



Phylum Echinodermata



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Diversity

- **Echinodermata means “spiny skin”**
- **Echinoderms usually inhabit shallow coastal waters and ocean trenches**
- **Organisms in this class include:**
 - **Sea stars**
 - **Brittle stars**
 - **Sand dollars**
 - **Sea cucumbers**

General Characteristics

- Adults exhibit **pentamerous** radial (**pentaradial**) symmetry
- Radial symmetry is *secondary*: free-swimming larvae are bilaterally symmetrical, then undergo metamorphosis to become radially symmetrical adults.

Pentaradial Symmetry

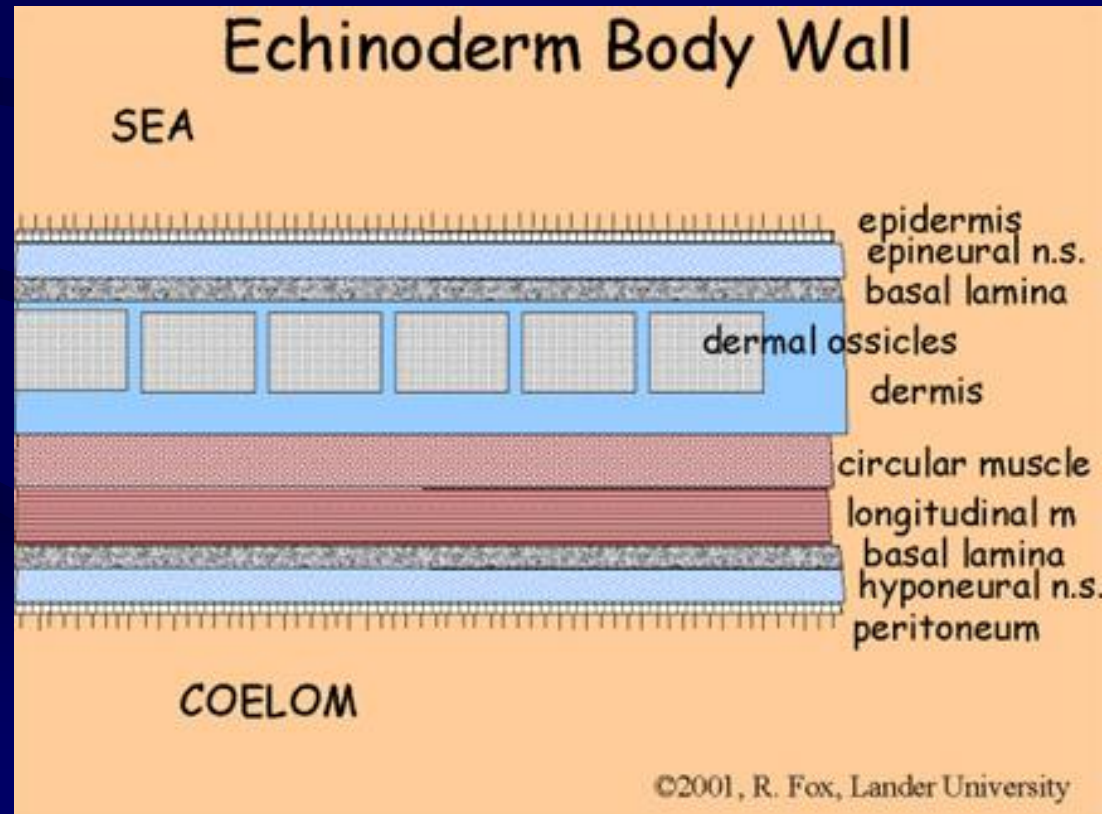


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General Characteristics

- Poorly ganglionated; possess few sensory structures.
- IOW - Have a nervous system, but no head or brain.
- Body wall contains an endoskeleton of **calcareous plates - ossicles**



General Characteristics

- Possess a network of canals throughout the body - **water vascular system (WVS)**.
- The canals are connected to extensions called **tube feet (=podia)**, located on the oral surface
- The water vascular system is important for locomotion, feeding, excretion, and gas exchange.



- Sexes are separate; gametes shed into the water; fertilization is external

Evolution & Classification

- **Echinoderms are from the Cambrian period & date back to over 500 million years ago**
- **Scientist believe that they evolved from a bilaterally symmetrical ancestor.**
- **The inferred ancestral larva is very similar to the modern Sea Star larva.**
- **Fossil Records show how conditions changed, causing them to evolve from sessile organisms to free-living ones.**

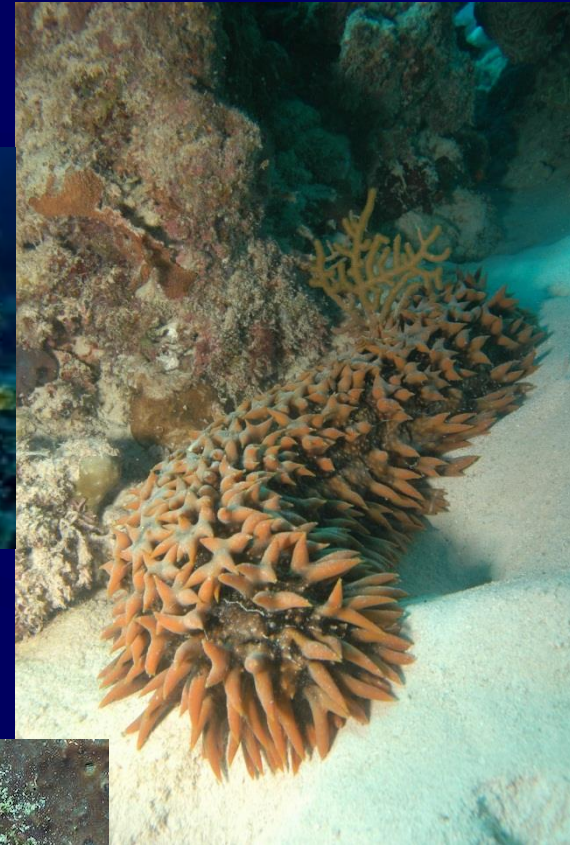
Echinoderm Diversity

Classes

Taxonomists have divided
the roughly 6,000 species
of echinoderms into five
classes:

