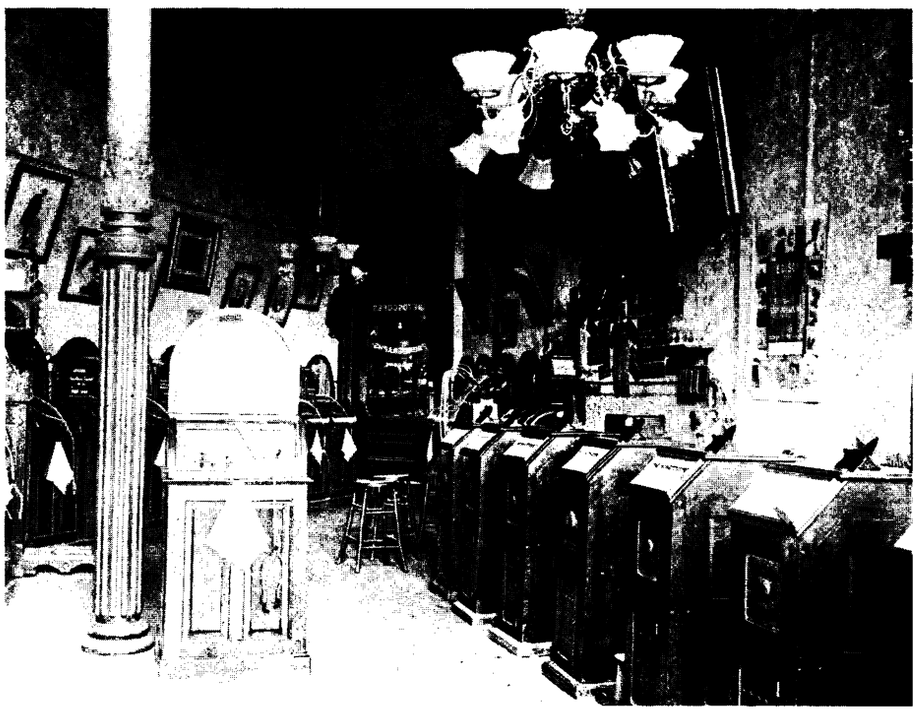
ers ("muckers") valued for their ability to combine skills of both hand and head. Their autocratic boss walked the shop, spitting on the floor, joking, questioning trying his own hand, ceaselessly challenging, criticizing, cajoling, inspiring, perspiring.

But it was all, Millard points out, something of an illusion. Edison reputedly staked everything on great campaigns: round-the-clock efforts to perfect the phonograph, assembling great machines to concentrate the low-grade iron ore of New Jersey. But the main profits came from humbler applications of invention: the nickels put in Edison phonograph nickelodeons or Edison "peep show" Kinetoscopes and a concrete business spun off the iron ore disaster. By the 1920s, the West Orange laboratory was a service organization for perfecting such products, not a group of pioneers looking for new ones.

Millard shows Edison losing leadership in the phonograph industry, blowing millions on the iron ore mining process, succeeding only briefly in pioneering and monopolizing motion pictures, and introducing a storage battery so defective he bought it back from customers rather than sully the Edison name. Analytical chapters (unfortunately poorly supported with numbers on sales, profits, and employment) highlight the clash between the company's adoption of modern business methods and the persistence of Edison's absolute authority. The book fits into the gap on the Edison bookshelf between Byron Vanderbilt's *Thomas Edison Chemist*, which more fully treats the science and technology of Edison's later work, and Matthew Josephson's lively yet accurate biography. It complements the best study of Menlo Park, Robert Friedel and Paul Israel's *Edison's Electric Light*, which shows how well the very Edisonian methods that failed so often at West Orange could work when the time and challenge were right.

