



Echinoderm

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Introduction

- Concepts

1. Echinoderms are a part of the deuterostome evolutionary lineage. They are characterized by pentaradial symmetry, a calcium carbonate internal skeleton, and a water-vascular system.
2. Although many classes of echinoderms are extinct, living echinoderms are divided into six classes:
 - a. Asteroidea, sea stars
 - b. Ophiuroidea, brittle stars and basket stars
 - c. Echinoidea, sea urchins and sand dollars
 - d. Holothuroidea, sea cucumbers
 - e. Crinoidea, sea lilies and feather stars
 - f. Concentricyloidea, sea daisies
3. Pentaradial symmetry of echinoderms probably developed during the evolution of sedentary lifestyles, in which echinoderms used the water-vascular system in suspension feeding.

Introduction

- Evolutionary Perspective

- ✓ Sedentary and filter feeders
- ✓ Common ancestry with hemichordates and chordates: deuterostomes, radial and indeterminate cleavage
- ✓ Evolved from bilateral symmetry

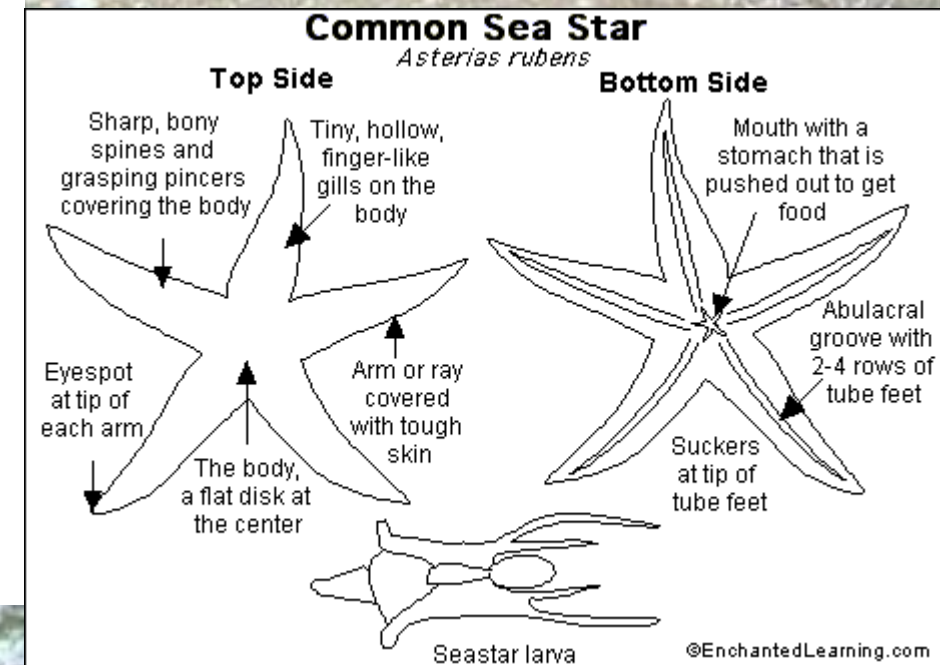
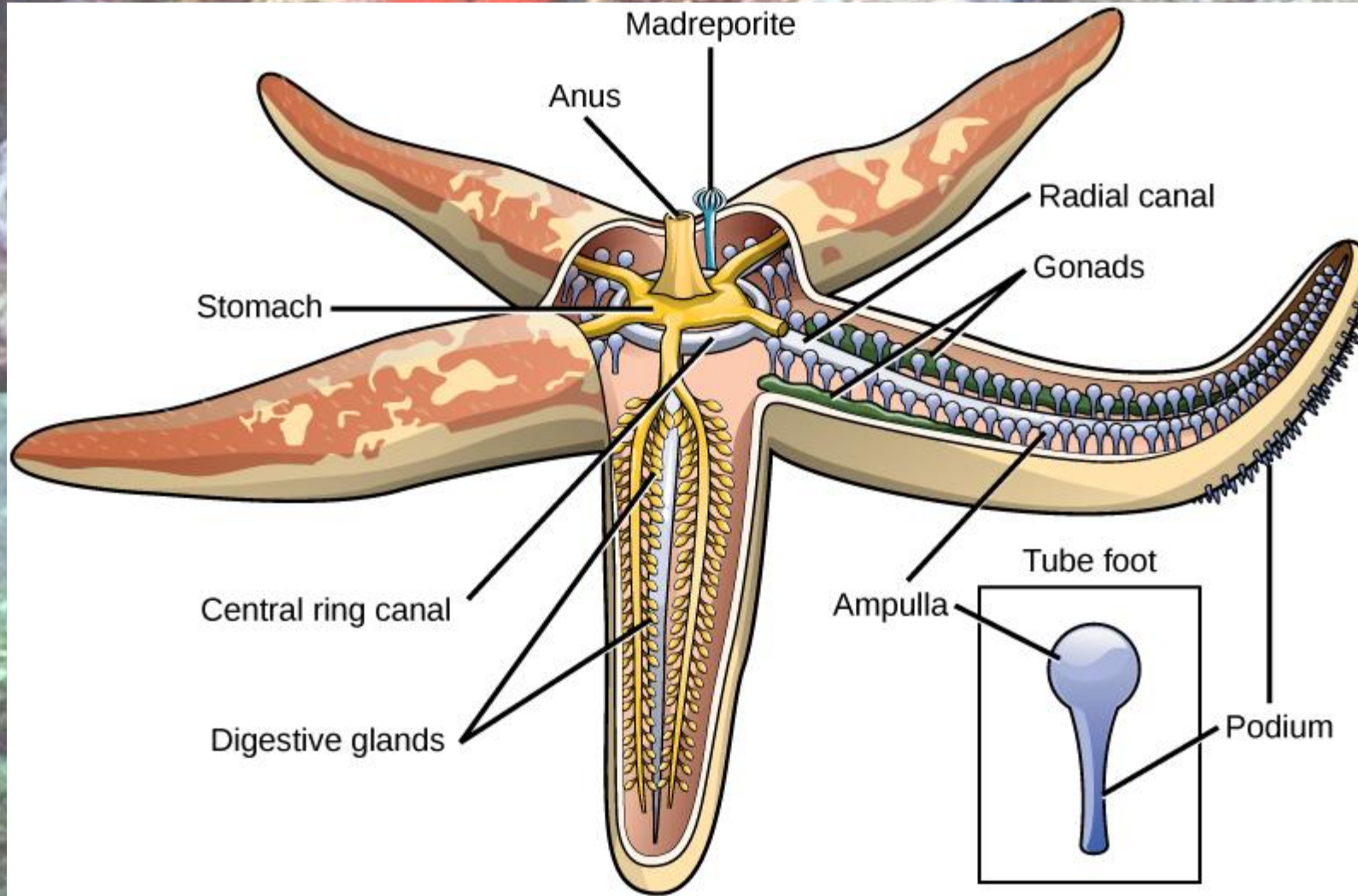
- Characteristics of the phylum Echinodermata include:

