lights the consequences of increasing managed care and the lack of monitoring of drug use. The comparison of prescription errors with the number of transport accidents is not convincing, as the magnitude of the problem is always understood by describing the population exposed or at risk (denominator in public-health parlance). Nevertheless, the authors attempt to explain the risk factors for such errors, the barriers in reducing them and also make broad suggestions. There is an overlap in the risk-factor analysis, leading to confusion. The model of transport accident prevention seems to have limited scope. This is mainly because the occurrence of prescription errors is pervasive, especially with direct advertising to consumers, lack of uniform hospital policy for reporting all adverse drug events and the weak post-marketing surveillance of drugs.

All the topics reviewed are of current public health importance to all countries. The reviews have been extensive, exploring from the historical context to explaining the implications for future generations. There has been some important message in each of the articles to improve public health practice. Social and economic determinants influence health and disease in a profound way, and any intervention requires proper conceptualization, planning and implementation. Dynamic public health practitioners are necessary for initiating change and making all stakeholders accountable. Financial, public and political commitment is required for sustaining any gains in public health.

R. SUKANYA

Sree Chitra Tirunal Institute for Medical Sciences and Technology, Thiruvananthapuram 695 011, India
e-mail: sukanya@sctimst.ker.nic.in

Annual Review of Plant Biology 2002. Deborah P. Delmer *et al.* (eds). Annual Reviews, 4139 El Camino Way, P.O. Box 10139, Palo Alto, CA 94303-0139, USA. vol. 53. 627 pp. Price not mentioned.

The change in the title of the series from *Annual Review of Plant Physiology* to *Annual Review of Plant Physiology and Plant Molecular Biology* in 1988 and now to *Annual Review of Plant Biology* in 2002, in a way, reflects the trends in research activities in the area of physiology and molecular biology. This title seems to be the most appropriate in the present context, especially in the post-genomic era, where one is trying to integrate the wholesome information to understand the overall structure and functional relationship and the basic molecular mechanisms underlying developmental and physiological activites. With the change in the title, there has been a change in the editorial board and the present volume has been edited by Deborah Delmer, Hans Bohnert and Sabeena Merchant.

Although in the last decade a number of review journals have been fashioned, the *Annual Review* still holds on to stay as the best impact-factor journal that provides in-depth coverage of selected topics. The information compiled by the authors is exhaustive and at the same time comprehensive.

I have been personally subscribing to the *Annual Reviews* since 1984. As in previous years, even in the present volume the selection of topics and material under each chapter has been well covered. The developments in plant metabolism have been covered under three chapters: lysine metabolism, lipoxygenase pathways and fate of alpha-keto-acids. The chapter on lysine by Galili covers both the metabolic and catabolic pathways and presents data to show that the enzymes involved in these pathways are regulated both at the transcriptional and post-translational levels. These studies, it is hoped, will provide information for breeding for higher lysine level in crop plants, although the authors feel that genomic metabolic profiling and NMR approaches would be required in future to analyse flux control of lysine synthesis and catabolism. The chapter on lipoxygenase by Feussner and Wasternack covers in detail the specificity and localization of different lipoxygenases. More importantly, the mechanisms by which the lox pathway is induced in response to wounding, dehydration, insect attack, etc. are discussed and also the nature, and role of the second messengers like jasmonates or antifungal compounds has been well presented. This is an important area of work, whereby one can explain how the interactions and signal communications between plant–plant and plant–insect occur. Some of these aspects have also been covered in a chapter on plant–herbivore interaction. The alpha-ketoacids occupy a key position in intermediary metabolism and in plants, one finds four species of alpha-ketoacid dehydrogenase complexes. An account of their functions and genomic and evolutionary aspects is covered in a chapter by Mooney *et al.*

