Cells: shaping tissues and organs

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Apical constriction

During several morphogenetic developmental processes, epithelial sheets contract some of their cells to cause invaginations or bending. To do this, epithelial cells constrict apically located actin and myosin while lengthening the basolateral axis in a process called *apical constriction*. **Frank Mason** (Martin Laboratory, Massachusetts Institute of Technology) showed that RhoA signaling is polarized to the center of the apical surface and that this stabilizes actomyosin structures spanning the apex. **Bing He** (Wieschaus Laboratory, Princeton University) found that these contractile forces also cause the cell to lengthen by an unexpected force—viscous flow. Apical constriction drives the viscous cytoplasm, as visualized by injected beads, to stream along the surface of the embryo and converge toward the ventral midline, where it forms an inward flow perpendicular to the surface that leads to cell lengthening. In this process, cell membranes were found to passively move with the ambient cytoplasm without offering appreciable driving force or resistance.

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Matrix shaping of cells, nuclei, and tissue

Two talks investigated how the matrix can impact cell behavior. **Zev Gartner** (University of California, San Francisco) discussed how epithelia with heterogeneous cell–cell interactions could self-organize into a bilayer depending on cell identity only if embedded within a matrix that programs this layering. If these same cells are embedded in inert agarose gels, they cannot segregate properly into two layers. This is because the matrix only binds the outer myoepithelial cells, which in turn bind the nonadhesive inner luminal epithelial cells, thereby layering tissues from the outside-in. Alternatively, density of the matrix can affect the shape of the cell nucleus by altering its lamin A content. **Joe Swift** (Discher Laboratory, University of Pennsylvania) showed that when cells are plated on a stiffer matrix, lamin A, but not lamin B, increases and polymerizes at the nuclear envelope. Increased lamin A at the nuclear envelope could act as a shock absorber for nuclei as cells become compressed in stiff tissue. Diseases such as muscular dystrophy have point mutations in the stress-sensitive regions of lamin A that could affect cell function in stiff tissue. Moreover, low or high levels of lamin A increase differentiation of stem cells into fat or bone, respectively, suggesting lamin A's importance in regulating nuclear structure and function.

Misregulating cell division and death in development and tumorigenesis

How do complex stratified epithelial structures evolve from a simple polarized layer? **Robert Huebne**r (Ewald Laboratory, Johns Hopkins School of Medicine) showed that during mammary gland development, luminal (top) cells of an epithelial bilayer frequently divide perpendicularly, resulting in stratification of the layer. The apical-most daughter cell remains polarized, whereas the basally positioned one loses polarity. Tumorigenesis may recapitulate developmental stratification, as ErbB2 expression similarly drives increased vertical divisions and stratification. **Gloria Slattum** (Rosenblatt Laboratory, University of Utah) demonstrated that a process that promotes epithelial cell death could be subverted to instead promote invasion by transformed cells. During homeostasis, epithelial cells turn over by extruding cells that later die. Oncogenic K-Ras cells, which are highly autophagic, degrade the signal required to extrude cells apically. Instead of preventing extrusion altogether, these cells extrude basally into the matrix and underlying tissue, allowing them to live and potentially invade the rest of the body.