

Annual Review of Plant Biology, 2014. Sabeeha S. Merchant, Winslow R. Briggs and Donald Ort (eds). Annual Reviews, 4139 El Camino Way, P.O. Box 10139, Palo Alto, CA 94303-0139, USA. Vol. 65. xiii + 790 pp. Price: US\$ 101.

It is both a daunting as well as a pleasant task to review the *Annual Review of Plant Biology (ARPB)*, owing to its sheer size and the wide array of research topics. This volume of *ARPB* has an excellent compilation of review articles covering most of the established as well as some emerging fields of plant biology worldwide. The *ARPB* also provides future perspectives after each review, which aid specialists and young researchers alike, in deciding/validating their own future research endeavours. As always, the volume starts with a semi-autobiographical front-piece by Barry Osmond, a renowned name in the field of photosynthesis research. He traces the historical developments in the field of photosynthesis research from the days of basic biochemistry to the era of advanced techniques, instruments and remote sensing. He also comments in the article how science, in general, and the scientific community in particular, have suffered due to political interventions and change from 'high-trust research system' to 'low-trust research system' for approval of funds. In the concluding paragraph, Osmond subtly points to how performance indicators have shifted research from being 'collective' to 'competitive', with associated drawbacks and validates the same with a few interesting examples across nations. This volume has 27 other reviews spanning almost 800 pages and covering a large array of topics, including crop improvement, development, signalling, genetics, etc.

The volume contains several reviews related to crop improvement. The article by López-Arredondo *et al.* describes the problem associated with phosphate nutrition, and the breeding and genetic engineering strategies to produce high P-efficient crops. It also describes optimized fertilizer use and agricultural sustainability with low environmental cost. A few articles describe how genetic engineering of crops and their traits like male sterility has helped in the development of crops with increased tolerance to various stresses like drought, and the steps involved in the production of these genetically

engineered crops. The article by Hu and Xiong describes the recent progress in genetic, genomic and molecular studies of drought resistance in major crop plants. It also provides a comprehensive list of well-characterized genes like various QTLs, AREBs, DREBs, transcription factors like NAC, bZIP, ABF3, and various kinases associated with drought resistance. The article by Farré *et al.* discusses the various approaches to engineer metabolic pathways and the steps which can be manipulated. The authors describe the progress and pitfalls involved in the form of a cartoon of snakes and ladders.

A number of articles review the development of various plant organs/organelles and the metabolism associated with developmental processes. McFarlane *et al.* discuss the cellular mechanism of cellulose synthesis and cell-wall formation, including trafficking of cellulose synthase complex, its regulation and recycling. The review by Osteryoung and Pyke describes the mechanism of plastid division with focus on chloroplast, and the difference between plant chloroplast and algal systems. Balk and Schaedler discuss the importance of iron in plants, the chemistry of iron, heme and iron-sulphur clusters. They also describe the mechanism of iron co-factor assembly and its compartmentalization. Molecular control, including the genes and pathways involved, of inflorescence development has been described in detail by Zhang and Yuan. They also discuss how inflorescence development can affect crop yield. Furuta *et al.* review the recent progress made in the understanding of procambial development and the roles of various phytohormones, small RNAs and transcriptional networks in this process. Bellini *et al.* bring out the developmental processes and the underlying mechanisms which give rise to lateral and adventitious roots. The authors also discuss about the role of nutrients, hormones, aging and environmental factors which aid in this developmental process. Roles of non-structural carbon from omics to physiological viewpoint are discussed in the review by Dietze *et al.*

Secondary metabolite biosynthesis has become one of the emerging fields of plant research and continuing with this theme, this volume contains two well-written articles on terpene biosynthesis. The article by Thimmappa *et al.* not only critically examines the recent develop-

ments in the field of triterpene biosynthesis, but also discusses the strategies used for discovering new pathways of triterpene biosynthesis. The review by Zi *et al.* focuses on the origin, function and evolution of diterpenoid metabolism and the structural diversity of diterpenoids, with emphasis on gibberellins. Barkan and Small in their review discuss about one of the largest protein families – pentatricopeptide repeat proteins. They clearly bring out the evolution of these proteins, their molecular functions and the effect they exert on the physiology of plants. Their role in RNA recognition and engineering of RNA-binding proteins is also well mentioned.

A number of articles bring out the current state of research in the field of light signalling. Rochaix describes the regulation and dynamics of light-harvesting system and explains how Light Harvesting Complex (LHC) helps maintain optimal performance of the photosynthetic machinery under both limiting and excess of light. The role of light as a signal in morphogenesis (both skotomorphogenesis and photomorphogenesis) is reviewed by Wu. The review traces the developmental process, the factors regulating morphogenesis including transcription factors and splicing factors, miRNAs and protein degradation. It also traces the regulation at all levels and beyond the central dogma, i.e. transcriptional, post-transcriptional and translational levels. The role of light in plant defence and immunity is reviewed by Ballaré. The crosstalk of defence and hormone (jasmonic acid and salicylic acid) signalling is highlighted in the review as many of the genes like *PR* genes, WRKY transcription factors, etc. regulating these processes are the same.

