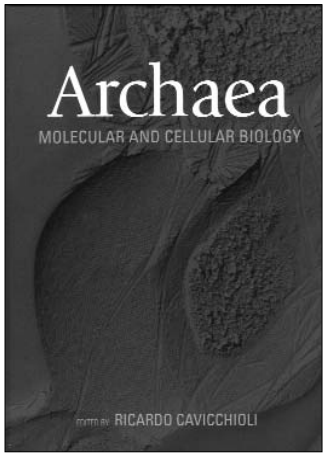
INTERNATIONAL MICROBIOLOGY (2007) 10:151-152
ISSN: 1139-6709 **www.im.microbios.org**



Archaea: molecularand cellular biology

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2007, ASM Press, Washington, DC
556 pp, 22 × 28.5 cm
Price: US$ 129.95
ISBN: 978-1-55581-391-8

Archaea, like bacteria, are single-celled organisms lacking a nucleus and are therefore prokaryotes. Nevertheless, in 1977, with Carl Woese's phylogenetic taxonomy based on 16S rRNA, it became clear that not only do archaea differ from bacteria—and thus constitute a third primary line of evolutionary descent—surprisingly, they are more closely related to eukaryotes than to bacteria. Although archaea are similar to other prokaryotes in most aspects of cell structure and metabolism, in the central processes of molecular biology, i.e., transcription and translation, they resemble eukaryotes in that they use eukaryotic-like initiation and elongation factors, TATA-binding proteins, etc. The similarities and differences of archaea vs. eukaryotes and bacteria have led to an open debate on the course of evolution.

With the discovery that they represent a different branch of the biological world, archaea have expanded and altered the field of microbiology. Contrary to long-established concepts regarding the parameters that define a habitable environment, many archaea are able to survive and thrive under some of Earth's most extreme conditions, from relatively high-temperature environments, often above 100ºC, e.g., near geysers, thermal vents, and oil wells, to extremely cold, highly-saline, acidic or alkaline habitats.

Despite the general importance of archaea to biology, they have been the focus of few textbooks. Instead, most of the available scientific information was scattered throughout the microbiological literature. *Archaea: Molecular and Cellular Biology* compiles the information accumulated through recent discoveries in the field of archaeal biology and is the first comprehensive textbook to address the unique properties of the archaeal cell. The book consists of a straightforward collection of 23 reviews (chapters) from the world's leading researchers, written and edited to emphasize each author's individual area of expertise. As a result, it provides a broad coverage of the subject, one that integrates the latest knowledge on the biology, ecology, and evolution of archaea.

Appropriately, Chapter 1, "The Archaea: an invitation to evolution" is an introduction by Carl Woese, who provides a stimulating account of the proposal, in 1977, of the archaebacteria (renamed archaea in 1990), the controversial early days in the history of the archaeal movement, and the implications of archaea for microbiology as a whole. Woese's three-domain system (*Archaea*, *Eukaryota*, and *Bacteria*), and the new taxonomic tree that derived from it, helped clarify the diversity of microbes, although the acceptance and validation of Woese's classification by the scientific community was a slow process. However, as the amount of supporting data on the unique properties of archaea increased, particularly those which differentiated them from bacteria, the majority of biologists came to accept this system as the best representation of evolution.

Chapter 2 covers the general characteristics of archaea as well as the most important model organisms. Traditionally, archaea are usually placed in one of three groups depending on their preferred habitat: halophiles (living in extremely saline environments), methanogens (methane-producers living in anoxic environments), and hyperthermophiles (found in a variety of high-temperature environments). Recent studies, however, have shown that while many archaea are extremophiles, others are present in "mesophile ecosystems" such as soil, freshwater, seawater, and marine sediments, stressing the diversity and ubiquity of this domain. Thus, rather than a single model organism, a broad range of archaea must be studied to answer questions regarding archaeal morphology, physiology, molecular mechanisms of adaptation, etc.

The core of the book (Chapters 3–18) describes the key cellular processes of archaea, such as DNA replication and the cell cycle, transcription, and translation. It also explains those features that are unique to archaea, including aminoacyl-tRNA synthesis, protein folding, and signal transduction in extreme conditions, the lipid composition of the archaeal cell membrane, and the distinct motility structures of these microorganisms. In particular, Chap. 12 discusses the many different types of archaeal metabolism. Although many of archaea's metabolic properties are shared with *Bacteria* and *Eukarya*—and the widely conserved pathways found in all three domains suggest their early evolutionary origin—the unique or unusual features of archaeal metabolism are outstanding. In doing so, that chapter integrates the better-

known enzymological data with information from genome sequences. These data not only provide evidence for archaea's distinct phylogeny, but also highlight their particular lifestyles and growth requirements.

Chapters 19 and 20 cover archaeal genomics and functional genomics. More than 20 archaeal genomes have been sequenced to date. Given the phylogenetic placement of the archaean domain with respect to *Bacteria* and *Eukarya*, functional genomics (transcriptomics, proteomics and structural genomics) can provide an unequalled evolutionary perspective on the processes and mechanisms underlying extant biological systems. Archaea's unique characteristics have largely forestalled attempts to apply bacterial or eukaryal molecular genetics' protocols to the study of this domain. However, as discussed in Chap. 21, in recent years scientists have been able to overcome these difficulties by developing a series of archaea-specific techniques. The book concludes with two chapters dedicated to current and potential biotechnological and biomedical applications of archaea, such as archaeosome vaccines and drug-delivery systems.

The first edition of *Archaea: molecular and cellular biology* brings together archaeal biology, evolution, and molecular and cellular biology in a single volume. The book contains numerous tables, diagrams, illustrations and highlighted panels to support the reviews. It not only details discoveries about archaea made over the past 10–15 years but also anticipates progress expected from further study of this domain. The book is intended to provide researchers, instructors, and graduate students with an authoritative reference source on the unique qualities of archaea. In the words of the book's editor, Ricardo Cavicchioli, it aims to inspire "the younger generation of biologists to try their hands at these organisms, whose secrets we have only begun to unlock and which offer so much in the way of fundamental insights and practical benefits."

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