Animal Development

[Note: This is the text version of this lecture file. To make the lecture notes downloadable over a slow connection (e.g. modem) the figures have been replaced with figure numbers as found in the textbook. See the full version with complete graphics if you have a faster connection.]

Fertilization in mammals: 1) swim past follicle cells, 2) <u>acrosome reaction</u> (enzymes), 3) bind to receptors $\Rightarrow$ <u>cortical reaction</u> with depolarization and release of cortical granules = fast and slow block of <u>polyspermy</u>, 4) fuse and enter (both head and tail)

[See Fig. 47.5]

Establishment of Body Axis

- **In amphibians and most other animals, the point of sperm entry determines the ventral axis, whereas the poles of the egg (animal and vegetal poles) determine anterior and posterior axes.**

[See Fig. 47.7]

Uneven division of cytoplasmic components starts the process of <u>determination</u>

[See Fig. 21.9]

- **In mammals, cleavage and other divisions are more even in size**
- **Morphogenesis = change in cell shape, adhesion to other cells, and movement to other locations in embryo and organ**

[See Fig. 21.2a]

Three stages of development

1) Cleavage: no enlargement of zygote
- **first divisions create a solid ball of cells = morula**
- **later divisions create a hollow ball called a blastula (center is blastocoel)**

2) Gastrulation: involution of cells in ball create gastrula, ectoderm, mesoderm, and endoderm are created

3) Organogenesis: formation of organs from ectoderm, mesoderm, and endoderm

Detail of gastrulation

[See Fig. 47.10]

Organogenesis

- **Ectoderm becomes the nervous system and outer epithelium**
- **Mesoderm becomes internal organs (skeletal system, muscles, circulatory system, reproductive system, excretory system, and dermis)**
- **Endoderm becomes internal epithelia (lungs and digestive system), liver, pancreas, and thyroid glands.**

[See Fig. 47.11]

Focus on development of human embryo

[See Fig. 47.15]

Extraembryonic membranes

- **chorion surounds everything**
- **amnion grows to surround embryo = amniotic sac**
- **yolk sac doesn't contain yolk, is site of fetal blood production**
- **allantois becomes part of the umbilical cord**

• Mammalian cells after the first cleavages are totipotent (can become anything if separated)

e.g. identical twins

• Later (sometimes as late as the blastocyst stage) developmental potential becomes restricted to certain tissues and organs

[See Fig. 47.21]

- **The placement of cells in the blastula determines which tissues and organs they will become = <u>cell fate</u>**

[See Fig. 47.20]

Map of cell fate in the nematode *Caenorhabditis elegans*

[See Fig. 21.4]

Inductive signals

- **contact with neighboring cells can regulate development**

- **cells in different regions secrete different growth factors (e.g. NGF for nerves, FGF for fibroblasts, IGF for skeletal system)**

- **receptors for growth factors are present or active on some cells and not on others.**

e.g. Speeman & Mangold's organizer

[See Fig. 47.22]

Inductive signals

- **gradients of growth factors trigger expression of genes that regulate differentiation of organs in different body segments**

- **Hox genes (homeobox containing genes) are generally conserved genes that regulate expression of other proteins (like transcription factors)**

a genetic cascade

[See Fig. 21.14]

The *myoD* gene is an example of a gene in the cascade that turns undifferentiated cells into muscle cells

[See Fig. 21.8]

If cell fate is determined early in development, how can an adult animal be cloned?

- **the nucleus of an adult animal cell can be inserted into a *denucleated* donor egg and stimulated to divide**

- **surrogate mother carries the egg**

- **“clone” is genetically identical to original but has different cytoplasmic factors (primarily mitochondria)**

[See Fig. 21.7]