to arrive at a more holistic assessment of the potential applications of new technology.

Francis initiates his case for the range of potential realities by calling into question some of the bold predictions made by economists and sociologists about the consequences of new technology. He points out that even though there has been tremendous attention paid to dire predictions about job loss stemming from new technologies, the evidence is not especially convincing from either the doomsayers or the techno-Pollyannas. The same conclusion applies to predictions of wholesale deskilling for the industrial and clerical labor force: in some case studies Francis surveys, there has been a clear diminution of skill and worker discretion; in others, however, jobs have been enlarged, for example through the addition of programming skills, or enriched through a more explicit connection of workers to the whole of a production activity rather than the parts.

Having established that outcomes do not reside in the technology itself, Francis then explores the forces that can and will shape the organization of work and the enterprises in which it is carried out. He notes, for example, that market forces will play an important role in the selection and implementation of technologies, particularly as some enterprises sharpen their ability to collect data about their environment, process it quickly by means of powerful (but relatively inexpensive) computers, and react to shifts in competition and in investment opportunities. To capture the benefits of information processing and manufacturing flexibility, enterprises may be compelled to abandon the time-honored principle of hierarchy and search for new organizational designs, for example, building strategic alliances with other firms, subcontracting functions rather than vertically integrating them, or creating team models within a matrix organization. Traditional methods of supervision and control may be rendered archaic through the introduction of highly integrated systems of production, inspection and monitoring, and inventory control.

Translating potential uses into reality will, Francis concedes, require active deliberation and negotiation on the part of unionists and policy-makers, in addition to enterprise managers. To that end, he devotes the final chapters of the book to a checklist of issues that ought to be part of technology assessment. Since the preceding chapters argue against technological determinism—and, in the process, underscore the variable uses of new technology—the prescriptive checklist tends to be quite general in nature. It may provide a beginning agenda for discussion, particularly for union leaders and politicians, but it will have to be substantially revised and augmented if those in the trenches (such as lower-level union representatives, middle managers, and engineers) are to be meaningfully engaged. On its own, *New Technology at Work* is unlikely to shake the stars from the eyes of the manager who wants his factory to run by itself.

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Crosscurrents in Cytogenetics

Beyond the Gene. Cytoplasmic Inheritance and the Struggle for Authority in Genetics. JAN SAPP. Oxford University Press, New York, 1987. xvi, 266 pp. $35. Monographs on the History and Philosophy of Biology.

In *Beyond the Gene*, Jan Sapp has written a book that will inform, delight, and infuriate. It informs because it gives an extended survey of research into cytoplasmic inheritance, an area ignored by the standard histories of genetics and biology. It delights because the printed and archival material Sapp brings to light is lively and provocative. It infuriates because Sapp has in reality written two books, and the second—about authority in science—does not interdigitate well with the first. I will address this last feature at the end of the review.

The first two chapters set the conceptual parameters of the survey. Sapp turns to an array of embryologists and Mendelian geneticists who between 1910 and 1940 expressed dissatisfaction with the contemporary chromosomal explanation of heredity. Some, such as Frank Lillie and Albert Brachet, complained that classical genetics failed to elucidate the processes of development and evolution. Others, such as Carl Correns and Erwin Baur, argued that the cytoplasm also contained hereditary material. Endorsing the second assertion, Jacques Loeb went further to insist that "the cytoplasm of the egg is the future embryo (in the rough)" and that "the Mendelian factors only impress the individual (and variety) characters upon this rough block" (quoted on p. 21). Sapp argues that during this period classical genetics, by designating hereditary events as solely those phenomena that could be studied by the classical hybridization techniques, "constructed" its own, delimiting definition of heredity. In so doing, it left the impression that development was merely an epiphenomenon, and it ignored cytoplasmic bodies that might plausibly serve as structures of transmission. The 20th-century efforts to investigate and promote these two excluded domains of "heredity" are explored in the subsequent chapters. Although they are different, Sapp designates both as "cytoplasmic inheritance."