1. Calcareous endoskeleton in the form of **ossicles** that arise from mesodermal tissue.
2. Adults with pentaradial symmetry and larvae with bilateral symmetry.
3. Water-vascular system composed of water-filled canals used in locomotion, attachment, and/or feeding.
4. Complete digestive tract that may be secondarily reduced.
5. Hemal system derived from coelomic cavities
6. Nervous system consisting of a nerve net, nerve ring and radial nerves.

Water Vascular System

- Is a series of water-filled canals, and their extensions are called **tube feet**
- Includes a ring canal that opens to the outside or the body cavity through a **stone canal** and **madreporite**
 - ✓ Madreporite – sievelike plates that serves as an inlet to replace water lost from the WVS and equalized pressure differences between WVS and the outside
 - ✓ Tiedmann bodies – swellings associated with the ring canal; site of the production of phagocytic cells (**coelomocytes**)
 - ✓ Polian vesicle – sacs associated with the ring canal that functions in fluid storage for the WVS
 - ✓ Radial canals – lateral branches of the ring canal going to the tube feet
 - ✓ Tube feet – associated with an ampulla with valves and terminates into a suction cup

Water Vascular System



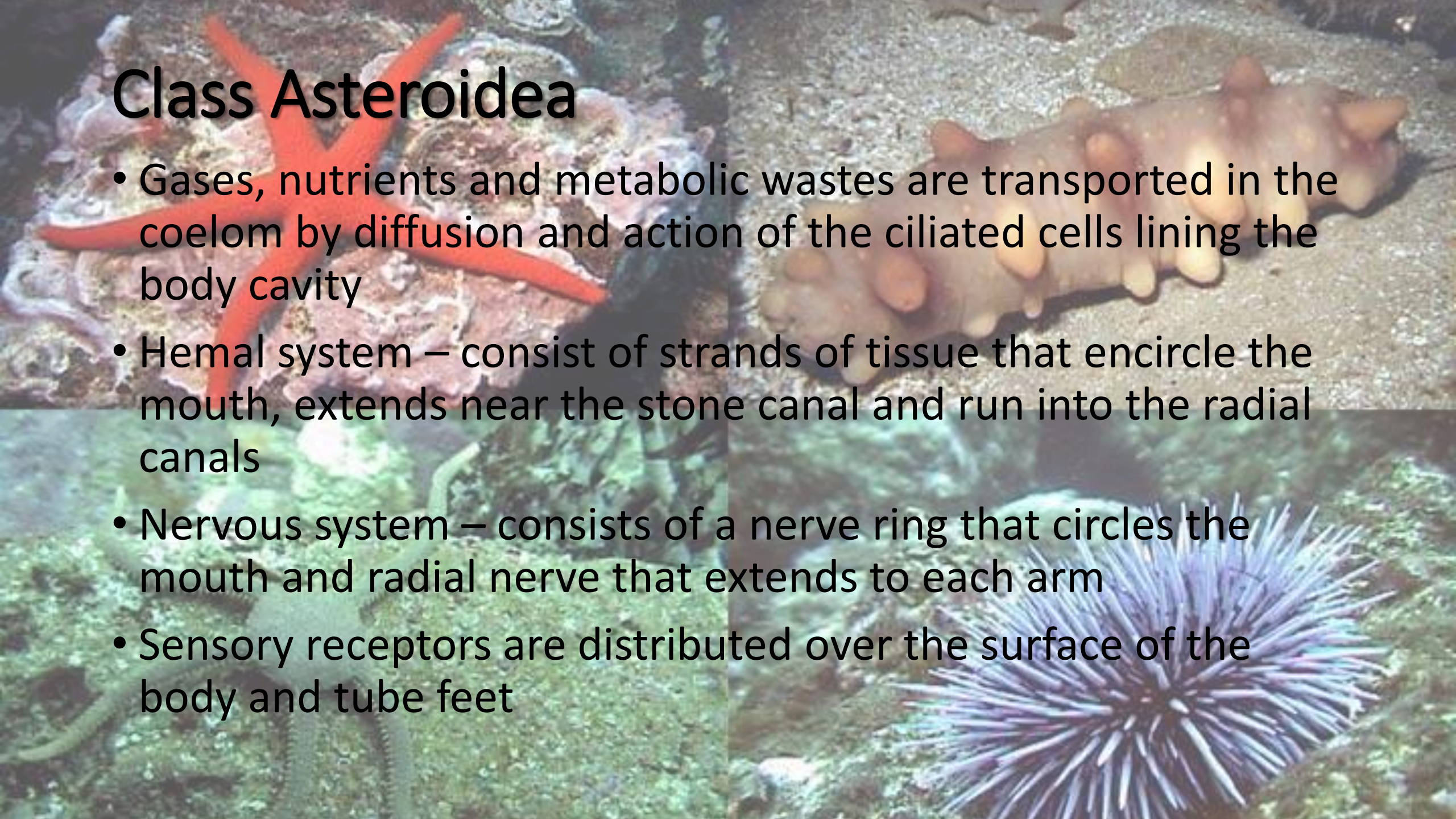
Class Asteroidea

- Sea stars
- Live on hard substrates
- Brightly colored with red, orange, blue or gray
- Has 5 arms, oral opening with oral spines
- With dermal brachiae, pedicellariae, ambulacral groove
- Feed on snails, bivalves, crustaceans, polychaetes, corals, detritus and others
- Mouth → esophagus → stomach (cardiac and pyloric) → pyloric caecae (2 in each arm) → rectal caecae → aboral surface



