INTRODUCTION

Getting into Shape

AS DEVELOPMENT PROGRESSES FROM A SINGLE FERTILIZED EGG TO 2, 4, 6, 8, 16 cells, and so on, the early apparent homogeneity soon transitions to cells displaying varied sizes and shapes. Cell adhesion and cortical tension, with their associated forces, contribute to such changes. Crowded cells are pushed and pulled, but some make their own way via cell-autonomous migration or chemotaxis. These events proceed in an amazingly precise, choreographed manner, both temporally and spatially. Distinct germ layers and ultimately the stereotypic body form result, with amazing robustness. This special issue presents exciting advances in understanding morphogenesis, or the development of body shape.

Morphogenetic events are quickly coming into focus through new imaging techniques. Science’s online Review by Philipp Keller (p. 1184) looks at recent advances, with numerous figures and movies exemplifying the exciting possibilities to detail the dynamics of development as seen by light microscopy of live organisms. Morphogenesis can be viewed at short or long temporal scales to fit with fast subcellular rearrangements or slow organismal events, respectively, and at ever-expanding tissue depth. By combining imaging techniques with computational approaches and mathematical models, new facets of developmental discovery are made possible.

Epithelia are characterized by layers of densely packed cells that are joined by strong adhesive contacts. These tissues provide structural integrity to developing embryos and adult organs and serve as barriers to pathogens and protection from dehydration. Despite what appears to be a set structural form, epithelial cells display active dynamics with fluid behavior. Guillot and Lecuit (p. 1185) review mechanical aspects of epithelial cell junctions in cell division, cell extrusion, and cell intercalation, in which cells change shape and location to drive local tissue deformation.

Stem cells are uniquely able to self-renew and differentiate. Recent work shows that when certain stem cells are placed in the right environment, they can self-organize to form organlike structures. Sato and Clevers (p. 1190) review research in which single Lgr5 stem cells develop into epithelial organoids that resemble in vivo intestinal epithelium. This in vitro morphogenesis provides complex structures that can be used for stem cell and organ research as well as disease modeling and regenerative medicine.

A collection of News articles on Mysteries of Development (p. 1156) explores what we don’t yet understand about how growing organisms control size, how symbionts help drive development, why brains lose so many cells as they mature, and how the fetal environment shapes later health. By continuing to probe the components, movements, and mechanics involved in development, a deeper understanding of the makings of organismal life is gained, with expanded opportunities to address events when things go awry.

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