throughout its development, based on a combination of cell lineage studies and reconstructions of electron micrographs of serial sections, has made possible a genetic analysis of the control of cell lineage by studies of a large number of mutants which distort particular cell lineages. Many types of such mutants remain to be identified by new types of selection procedure, but this work is at the stage where molecular analysis of lineage mutants is possible – obviously a very important area for experimental embryology.

Muscle anatomy, assembly and function have been studied mainly on the body-wall musculature responsible for movement of the animal forwards and backwards. The major muscle components are similar to those of other animals: muscle extracts contain myosin with both heavy- and light-chain subunits, actin, paramyosin, tropomyosin and troponin-like proteins. The myosin heavy chain coded for by the *unc-54* gene, paramyosin coded by *unc-15* and actins coded by *act-1* and *act-3* are all body-wall muscle constituents, and their positions have been further defined using monoclonal antibodies, together with a number of other muscle-associated proteins. More than 25 genes whose mutations cause uncoordinated or slow movement have now been identified as muscle genes. The *unc*-22 gene, identified by its distinctive 'twitcher' mutant phenotype, codes for a polypeptide of more than 500 kD located in the myofilament lattice in the A band, but in spite of extensive molecular analysis its function remains mysterious, and it is not known whether it has an analogue in vertebrate muscle.

The nervous system is one of the main targets of genetic research in *C. elegans*, and is the most complex organ in the animal, containing 37% of the somatic nuclei in hermaphrodites and 46% in males. The complete nervous system of the hermaphrodite has been reconstructed, and a partial reconstruction of the nervous system in the male tail, where most of the sexual differences occur, has been described. Experimental studies include the development of the nerve cell lineage and the effects of both laser ablation of particular cells and of mutations on cell lineage and on behaviour, and pharmacological observations on effects of putative neurotransmitters, their agonists, etc. Behaviours that have been studied by mutational analysis include coordinated movement, chemotaxis, thermotaxis, osmotic avoidance, male mating, egg laying and mechanosensation. This system has been analysed to a resolution and completeness that has not been possible for any other animal, but we are still far from being able to design a computer or robot model of *C. elegans* which would mimic the behaviour of the real animal. Those who think they are well on the way to building a model of the human brain with a 4th or 5th generation computer should perhaps try to cut their teeth on *C. elegans*.

Let us finish with the chapter on sexual dimorphism and sexual selection, which also reports many interesting discoveries. The primary sex-determining signal is the *X/A* ratio, which appears to set the states of a small number of sex-determining genes, which then direct development along a particular sexual pathway. Of the seven major genes so far identified, the three *tra* genes appear to be required in the hermaphrodite but not in the male, the *her-1* gene is required in the male only, and the three *fem* genes are required for male somatic development and also for spermatogenesis in both males and hermaphrodites. Dosage compensation is thought to be achieved by increasing transcription from the single *X* chromosome of the *XO* male or decreasing transcription from the two *X* chromosomes of the *XX* hermaphrodite. Thus there are similarities between the sex determination and dosage compensation systems of *C. elegans* and *Drosophila*.

To summarize, *C. elegans* has fully borne out Sydney Brenner's hopes for its future: its has obviously become of unique value for analysing the genetic control of metazoan differentiation, and of the relation of behaviour to the nerve cell system in all its aspects.

The book under review, which covers in detail the whole field of *C. elegans* research, makes absorbing reading, and should be studied by all those with an interest not just in worms but in the wider problems of understanding gene action in multicellular organisms. This book should be of value to a wide readership for many years, and my only cavil it at its high price. A paperback edition at a much reduced price would certainly find its way to the private bookshelves of numerous geneticists, embryologists, cell biologists, etc., and I hope the publishers will take heed.

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Practical Isozyme Genetics By N. PASTEUR, G. PASTEUR, F. BONHOMME, J. CATALAN and J. BRITTON-DAVIDIAN. Chichester: John Wiley. 1988. 215 pages. £29.95. ISBN 0 745 8 0501 9.

This is an English translation of a French text published in 1987. It consists of three major parts. Part I comprises an outline of the principles involved in protein electrophoresis and discusses the genetic interpretation of gels, part II describes the laboratory techniques involved and includes staining protocols for about 50 enzymes, and part III outlines some (elementary) methods of data analysis. In line with the authors' experiences, the book concentrates on animal examples.

