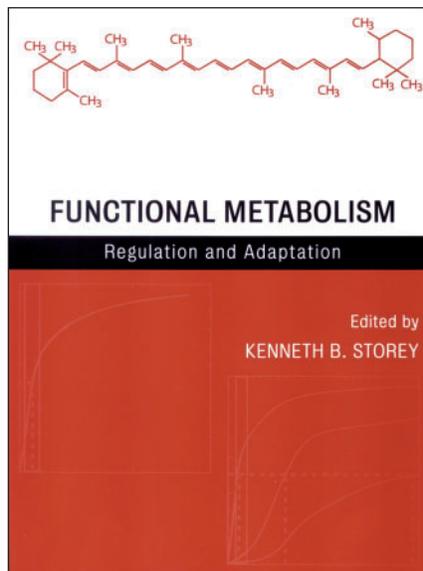


METABOLISM: INTERFACE BETWEEN INTEGRATIVE PHYSIOLOGY AND FUNCTIONAL GENOMICS



Functional metabolism: regulation and adaptation

Edited by Kenneth B. Storey

Wiley Press (2004)

pp. 616. ISBN 0-471-41090-X (hbk)

£76.50/ 108.40 (hbk)

Metabolism is the principal and indispensable manifestation of life that supports the life-long homeostasis of organisms. It comprises a number of specific pathways whose components are expressed and activated depending upon the organism's requirements and environmental conditions. The control mechanisms that regulate metabolic pathways remain fascinating signatures of fundamental ecological events and metabolic achievements in a species' life history. Functional metabolism provides a key data-mining strategy in the present post-genomic transition from the earlier heuristic, often empirical, description of biological functions to the qualitatively new disciplines of integrative physiology and functional genomics.

For the scientific community, *Functional Metabolism: Regulation and Adaptation* edited by Kenneth B. Storey provides the first comprehensive survey that covers metabolic subjects, from elementary thermodynamics and kinetics of enzymatic reactions to complex mechanisms of signal transduction and molecular control of transcription and translation. As well as

covering basic biochemistry and molecular biology, this book offers the reader an innovative, comparative and integrative overview of the regulation of carbohydrate, lipid and amino acid metabolism. Current understanding of different forms of biological energy transformation, mitochondrial function, hormonal integration of metabolism, metabolic compensations of oxidative and free radical processes and stress are summarized in different chapters. The book also provides up-to-date condensed explanations of metabolic disorders, including primary neurodegenerative diseases, diabetes, obesity and blood diseases. Special attention is given to the molecular mechanisms of biochemical adaptations to environmental stresses, including examples of metabolic responses to oxygen limitation, hibernation and low temperature challenges.

The book presents a lucid sequence of twenty short, but comprehensive, reviews of specific areas of metabolism, written by recognized experts in each of these fields. The first seven chapters provide an overview of the fundamental concepts of metabolism, along with molecular and biophysical descriptions of basic metabolic mechanisms. Chapter 1 deals with basic principles and a variety of metabolic control mechanisms, with a short description of key approaches used in the study of metabolism. As will become apparent to readers of this book, functional metabolism is studied using a wide array of approaches. These range from high-resolution conformational analyses of molecular catalysis to the exploration, model reconstruction, and computer simulation of integrated physiological processes as well as the evolution of signaling, catabolic and anabolic pathways. Chapter 2 develops the basics of enzymatic catalysis with emphasis on kinetic paradigms of enzyme functions, while Chapter 3 examines the specificity of *in vivo* enzymatic catalyses. Chapter 4 covers the structure and role of signal transduction in metabolic regulation. Chapter 5 discusses intracellular processing of metabolic information through tyrosine phosphorylation, protein kinase-mediated mechanisms, second messenger pathways, and protein-protein interactions, accompanied by very useful comparative data and diagrams. Metabolic regulation through molecular mechanisms of transcription is dealt with in Chapter 6, and Chapter 7 discusses translation in eukaryotic cells.

These first seven chapters incorporate several important examples of basic and

specific metabolic mechanisms. Readers may appreciate the extended descriptions of multi-substrate reactions and reciprocal regulations upon cooperative enzymatic mechanisms discussed in Chapter 2, as well as several practical approaches and examples in the assay, calculation and model reconstruction of *in vivo* metabolic pathways in Chapter 3. Similarly, refreshing and striking examples of metabolic reactions are covered in Chapters 4 and 5. These include two component signal transduction cascades primarily known in bacteria and archaea as mechanisms to interact with the environment, a variety of eukaryotic protein kinases, complicity G-protein-coupled receptors and regulatory cascades, and the diversity of NO signalling and tyrosine phosphorylation pathways.

Chapter 8 describes the 'powerhouse' roles of mitochondria in cellular metabolism, which comprise several principal nodes of the metabolic network. It begins with a brief summary of energy metabolism, describing key mitochondrial mechanisms, enzymes, and pathways including TCA and the respiratory chain, the glyoxylate cycle, urea cycle, fatty acid cycle, ketogenesis and amino acid degradation pathways. Internal and external regulation of oxygen sensing and calcium signalling in mitochondria are described briefly, since more detailed descriptions are incorporated into other chapters. Specific roles of mitochondria are illustrated by striking examples of non-shivering, proton-translocation-uncoupled thermogenesis. This chapter concludes by summarizing our current understanding of genetic- and

bioenergetics-based mitochondrial dysfunctions, including degenerative diseases and aging, as well as necrosis and apoptosis cascades.

Dissonances in the interactions between metabolic pathways may dramatically reduce an organism's fitness and are associated with a number of metabolic disorders in humans and other animals. Identification and characterization of critical nodes in metabolic networks are essential for the development of new approaches to treat these disorders. The second part of the book focuses on specific metabolic functions relevant to critical metabolic processes in mammals and includes examples of common metabolic disorders in man, as well as detailing biochemical adaptations to environmental stresses. This section comprises the following important chapters: (9) overview of energy metabolism in human health and disease; (10) hormones in human metabolism and disease; (11) muscle metabolism and plasticity; (12) role of oxygen in metabolism; (13) oxidative stress; (14) biochemical adaptations including specific sections on aerobic, temperature and electrolyte conditions; (15) hypoxic metabolism; (16) mammalian hibernation; (17) metabolic background of cold and freeze tolerance. Applied aspects of metabolic responses relevant to transplantation of stem cells, tissues, and organs are covered in chapters 18 and 19. The final chapter is devoted to an analysis of the origin of life and the evolution of metabolic mechanisms.

The writing of *Functional Metabolism*:

Regulation and Adaptation is elegant and precise. The text is complemented by schematic artwork and a number of text boxes summarizing important facts and examples. References are limited but present a well-selected and up-to-date set for additional reading. This book is unique among publications that are relevant to metabolism, primarily because it is the most comprehensive survey of metabolism currently available. It remains the most exhaustive review of metabolism despite some omissions, such as the role of biological membranes, membrane transport and plasma membrane energization, which serve as essential components of cellular homeostasis, metabolic processes and regulatory mechanisms between providers and emitters of metabolic substrates.

In summary, this book is valuable reading for students and researchers alike. It establishes an essential integrative and comparative mentality in undergraduate and graduate biology students and is an encyclopaedic source for researchers who work in areas linked to the fields of metabolic functions and disorders.

10.1242/jeb.01504

Dmitri Y. Boudko
The Whitney Laboratory for Marine
Bioscience
University of Florida
Boudko@whitney.ufl.edu

©The Company of Biologists 2005