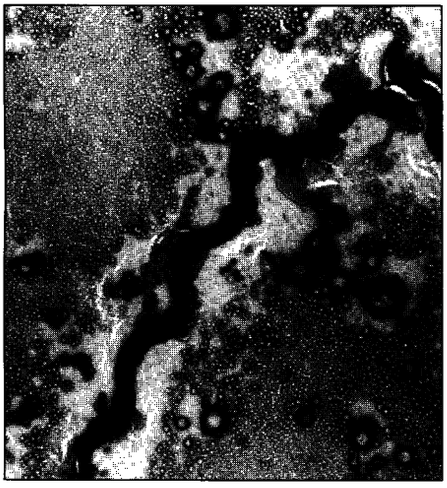
States, the book deals overwhelmingly with the disease in the northeastern states, where in fact most of the ecologic research has been conducted. In a brief overview of Lyme disease ecology in his introduction to the book Ginsberg does devote a small amount of space to the situation in the western and southeastern states (one page) and in Europe and Asia (one paragraph). The thorough chapter on the natural history of *B. burgdorferi* in vectors and vertebrate hosts also transcends the Northeast, discussing some of the ecologic differences among the major vectors of *B. burgdorferi* worldwide. This chapter also contains a brief discussion of reservoir hosts; a useful table of other species of *Borrelia*, their vectors, and their associated diseases; and a table listing wild and domestic animal hosts for *B. burgdorferi*.

Two intriguing questions associated with Lyme disease have to do with the antiquity of *B. burgdorferi* and its tick vectors and their distribution and spread in the United States. Ginsberg clearly lists the evidence and correctly notes where evidence ceases and speculation begins. For example, he points to the difficulty of establishing the historical distribution of *I. scapularis* on the basis of scattered indirect sources. Given the available evidence, he notes, the most likely hypotheses for historical trends in the distribution of northern populations of *I. scapularis* are (i) recent geographical spread from a few coastal New England islands and (ii) local spread coupled with population increases of a widespread, but formerly rare, species. He comments, "The published records and the collections found in museums, on which these hypotheses are based, are each generally the result of the efforts of a few collectors who went into an area with a specific set of interests. A diminutive species that is spottily distributed at low population levels could easily have been missed in the few surveys that have been taken. Therefore, these alternative scenarios must remain speculative at present." This objective analysis is especially refreshing given that the first hypothesis has often been assumed to be correct in the absence of sufficient evidence. The same objective approach is taken toward such topics as the antiquity of Lyme disease in North America, historical changes in vegetation and host populations, and current tick distribution and spread.



"Unfixed, negatively stained micrograph of *Borrelia burgdorferi*." [From Anderson and Magnarelli's chapter in *Ecology and Environmental Management of Lyme Disease*; courtesy Connecticut Agricultural Experiment Station]

The second half of the book is devoted to Lyme disease surveillance, personal protection against ticks, and vector management and offers useful practical information for researchers as well as for the general public. The final chapter, devoted to ecologic principles that should underlie environmental management of ticks and Lyme disease, contains discussions of such strategies as habitat modification (including burning, mowing, and other procedures); removal or reduction of tick hosts (especially deer); application of acaricides to hosts and habitats; use of predators, parasitoids, and pathogens of ticks; disruption of tick reproduction via pheromone manipulation; and release of sterile male ticks. This chapter sets the stage for a "forum" in which eight Lyme disease researchers comment on the subject of environmental management, providing additional information and perspectives. There seems to be general agreement among all the contributors that everyone who is exposed to ticks should employ personal protection methods to avoid tick attachment. Opinions differ regarding the effectiveness of various other methods of tick control.

It is clear from this book that no single intervention technique will work in all situations. Indeed, even a combination of techniques does not always produce the desired results. Intraspecific tick populations usually vary in different ecologic areas. Nevertheless, integrated pest management is the most logical, effective approach to managing tick populations, just as it is in the management of agricultural pests. Similarly, attempts to manage ticks or any other kind of pest should be based on an understanding of the fundamental ecology of the offending pest or vector. Ecologic relations are complex, interdependent, and variable. Clearly, caution must be exercised and management techniques tailored to fit the particular situation.

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## Photosynthesis

**The Photosynthetic Reaction Center.** JOHANN DEISENHOFER and JAMES R. NORRIS [Eds.]. Academic Press, San Diego, 1993. In two volumes. Vol. 1, xiv, 432 pp., illus. Vol. 2, xviii, 574 pp., illus. $129 or £99 each.