But do not dismiss the later Edison. Like the young wizard, he dared greatly and lived fully: dodging ore boulders, shepherding dancing girls, pugilists, or Buffalo Bill through his "Black Maria" movie studio, and, in 1906, worn out and ill from too many great campaigns, mounting yet another to perfect that battery, long after any sensible businessman would have written it off. Picture him at the bench after thousands of failed experiments, stout, bent, white-haired, tired, deaf, and desperate, a hero in the mold of Tennyson's aging Ulysses "made weak by time and fate, but strong in will," determined "to strive, to seek, to find and not to yield." He and his muckers did find a scientifically improbable combination of nickel flake, graphite, and lithium that saved the battery. He never did yield. He was looking for revolutionary ways to make rubber from goldenrod plants a few months before his death in 1931. Millard sensibly focuses on analyzing the business. But Edison the man, an exasperating, never-satisfied Ulysses of invention, shines through.

GEORGE WISE
General Electric Research and Development Center, Schenectady, NY 12301



Amusement arcade with Edisonian devices, San Francisco, 1894 or later. At left are coin-slot phonographs, with ear tubes dangling; at right are peephole Kinetoscopes. "The Kinetoscope was a hurried first attempt to get moving pictures into a form suitable for commercial exploitation. It was closely modeled on the coin-slot phonograph, which was the only part of Edison's talking machine business to experience any growth of sales in the gloomy years after 1892." [From *Edison and the Business of Innovation*]

Dividing Cells

Meiosis. BERNARD JOHN. Cambridge University Press, New York, 1990. xii, 396 pp., illus., $89.50. Developmental and Cell Biology Series.

Meiosis was one of the first topics covered in my introductory college biology class. It is a fundamental property of most eukaryotes and is basic to sexual reproduction. In fact, Mendelian genetics is a formal explanation of the events of meiosis. Despite this familiarity, meiosis has received much less attention from molecular biologists than its partner, mitosis. One reason for this may be that the majority of the literature of meiosis is classical cytogenetics and is relatively inaccessible to molecular biologists looking to place their work in the broader context. This book by John, an established expert in the study of meiosis, should thus be welcomed in the hope that it will serve as a cornerstone in defining problems awaiting genetic and molecular solutions.

John offers a broad, largely historical survey of the literature for both animals and plants. The topics he chooses are interesting and appropriate. Meiosis, despite (or perhaps because of) its fundamental role in eukaryotic life, is a widely varied phenomenon, and its outcome of genetic continuity with diversity is reached by an assortment of mechanisms. Most of us think of conventional, chiasmate meiosis, with well-behaved chromosomes and tidy steps. Although the majority of organisms have this chiasmate version, many are achiasmate entirely, in one sex, or for a particular chromosome. Other organisms invert the sequence of the two divisions, placing the equational division before the reductional division. For readers accustomed to conventional meiosis these variations may be surprising; John presents them well, both in text and in diagrams. These variants serve as a reminder that not everything will be learned from our selected model organisms. Even in organisms with chiasmate meiosis, many of the elementary processes are still poorly understood. In reminding us of how little we really do know the book is very successful.

Ultimately, however, the book fell short

of my expectations. Although the scope of the material surveyed is impressive, the lessons are sparse. Many details are given, but few summaries or models or themes. For example, the question of how chiasmata are distributed is a fascinating one, which the book introduces well. However, the intriguing beginning is followed by a barrage of data about the number and location of chiasmata in different species, without interpretation of what any of this means about the way meiosis works or the impact on the organism.

In order to be a cornerstone of the literature, a book needs to be accessible and solid. Unfortunately, this one is weak in both regards. The writing style is pedantic and often turgid, introducing Greek roots, quoting in the original French without translation, and coining new words and expressions. For instance, a reader trying to figure out what happens in sex chromosome univalents has to contend first with words like "syntelic" and "amphitelic" and then worry about where the chromosome goes. The net effect is that the book is much harder to read than it should be.

