work. Several other recent collections, however, are available to serve that purpose. Finally, one minor (and probably unavoidable) shortcoming of the work is that to those who follow the field closely several of the articles already will seem somewhat dated. Nevertheless, the provocative research described and the thoughtful discussions offered by these workers in an exciting and expanding field will make this volume of benefit to cell and developmental biologists of all levels of experience.

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THE GROWTH AND FORM OF MODULAR ORGANISMS. *Proceedings of a Royal Society discussion meeting held on 27 and 28 June 1985.*

Edited by J. L. Harper, B. R. Rosen, and J. White. The Royal Society, London. £43.00. vi + 250 p. + 3 pl.; ill.; no index. [First published in *Philosophical Transactions of the Royal Society of London*, Series B, Volume 313 (No. 1159).] ISBN: 0-85403-281-9. 1986.

MODULAR ORGANISMS: CASE STUDIES OF GROWTH AND FORM. *Papers relating to a discussion meeting on growth and form in modular organisms.*

Edited by J. L. Harper, B. R. Rosen, and J. White. The Royal Society, London. Price not available (paper). pp. 109-224 + 6 pl.; ill.; no index. [*Proc. R. Soc. Lond. B*, 228:109-224, 1986.] ISBN: 0-85403-282-7. 1986.

The increasing recognition that organisms whose parts are iterated (i.e., are modular) can provide both superb experimental material and novel insights into ecological and evolutionary processes has generated much recent biological interest. These two companion volumes, based on a Royal Society meeting held in June, 1985, reflect this surge of interest. In all, 22 research papers are included: the topics covered range from lower plants to graptolites, and from bryozoan physiology to the growth form of trees.

The prefaces to both volumes suggest three fundamental questions that underlie the distinction between modular and unitary organisms: What are the consequences of varying selective pressures on a single genet (the entire genotypic individual—i.e., the sum of all clones) distributed across a range of habitats? Because the germ plasm is not segregated in modular organisms, what is the potential evolutionary role of somatic mutation? What are the demographic consequences of the fact that modular organisms, in theory, can grow exponentially without senescence? Unfortunately, none of the papers that follow the promising introductions deals explicitly with these exciting issues: if mention is made, it is often superficial, and to this end these volumes fail to contribute meaningfully to these fundamentally important problems. Notable exceptions are fine experimental papers by D. J. and R. H. Hughes and a review by G. O. Mackie.

The papers in these volumes are also plagued by problems of definition: the term "module" is used indiscriminately to refer to units ranging from the repeated internodes which compose a tree branch to physiologically discrete individuals produced by asexual reproduction. As a summary statement by G. C. Williams suggests, although palm trees may be modular in a mechanical sense, they would provide a seriously handicapped vehicle with which to address the basic questions mentioned above. Equally vexing problems arise with the terms "clonal" and "colonial."

These volumes and their recently published counterparts bring into clear focus the enormous range of biologically interesting phenomena encompassed by modular organisms. They do not answer, nor perhaps should they be expected to answer the question of whether the biological distinction between modular and unitary species is greater—i.e., more fundamental—than that between plants and animals. It is certain, however, that a long overdue and intellectually profitable start has begun.

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MICROBIOLOGY

ENERGETICS OF MICROBIAL GROWTH. *A Wiley-Interscience Publication.*

By Edwin H. Battley. John Wiley & Sons, New York. $59.95. xxiii + 450 p.; ill.; index. ISBN:0-471-08492-1. 1987.

This is in many ways a classical book, a statement that is at once both congratulatory and pejorative. "Classical," because it provides a really first-rate history of theoretical and experimental attempts to describe the energy changes, and particularly the heat changes, accompanying microbial growth and metabolism. "Classical," too, because the treatment is in terms of classical thermodynamics alone, and covers little of what in Europe are considered to constitute the modern body of work and ideas of the 1970s and 1980s.

