

# Early Embryonic Development

# Zygote - Embryo

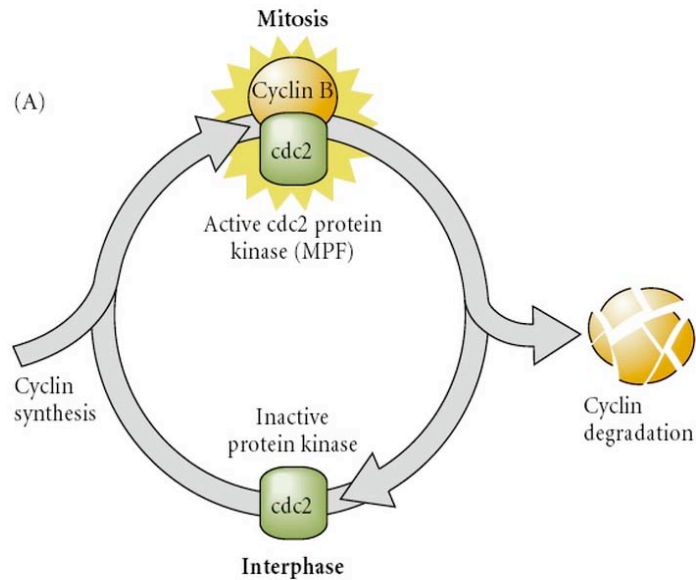
- two gametes fuse to produce **zygote**
- with first division **embryo** is produced

# Cleavage

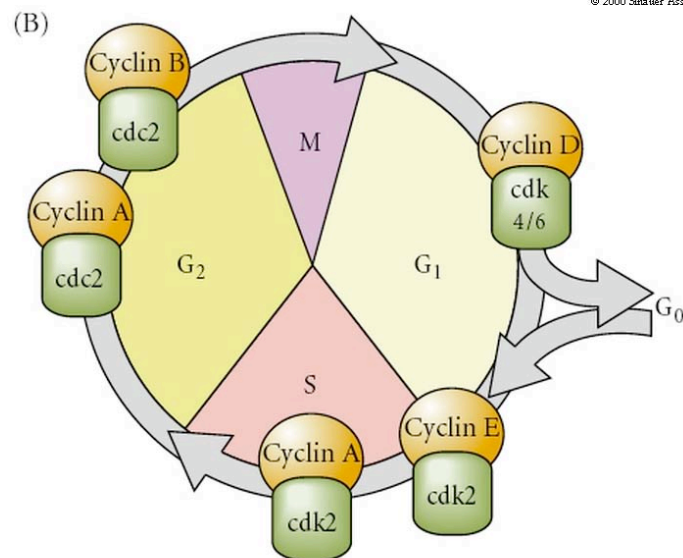
**A series of mitotic divisions whereby a multicellular organism is formed**

