BIO 221
Invertebrate Zoology I
Spring 2010

Stephen M. Shuster
Northern Arizona University

http://www4.nau.edu/isopod

Lecture 17

Class Ophiuroidea

a. Brittle stars

b. Detritivores; move more rapidly than asteroids, breakable arms.

Class Ophiuroidea

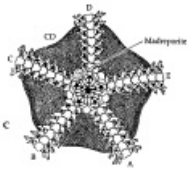
1.Bodies are stellate with rays clearly set off from the disk.

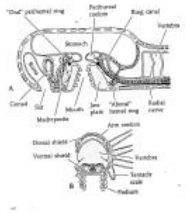
2. Ambulacral grooves are always closed.

Class Ophiuroidea

3. Podia lack suckers.
4. The five rays may be branched (basket stars) or unbranched (brittle stars).

Class Ophiuroidea



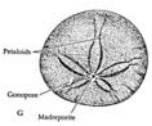


5. Ossicles form verterbra like articulations on the rays.
6. The gut lacks an anus.

Class Echinoidea

Sea urchins, Sand dollars

1. Primarily herbivores, detritivores
2. Body globose or discoidal.



Class Echinoidea

2. Sometimes with 2º bilateral symmetry
3. More complicated systematics than other classes.

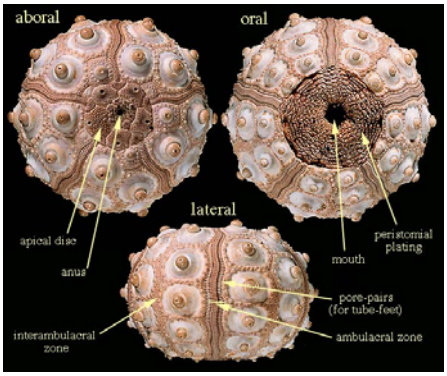
Class Echinoidea

1. Bodies are oriented with the oral surface toward the substrate.
2. The aboral surface, including the anus and madreporite, faces upward.

2º Bilateral Symmetry

1. Ancestral bilateral symmetry revealed during development.
2. Radial symmetry appears next.
3. Secondary development of bilateral symmetry in some taxa.

Fused, aboral skeletal plates



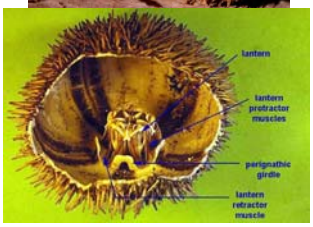
"Regular" vs. "Irregular"

1. The former designation identifies round species; the latter identifies elongate or flattened species.

"Regular" vs. "Irregular"

Identifies structural grades rather than evolutionary relationships.

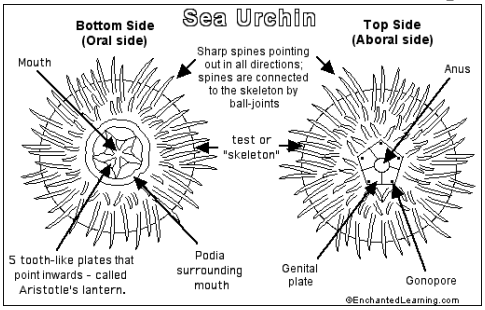
Aristotle's Lantern



1. This jawlike apparatus is used for scraping algae and other food particles from the rocks upon which these organisms graze.

Closed Ambulacrae

1. Form a ***test*** consisting of fused, aboral skeletal plates.

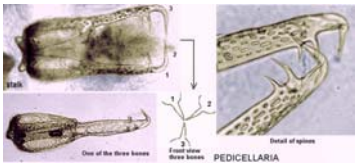


Spines, Podia, Pedicellaria

2. Echinoids possess numerous elongated and moveable spines that protrude from the body surface.

Spines, Podia, Pedicellaria

3. These assist in locomotion, attachment to the substrate and providing protection from predators.



Echinoid Systematics

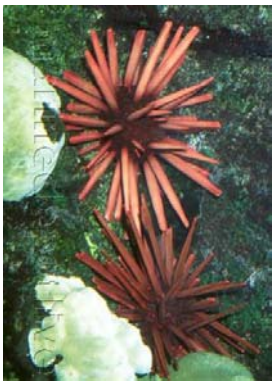
1. Recently revised, and re-revised.
2. Two subclasses.
   a. Subclass Perischoechinoidea (Cidaroidea)
   1. ancestral urchins - pencil urchins

Subclass Cidaroidea

1. Highly rounded tests,
2. A single podium on each ambulacral plate.
3. Thick pencil-like spines ("pencil urchins").
4. Gills absent.

