

Invertebrates – Protostomes II

Annelids



Mollusca



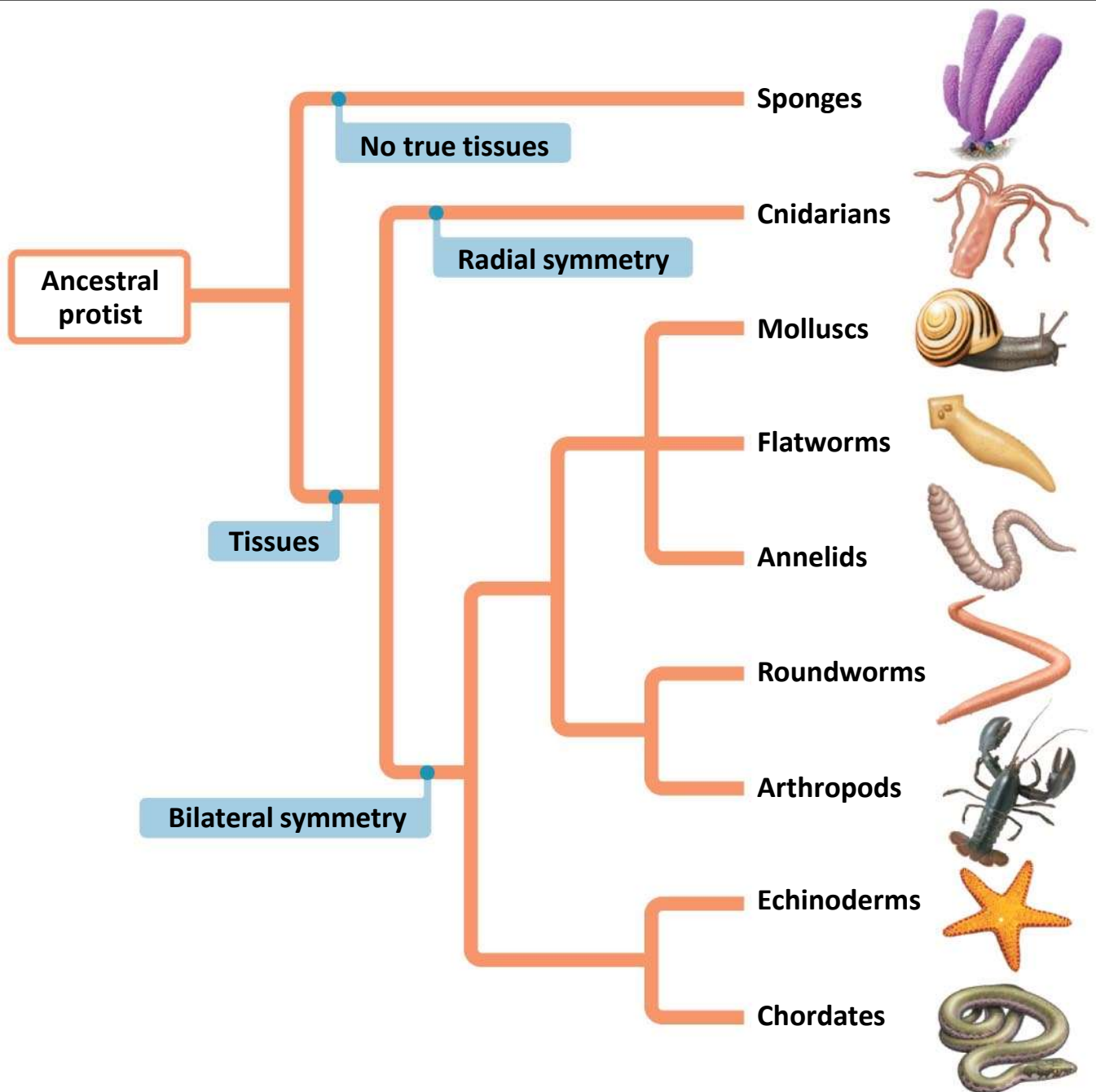


Figure 17.5

Sponges - Porifera

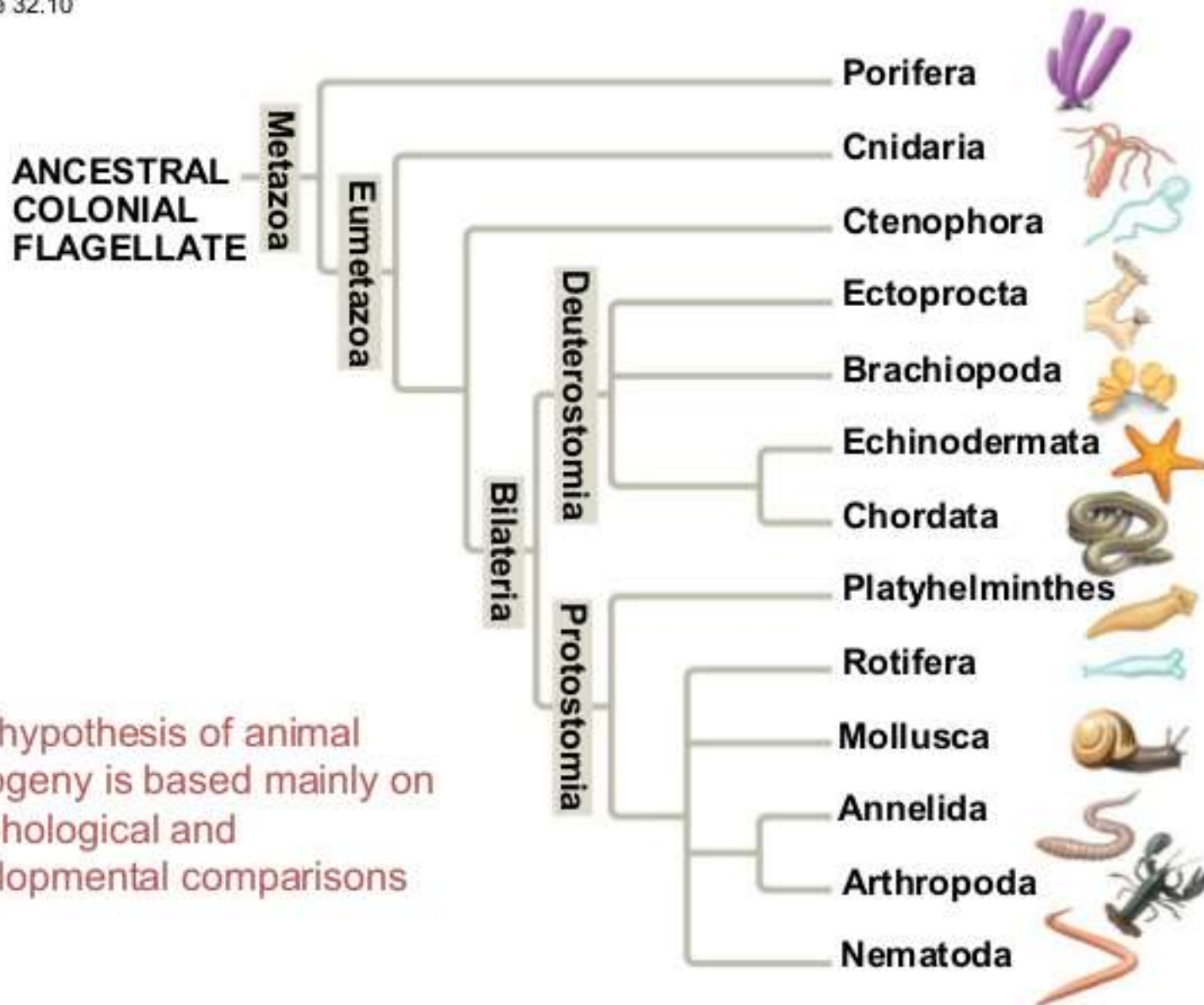


Cnidaria - Purple striped jelly, *Pelagia panopyra*



Animal Diversity

Figure 32.10



One hypothesis of animal phylogeny is based mainly on morphological and developmental comparisons

Coelomate Animals

Cavity develops entirely within the mesoderm
Makes it easier for complex organs to develop
Permits a closed circulatory system

Two major kinds:

- **Protostome** – mouth develops from blastopore.
Rotifers, Flatworms, Annelids, Molluscs, Arthropods
- **Deuterostome** – anus forms from blastopore
Echinoderms, Chordates