- 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

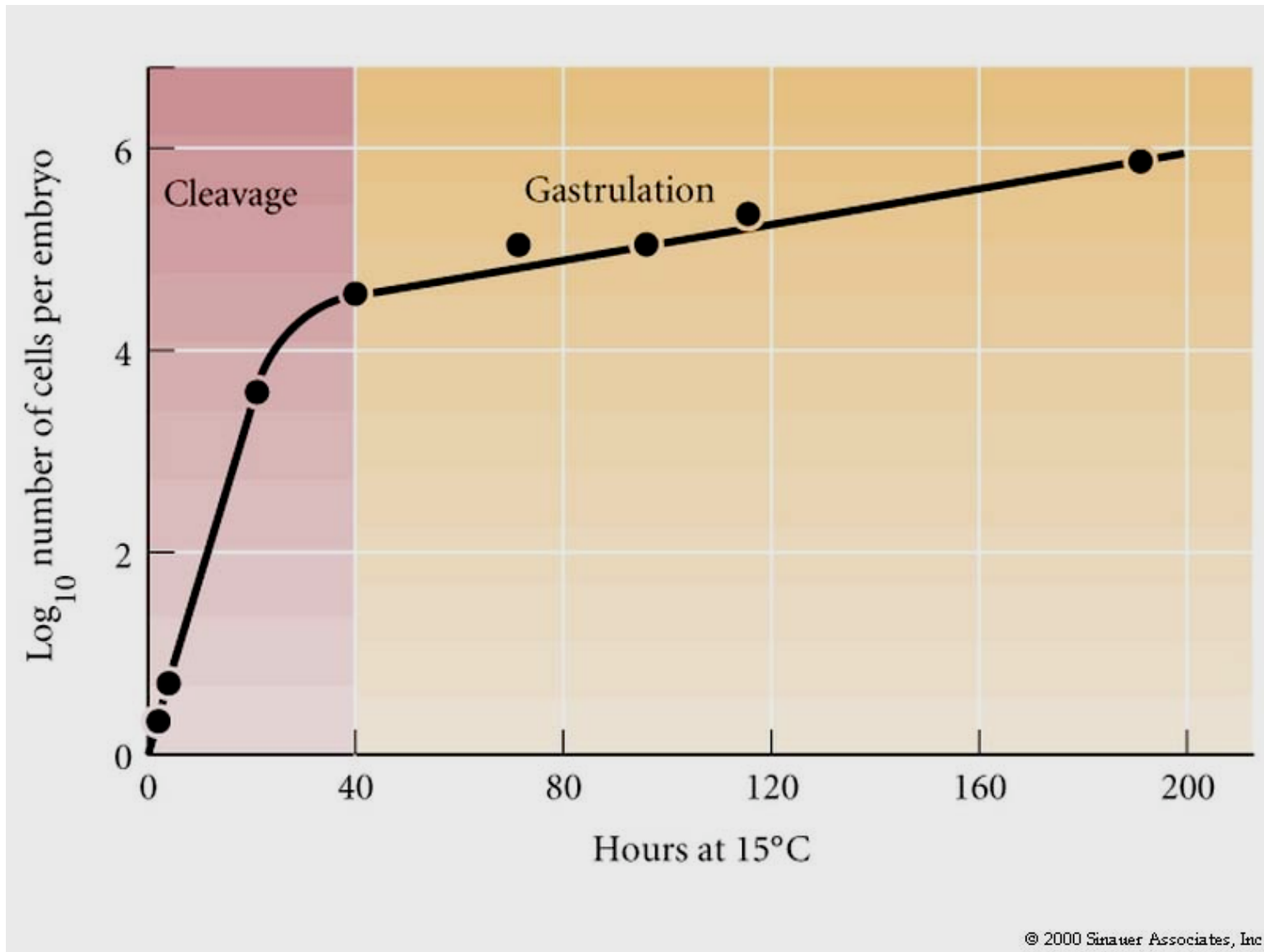


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# Cleavage

- 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

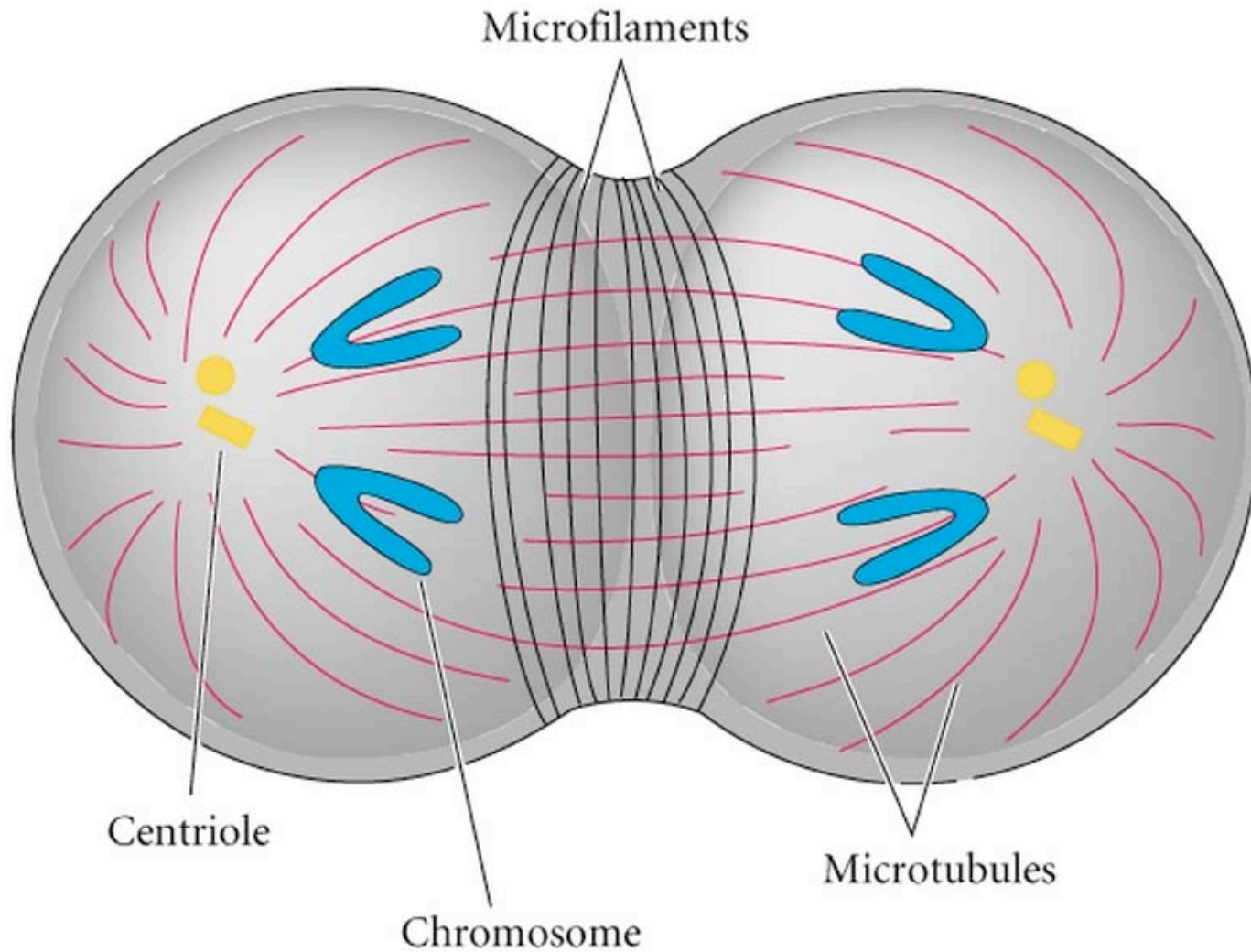


Rate of formation of new cells in the frog  
*Rana pipiens*

# 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





# 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
- **OLIGOLECITHAL 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