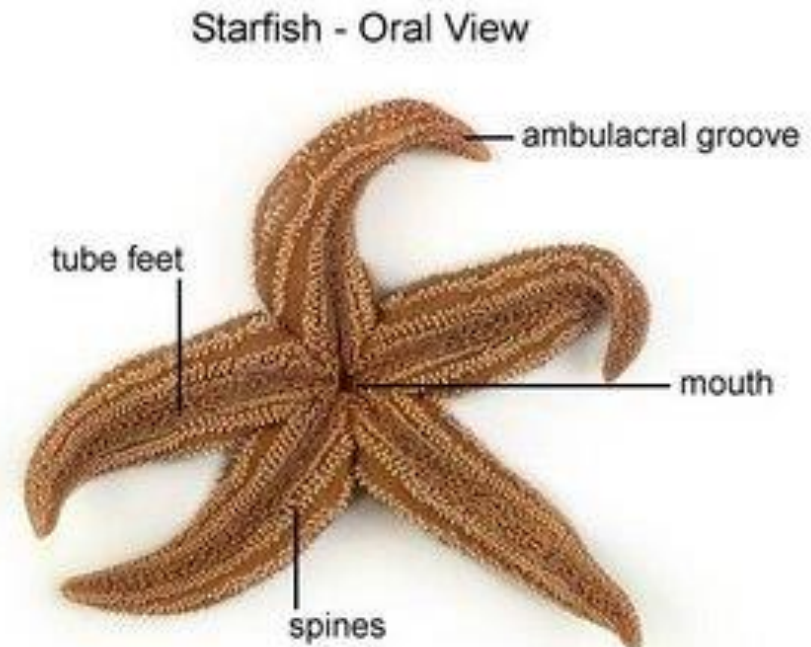
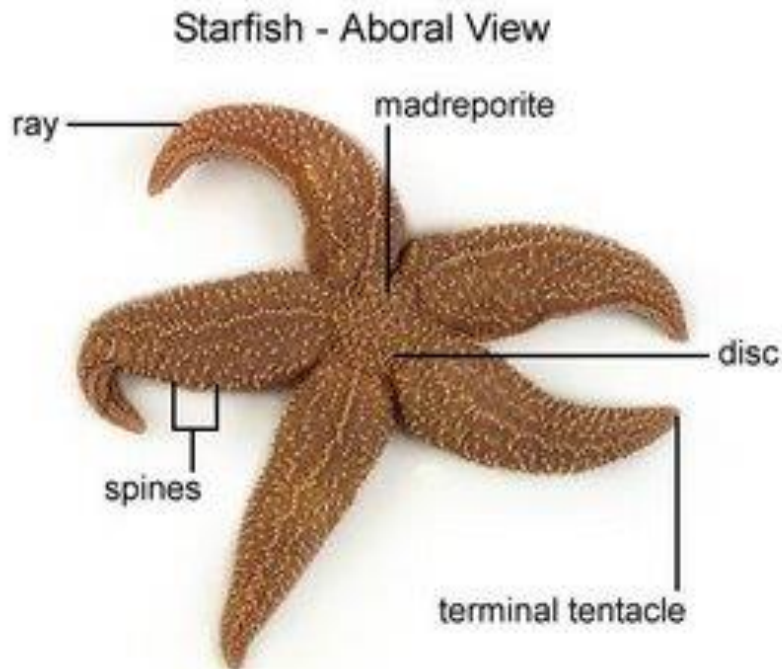
Echinoderm Diversity

- Asteroidea
- Ophiuroidea
- Echinoidea
- Crinoidea
- Holothuroidea



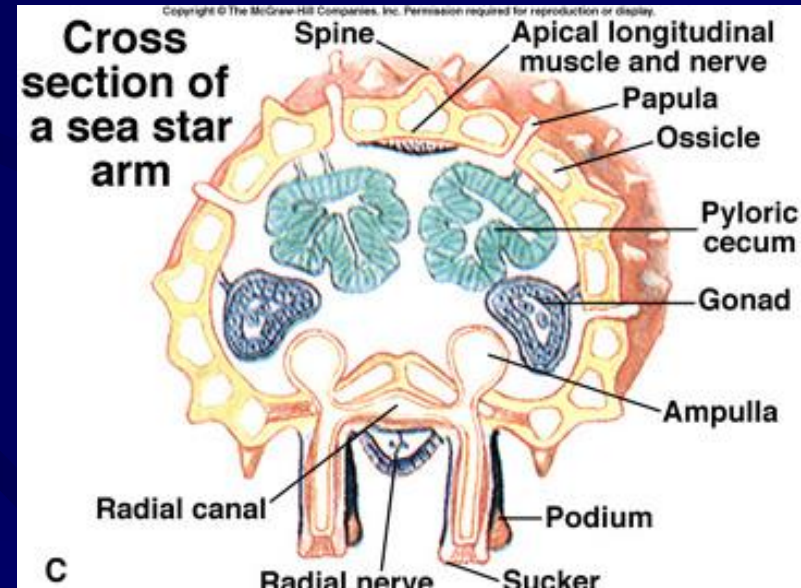
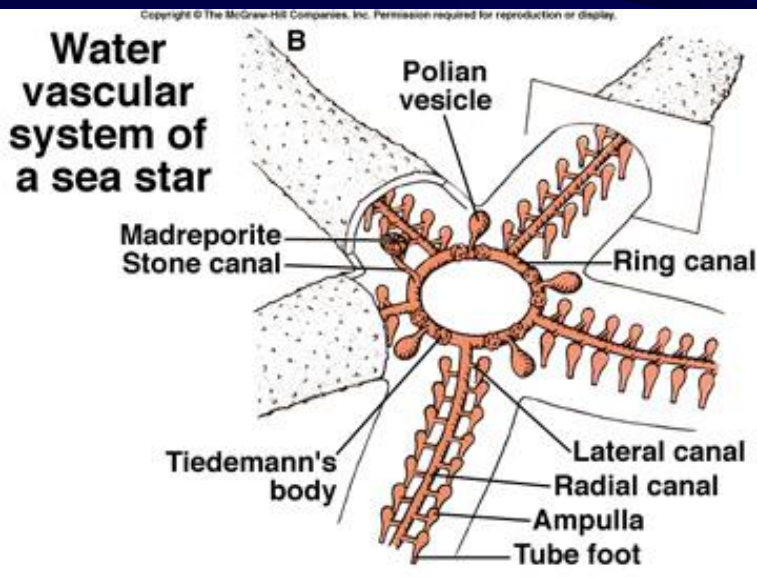
Class Asteroidea - "star-like"

