Bacterial Physiology and Metabolism

Recent determination of the genome sequences for a wide range of bacteria has made an in-depth knowledge of prokaryotic metabolic function even more essential in order to give biochemical, physiological and ecological meaning to the genomic information. Clearly describing the important metabolic processes that occur in prokaryotes under different conditions and in different environments, this advanced text provides an overview of the key cellular processes that determine bacterial roles in the environment, biotechnology and human health. Prokaryotic structure and composition are described as well as the means by which nutrients are transported into cells across membranes. Discussion of biosynthesis and growth is followed by detailed accounts of glucose metabolism through glycolysis, the TCA cycle, electron transport and oxidative phosphorylation, as well as other trophic variations found in prokaryotes including the use of organic compounds other than glucose, anaerobic fermentation, anaerobic respiration, chemolithotrophy and photosynthesis. The regulation of metabolism through control of gene expression and enzyme activity is also covered, as well as the survival mechanisms used under starvation conditions.

Professor Byung Hong Kim is an expert on anaerobic metabolism, organic degradation and bioelectrochemistry. He graduated from Kyungpook National University, Korea, and obtained a Ph.D. from University College Cardiff. He has carried out research at several universities around the world, with an established career in the Korea Institute of Science and Technology. He has been honoured by the Korean Government, which designated his research group a National Research Laboratory, the Bioelectricity Laboratory, and has served as President of the Korean Society for Microbiology and Biotechnology. Professor Kim wrote the classic Korean microbiology text on *Microbial Physiology* and has published over 100 refereed papers and reviews, and holds over 20 patents relating to applications of his research in environmental biotechnology.

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To our families

Hyungock Hong, Kyoungha Kim and Youngha Kim
and
Julia, Katie and Richard Gadd

Contents in brief

Contents

Preface

Knowledge of the physiology and metabolism of prokaryotes underpins our understanding of the roles and activities of these organisms in the environment, including pathogenic and symbiotic relationships, as well as their exploitation in biotechnology. Prokaryotic organisms include bacteria and archaea and, although remaining relatively small and simple in structure throughout their evolutionary history, exhibit incredible diversity regarding their metabolism and physiology. Such metabolic diversity is reflective of the wide range of habitats where prokaryotes can thrive and in many cases dominate the biota, and is a distinguishing contrast with eukaryotes that exhibit a more restricted metabolic versatility. Thus, prokaryotes can be found almost everywhere under a wide range of physical and chemical conditions, including aerobic to anaerobic, light and dark, low to high pressure, low to high salt concentrations, extremes of acidity and alkalinity, and extremes of nutrient availability. Some physiologies, e.g. lithotrophy and nitrogen fixation, are only found in certain groups of prokaryotes, while the use of inorganic compounds, such as nitrate and sulfate, as electron acceptors in respiration is another prokaryotic ability. The explosion of knowledge resulting from the development and application of molecular biology to microbial systems has perhaps led to a reduced emphasis on their physiology and biochemistry, yet paradoxically has enabled further detailed analysis and understanding of metabolic processes. Almost in a reflection of the bacterial growth pattern, the number of scientific papers has grown at an exponential rate, while the number of prokaryotic genome sequences determined is also increasing rapidly. This production of genome sequences for a wide range of organisms has made an in-depth knowledge of prokaryotic metabolic function even more essential in order to give biochemical, physiological and ecological meaning to the genomic information. Our objective in writing this new textbook was to provide a thorough survey of the prokaryotic metabolic diversity that occurs under different conditions and in different environments, emphasizing the key biochemical mechanisms involved. We believe that this approach provides a useful overview of the key cellular processes that determine bacterial and archaeal roles in the environment, biotechnology and human health. We concentrate on bacteria and archaea but, where appropriate, also provide comparisons with eukaryotic organisms. It should be noted that many important metabolic pathways found in prokaryotes also occur in eukaryotes further emphasizing prokaryotic importance as research models in providing knowledge of relevance to eukaryotic processes.

This book can be considered in three main parts. In the first part, prokaryotic structure and composition is described as well as the means by which nutrients are transported into cells across

membranes. Discussion of biosynthesis and growth is followed by detailed accounts of glucose metabolism through glycolysis, the TCA cycle, electron transport and oxidative phosphorylation, largely based on the model bacterium *Escherichia coli*. In the second part, the trophic variations found in prokaryotes are described, including the use of organic compounds other than glucose, anaerobic fermentation, anaerobic respiration, chemolithotrophy and photosynthesis. In the third part, the regulation of metabolism through control of gene expression and enzyme activity is covered, as well as the survival mechanisms used by prokaryotes under starvation conditions. This text is relevant to advanced undergraduate and postgraduate courses, as well as being of use to teachers and researchers in microbiology, molecular biology, biotechnology, biochemistry and related disciplines.

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