Subclass Cidaroidea

1. *Eucidaris* sp. This genus is commonly found in lower rocky intertidal areas in the northern Gulf of California.



Subclass Euechinoidea

True urchins and Sand dollars

1. Formerly with four superorders.

Now, two "Infraclasses"; one with three "Cohorts".

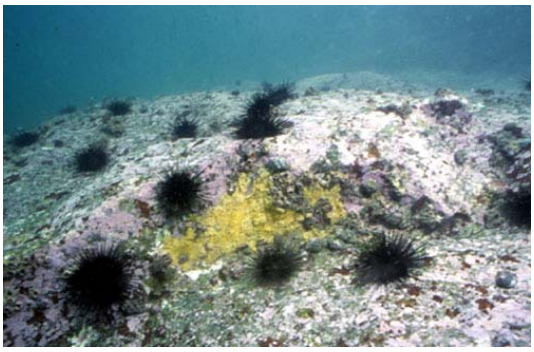
Diadematacea

The hollow spined urchins.

With long, breakable, "poisonous" spines.

Diadematacea

Diadema sp.



Echinacea

The Solid Spined Urchins

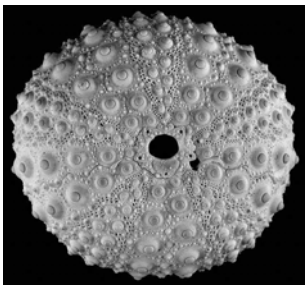
Most of what you encounter as regular sea urchins.

Echinacea

Echinometra
Strongylocentrotus
Arbacia
Toxopneustes
Lytechinus

Sea Urchin Speciation

Echinometra



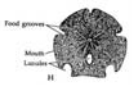
Irregularia

Also known as the Gnathostomata, include the Atelostomata.

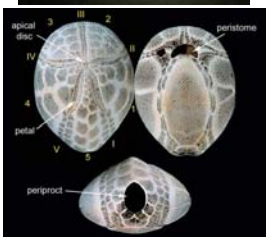
Include the heart urchins, sand dollars and sea biscuits.

Irregularia

Dendraster
Clypeaster
Encope, Mellita
Agassizia

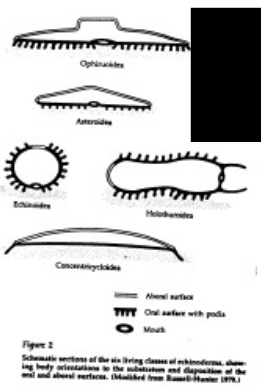


2º Bilateral Symmetry



Subphylum Eleutherozoa

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



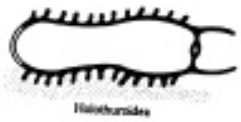
Class Holothuroidea

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."

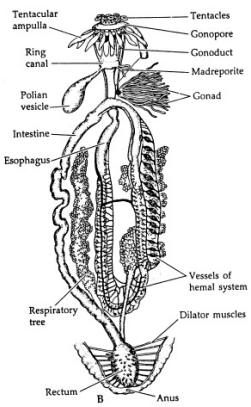
3. Tube feet along selected ambulacra.

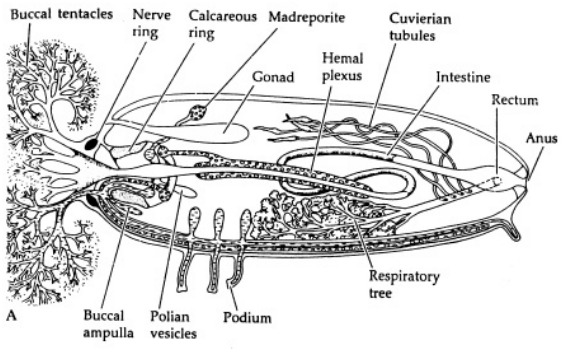
Class Holothuroidea

5. Well developed hemal system.

6. *Rete miriable* – "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.

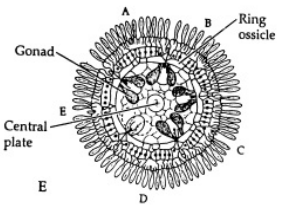
Class Concentrocycloidea

Sea Daisies

a. Primarily deep sea.

b. Associated with rotting wood.

c. Possibly belong within the Asteroidea.

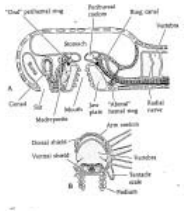


Echinoderm Reproduction

a. Separate sexes

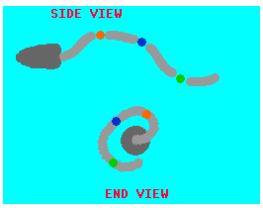
b. Fertilization external.

