transcription leading, for example, to changes in the stoichiometry – and thus levels of cell surface expression – of class II heterodimers. Similarly, in rats transgenic for the class I *HLA-B27*, the development of spondylarthropathies correlates with the levels of expression of the transgene (cited by Hall and Bowness, Chapter 15). Wassmuth (Chapter 8) also refers to the role of class II transcription factor mutations in the aetiology of a group of congenital immunodeficiencies, where there is a complete failure to express certain HLA loci with subsequent failure of lymphocyte selection and maturation in the thymus.

In addition to chapters on MHC assembly and transport, crystal structure and function in antigen presentation, the book also contains an excellent chapter on serological and molecular methods for HLA typing (Chapter 6), a summary of the levels of constitutive HLA antigen expression on different tissues and cell types (Chapters 7 and 8) and a useful compilation of the various peptide binding motifs for different class I and class II alleles (Chapter 12). Finally, the description of the gene hunting exercise for HLA class III genes (Chapter 3) is a fine example of the new approaches to genome analysis. This chapter also gives an insight into the problems of transcriptional regulation of closely spaced genes – genes-within-genes are a feature of the class III region.

On the whole, the book is well edited and acceptably up to date (most chapters contain a liberal scattering of 1995 references and there are occasional 1996 citations). Anyone reading the book from cover to cover will find extensive repetition of the basic concepts of the MHC, but the book is not really designed to be read in this way. Each chapter is self contained and intelligible without reference to others (although there are a number of abbreviations which are not explained either in the text or in the abbreviations list at the front of the book). Having said that, reading the book in its entirety is very informative as it is only then that the differences in nuance become apparent.

ELEANOR M. RILEY
Institute of Cell, Animal and Population Biology, University of Edinburgh

The Shape of Life – Genes, Development and Evolution of Animal Forms, by RUDOLF A. RAFF. University of Chicago Press 1996. 544 pages. ISBN 0 226 70265 0 (cloth), 0-226-70266-9 (paper). Price £43.95 ($55) cloth, £23.95 ($29.95) paper.

There has been remarkable progress in our understanding of how genes control development and this opens up quite new ways of thinking about evolution. For all evolutionary changes in multicellular animals and plans are due to changes in their DNA changing how the organisms develops. So while it is possible to have an evolutionary theory without any consideration of embryonic development, such a theory will always be deficient. One of the key questions, for example, is why out of the millions of animal species there are so few body plans – thirty-five. The answer must involve a contribution from development. Again, if one wishes to understand how limbs developed from fins, one needs to know how the limb and fin develop and how the genes control these processes. These are central themes of this book.

Raff makes clear that homology is the basis for all evolutionary comparison. Unfortunately, it is a concept fraught with difficulties. How does one decide if the insect leg is homologous or analogous to the vertebrate limb? Structures, it is claimed that are clearly homologous, do not always arise in the same way in development. If that is true then one cannot use the most intuitively satisfactory definition, namely homologous structures have a similar developmental programme together with evolutionary continuity.

An examination of metazoan origin suggests that just before the visible Cambrian radiation 'the pace of metazoan evolution seems to have quickened. It is likely that the truly defining steps in metazoan evolution occurred during that interval'. How wonderful it would be to understand just what happened then!

There is an analysis of phylogenies from molecular and morphological approaches which have yet to be reconciled, together with cladistic and evolutionary classification. One needs to be able to identify primitive from derived states. There is also the problem of proper dating of the fossil record which, if incorrect, can lead to errors in calibrating molecular clocks.

One of the most exciting discoveries has been that the same set of genes – the *Hox* genes – are involved in providing positional identity to cells along the antero-posterior axis of many animals. This pattern of gene activity is characteristic of the phylotypic stage – the stage at which the body plan of a phylum is blocked out. However, both before and after this stage there can be considerable variation. Just why this stage is so well conserved is a matter of much discussion. It may be just too difficult to alter once it has been established. My own view is that this is when the basic pattern of positional identities is established and then the positional information can be interpreted in many different ways. To change this basic co-ordinate system would involve a major leap and would be unnecessary.

Whatever the reason, conservation of body plans provides a developmental constraint. Developmental constraints are important for understanding evolution for they determine what sorts of animal forms can evolve. It is difficult to imagine mice developing feathers as just too many changes in the developmental programme are required and each has to be adaptive.