- Sea Stars
- Typically have 5 arms which merge with a central disc
- Mouth is located in the center of *oral surface* (bottom) which is directed downward; all sea stars are carnivorous
- Sea stars are believed to share a *common evolutionary history* with humans and other chordates



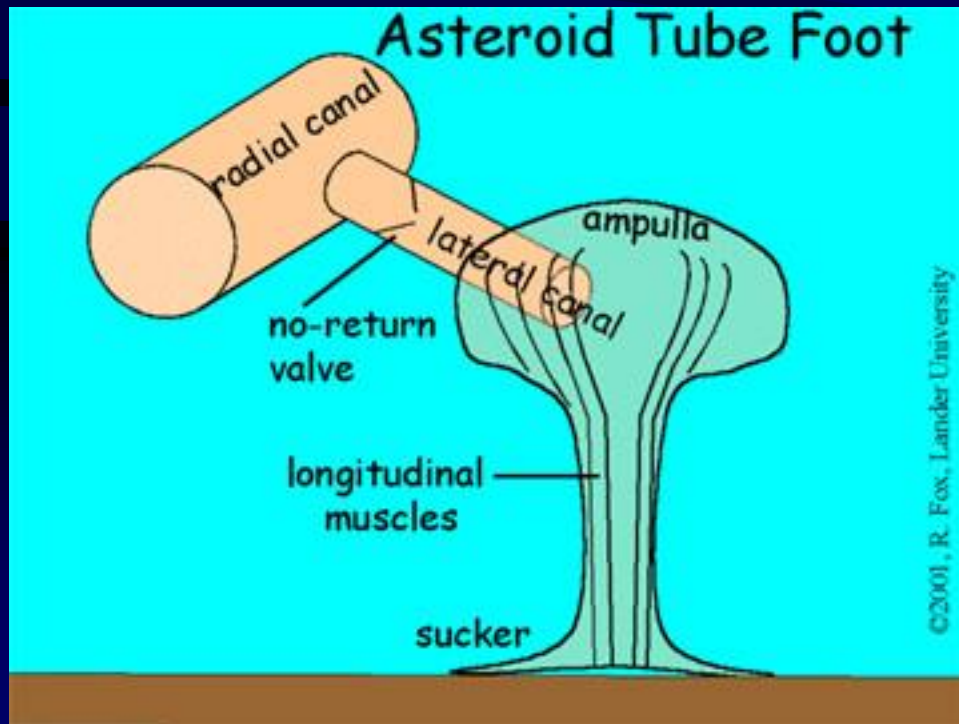
Water Vascular (Hydrostatic Pressure) System

- On the **aboral surface** (top) is the opening of the water vascular system - the **madreporite** (=sieve plate)
- Water enters the madreporite and goes through the **stone canal** canal to the **ring canal**
- Water then passes through a **radial canal** extending into each arm
- All along the length of these canals are **lateral canals** that terminate in a bulb-like structures called **ampullae** equipped with tube feet
- Tube feet line the grooves on the oral surface - **ambulacral grooves**



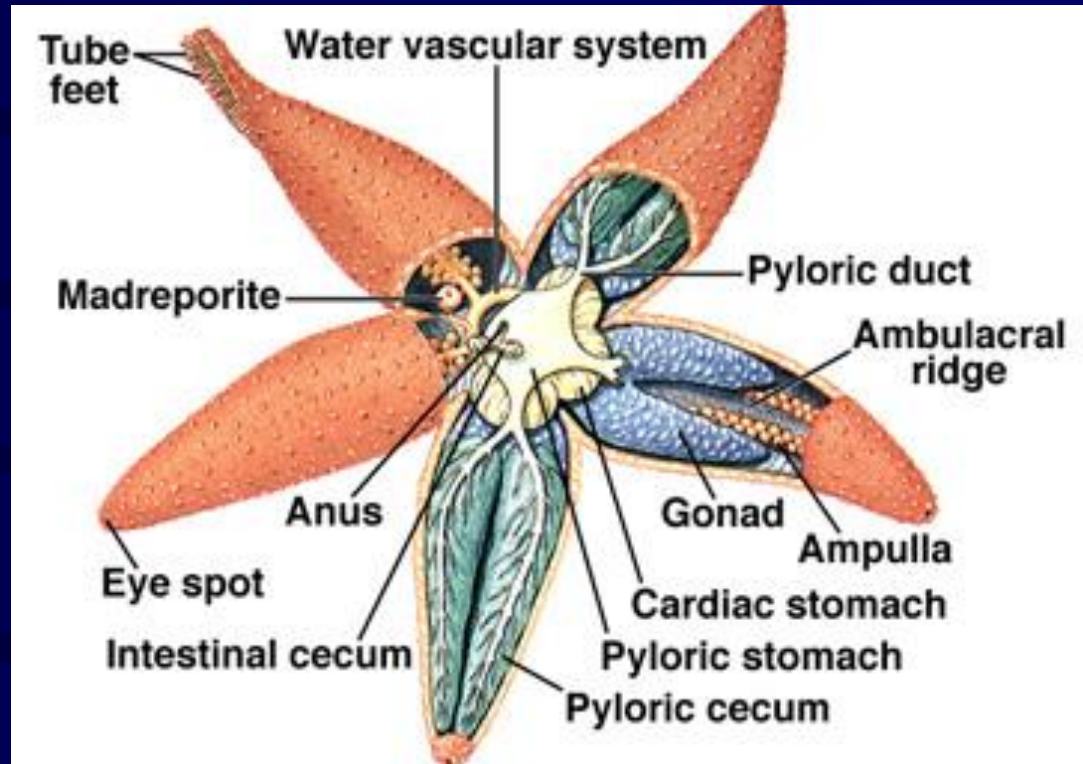
How the Podia Operate

- Ampulla contract and force fluid into the podia causing it to become extended
- Suckers at the tips of the podia come into contact with the substrate and adhere to the surface
- Then the podia contract, thereby forcing water back into the ampulla, and the body is pulled forward