In a chapter devoted to Germany Sapp surveys the ideas of cytoplasmic heredity of Victor Jollos, Hans Winkler, and Fritz von Wettstein, among others. In one way or another these biologists challenged the "monopoly of the nucleus." Some of the biographical events, such as Jollos's inability to gain professional recognition when he immigrated to the United States, provide intriguing social history, but the vignettes of German biologists, as a whole, are the weakest part of the book because they fail to place the cytoplasmic ideas into the broader context of German research. Better constructed are the ensuing chapters on Tracy Sonneborn and his discovery of the kappa factor in *Paramecium* and Boris Ephrussi and his production of mutants petites in yeast. In addition to giving a fuller perspective on the life and work of these pivotal figures the same chapters depict George Beadle as the "bastion of Mendelism" and C. D. Darlington and Joshua Lederberg as adding interpretative support to the concept of plasmagenes. Sapp nicely disentangles the neo-Lamarckian backdrop to French biology before presenting the further cytoplasmic research of Philippe L'Héritier, André Lwoff, and Jean Brachet. These central three chapters leave the impression that research into cytoplasmic inheritance represented a vigorous and challenging undertaking even though it appeared not to be in the mainstream of genetics.

Sapp reexamines the Lysenko affair and its impact on Western biology from the perspective of cytoplasmic inheritance. Recently Nils Roll-Hansen has pointed out that T. D. Lysenko's earliest work on vernalization had been applauded by some Western scientists. It would not have been inappropriate, Sapp intimates, for Western biologists therefore to take his initial hereditary claims seriously. It is valuable to discover how Lysenko's actions were received by supporters of cytoplasmic inheritance in the West when in the late 1940s he officially suppressed classical genetics and claimed to have demonstrated cytoplasmic and environmental influences in heredity. But Sapp has more in mind. "Did [classical geneticists] use Lysenkoism as a weapon to attack their Western competitors who opposed classical neo-Darwinian doctrines . . . ?" (pp. 167–68). What follows are fascinating accounts of how Sonneborn as president of the Genetics Society of America failed in his attempt to establish a Committee to Counteract Antigenetics Propaganda with power to speak for the entire society and how

Ephrussi successfully convinced Warren Weaver of the Rockefeller Foundation that in France he had to tread a narrow path between traditional, ultraconservative neo-Lamarckians and leftist sympathizers of Lysenko. Sapp does not demonstrate a consistent anti-Lysenko position, nor does he answer his more provocative question about a symmetrical Western effort to beat down cytoplasmic studies. What does emerge is a demonstration, perhaps inadvertent, that the pluralism in Western science rendered impotent efforts to establish official scientific positions.

The discovery of the structure of DNA in 1953 altered the conflict between nuclear and cytoplasmic theories of heredity. Sapp sees a shift from disputes about the cellular location of materials of transmission to efforts to develop three-dimensional concepts entailing the processes of message transfer and feedback regulation. This new perspective encouraged Sonneborn and many of his associates to consider morphogenesis and gene regulation in terms of nuclear-cytoplasmic hereditary systems. In Sonneborn's words, "the cytoplasm is more than a bag of chemicals. It is highly structured." The ultimate question became "How is this organization, especially the difference in organization between different cells of the same organism, determined" (p. 213).

A short survey of this book cannot do justice to the rich feast of details and quotations gathered by Sapp. In many ways, however, Sapp's effort to be inclusive robs him of the opportunity to analyze in greater depth the specific conceptual problems having to do with cytoplasmic inheritance and the undifferentiated somatic genome, the inheritance of acquired characters, or the multiple meanings of "heredity." Instead Sapp focuses on another theme. Throughout he identifies events with the "struggle for authority," a concept borrowed from the French sociologist Pierre Bourdieu. By authority in science Sapp means more than the ability to exercise political power; he implies a status conferred by a combination of scientific achievements, institutional associations, and social acceptance by peers and competitors. Throughout his book Sapp constantly suggests that the proponents of cytoplasmic inheritance possessed a smaller degree of authority than did classical geneticists. Sapp's studies of Sonneborn and Ephrussi, however, belie this conclusion. Both appear to have comported extensive authority even as their specific theories were being questioned.