Blastopore

becomes the mouth



Annelida
Mollusca
Onychophora
Arthropoda

Protostomes

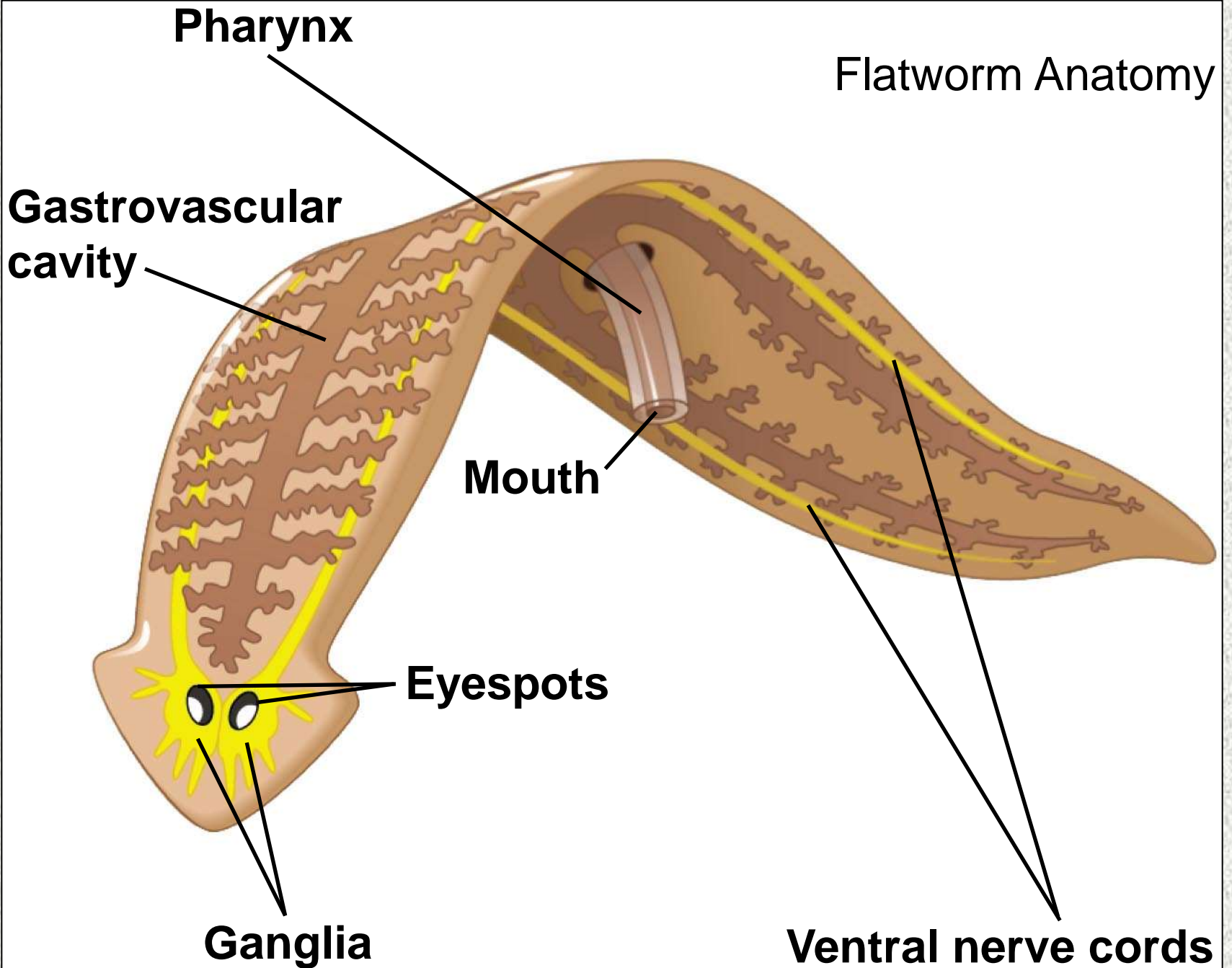
becomes the anus

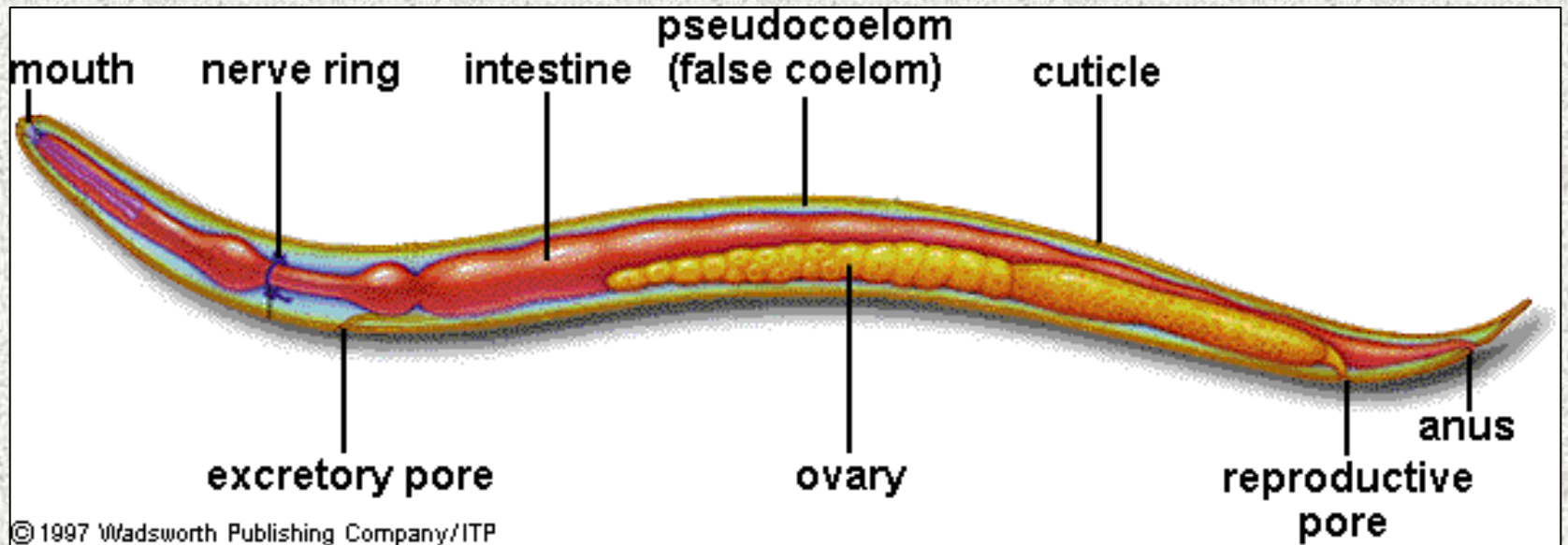
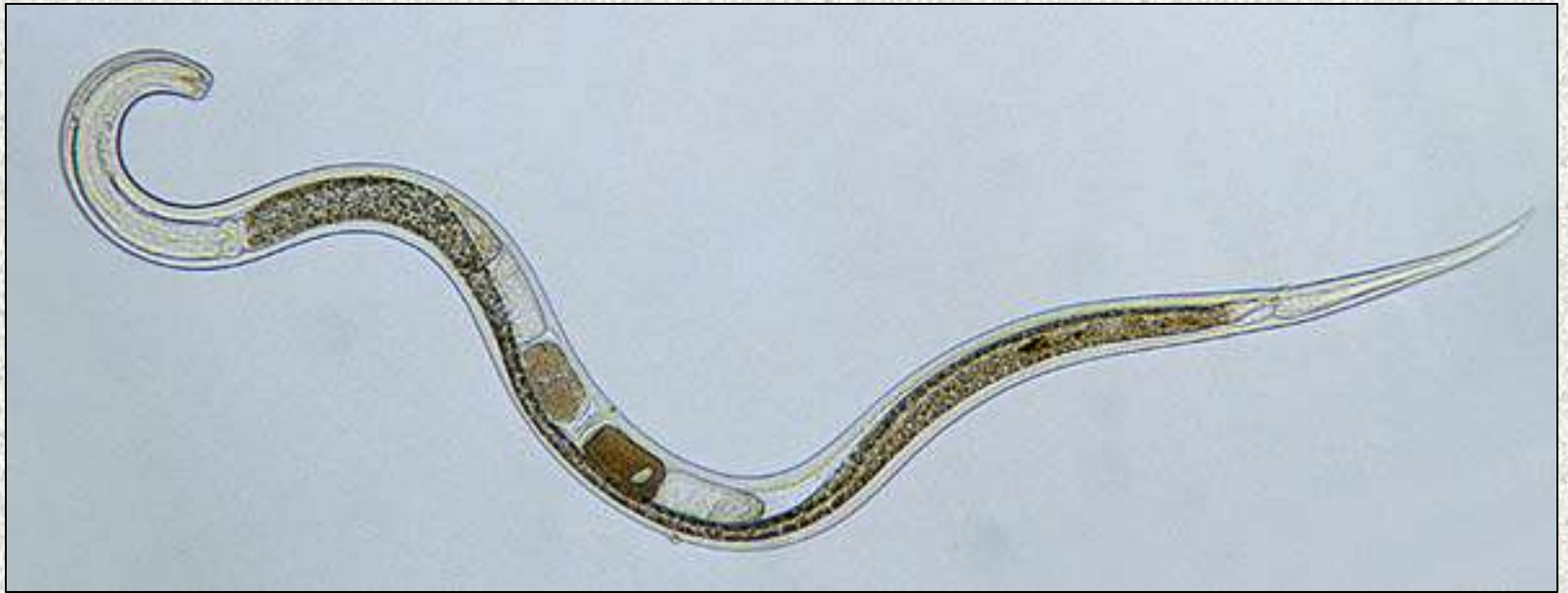


Echinodermata
Chordata

Deuterostomes

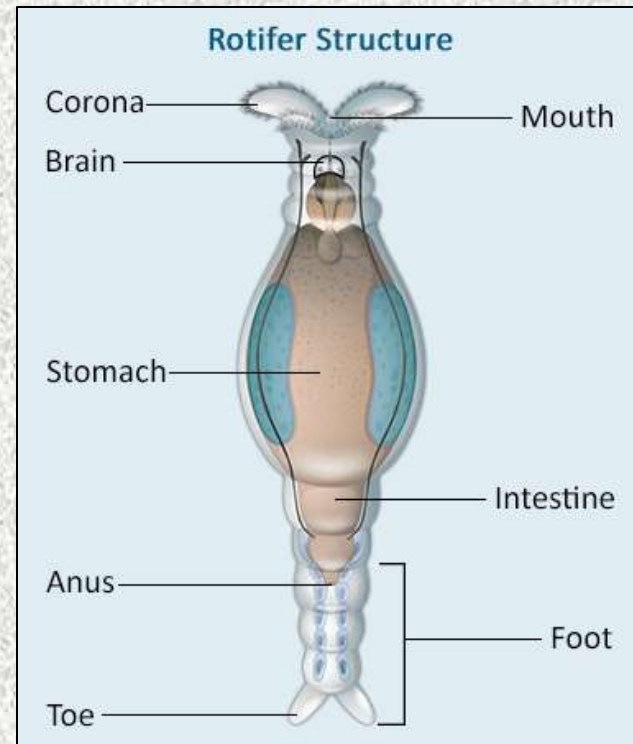
Flatworm Anatomy





Rotifers

- Tiny animals that inhabit fresh water, the ocean, and damp soil
- Smaller than many protists but are truly multicellular and have specialized organ systems



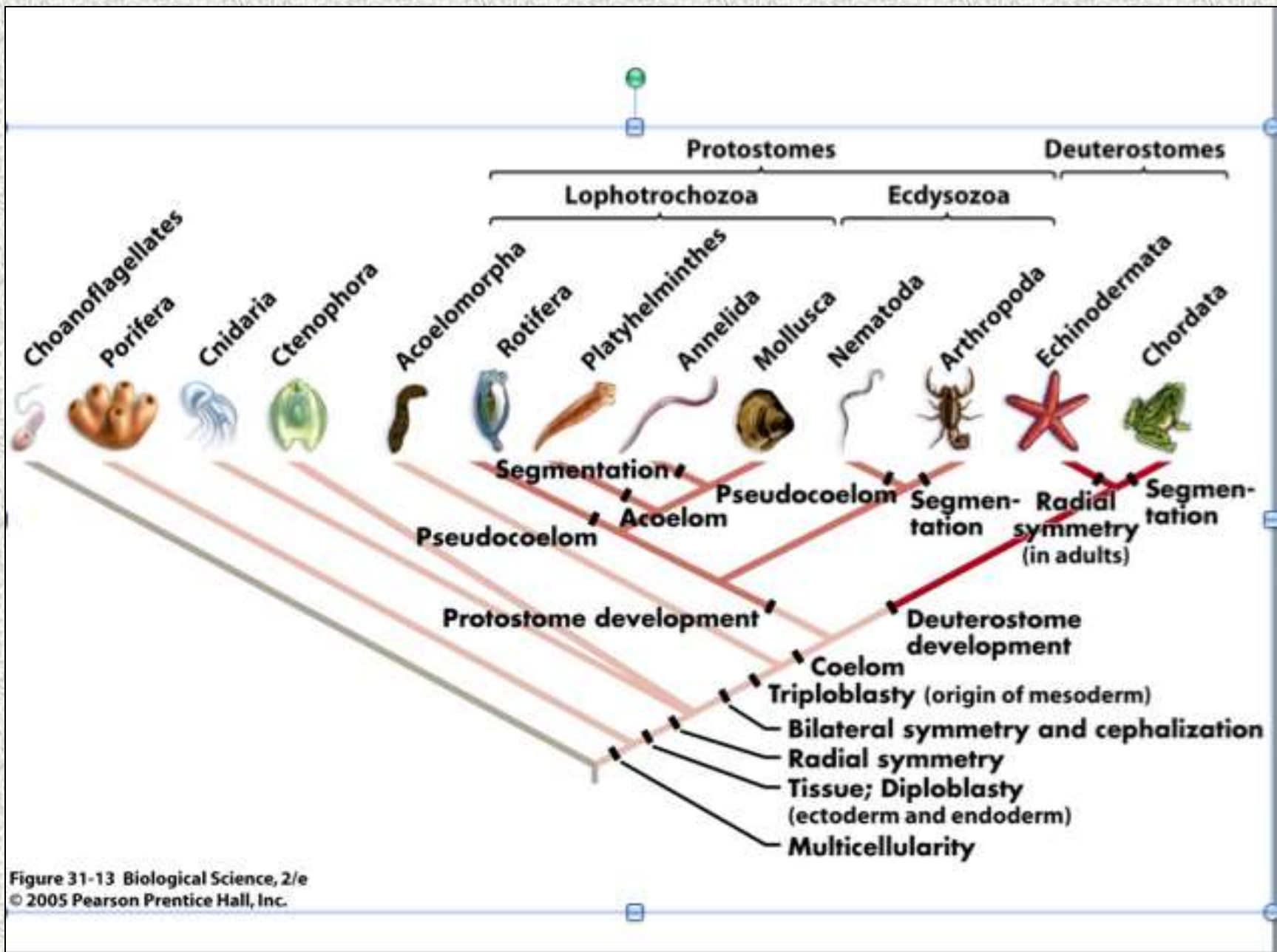
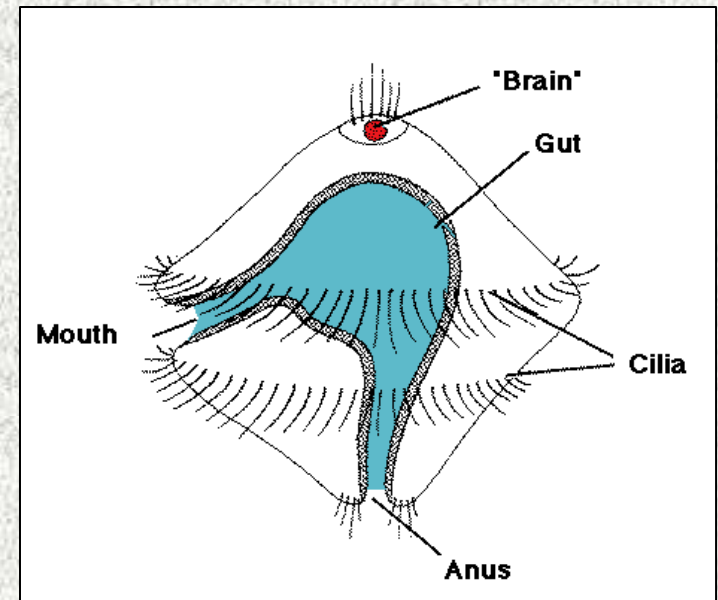
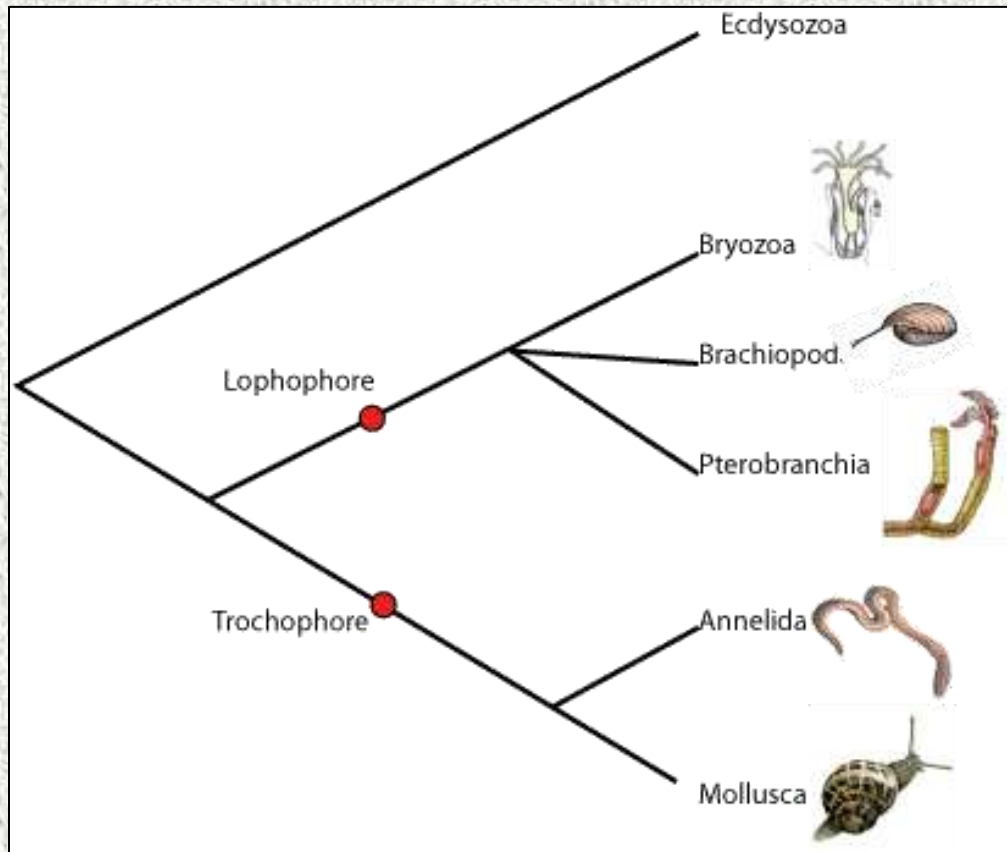


