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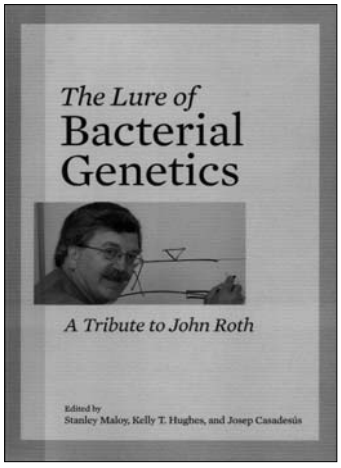

The lure of bacterial genetics. A tribute to John Roth

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When Louis Pasteur and Robert Koch discovered the essential role played by microbes in human life, microbiology became a science with practical implications for the well-being of humankind, but with scarce importance for the core of biology. All that changed beginning in the 1940s. Studies started in the 1940s but developed in the 1950s and early 1960s were able to show that mutations in bacteria are spontaneous, that prokaryotes can exchange genetic material, and that this material is DNA. These studies provided evidence for the unity of genetics and established microbiology as a fundamental discipline in biology. In 1961, the discovery of induced enzyme synthesis (the "operon theory") was another essential contribution of microbes to biology. Not a single microbial species is characterized by a specific and fixed metabolic pattern. Instead, by altering their enzymatic equipment, microbial cells can adapt to new environments. This process allows new characteristics to be introduced into an otherwise genetically constant microbial cell in response to environmental changes.

The lure of bacterial genetics. A tribute to John Roth was written and edited by former students of John Roth and by colleagues who are specialists in the field of bacterial genetics. Over the years, John Roth has inspired many undergraduates to pursue graduate training; he has also encouraged many graduate students and postdoctoral fellows, who later developed successful careers in academia or industry. *The lure of bacterial genetics* could be considered John Roth's legacy. The contributions of the invited authors are grouped in seven sections comprising 33 chapters that provide an overview of the field of bacterial genetics and how it has evolved. The chapters are based on the experience and expertise of the authors and reflect the most important triumphs and mishaps that occurred along the paths to numerous observations and discoveries.

Section I (Chaps. 1–4) traces John Roth's interest in bacterial genetics. John Roth himself (Chap. 2) draws on his own extensive lecture experience to provide practical guidelines for giving a seminar to graduate students. This section also relates the experiences of students (now investigators) in the advanced bacterial genetics course regularly held at Cold Spring Harbor, with special reference to the topics taught by John Roth. The courses held each summer at Cold Spring Harbor have long been popular with students, who while they are there have no obligations other than to pursue their interest in science.

Microorganisms must overcome a wide range of fluctuating variables in their surroundings, which they do by modifying the expression of numerous genes in response to extracellular and intracellular conditions. Section II (Chaps. 5–11) provides several examples of this response: the biotin and proline operons, the D-galactose metabolic pathway, and the heme pathway.

In 1965, when the genetic code was finally deciphered, it was thought that triplet decoding would be immutable. Frameshift suppressors are tRNA mutants that can read four-letter codons and are thus able to correct mutations caused by single-base additions to mRNA. A breakthrough discovery—made between 1985 and 1987—was the demonstration that frameshifting plays an essential role in gene expression. These topics are discussed in Section III (Chaps. 12–14).

In Section IV (Chaps. 15–20), several examples are provided of the relationship between genetics and physiology/metabolism, such as the genetic-physiological link in the swarming response of *Serratia*, genetically based contact-dependent growth inhibition, adaptable pathways for host infection by pathogenic bacteria, and bile-induced mutagenesis in *Salmonella* populations.

Evolution is the result of genetic variation and selection and is the fundamental strategy of life, allowing organisms to adapt to new environments and to adverse conditions. Genetic variations in bacteria occur by three distinct mechanisms: point mutation, genetic rearrangements, and lateral gene transfer. Genomics and genome sequencing studies have corroborated that the relative positions of genes on the chromosome may influence their expression, mutational bias, and rearrangement. These studies have also led to

insights into paralogous gene evolution and the reductive evolutionary process (Section V, Chaps. 21–25). In adition to its "original" set of genes, the bacterial genome may contain elements from other bacteria: genomic islands, plasmids, and bacteriophages (Section VI, Chaps. 26–32).

Section VII (Chap. 33) is a reflection by John Roth on the future of bacterial genetics. We must study the organism to understand inheritance, mechanisms of gene regulation, etc., as John Roth says in their "fish history." "Never mind the fat fish, let's study the boat."

One of the book's contributors reminds us the words of Mark Twain: "There is something about science. One gets such wholesale returns of conjecture out of such a trifling investment of fact." In considering John Roth's scientific career, we realize that contributions to basic science are of two kinds, making discoveries and solving problems. John Roth has excelled in both.

I strongly recommend *The lure of bacterial genetics* for advanced students and researchers in the field of microbiology. It is especially worthwhile reading during those all too frequent times in the lab when an experiment fails. According to John Roth, in that situation the best one can do is to ask the right questions in order to find the solution to the problem and to seek the advice of other people working in similar areas. Symbiosis in nature is the rule, not the exception; the same should hold true for scientific endeavor.

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