tommos, and by Ann Magnuson, Stenbjörn Styring and Leif Hammarström respectively.

Other features that deserve special mention and make the book more impressive and informative, are discussions of instrumentation and methodology of different spectroscopic techniques like Mn X-ray absorption near edge spectroscopy, Mn K $\beta$  X-ray emission spectroscopy, Fourier transform infrared vibrational spectroscopy, electron paramagnetic resonance, electron crystallography, and X-ray crystallography and their implications in the understanding of PS II structure and functioning. This should be useful to students at both undergraduate and graduate levels as well as researchers. The 16 coloured plates at the beginning of the book, and different illustrative figures in the text are not only eye-catching, but necessary for in-depth understanding of PS II structure and excitation energy and electron transfer within this enzyme. All the chapters are scholarly and provide the readers with leads into the literature through their extensive and complete references. Inclusion of short biographies and photographs of the Series Editor; the Editors, Assistant Editor and typesetter, gives this volume a personal flavour. If one examines the list of authors of this book, it is the 'who's who of photosystem II researchers in the world'.

Thus this book is impressive in all aspects. Such plentiful knowledge on PS II can be explored in the bioengineering of PS II to provide photo-protection and generation of new non-polluting fuels from solar energy and water. As this is a topic of global interest nowadays, this book is informative and has been published at an appropriate time. Further, this book is a molecular guide to future protein engineers and bio-mimetic chemists working in the field of generating fuel cells. This remarkable book is a must read for all students and researchers involved in the field of photosynthesis, biochemistry, biophysics, molecular biology and

biotechnology. We recommend this book to all the major science and engineering libraries as well as people working in industry and researchers in PS II bioengineering.

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Plant diseases significantly influence world economy. According to FAO estimates, plant diseases could cost the US alone \$33 billion per year (Maor and Shirasu, 2005). Among all plant pathogens, fungi probably cause the most devastating damage, with it being estimated that more than 13,000 fungal pathogens and 75,000 plant-fungal combinations exist in the world. A recent record of the plant pathogens in the world showed that 12 of the 19 most threatening pathogens listed are fungi (Maor and Shirasu, 2005). Recent advances in molecular biology, especially the use of model plant-microbe systems, have significantly increased our understanding of the complexity of the ongoing plant-pathogen war. Plant pathologists are working around the world to develop new, more efficient and environmentally sustainable methods to manage plant diseases. In this context, the present volume of *Annual Review of Phytopathology* provides a broad conceptual, in-depth analysis and persuasive arguments on various fascinating aspects of plant-pathogen interactions and effective, durable control measures against harmful pathogens.

This volume contains detailed accounts written by leading researchers on a wide variety of topics that are of contemporary and prime importance in the field of plant pathology and global food security. The volume offers an excellent compendium of articles in the diverse field of phytopathology. The most impressive fea-

## BOOK REVIEWS

tures of all the review articles are the 'Introduction' and 'Background' in the beginning of each article. They offer a baseline overview of the topic under discussion; this is immensely relevant since the readers of this book are from a wide plant pathology background.

The book opens with an excellent commentary by Robert Webster, on the role of a plant pathologist in an era of dynamic changes in the field of food production and food security. He stresses the need for plant pathologists to confirm to the central purpose of gaining knowledge of the host-parasite interaction and use the knowledge generated toward the control and management of plant disease. His description of early research efforts in rice disease control and adoption of newer technologies and policies, should be an inspiration for the new-age plant pathologists.

Global food security is threatened due to increasing number of plant diseases and more than 10% of global food production is lost to plant diseases. A vast number of plant pathogens cause diseases among the fourteen crop plants, which give bulk of the food for human consumption. The article on plant diseases as a threat to global food security sheds light on some important diseases of huge economic value and also discusses in detail about the challenges and solutions for ensuring food security. The article also has some excellent inputs in various areas of molecular epidemiology, determination of virulence characteristics of the pathogens using different serological and molecular tools of contemporary significance. Other interesting articles include some of the most exciting and less reviewed topics like the role of coat protein in replication of ilaviruses. This article dwells extensively on molecular events involved in binding of coat protein to viral RNA and also on the role of Poly A-binding protein in the translation of viral RNA. The role of encapsidation in virus movement has been extensively discussed and examples of transient gene expression in tobacco protoplasts, which show some intriguing new information on the role of coat protein mediated infection in Bromoviridae, have also been shown. Another article describes interesting new insight into viroids and their interaction with the hosts. This article describes in detail about the pathogenic effects of viroids mediated by si RNA and recent experimental proof has been provided to prove the hypo-

thesis that viroids influence host gene expression at both post-transcriptional and translational levels. The article also provides new experimental proof using post-transcriptional gene silencing to show that viroids exert their pathogenic effects via specific si RNAs.