Nutrition

- prey on oysters, clams, and other seafood that is used by people
- Mouth leads to a 2-part stomach: a large **cardiac stomach** and a smaller **pyloric stomach**
- The pyloric stomach connects with **digestive glands (=pyloric caecae)** that runs into each arm
- A short intestine extends from the pyloric stomach to an anus on the aboral surface
- Associated with the intestine are **rectal caecae** that pump the fecal wastes out of the anus



Nutrition - Feeding

- Starfish eat mainly bivalves such as clams, mussels and oysters. They will also eat small fish, sea snails and barnacles. A starfish will basically eat any sea creature that is too slow to avoid being captured by it. Some starfish eat decomposing animals, algae and plant matter. Other species such as the Crown-of-Thorns Starfish eat coral polyps and sponges, destroying large sections of coral reef.

Nutrition - Feeding

- Starfish have an interesting way of eating their prey. When they find a clam, mussel or oyster, they pry the shell open with their arms, then insert their stomach into the shell. They do this by extending (**evert**ing) their stomachs out through their mouths and digesting their prey before pulling their stomach back inside via the mouth opening on the bottom of their bodies.

Crown-of-Thorns Sea Star



Reproduction

- Sea Stars can reproduce asexually by regeneration
 - deliberately split the body; can grow from a small fragment such as one arm, as long as at least $\frac{1}{4}$ of the central disc is present



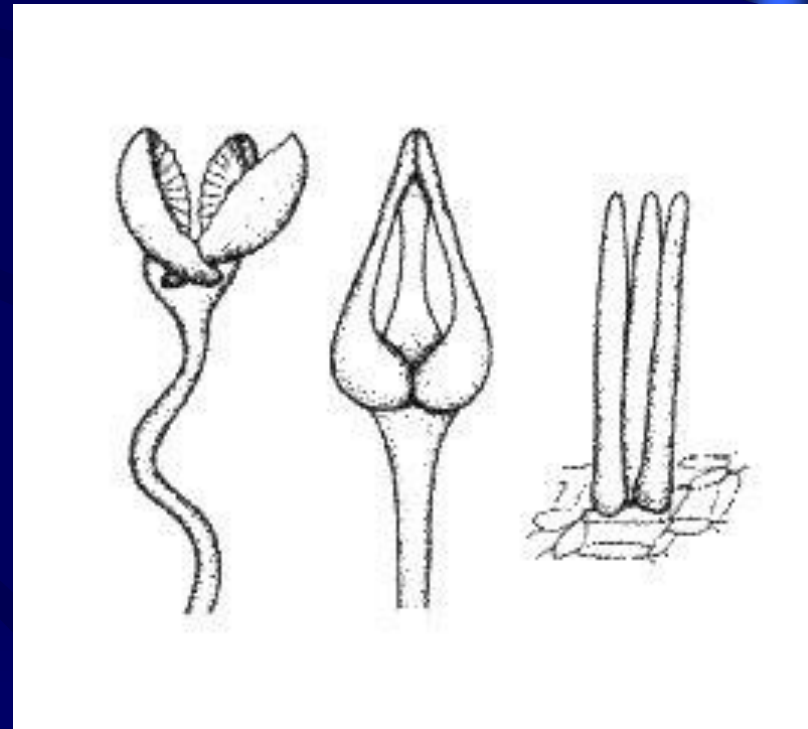
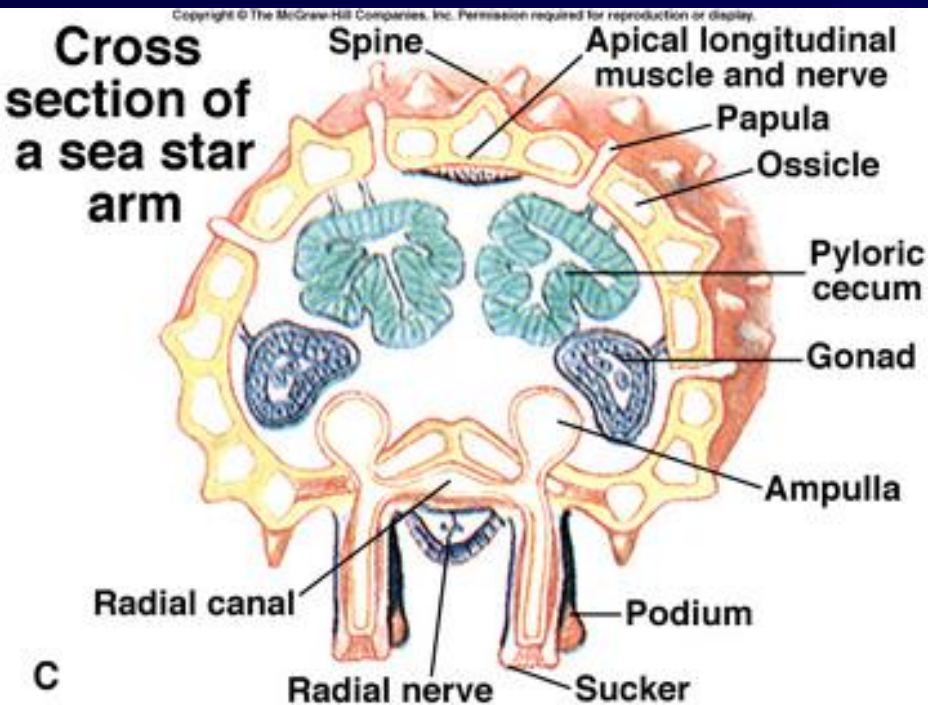
Reproduction

- Sea Stars can reproduce sexually by releasing eggs and sperm into the ocean. Sea Stars have distinct sexes.