Raff thinks that changes in timing of developmental events – heterochrony – has been the single most pervasive idea in evolutionary developmental biology. But he makes a critical assessment as to whether such

a view is valid. The most famous heterochronic change is neoteny in which somatic maturation is slowed with respect to sexual. There are also many examples in postnatal growth of different organs – most new-born puppies look similar. But it is worth noting that the rate of growth of long bones is largely determined by the length of the proliferative zone of the growth plate and not by any timing mechanism.

Larval forms are very common in marine animals and their evolution is a fascinating problem. Raff implies that larval forms of sea urchin are the primitive condition and direct development a later modification. He shows that it is possible for early stages to be very significantly modified. However, I find it hard to imagine how adults could have originally developed from a larval stage – the case of the tadpole and insect larvae, which are clearly interposed stages, provide a much more plausible scenario. Indeed the evolution of novelty is a central problem.

Raff has summarised and brought together an enormous amount of information from relevant areas, particularly palaeontology, and has included historical as well as literary perspectives. There are references to Aldous Huxley's story about an ageing man reverting to ape-like form and Stefan Themerson's version of humans as seen by ants. In a way there is almost too much and the lack of extensive illustrations make many of the arguments – particularly in relation to development – difficult to follow. Nevertheless this is an invaluable resource for anyone at all interested in this rapidly advancing subject. There are, however, a few lacunae; the most striking is that there is nothing on the evolution of development itself – how, for example, did gastrulation evolve and why did the evolution of multicellular organisms occur at all? There is also very little on the cellular and molecular basis of development of form – what is sometimes referred to as morphogenesis. It is only by understanding the cellular basis of these processes that we can understand how they evolved. Development is essentially about how differential gene activity controls cellular behaviours.

LEWIS WOLPERT
Professor of Biology as Applied to Medicine, University College, London

Gregor Mendel: The First Geneticist. By V. OREL. Oxford University Press, 1996. pp. x + 363. Price £29.50, Hardback. ISBN 0 19 8547 74 9

Gregor Mendel's case is a curious one. His work was barely noticed in his lifetime, and his influence on genetics as it developed from 1900 onwards was more that of a catalyst than a pioneer because his now famous paper, published in the Moravian town of Brno in 1866, only came to light at the moment its main results were being independently discovered. Yet it, and its self-effacing author, exert a continuing fascination, partly because the work reported was so far ahead of its time – thirty-five years in a rapidly-developing science – partly because it was written up in such a meticulous and modern manner, and perhaps not a little because of the collective guilt felt by succeeding generations for the paper's neglect despite its wide distribution. And then there is the question of the good fit of the data to the Mendelian expectations.

R. A. Fisher pointed out in *The Genetical Theory of Natural Selection* (1930) that 'had any thinker in the middle of the nineteenth century undertaken, as a piece of abstract and theoretical analysis, the task of constructing a particulate theory of inheritance, he would have been led, on the basis of a few very simple assumptions, to produce a system identical with the modern scheme of Mendelian or factorial inheritance', and in 1936 when he wrote *Has Mendel's work been rediscovered?* he speculated that this is just what had happened, and that Mendel's 'experimental programme becomes intelligible as a carefully planned demonstration of his conclusions'. John Arbuthnot – the creator of John Bull and in 1710 the inventor of the significance test – had wondered

> *What am I? how produced? and for what end?*
> *Whence drew I being? to what period tend?*
> *Am I the abandoned orphan of blind chance,*
> *Dropt by wild atoms in disordered dance?*
> *Or from an endless chain of causes wrought?*
> *And of unthinking substance, born with thought?*

and anyone familiar with the elements of combinatorial theory, as Mendel was, might well see the link between the 'blind chance' which governed the 'wild atoms in disordered dance' and the binomial coefficients 1:2:1. Even Francis Galton, who knew rather little mathematics, was able to explain to his cousin Charles Darwin (who knew even less) in 1875 that 'If there were two gemmules only, each of which might be either white or black, then in a large number of cases one-quarter would always be quite white, one-quarter quite black, and one half would be grey'.

Thus Mendel's work raises many questions of interest to historians of science, regardless of its lack of impact when first published. What was the state of the relevant sciences in 1865 and how much might Mendel have known? What was his level of education, especially in mathematics? What textbooks had he used? Why was the work not seen as the striking advance it appears to us? How were the experiments organised, and at what stage are the integer ratios confirmed? To what extent had botanists arrived at Mendel's ratios independently by 1900? How have subsequent generations viewed the paper? How should we?

Dr Orel is the Emeritus Head of the Mendelianum at the Moravian Museum in Brno, and this biography is the result of a lifetime's study of Mendel and his intellectual and physical environment. No stone has been left unturned, no source untapped, no paper unread (there are 641 references, of which more than