Book Reviews

Developmental Biology

Pattern Formation. A Primer in Developmental Biology. GEORGE M. MALACINSKI and SUSAN V. BRYANT, Eds. Macmillan, New York, and Collier Macmillan, London, 1984. xxviii, 626 pp., illus. $58.

Any subject of inquiry in which the issues are major but the progress has been slow warrants an occasional book to assess the situation. How cell activity is orchestrated into the harmonious progression of structure in developing organisms is the issue here. One wants to understand why muscle protein is prominent in the limbs and not in the liver. Further, why does muscle protein run along the limb rather than wrap itself around the bone in the ring-like configuration found in the lips? Specific geometrical features of large organisms are inherited as rigorously as are the biochemical traits of eye and petal color. The question is, how is it done? Efforts to provide answers have had to cope with three challenges: the developmental progression has myriad states; it involves intricate geometrical changes over large distances; and it must be efficiently encoded in the genome.

This well-edited book on pattern comprises 26 chapters that introduce the questions and the biological systems that have been studied and the modes of analysis that have been employed to answer the questions. The book is quite readable. The editors have enforced guidelines for style and clarity, prodded the authors with stimulating questions, and even provided a short glossary to explain the sometimes painfully abstract jargon of the field. The book is suitable for motivated individuals, or classes, with a year's experience in biology.

A striking feature of development is that the parts of the organism are almost always in a locally harmonious arrangement. Even in monsters, such as two-headed snakes, the details of local construction are quite normal. This can be explained, according to Winfree, by a pervasive continuity principle. The idea is that epithelia tend to maintain, or restore, gentle gradients in two variables, the gradients being at right angles. This principle of gradual change can explain not only the normal coherence of structure but also the otherwise bizarre responses to certain animal transplants in which superfluous limbs sprout from the junction of limb grafts. The unexpected limbs are the organism's extraordinary effort to restore smooth continuity in two variables between the highly different partner tissues of the original graft. Details of the cellular and molecular basis of the gradients are lacking. As far as one knows, the gradients could be of anything: voltage, surface stickiness, elasticity, *p*H. Most models for biological form and pattern reduce the problem to phenomena in a plane. Hence, the two-dimensional gradient principle is of major importance.

A major premise, still shakable, is that much of developmental pattern can be explained on the basis of "morphogens," postulated chemical substances whose concentrations serve as position indicators. The chemicals are thought to exist in gradients expressly for this purpose. The idea is that consecutive levels in the gradient are "interpreted" into specific structure by consecutive cells along the line. The different couplings between level and structure bring on pattern. Obvious difficulties are that the gradient must be measured precisely and that the interpretations must be large in number. This latter leads Karlsson to suggest that maybe for the most part one thing just leads to the next without constant reference to position indicators. Morphogens, in their most powerful sense, have not been isolated. Retinoid compounds, which are discussed by Maden, come closest to being morphogens in that they consistently modify limb regeneration.

Once it is assumed that morphogens do exist and that the problem of converting their concentrations into structure is not too serious, a variety of ingenious model systems can generate appropriate morphogen patterns to explain much of the course of development. Positional information concepts, including the polar coordinate model and limb polarization, are presented by several authors. Reaction-diffusion schemes, which use two interacting morphogens, are especially powerful in producing progressively more intricate spatial patterns, exactly what is needed. Several authors deal with this approach.

The organisms chosen for consideration range across the entire spectrum. The list includes higher plants, Protozoa, and especially *Drosophila*, in which genetic approaches have been well developed. Bacteria, yeast, and nematodes are not included.

The book makes it clear how a relative still water, such as pattern formation, can elude the clarifying onrush of modern biology. Molecular biology deals beautifully with linear issues, such as sequence. This takes us up to the point where an amino acid chain folds up into a functional three-dimensional protein. That is one thing. How gene products can cause the progeny cells of a hen's egg to fold up into a chicken that can fly, and perhaps think, is another. Fully convincing dogma pertinent to the multicellular aspects of this process is still to come. For those interested in the best current tries at it, *Pattern Formation* is recommended.

PAUL B. GREEN
*Department of Biological Sciences,
Stanford University,
Stanford, California 94305*

Laurentide Ice Dynamics

Late Pleistocene History of Northeastern New England and Adjacent Quebec. HAROLD W. BORNS, JR., PIERRE LASALLE, and WOODROW B. THOMPSON, Eds. Geological Society of America, Boulder, Colo., 1985. x, 159 pp., illus. Paper, $22.50. Special Paper 197. From a symposium, Bangor, Maine, April 1981.

The wastage of the Wisconsinan Laurentide Ice Sheet affords an analog that has been invoked in projecting the future interaction of Antarctic ice and rising sea level due to current climatic change. Evolving views on the recession of the Laurentide Ice Sheet therefore have implications for our understanding of ice sheet wastage in general.

For the past century, the prevailing view has been that the ice sheet retreated generally northward from the sub-parallel moraines of coastal New England to the Laurentian uplands. In recent years, however, Canadian geologists have reported increasingly convincing evidence of northward ice flow toward the Gulf of St. Lawrence in late Wisconsinan time, supporting views proposed independently by R. N. Ells and Robert Chalmers in 1887.