Figure 31-13 Biological Science, 2/e
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The Protostomes are divided into two groups:

1. **Lophotrochozoa** - which includes the segmented worms, molluscs, lophophorates and several smaller phyla.

2. **Ecdysozoa** - which includes the arthropods and several other phyla that periodically molt.



trochophore larva

Molluscs – Phylum Mollusca

- Snails and slugs, oysters and clams, and octopuses and squids
- Large phylum, second only after Arthropods
- Widespread, abundant, 50,000 known
- Most marine, some freshwater, a few terrestrial (snails, slugs)



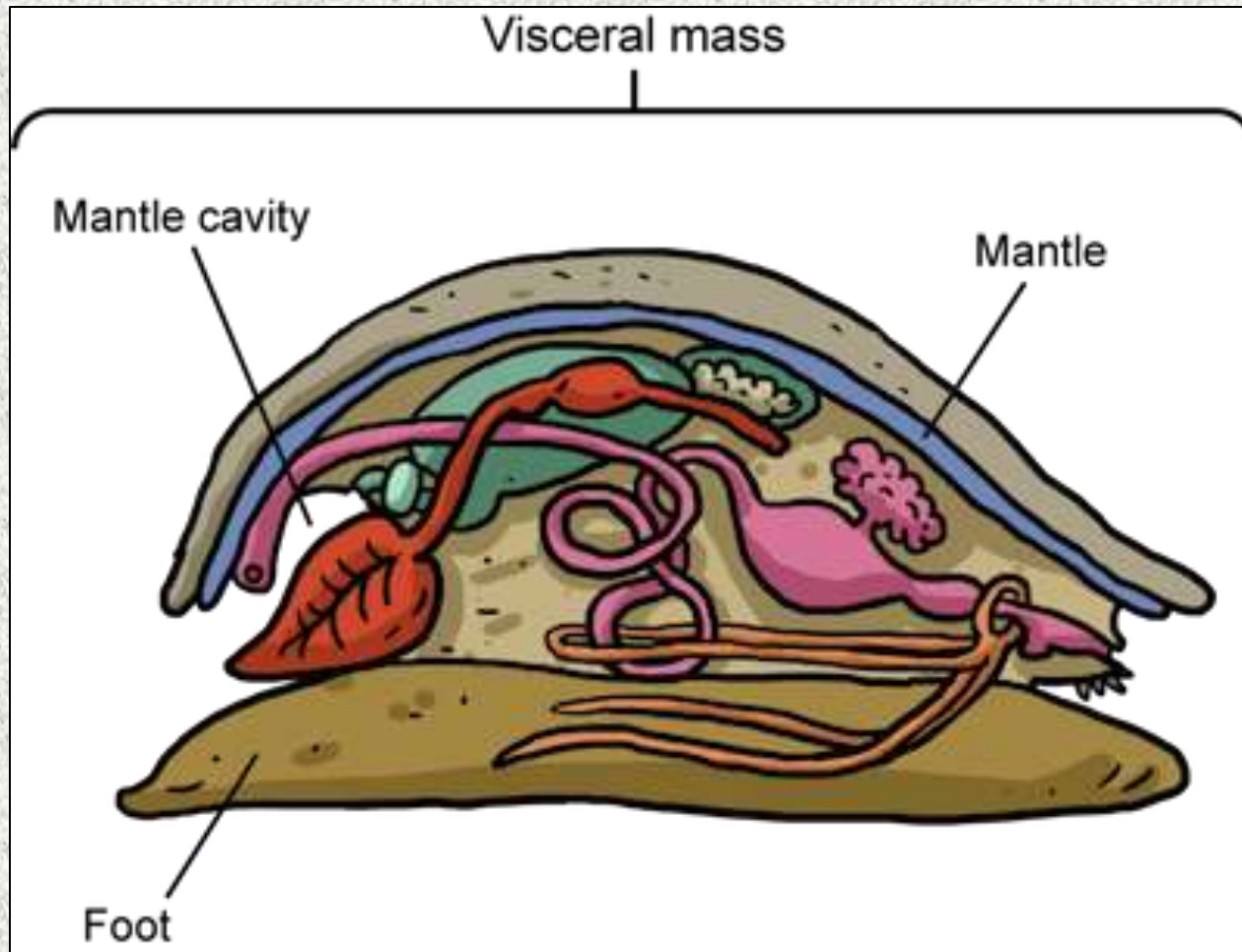
Mollusca Characteristics

- Bilateral symmetry, cephalization
- Coelom, reduced to region around heart
- Mantle
 - draped over viscera
 - secretes shell
- Complete digestive tract, radula
- Trochophore larvae
- Locomotion by muscular foot
- Heart, liver, gills (ctenidia), kidney

Mollusc Structure

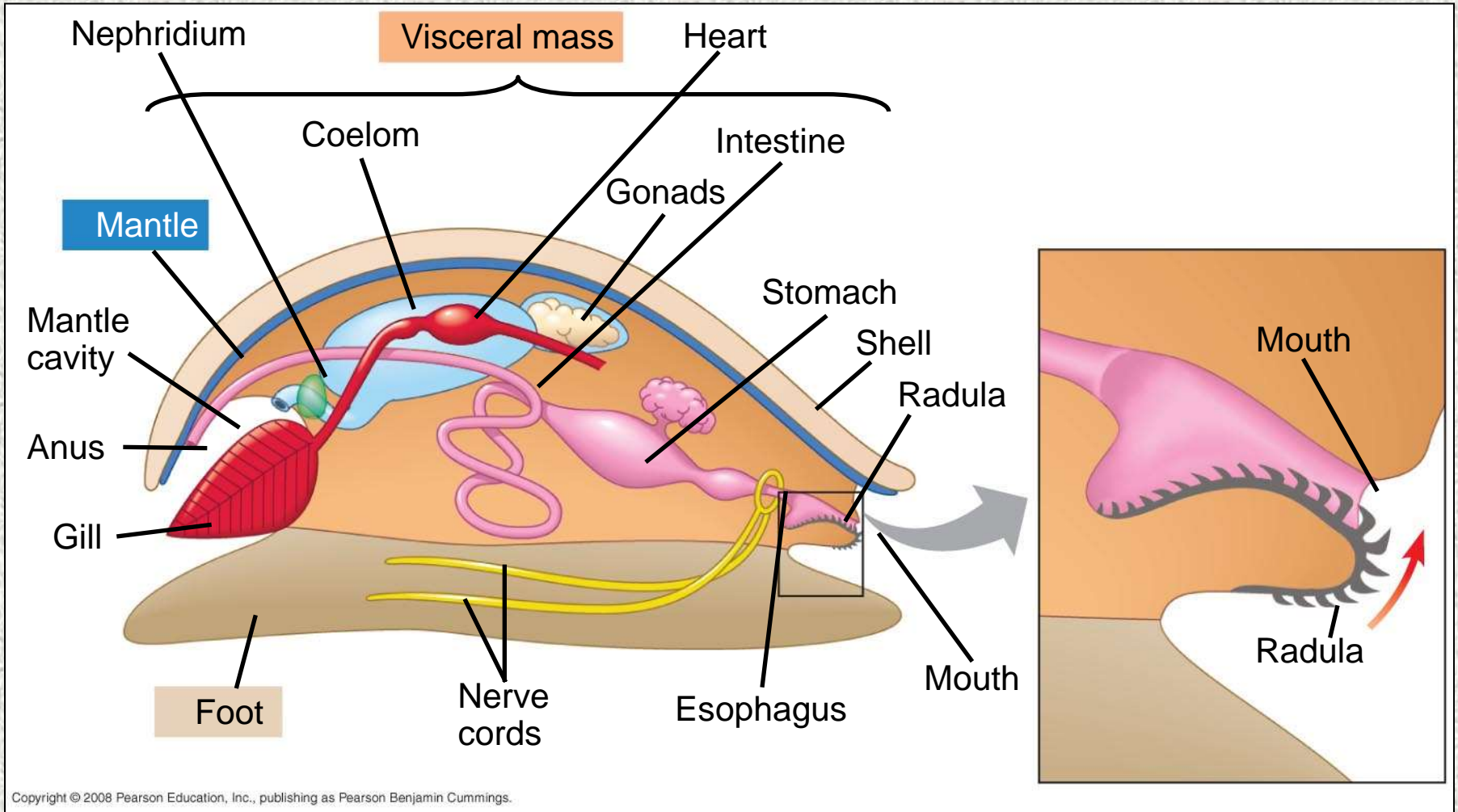
- Molluscs are soft-bodied animals, but most are protected by a hard shell
- All molluscs have a similar body plan with three main parts:
 1. **Muscular foot** - movement
 2. **Visceral mass** - organs
 3. **Mantle** - secretes the shell
- Many molluscs also have a water-filled **mantle cavity**, and feed using a rasplike **radula**

