

## LECTURE 27

### From CHAPTER 21: DEVELOPMENT OF MULTICELLULAR ORGANISMS

#### INTRO: Universal mechanisms of animal development

Figures covered: Fig. 21-1 through 21-8

#### Review concept of "cell memory" (Chapt. 7)

- Cells in the embryo inherit a spatiotemporally unique "history" or "memory" (epigenetic inheritance) in form of specific regulatory proteins and chromatin states passed on to them from their progenitor cells; these factors determine gene expression potential, responses to signals from neighboring cells.

#### Evolutionary conservation of genes in animal species

- Comparison of genome sequences of *C. elegans* (19,000 genes), *Drosophila* (14,000 genes) and humans (30,000 genes) indicates 50% of the genes in each of these species have clear homologs in one or both of the other two species
- Homologous proteins from distant animal species can be functionally interchangeable in development (example: transgene expressing *Drosophila* Engrailed protein rescues brain defects in mice with mutations in their engrailed-1 genes)
- Pax-6 proteins of mouse and squid are functionally equivalent to homologous *Drosophila* Eyeless protein in ability to induce ectopic eye-tissue when ectopically expressed in developing fly legs

#### Genes enriched in multicellular organisms compared to yeast (unicellular eukaryote) encode :

- Transmembrane proteins for cell adhesion and cell signaling
- Gene regulatory proteins (DNA binding transcription factors (TFs)) (yeast has 7 bHLH family TFs, *C. elegans* has 41, *Drosophila* 84 and humans 131)

#### How does morphological diversity arise? Regulatory DNA defines developmental program of each gene and ultimately of the organism

- Fig. 21-4: tool kit of proteins is well-conserved betw/ diverse animal species; so apparently diversific'n of species is mainly dependent on:
  - changes in regulatory regions of genes (altering timing, intensity and persistence of gene expression to alter morphological features, physiology, etc)
  - expansion of gene families (via gene duplication events, and subsequent regulatory region divergence, as noted above)

#### Animal embryos share basic anatomical features

- Fig. 21-3: from blastula to gastrula, generation of 3 primary cell layers:
  1. ENDODERM (inner) will form inner lining of the gut & its derivatives (lungs, liver, pancreas, etc)
  2. ECTODERM (outer): will form epidermis and nervous system
  3. MESODERM (middle): will form muscles, connective tissues, vascular system, urogenital organs.
- Cell lineage tracing is a means of tracking descendants of individual cells to create cell fate maps (Fig. 21-5)

Terms to know:

homologous gene  
homologous protein  
genetic rescue  
transgenic fly  
drosophila eyeless  
pax-6  
cleavage  
ectoderm, endoderm, mesoderm  
blastula, gastrula  
enhancer  
cell lineage tracing  
developmental genetics, descriptive embryology, experimental embryology  
genetic screen