Through x-ray crystallography and nuclear magnetic resonance studies, a wealth of information has been obtained on the three-dimensional structure of a number of soluble proteins, including a bacteriochlorophyll-binding protein. However, it is a major challenge to have membrane-protein complexes form sizable, stable crystals that diffract x-rays to high resolution and that can be used to determine the atomic structure of the protein complex. The first example of a membrane-protein complex for which a high-resolution (3 Å) crystal structure could be obtained was the photosynthetic reaction center complex from a purple bacterium. This work, carried out by Hartmut Michel, Johann Deisenhofer, and their colleagues in the mid-1980s, represented a milestone in the structural analysis of membrane-protein complexes. Since then, similarly detailed information has been obtained on homologous reaction center protein complexes from purple bacteria and, recently, on a light-harvesting chlorophyll protein from plants.

The detailed structural information provided by the crystal structure of the bacterial reaction center has triggered an avalanche of investigations targeting a functional understanding of the properties and mechanisms of energy and electron transfer events in photosynthetic reaction centers. A significant part of this research is reviewed in *The Photosynthetic Reaction Center*, which includes coverage of a number of different techniques and approaches used in the analysis of photosynthetic reaction centers from purple bacteria (ranging from crystallization of an antenna complex to sophisticated absorption and magnetic resonance spectroscopy) as well as discussions of related reaction centers, such as photosystem II from plants. In addition to material on the structure and function of the bacterial reaction center, the first volume includes informative contributions on light-harvesting antenna systems, biochemical replacement of pigments in reaction centers, biogenesis of the photosynthetic apparatus in purple bacteria, and parallels with the photosystem II complex from plants; because the purple bacterial and photosystem II reaction center complexes appear to be related evolutionarily, the determination of the structure of the purple bacterial reaction center has had a significant impact

on the directions of research on photosystem II. The second volume deals mostly with theoretical aspects and sophisticated spectroscopic analysis methods of charge separation and electron transport in the reaction center and in model systems but also includes sections on topics not usually reviewed in this context, such as the structure and spectroscopic characteristics of carotenoids and infrared vibrational spectroscopy. The work's wide spectrum of approaches illustrates the interdisciplinary nature of the research that is currently performed to investigate basic processes in photosynthesis and emphasizes the importance of this research for progress on broader issues, including structure-function relationships in membrane-protein complexes and electron transfer events in biological systems.

The large amount of information presented here may overwhelm the reader who is not thoroughly familiar with at least some aspects of photosynthetic reaction centers or electron transfer. Also, like many multiauthored works, the volumes have suffered from a long publication lag, and many chapters include references only through 1991, except perhaps for work from the authors' own laboratories. Nevertheless, *The Photosynthetic Reaction Center* will be a valuable resource for all those interested in this important system.