Molluscs share a three-part body plan



Visceral mass contains the organs

Have a mouth, heart, stomach, nervous system, gonads, and an anus

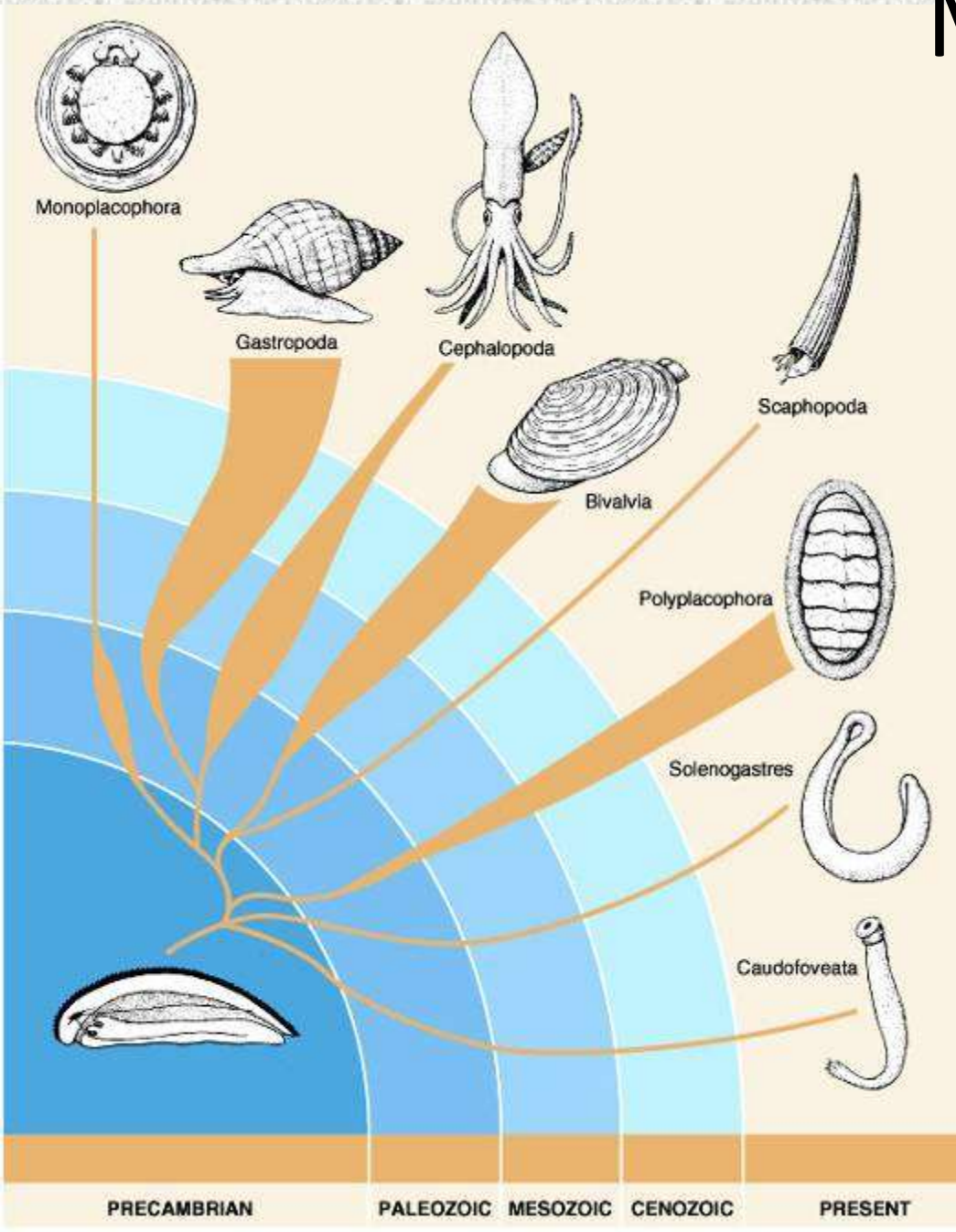


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Foot – muscular organ

Radula scraping/feeding structure

Mollusc Phylogeny



- 50-80,000 extant species
- 40,000 extinct species
- Fossil records from precambrian period of proterozoic eon (>570my BP)

Ammonites – extinct group related to squid

Lived in the seas between 240 - 65 million years ago, when they became extinct along with the dinosaurs



Ammonites



Major Groups Of Molluscs

- **Chitons**, overlapping plates
- **Gastropods**, protected by a single, spiraled shell
- **Bivalves**, with a shell divided into two halves hinged together
- **Cephalopods** typically lacking an external shell, built for speed and agility

Gastropods



Snail (spiraled shell)



Sea slug (no shell)

Bivalves (hinged shell)



Scallop

Cephalopods (large brain and tentacles)

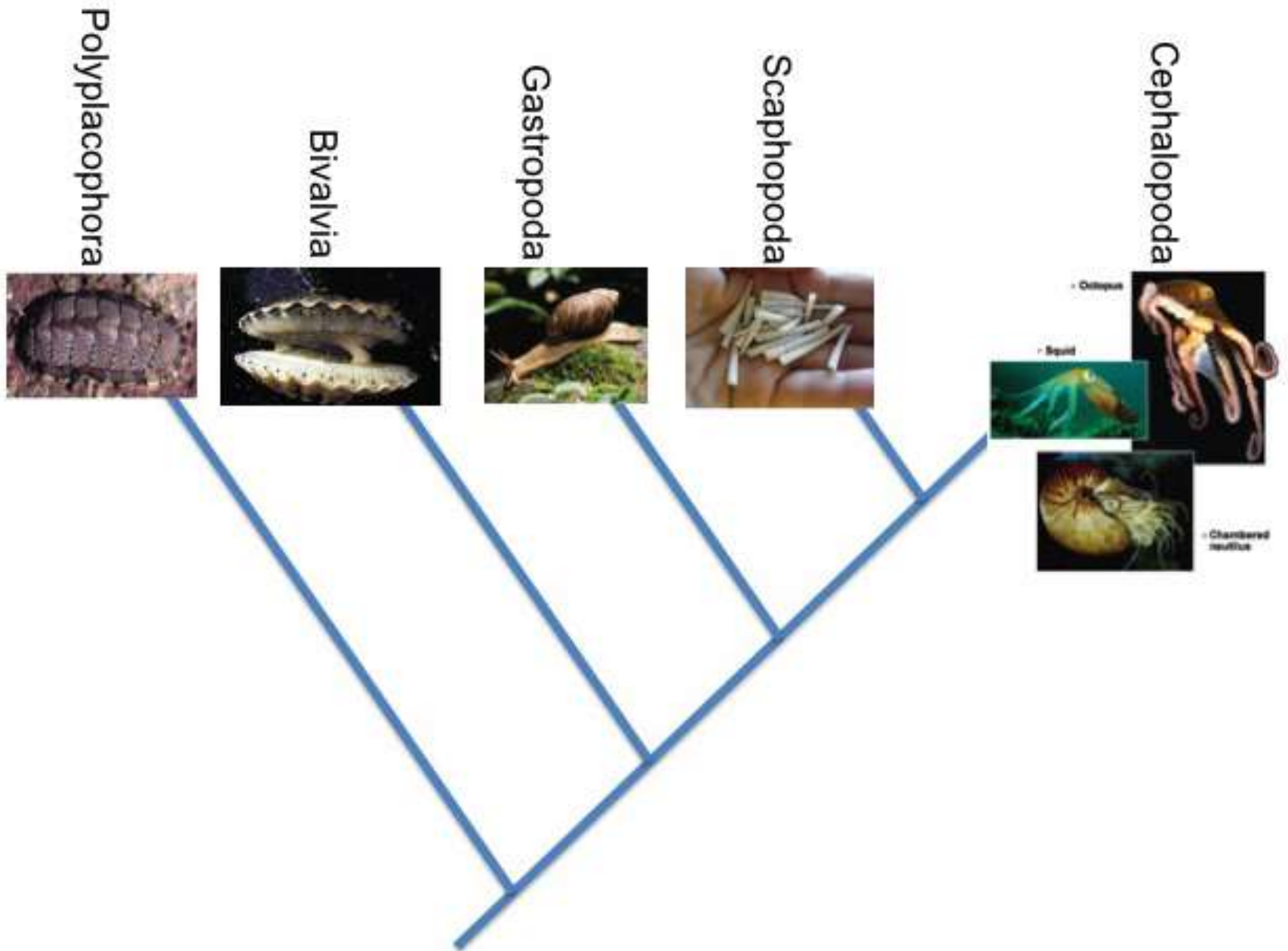


Octopus



Squid

Molluscan classes



Chitons

- Class Polyplacophora (poly= many; plachos= plates)
- Oval-shaped marine animals encased in an armor of six to eight dorsal plates



Feed on algae,
use their radula
to separate it
from the rock

Chitons



Chiton Characteristics

- Elongated, dorsoventrally flattened
- Reduced head
- Bilaterally symmetrical
- Radula present
- Shell of eight dorsal plates
- Foot broad and flat
- Multiple gills, along sides of body between foot and mantle edge



Bivalves

- Class Bivalvia includes clams, oysters, mussels, and scallops
- Shell divided into two halves



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- The mantle cavity contains gills used for gas exchange and feeding
- Filter feeders

Eyes
Sense changes in light

Bivalve Characteristics

- Body enclosed in mantle
- shell has two lateral valves with dorsal hinge
- Umbo – oldest part of shell
- Head greatly reduced
- No radula
- A few species with eyes on mantle margin
- foot usually wedge-shaped, used for burrowing