Class Asteroidea

- Gases, nutrients and metabolic wastes are transported in the coelom by diffusion and action of the ciliated cells lining the body cavity
- Hemal system – consist of strands of tissue that encircle the mouth, extends near the stone canal and run into the radial canals
- Nervous system – consists of a nerve ring that circles the mouth and radial nerve that extends to each arm
- Sensory receptors are distributed over the surface of the body and tube feet



Class Asteroidea

- Has the powers of regeneration
- Dioecious with 2 gonads in each arm with gonophores
- External fertilization
- Factors to consider are: temperature and photoperiod
- Embryos are planktonic with cilia → bipinnaria larva → brachiolaria larva → juvenile sea star



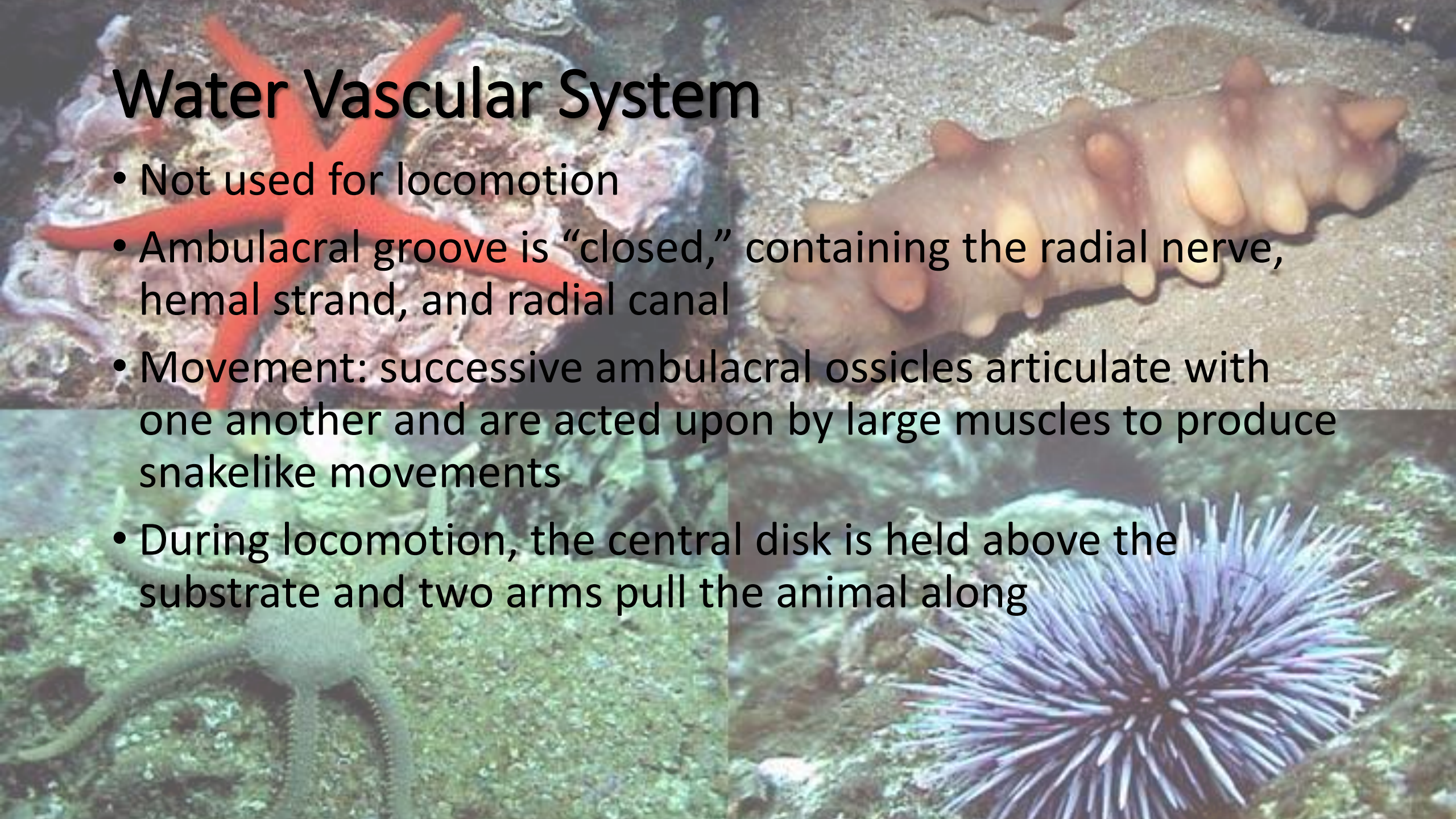
Class Ophiuroidea

- *Ophis*, snake + *oura*, tail + *oeides*, in the form of
- Includes basket stars and brittle stars
- Most diverse group of echinoderms
- Brittle stars have unbranched arms with a pentagonal central disk
- Basket stars – branched arms
- No dermal branchiae or pedicellariae
- No suction disks and ampullae
- Madreporite on the oral surface



