or was an induced phenomenon; they were done 30 years after Pfeffer's first use of the term "induction" and at the same time as the publication of Herbst's monograph on developmental mechanisms in 1901. Herbst is the subject of a stimulating chapter by Jane Oppenheimer.

The second recurring theme is the dialectic between neo-epigenesis and neo-preformation, arising out of two centuries of debate about whether the embryo forms *de novo* or whether a germ (homunculus) is contained within the egg or sperm. The "neo" implies that the debate has not yet been resolved. Indeed, it continues today as a dialectic between genetics and epigenetics: the genetic explanation proposes that all the information required to build an embryo is contained within the genome; neo-epigeneticists, on the other hand, believe that even a complete knowledge of the genome and of the interactions between gene products will not suffice to understand development: we must also understand the rules that are imposed on the genome by the cellular environment. In the book, this debate is followed up to the 1980s in an interesting chapter by Jan Sapp.

Hans Spemann and some of his associates and Thomas Hunt Morgan were responsible for the introduction of genetics as a tool complementary to experimental embryology, although Morgan's contribution did not earn him a chapter in this book. His role is reviewed briefly in Gilbert's own chapter, which does a great job by filling some gaps and bringing together genetics and embryonic induction. Here one catches a few glimpses of Morgan and a good perspective on Waddington's contribution, as well as a timely survey of the role of Salome Gluecksohn-Schoenheimer (now Salome Gluecksohn-Waelsch) in research on the *T* (*brachyury*) gene, which as early as the 1930s was suspected to play an important role in induction and axial specification. New work on this gene, which has recently been cloned, is beginning to lead to the same conclusion.

Leon Browder's insight in including this volume in his "comprehensive synthesis" of developmental biology is laudable. Equally worthy of praise is Gilbert's choice of authors, although a brief reading list of other books on the history of developmental biology would have been nice. But this is a quibble. This book, together with Viktor Hamburger's *The Heritage of Experimental Embryology: Hans Spemann and the Organizer* (Oxford University Press, 1988), should be on the shelf, if not at the bedside, of every developmental biologist and should be read by everyone new to the field. It will be a source of real inspiration.

Claudio D. Stern
Department of Human Anatomy,
Oxford University,
Oxford OX1 3QX, United Kingdom

Drosophila Unfolded

The Making of a Fly. The Genetics of Animal Design. PETER A. LAWRENCE. Blackwell Scientific, Cambridge, MA, 1992. xiv, 228 pp., illus., + plates. Paper, $29.95.

The 1980s were years of extraordinary excitement in developmental biology because of the explosive coming together of genetics and molecular biology: for the first time mechanisms that direct the unfolding of the egg into a complex multicellular animal, the fruit fly, became clear. We now understand, at a satisfying level, quite a bit about the development of this animal.

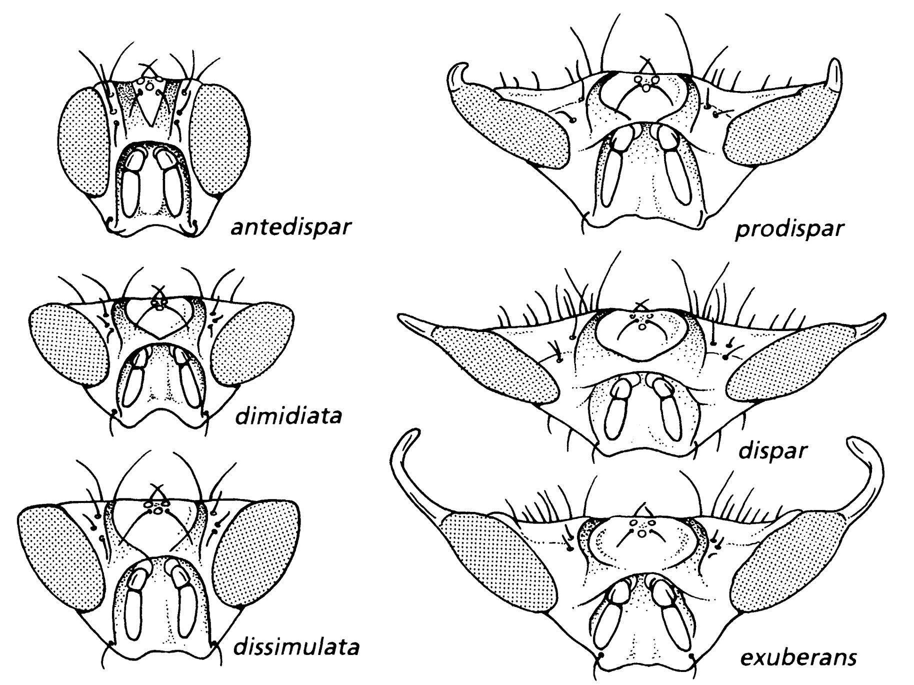
Peter Lawrence has put together much of what we know in his new book. From a deliberately personal and biased viewpoint, he describes what is known about early axis determination, segmentation, segment identity, bristle formation, and eye development.

