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EDITORIAL

Frontiers in Development

The challenge of development is universal to all multicellular organisms, whether plant or vertebrate, insect or coelenterate. In each case, the egg must find a way to give rise to a great variety of differentiated cells, all arranged in specific functional groups as tissues or organs and able to coordinate their activities as part of the adult organism.

The beautiful descriptions of embryology begun by the founders of the field in the 1800s serve as a lesson in the diverse routes that can be found to solve the problem of development. The spiral cleavage pattern of the snail *Ilyanassa*, the morphogenesis of the skeleton in the sea urchin pluteus larva, and the remarkable twists and turns taken by the mouse embryo during organogenesis are only a few examples of the complexity of development. This issue of *Science* provides Perspectives, Articles, and News reports to illustrate what is known and to speculate on what will be learned in the future of this fascinating field.

Wolpert suggests that the main principles of development have been elucidated, and discusses whether, therefore, it will be possible to predict the final product of development from the starting point. Patel examines the evolution of segmentation by comparing what is known about segmentation in the fruit fly, *Drosophila*, to segmentation in other insects. Nüsslein-Volhard discusses how insights from genetic approaches to the study of development in *Drosophila* are being applied to study development in a vertebrate, the zebrafish, *Danio rerio*.

Cooley and Theurkauf discuss how changes in the cytoskeleton during oogenesis in *Drosophila* function in the determination of the organization of the egg and in the establishment of the polarity of the egg and embryo. Kimble has found that the establishment of asymmetry during the development of the anterior-posterior body axis in the nematode requires translational repression, as it does in *Drosophila*. In contrast with *Drosophila*, anterior-posterior axis determination in *Caenorhabditis elegans* requires different types of molecules and occurs when the embryo is subdivided into cells.

Rubenstein, Martinez, Shimamura, and Puelles discuss the development of the vertebrate forebrain and propose that, even though the adult forebrain structures are morphologically complex, their development is best explained as beginning with a segmentally arranged tissue. In contrast, in the vertebrate limb, the typical pattern of bones arises from the seemingly undifferentiated mass of the limb bud, as discussed by Duboule. That developmental process may be explained by a close look at the evolutionary transition from ancestral fish fins to tetrapod limbs.

Plants face the same developmental challenge as animals, but with different constraints in the motion of cells. Goldberg, de Paiva, and Yadegari describe the early embryogenesis of the flowering plant *Arabidopsis*, and the insights gained from mutants defective in embryogenesis.

Kessler and Melton state that many advances have been made using the *Xenopus* system in the determination of the nature of the molecules required during cell-cell interactions for the induction of mesoderm and nervous tissue. Many of these molecules are members of families of secreted factors, such as the transforming growth factor superfamily.

In addition to these articles, the News section provides an account of what developmental scientists view as the most important unanswered questions in their fields and also of the areas where they think the most progress will come in the next 5 years. Other News articles take a closer look at some of these hot areas, including organ and tissue formation, axonal guidance, and cell signaling during development, as well as describing one way in which developmental research may contribute to new clinical applications.

The new studies confirm what had been previously believed—that the mechanisms of development and the molecules instrumental to that development have a general theme. Thus, each organism serves, in part, as a model for the others, making the differences as well as the similarities illuminating. The combination of the substantial progress already achieved and the large amount of unexplained phenomena makes the future of this field particularly bright.

Pamela J. Hines, Jean Marx, and Suki Parks