Additional Characteristics

- The endoskeleton is made up of calcareous plates that often penetrate the dermis as spines
- Between the spines and plates are projections called **papulae**, also known as **skin gills** which function in gas exchange and excretion
- Other projections on the body wall include tiny jaw-like appendages called **pedicellaria** - tiny forceps that protect and clean the body surface



Ophiuroidea

"snake-like"

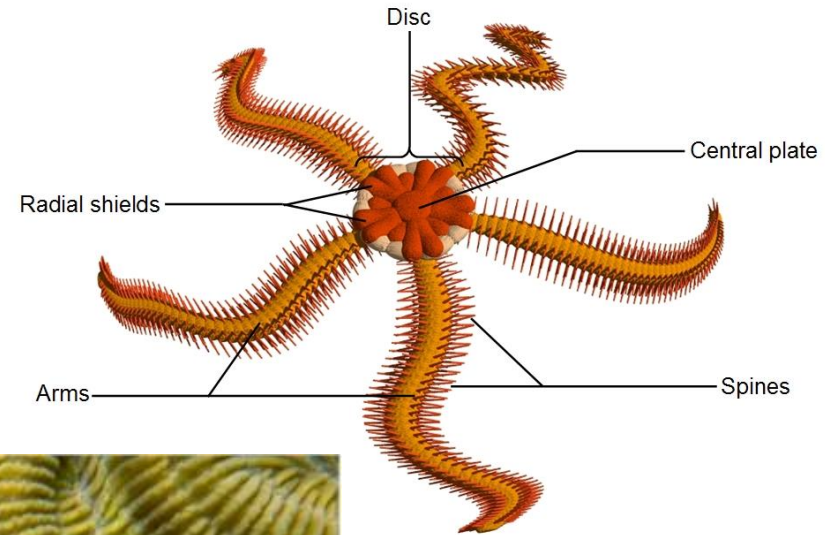


- largest echinoderm class
- includes basket stars & brittle stars
- primarily reside under stones & in crevices and holes of coral reefs
- have thin brittle arms that break off & regenerate themselves quickly
- feed by raking food off the ocean floor with their arms and bottom of tube feet
- also trap food with mucous strands between their spines.

