medical curriculum of the MCI that will be rolled out later in 2019. At the same time, it is a stark reminder that for over 150 years we have failed to capitalise on the initial foundations that were laid in the early GMC curriculum. The book also reminds us that things can deteriorate if we do not continually align ourselves to the fundamental purpose for which an institution is started. These are only a couple of the many lessons that speak to us today. There are many more.

When I was asked to review this book, I readily agreed. There is a paucity of in-depth literature on medical institutions in India, and this book is a valuable addition to this literature. It would be good if this book inspires others to probe their own institutional history and disseminate it. This book is not one that you can read and keep aside – I found myself going back again and again to review various aspects as I continued in my daily work as a medical educator. This book should find a place in every library, particularly in medical college libraries – I am glad it has a place in mine.

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Annual Review of Plant Biology, 2018. Sabeeha S. Merchant, Wilhelm Gruissem and Donald Ort (eds). Annual Reviews, 4139 El Camino Way, P.O. Box 10139, Palo Alto, California 94303-0139, USA. Vol. 69. vii + 815 pp. Price: US$ 112.

Last year I reviewed the *Annual Review of Plant Biology* (*ARPB*) *2017*. This year when I received an invitation to review this volume of *ARPB*, I readily accepted as this gives me an opportunity to update myself on different topics that are reviewed by the experts in their research areas. However, I did not realize that this volume has 29 chapters running into 815 pages, including the prefatory chapter, lot more compared to the 2017 volume which had 21 chapters included in 586 pages. The size of *ARPB* is increasing, which reflects the pace at which the science is advancing, and many interesting and important discoveries are being made almost on weekly basis.

One of the important areas of research that has been a focus of many plant laboratories is to understand the mechanisms of perception of external stimuli, and biochemical and molecular components for transducing the information to regulate plant growth and development. In this context there are three chapters that deal with protein kinases. Liang and Zhou describe the nature of receptor-like cytoplasmic kinases which are involved in transmembrane signalling; specifically they have reviewed their role in defence responses against microbial pathogens. The receptor-like cytoplasmic kinases, many of which have been identified, seem to interact with receptor kinases that perceive brassinosteroids to regulate various developmental processes like pollen tube guidance, floral organ abscission and even abiotic stress responses, possibly thorough phosphorylation relay mechanisms. As shown in figure 3, receptor-like cytoplasmic kinases also interact with mitogen activated protein kinase (MAPK) cascade. Komis *et al*. bring out in detail, the role of MAPK in cellular functions and development. They have given a detailed entry of functions and localization of MAPK cascade members, as reported from different species, and have lucidly presented in figure 2, the main MAPK modules involved in the development of vegetative parts, as also during flower development. Since plants possess a cell wall, how do signals get perceived and transduced at the level of the cell wall? Lately, plant malectin-like receptor kinases, also known as *Cathranthus roseus* receptor-like kinase 1-like proteins (*Cr*RLK1Ls) have been shown as potential cell-wall sensors which also can interact with receptor-like cytoplasmic kinases, mentioned above, and other signalling partners, like RALF peptides, or RAC and Rho GTPases, etc. to control plant processes. Such malectin-like kinases have been reviewed by Franck *et al*. They discuss in more detail the comparative genomics of these kinases and also their important role in plant immunity, reproduction, hormone signalling and abiotic stress tolerance.

During the last decade various cellular signalling components have been described which function on their own or crosstalk with others to regulate gene expression and development. In this volume, the role of a few of them has been presented. Production of reactive oxygen species (ROS) is mostly considered to be toxic to plants, and hence the system has built up antioxidative mechanism to remove or reduce the impact of such oxidants as ROS. However, during the last decade or more, ROS have emerged as a major regulatory molecule.