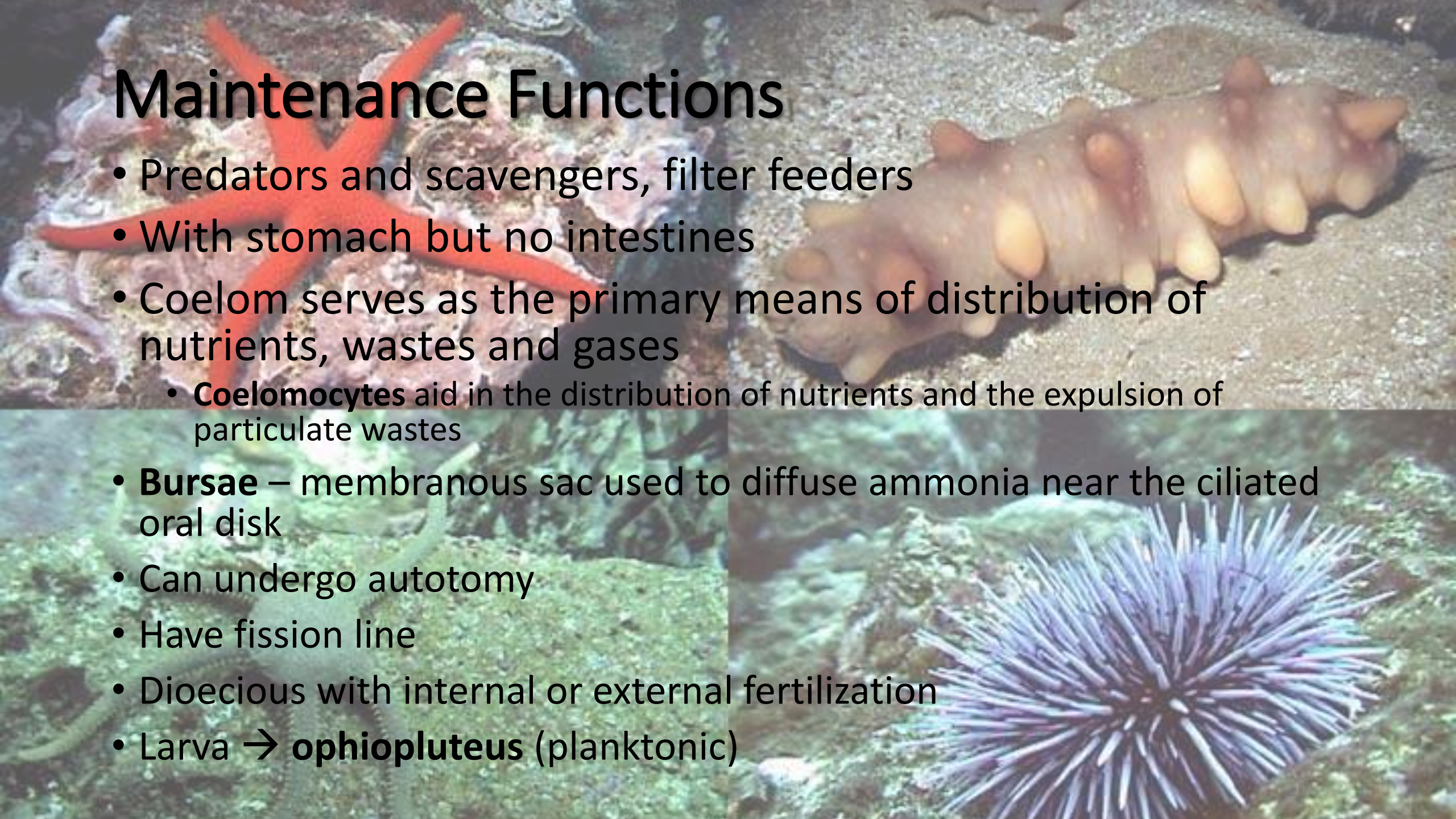
Water Vascular System

- Not used for locomotion
- Ambulacral groove is “closed,” containing the radial nerve, hemal strand, and radial canal
- Movement: successive ambulacral ossicles articulate with one another and are acted upon by large muscles to produce snakelike movements
- During locomotion, the central disk is held above the substrate and two arms pull the animal along



Maintenance Functions

- Predators and scavengers, filter feeders
- With stomach but no intestines
- Coelom serves as the primary means of distribution of nutrients, wastes and gases
 - **Coelomocytes** aid in the distribution of nutrients and the expulsion of particulate wastes
- **Bursae** – membranous sac used to diffuse ammonia near the ciliated oral disk
- Can undergo autotomy
- Have fission line
- Dioecious with internal or external fertilization
- Larva → **ophiopluteus** (planktonic)



Class Echinoidea

- Sea urchins, sand dollars and heart urchins
- Echinoids, spiny + ooids, in the form of
- Specialized in living in hard substrates
- Sea Urchins
 - Rounded with oral end oriented towards the substrate
 - Skeleton is called the test
 - Spines may be venomous
 - Pedicellariae may have either 2 or 3 jaws
- Move by using spines for pushing against the substrate and tube feet for pulling



Sea Urchin

**Bottom Side
(Oral side)**

**Top Side
(Aboral side)**

Sharp spines pointing
out in all directions;
spines are connected
to the skeleton by
ball-joints

test or
"skeleton"

Mouth

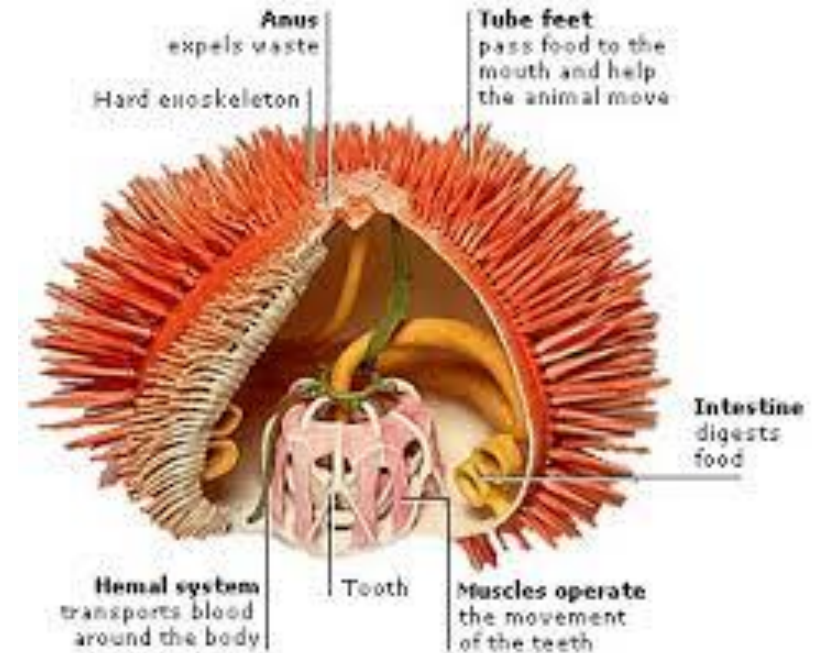
Anus

5 tooth-like plates that
point inwards - called
Aristotle's lantern.