Scallops Swimming

<https://www.youtube.com/watch?v=H5O1XYZcDh8>

World's Weirdest - Clams vs. the World

<https://www.youtube.com/watch?v=KVFDfv6R2M>

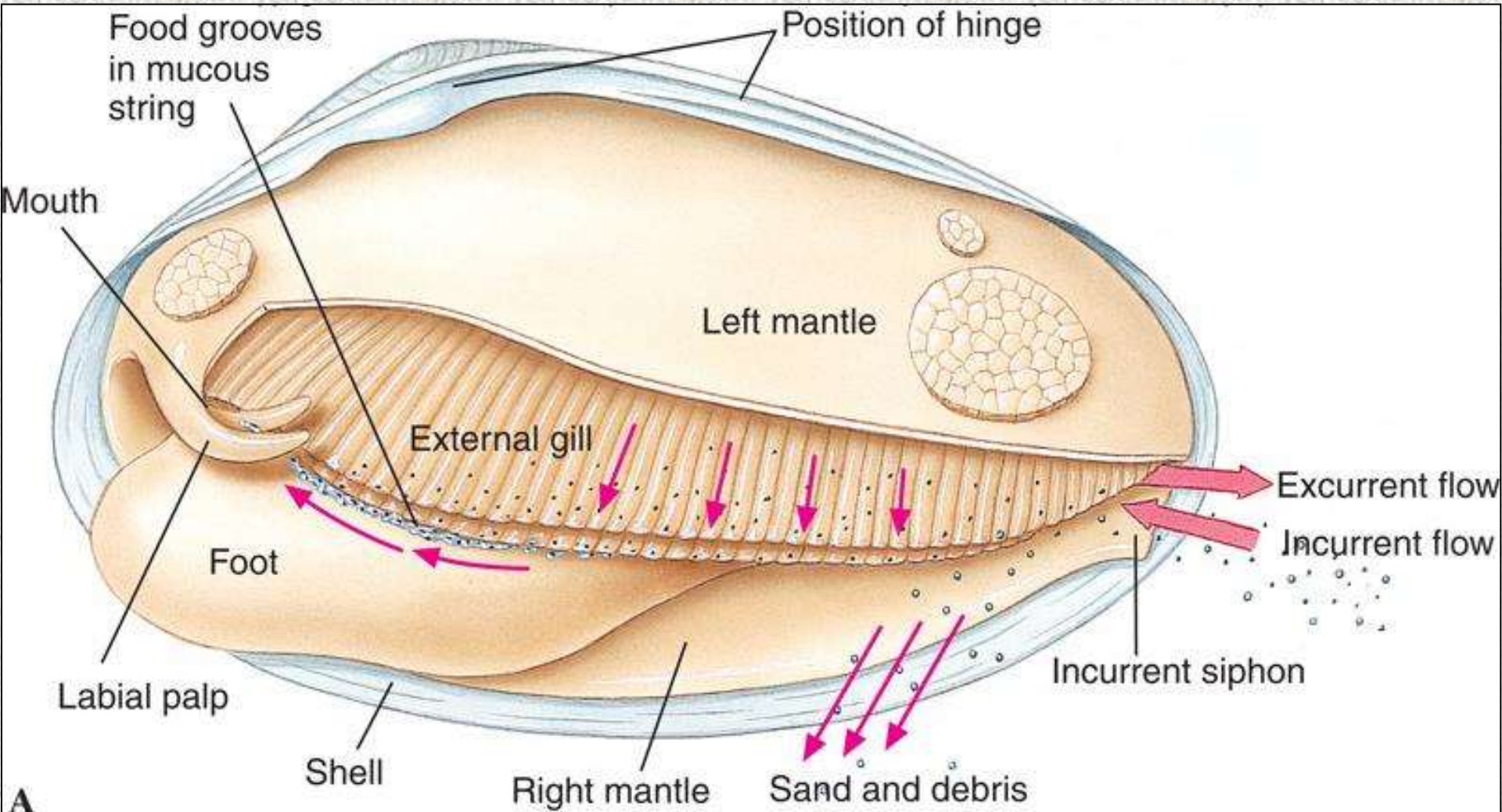
Bivalvia

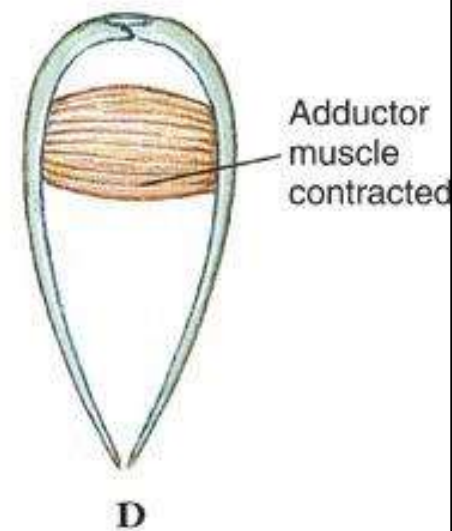
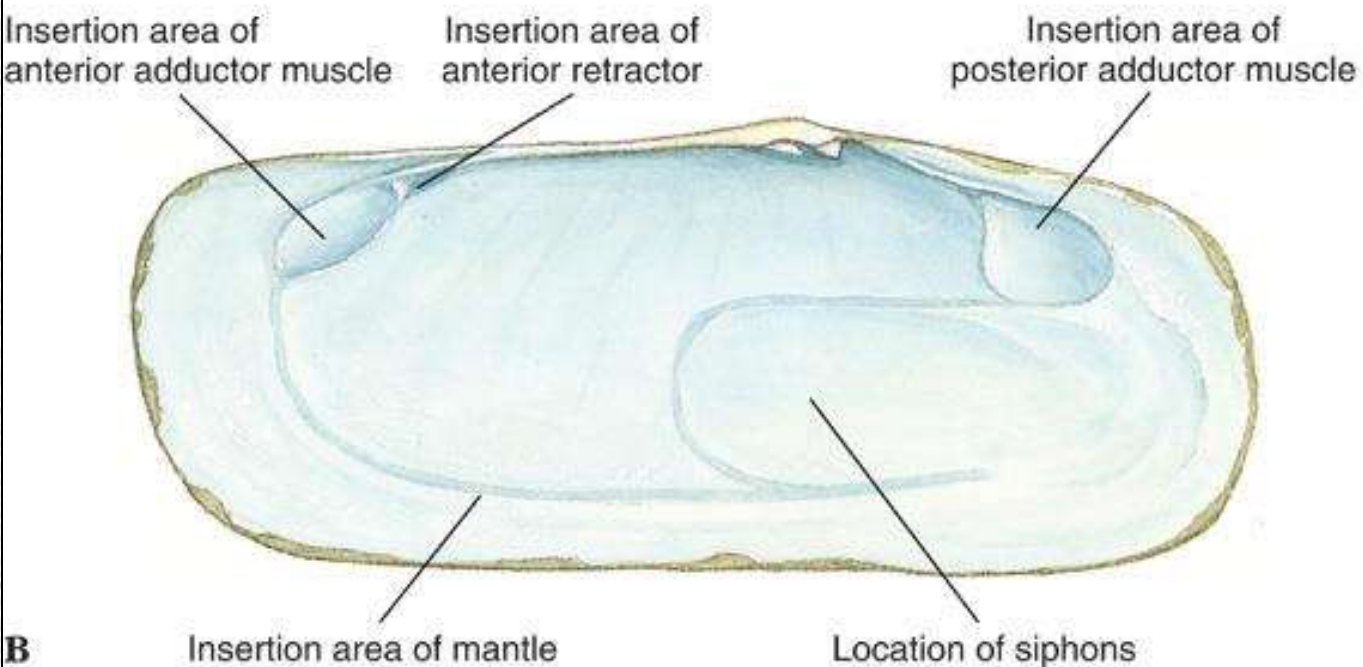
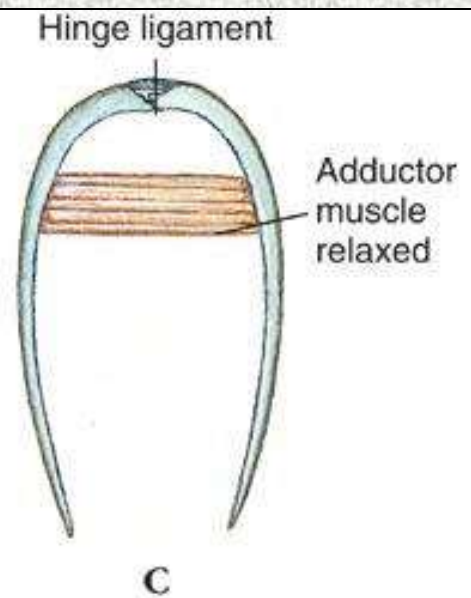
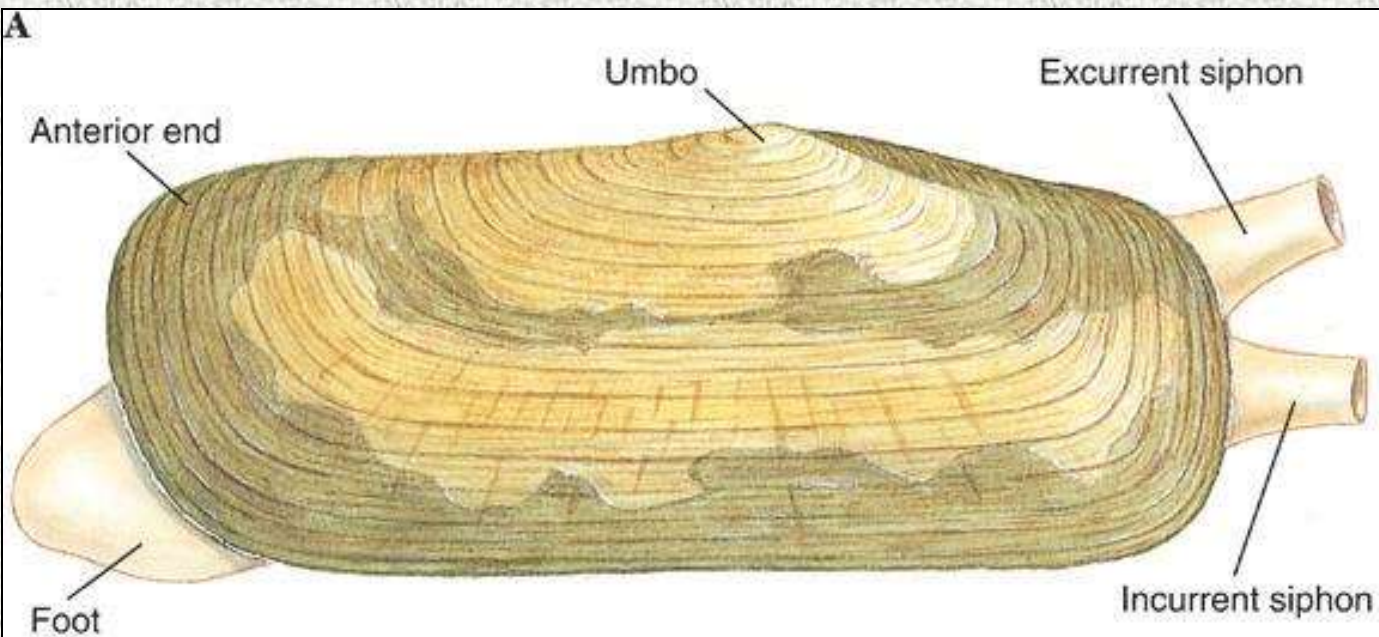
- Two shells
- Incurrent and excurrent siphons
- No cephalization



Bay scallop (*Aequipecten irradians*)

Clams have ciliated gills, incurrent and excurrent siphons brings water, food filtered out of water





Freshwater Mussels

Missouri River



- Edible Clams, oysters, mussels, scallops
- Many species



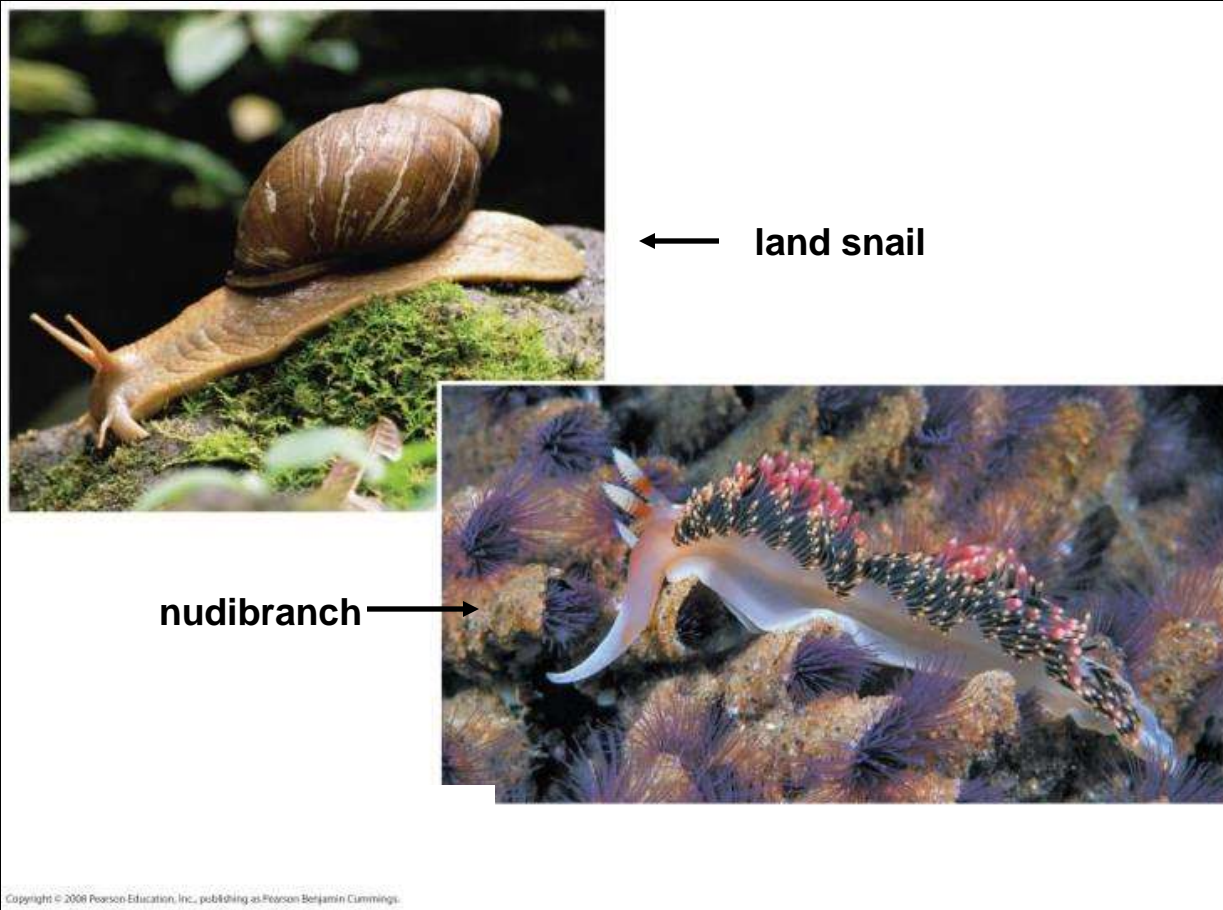
Clams in white wine sauce



Edible mussels
(*Mytilus edulis*)

Gastropods

- Gastro= stomach; pod= foot
- About three-quarters of all living species of molluscs are gastropods