Waszczak *et al*. have compiled relevant papers on the production of ROS in different organelles, mechanisms of ROS sensing, which can be determined by local sensors, and how increased ROS production can initiate signalling between organelles as well as between cells. They have discussed in detail the role of ROS in plant development, especially during stomatal closure and in plant immunity. One of the regulators that can coordinate immune and growth responses are jasmonates. In the complexity of signal network is the major stress hormone, jasmonate and the receptor active conjugate jasmonyl-L-isoleucine (JA-Ile) which regulate transcriptional responses to environmental cues. All this is reviewed by Howe *et al*. It has been brought out clearly that JAZ proteins, which are transcriptional repressors of transcriptional factor MYCs, contribute to diversity of jasmonate-regulated processes by forming various JAZ interaction modules. One of the precursors of JA-Ile is jasmonic acid, an oxypilin. During the last decade, the mechanism of action of oxypilins, especially jasmonates, and their role in plant stress responses have been elucidated in a number of cases. Wasternack and Feussner have covered in detail the biochemistry and function of oxypilins, and their important role as signalling molecules in defence and development, which occurs also by fine-tuning the homeostasis of the active and inactive compounds generated by oxypilin metabolism. In addition to these somewhat related signals, this volume has a detailed account on nitrate as a signalling molecule by Wang *et al.* During the last decade lot of information has accumulated on the mechanism of nitrate transport, distribution within different parts, and on the perception and signalling pathways. A detailed listing and possible roles of NRT1 and NPF transporters from different systems have been given as also how transgenic approaches using some of these components have been used to improve nitrogen use efficiency, plant growth and yield.

A few in-depth reviews deal with recent fundamental discoveries and new findings to explain the process of cellular differentiation, development and the process of autophagy, the cell death for recycling of nutrients. Hong *et al*. take us through the process of plant morphogenesis from undifferentiated cells to the formation of organs. They describe the variations in cellular heterogeneity and the role of various morphogens to induce differentiation in shapes via regulating cell division patterns. How shoots differentiate and achieve their shape and architecture, as directed by their genome is reflected, based on current knowledge, by Wang *et al*. They describe the functions of meristems and molecular basis of stem development, shoot branching, as also the inflorescence development and describe how information on plant architecture can be used as an important trait for breeding novel varieties.

As the process of inflorescence and flower development begins, the specific cells enter into meiotic cell division, both in the female and male sex organs. Wang and Copenhaver have summarized the role of novel genes and their products in regulating the process of meiosis, especially the process of meiotic recombination. Interestingly, they also discuss how the external stress environment, abiotic and biotic, effect meiotic recombination. In fact, there are two reviews that specifically deal in detail, on some other aspects of abiotic and biotic stresses. Tardieu *et al*. describe the physiological basis of drought tolerance, while Angela E. Douglas presents various strategies towards developing insect pest resistance in crop plants. Drought tolerance has short-term and long-term responses, which basically involve maintenance of water potential, osmotic potential, optimizing carbon versus water status, water uptake and water use efficiency, etc. How these traits can be used for plant breeding has also been discussed in the chapter. Douglas discusses the use of *Bt*, RNAi and crisper technologies, and how insect microbiome can be managed to improve crop resistance.

One of the defence strategies against plant bacterial, fungal and viral infections is to restrict pathogen growth by the process of autophagy, which is also involved in many other processes for recycling of nutrients, like during grain development. Marshall and Vierstra summarize our current understanding of the autophagic machinery, which basically is conserved amongst different systems, like yeast and animals. It is induced under different conditions and its selectivity is determined by receptors. There is an important role of vacuoles, as phagosomes which fuse with tonoplast, and luminal contents are exposed to vacuolar hydrolases. In plants, vacuoles develop lytic role in vegetative tissues, but in certain tissues, like endosperm, they serve as storage tissues for proteins or storage of metabolites as in seed coats. These and other roles of vacuoles, especially the role of vacuolar membrane dynamics that occurs during defence responses against viral or bacterial attacks, are discussed by Shimada *et al*. The involvement of vacuolar processing enzymes in program cell death (PCD) is also covered. Though there are different pathways, many proteins, like storage proteins, are targeted to vacuoles via endoplasmic reticulum (ER). The importance of ER in protein quality control, like correct folding, post-translational modifications, assembly and degradation, is reviewed by Strasser. ER receives over one-third of proteins for quality check. One important role, as mentioned above, is to target misfolded proteins to degradation. The role of HRD1 (3-hydroxy-3-methyl glutaryl-CoA reductase degradation 1) complex, which is a ubiquitin E3 ligase with RING finger domain, is brought out in context in this review.