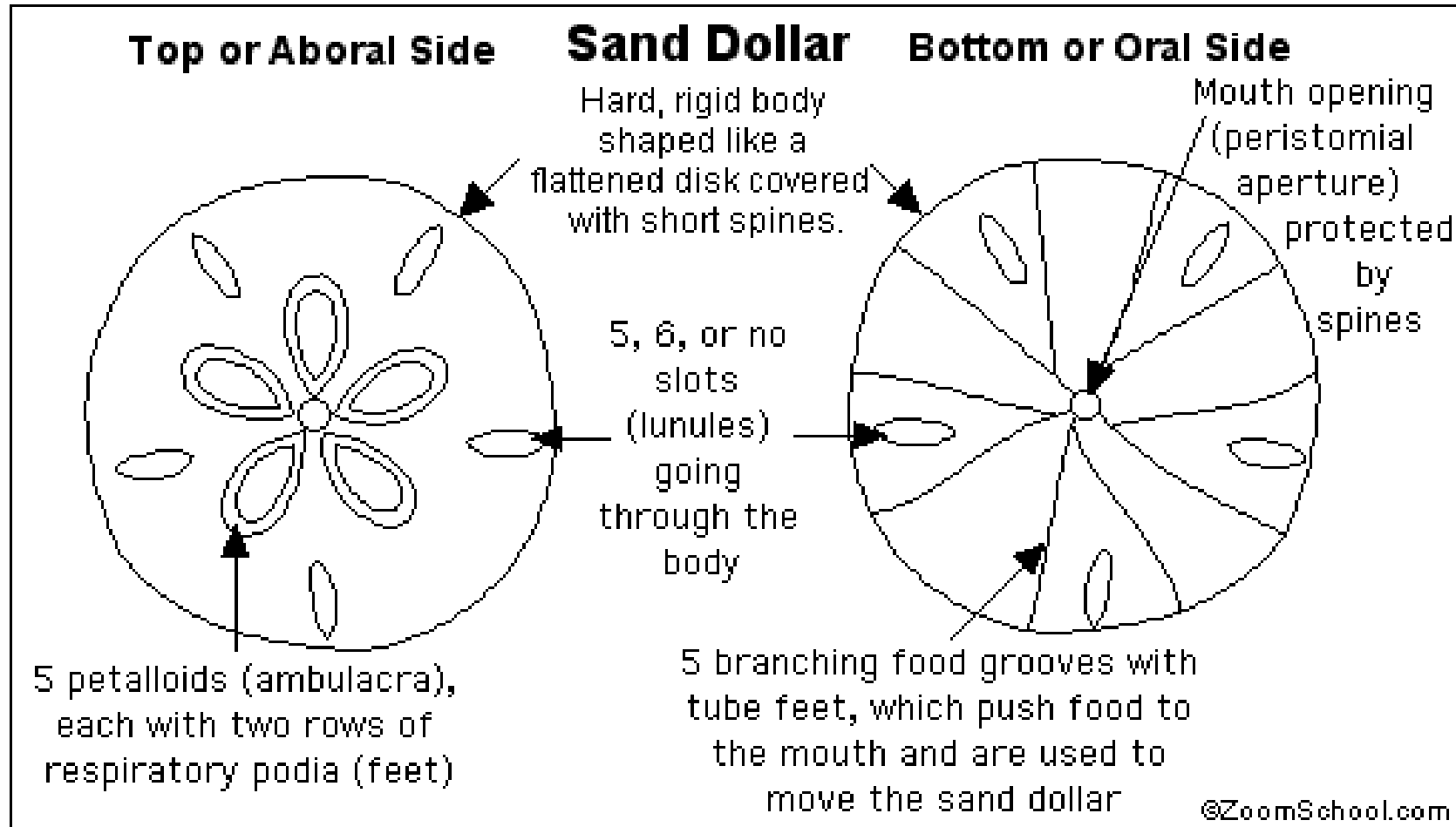
Podia
surrounding
mouth

Genital
plate

Gonopore



Sand Dollar Anatomy

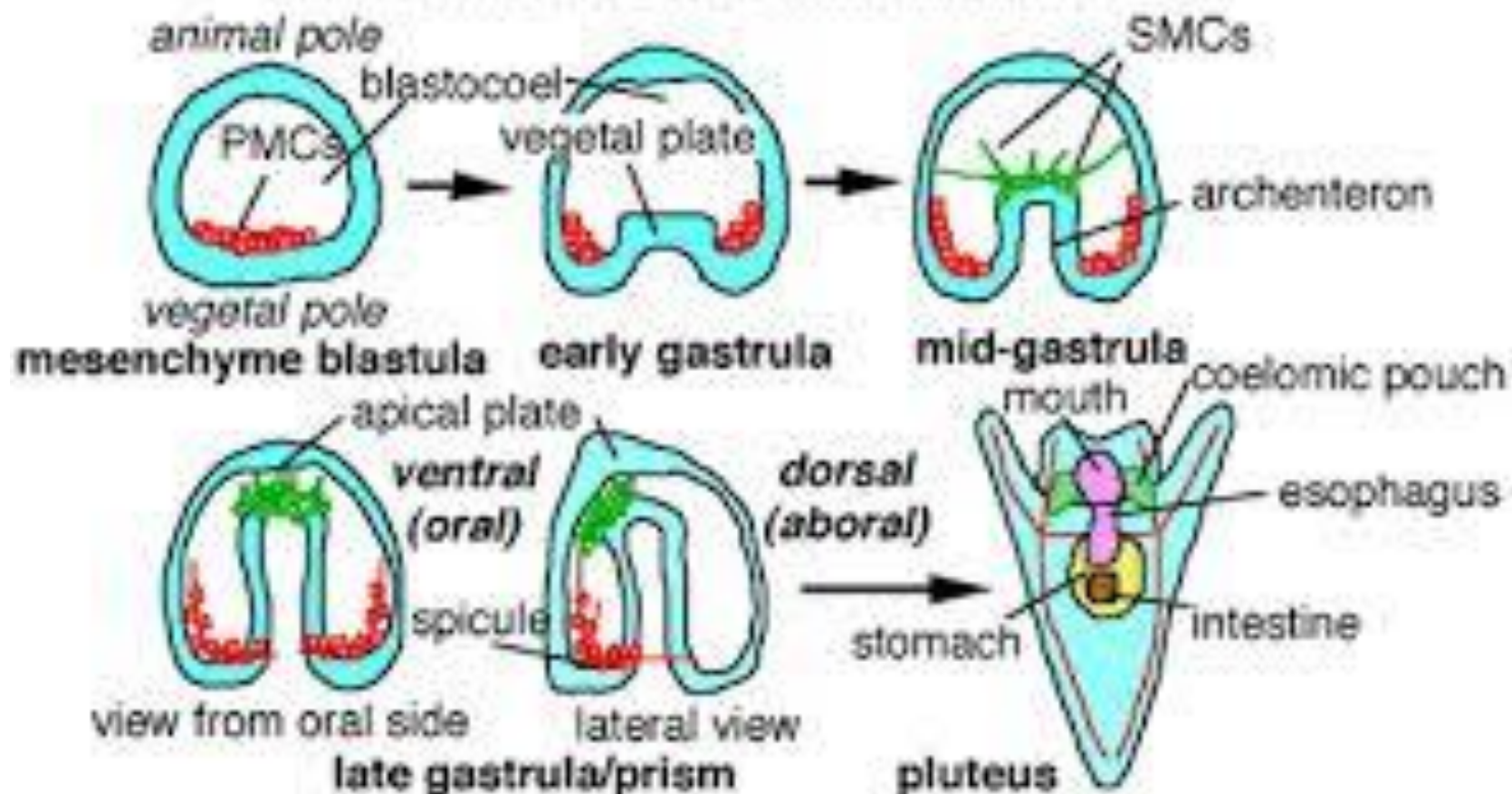


Maintenance Functions

- Feed on algae, bryozoans, coral polyps and dead animals
- *Aristotle's lantern* – chewing apparatus that can be projected from the mouth
- Mouth cavity leads to the pharynx, esophagus, intestines and anus
- Large coelom with coelomic fluids
- Gas exchange occurs by diffusion
- Dioecious, gonads found in the internal body wall of the interambulacral plates
- Fertilization is external → **pluteus larva**