Brittle Stars



Serpent Star – aboral (top) view

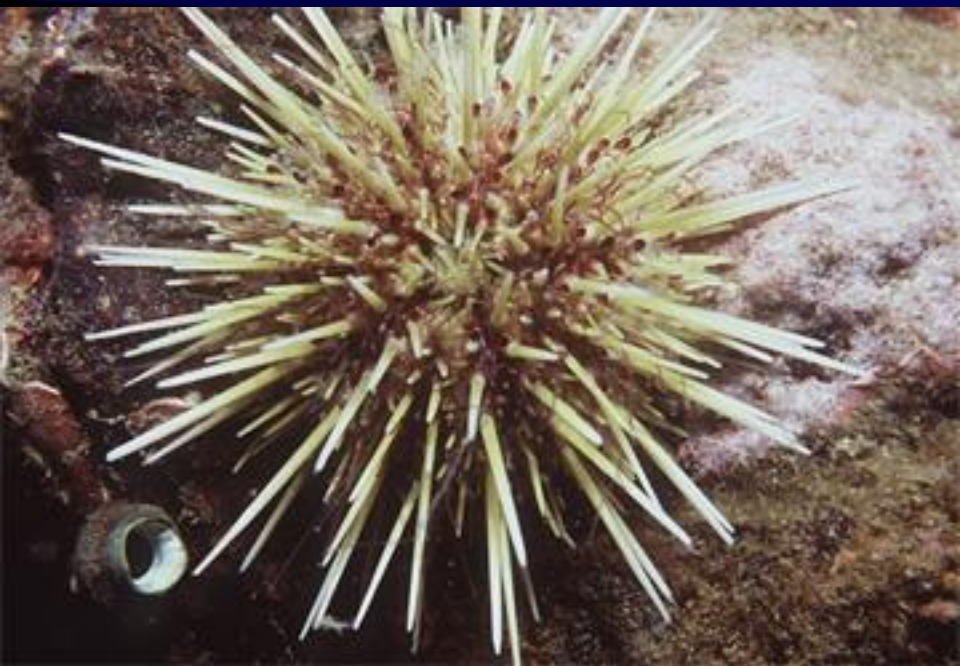


Brittle Stars



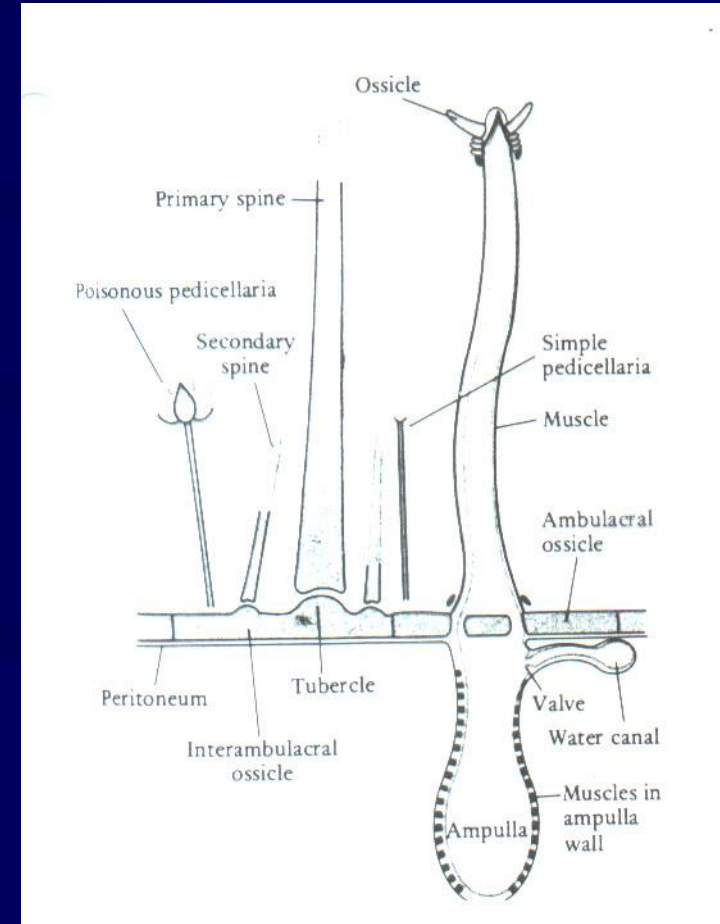
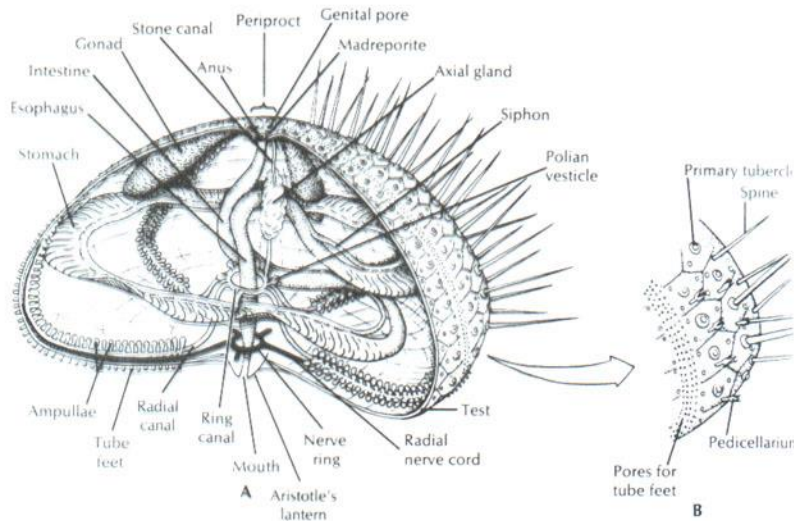
Echinoidea - "hedgehog-like"

- Lack arms
- Body is enclosed in a shell or **test**
- Body surface is usually covered with moveable spines
- Include Sea Urchins, Sand Dollars, and Sea Biscuits

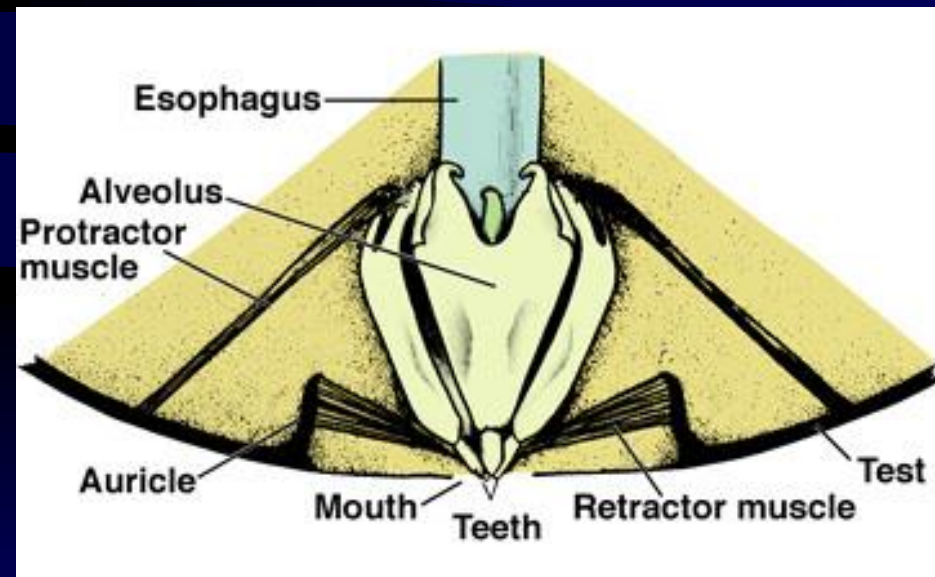


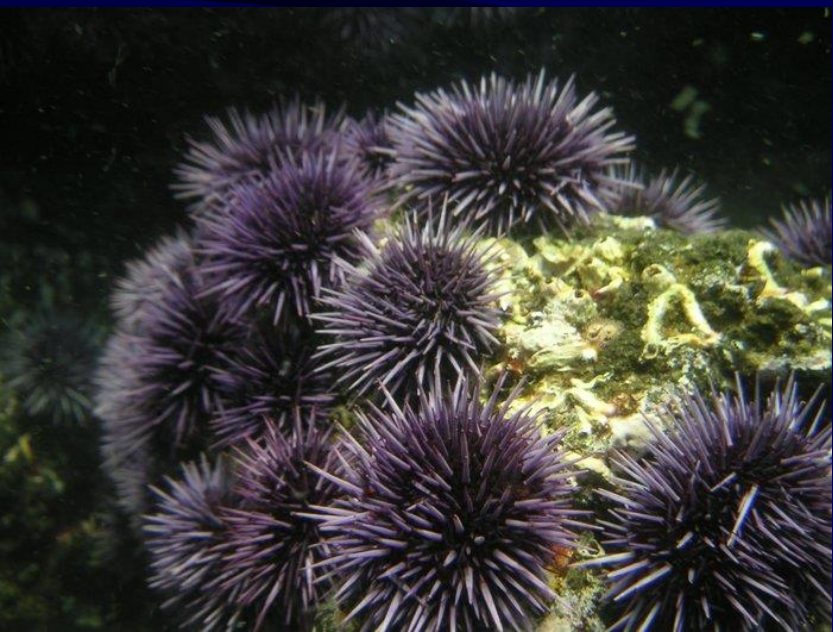
Sea Urchins

- Spherical body
- Ambulacral plates bearing tube feet that radiate out toward the aboral surface
- Use podia and spines during locomotion
- The spines are moveable and articulate with the with the calcareous ossicles; *may be venomous*