-Amount-

-Distribution-

-Pattern-

-Symmetry-

## Birds

- Megalecithal
- Telolecithal
- Meroblastic
- Discoidal

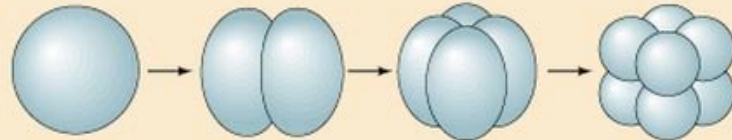
# Patterns of Cleavage

## I. HOLOBLASTIC

### A. Isolecithal

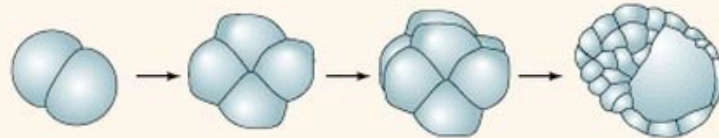
#### 1. Radial

Echinoderms, amphioxus



#### 4. Rotational

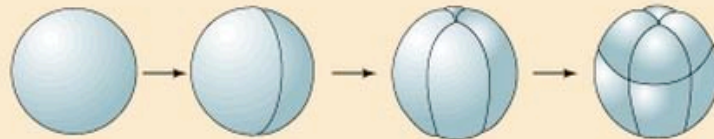
Mammals, nematodes



### B. Mesolecithal

#### Radial

Amphibians

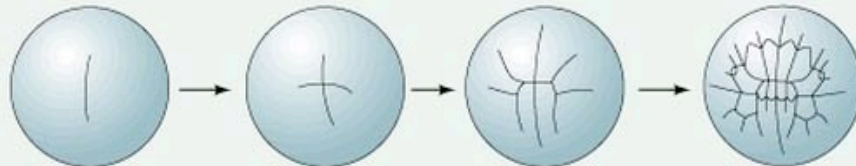


## II. MEROBLASTIC

### A. Telolecithal

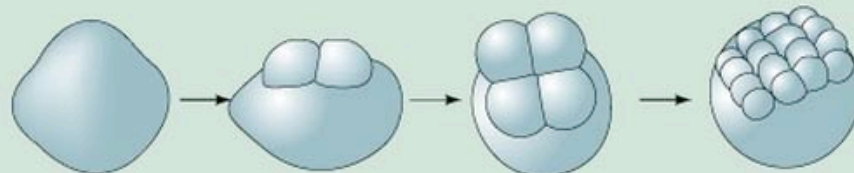
#### 1. Bilateral

Cephalopod molluscs



