

MCDB 4650-Developmental Biology: Course Learning Goals

Topics we expect you to be familiar with when you begin (at the level covered in Alberts et al., *Molecular Biology of the Cell* or equivalent):

- molecular biology of eukaryotic gene expression; classes of transcription factors.
- Eukaryotic protein synthesis and secretion.
- Transmembrane signaling; classification of signaling pathways.
- structure and function of: cellular components, extracellular matrix, epithelial and mesenchymal cells.
- The roles of cytoskeletal components in cell motility.
- Mendelian genetics.
- DNA markers.
- mitosis and meiosis.
- chromosome structure.
- standard techniques of modern molecular biology [restriction digests, gel electrophoresis, Southern, "Northern" and "Western" blots, hybridization with nucleic acid probes, autoradiography, footprinting analysis, gel shift (EMSA) analysis, co-immunoprecipitation, making genomic and cDNA libraries, DNA sequencing, polymerase chain reaction (PCR), RNA interference].

What we expect you to be able to do when you finish:

- Compare combinatorial control of transcription during development to combinatorial control of cell signaling during development.
- Predict different mechanisms that could be responsible for control of gene expression in development.
- Design experiments that would demonstrate the principles of cell fate, cell commitment (determination), and differentiation.
- Compare the roles of different transmembrane signaling pathways in development
- Discuss eukaryotic genome organization and information content.
- Justify the importance of “model organisms” in the study of development, and the advantageous biological features of *C. elegans*, *Drosophila*, *Xenopus*, chick, and mouse.
- Compare the uses of forward and reverse genetics.
- Explain fertilization and cleavage, and justify why cleavage is an important step in development.
- Design experiments that would demonstrate the cell movements of gastrulation .
- Evaluate experiments that demonstrate the establishment and patterning of axes in embryos.
- Explain how the neural tube and the nervous system form and are patterned.
- Interpret the effects of lateral inhibition in establishing neural fates.
- Compare how vertebrates and invertebrates become segmented or divided into repeating units.

- Explain how Hox genes control patterning along the anterior-posterior axis and in many developing organs.
- Compare how different organ systems are established and patterned.
- Explain the mechanisms of 1° and 2° sex determination, dosage compensation, and imprinting in vertebrates, and compare these processes to those in invertebrates.
- Describe how transgenics, genomics, proteomics, and cultured stem cells can be used to study development, and be able to design experiments using these techniques.
- Describe some of some major still unanswered questions in development.

Throughout the course we stress experimental approaches. *We expect you to understand the evidence for what is known and the available methods for approaching what is unknown in modern developmental biology.* We also expect you to be able to read developmental biology papers in current journals and understand the methods and the evidence presented well enough to judge the validity of the conclusions.

We hope you will achieve these non-content goals by the end of the course. Be able to:

1. Explain where the information in the textbooks comes from and judge how reliable it is.
2. Describe how research is supported, done, communicated, evaluated, and validated or invalidated.
3. Look at other sources beyond the textbook for additional information.
4. Read a research paper in the current developmental biology literature.
5. Gauge how much new understanding you have gained through this course.
6. Verbalize how you learn best.