Phylum Echinodermata

Subphylum Eleutherozoa
1. Body form is highly variable but always with oral side down or body extended horizontally.

Class Holothuroidea
Sea Cucumbers
1. Body elongate
   a. Reduced rows of tube feet; 5 -> 3
   b. Different form of bilateral symmetry from echinoids.

Class Holothuroidea
2. Skeleton reduced; another example of “filled rubber.”
3. Tube feet along selected ambulacra.

Class Holothuroidea
5. Well developed hemal system.
6. Rete mirabile – “wonderful network”
   a. Associated with respiratory tree.
Class Holothuroidea
7. Defense and self preservation:
   a. Cuverian tubules - toxic threads shot out of anus.
   b. Evisceration during stress.

Class Concentrocycloidea
Sea Daisies
a. Primarily deep sea.
b. Associated with rotting wood.
c. Possibly belong within the Asteroidea.

Echinoderm Reproduction
a. Separate sexes
b. Fertilization external.
   1. some evidence of aggregation associated with breeding

Sperm motility
The sperm moves by rotating its tail in a spiral motion through the water. This induces waves of force backward propelling the sperm forward.

Sperm motility
If the sperm hits a hard surface, like an egg, the spiral motion will cause the entire sperm to rotate.
Acrosome Reaction
Receptors on the sperm (red) come into contact with the egg jelly (yellow), causing the acrosome (green) to fuse with the plasma membrane of the sperm.

Acrosome Reaction
The actin (pink) goes from a globular state to a filamentous state pushing the front of the sperm outward exposing the binding receptors (blue).

Acrosome Reaction
The binding receptors can now bind with the egg.

NO Reaction
The cytoplasm of the sperm contains NOS (Nitric Oxide Synthase) which is activated along with the acrosome reaction by contact with egg jelly (yellow).
Activated NOS (green) produces Nitric Oxide [light green spray].

NO Reaction
Upon fusion with the egg, NOS is released into the egg, whereby the NO produced activates Calcium release [red spray]. Calcium activates NOS already present in the egg, releasing more NO, which releases more Calcium, etc. Starting a wave of calcium throughout the egg.

Fertilization Membrane
NO Reaction induces the formation of a fertilization membrane, preventing further sperm entry. Here, proteins on the plasma membrane are displaced and proteins inside the vesicle are now exposed to the outside of the cell.
The contents of the vesicle are expelled into the environment. In the case of the special "cortical granules" of the sea urchin egg, this expelling of contents is what raises the fertilization membrane, preventing further sperm entry.

Too many sperm cause developmental anomalies. Polyspermic embryos will die.

Too few sperm and eggs go unfertilized. Such “sperm limitation” can limit sexual selection in the sea.

Usually, the cortical reaction raises the fertilization membrane and cell divisions occur until the blastula stage. Then, the embryo releases an enzyme that dissolves the fertilization membrane and the young embryo swims free to continue development.

1. Often presented as a progression of stages
   a. Representative stages exist in various groups.
   b. Need not represent the actual progression.
Larval Development

1. Often presented as a progression of stages
   a. Representative stages exist in various groups.
   b. Need not represent the actual progression.

Dipleurula

1. Hypothetical ancestral larval type thought to have given rise to echinoderms.

2. Characteristics
   a. Mouth, anus, band of cilia.
   b. Bilateral symmetry

3. Resembles somewhat the “vitellaria” (doliolaria) larva of crinoids.

Doliolaria

A barrel-shaped stage with a series of 4 or 5 circumferential bands.

Usually nonfeeding (lecitotrophic).

Auricularia

1. Larval form of sea cucumbers.

2. Ciliary band becomes convoluted as the larva grows.

As the larvae swim, food particles are directed towards the mouth.
**Bipinnaria**
1. Ciliary bands separate, elongate to further define arms.
   a. Often more "arms" than expected from pentaradial symmetry.

**Bipinnaria**
2. Larva is usually *planktotrophic* - feeds by ciliary action which beats plankton to mouth.
   3. Cilia are also locomotory.

**Brachiolaria**
1. Three small projections form at anterior end.
   a. Usually allows larva to settle and begin metamorphosis.

**Brachiolaria**
2. *Adult rudiment* often forms within larval shell.
   a. Eventually emerges to release postlarva.
   b. Postlarvae have names particular to classes.

**Pluteus**
1. Larva of ophiuroids and echinoids with long extensions of arms.
2. Often remain in plankton for long periods (planktotrophic).

**Blastula to Pluteus**
Yellow is ectoderm, orange is endoderm, red is primary mesenchyme cells and skeleton, orange "dots" are secondary mesenchyme cells. Process from "blastula" to "pluteus" takes about 48 hours.

Note: Anus is formed before the mouth.