pressure. Changes would certainly be necessary to adapt those genes to being separated by the nuclear membrane from the site of protein synthesis in the cytoplasm. Selection for the necessary sequence changes would increase the probability of fixation of mutations and thus increase the rate of base-pair substitution. It is also worth remembering that not all parts of a gene are subject to the same degree of selection, and thus to the same rate of substitution. Some regions of the mitochondrial 21*S* rRNA gene are very similar to that of *Escherichia coli* 23*S* rRNA whereas others have diverged widely (Dujon, *Cell* **20**, 185 [1980]); which regions should we use in making phylogenetic trees?

It is disappointing to see so little discussion of these and other problems of data interpretation in this book, or outside of it for that matter. The symbiont school passes over the problems lightly; one would think they would want to consider alternative interpretations of their data more carefully, in self-defense if for no other reason. In their attacks on the symbiont theory, members of the autogenous school mention the difficulties of interpreting sequence data but give surprisingly little consideration to what evolutionary geneticists tell us about the factors that influence rates of evolution. And surely no theory of the evolutionary origin of organelles can be considered complete and correct until it has explained not only the sequence data but also the numerous other aspects of cell and organelle phenotypes discussed in this book. Excellent reviews of genome structure and protein synthesis in chloroplasts (Gillham and Boynton) and mitochondria (Mahler; Locker *et al.*) show that these organelles are highly diverse and exhibit a remarkable mixture of prokaryotic and eukaryotic features. Why do mitochondria alone have a different genetic code? Why have the number and kind of different genes in mitochondria and chloroplasts changed so little in the evolutionary paths from protists and fungi to humans? Indeed, why should there be any genes at all in these organelles? The papers by Whatley and Gibbs show that some algal chloroplasts are surrounded by three or four membranes instead of the usual two. This is interpreted as representing separate symbiotic events, but the interpretations do not seem to fit well with the phylogenies deduced from sequence data. Could they also be explained by an autogenous theory?

One comes away from this book with the impression of having witnessed an argument or debate, but not a real discussion. Members of both schools tend not to think very hard and deeply about how their data would fit alternative hypotheses. The symbiotic school is emperor for the day, and the emperor does have clothes, but they seem rather transparent. The wide acceptance of the theory may owe a great deal to its novelty and psychological appeal, which are expressed clearly and poetically by Lewis Thomas (*The Lives of a Cell*, Viking, 1974). The notion that "we are shared, rented, occupied" by former symbionts is certainly appealing to the emotions, but I prefer to reserve judgment on its scientific validity.

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Epithelial Transport

Epithelial Ion and Water Transport. Papers from a workshop, Dunedin, New Zealand, Apr. 1980. ANTHONY D. C. MACKNIGHT and JOHN P. LEADER, Eds. Raven, New York, 1981. xx, 372 pp., illus. $42.

The study of epithelial transport has progressed considerably in recent years. Biophysical and biochemical techniques newly applied in this field have permitted in-depth examination of the mechanisms of epithelial salt and water transport. Among these techniques, sophisticated intracellular and transepithelial electrophysiological methods, electron microprobe analysis, light microscopy of living tissue, and studies in isolated membrane vesicles are or will eventually become widespread experimental tools in the study of epithelia. This multiplicity of experimental approaches has made it difficult to provide up-to-date overviews of the subject. Books such as this one are therefore useful complements to publications in research journals.

The volume consists of 35 papers presented at a workshop held in honor of James R. Robinson. The papers are organized in a progression from basic methodological aspects to more specific problems. There are sections on optical and biochemical techniques, intracellular microelectrode methods, measurements of intracellular ions, with ion-selective microelectrodes and electron microprobe analysis, leaky epithelia, tight epithelia, models of ion transport, and regulation of cell volume. The result is a well-organized book of overall high quality.

Most of the contributions are well written, concise, and of current interest. As a whole, they provide a good sample of the essential problems that are currently confronted. Reports on current research, very much in the style of regular research papers, are presented next to papers in which specific techniques or problems are reviewed from a broader viewpoint.

I have chosen, rather arbitrarily, to comment on some of the contributions that appear to be the most exciting because they represent important technical accomplishments or because of the significance of the results themselves.

Di Bona and co-workers discuss the use of differential interference contrast and fluorescence optics in the study of epithelial transport. The most impressive results are those obtained in gastric glands, where acridine orange emission at 624 nanometers allowed the investigators to identify the intracellular low *p*H compartment during stimulation of proton secretion. Additional experiments proved that adenosine triphosphate alone restores the cell capacity for proton secretion after adenosine triphosphate depletion.

Frömter *et al.* communicate successful determinations of cell-membrane resistances and capacitances in *Necturus* gallblader, obtained by transepithelial and intracellular impedance measurements. The data can be obtained rapidly with a single intracellular microelectrode, and they compare excellently with those obtained by flat-sheet cable analysis, which is slow and technically more difficult. Further development of this technique holds high promise for studies of leaky epithelia, including renal tubule segments.

