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# PREFACE

One of the great accomplishments of biochemistry and molecular biology has been the elucidation of many of the major unifying principles and mechanisms that serve as the foundations of all living systems. Common mechanisms of energy transformation, catalysis, and the coding and processing of genetic information testify to the unity of life at the molecular level. While no one can deny these triumphs of reductionist approaches to biology, these insights into unifying principles of biochemical design in living systems seem to offer relatively few direct answers to a question of central importance to many biologists: How to account for the mechanisms underlying the immense diversity of organisms? What are the fundamental ways in which the basis biochemical structures and functions of living systems are adaptively modified to allow organisms to exploit the full range of natural environments and to maintain the radically different modes of life we see in nature?

The question of how a set of common mechanisms are extended into uncommon and diverse contexts is not new. Decades ago a similar gap existed between the fields of comparative anatomy and physiology. This gap was bridged by the concept of adaptation, and it is our belief that the concept of adaptation can be extended to the molecular level to effect a bridge between the observations of universal molecular mechanisms, on the one hand, and extreme biological diversity, on the other hand. Thus, the focus of our book is on the ways in which the ubiquitous molecular structures of organisms are modified to permit organisms to thrive in such diverse environments as the polar regions, deserts, and the deep sea, and to achieve modes of living that may involve major changes in type and quantity of nutrients available and in the oxygen that is present to support respiration.

In developing the central theme of biochemical adaptation we have selected examples for study that strike us as providing especially clear illustrations of the fundamental strategies of adaptation at the biochemical level. Our scope of treatment is not encyclopedic. Instead, we have focused on topics for which there either are numerous data, which allow a detailed analysis to be achieved, or where the basic

phenomenology is so interesting that, despite a lack of large numbers of data, it seemed to us worthwhile to draw questions of potential interest to the readers' attention. Our hope is that the examples we have chosen will be exciting and will provide the reader with an impetus to examine other, less well-studied problems in biochemical adaptation.

Our indebtedness to those whose efforts have helped make this book possible is a pleasure to acknowledge. At the top of the list are the students and postdoctoral scholars who have given us the type of stimulation that has kept our enthusiasm for this writing project, and for research per se, at a high pitch. P.W.H. wishes to express particular thanks to the students and postdoctoral fellows contributing to the current fermentations in his laboratory: H. Abe, J. Ballantyne, M. A. Castellini, G. P. Dobson, J. F. Dunn, B. Emmett, R. Foreman, C. J. French, U. Hoeger, T. P. Mommsen, B. J. Murphy, W. Parkhouse, E. A. Shoubridge, and R. Suarez. Earlier students who have continued to influence the thinking and work in P.W.H.'s laboratory include J. Baldwin, H. Behrisch, J.H.A. Fields, H. Guderley, M. Guppy, T. P. Moon, T. Mustafa, T. Owen, J. Storey, and K. B. Storey. In addition, P.W.H. wishes to acknowledge his numerous colleagues around the world who have made the entire enterprise all the more exciting and who on occasion have combined the adventures of intellect with the adventures of scientific expedition.

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Finally, we wish to emphasize that the task of preparing a book transcends the generation of ideas. The manipulation of manuscripts and figures, while the primary responsibility of the authors, could

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*Vancouver, British Columbia*
George N. Somero
*La Jolla, California*

Common Metabolites

| | |
|---|---|
| AMP, ADP, ATP | adenosine 5′-mono-, -di-, -triphosphate |
| cAMP | 3′,5′-cyclic AMP |
| ArgP | arginine phosphate |
| CMP, CDP, CTP | cytidine 5′-mono-, -di-, -triphosphate |
| CoA | coenzyme A |
| Cr, CrP | creatine, creatine phosphate |
| DG | diglyceride |
| DHAP | dihydroxyacetone phosphate |
| DNA | deoxyribonucleic acid |
| 2,3 DPG | 2,3 diphosphoglyceric acid |
| $FAD^+$, FADH | flavin adenine dinucleotide, and its reduced form |
| F6P | fructose 6-phosphate |
| F1,6BP | fructose 1,6-bisphosphate |
| F2,6BP | fructose 2,6-bisphosphate |
| G3P | glyceraldehyde 3-phosphate |
| G6P | glucose 6-phosphate |
| GMP, GDP, GTP | guanosine 5′-mono-, -di-, -triphosphate |
| imid | imidazole |
| IMP, IDP, ITP | inosine 5′-mono-, -di-, -triphosphate |
| KGA | ketoglutarate |
| MG | monoglyceride |
| $NAD^+$, NADH | nicotinamide adenine dinucleotide, and its reduced form |
| $NADP^+$, NADPH | nicotinamide adenine dinucleotide phosphate, and its reduced form |
| P5C | pyrroline-5-carboxylate |
| PEP | phosphoenolpyruvate |
| PGA | phosphoglycerate |
| Pi | inorganic phosphate |
| PPi | inorganic pyrophosphate |
| TG | triglyceride |
| UMP, UDP, UTP | uridine 5′-mono-, -di-, -triphosphate |

Common Enzymes

| | |
|---|---|
| CPK | creatine phosphokinase |
| CS | citrate synthase |
| FBPase | fructose 1,6-bisphosphatase |
| α-GPDH | alphaglycerophosphate dehydrogenase |

| | |
|---|---|
| HK | hexokinase |
| IDH | isocitrate dehydrogenase |
| KGDH | k toglutarate dehydrogenase |
| LDH | lactate dehydrogenase |
| MDH | malate dehydrogenase |
| ODH | octopine dehydrogenase |
| PDH | pyruvate dehydrogenase |
| PEPCK | phosphoenolpyruvate carboxykinase |
| PFK | phosphofructokinase |
| PGK | phosphoglycerate kinase |
| PK | pyruvate kinase |

CONTENTS

FIGURES

TABLES