Chapter 1 provides an elementary but lucid introduction to Chemical Thermodynamics, its scope and (to some extent) its limitations. But even here no mention is made of the difficulties, raised by Benzinger and by Lumry, in particular, of deriving the

experimental thermodynamic properties of macro-objects such as proteins (let alone cells). Nowhere in the book, nor in the index, is the concept of non-equilibrium thermodynamics, so necessary for treating open systems, even considered. Chapters 2 to 7 are taken up with a more-or-less chronological account of the development of ideas concerning heat production, and its biochemical basis, by microbial cells. Personally, I found these fascinating, since they described much work of which I was largely unaware. Inevitably, Pasteur was involved at the outset, and the early part of this century, when thermostatics ruled and the subject of chemical thermodynamics was beginning to find its feet, saw many studies that sought to measure microbial heat production. However, and at the risk of reinventing the wheel, the subject is once again timely, not least because of the importance of heat production to optimizing the scale-up, and consequent cooling requirements, of biotechnological processes.

The foregoing, we assume, was the prelude to the author's own studies in the 1960s, which form the subject of Chapter 8, while Chapters 9 and 10 give what in my view is a somewhat sketchy and eclectic view of progress to date. Here the author argues strongly that the free-energy change for anabolism is approximately zero; this is not in fact news, and in any event is a simplification since the free-energy changes accompanying anabolism depend, of course, upon the degree of reduction of the carbon-substrate.

Thus, and in conclusion, I would recommend this book warmly for its historical sections. But readers should be aware that there is much of recent, present and future importance that is not covered at all.

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CYTOLOGY AND MORPHOGENESIS OF BACTERIA. *Encyclopedia of Plant Anatomy, Volume VI, Part 2.*

By Frank Mayer; Series Editors: H. J. Braun et al. Gebrüder Borntraeger, Berlin. DM 148. ix + 290 p.; ill.; subject index. ISBN: 3-443-14017-3. 1986.

In writing this book the author has attempted to do more than simply to describe the cytological properties of bacteria. Because of the convenience of working with them, bacteria are the most studied of all organisms on the macromolecular level, and a major purpose of this book is to correlate cytology with macromolecular function, where this is possible. In addition, where experimental methods have resulted in changes in the interpretation of cell structure a correlation of the former with the latter may lead to a better interpretation of the experimental results. The book is thus so arranged that cytological descriptions are often followed by a description of selected aspects of related function and morphogenesis. Also included are descriptions of recent developments in technique, such as low-temperature embedding, cryo-techniques, and computer averaging, that the author feels will be of great significance both in correcting views resulting from artifacts of preparation when previous techniques were used, and in detecting presently unknown cytological properties of bacterial cells.

The book is divided into sections rather than chapters, Section 1 being a short introduction. This is followed by a section on methods of investigation using light microscopy or electron microscopy. Section 3 deals with the structural concept of the bacterial cell by pointing out the structural principles common to all bacteria. Section 4 very briefly touches on those mechanisms that may have to do with the determination of cell shape, to what little extent this seems to be known. The longest section of the book is Section 5, on the cytology of the bacterial cell. This includes extensive information on the cytosol; the cell envelope; capsules, sheaths, and slime; the cytoplasmic membrane; intracytoplasmic membranes; inclusion bodies; the bacterial ribosome; the organization of the bacterial nucleoid; non-flagellar bacterial appendages; structural and functional aspects of bacterial motility; bacterial endospores, exospores, cysts, myxospores, and other persistent states; and bacteria lacking peptidoglycan in their walls. Sections 6, 7, and 8 are interrelated in that they treat the several aspects of cell assembly, the general cytological aspects of cell division, and the interrelationships between the two, respectively. The last section deals with homologous and heterologous associations involving bacteria.

One of the most valuable aspects of this book is its impressive list of nearly a thousand references searched through 1984, all complete with title and full pagination. There are 234 figures, including micrographs and drawings.

This book is concisely written in a style that does not tire the reader, something that is all the more remarkable in that so much information has been included in so few pages. It is certainly the present-day reference of choice when seeking general information on the cytology and morphogenesis of bacteria, or when looking for up-to-date and easy access to literature on these subjects.

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BACTERIA IN NATURE. *Volume 2: Methods and Special Applications in Bacterial Ecology.*

Edited by Jeanne S. Poindexter and Edward R. Leadbetter. Plenum Press, New York. $52.50. xvii + 385 p.; ill.; index. ISBN: 0-306-42346-4. 1986.

This book is the second in a series of ten planned by the editors to comprise a treatise on bacterial ecol-