Helix – garden snail

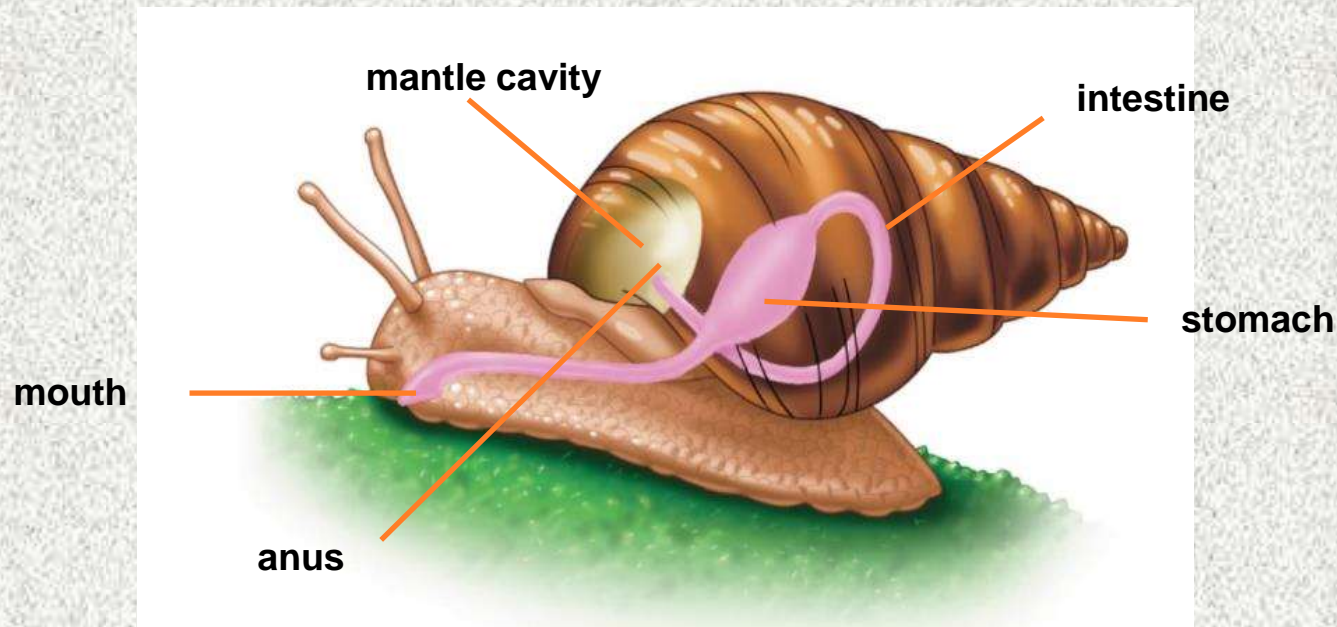


Gastropod Characteristics

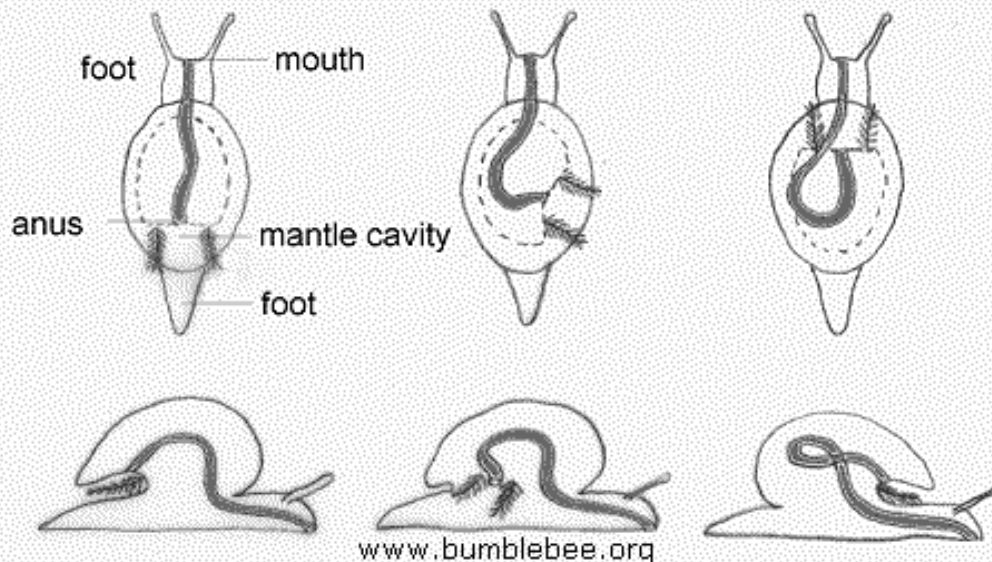
- Bilaterally symmetrical, but body usually asymmetrical with a coiled shell (torsion)
- Some species lack shell and are not coiled
- Head well-developed, with tentacles and eyes
- Radula present
- Mantle modified into a lung or gill
- Foot large and flat



Distinctive characteristic is **torsion**, which causes the animal's anus and mantle to end up above its head

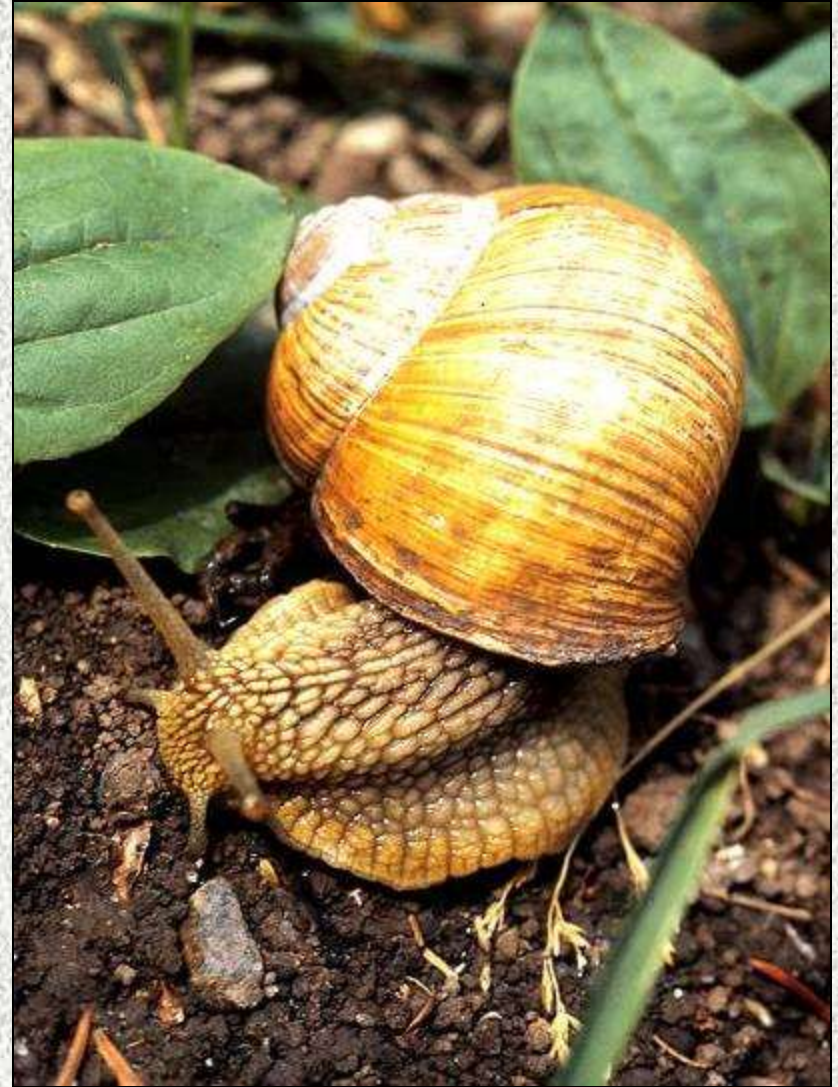


Torsion occurs in the larval stage

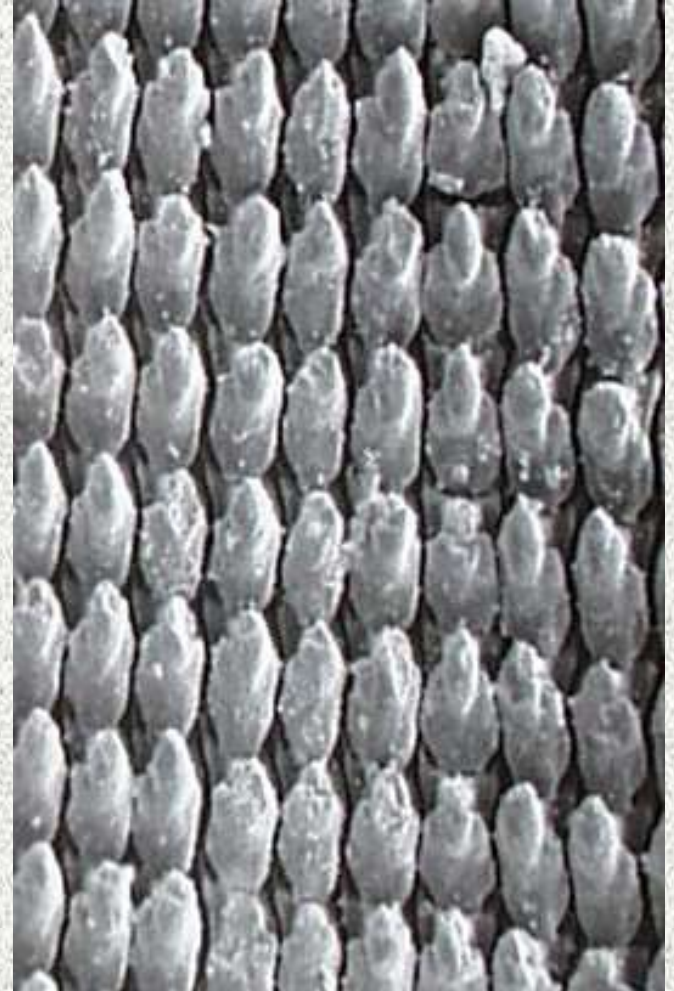
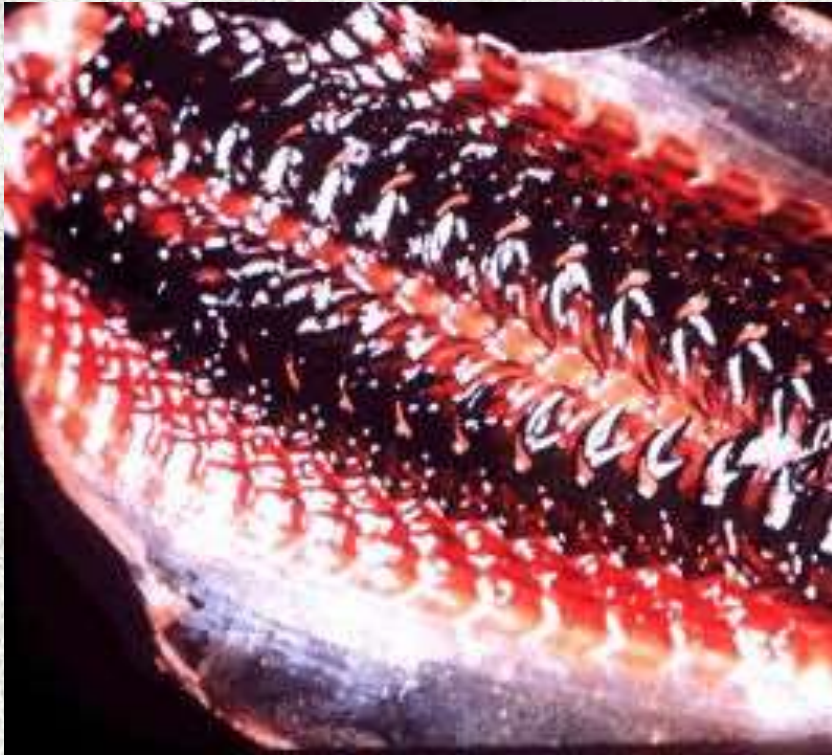


Snails

- Lost gills
- The mantle cavity serves as a “lung”
- Glandular epidermis
Secrete mucus (slime)
upon which gastropod
glides



Radula



Snail Reproduction

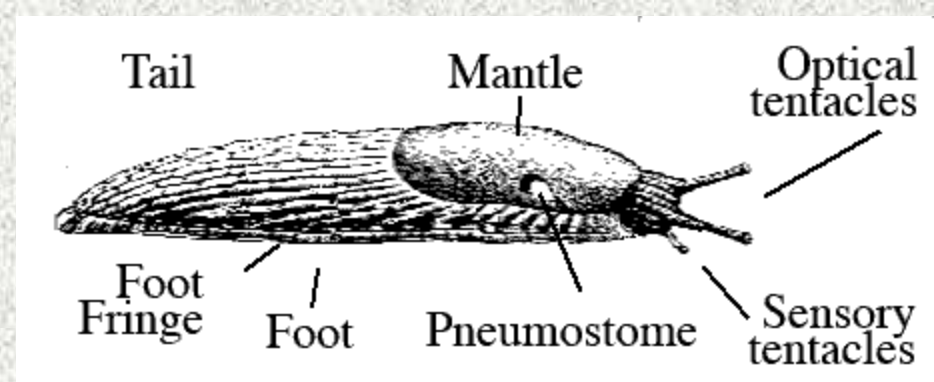
- Most terrestrial slugs and snails are hermaphrodite, so any two individuals of the same species can mate
- During copulation each snail transfers a spermatophore to the other



Eggs are usually deposited in a gelatinous mass in shallow burrows or the undersides of stones

Slugs

- Terrestria, lack shells
- Mantle thickened
- Pneumostome - Air intake into mantle cavity



Banana Slug



Thick
Mucous

Marine Gastropods

Sea Hare – *Aplysia sp*



Can reach 31 lbs



SEA HARE BIOWEAPONS - A Colorfully Sticky Defense

<https://www.youtube.com/watch?v=2vDY9KI8KEI>

***Aplysia californica*: sticky secretions save sea hares from predators**

https://www.youtube.com/watch?v=8_mw5bdIk9Q

<https://www.youtube.com/watch?v=sZ7gJ2C83Y8>

Marine Gastropods



Marine Gastropods - Nudibranch

- Extraordinary colors and forms
- Lost their shells
- Active predators, chemical defenses



Marine Gastropods - Nudibranch



Cephalopods - squids and octopuses



Cephalopods Characteristics

- Cephalo = head ; pod = foot
- Shell often reduced or absent
- Head well developed with a modified radula to form a beak
- Foot modified into arms and/or tentacles
- Nervous system with centralized brain
- Complex, well-developed eyes

Cephalopods

- Shell lost in Octopus, extremely reduced and enclosed in mantle in squid
- Cephalization
 - Eye
 - Beak around mouth
- Tentacles/arms



