

thorough retrospective analysis of various hypotheses and theories with an open mind.

The book does not have adequate illustrations and figures, while the limited number of figures given are not of good quality. There are a large number of excellent books available on various aspects of the earth and its processes. The only individual aspect of the present book is that it seeks to provide an explanation to global tectonics and the global features largely based on the concept of the earth expansion theory. However, till date evidences for an expanding earth are either ambiguous or are based on tenuous and ad-hoc assumptions. Also, it has not yet been possible to find a satisfactory mechanism for planetary expansion.

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It is a pleasure to read an issue of the *Annual Review* in any subject area, and the 2007 edition of the *Annual Review of Plant Biology (ARPB)* is no exception. *Annual Reviews* have been the staple diet on which most of us have grown up as research scholars. The credit goes to their authors, editors and publishers, who have ensured that the volumes continue to be not just relevant but also critically important for researchers today, despite the advent of the minireview culture and the growth of monthly review journals over the years. For anyone seeking a single-point entry for comprehensive and balanced reviews of the literature and an excellent source of back references with complete citation details, there are very few alternatives to the *Annual Reviews* even today. This is particularly important for young researchers who need to know what is known and what it not, as well as how to proceed further, from a broader perspective, before they can better appreciate the latest insights, slants, trends and opinions, which have their own value.

The *ARPB 2007* presents an excellent collection of 20 definitive and timely review articles encompassing most of the dominant themes in plant biology today. In addition, there is the frontispiece, a feature unique to the *Annual Reviews* that provides fascinating insights into the triumphs, trials and tribulations of doing science and developing technology, straight from the scientists at the centre-stage of all the action. In this issue, Diter von Wettstein's frontispiece is an account of his group's genetic engineering of barley for improved (animal) feed and metabolic engineering of proanthocyanidin-free barley for haze-free beer. Besides the interesting narrative of research in his laboratory and elsewhere spanning over nearly three decades, his perspective highlights the inter-connectivity between what we often artificially segregate as basic science, applied science and technology development.

Reviewing the 20 articles comprising this 500-page volume is a daunting task. An attempt is made below to capture some of the highlights from related groups of articles in the following section from our own perspective based on plant signal transduction and gene regulation.

Light is critical for plants, not only as a source of energy for photosynthesis but also as a signal for numerous physiological and developmental processes. The review by John Christie on phototropins highlights the role of these blue light receptors (with light-activated ser-thr kinase activity) in phototropism, stomatal opening, chloroplast movement and other light-dependent processes that serve to optimize the photosynthetic efficiency of plants. One of the most critical developmental processes regulated by light is stomatal opening, which includes blue and red light-mediated events. While Bergmann and Sack discuss the relationships between the environmental signals, stomatal development genes and control mechanisms of shoot gas exchange, Shimazaki *et al.* review the myriad mechanisms in stomatal development, including the synergistic interactions between blue light (phototropins) and red light signalling processes and guard-cell chloroplasts. The article also throws light on the properties of the plasma membrane H⁺-ATPase in guard cells and the possible role of type-1 protein phosphatase in mediating light signalling.

Continuing on the theme of signalling, the review by Schachtman and Shin offers

a comprehensive and unparalleled insight into the events that lead to plant responses to nutrient-deficient conditions. From the commonalities and differences in response to phosphorus, nitrogen, potassium and sulphur deficiencies to nutrient sensing and signalling, the authors cover a vast and yet relatively uncharted domain of research, putting the downstream responses of nutrient deprivation in perspective. With the rising nutrient input costs in agriculture and the adverse environmental impacts of poor nutrient use efficiencies in crop plants, an integrative approach to the development of nutrient-efficient varieties is the need of the hour. The article by Osmont *et al.* offers an in-depth perspective on the recent advances regarding the role of various nutrients and phytohormones in root branching, which are important in plant growth and development. Spanning genetic methods involving *Arabidopsis* to alternative high throughput approaches like microarray and proteomic analyses of root branching, it raises some pertinent queries about the nature and regulation of pathway(s) controlling initiation and maintenance of root meristems across root types.

The search for the role of plant hormones in plant development and productivity has also drawn the attention of researchers towards the mechanisms of hormone signalling. Gibberellin (GA) is a well-known phytohormone that affects a range of plant responses and occurs as soluble and membrane-bound forms. Ueguchi-Tanaka *et al.* have traced the history of attempts to identify receptor candidates for GA and their role in GA-signalling. Discussing the key steps of GA-signalling pathways and the role of DELLA proteins, the review throws light on the biochemical and physiological characteristics of the GID1 GA receptor. With several lines of evidence suggesting the presence of a plasma membrane-bound GA receptor, identification and isolation of such a receptor is the next objective. Interestingly, these authors, who were among those who originally characterized some GA-insensitive rice dwarfs as G-alpha mutants and strongly suggested G-protein pathways in GA-signalling less than a decade ago, now cite their unpublished data to advise that the 'involvement of trimeric G-proteins in GA signaling should be reviewed with care'. Our own comparison of microarray-derived G-alpha responsive and GA-responsive

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gene lists in *Arabidopsis* also indicates very few overlapping genes (unpublished results).