Continuing with the theme of signalling, Urano and Jones bring out the differences and their significance between animal and plant G-protein components. They also describe the controversy regarding plant G-protein coupled receptor (GPCR), as it is totally different from its animal counterparts. They argue that plants actually do not require any GPCR as plant G-proteins are self-activating, and the counterpart of GPCR in plants is RGS1 and not GCR1. The article on sucrose metabolism by Ruan also describes the role of G-protein signalling. Sucrose acts as a key carbon source for plants, and modulates development and stress response. Matsubayashi in his review

describes the importance of intercellular signalling mediated by small peptides. The review traces the biosynthesis of these peptides, their post-translational modification, proteolytic processing and finally formation of biologically functional protein.

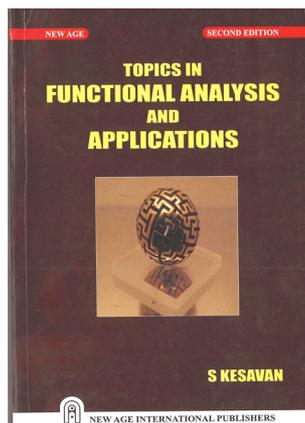
A few reviews deal with various aspects of genetics and genome evolution. The diversity and role of small RNAs like DCI (Dicer-like), AGO1, HEN1, etc. along with their biogenesis and role in gene silencing are reviewed by Bologna and Voinnet. Bennetzen and Wang describe different types of transposable elements, their origins, specificities and regulation. Huang and Han discuss natural and artificial variations which lead to crop improvement. They also discuss how crop genome studies and advancements in sequencing techniques, sequencing-based genotyping and genome-wide association studies have aided in crop development and domestication.

As always, reviews related to some upcoming field of research are also included. The topic chosen in this volume is plant molecular pharming, which is reviewed exceptionally well by Stoger *et al.* Plant molecular pharming is used for production of pharmaceutical products required in the treatment of chronic and infectious diseases, especially where these products are required in large quantities in a short span of time. The authors also bring out the challenges involved, need of further optimization of product isolation, etc. Plant molecular pharming can be of great help with the increasing population and higher demand for medicines in large quantities and affordable rates.

Thus, the *ARBIP* continues to provide a comprehensive view of research topics and challenges lying ahead, which are of interest to both freshers and esteemed researchers alike.

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Topics in Functional Analysis and Applications. S. Kesavan. New Age International (P) Limited, 7/30A, Daryaganj, New Delhi 110 002. 2015. 2nd edn. xi + 247 pp. Price: Rs 250.

The first thing one notices about this book is that the preface is the same as that of the first edition which was published way back in 1989. While it is good to keep the original preface, it would have been better to add a new one for the second edition.

The title of this book should have been '*Topics in Partial Differential Equations with Applications*' because this book is really on that topic. This book by Kesavan, is a landmark text by an Indian author in the theory of partial differential equations (PDEs). The foremost reason is that it is the very first book in this country to treat the topic of PDE using distribution theory as far as the present reviewer is aware. Treatment of PDEs draws resources from many sub-disciplines, which come under the broad umbrella of functional analysis. Among these, the most important is the theory of distribution. The challenge that a teacher of PDEs faces is the following. If he/she dwells too much on the theory of distributions, then the students wonder why they have to go through this advanced and fairly difficult diversion, before they can reach their own topic of interest, viz. PDEs. And the students of such a course might comprise of pursuants of physics and engineering, apart from mathematics, because PDEs have widespread applications. Of course, it is by now folklore among mathematicians, that the best way to handle PDEs is through the theory of distributions; that is what Laurent Schwartz has shown. It might be a tad too presumptuous to preach that to students of a mixed background. Thus for a teacher

of a one-semester course in PDEs, this becomes a dilemma – the researcher in her wants to follow the rigorous and beautiful treatment in the style of Laurent Schwartz and the teacher in her wants to quickly get to the point to satisfy the students' curiosities. Kesavan's book, which originated from teaching such a course, takes care of this by treating distribution theory in the first chapter in a manner which is essential, not too technical and rigorous. He avoids the finer details of the inductive limit topology and sticks to the basics of how a sequence of distributions converges. Needless to say, an initiated reader can take-off from there, if the beautiful theory of distributions catches his/her fancy and can read from Walter Rudin's book, *Functional Analysis*.

Once the distribution theory is over, the book spends a considerable amount of effort on Sobolev spaces, again something basic, that a student of PDEs would require. The discussions on PDEs start from chapter 3, where examples of elliptic boundary-value problems are solved.

While it is well known that many physical situations give rise to PDEs (often through variational problems), it takes a deep look to solving these PDEs to realize the importance of several mathematical techniques that are often interesting in their own right. One such technique is approximation by smooth functions. At first sight, it strikes a reader as quite a marvel that Dirac delta function can be approximated (and motivated) well by successive normal densities with lesser and lesser standard deviations. Far-reaching generalizations of such ideas, using mollifiers and convolution, are explained in this book with great lucidity.

Several of the concepts discussed in this book had their origin in physics. An early inquiry at the time of beginning of quantum mechanics was about all possible (irreducible) representations of the so-called canonical commutation relations (CCR). It was important to know this because position and momentum satisfied CCR; so one would obviously have to know all its representations. However, Heisenberg's CCR presented a certain subtle challenge – one had to be careful about domains of the unbounded self-adjoint operators that were involved. Weyl had the ingenious idea of studying the CCR in the form of one-parameter groups, i.e. he found a way of exponentiating