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## The Gram-Positive World

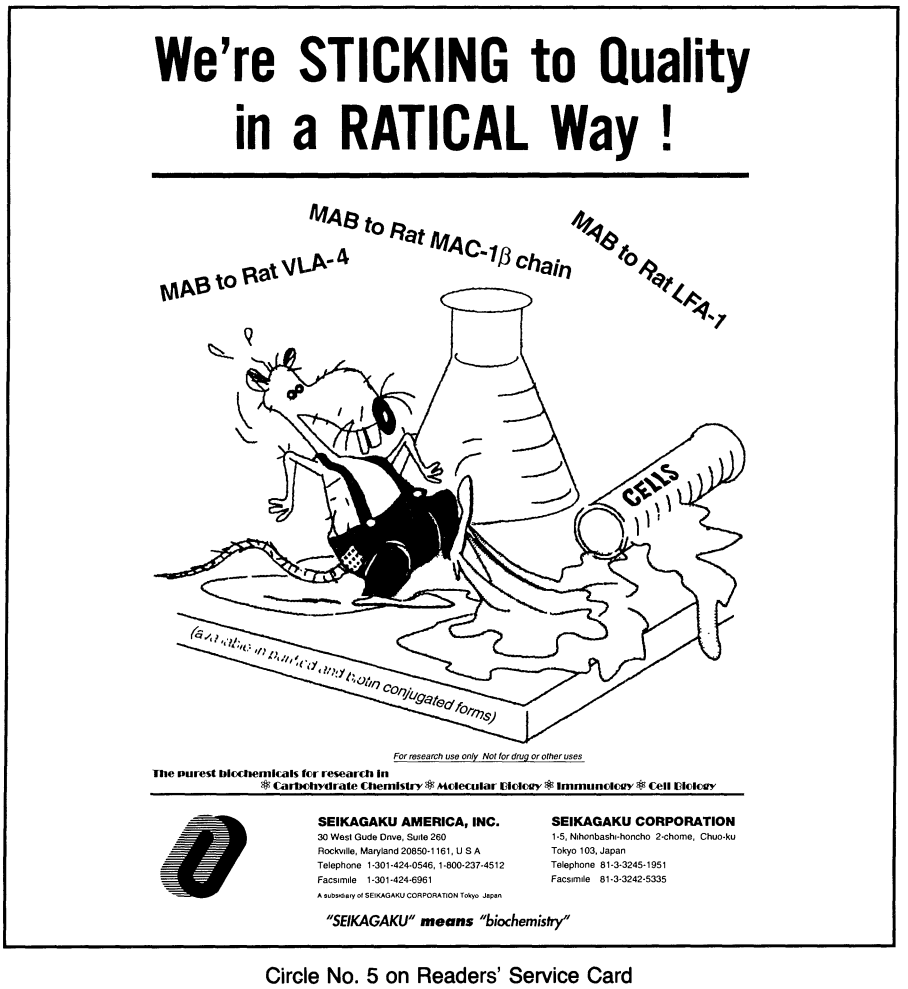
***Bacillus subtilis* and Other Gram-Positive Bacteria.** Biochemistry, Physiology, and Molecular Genetics. ABRAHAM L. SONENSHEIN, JAMES A. HOCH, AND RICHARD LOSICK, Eds. American Society for Microbiology, Washington, DC, 1993. xiv, 987 pp., illus. $125; to ASM members, $98.

*Bacillus* researchers have long been plagued by frustration with the inefficiency of their efforts. There has often been an expectation on the part of some of their colleagues that *Bacillus* findings should conform to the *Escherichia coli* paradigm, and *Bacillus* researchers have been obliged to devote valuable time and energy to explaining why this expectation is unjustified. Some of this frustration is evident in *Bacillus subtilis and Other Gram-Positive Bacteria*, many of whose chapters open with an account of how the particular aspect of *Bacillus* under discussion diverges from the *E. coli* model.

The book demonstrates that *B. subtilis* occupies a special place in the Gram-positive world. Modeled on the *E. coli* "Bible," *Escherichia coli and Salmonella typhimurium: Cellular and Molecular Biology* (1987)—also published by the American Society for Microbiology—but consisting of a single volume rather than two, the book contains 64 papers by more than 100 contributors. About 15 percent of the chapters are devoted to species other than *B. subtilis*. As the book shows, Gram-positive organisms, although diverse, share many physiological and structural features that distinguish them from the more extensively studied Gram-negative species. Aside from the classic differences in cell wall and cell envelope, areas of divergence include methods of genetic exchange, transcription and translation machinery, postexponential-phase phenomena (especially endospore formation), chromosome topology, and aspects of chromosome replication, modification, and repair.

The book is divided into ten major sections. The first, which introduces the reader to some of the major Gram-positive organisms and their most interesting features, opens with a chapter on the systematics and ecology of *Bacillus* that catalogs the heterogeneity among the more than 70 *Bacillus* species. A subsequent chapter on *Staphylococcus* deals with pathogenicity, plasmids, and resistance determinants that function in *Bacillus*. Chapters on *Clostridium, Streptococcus, Lactococcus* and *Lactobacillus, Streptomyces, Pasteuria* (a frequently overlooked genus parasitic on nematodes), and *Bacillus anthracis* (one of the few *Bacillus* species pathogenic for humans or animals) each devote a few pages to a subtopic that has benefited from direct analogy to *B. subtilis*. These chapters and those devoted to genetic maps of similar organisms (in the section on chromosome structure) demonstrate similarities among the five most extensively characterized Gram-positive organisms and provide an excellent overview of our current knowledge of the genetics, physiology, and metabolism of each of these species. The chapter on phages, although limited in scope, is a very worthy contribution.

A section on metabolism and its regulation contains a brief synopsis and overview of significant metabolic pathways in *B. subtilis* (that is, intermediary metabolism).



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