1. some evidence of aggregation associated with breeding



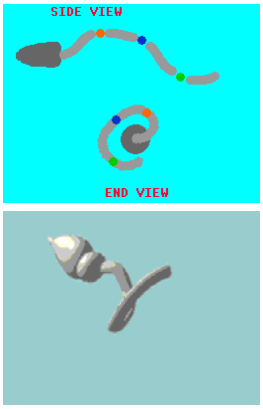
Sperm motility

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



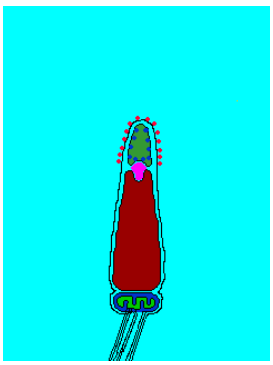
Sperm motility

If the sperm hits a hard surface, like an egg, the spiral motion will cause the entire sperm to rotate.



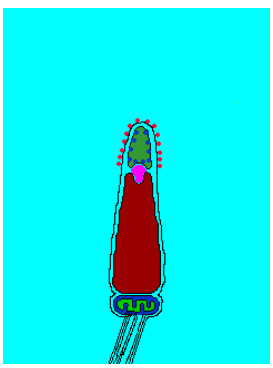
Acrosome Reaction

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.



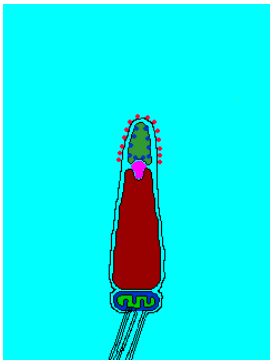
Acrosome Reaction

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

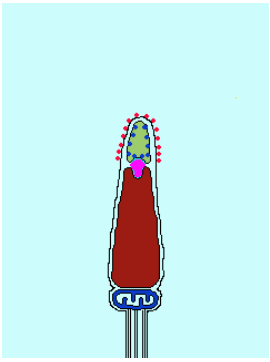
The binding receptors can now bind with the egg



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].

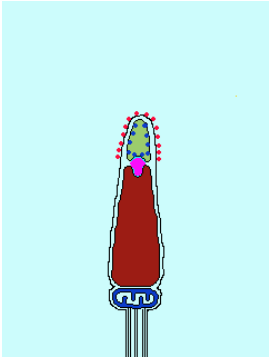


NO Reaction

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.

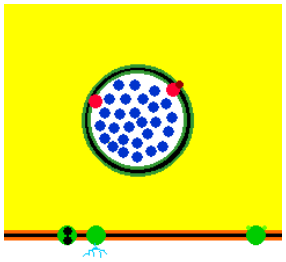
Starts a wave of calcium throughout the egg.



Fertilization Membrane

NO Reaction induces the formation of a ***fertilization membrane***, preventing further sperm entry.

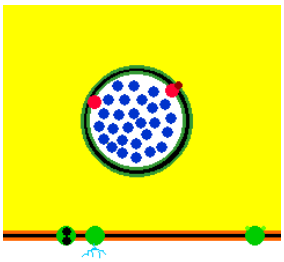
Here, proteins on the plasma membrane are displaced and proteins inside the vesicle are now exposed to the outside of the cell.



Fertilization Membrane

The contents of the vesicle are expelled into the environment.

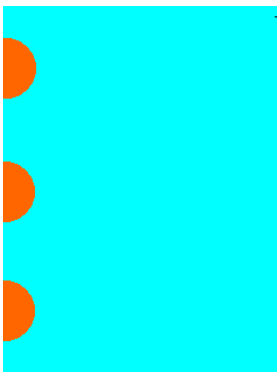
In the case of the special "cortical granules" of the sea urchin egg, this expelling of contents is what raises the fertilization membrane, preventing further sperm entry.



Polyspermy

Too many sperm cause developmental anomalies.

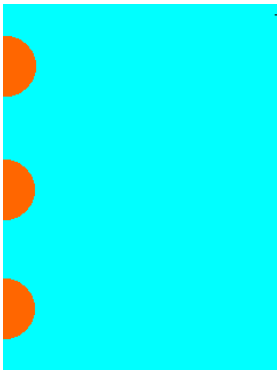
Polyspermic embryos will die.



Sperm Limitation

Too few sperm and eggs go unfertilized.

Such “sperm limitation” can limit sexual selection in the sea.



Just Right!

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.