- Sea urchins generally feed by scraping algae from rocks
- Accomplished via a complex chewing apparatus called **Aristotle's lantern**





Sand Dollars

- Live along seacoasts & sandy areas
- Flat, round shape bodies; and adaptation for shallow burrowing
- Locomotion: short spines (also aid in burrowing & cleaning their bodies)
- Use tubes to filter food out of water



Class Crinoidea

"lilly-like"

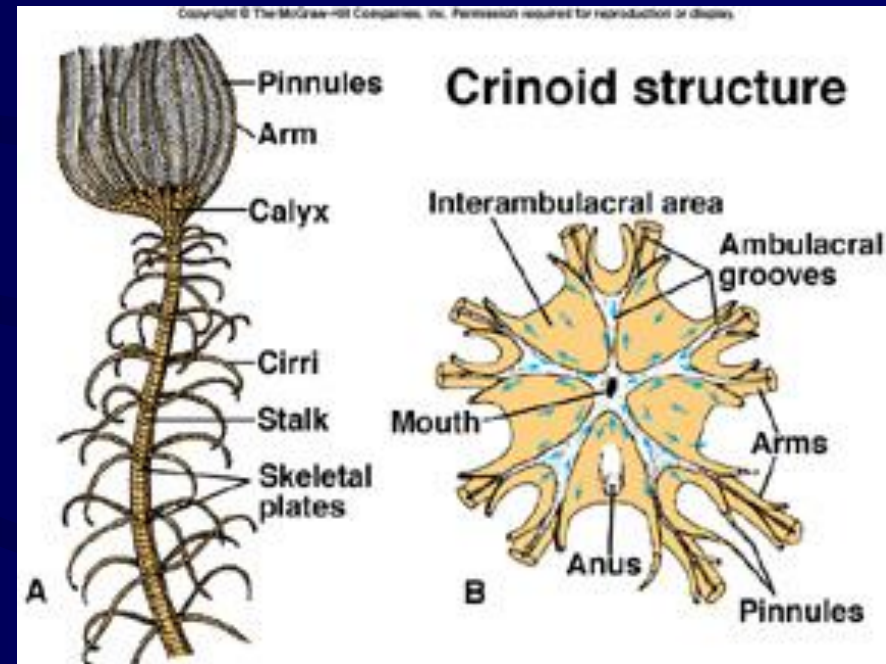
(Feather Stars; Sea Lilies)

- Most primitive of the echinoderms
- Unusual in that the oral surface is directed upward
- Aboral surface is *attached* to the substrate by means of a **bendable stalk** = *sessile*



Crinoidea

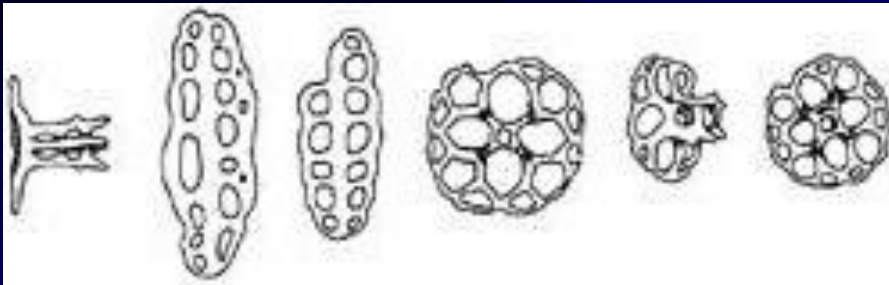
- The portion of the crinoid body attached to the stalk is called the **crown**; bears a number of arms
- Along the length of the arms are branches called **pinnules**
- The arms and the pinnules have ambulacral grooves with suckerless podia
 - secrete mucus: sticky!
- The ambulacral grooves are heavily ciliated and the cilia are used to direct food to the mouth (=filter feeding)



Class Holothuroidea

Sea Cucumbers

- Lack arms
- Oral-aboral axis is greatly extended
- Endoskeleton is reduced to a few ossicles scattered over the surface of the animal making them rather *soft bodied*
- Some species crawl along the substrate using podia; others have *peristaltic locomotion* via muscle contractions