Besides the difficult style, the information is inaccessible in other ways. Topics are often dealt with in more than one place with few cross-references. For instance, the behavior of sex chromosome univalents is discussed at least twice, but neither section refers to the other section. Nor does the index help. Having finished the book, I needed to look up the properties of a particular mutant in *Drosophila*, only to find that neither the gene name nor its properties was indexed, and the "*Drosophila melanogaster*" heading included all references to *Drosophila*, with no subheadings for chromosomes, mutations, or other topics. Even worse, the description of the mutant had no literature citation.

Given the scope of the material surveyed, it is probably inevitable that some of the presentation is badly out of date or slanted in odd ways. For example, distributive pairing is discussed in about a page, with more space devoted to old questions about its existence than to any description of what is occurring or the mutants affecting it. Again, the control of the onset of meiosis has been well studied in *Caenorhabditis elegans*, but the references to it stop with 1983; since then, one of the genes involved in this has been identified, cloned, analyzed, published in prominent journals, and extensively reviewed in secondary sources. The material on the chromosome aberration *Sxr* in the mouse ends with 1982 and postulates what occurs in *Sxr* animals; the postulates are correct, but the papers proving this are not cited.

I had high hopes for this book and wish that they had been fulfilled. The reader will come away impressed by the variety of ways meiosis is accomplished, but the cytological information is catalogued in a way that makes it difficult for a newcomer to grasp the principles or see the interesting problems. In addition, a book with this much detail is only as good as its index and citations of the primary literature, and this one falls short.

PHILIP M. MENEELY
Fred Hutchinson Cancer Research Institute, Seattle, WA 98104

Biophysics of Radiation

Radiation Biophysics. EDWARD L. ALPEN. Prentice Hall, Englewood Cliffs, NJ, 1990. xx, 392 pp., illus. $60. Biophysics and Bioengineering Series.

To understand how radiation can cause cell damage or death requires a solid working knowledge of both physics and biology. Treatments of this subject have generally either emphasized biology with minimal attention to physics or vice versa. *Radiation Biophysics* is a comprehensive textbook that bridges the gap between radiation physics and radiation biology by integrating these fields rather than focusing on one or the other.

Though a sound foundation in basic physics is required, the first five chapters of *Radiation Biophysics* lead the reader gently through the atomic physics and radiation chemistry needed to understand how ionizing radiation is generated and how it interacts with matter to modify important biological molecules such as DNA. The next four chapters are devoted to a detailed treatment of cell killing as an endpoint of radiation. This is especially critical for those interested in the therapeutic uses of radiation. These chapters should not be overlooked, however, by the reader more interested in low-dose effects—a valuable presentation is given of mathematical models that are used for fitting results and, possibly, to explain the biophysical basis of cell killing. Though the details of these models may not be directly applicable to other biological effects, the insights they offer into the quantitative description of biological phenomena are useful both in a general sense and for reading later chapters.

The next chapters discuss such important topics as radiation carcinogenesis, genetic effects, and risk assessment. The treatments of these subjects are especially well developed for a text at this level and contrast the stochastic nature of the low-dose endpoints with the nonstochastic nature of the endpoints important in radiotherapy.

There is a chapter explaining the basis of the enhanced biological effects of high linear-energy-transfer radiation, such as the alpha particles characteristic of radon gas and neutrons produced in the course of nuclear fission for power generation. This is followed by two chapters describing the various sources of ionizing radiation in our environment. Obviously, there is a wide variety of such sources, both natural and, more important, from a regulatory point of view, anthropogenic. The author has done a good job of briefly describing all of these sources and also of providing a needed perspective on their relative contribution to the average total dose to the human population.

Radiation Biophysics brings together diverse subject matter in a cogent yet highly readable manner, reflecting the extensive experience of the author as a teacher of this material. The book should also, however, find utility beyond the classroom.

RAYMOND E. MEYN
Department of Experimental Radiotherapy, M. D. Anderson Cancer Center, University of Texas, Houston, TX 77030

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