As far as signalling receptors are concerned, none has attracted as much attention as the plant heterotrimeric G-protein complex. With the identification of *Arabidopsis* as a model system for studying signal-transduction pathways utilizing the heterotrimeric G-protein, the area has progressed rapidly. With loss of function gene knockouts appearing to grow without drastic developmental defects, the genetic approach to studying G-protein signal transduction is also feasible. Temple and Jones offer many such exciting insights into the area of plant heterotrimeric G-protein signal transduction. Using well-thought-out models and schematics, the review captures the true essence of G-proteins, its evolution, the role of individual subunits and structure–function relationship between the GPCR and the subunits themselves.

Genetic engineering efforts to create transgenic plants have received considerable attention and the role of mutants and transgenics in studying various metabolic and signalling mechanisms is also in vogue. The review by Johnathan Napier on the production of unusual fatty acids in transgenic plants is perceptive, offering future avenues for raising genetically modified crops with modified fatty-acid profiles.

Dwindling fuel resources have already sparked-off a quest for renewable greener fuel solutions. In this aspect, the application of hydrogenases and other enzymes derived from oxygenic photosynthetic organisms offers an attractive proposition. The review by Ghuirardi *et al.*, not only discusses the fundamental aspects of such enzymes with a potential to produce renewable fuels, but also addresses some of the challenges that need to be resolved before practical photobiological fuel-systems can be developed. Of course, the more conventional interest in photosynthetic (PS I) cyclic electron transport has also been addressed in a separate review by Shikanai, combining the recent advances from cyanobacteria to post-genomic model plants like *Arabidopsis*. Mutant analysis in *Arabidopsis* has revealed that out of the two partially redundant routes of cyclic electron transport in higher plants, the NDA-dependent and PGR-5-dependent routes, the latter is essential for both photosynthesis and photoprotection. In terms of the physio-

logical significance of the PSI cyclic transport that has been largely overlooked or underestimated, this review points out that it is essential for balancing the generation ratio of ATP and NADPH to prevent the over-reduction of the stroma, and possibly energize C4 photosynthesis. Many new lines of evidence have also been presented in the review to reconsider the fundamental mechanisms of chloroplast energetics.

Alternative splicing of precursor mRNAs in plants has largely remained an unexplored area, as it was considered to be rare in plants. However, the review by Reddy of recent genomewide computational analyses and other studies reveals its high prevalence and compels us to take this phenomenon more seriously. Extensive alternative splicing has been found in the pre-mRNAs of many spliceosomal proteins, especially the ser/arg-rich proteins. Alternative splicing increases the transcriptome and proteome complexity within and between cells/tissues/organs, and could constitute an important post-transcriptional regulatory mechanism of modulating gene expression in plants. While these are genetically determined, epigenetic mechanisms add an additional layer of complexity in understanding gene expression in plants. They can be particularly intriguing in polyploids, due to the extensive phenotypic variation that results from the adjustments made by the plant to its ploidy status, with implications for adaptive evolution and crop domestication. The review by Jeffrey Chen on genetic and epigenetic mechanisms for regulation of gene expression in polyploids highlights the recently emerging themes in the otherwise poorly understood mechanisms involved, such as changes in DNA sequence, *cis* and *trans*-acting effects, chromatin modifications, RNA-mediated pathways and regulatory networks.

The role of reactive oxygen species and reactive nitrogen species in plants, especially under biotic or abiotic stress situations, and the oxidative modifications to various cellular components has been reviewed by Moller *et al.* They critically assessed the current state of knowledge regarding the modifications of polyunsaturated fatty acids, DNA, carbohydrates and proteins, the fate of the modified components, the energetic costs of replacing them and the strategies to minimize their transfer to the next generation. In addition, there are reviews

dealing with other fascinating physiological, biochemical and developmental aspects of plant biology like leaf senescence by Lim *et al.*, tetrapyrrole biosynthesis by Tanaka *et al.*, Arabinogalactan proteins by Seifert *et al.*, ATP-binding cassette transporters by Rea, and tracheary element differentiation by Turner *et al.*, which provide extensive coverage of the recent literature and highly perceptive insights in those topics, but simply cannot be accommodated here due to lack of space. Last but not the least, the introduction of poplar tree as a new post-genomic model system for plant biology in an excellent review by Jansson and Douglas which offers great potential for research in eudicots and look at tree-specific traits like wood formation, which is currently not possible in *Arabidopsis*.

In conclusion, the current volume of the *ARPB* would prove to be a valuable resource for advanced researchers as well as research students. Over the years, many improvements have been introduced in the text layout and design, including coloured headings, abstract and highlights, keywords, explanations for key terms and concepts in the margins, summary points and annotated references highlighting their importance, as well as additional 'related resources' and most of all, tremendous improvements in tables, figures and illustrations in full colours, which have all contributed to an attractive and reader-friendly product that has come of age. The on-line version has many more user-friendly features, hyperlinks and enhancements to benefit from, and possibly to borrow some of their illustrations for teaching/presentation purposes. Some of these improvements have also made the *Annual Reviews* important as educational resources for classroom teachers and students, a status that they did not enjoy widely till recently. To sum up, the *Annual Reviews* richly deserve their loyal readership and subscription, and electronic access to the *ARPB* must be universally made available through the various e-journal consortia in India and elsewhere.

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