Beyond the Gene will clearly be an important book in the history of 20th-century genetics. It will be controversial because of its double message. At a minimum it will focus attention on an area that has been woefully neglected. That may be the sufficient test of an "authoritative" piece of historical research.

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Organisms for Study

Observing Marine Invertebrates. Drawings from the Laboratory. DONALD P. ABBOTT. Galen Howard Hilgard, Ed. Stanford University Press, Stanford, CA, 1987. xxvi, 380 pp., illus. Spiral bound, $29.50.

The late Donald Abbott of Stanford University influenced the direction and style of research on marine invertebrates through the many students who took his course and went on to develop their own varied topics of research. Abbott's own published research, on ascidians, was specialized, and these students were not disciples following his research program. How did he teach them to develop their own questions? This book gives a partial answer.

Because many of the species available at the Hopkins Marine Station were poorly known, Abbott made his own drawings and notes during laboratory sessions. His former students urged him to publish a selection from his notebooks, and Galen Hilgard has served science well in working with Abbott during his final illness to produce this volume.

The drawings and notes, arranged taxonomically, are potentially useful for both content and method. The information on morphology will be useful in invertebrate zoology courses on the west coast of North America. The method of recording observations is of broader application. How to observe an unfamiliar organism and develop questions from the observations is difficult to learn or teach. This book shows Abbott's style of observation. The drawings and notes are simple but effective. No one using the book will be daunted by lack of artistic skill or special equipment. Unresolved points of structure or behavior that interested Abbott are clearly labeled as such. A few drawings by students are included, and these show how easily style and content can be modified to suit individual interests.

Abbott's notes are personal and informal. This is both a strength and a weakness. The approach to particulars and their inherent interest is clear, but the usefulness of such simple observations in challenging general hypotheses and suggesting new ones is not explicitly illustrated.

Introductory material and selected quotations include good advice and add to the charm of the book. Although in most research observation begins with the death of the specimen, Abbott reminds us, "Get the experience of looking at fresh things. If you watch live animals, you gain clearer insights in shorter time than you would watching dead animals for much longer."

Despite much current interest in pattern and mechanism, functional analysis is rare in research. One cannot learn to read the functional implications of form entirely from a book, but this book will help students begin to read animals.

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Ontogeny and Phylogeny

Animal Evolution in Changing Environments. With Special Reference to Abnormal Metamorphosis. RYUICHI MATSUDA. Wiley-Interscience, New York, 1987. xviii, 355 pp., illus. $44.95.

Ever since Lamarck, a persistent minority of evolutionists has argued for the inheritance of phenotypically acquired characteristics and their subsequent molding by selection. It is from this perspective that the distinguished insect morphologist Ryuichi Matsuda examines heterochrony and metamorphosis in this posthumous work. Matsuda emphasizes the influence of environmental stimuli on endocrine function and suggests that environmentally induced, hormonally mediated changes in metamorphosis produce the kinds of major structural reorganizations that could account for the origins of major groups such as the animal phyla.

Matsuda begins by asserting the prevalence of metamorphosis among the Metazoa. One has the distinct impression that he is suggesting that metamorphosis is primitive (in the cladistic sense) at some level among the Metazoa, because he goes on to argue that virtually all animals have either the "primary" developmental pattern of pelagic larvae metamorphosing into benthic adults, a "secondary" pattern (larva to pupa to adult), or a modification of these patterns which he calls "abnormal metamorphosis." Thus Matsuda apparently considers reptiles, birds, and mammals to have "abnormal" metamorphosis, although only invertebrates, fishes, and amphibians are discussed in this work. In our vertebrate-centered world, only a cladist or an invertebrate zoologist could view amniote development in this novel way.