Armstrong and Garcia-Diaz provide an interesting discussion of criteria for the use of microelectrodes to measure membrane potentials in epithelial cells. This paper is complemented well by one by Armstrong on ion-selective intracellular microelectrodes. Because both techniques are increasingly used in epithelial physiology, both papers will be useful to newcomers and to established investigators.

Excellent papers by Rick *et al.*, Thurau *et al.*, and Dörge *et al.* cover the use of electron microprobe analysis of epithelial function.

The sections on leaky epithelia, tight epithelia, and models of epithelial transport are more restricted in content and are heavily directed to ion transport, with only brief references to water transport mechanisms. An elegant study in the section on models of epithelial transport is by Schultz *et al.* on the mechanism of sodium entry across the apical

membrane of rabbit colon. The sodium current-voltage relationship was determined, and the possibilities of a channel or a carrier accounting for the sodium uniport are lucidly discussed.

The heterogeneity of epithelial transport functions and the large number of tissues under current investigation make it impossible to cover the field in a single volume, as do the number of biophysical and biochemical approaches to the study of these complicated tissues. Hence, it is probably not entirely fair to criticize the choice of topics, but I could not help missing discussions of important recent developments, such as transport studies in isolated membrane vesicles and noise analysis techniques applied to both tight and leaky epithelia.

The section on cell-volume regulation, although interesting by itself, does not fit clearly in the volume. Since these papers were not restricted to the subject of cell-volume regulation in epithelia, it might have been appropriate to include one or more papers on the interesting recent results obtained in red blood cells.

In summary, this is a useful, timely volume. I recommend it highly to both established workers and newcomers to the field.

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The Chromosomes of Insects

Insect Cytogenetics. Papers from a symposium, London, Sept. 1979. R. L. BLACKMAN, G. M. HEWITT, and M. ASHBURNER, Eds. Published for the Royal Entomological Society by Blackwell Scientific, Oxford, 1981 (U.S. distributor, Halsted [Wiley], New York). viii, 278 pp., illus. $69.95. Symposia of the Royal Entomological Society of London, No. 10.

The insects show more chromosomal diversity than any other class of animals. This diversity is manifested in the range of the number of chromosomes and amount of nuclear DNA, the variety of chromosomal sex-determining systems, and the multiplicity of chromosomal forms. It is also reflected in the enormous amount of research carried out on insect chromosomes. This book is a collection of 15 papers that cover the breadth of studies on insect cytogenetics. The papers are grouped into sections on genome organization, chromosome structure and function, breeding systems, ecology and speciation, and the cytogenetics of pest insects. The contributors are of the first rank of insect cytogeneticists, and this is reflected in the overall high quality of the papers.

The papers concentrate on two topics, the organization of DNA within insect chromosomes and evolutionary cytogenetics. The treatment of the first of these comprises five papers. Peacock and Lohe review with remarkable brevity the literature on repeated sequences in *Drosophila* chromosomes. The subject has been studied extensively, and this paper furnishes the reader with a nearly complete introduction that is direct and readable. Peacock and Lohe are willing to speculate on the functions of repeated sequences and to interpret freely the evidence from a number of laboratories. Though this is one of the better papers, I mention it chiefly as an example of the general style of these five. They are comprehensive, are usually concise and current, and include general conclusions and speculation. Ashburner's review of the organization of polytene chromosomes demands special note. Despite the extensive research on the giant chromosomes of insects, many questions about their structure and their relationship to the interphase chromosomes of diploid cells remain unanswered. Ashburner has performed a valuable service in laying out these questions clearly, with extensive citation of the literature.

The material on evolutionary cytogenetics is presented as comprehensive research papers, each concentrating on a single species. Many of these papers address the issue of chromosomal changes and the isolation of species. Because of the nature of cytogenetic evidence, it is not surprising that the ideas presented about speciation have more to do with gross chromosomal mechanisms than with genetic polymorphism. This inherent bias notwithstanding, the evidence for population changes related to chromosome rearrangements is strong. Since subspecies of grasshoppers can be distinguished by their karyotypes, it is possible to study the origins and effects of hybrid zones between taxa. The papers by Hewitt and Barton and by Shaw, Moran, and Wilkinson demonstrate clearly that parapatric taxa can be isolated by hybrid inferiority without major geographical barriers. Though these authors indicate that chromosomal changes alone do not account for the observed heterozygote inferiority, it becomes clear that rare single events, such as chromosome fusions or inversions, can, under appropriate conditions, lead to genetic isolation.

Many of the other papers on chromosome systems in insects give an indication of the diversity of karyotype variations, many of which could lead to species isolation. Noteworthy examples are Nur's review of the difficult literature on coccid chromosome behavior, Rothfel's clever analysis of the natural occurrence of chromosome rearrangements in blackflies, and Carson's reconstruction of the recent evolutionary history of the picture-winged *Drosophila*.

It is apparent that the integration of molecular analysis into more classical cytogenetics has barely begun. This excellent volume, if read carefully, establishes many of the areas in which this hybridization is likely to occur.

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(Continued on page 596)