#### 2. Discoidal

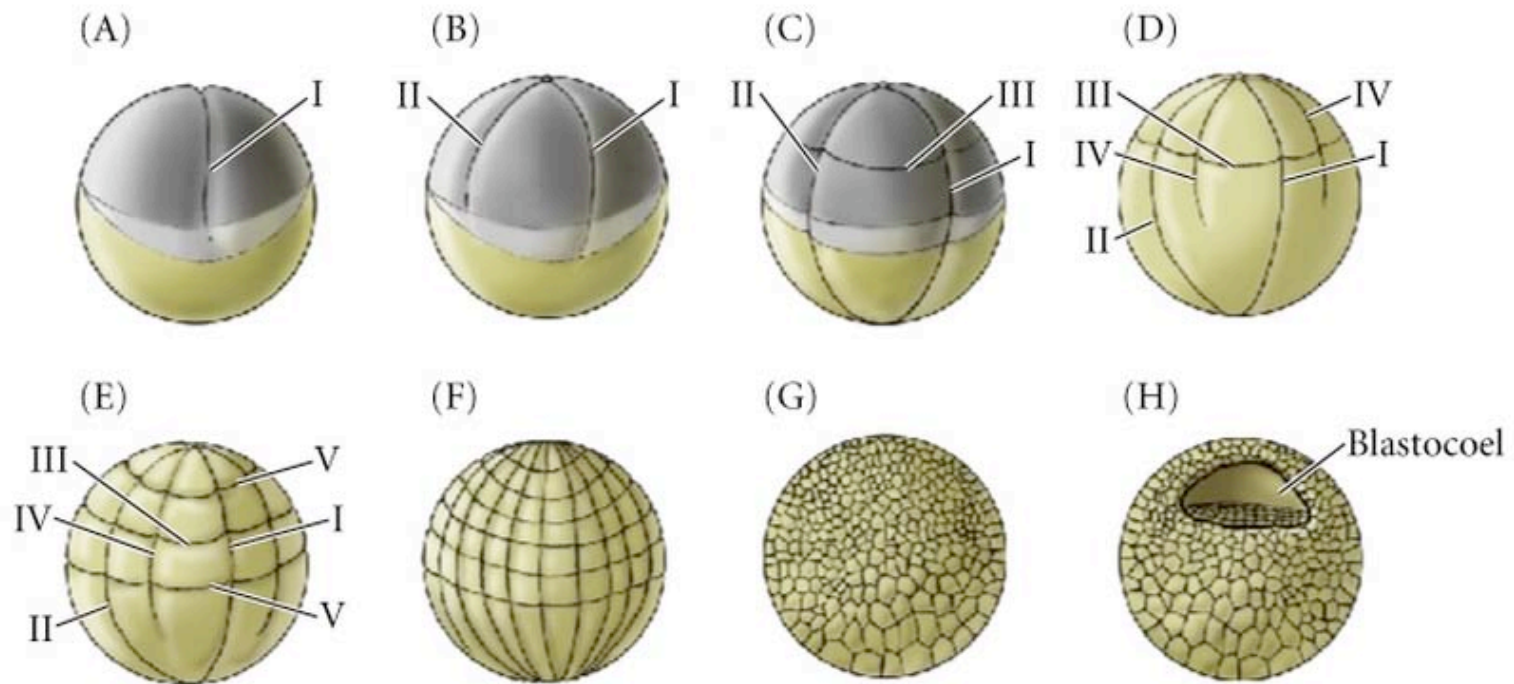
Fish, reptiles, birds



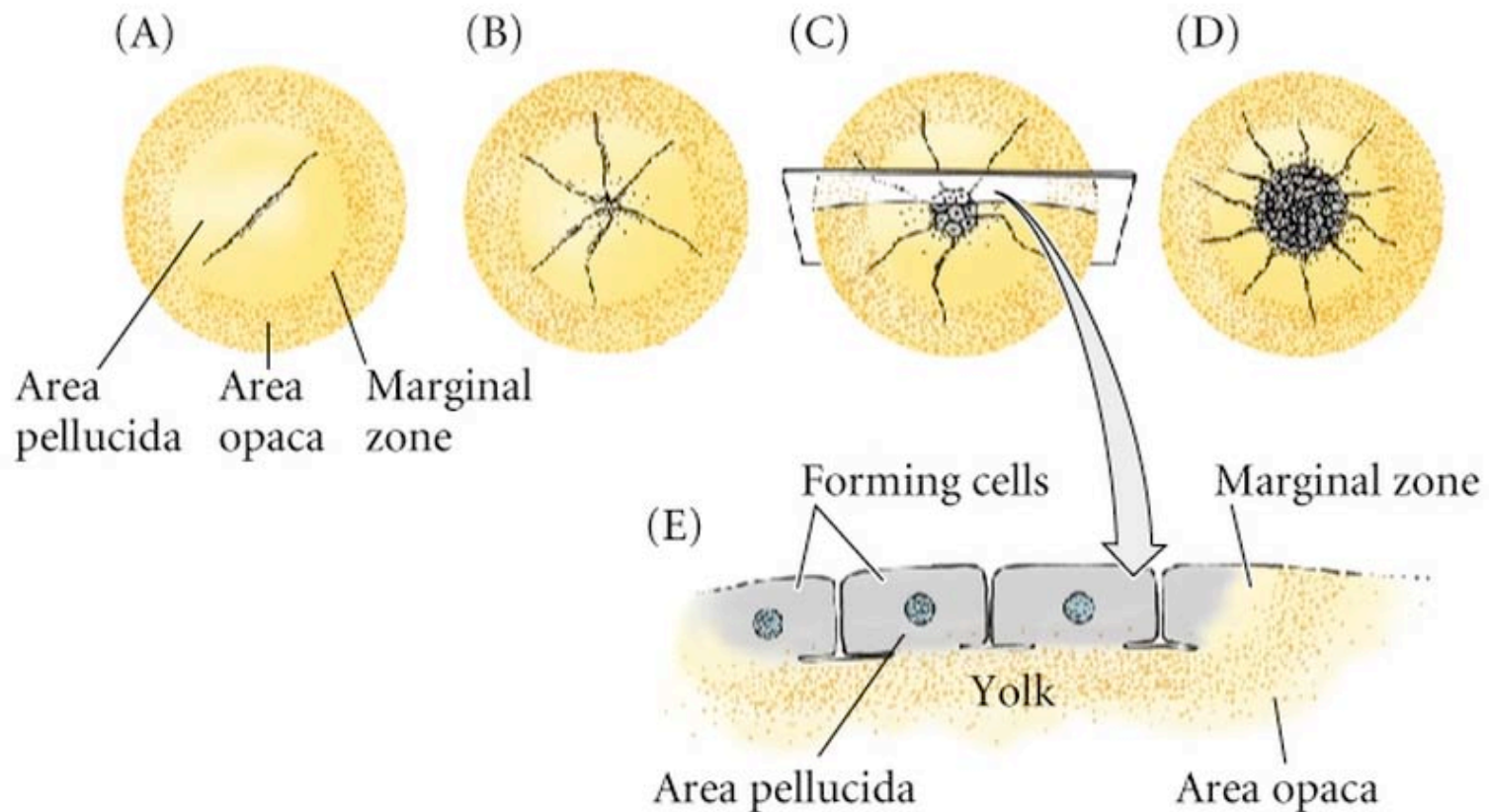
# Cleavage-The Big Picture

- 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**

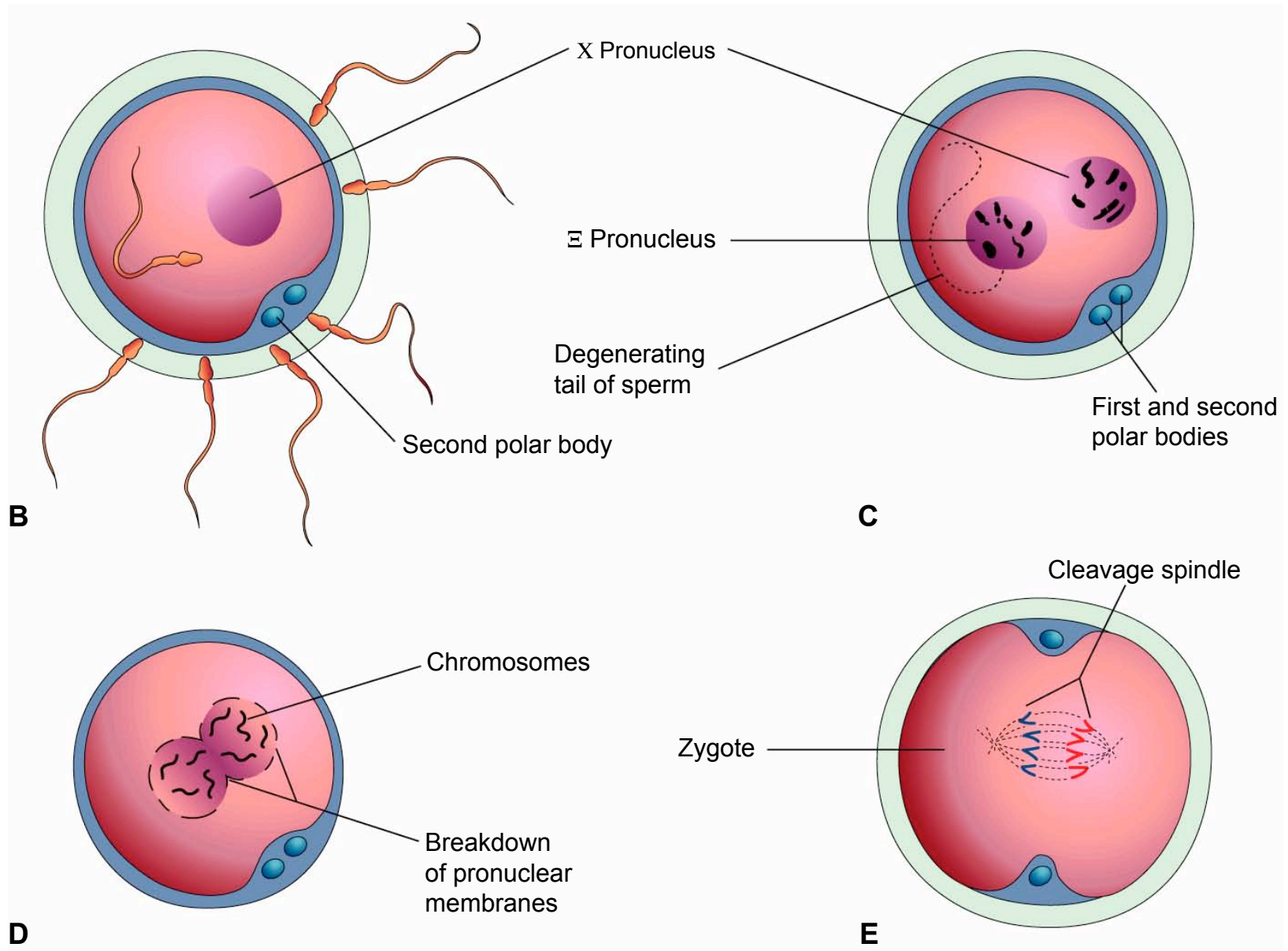
# Meroblastic radial cleavage in frogs w/ mesolecithal yolk

