Early Embryonic Development

Diagram: (a) 

- Pluriblast
- Zona
- Trophoblast

Blastocoelic cavity
Zygote - Embryo

- two gametes fuse to produce zygote
- with first division embryo is produced
Cleavage

A series of mitotic divisions whereby a multicellular organism is formed

- Cells produced are called blastomeres
- Controlled by maternal mRNA and protein in most species
- Most species = no net gain in volume
  - allows rapid division
  - is accomplished by skipping the G1 and G2 growth period between mitotic divisions
Mitosis Promoting Factor

- Regulates biphasic cycle of early blastomeres
- Made up of two subunits
  - Cyclin B: accumulates during S phase and degrades following M phase
  - Cyclin-dependent kinase (cdc2): phosphorylates key proteins involved w/ mitosis
Cleavage

- Rapid exponential increase in cell #
  - Frog egg divides into 37,000 cells in 43 hrs
    - 1 cleavage/hr
  - Drosophila-50,000 cells in 12 hrs
    - 1 division every 10 mins for 2 hrs
- Initially synchronous until mid-blastula transition
  - Growth phases added
  - Synchronicity lost
  - New mRNA transcribed
Rate of formation of new cells in the frog *Rana pipiens*
Mechanism of Mitosis

• Result of two coordinated processes
  - Karyokinesis
    • Mitotic spindle of tubulin microtubules
    • Draws chromosomes to centrioles
  - Cytokinesis
    • Contractile ring of actin microfilaments
    • Creates cleavage furrow
Cleavage Furrow

- Microfilaments
- Centriole
- Chromosome
- Microtubules
Amount of Yolk in Oocyte

- **POLYLECITHAL or MEGALETHICAL** - large amount of yolk
  - found in elasmobranchs, teleost fishes, reptiles, birds
- **MESOLECITHAL** - moderate yolk
  - found in frogs and salamanders
- **OLIGOOLECITHAL OR MICROLECITHAL** - little or no yolk
  - echinoderms, cephalochordates (*Amphioxus*), urochordates (tunicates), prototherian mammals
Location/Distribution of yolk

- **a. CENTROLECITHAL** - centrally located
  - found in arthropods, many insects
- **b. TELOLECITHAL** - at a vegetal pole
  - these eggs have animal pole with "active" cytoplasm thickened below which lies the maternal pronucleus
  - thickened regions called **BLASTODISC**
  - common in mega- and mesolecithal eggs
- **c. ISOLECITHAL OR HOMOLECITHAL** - yolk evenly distributed
  - common in oligolecithal eggs
  - marsupial mammals
General Patterns of Cleavage

• **HOLOBLASTIC CLEAVAGE**
  - complete, equal daughter cells
  - common in micro- and mesolecithal eggs

• **MEROBLASTIC OR DISCOIDAL CLEAVAGE**
  - only blastodisc divides
  - megalecithal eggs
For Example

**Mammals**
- Oligolecithal
- Isolecithal
- Holoblastic
- Rotational

**Birds**
- Megalecithal
- Telolecithal
- Meroblastic
- Discoidal
Patterns of Cleavage

I. HOLOBLASTIC
A. Isolecithal
  1. Radial
     Echinoderms, amphioxus

4. Rotational
   Mammals, nematodes

B. Mesolecithal
   Radial
   Amphibians

II. MEROBLASTIC
A. Telolecithal
  1. Bilateral
     Cephalopod molluscs

2. Discoidal
   Fish, reptiles, birds
Cleavage-The Big Picture

• Series of cytoplasmic divisions w/out growth
• Initially forms a solid mass of cells known as the **morula**
• A fluid-filled cavity forms w/in the morula called the **blastocoel**
• The hollow ball of cells is now known as the **blastula**
Mero blastic radial cleavage in frogs w/ mesolecithal yolk
Meroblastic bilateral cleavage in birds w/ telolecithal yolk
The images depict the stages of fertilization and early development of an egg cell:

**B**
- **X Pronucleus**
- **Second polar body**
- **Degenerating tail of sperm**

**C**
- **Ξ Pronucleus**
- **First and second polar bodies**
- **Cleavage spindle**

**D**
- **Chromosomes**
- **Breakdown of pronuclear membranes**

**E**
- **Zygote**

2-cell stage

4-cell stage

Polar body
Zona pellucida
Blastomere

8-cell stage

Zona pellucida

Morula

Inner cell mass
Degenerating zona pellucida
Blastocyst cavity
Trophoblast

Early blastocyst

Later blastocyst
Mammals - Humans

• Blastula also forms
  - Inner cell mass = embryo
  - Trophoblast - placenta
Corona radiata (composed of follicular cells)

Polar body (nonfunctional cell)

Degenerating sperm

Blastomere

Zona pellucida
Polar body
Inner cell mass
Blastocyst cavity
Trophoblast
Remnant of zona pellucida