Life Cycles – Sea Urchin Development

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Sperm Structure

- **Head** – compacted nucleus
  - acrosome – modified lysosome
- **Midpiece** – mitochondria
- **Residual cytoplasm**
- **Tail** – axoneme
  - Centriole

Diagram illustrates the sperm structure with labels for each component.
Fertilization
Sea Urchin Fertilization

raised fertilization envelope

fertilized egg = zygote

blastomeres

unfertilized egg
Cleavage

- post-fertilization development

- mitosis, cell division

- no growth

- provides:
  - raw material for development
  - division of embryonic cytoplasm
    - equal
    - unequal
### Cleavage Patterns

#### Holoblastic (complete cleavage)
- **Isolecithal**
  - Radial (echinoderms, amphioxus)
- **Mesolecithal**
  - Spiral (annelids, molluscs, flatworms)
  - Bilateral (tunicates)
  - Rotational (mammals, nematodes)
  - Radial (amphibians)

#### Meroblastic (incomplete cleavage)
- **Telolecithal**
  - Bilateral (cephalopod molluscs)
  - Discoidal (fish, reptiles, birds)
- **Centrolethical**
  - Superficial (most insects)
Holoblastic Cleavage

**Radial**
- echinoderms, amphioxus
Sea Urchin Cleavage

holoblastic radial cleavage
Unequal Cytoplasmic Distribution

Xenopus egg

animal

vegetal
1\textsuperscript{st} cleavage - meridional

pronuclei

Vegetal pole

Animal pole

2\textsuperscript{nd} - meridional

3\textsuperscript{rd} - equatorial

4\textsuperscript{th} - unequal cleavage between animal and vegetal hemispheres

Micromeres

Macromeres

Mesomeres

Animal half

Vegetal half
Embryogenesis Fate Maps

Micromeres → Macromeres

oral ectoderm

aboral ectoderm

vegetal plate/endoderm

small micromeres

skeletogenic mesoderm

vegetal plate mesoderm

ciliated band

larval spicules
Gastrulation

gastr-
“stomach”

- formation of independent cell layers
  - raw material for **morphogenesis**

- formation of a body cavity
  - archenteron – primitive gut

- formation of mouth (**protostomes**) or anus (**deuterostomes**)
  - proto – 1\(^{\text{st}}\)
  - deutero – 2\(^{\text{nd}}\)
  - stome - opening
Sea Urchin Gastrulation

Gastrulation - formation of three tissue layers (germ layers) and the archenteron (primitive gut)

Ingression

**PMCs** - primary mesenchyme cells (mesoderm equivalent in urchins)
Sea Urchin Gastrulation - 2

Invagination

- blastocoel
- vegetal plate
- blastopore

- Ectoderm
- Secondary Mesenchyme Cells
- Blastocoel
- Archenteron
- Skeleton
- Primary Mesenchyme Cells
Sea Urchin Development

(A) Animal
Vegetal

(B) Ectoderm
Endoderm
Oral ectoderm
Vegetal plate

(C) Ciliary tuft
Primary mesenchyme cells

(D) Secondary mesenchyme cells
Syncytial cables
Primary mesenchyme cells
Invaginating endoderm
Blastopore
Sea Urchin Development

Deuterostome – mouth from 2nd opening vertebrates, echinoderms, etc.
Protostome – mouth from 1st opening (blastopore) arthropods, mematodes, annelids, etc.