About four chapters in this volume have been devoted to the area of photosynthesis and chloroplast biology. One chapter is devoted to ribulose-1,5-bisphosphate carboxylase/oxygenase. After so many reviews, books and papers that have been written about this protein, one wonders what new information would have been covered in this chapter. There are more than 2000 rbcL and 300 rbcS sequences available in the data bank. Though this enzyme is present in high amounts in green plants, it has low catalytic rate for CO_2 fixation and also uses O_2 as an alternate substrate. It has been in the interest of many to manipulate Rubisco for crop-improvement programmes. But this has not been possible to achieve so far. In the present review the authors have discussed the detailed atomic resolution structures of Rubisco and suggest that it may require 'multiple mutations that subtly change the positioning of critical residues' based on the new structure information to improve the efficiency of the enzyme. In another chapter, Xiong and Bauer have discussed the evolution of photosynthesis based on the information obtained from studies on photopigments and reaction-centre holoproteins from different sources. They have also discussed evolution of cytochrome-bc complex and carotenoid biosynthetic genes. Those interested in this topic should read this chapter along with other reviews on the subject. The inclusion of a review on chlororespiration is timely. In fact, this topic is not being taught mainly due to the fact that its presence was always considered to be controversial. However, the recent discovery in higher plants of a plastid-coded NAD(P)H-dehydrogenase (Ndh) complex and a nuclear coded plastid localized terminal oxidase (PTOX) has given credibility to the concept of the existence of chlororespiration. It was in early 1960 that Goedheer postulated that oxidation of intersystem electron carriers in dark could occur via 'some kind of chloroplast respiration'. Later, finding an effect

of respiratory inhibitors on chlorophyll fluorescence suggested the existence of respiratory chain connected to photosynthetic electron transport. These data were doubted, since redox interactions between chloroplast and mitochondria could exist. However, with the new discoveries that have been made during the last few years, the concept of chlororespiration has received molecular support. I hope this topic will slowly find a place in plant physiology textbooks in the near future. The chapter on PSII by Diner and Rappaport deals with the data that have recently been obtained on 2D and 3D electron and X-ray crystallography of photosystem II core complexes.

Besides the topics dealing with metabolism and photosynthesis, I could classify a number of chapters under the title of development and signal transduction. The activities in this area have been greatly aided by the genome sequencing projects as also through screening for large number of mutants, using *Arabidopsis* as a model system. One of the major problems in differentiation is to understand how a pool of cells in the shoot apical meristem (stem cells) develop into lateral organs and later convert themselves into floral meristems. Research in this area in the last few years has been compiled by Fletcher. The discussion in this review not only covers the mechanisms and the genes involved in stem cell maintenance and cellular signalling among cells in the apical meristem, but also the possible way by which stem-cell activity is terminated during flower development. The role of *clavata* gene products (so far three *clavata* genes have been cloned) and of *Wuschel* in signalling and in regulating the expression of other genes has been well illustrated. In a somewhat similar vein, Ye *et al*. have tried to analyse how specialized tissue, xylem and phloem are differentiated from meristematic cambial tissue. Though some information has been coming through the use of systems like *Coleus*, *Zinnia*, pine and poplar, a major understanding of the genes involved, and the role of hormones in this process has come from the work done on *Arabidopsis*. This chapter has listed a large number of mutants that have been isolated for vascular differentiation, tissue organization within vascular bundles, vascular pattern in stems and roots, and in leaf venation pattern. However, the nature of the genes and the role of their products in most cases are still unknown. Two other topics covered under a similar theme are on abscission by Roberts *et al*. and on gravitropism by Boonsirichai *et al*. While during development cells coordinate and communicate to grow and differentiate, during the process of abscission there is cell separation. This has great implications in plant life-cycle, as many phenomena like leaf fall, pollen development, anther dehiscence, flower abscission, pod dehiscence and seed germination are dependent on processes leading to cell separation. Most of these concerns and also the molecular basis of abscission are discussed with illustrations by Roberts *et al*. One other event in the development of plants that has been shrouded in mystery, is the ability of plant roots to use gravity as a guide for making their route through the soil. Root gravitropism has now been studied using modern genetic tools and it seems that multiple genes are involved in this process; however, more detailed work has been carried out on a few of these, especially the *ARG1/RHG* gene which encodes a dnaJ-like protein. In gravitropism, role of calcium has been implicated and it has been shown that auxin has an overriding effect in directing this process. The chapter on root gravitropism deals at great length on auxin signalling and other related aspects of auxin action.

