

Preface

Biology has captivated the imagination of researchers with diverse backgrounds as never before. For example, physicists are now exploring the origin and consequence of noise in gene expression, which appears to be important in epigenetic phenomena. Engineers are looking at biological systems from a design perspective. No doubt, conventional biologists will continue to provide insights by combining conventional approaches with high-throughput ones. These diverse efforts have resulted in the disintegration of biology into sub-disciplines. This is unavoidable because biology is inherently complex. No matter which branch of biology one studies, if the ultimate goal is to understand biology as a unitary subject, we then need to integrate these seemingly disparate aspects into a coherent whole. This is what I have attempted to do in this book.

Galactose-metabolizing enzymes are expressed in yeast upon exposure to galactose but not to glucose. This observation, first made more than a century ago, was to later become a paradigm par excellence with wide-ranging implications. The problem to be tackled here was how yeast (or any organism) adapts to changing environmental conditions. This fundamental problem continues to keep us occupied even today. Come to think of it, for survival, organisms ought to adapt. Therefore, it is not surprising that adaptation transcends every conceivable biological process that goes on in a living system. Despite considerable effort, it is only in the past few decades that we have begun to appreciate what it takes for an organism to adapt to a changing environment. It is fascinating to recapitulate the evolution of the thought processes that have brought us to our current understanding of this ubiquitous biological phenomenon. *Yeast Galactose Regulon: From Genetics to Systems Biology* encapsulates the quintessence of adaptation. Here, I have used our knowledge of how yeast adapts to galactose in a symbolic fashion to weave a common thread between wide-ranging biological themes and mechanisms as explored by conventional and contemporary approaches.

The book is divided into eight chapters. Chapter 1 summarizes the basic aspects of the yeast life cycle. I have compared this with the human life cycle to emphasize the commonality despite the evolutionary divergence. Using yeast as an example, I have conveyed that organisms are open systems, and grow at the expense of matter and energy. Knowledge of this transaction is as important as understanding the

inner-workings of the cell. Chapter 2, which addresses the growth kinetics of yeast, is discussed to highlight how organisms have evolved strategies to be competitive. The fundamental concept proposed by Theodosius Dobzhansky that “Nothing in biology makes sense except in the light of evolution” is further extended to discuss the phenomenon of adaptation with specific reference to galactose utilization in yeast. This is an important transition from a generic perspective to a specific example. Chapter 3 describes identification of the genes involved in the metabolism and regulation of galactose utilization using the classical genetic approach. Chapter 4 is a continuation of classical genetic analysis to unearth the molecular interactions. These two chapters are loaded with the concepts of classical genetics, which are still being used today. They reinforce the view expressed by Victor A. McKusick that “Genetics is to biology what atomic physics is to physical sciences”. Chapter 5 describes the molecular genetic experiments that have paved the way for the elucidation of molecular details at higher resolution. This is a classic example of how yeast biologists quickly embraced the growing technological breakthroughs of genetic engineering. Chapter 7 describes experiments illustrating the finer aspects of the galactose genetic switch. Finally, Chapter 8 discusses the contemporary approaches of biological analysis: genomics and systems biology. Evolutionary and applied aspects of galactose metabolism are also included in this section.

The system-centric approach followed here provided sufficient latitude to investigate the various facets of this fascinating paradigm. I have included the logic, results, and interpretations of what I think are the most important experiments. I have also included the misinterpretations of a few important experiments. These misinterpretations were not because the experiments by themselves were faulty. In some cases, the assumptions were tacitly believed to be true, while in other cases, misinterpretations were more appealing than the true alternatives that were not in conformity with the prevailing view. To a young researcher, such examples should illustrate the importance of objectivity and intuition in scientific pursuits.

Although the chapters are connected through a central theme, they can also serve as independent topics. This provides the flexibility for either downward or upward integration, depending upon one’s interest and background. I have not cited the references in the text but have provided them at the end of the chapters. This is to avoid distraction from the main line of thinking. Elementary knowledge of genetics, biochemistry, and molecular genetics is all that is necessary to understand the concepts. I believe this book provides a panoramic view of how the living system can be dissected by experimental and theoretical analysis to unravel even the most minute details of biological processes that have evolved over millions of years.

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