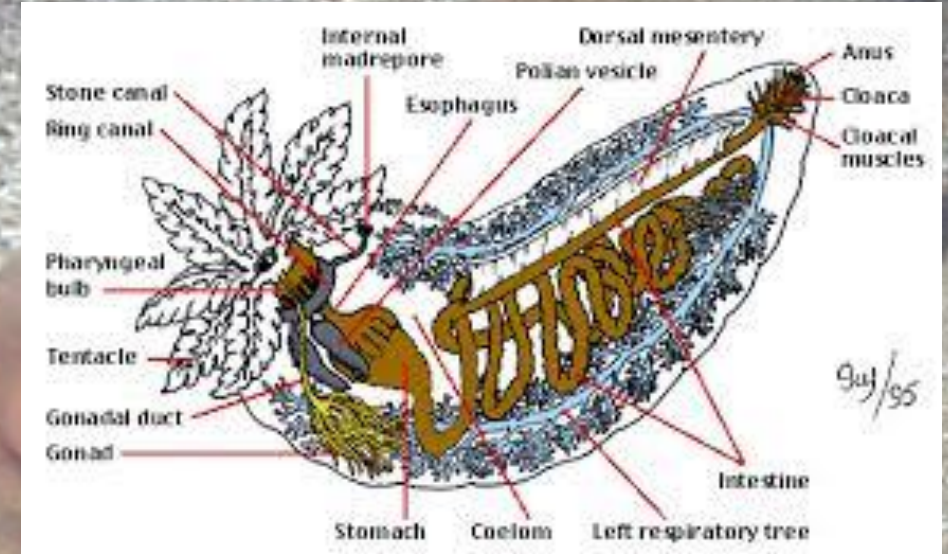


An Overview of Sea Urchin Gastrulation

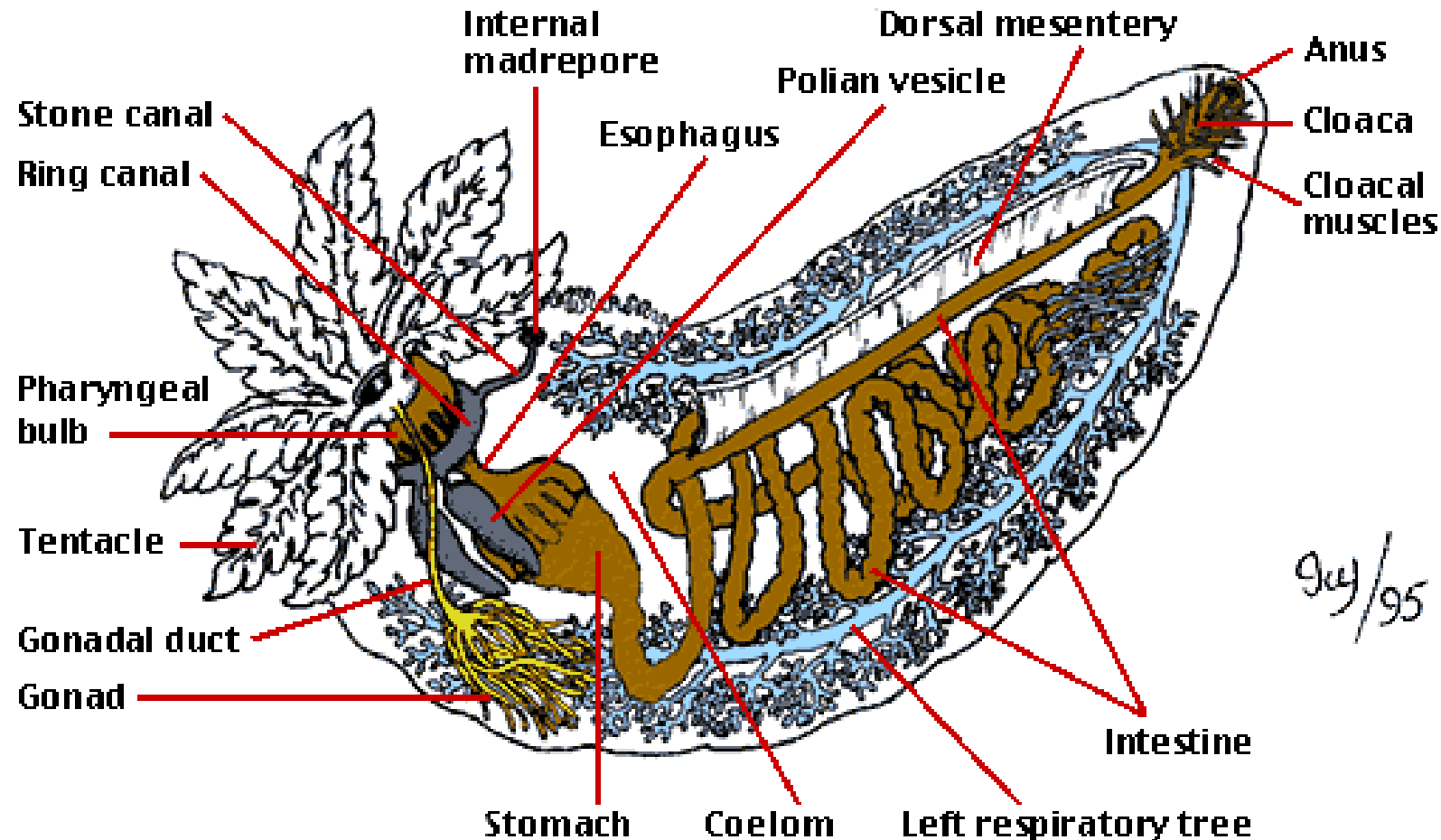


Class Holothuroidea

- Sea cucumbers
- Found at all depths in all oceans
- Elongated oral-aboral axis, no arms
- Tube feet surrounding the mouth called tentacles
- No protruding spines (pedicellariae)
- Microscopic ossicles
- Internal madreporite
- Ring canal encircles the oral end and gives rise to 1 to 10 Polian vesicles