One of the most influential plant hormones that regulates plant development from embryogenesis to flowering and endosperm development is auxin. The molecular mechanism of action of auxin has been well studied and dissected during the last few decades. One of the proposed actions is through regulating its polar transport to build specific concentrations in different tissues. Zhao shows that the local auxin synthesis via TAA/YUC pathway plays an equally important role in development as also in response to light, temperature, pathogens and toxic metals. Nebenfuhr and Dixit describe the role of kinesins and myosins, the motor proteins, in cell division, expansion, long-distance transport of components like cellulase synthase, and in gravitropic bending.

There are two reviews on the new techniques, like the use of dyes, fluorescence microscopy, FRET to observe membrane proteins configuration (Wang *et al.*), and other biosensors to accurately monitor calcium changes, pH, ROS, redox, hormones, nutrients and transport of nitrate and ammonium, etc. (Walia *et al*.).

In this volume the topics related to diversity and evolution have been covered in seven chapters.

Based on recent data obtained through omics technologies and sequencing of over 1100 genomes, Thiel *et al*. have reviewed the diversity, taxonomy and phylogeny of chlorophilic bacteria, which occur in seven phyla. These data have also revealed information about some of the processes in these organisms like photosynthesis, nitrogen and carbon fixation, symbiosis and ecosystem. It has been predicted that free living cyanobacteria, through endosymbiosis, may have transformed life forms into photoautotrophic behaviour. Nowach and Weber, again based on genomic information, describe the process of horizontal gene acquisition resulting in organelle evolution. They also describe the evolution of nitrogen-fixing organelles. Three chapters deal with the evolution of different morphological traits in plants. Henry *et al*. have compiled information on the evolution of dioecy, which is the presence of male and female flowers on separate individuals. They have discussed whether it may be possible to alter various genes or pathways to induce dioecy. The understanding of the transition to flowering plants during evolution is explained by Vamosi *et al.*, who present hypotheses on the extinction patterns and angiosperm diversification. Also, based on new genomics information, Fishman and Sweigart discuss the evolutionary processes which occur within species that result in hybrid incompatibilities, one of the causes of speciation. Which of the non-native species then become invasive and, how non-native species show relatedness to native residents have been critically reviewed by Cadotte *et al.*, who also discuss Darwin's pre-adaptation and naturalization hypotheses based on new information. Kreiner *et al*. deal with population genetic parameters which influence resistance and adaptation to herbicide in weeds.

Taking clue from palaeo-botanical research and climatic parameters, McElwain has analysed how plants survived under high or low atmospheric CO_2 as well as during major changes in global warm conditions. One conclusion that followed from this study is that 'many

taxa are preadapted to climate future whereas others can adapt *in situ*'. He also shows that high artic vegetation will have a more important role in biogeochemical cycling of carbon and water towards the end of this century, if we continue to use fossil fuels and make continuous changes in land use. Ramankutty *et al*. deal with the global trends that we observe on the changes in the agricultural land use and the consequent impact of this on environmental health and food security. They recommend that we will have to 'combine modern breeding technologies, including genomic solutions and genomic engineering, with geo-ecological farm practices'.

Lastly, the prefatory chapter in this volume is by Mary-Dell Chilton, one of the pioneers in the area of genomic engineering facilitated via *Agrobacterium*-mediated gene transfer. She has described her early life; how she studied chemistry, physics and biology, her science career as it moved from her Ph D to track position at the University of Washington, St Louis, USA, and then to the industry. Her whole write-up is very engaging for the reader. Lot of lessons to learn from her experience, and Chilton is an inspiration to many in the field of plant biology.