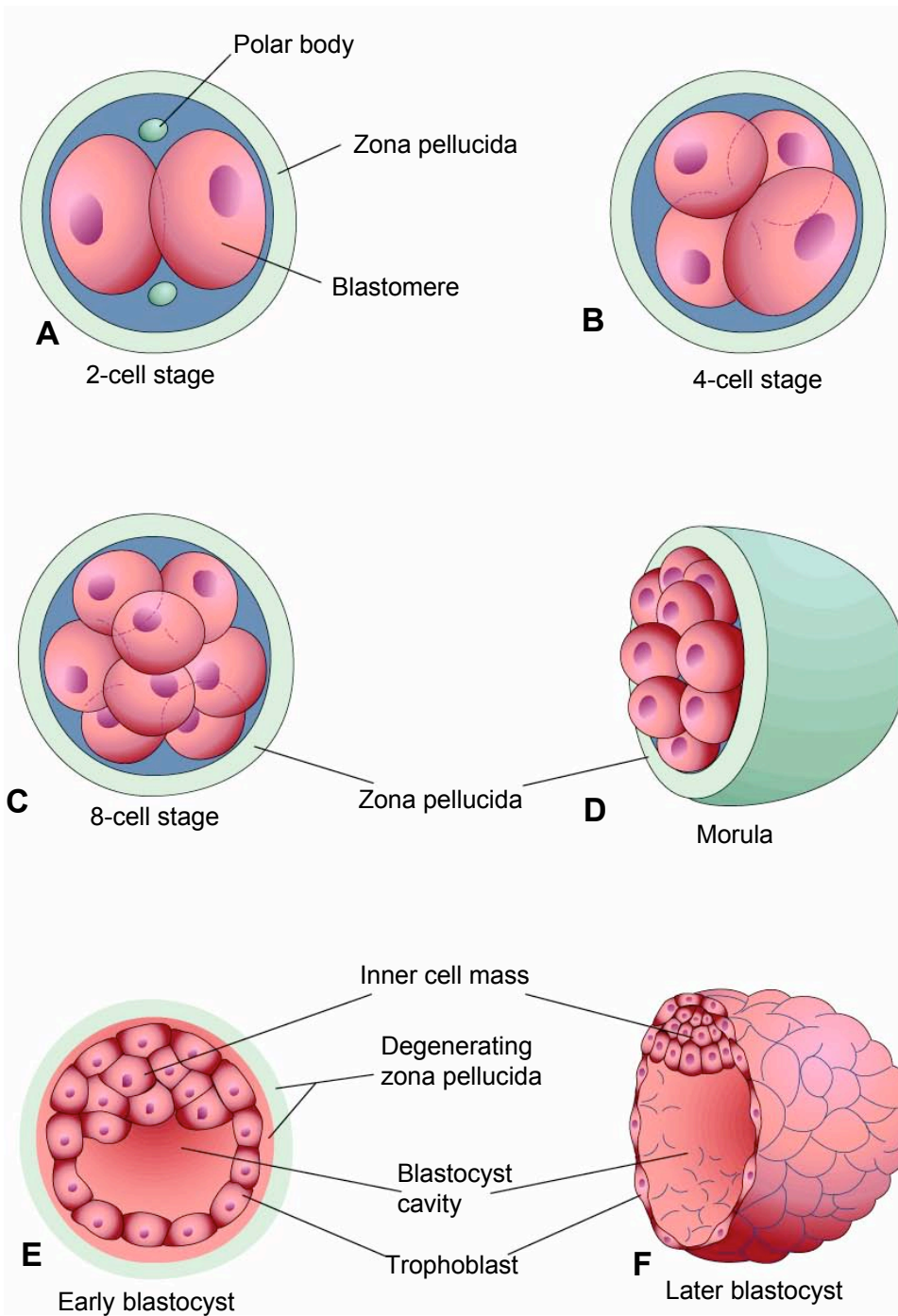


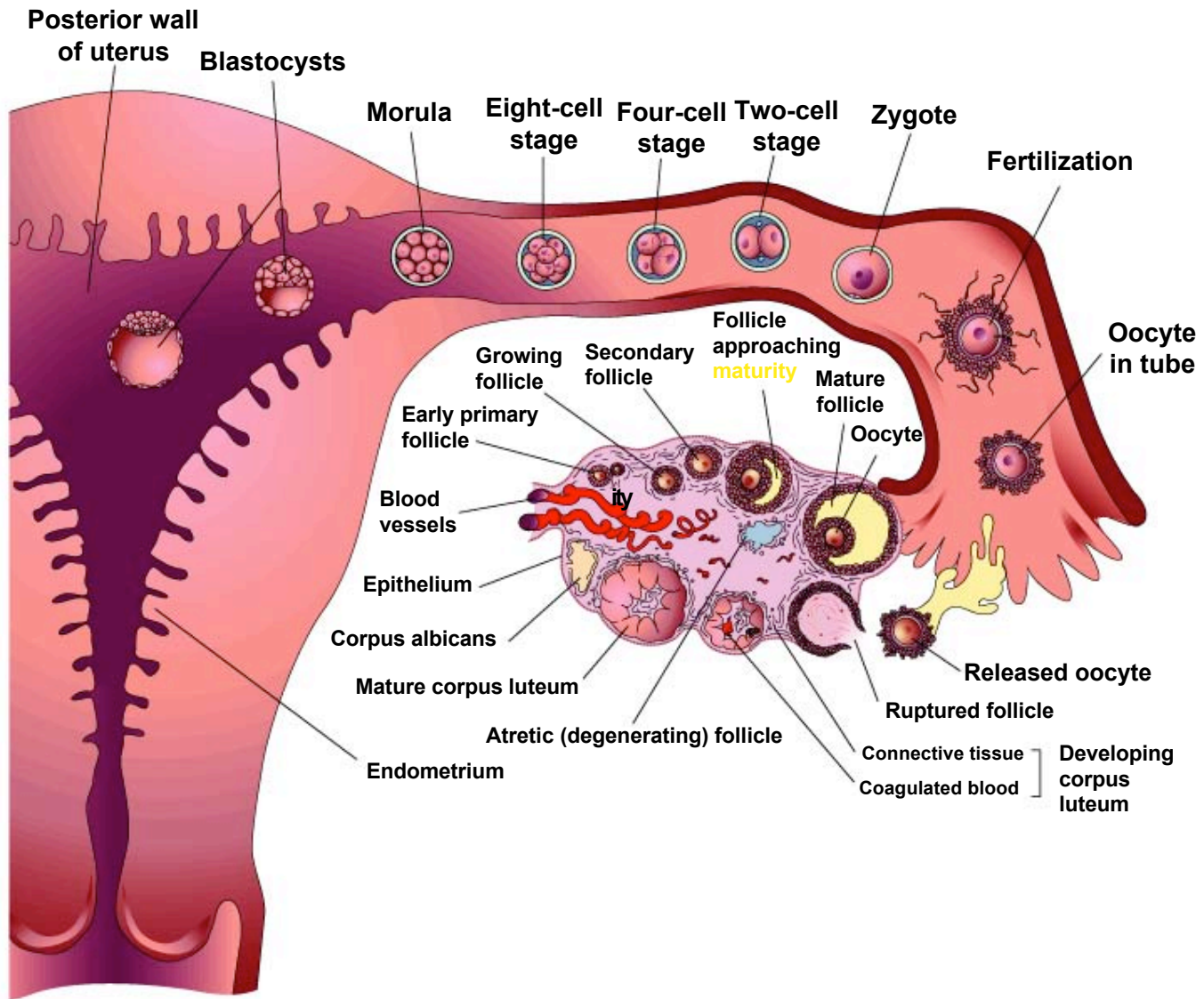
# Meroblastic bilateral cleavage in birds w/ telolecithal yolk