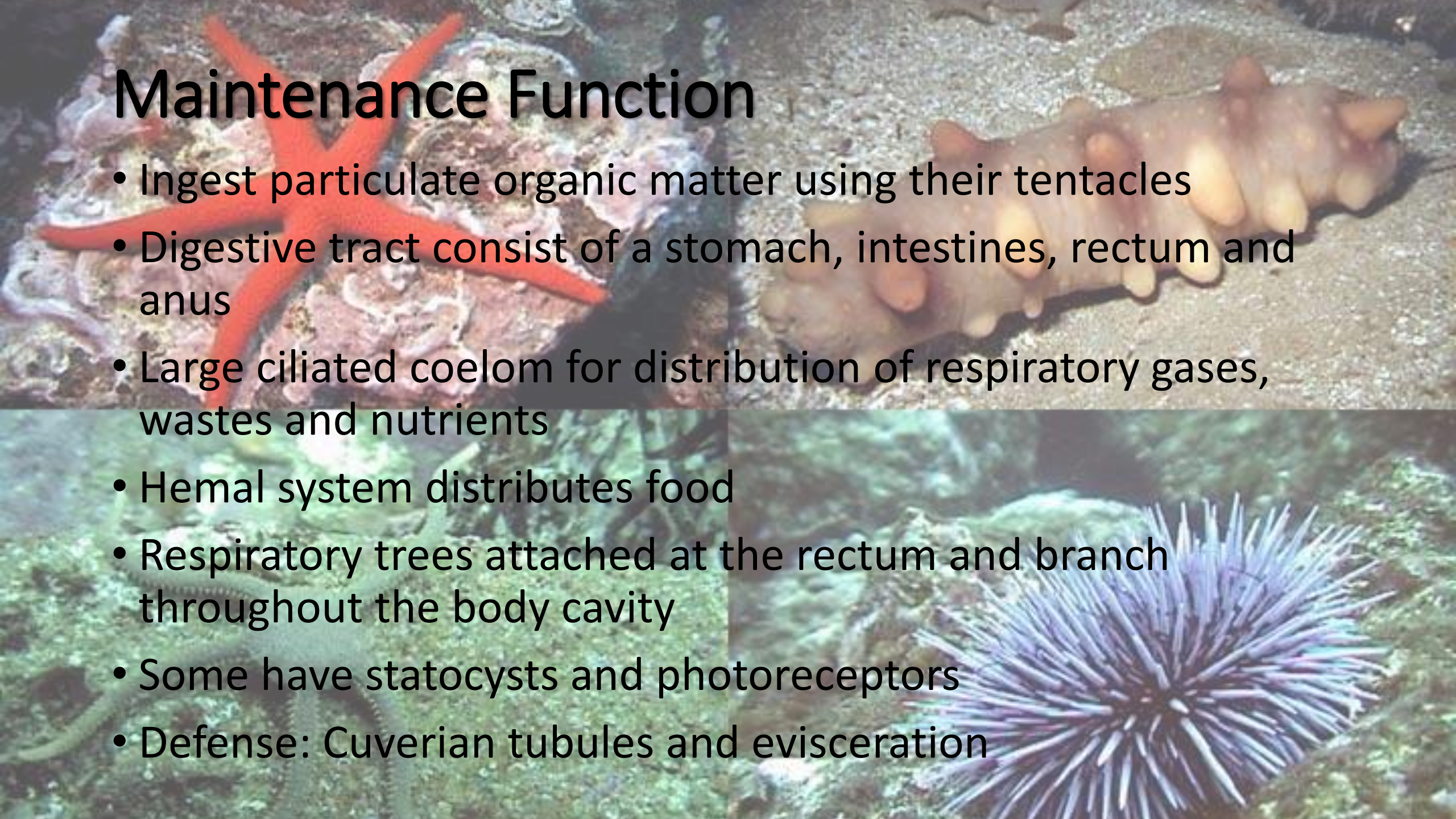
Sea Cucumber Anatomy





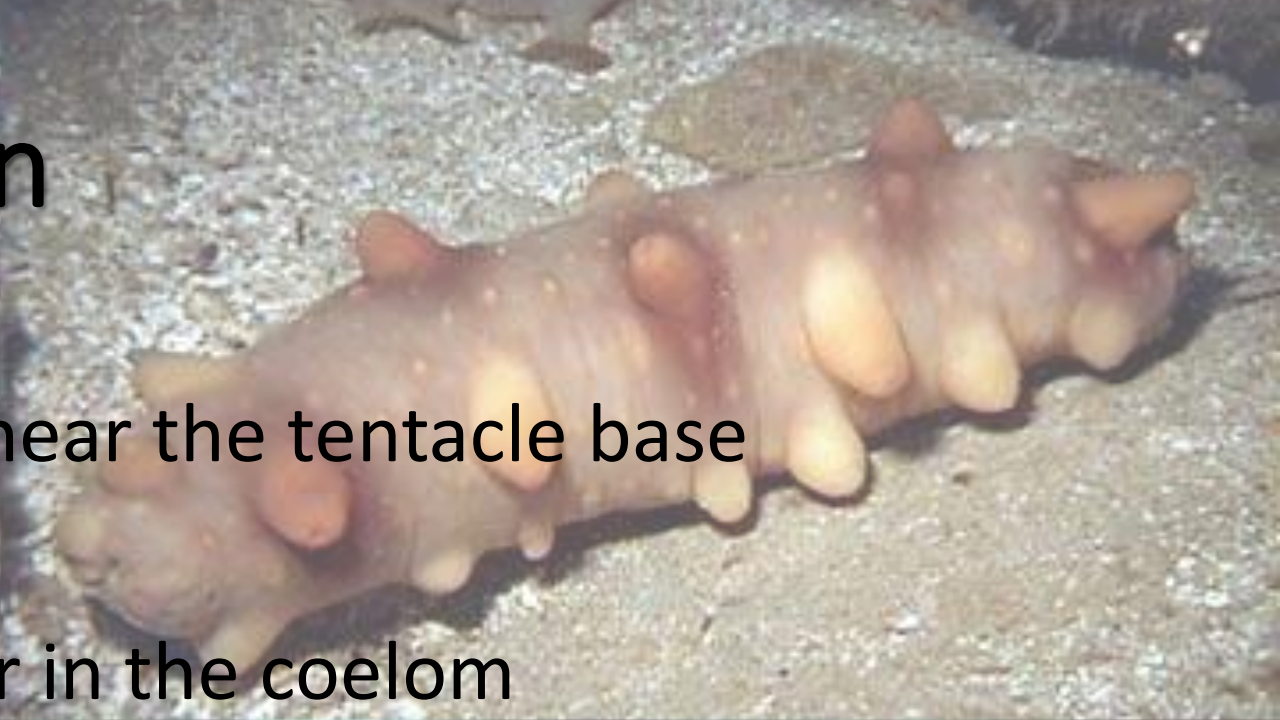
Maintenance Function

- Ingest particulate organic matter using their tentacles
- Digestive tract consist of a stomach, intestines, rectum and anus
- Large ciliated coelom for distribution of respiratory gases, wastes and nutrients
- Hemal system distributes food
- Respiratory trees attached at the rectum and branch throughout the body cavity
- Some have statocysts and photoreceptors
- Defense: Cuverian tubules and evisceration



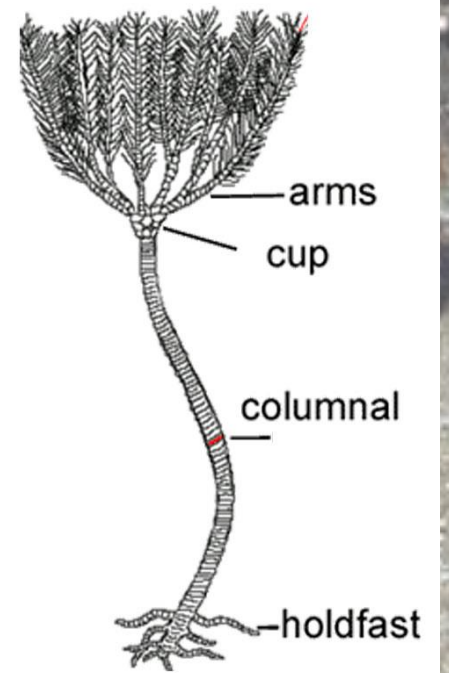
Maintenance Function

- Dioecious
- Single gonad and gonophore near the tentacle base
- External fertilization
- Eggs are brooded externally or in the coelom
- Transverse fission



Class Crinoidea

- Krinoid, lily + ooides, in the form of
- Sea lilies and feather stars
- Most primitive and most different
- Attach permanently in their substrate by a stalk
- Stalk with projections, or cirri, arranged in whorls called the crown
- Aboral end of the crown attached to the stalk is called the calyx
- Ambulacral groove lead toward the mouth
- Mouth and anus open onto the upper surface



Class Concentricycloidea

- Single described species known as sea daisies
- Lack arms
- Less than 1 cm diameter
- Have 2 circular water-vascular rings encircling the disklike body
 - Outer ring – contains tube feet and ampullae
- Have Polian vesicles
- No internal digestive system
- Velum – covers the surface of the animal applied to a substrate and digests and absorbs nutrients
- No free swimming larval stages are apparent



Echinoderms