The general aspects of auxin-mediated signalling and gene expression are also covered in a chapter on molecular genetics of auxin signalling by Leyser. This area of research activity, viz. signal transduction has invited the attention of the best laboratories and has also yielded interesting and important information. A few years ago, we had organized a symposium on this topic, the details of this are now available in the form of a book[1]. Among the various hormones, auxin signalling has been best studied. It is now well established that auxin-regulated degradation, via ubiquitination and 26S proteosome pathway, of Aux/IAA proteins, is an essential part of auxin response. Aux/IAA proteins act as transcriptional regulators through the formation of a variety of dimers. They can dimerize with other members of their own family or with another class of transcription factors called auxin response factors (ARFs).

There are three other chapters that cover different aspects of plant signalling. One of the interesting concepts that has germinated in the recent past is the role of various ions in regulating development. In this context the effect of nitrate has been rather dramatic. It has been shown that roots can respond to nitrate concentration, which can lead to proliferation of lateral roots. This means that there exist local signalling pathways that are sensitive to localized changes in nitrate concentration. The data that have led to these novel discoveries and the details of nitrate signalling mechanisms and their interactions with sugar-sensing and hormone-signalling pathways has been described by Forde. He also presents the work of some laboratories who have shown that it is not only the localized but also nitrate accumulation in shoot that, through long-distance signaling, regulates root development. There is also a chapter on classification of plant non-selective ion channels by Demidchik *et al.*, which describes mechanisms of their gating by voltage, cyclic nucleotides, glutamate, reactive oxygen species and stretch. Some of the genes encoding these channels have been identified but as the authors point out, most of these still remain to be characterized.

One of the environmental factors that has major authority on plant development is light. In many earlier reviews in this series, details of photoreceptors like phytochrome and blue light receptors, role of light-mediated signalling and gene expression, etc. have been discussed. However, in view of major advances and large body of information that has grown in the last few years, it is timely that an account on phytochrome signalling has been included in this volume, and the chapter has been authored by Nagy and Schaefer. There are five different phytochromes (A–C) in *Arabidopsis*, but more work has been done on A and B. Earlier, it was shown that following activation of the receptors, different signal pathways are induced, like those leading to increase in calcium concentration or cyclic GMP levels, which in turn regulate gene expression. Using mutational approach a large number of components have been identified, some of which are required for gene activation (like transcription factors), whereas others must exit from the nucleus and their degradation, which occurs via ubiquitin pathway, is essential for triggering light-mediated responses. During the last few years, another pathway has been

reported, i.e. the photoreceptor itself moves into the nucleus where it can bind to some transcription factors and regulate gene expression. This was a bold new concept then, but now seems to be true for both A and B phytochromes and has received a lot of experimental support. This may be true for other phytochromes also. The review by Nagy and Schaefer has covered these aspects well. In addition, they also induce one to think about the role of the phytochrome pool that does not enter the nucleus and remains in the cytosol.

With regard to applications emanating from molecular physiological work, one area that has gained wide attention is abiotic and biotic stress-tolerance mechanisms. During the last few years, using genetic and genomic approaches, a large number of genes have been identified that are regulated in response to salinity, drought and cold stress. The Japanese group headed by Shinozaki has now analysed over 7000 genes of *Arabidopsis* and Bohnert's group has analysed thousands of genes using yeast and rice gene chips. The signalling pathways that lead to the induction of these genes are either dependent or independent of ABA and may involve different protein kinases, including MAP kinases. However, during the last 3–4 years, Zhu and his group at Arizona have discovered a novel pathway in response to salinity stress called SOS (salt overlay sensitive) pathway, that involves a calcineurin-like protein (SOS3), a kinase (SOS2) and plasma membrane Na^+/H^+ antiporter (SOS1). A detailed description of these components and others has been given in the chapter by Zhu on stress signalling. This group has now characterized other mutant salt-sensitive phenotypes also, like SOS4 and SOS5, which throw further insight into the mechanisms that lead to sensitivity/resistance to higher salt concentration. In his account on temperature stress, Iba from Kyushu University, summarizes the present work on heat-shock proteins and the role of osmoprotectants like glycinebeatine and detoxifiers of active oxygen species in contributing to temperature stress tolerance. He has also listed the major experiments where the ability of plants to tolerate high or low temperature stress was functionally demonstrated by genetic engineering. The effect of heavy metal stress is discussed in a chapter by Cobbett and Goldsbrough. They have covered in great depth, the present status of research on phytochelatins and metallothioneins with respect to gene cloning, organization, expression and the role of proteins in metal sequestration.

