Book Review

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Control of primary metabolism in plants. Annual Plant Reviews, Volume 22
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In the context of primary metabolism in plants, this book aims at linking the remarkable advances in molecular genetics with the emerging roles of metabolomics, proteomics and transcriptomics with some traditional biochemistry, such as protein chemistry and enzymology. In a lucid preface, the editors give a clear statement of the needs, in terms of research strategy, for understanding biological processes in the post-genome era. ‘Metabolic regulation’ and ‘metabolic control’ are defined and illustrated in the preface, which provides the discussion thread shared by all the authors. A major strength of this book is the care the authors take throughout their work to make the link between the knowledge of molecular, reductionist-based, enzyme-control mechanisms to organismal-level explanations of ‘metabolic regulation’ or ‘metabolic control’. In general, a good balance has been found between the presentation of the historical and main concepts, relevant information and references, and the latest developments in each specific domain. This book can be used by novices, since many of the chapters provide introductory material, but it is also a conspectus of areas of current research interests for experienced scientists.

The book comprises 13 chapters. The first three chapters are devoted to the emerging roles of genomics, proteomics and metabolomics to study plant metabolic control. The three following chapters deal with more generic aspects of metabolic regulation or control, with chapters on metabolite transporters, plant enzyme control by reversible covalent modification, protein interaction (i.e. protein-kinase, phosphatase and 14-3-3 proteins), and redox signal transduction in plant metabolism. The seven last chapters focus on the control of specific pathways and enzymes of primary plant metabolism (i.e. CO₂ fixation and assimilation, sucrose and starch synthesis, glycolysis and respiration and sulfur metabolism).

The first chapter (by Oliver Thimm, et al.) presents the transcript profiling technologies that are available and discuss the different steps that are required in transcriptomics approaches, from planning of experiments to data visualization. Because the major bottleneck in such experiments is no longer the generation of data but the analysis and interpretation of the datasets produced, a special effort has been made to discuss data management, data processing, raw data handling, normalization, data mining and data visualization. In the second chapter (by Lee Sweetlove), the various ways in which the proteomic approach can be utilized to study plant metabolism and metabolic control has been outlined. It begins with a very brief overview of the basic methodologies of proteomics (useful for students) and then reviews a series of different proteomic approaches that have relevance to the control of central metabolism (i.e. quantitative proteomics, cataloguing protein localization, post-translational modifications and protein–protein interaction). This extensive and comprehensive chapter gives a good overview of proteomics as a valuable tool to reach a better understanding of the control of metabolic networks. Chapter 3 (by Oliver Fiehn) presents a general outline on metabolomics in order to answer the question “what is metabolomics?”. This chapter focuses on the flowchart of a plant metabolomic experiment and specifically deals with problems associated with generating and annotating valid metabolite data. This chapter should be very useful for students and novices in this rapidly emerging sector of post-genome research. As a complete review of the current status of plant metabolomics research, however, it cannot compete with the recent book Plant metabolomics edited by Saito, et al. (2006).

Chapter 4 (by Mechthild Tegeder and Andreas Weber) provides an excellent reminder of the complexity in the highly compartmentalized plant cell and the critical role of transporters for sustaining the complexity of biosynthesis/catabolism, growth and regulation of metabolism. The authors give a clear overview of the types of transporters present in plants, their location and kinetic properties, and their implications in metabolic fluxes. Chapters 5 (by Greg Moorhead, et al.) and 6 (by Santiago Mora-Garcia, et al.) discuss the role of covalent modification of proteins, protein interactions and redox signal transduction as fundamental regulatory events in cells. This part of the book is definitively not for novices but it provides a very useful reference for researchers in metabolism.

Chapters 7 (by Brigitte Gonterro, et al.) and 8 (by Hugh Nimmo) cover the complex process of photosynthesis, mainly through recent findings regarding ‘key’ enzymes and their control. In chapter 7, the authors highlight the fact that non-regulated enzymes catalysing readily reversible reactions have a significant share in the control over the
photosynthetic carbon flux. They draw attention to the fact that small changes in the activity of non-regulated enzymes can affect the Calvin cycle, while significant changes in the activity of so-called and long-known regulated 'key' enzymes do not. I find this section excellent, particularly for students. The short chapter 8 covers a specific subject relevant to the control of phosphoenolpyruvate carboxylase (PEPC) by PEPC-kinase. It is clearly not suitable for students but it provides a useful reference for researchers in plant metabolism.

Chapters 9 (by Elspeth Macrae and John Lunn) and 10 (by Matthew Morell, et al.) cover the control of sucrose and starch synthesis, respectively. While in plant physiology textbooks these pathways are simply described, in these chapters a particular effort has been made to revisit current models of how regulation of individual steps is integrated to control flux through the pathway as a whole, and how these might need to be updated in light of recent discoveries.

Chapter 11 (by Allison Mcdonald and Greg Vanlerberghe) covers the organization and control of plant mitochondrial metabolism. After a sharp description of the organization of the tricarboxylic acid cycle and electron transport chain of the mitochondria, the authors highlight recent advances in mitochondrial metabolism and its control under various physiological contexts and with other metabolic pathways. Chapter 12 (by Christine Foyer, et al.) is devoted to the interaction of photosynthetic carbon and nitrogen metabolism. The authors give a clear inventory of the complex network of controls and try to understand how C/N interaction is integrated and influenced by the environment. The last part of this chapter is devoted to modelling as a promising approach to understanding the complex network of controls of C/N interaction. In the context of systems biology, these models appear like a first step on a long road and should be considered more as an exploratory approach than a final statement.

In the last chapter (by Malcolm Hawkesford, et al.), the authors present a complete and clear review of the uptake and assimilation of sulfate in plants and the major regulatory mechanisms contributing to the control of S-metabolism. This chapter will be very useful for students as well as for researchers.

Overall, the authors have been very successful in reaching their goal of synthesizing the current information available on control of primary metabolism in plants. I found this an excellent textbook. It provides a valuable synthesis of primary metabolism. Although not all chapters are suited for undergraduates, I did find material that will be useful for teaching and researchers. My main regrets come from the fact that ‘proteolysis’ and ‘sugar signalling’, two important sectors of primary metabolism, were not the subject of specific attention.

LITERATURE CITED


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