Cellular Mechanisms seminar notes continued...

Seminar 5

Today, we moved on from patterning and differentiation to begin to address morphogenesis, the creation of anatomy.

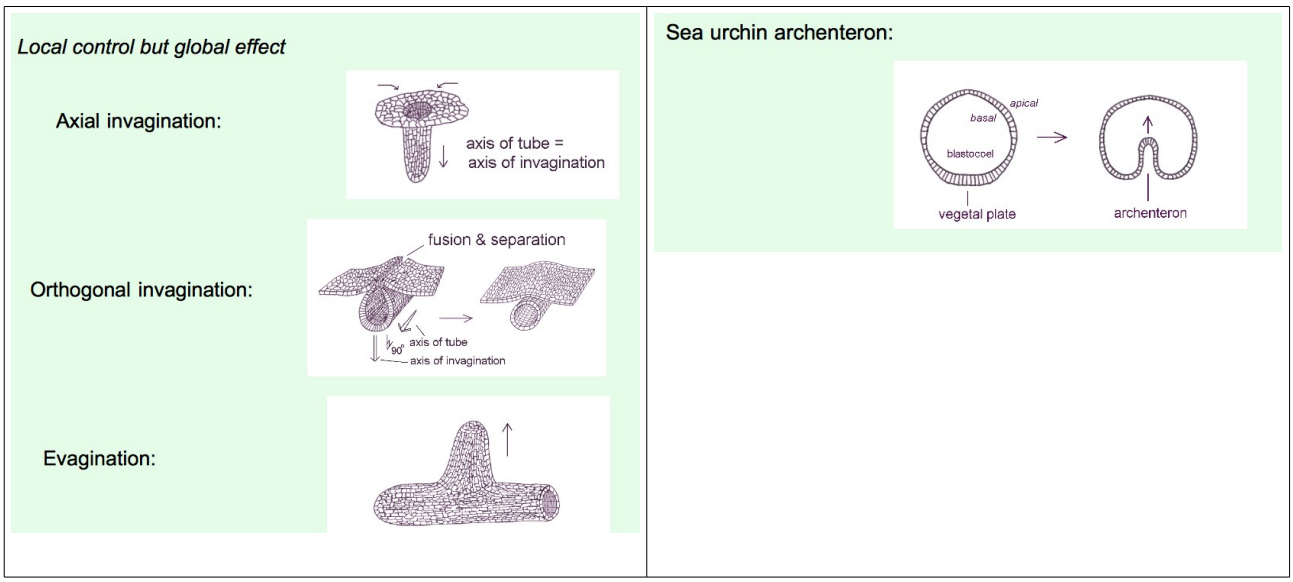
Given that animal development is complicated, understanding morphogenesis may seem to be very daunting. We therefore set out with an aim to discover whether we could simplify matters. We began by telling developmental stories*, and expressing them as sequences of morphogenetic events. Doing this for several different stories (see photos below) highlighted that the same morphogenetic events come up again and again:

- Proliferation
- Elective cell death
- Cell migration
- Mesenchymal condensation
- Mesenchyme-to-epithelial (/endothelial) transition and vice-versa
- Tubulogenesis
- Bending of sheets and tubes
- Branching of sheets and tubes
- Invagination/ evagination
- Fusion of sheets/tubes

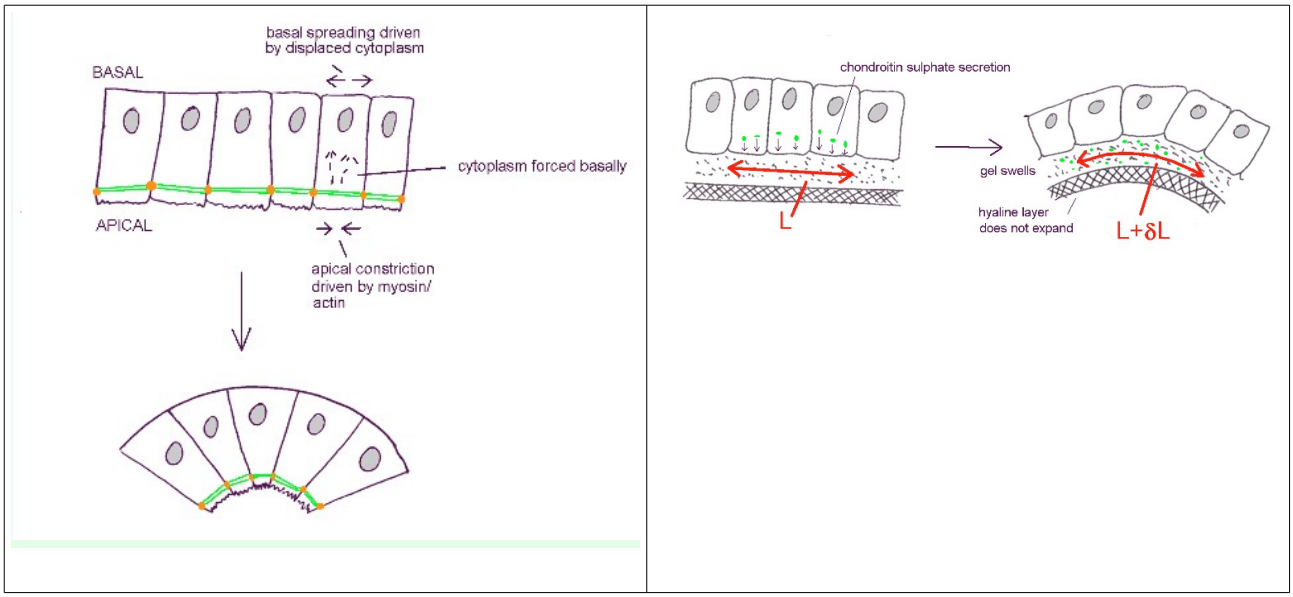
*** Important learning/ revision advice**: The main aim of this course is to encourage you to think about the 'big questions' of developmental biology, and to get a clear overview of what is going on. This is in contrast to courses that concentrate on analysis of very precise details of specific developmental events. The exam questions also tend to be big and broad (like the noise one you tried as homework last week). To score well in answering such questions, you need to draw on examples from real developing systems. Which systems you know about is really your choice (you could use Drosophila early development, or kidney development, or heart development or whatever to illustrate most of these questions), *but you do need to know some sequences of developmental events.* For the medically-inclined, Langman's Medical Embryology is a good source. Gilbert etc are also useful, but can be more 'bitty'. My own *Life Unfolding* may also help. If the analogy helps, imagine you are doing your Honours year in English literature: a lecturer may be helping you explore the various structures of poetry and the rhetorical structures used, but she would take for granted that have a few poems in your head to which to apply your learning. It's the same thing here.

