mental results but also some of the flavor of more than a decade of rapid and frequently perplexing discoveries. Unfortunately the price justifies purchase only for those small libraries or marine laboratories that do not hold the journals in which most of the material contained in the volume has appeared.

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Extrachromosomal Genetics

Organelle Heredity. NICHOLAS W. GILLHAM. Raven, New York, 1978. xvi, 602 pp., illus. $49.50.

It has now been 70 years since Correns and Baur found genes in the cytoplasm that do not obey the laws of Mendelian genetics. The study of cytoplasmic genes accelerated in the 1950's with the use of microbial systems (*Neurospora*, yeast, *Chlamydomonas*); it took wing in the 1960's with the discovery of DNA in mitochondria and chloroplasts. The last decade has seen the study of organelle genes become one of the fastest-flying fields of genetics, thanks to the combination of sophisticated molecular techniques with unique kinds of mutants and genetic analysis. *Organelle Heredity* is a careful and thorough record of most of the main lines of progress in the field.

It is now clear that eukaryotic cells carry two distinct genetic systems, three if they are photosynthetic. The DNA molecules in the mitochondria and chloroplasts are viruslike, carrying only a few genes relative to the vast number in the nucleus. But the absolutely indispensable role of those genes in the manufacture of the respiratory and photosynthetic systems gives them an importance far beyond their numbers. A detailed understanding of the structure and function of such genes lies not too far away; the mitochondrial DNA of yeast in particular provides an unusually tractable system for detailed mapping at the molecular level and may shortly become known (and perhaps even understood) in an amount of detail rivaling that of our knowledge of viruses. Questions of general interest for students of cell biology and genetics arise at every step. Why are some components of mitochondria and chloroplasts coded by the organelle genes and made inside the organelles while others are coded by nuclear genes and imported? How are the multiple genetic systems controlled and made to function in concert although they are inherited with relative independence? Why are the organelle genetic systems essentially population systems, with tens or hundreds of identical molecules in each cell, while the nuclear genome is haploid or diploid? How and why are genes in mitochondria and chloroplasts so often inherited from only one parent, and why do they segregate during vegetative reproduction, while the nuclear genes in the same cells are inherited biparentally and segregate only during mitosis?

Gillham, a leader in the field, has carefully described the observations and experimental evidence relating to these and other questions about the structure, function, and behavior of organelle genes. There is a wealth of experimental detail, nicely illustrated with graphs, diagrams, and well-printed electron micrographs. Especially useful are tables summarizing data such as the sizes and coding capacities of organelle DNA's of various organisms. There is also careful explanation: experimental methods are explained and evaluated, and the life cycles and husbandry of the principal experimental organisms are described. A modest background in cell biology and genetics will permit graduate or advanced undergraduate students to follow the presentation, although it is not really easy reading because of the detail and the broad scope. The literature is reviewed through 1976 on most topics and through 1977 on some; I know of only a few important papers that have been overlooked. It is a measure of the virtues of the book that I can look with confidence to it for a review of many areas rather than having to wade through my reprint file. It is unfortunate that the price will tend to limit the book to library use, for it deserves to be on the bookshelf of everyone interested in the field.

Though the coverage in the book is broad, it is a bit uneven. Transmission genetics and genome structure are given somewhat more space than organelle biogenesis; the book has more of the flavor of genetics than of molecular biology, although the field itself is at the moment dominated by molecular techniques such as cloning, restriction analysis, and sequencing. It is unfortunate that Gillham's literature review ended just as a great burst of activity with these techniques began. The reader will need to supplement *Organelle Heredity* in this area; the forthcoming collection of papers from the 1979 symposium on extrachromosomal DNA sponsored by ICN Pharmaceuticals, Inc. and UCLA would be a nice introduction to the newer discoveries, such as split genes and restricted codon usage in organelle genomes. A few topics, for instance the experiments on petite mutagenesis, seem to me to have been allotted more space than is justified by their information content. Where there is controversy, Gillham's treatment is scrupulously fair. Some experiments and hypotheses are described and then shown to be false in the light of later observations; this takes up space that might have been profitably devoted to other topics, but at the same time it gives the reader a better feeling for the development of the field and enables Gillham to teach some valuable lessons about the experimental pitfalls lying in the path of the unwary.

Gillham is probably wise to have omitted discussion of the evolutionary origin of organelles; the symbiont hypothesis that has captured the imagination of many has been thoroughly covered in many other places. Also omitted is any discussion of organelle evolution; that is a topic of growing interest (organelle DNA turns out to be an excellent molecular clock and clue to phylogenetic relationships), but some of the best experimental work appeared after the book was written and the theory of organelle evolution and population genetics is still rudimentary.

The book begins with an excellent introduction that summarizes most of the major themes, concepts, and questions of organelle gene heredity and function. Each chapter or group of related chapters ends with a summary of the main conclusions and speculations about likely directions for future work. Some of the predictions have been realized since the book was written, a tribute both to the rapid movement of the field and to the clarity of the author's vision. Gillham is if anything too cautious about making the sorts of generalizations that, even if they failed to stand the test of time, would help the reader tie together the great mass of information and theory. This caution and the organization of the book around experimental systems rather than problems give it a strongly phenomenological flavor. Nevertheless, Gillham has succeeded admirably in his aim to produce a worthy successor to Ruth Sager's *Cytoplasmic Genes and Evolution*; his *Organelle Heredity* is likely to be the standard reference for many years.

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