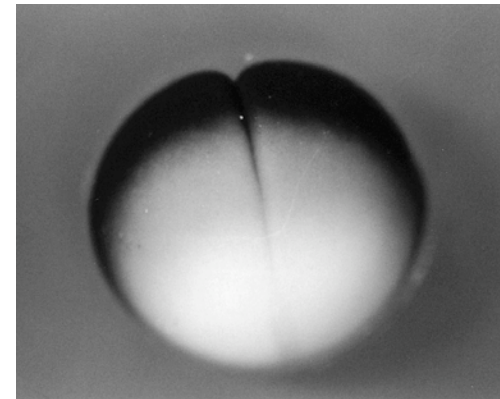






# Mammals - Humans

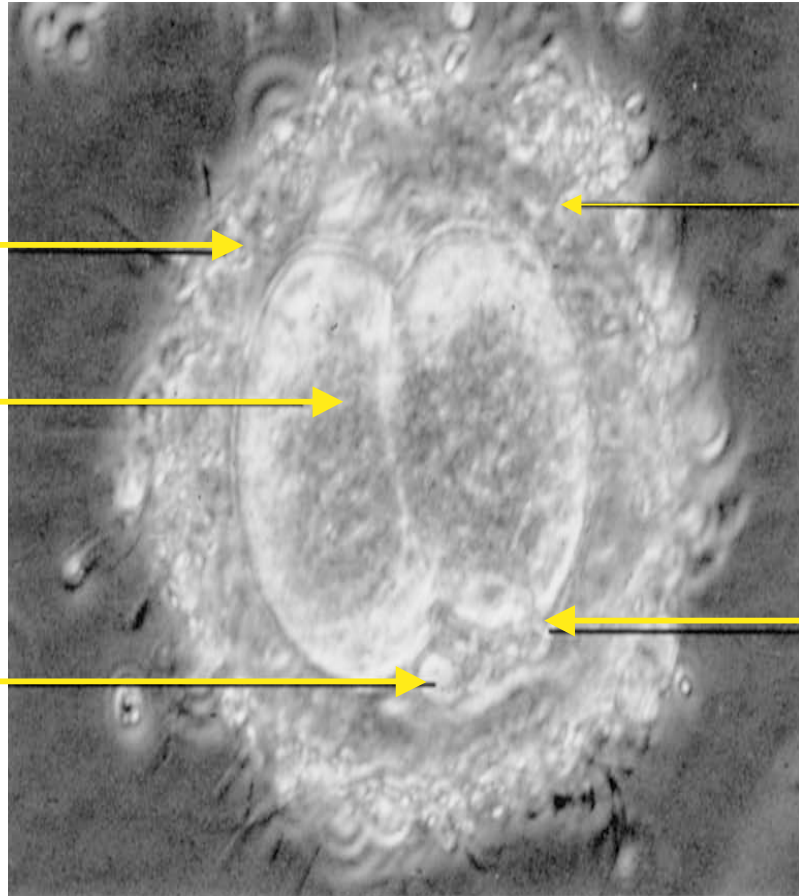
- Blastula also forms
  - Inner cell mass = embryo
  - Trophoblast - placenta



**Corona radiata**  
(composed of follicular cells)

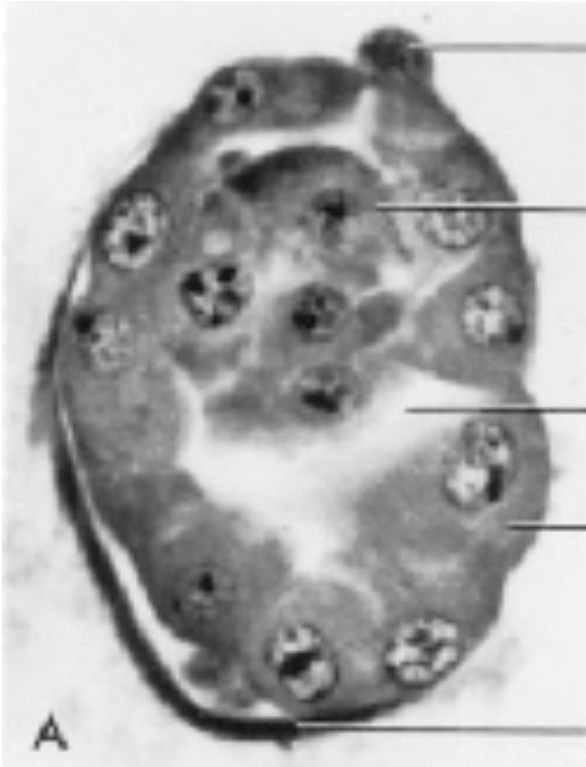
**Blastomere**

**Polar body**  
(nonfunctional cell)



**Degenerating sperm**

**Zona pellucida**



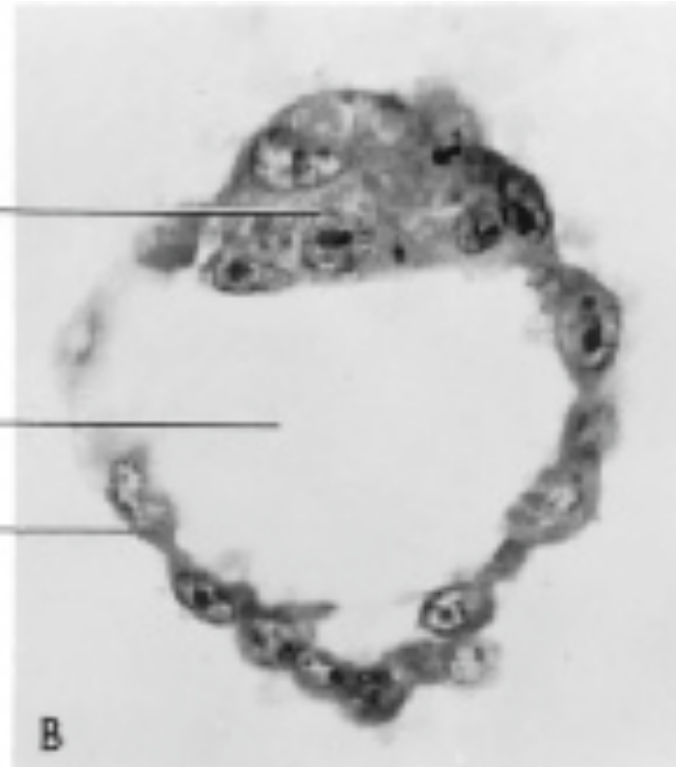
**Polar body**

**Inner cell mass**

**Blastocyst cavity**

**Trophoblast**

**Remnant of zona pellucida**



**Inner cell mass**

**Blastocyst cavity**

**Trophoblast**