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Prokaryotic Biology in the Post-Genomics Era

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Introduction

Biologists working on prokaryotes created the molecular biology revolution. They discovered the mechanisms of DNA replication, transcription and translation, and they developed the molecular techniques that made genome sequencing possible. With a record like that, it would be understandable if microbiologists decided that there is nothing left to do. Instead, the field of prokaryotic biology is entering a new and exciting phase that will have effects in many different areas. At the most basic level, the next challenge is to answer the question: What are the essential features of a free-living organism? The availability of many prokaryotic genome sequences will make it possible to identify the features that make prokaryotic life possible. This will not be a simple task. Scientists do not recognize one-third of the genes in the existing genome sequences. In addition, a substantial number of the remaining genes have probably been misidentified. Learning the functions of these unknown genes is the next order of business. Even this daunting task is only the beginning. The next step will be to understand better how the products of these genes interact with each other to constitute a living cell. The potential practical yields from studies in this area are enormous, both for developing new industrial processes and for more effective prevention and treatment of human disease.

In the area of human disease, there are many challenges. First, it is important to solve the growing problem of antibiotic-resistant bacteria. Where does resistance arise and why are resistant strains often as competitive as sensitive ones? It will be necessary to work hard and effectively to avoid losing cures that the public now takes for granted. A second important goal for health-oriented research is to learn whether there are groups of prokaryotes now thought not to be capable of causing infections that can actually cause infections in some settings. Finally, the example of *Helicobacter pylori* has inspired biologists to look for other chronic diseases that may be caused by bacteria, in hopes of finding new cures.

Molecular techniques have revolutionized environmental microbiology and have opened up new opportunities for characterizing microbial communities. These techniques have also revealed the enormous genetic and metabolic diversity that is found in the microbial world. Cultivating and studying the many microbes that have been missed in the past could yield many important new products and processes. Geomicrobiology and astrobiology have further expanded the scope of environmental microbiology.

The field of prokaryotic biology, which already has so many outstanding accomplishments to its credit, is poised to make still greater advances in the future.