When plants are attacked by insects, they respond in various ways. This involves a wound-induced response and also a insect-specific elicitor response. A description of plant–herbivore interaction, induction of signals like jasmonic acids, octadecanoids, reactive oxygen species, etc; the signalling pathways and their crosstalk to other inducers, and the resulting metabolic changes have been well collated by Kessler and Baldwin. It is now known that the genes induced in response to insect attack are regulated via herbivore-specific transacting elements.

In addition to the various topics covered in this volume and briefly described above, the editors have now brought to focus a few model plants which are being used to understand some specific problems of plant biology or specifically their own biology. The years 2001 and 2002 saw a number of announcements regarding the completion of sequencing of rice genome, both *japonica* and *indica*. This has brought in a wealth of information which can be used for structural and functional comparisons with other biological systems. Shimamoto and Kyozuka have dealt with this topic and have concentrated on genes involved in reproductive development and those involved in defence signalling. Lately, a lower plant, *Physcomitrella patens* (a moss), has shown great potential for functional study of important genes. An account of this has been presented by Schaefer (from Lausanne University). If you wish to study the function of your gene and want to use this moss for your study, link to www.moss.leeds.ac.uk. (This information was passed on to me by Ralph Quatrano during his visit to our institute.) And finally to the lowest of all, the diatoms. These marine diatoms contribute about 20% of global primary productivity. The chapter by Falciatore and Bowler covers various aspects of diatom biology: how they perceive environmental signals like nutrients and light. One interesting facet of these organisms is that they can also sense and respond to the presence of other organisms like bacteria and have quorum-sensing phenomenon.

Last but not the least, there is the prefatory chapter which one always looks forward to reading. This time it is by no less a person than Benson, whose pioneering work on the use of radioactive carbon dioxide led to the qualification of path of carbon in photosynthesis. Like with many such chapters, from the present one too, we can draw a lot of inspiration and courage to take up challenging problems in biology.

The volume 53, with its contents and coverage, has stood by its new name of *Annual Review of Plant Biology*. It was mentioned in one of the reviews in this journal earlier that *Annual Reviews* should also consider publishing articles with colour illustrations. This is what one sees now in this volume. There are many workers who by habit would like to read *Annual Reviews* but then to those who would not, I recommend they should read it to upgrade their knowledge in the area of research in which they may not be directly working. To get fuller insight into the overall biology of a plant, one has to look at data from a genomic and a panaromic view, thereby intergrating information from different fields. I also recommend it to the teachers of botany who can update their teaching notes, as in many universities in India it is difficult to lay hands on all important journals and new books.

1. Sopory, S. K., *Signal Transduction in Plants: Current Advances* (eds Oelmueller, R. and Maheshwari, S. C.), Kluwer, Dordrecht, 2001.

S. K. SOPORY

International Centre for Genetic Engineering and Biotechnology, New Delhi 110 067, India

A Field Guide to the Common Invertebrates of the East Coast of India. S. Antony Fernando and Olivia J. Fernando (eds). Centre for Advanced Study in Marine Biology, Annamalai University, Parangipettai. 2002. 258 pp. Price not mentioned.

The Centre for Advanced Study in Marine Biology, Annamalai University must