Lawrence does not attempt to cover everything that is known about fly development. He has selected topics that he is particularly interested in, and in most cases these are areas in which he has made a personal contribution. It is a tribute to Lawrence's scientific good taste that his career has covered a broad range of fundamental issues in development. Segmentation, compartments, segment identity, muscle development, intrasegmental patterning, bristle spacing, and eye development are all areas that Lawrence knows intimately through his own work. He covers the facts in each of these areas, spicing them with his individual perspective.

Because of the range of topics covered and the chatty, easy-to-read style, this book will be of particular value to those with some background in developmental biology who would like an overview of the current understanding of *Drosophila* development. Physically it is a pleasure to read: it is printed on high-quality paper; the print is not cramped on the page; there are lots of figures.

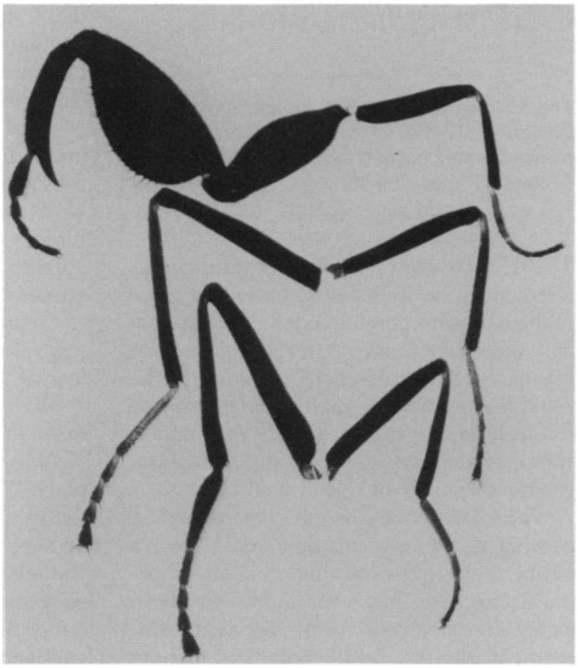
Given the scope of the book, Lawrence makes amazingly few mistakes of fact. However, the facts are very dense in places. For instance in the segmentation section, I was concerned that the non-drosophilist who didn't already understand the relationship between *nanos* and *hunchback* and *knirps* would throw up his or her hands and complain again about all those silly gene names.

At some points I think Lawrence's informal style makes concepts murkier than they need to be. The analysis of genetic pathways is always a complicated business, and in his attempt to be easy to read Lawrence is sometimes imprecise to the point of being misleading. For instance, in several places he says that "downstream" genes serve "subordinate" functions. This is confusing because "subordinate" inevitably connotes being of lesser importance; surely he does not mean that the Bithorax Complex is less important than *Polycomb*, but I fear he could



"Heads of related species of *Drosophila*. These can be arranged in a series stretching from the mundane to the fantastical." [From *The Making of a Fly*]

"The legs of two related flies. On the left a predatory species and, on the right, the equivalent legs of a peaceful relative." [From *The Making of a Fly*]



leave the reader with that impression.