Squid

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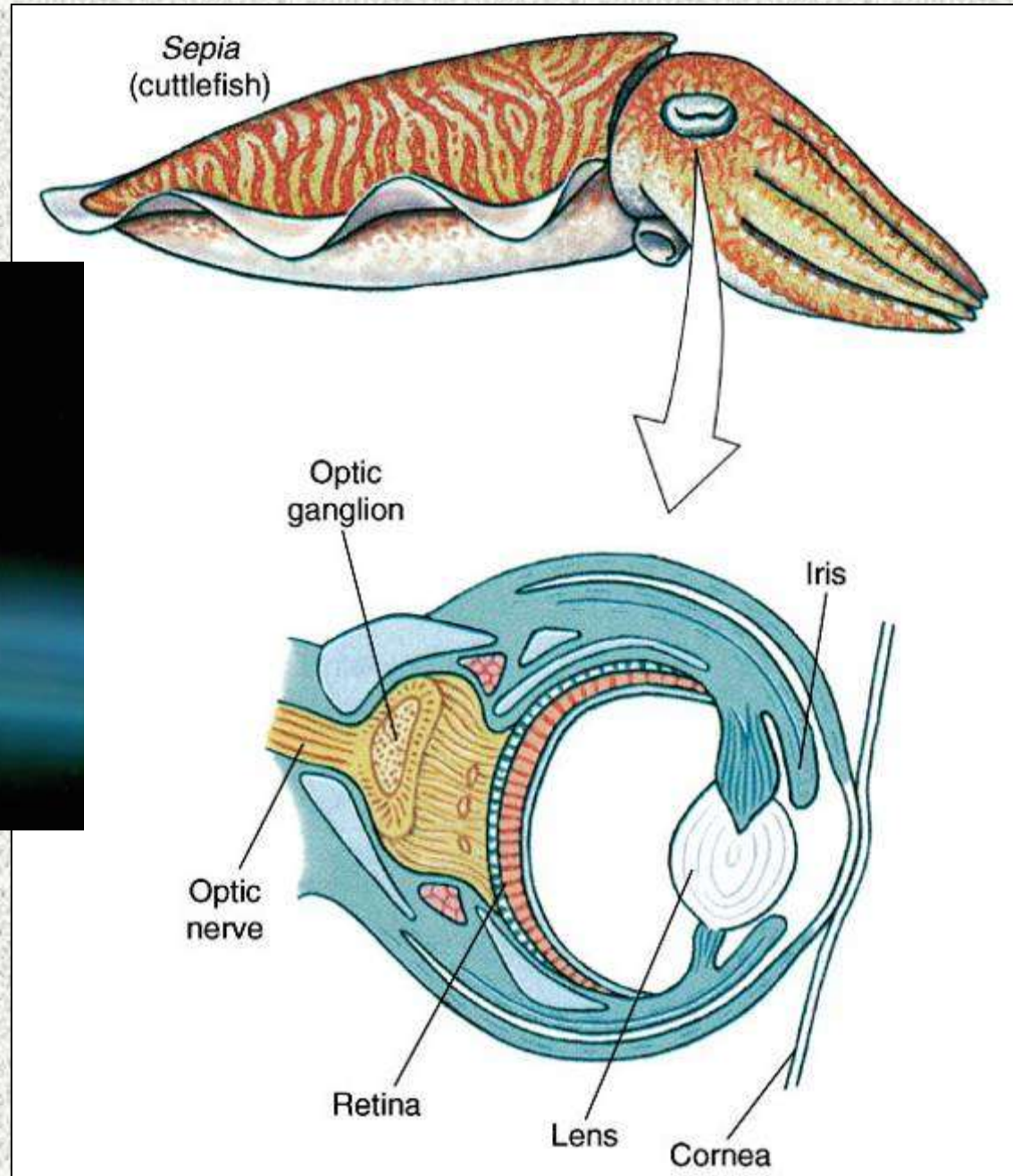


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Squid are the largest Cephalopods



Cephalopod Eye



Fried squid - Calamari



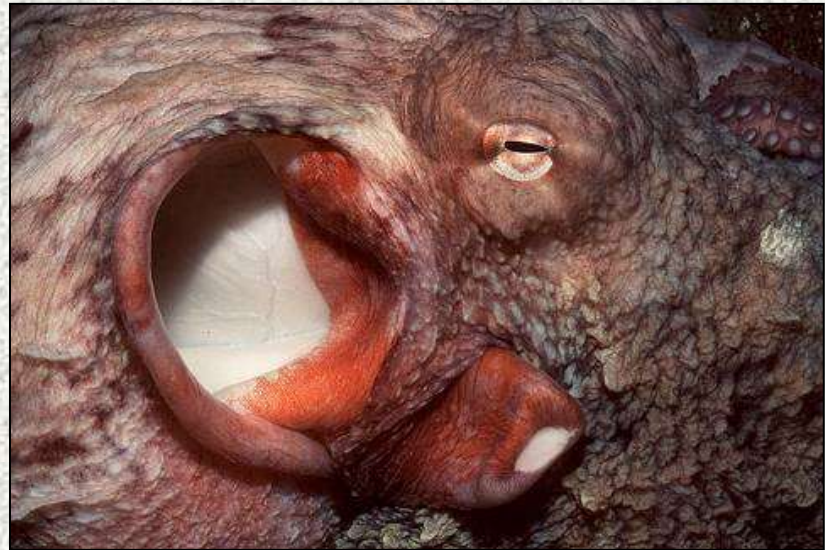
Octopus

- No shell.
- Beak made of chitin
- 8 tentacle arms with suction cups
- Keen vision and touch
- Highly intelligent
- Learn quickly
- Retain memory
- The most intelligent invertebrate



Octopuses often break out of their aquariums and sometimes into others in search of food. They have even boarded fishing boats and opened holds to eat crabs

Octopus



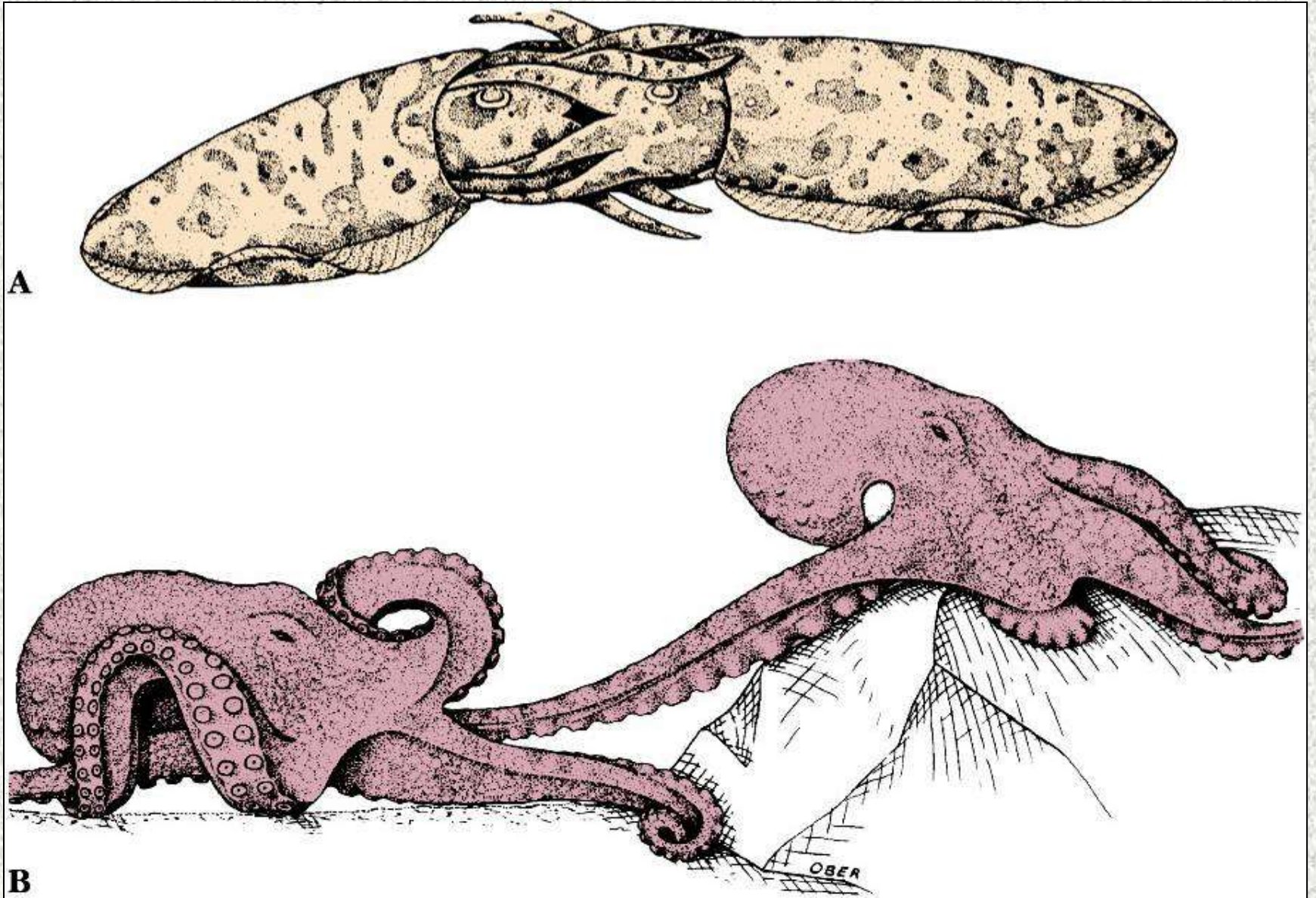
Octopus

Can assume a variety of colors, flash from one to another, use to court, communicate, camouflage



Can mimic movements of other sea animals

Squid and Octopus Mating



Annelids – Segmented Worms



Earthworms are Annelids

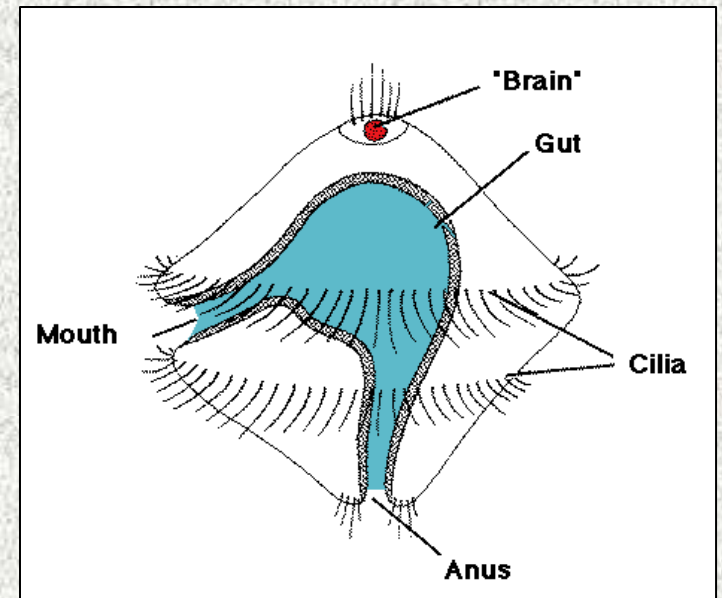
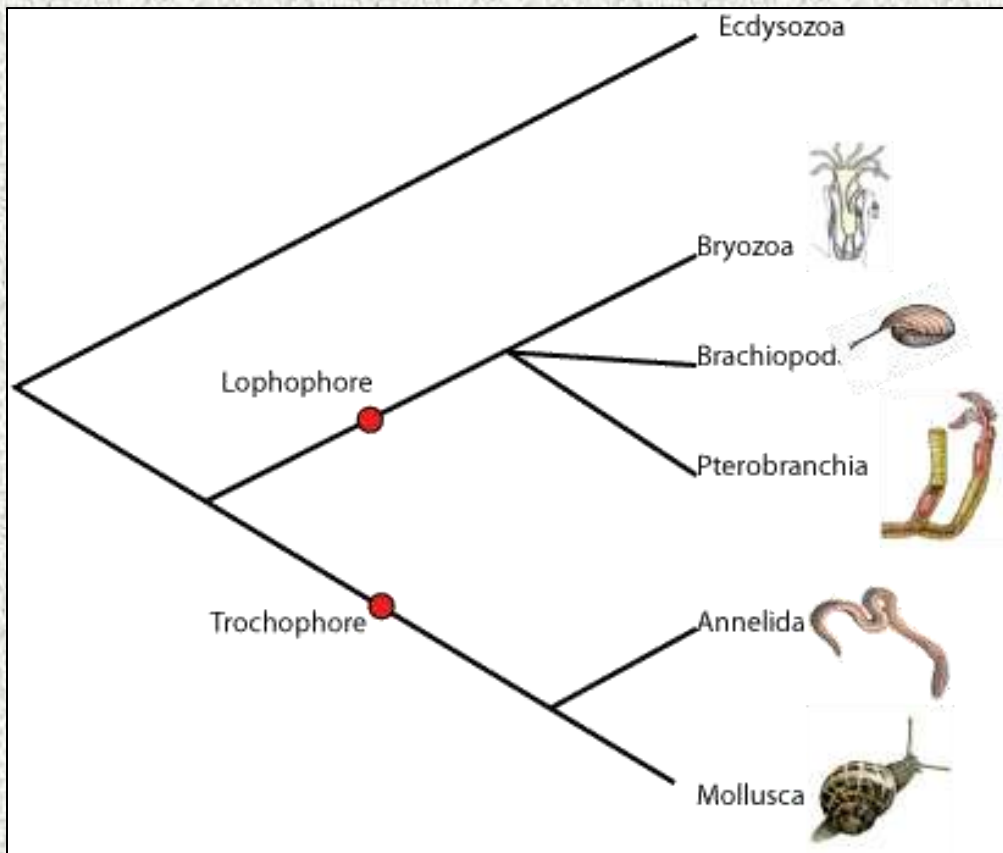