This volume has covered interesting and complex topics which have been intensely reviewed by experts. Though there is a lot of specialization these days and one tends to read only those topics that are directly related to their research, yet I advise our young plant biologists that in order to get an integrated view of plant life, they should read beyond their caged research topic. There is no better way than to read this volume of *ARPB*, as also recent previous volumes. One should make it a habit to read *ARPB* ever year; I have been doing so for the last 40 years.

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Annual Review of Cell and Developmental Biology, 2018. Ruth Lehmann, Jennifer Lippincott-Schwartz and Alexander F. Schier (eds). Annual Reviews, 4139 El Camino Way, P.O. Box 10139, Palo Alto, California 94303-0139, USA. Vol. 34. xiv + 571 pp. Price: US$ 112.

This volume has a new editor in Ruth Lehmann. The 'Introduction' section in this volume is a retrospective of the previous editor Randy Schekman's views, particularly on science policy and science–society relationships. The future volumes of the *Annual Review of Cell and Developmental Biology* should give insights into Lehmann's views and style.

This volume has 23 reviews covering various aspects of cell and developmental biology. The first article in several of the earlier volumes was a perspective, which is a first-person account of an eminent cell biologist. This volume does not have it. Perhaps future issues will have perspectives, as these articles give useful insights into how a research area was chosen, executed, and also how coworkers were mentored. Based on the titles and contents in this volume, I have broadly classified them into different areas. In cell biology, Sherman reviews cell biology of stellate cells which are resident lipid-storing cells of the pancreas and liver that transdifferentiate to a myofibroblastic state related to tissue injury. The importance of these cells in the context of cancer is highlighted and also possible applications in therapies are discussed. The review by Yamashita *et al*. deals with specialized intercelluar communication via membrane protrusions known as cytonemes and tunnelling nanotubes. Cytonemes defined as 'filopodia of a special type' were initially observed in developing *Drosophila.* The usefulness of *Drosophila* as a model system in cell biology and relevance to higher organisms is evident. Tunnelling nanotube-like projections (TNTs) has been studied in cultured cells. The authors highlight the importance of TNTs in disease conditions. The relevance of programmed cell death in developmental biology of eukaryotes has been extensively researched and also reviewed. The review by Gudipaty *et al*. is not an update on well-known aspects of cell death or apoptosis. It is focused on unconventional forms of cell death and their relevance in cancer. The biogenesis of eukaryotic organelles has been studied extensively and is also the subject of several reviews. The signalling events and proteins that assist eukaryotic organelle biogenesis have been established to a large extent. Organelles are not generally used to define structures in prokaryotes. Grant *et al*. in their review entitled 'Organelle formation in bacteria and Arachaea' discuss lipid-bounded structures in bacteria that align and navigate along magnetic fields. They are referred to as magnetotactic bacteria and the organelles are referred to as magnetosomes. Protein sorting to magnetosomes makes interesting reading as it differs from protein sorting that takes place in bacteria. This process of organelle formation has no similarity with eukaryotes. Organelles in other exotic bacteria are also covered in this review. The figure that depicts organelles in bacteria and the chemical reactions that take place in them helps in appreciating these structures and their biology. Parton, who has made extensive contributions in the area of caveolae biology, reviews various aspects of caveolae. The review is focused on dynamics of caveolae and relationship to disease, which is being increasingly appreciated. The review by McCullough *et al*. deals with endosomal sorting complexes required for transport (ESCRT) pathway that modulates cellular membrane remodelling and fission. Of the five core complexes involved, the review is confined to ESCRT-III and Vps4. The authors describe the three-dimensional structures of proteins involved and how they mediate the membrane processes. The review highlights the importance of knowledge regarding the protein structures in order to get a deeper understanding of the membrane processes they mediate.

Various aspects of mammalian embryo development is perhaps one of the most extensively researched area. Zhang and Hiiragi discuss specifically, breaking of symmetry during embryo development. While the review is on mouse development, the authors also discuss similar and dissimilar aspects in other mammalian species. The excellent illustrations summarize the review well. This is perhaps one of the few reviews which does not discuss the role of signalling proteins or transcription factors involved.

Every volume of the *Annual Review of Developmental and Cell Biology* has reviews on immunology and plant. This one is no exception. There are two