PREFACE

Since 1963, *Advances in Botanical Research* has published more than 50 volumes dedicated to plant research. The present volume (#52) is named "Oxidative Stress and Redox Regulation in Plants". It is divided into 15 chapters written by expert scientists from 10 different countries.

The leading articles describe the molecular effects of reactive oxygen species (ROS) and their importance in signalling and control of transcriptional and translational events. The opening chapter by Lee Sweetlove and Ian Max Møller describes the "Oxidation of Proteins in Plants – Mechanisms and Consequences" and shows how ROS affect several macromolecules, and, in particular, proteins via the oxidation of cysteines but also through the carbonylation of many other amino acid residues. The contribution of the Jae-Heung Jeon group in South Korea (Kim *et al.*, Reactive Oxygen Species: Regulation of Plant Growth and Development) shows how ROS can be toxic to the cell but also necessary for signalling. It also details the interconnections between hormones and ROS, a timely topic. The adaptation of plants to UV light is also discussed in relation with the oxidative stress linked to these conditions by S. B. Agrawal, S. Singh and M. Agrawal (Agrawal *et al.*, Ultraviolet-B Induced Changes in Gene Expression and Antioxidants in Plants). This chapter also demonstrates that UV light promotes ROS formation, which in turn induces a modification of the gene transcription pattern in plants.

It is well known that the most important redox players in the cell are glutathione, often linked to glutaredoxins and thioredoxins. The metabolism of glutathione is described in a chapter by Naoko Ohkama-Ohtsu and colleagues (Okhama-Ohtsu, Fukuyama and Oliver, "Roles of γ-Glutamyl Transpeptidase and γ-Glutamyl Cyclotransferase in Glutathione and Glutathione-Conjugate Metabolism in Plants"). While the synthesis of glutathione is a multi-step process that occurs essentially in chloroplast, its degradation takes place outside this organelle in the apoplast and in the cytosol and it requires either γ-glutamyl transpeptidase or γ-glutamyl cyclotransferase and 5-oxoprolinase which are the focus of this chapter. The importance of glutathione as a signal molecule in the *Rhizobium* legume symbiosis is described in a chapter by the group of Pierre Frendo (Marino *et al.*, The Redox State, a Referee of the Legume-*Rhizobia* Symbiotic Game). Abundant evidence, including genetic knockouts, indicates that the redox state is absolutely essential for controlling this type of symbiotic interaction.

The following chapters deal mostly with thioredoxins and glutaredoxins and their importance in plants and fungi. The only one that describes these systems in a non-photosynthetic organism is a contribution from the group

of Eric Gelhaye (Morel *et al.*, Reactive Oxygen Species in *Phanerochaete chrysosporium*: Relationship Between Extracellular Oxidative and Intracellular Antioxidant Systems). This chapter describes the ligninolytic enzymes of this wood-degrading fungus and the many systems necessary to control ROS levels in this highly oxidizing extracellular environment. The next chapter by Yoshitaka Nishiyama and Toru Hisabori "Physiological Impact of Thioredoxin- and Glutaredoxin-Mediated Redox Regulation in Cyanobacteria" describes the thioredoxin and glutaredoxin systems in cyanobacteria, the influence of the redox poise on gene transcription and protein synthesis, plus an interesting complement that shows that the protein targets of these systems in cyanobacteria are probably very different from those in land plants.

Moving to land plants, the group of Renate Scheibe (Hanke *et al.*, Use of Transgenic Plants to Uncover Strategies for Maintenance of Redox-Homeostasis During Photosynthesis) offers a very comprehensive analysis of the literature concerning the analysis of redox mechanisms via the generation of transgenic plants. They demonstrate how difficult it is to dissect those mutants, due to the gene redundancy. The generation of multiple mutants is sometimes required, and besides, the fine-tuning of subtle physiological conditions may also be necessary to observe a phenotype. Similar genetic approaches in the laboratory of Yves Meyer (Reichheld *et al.*, Redundancy and Crosstalk Within the Thioredoxin and Glutathione Pathways: A New Development in Plants) have led to the conclusion that the glutaredoxins and thioredoxin systems are interconnected in plants. This was initially suggested by biochemically based experiments and then comforted by analyses of double mutants of the glutathione and thioredoxin pathways and Reichheld *et al.* describe these recent developments. Very recent progress on the protein import mechanisms into organelles is also described by Mónica Balsera, Jürgen Soll and Bob B. Buchanan, "Protein Import in Chloroplasts: An Emerging Regulatory Role for Redox". It appears now pretty clear that the import mechanisms are under redox control, Toc 35, Tic 55 and Tic 110 being the leading candidates.

The next three chapters are devoted to glutaredoxin and glutathionylation in plants. Shutian Li and Sabine Zachgo (Glutaredoxins in Development and Stress Responses of Plants) present remarkable results that implicate glutaredoxins of the CC type in flowering. These findings were absolutely unexpected and the ROXY (CC-type glutaredoxins) story once again shows the combined power of genetics and biochemistry. The contribution from the group of Stéphane D. Lemaire (Gao *et al.*, Glutathionylation in Photosynthetic Organisms) describes the latest developments concerning protein glutathionylation in plants, including the detection of glutathionylated proteins by proteomics and the role of glutaredoxins in deglutathionylation. Finally, the contribution of the group of Nicolas Rouhier (a chapter by Selles *et al.* "Glutaredoxin: The Missing Link Between Thiol-Disulfide Oxidoreductases

and Iron Sulfur Enzymes") shows that both iron–sulfur containing (ISC) proteins and glutaredoxins contain CxxC motives in their primary sequence. These motives or their CGFS derivatives are instrumental in glutaredoxins having the capacity to bind ISCs and also to transfer them to apoproteins. These developments are highly exciting as they connect those two separate protein worlds together.

The two last chapters describe thioredoxins from cereals. Studies in the laboratory of Bob Buchanan have shown earlier that thioredoxin is important in germination. In this volume, Pablo Pulido, Fernando Domínguez and Francisco Javier Cejudo have written a chapter entitled "Oxidative Stress and Thiol-Based Antioxidants in Cereal Seeds". They describe the oxidative stress generated during germination and the thiol-based antioxidant system of cereals formed by 1-Cys peroxiredoxin (1-Cys Prx), thioredoxin *h* (Trx *h*) and NADPH-dependent thioredoxin reductase (NTR). Finally, the last chapter is a contribution by the group of Birte Svensson (Hägglund *et al.*, Molecular Recognition in NADPH-Dependent Plant Thioredoxin Systems – Catalytic Mechanisms, Structural Snapshots and Target Identifications). This chapter describes the molecular properties of thioredoxins from barley, with emphasis on structure and proteomic methods that allow the detection of protein targets.

Together with the above-mentioned colleagues, we have tried in this volume to cover many important aspects of ROS impact on plants (generation, signalling, deleterious effects and destruction mechanisms). Quite often, this area of research has led to interesting and unexpected new developments (flowering and glutaredoxins, glutaredoxin–thioredoxin interconnections, redox control of protein import, glutaredoxins and iron–sulfur assembly, etc.). Obviously many other developments are still to come and the field is getting ever more exciting. We hope that this volume will prove useful to researchers and students in this area. The last comment concerning this volume is that coincidentally, as we were closing the receipt of the contributions, Dr. Naoko Ohkama-Ohtsu has given birth to a baby boy, Makoto, on 1 July 2009. All of the authors join me to congratulate the mom and wish a happy and successful life to the new born and to his older sister Yuka.

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