Unfortunately, for what is essentially a practical manual, coming from a major group of biochemical

population geneticists, there are a surprising number of errors. Some may have crept in via the translation process, some appear to result from poor proof-reading, but others seem likely to have appeared in the original French text. For example, in interpreting gel patterns, it is useful to know the quaternary structure of the enzyme, and the authors helpfully provide a list of such structures for this purpose. But the errors in this list may serve to hinder rather than assist. Fumarase, glyceraldehyde-3-phosphate dehydrogenase, malic enzyme and sorbitol dehydrogenase are all typically tetramers, not dimers, creatine kinase is a dimer, not a monomer (although it is true that in bony fish, muscle CK appears to be a monomer since heterodimers are not formed), alkaline phosphatase is usually a dimer, not a monomer, and only the cytoplasmic form of superoxide dismutase is a dimer, the mitochondrial form being a tetramer.

This muddle over quaternary structure permeates the text in several places, and could confuse students new to electrophoresis. For example, at one point the authors state '...malate dehydrogenase, an enzyme that is normally tetrameric but which in dimeric and even monomeric associations shows a certain catalytic activity'. MDH is a dimer not a tetramer, and the authors correctly refer to it as such in their list of quaternary structures. It may be that malic enzyme is being discussed here, which is typically a tetramer (although listed in the book as a dimer). Similarly, referring to lactate dehydrogenase, the authors correctly say that in most species the enzyme is a tetramer and that five bands will be formed in heterozygotes, but continue: 'However, in many species, heterozygotes have two chains (three bands) because the asymmetric heteromeric molecules (AAAB and ABBB) are not formed.' If the asymmetric hetero-tetramers were not formed (in my view an unlikely occurrence in allelic products at an LDH locus), enzymes in the heterozygotes would still consist of four chains, not two. Possibly the authors are referring to the D-lactate specific LDH of some invertebrate groups, which is dimeric and hence would produce three bands in heterozygotes.

Part II is the most useful section of this book, and includes a compilation of electrophoresis buffers and staining recipes. These looked workable, and the only obvious error was in the recipe for aconitase, which lacked the linking enzyme isocitrate dehydrogenase. Starch is favoured as the electrophoresis medium, and although this probably remains the medium of choice for most people engaged in this sort of work, many have recently switched, wholly or partly, to the use of cellulose acetate gels. These gels are more or less ignored here, but offer tremendous speed and convenience benefits over starch (we find the Helena Laboratories system to be especially well suited to the rapid analysis of large sample sizes). Furthermore, definition on such gels is often superior to starch gels, and certainly superior to the rather poor definition of some of the electropherograms presented by Pasteur *et al.*

In the preface, the authors write (in 1986) that no book dealing with all the techniques presented exists in English or French. However, in 1986, Richardson, Baverstock and Adams authored a rather similar work, entitled *Allozyme Electrophoresis* (Academic Press). This book is twice as long and far more comprehensive than *Practical Isozyme Genetics*, especially when it comes to data analysis. It does have the disadvantage of concentrating almost exclusively on cellulose acetate electrophoresis, yet at more or less the same price as *Practical Isozyme Genetics* would be my choice of the two. Nonetheless, electrophoresis laboratories will still find much of use in *Practical Isozyme Genetics*, especially if the errors are corrected in a second printing.

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Yeast Biotechnology. Edited by D. R. BERRY, I. RUSSELL and G. G. STEWART. London: Allen and Unwin. 1987. 512 pages. £60.00. ISBN 0 04 574042 9.

With the current surge of interest in research on yeast, both as a model eukaryotic microorganism and as an industrially useful organism, there has come a similar increase in new books relating to the biology and technology of yeasts. This volume on Yeast Biotechnology sets out to provide an insight into five areas fundamental to yeast biotechnological processes by way of contributions from experts in the field.

In many respects the book succeeds in its objectives, especially in the more traditional areas of growth of yeast and yeast nutrition, product formation and downstream processing. Some of these aspects have been covered in as much, or more, detail in other volumes such as the Cold Spring Harbor set of two on the *Molecular Biology of the Yeast Saccharomyces* and the Rose & Harrison multivolume treatise on *The Yeasts* although the chapter by Wiseman and his colleages on downstream processing was notable for its treatment of the problem of yeast disruption.

For the geneticist, particularly one interested in the recent developments in recombinant technology, the book is a little disappointing. This is not a criticism of those contributions that appear on classical and recombinant techniques, more on the absence from the volume of more detailed discussion of the extent to which yeast can and has been applied in the production of heterologous proteins and vaccines. The chapters