Economic, environmental and technological influences complicate the task of achieving disease-free products in economically important ornamental industry. The article on principles of plant health management for ornamental plants brings out a comprehensive review on the much-needed knowhow on various aspects of floriculture and nursery crop production like clean stock, host resistance, IPM as a disease control strategy and applications of biotechnology in clean offshore production for economic competitiveness. Strategies to screen horticultural crops for graft transmissible agents like viruses have advanced substantially over the past decade. In their review on pathogen testing and certification of *Vitis* and *Prunus* species, Rowhani *et al.* describe new molecular, serological and nucleic acid-based assays for certification.

*Phytophthora infestans* continues to be an enigmatic challenge for generations of plant pathologists and is still responsible for significant yield losses in potato. The fight against late blight has led molecular pathologists to trace the centre of origin and link it to the biology of the pathogen. The review on 'Biology of *Phytophthora infestans* at its center of origin' describes research efforts on population genetics and phylogenetic analysis on *Phytophthora infestans* across the globe. The article describes various phylogenetic methods used to trace variability of the pathogen with respect to its native host populations and hypothesizes that *Phytophthora* species evolved sympatrically from one ancestor to another through adaptive radiations onto their respective host families.

Plant defence responses effectively depend on the kind of virulence mechanisms followed by the pathogen. The review article on the mechanism of defence against biotrophic and necrotrophic pathogens describes in detail about the contrast in the responses of the host towards different pathogens. This article also provides some interesting and new genetic evidence for different signalling networks and also the crosstalk between salicylic acid and jasmonic acid/ethylene used by the host for countering pathogens following different infection strategies.

Jyoti Shah, in an article of extreme relevance, describes the role of lipids, lipases and lipid-modifying enzymes in plant disease. The article bridges the gap in existing knowledge on the role of lipids as elicitors of plant defence, lipopolysaccharides as pathogen-associated molecular patterns and lipid-based signal molecules in plant defence response.

In an excellent article on 'Mechanisms of fungal speciation', Linda Kohn reviews some interesting case studies which describe various aspects like ploidy, metapopulations, hyphal fusion and domestication. The article also contains some in-depth analysis on the various experimental approaches used in elucidating speciation of fungi.

Other reviews include some important topics of relevance like the commercialization and implementation of biocontrol, evolution of gemini viruses, molecular regulation of secondary metabolism in fungi, biology of economically important rhabdo viruses, molecular interaction between tomato and leaf mould pathogen and *Cladosporium fulvum*, tospovirus-thrip interactions and RNA silencing in productive virus infections.

Two of the most interesting reviews are the ones that describe signal crosstalk in induced resistance and genetics of plant virus interaction. The article on signal crosstalk describes in detail the systemic signalling in resistance and development of acquired resistance against pathogens. The review also describes the role of changes in the cellular redox potential in induced systemic resistance and expression profiling and signal signatures as novel tools for analysis of crosstalk in signalling networks during host-pathogen interaction. The latter review serves as a complete compilation of *R* genes active in various host plants and also gives some new insight into resistance to virus movement within and between cells, resistance to long-distance movement and co-evolution of virus resistance and viral avirulence gene.

All the articles are adequately supplemented with tables and illustrations. The book comes with an extensive index and on-line links. It is a good book for reference and meets the standards of the *Annual Review* series, with its hard paperback cover and printing. The description is simple enough for beginners as well as traditional plant pathologists to understand. The book is well produced with good quality figures and representations.

It has a precisely documented subject index for easy browsing of the book. The book will be an invaluable resource for researchers, teachers and students in the field of plant pathology.