Dermal ossicles

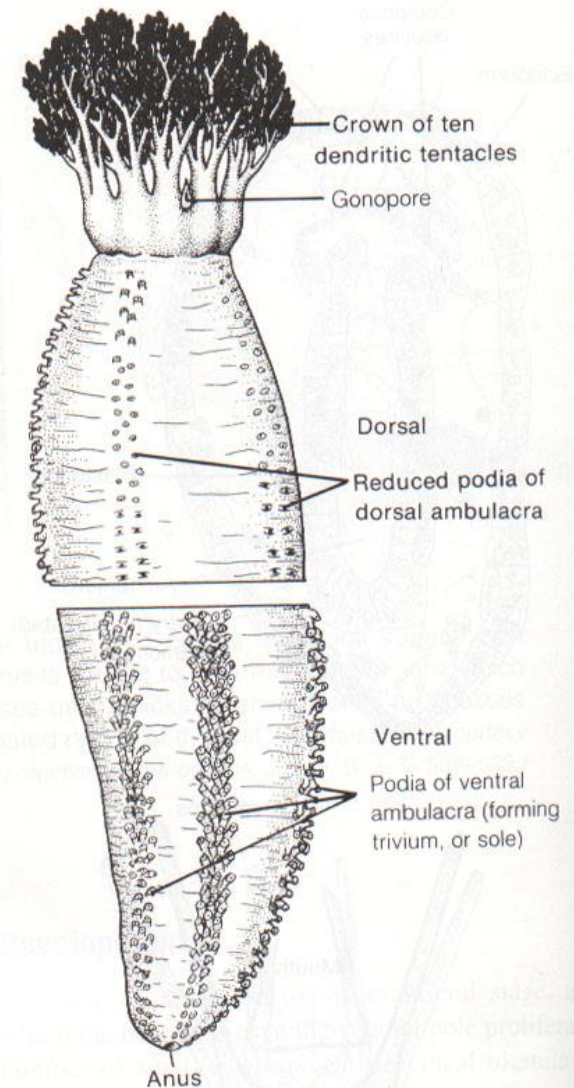
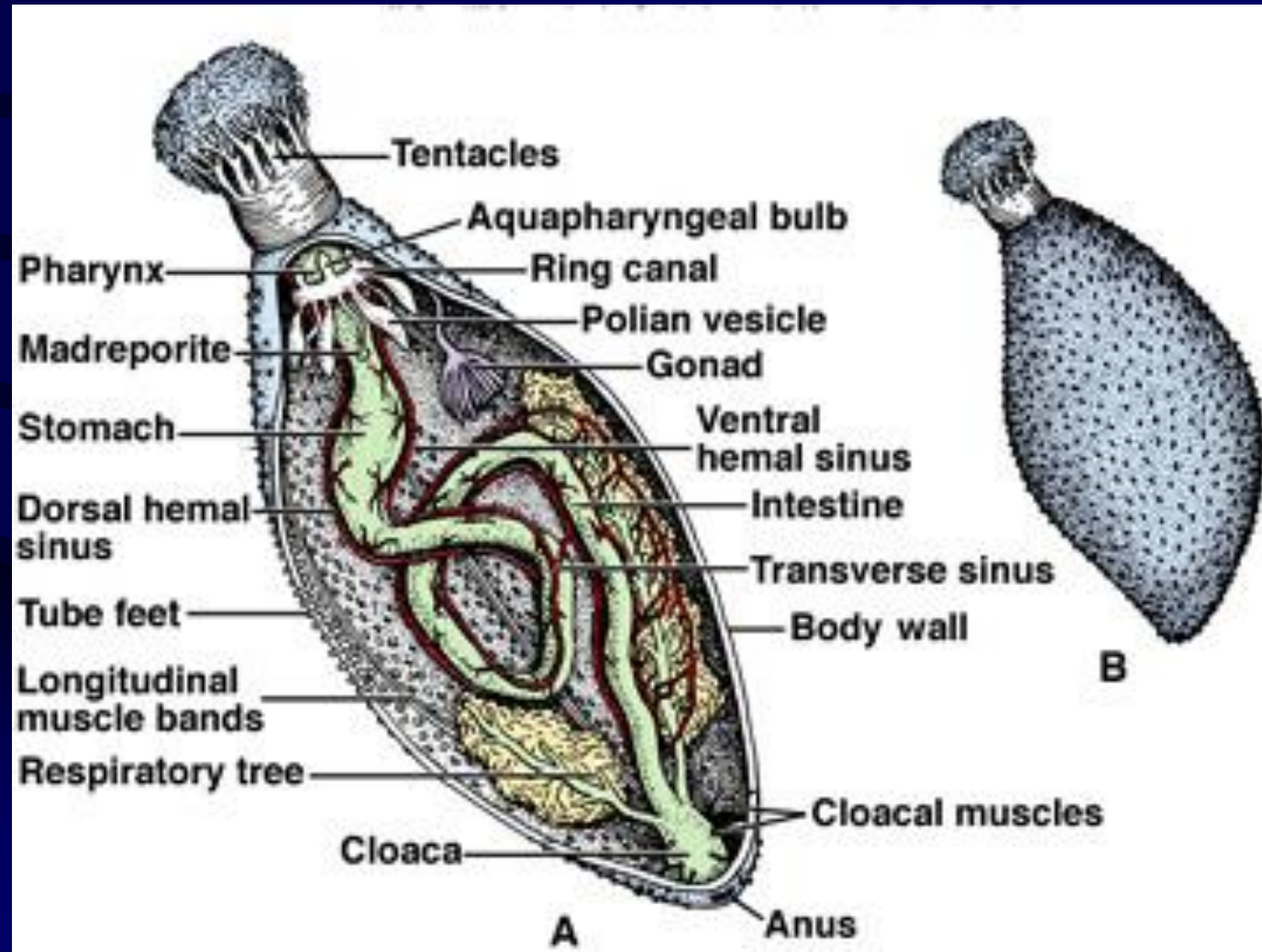
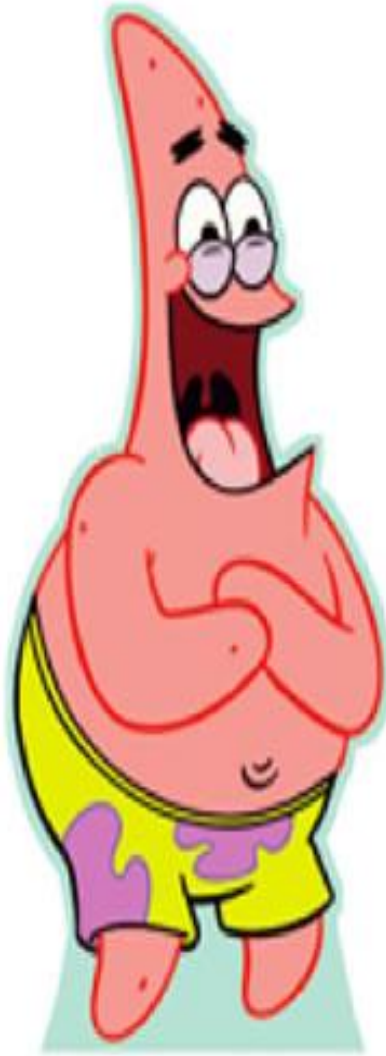


FIGURE 18-43 The North Atlantic sea cucumber, *Cucumaria frondosa*.

- At the oral end of the body are a group of tentacles (modified podia) that surround the mouth; used in *feeding on sediment*
- Have a muscular cloaca that is partly used in gas exchange
- The actual *gas exchange structures* are branching structures called *respiratory trees*







INTERESTING ECHINODERM FACTS!

- One group of echinoderms, the **SEA CUCUMBERS**, have no arms at all!
- The largest known sea star weighed 11 pounds!
- Female sea stars can lay up to 100 million eggs at a time!
- Sea cucumbers, if scared, will “throw up” their insides to ward off predators (evisceration)! They will then regenerate new organs!