Lawrence says the book is styled after Ptashne's *A Genetic Switch*. But whereas Ptashne's book constantly asks, how do we know what we know?, Lawrence's is more of a collection of stories about what is known. We know what we know about *Drosophila* embryos because of the nitty-gritty of molecular biology and genetics, but Lawrence's interest is primarily at the level of the cell and the group of cells. Consequently the descriptions of molecular and genetic experiments that define what is known about early embryogenesis sometimes come across rather flat and do not highlight why these experiments are truly exciting.

In contrast, the final three chapters on intrasegmental polarity, bristle spacing, and eye development give the best descriptions of these topics I have come across. Perhaps because the take-home lessons here are cellular rather than molecular, Lawrence's descriptions are at just the right level of analysis to capture the essence of these processes.

It is possible to publish a book like this in 1992 because the pace of progress in *Drosophila* developmental biology has slowed enough that the facts did not change fundamentally between the time of writing and the time of publication. I think this fact and Lawrence's presentation conspire to create the unfortunate feeling that the fly is made and we can all go home or go work on zebrafish now. There are a few topics that Lawrence points out as areas for future research, but these all sound like filling in the details, normal science after the revolution. Indeed we are living in a time of transition: now that many genes important in *Drosophila* development have been cloned, we need to think hard about how we can use what we have learned in order to address new problems, move to new levels of analysis, and apply the lessons from *Drosophila* to other organisms. I hope that students will not come away from this book with the sense that it's all over but will use it as a starting point for their own ideas that will take us into the new millennium of developmental biology.

Kathryn Anderson
Genetics Division,
Department of Molecular and Cell Biology,
University of California,
Berkeley, CA 94720

Reversal of Fate

Transdifferentiation. Flexibility in Cell Differentiation. T. S. OKADA. Clarendon (Oxford University Press), New York, 1991. x, 238 pp., illus. $98.

Prior to overt differentiation when they express recognizable phenotypes, cells in developing organisms are thought to pass through a state of determination in which the decision regarding their future fate is made. Although the outcome of these processes is generally assumed to be fixed, there are numerous examples in which differentiated cells can partially or totally switch their fate. This has led to the idea that perpetuation of the differentiated state may require active maintenance. The term "transdifferentiation" refers to the flexibility of cell differentiation, perhaps a consequence of "reprogramming" of already differentiated cells. The book *Transdifferentiation* by T. S. Okada provides a unique and thorough description of this important topic, knowledge of which is essential for a comprehensive understanding of the factors that control development.

The phenomenon of cell-type switching has been noted repeatedly over the last two centuries. The most common examples are associated with human pathological conditions, in which differentiated cell types arise in unexpected sites, or occur during regeneration of primitive organisms such as Hydra, in which an entire organism is recreated from a few adult cells. Until recently, however, there was controversy regarding the ability of specialized cells to switch their differentiated state during normal development. This stems largely from the difficulty of identifying and following the "transdifferentiating cell" within the organism over time, as a consequence of which it was impossible to distinguish phenotypic switching from differentiation of new cells from undifferentiated precursors. The advent of modern cell-culture and cell-marking techniques has obviated many of these problems, making it possible to verify a switch in cell phenotype in numerous cases. Because most cell types retain their full genomic complement of information long after differentiation, some dormant genes may be activated under appropriate conditions. Recent descriptions of tissue-specific gene expression suggest that one set of gene products is replaced by another, a phenomenon consistent with the possibility that transdifferentiation involves changes at the transcriptional level. The future challenge will be to unravel the molecular mechanisms underlying this flexibility and to compare them with the events of normal differentiation.

As a leader in this field, Okada is intensely aware of both the complexity and the importance of the concepts of transdifferentiation. Consequently, he unfolds the problem in a logical progression. The monograph first sets out to define the terminology, with the goal of eliminating unnecessary jargon and reconciling confusing terms such as "differentiation," "determination," and "commitment." The author then embarks on describing the process of transdifferentiation in numerous systems ranging from plants and *Drosophila* imaginal discs to mammalian neurons. Beginning with a straightforward examination of the relatively simple question of whether dormant genes can be activated by nuclear transplantation or the creation of heterokaryons, he proceeds to more complicated examples of transdifferentiation between apparently different cell types such as lens cells and neurons. Because transdifferentiation of adult cells can lead to can-