I raised this because, as a group, you were all surprisingly vague about bits of development you have, in theory, learned, and you collectively left and impression that, if someone had come in to find out what Honours developmental biology students know, and asked you to tell them a developmental story, I could not be sure that everyone in the room could have given an answer. What would *you* expect a Dev Biol graduate of a world-class university to know? Are you on course to meet your own expectations?

After coffee, we considered epithelial morphogenesis. First, invagination, a very common way to make tubes from sheets.

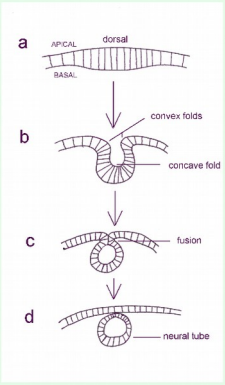


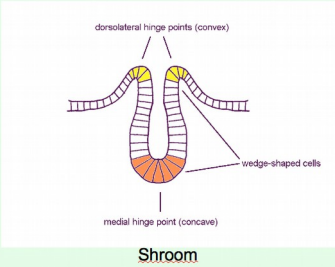
The general model for deformation is that of shroom-mediated (PubMed PMID: 25171888) apical acto-myosin constriction, but in the case of the eas urchin archenteron a quite different mechanism seems to dominate (below right):



The neural tube involves orthogonal invagination and neighbour exchange (mediated by the E-cadherin expressoin in ectoderm giving way to N-cadherin in the neural plate/tube). This brings us on to the more general topic of epithelial fusions, which also generally involve neighour exchange although the mechanisms are not always as clear-cut.

Neural tube:

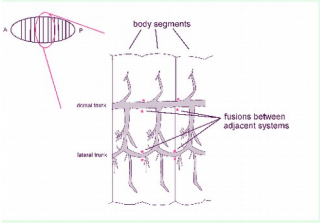


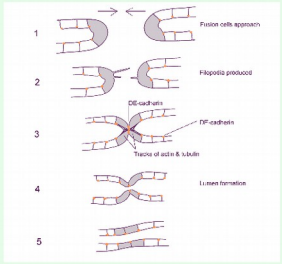


Shroom

Block Shroom (antisense): block folding

Drosophila trachea

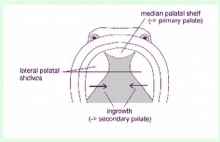


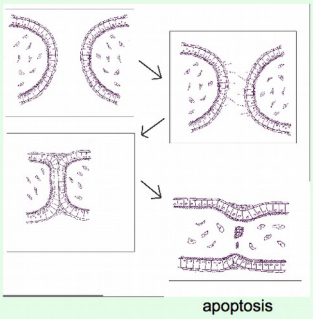


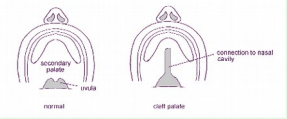
(another example of fusion)

Other examples (think about the polarity differences) include the palate and urethral plate.

Secondary palate

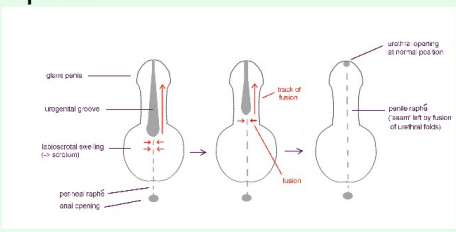


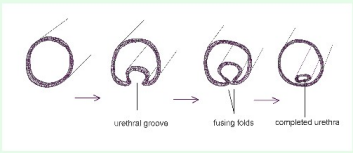




apoptosis

Urethral plate:





(we did not cover this, but it is relevant for fusion, like an upside-down neural tube)

Essay:

A paper published about 7 years ago in J. Anatomy suggested that most morphogenesis takes place by ten basic morphogenetic modules, performed in different orders and to different extents in different developing organs and tissues. The modules were proliferation, apoptosis, cell fusion, haptotaxis, chemotaxis, condensation, sorting, epithelial-mesenchymal transition, mesenchymal-epithelial transition and folding. Is this a reasonable view, or wishful thinking by someone trying to force life's complexity into pigeon holes?

(Please do this as before – e-mail essays with no name).

Remember there is no class on the 6th, as you have an exam that day.