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The *Annual Review of Plant Biology* (2005) edited by S. Merchant *et al.*, is as expected a collection of reviews summarizing recent advances in some exciting areas. The various articles are representative of current research in the area of genetic and epigenetic regulators of developmental fate; metabolic pathways; membrane dynamics and functions; interaction between plants and the environment. I summarize here some of the excellent reviews as examples of the resources in this volume. In addition to these research reviews is an interesting article by Peter Starlinger entitled 'Fifty good years', that chronicles the exciting decades of bacterial and phage genetics in the early days of The Cologne Institute of Genetics. He gives a vivid account of the transition of their research on bacterial IS elements to their pioneering work on the Sh-locus of maize that led to the co-discovery of the plant transposable element Ds. He touches on the active engagement between his laboratory and other maize geneticists that opened the way to study maize genes and transposable elements – a subject that captivated his attention until retirement. His commitment to teaching as a University Professor is evident from the importance he gave to teaching genetics, and 'Spring Meetings' organized to capture recent research progresses. He voices his opinion on the need for dialogue and debate between scientists and society

that could shape the opinion of educated public. All in all, an engaging, insightful and inspirational article.

There are about eight articles in the general area of developmental and cellular aspects of plant architecture. Leyser and Steen review the diversity of axillary meristem branching in dicots and monocots, highlighting the contribution of regulatory factors. Axillary meristem initiation, its outgrowth, its dormancy, and the role of auxin are topics of discussion, where advances made in *Arabidopsis* and tomato are summarized. By studying markers for apical meristematic cells, like *STM*, in wild type and mutants that lack axillary meristems, the origins of these meristems are being understood. The role of dynamic auxin fluxes that pattern organ initiation at the shoot apex is discussed with regard to axillary meristem development. Studies on bud outgrowth are reviewed, where it is evident that auxin action recruits yet another hormone, cytokinin as second messenger. New components of the auxin signalling pathway controlling bud morphogenesis were identified as the *Arabidopsis* MAX 1, 3, 4 genes whose homologues in pea and tomato are also involved in regulation of branch development. The article also provides an excellent review of the similarities and differences in axillary meristem development between monocot and dicots. The authors discuss regulatory factors controlling branching during vegetative growth and inflorescence development in model grasses such as maize and rice. Of interest are their discussions on factors like MOC1 that act as expected in vegetative axillary meristem initiation and outgrowth, in addition to acquiring a monocot-specific role in inflorescence branching. The genetic regulators of the branched inflorescence of maize and rice are well summarized. The authors point out that the interactions between these transcription factors and signalling molecules like auxin and cytokinin are unknown and are areas of future work. In summary, the article lucidly draws out the parallels between monocots and dicots and not surprisingly, discusses the several monocot-specific factors that could underlie the large diversity seen in monocot axillary meristem development. Fischer and colleagues discuss chromatin structure and epigenetic factors influencing gene expression, the maintenance of chromatin states through mitosis and chromatin modulation during plant development. This area finds paral-

els to several recent discoveries in animal development, where maintenance of the body plan requires the activity of chromatin modifiers. The article summarizes the discovery and functions for ATP-dependent remodelling complexes as known in yeast. Several of these factors, in *Arabidopsis*, control shoot development, flowering time, carpel development and transgene silencing. The role of histone modification – acetylation and deacetylation, methylation, the functions for Histone protein variants, DNA methylation, and RNAi-dependent changes in chromatin dynamics are reviewed and well outlined. The new roles for DNA glycosylases and DNA methylases in gene imprinting are discussed. The accompanying review by Sung and Amasino, adds greatly to our molecular understanding of how plants remember past encounters with winter. They succinctly review how exposure to a prolonged cold winter promotes the competence to flower in *Arabidopsis*. The genetic network controlling expression of *FLC*, a repressor of flowering, involving the VRN1, VRN2 and VIN3 chromatin remodelling factors are well outlined. The review also provides information on loci in other plants, particularly wheat, barley and *Brassica*. Despite these revealing molecular details, mechanisms that measure the duration of cold are not known. They outline the challenges that remain in this field – how are the chromatin remodelling complexes targeted to flowering repressors? Does this system operate in other flowering plants? And importantly, what is the clock that measures duration of cold exposure? Hong Ma provides in his article, an in-depth review of the genetics of stamen and pollen development. The review begins with the molecular control of stamen primordia specification summarizing the importance of Class B and C genes in specifying male reproductive organs in both angiosperms and gymnosperms. The article then reviews the recent reports analysing anther and pollen differentiation. The role of the *Arabidopsis* *SPL* gene in early aspects of anther cell differentiation and some genetically identified candidate targets for SPL acting to specify meiocytes and the tapetal cell layers are summarized. The article also reviews the genetic control of meiosis in *Arabidopsis*, where recent studies have gained advantage from prior knowledge on budding yeast. The article also reviews the literature of genes that act gametophytically, to control pollen de-