Annelida Characteristics

- Segmented Worms
- Marine, freshwater, and terrestrial
- Bilaterally symmetrical
- Segmented - each segment is separated by transverse septum
- Triploblastic with a well developed coelom
- Body is covered with a flexible non-chitinous cuticle
- Setae - hard, bristle-like chitinous structures

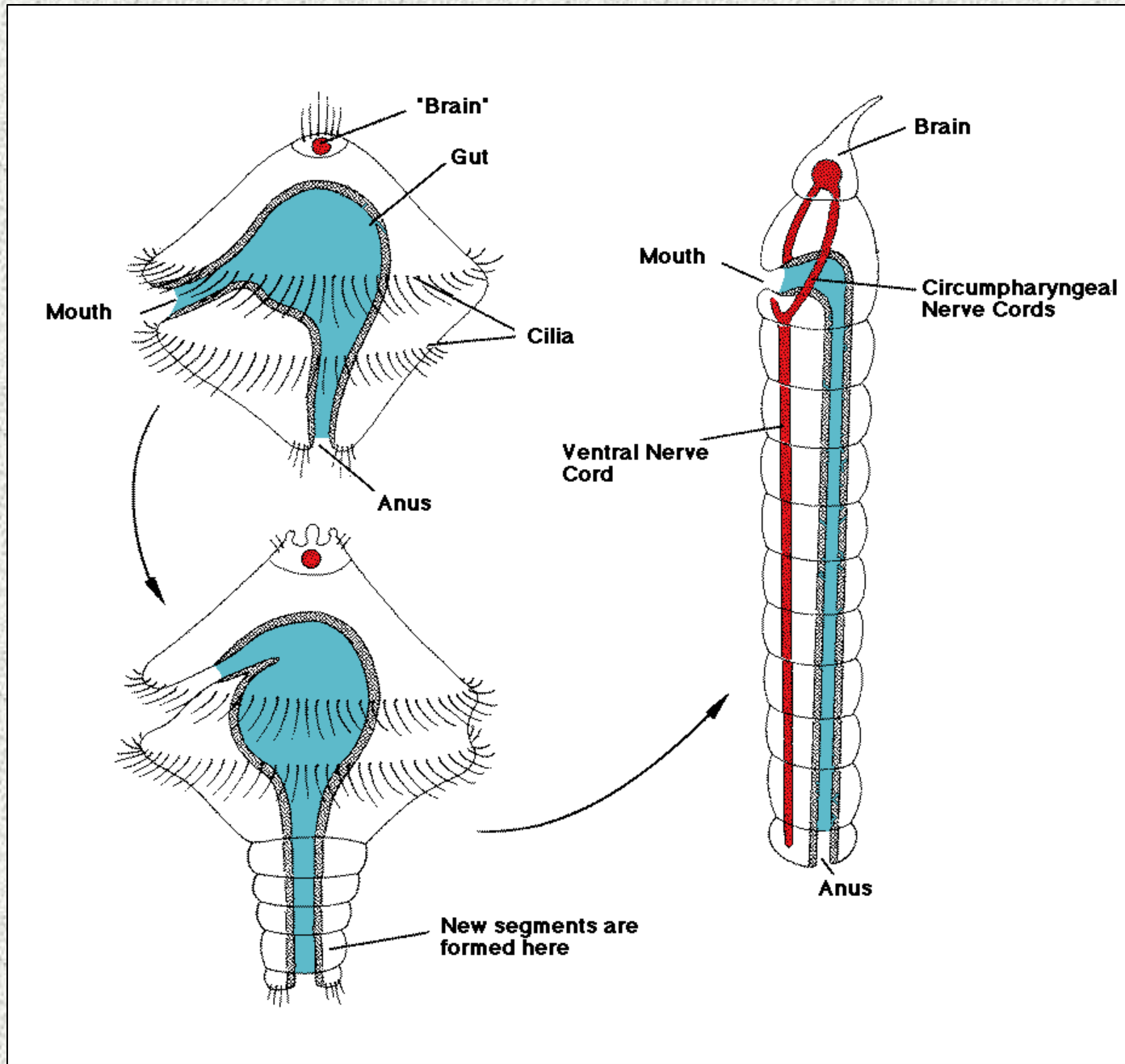
Annelids are:

- Protostomes
- Lophotrochozoa – trochophore larvae, related them to the Molluscs



trochophore larva

Annelids - basic body plan

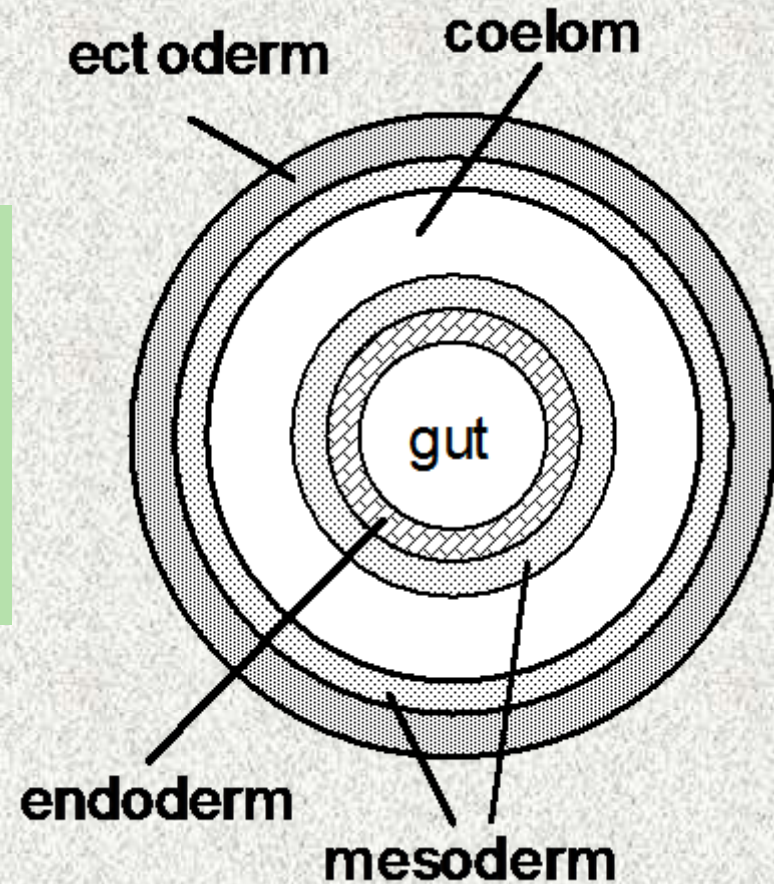
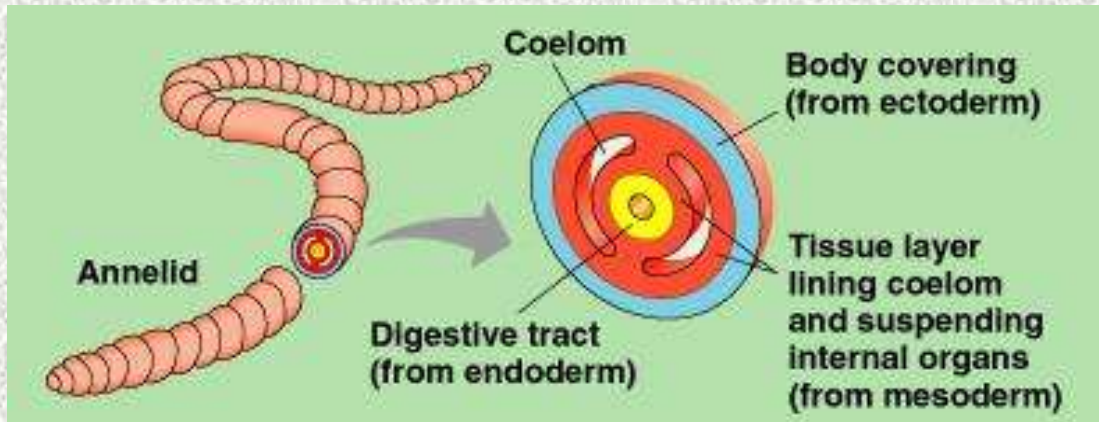


Annelida Characteristics

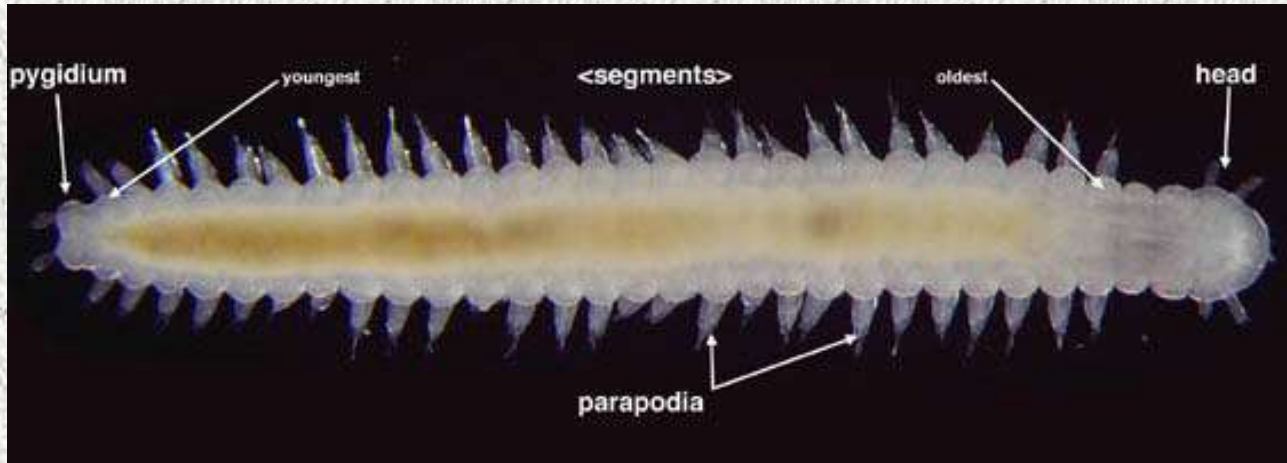
- Coelomate
- Complete digestive tract - with two openings, a mouth and anus; one-way movement
- Circulatory system is closed
- Excretory system typically consists of a pair of nephridia per segment

Coelom - Body Cavity

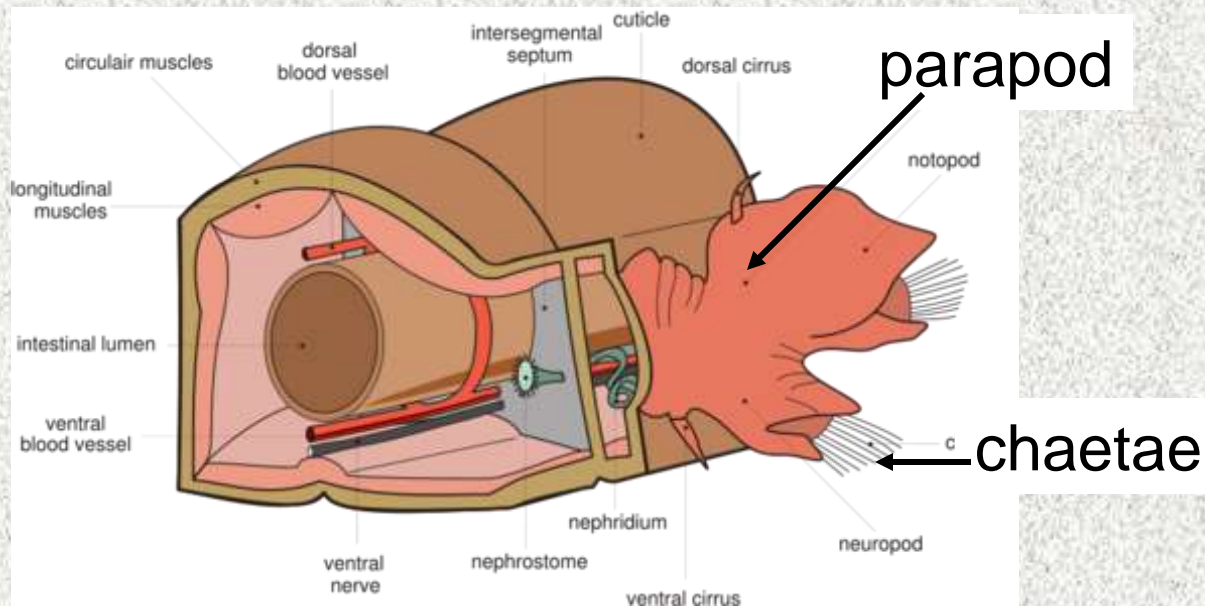
Eucoelomate- body cavity completely lined with mesoderm



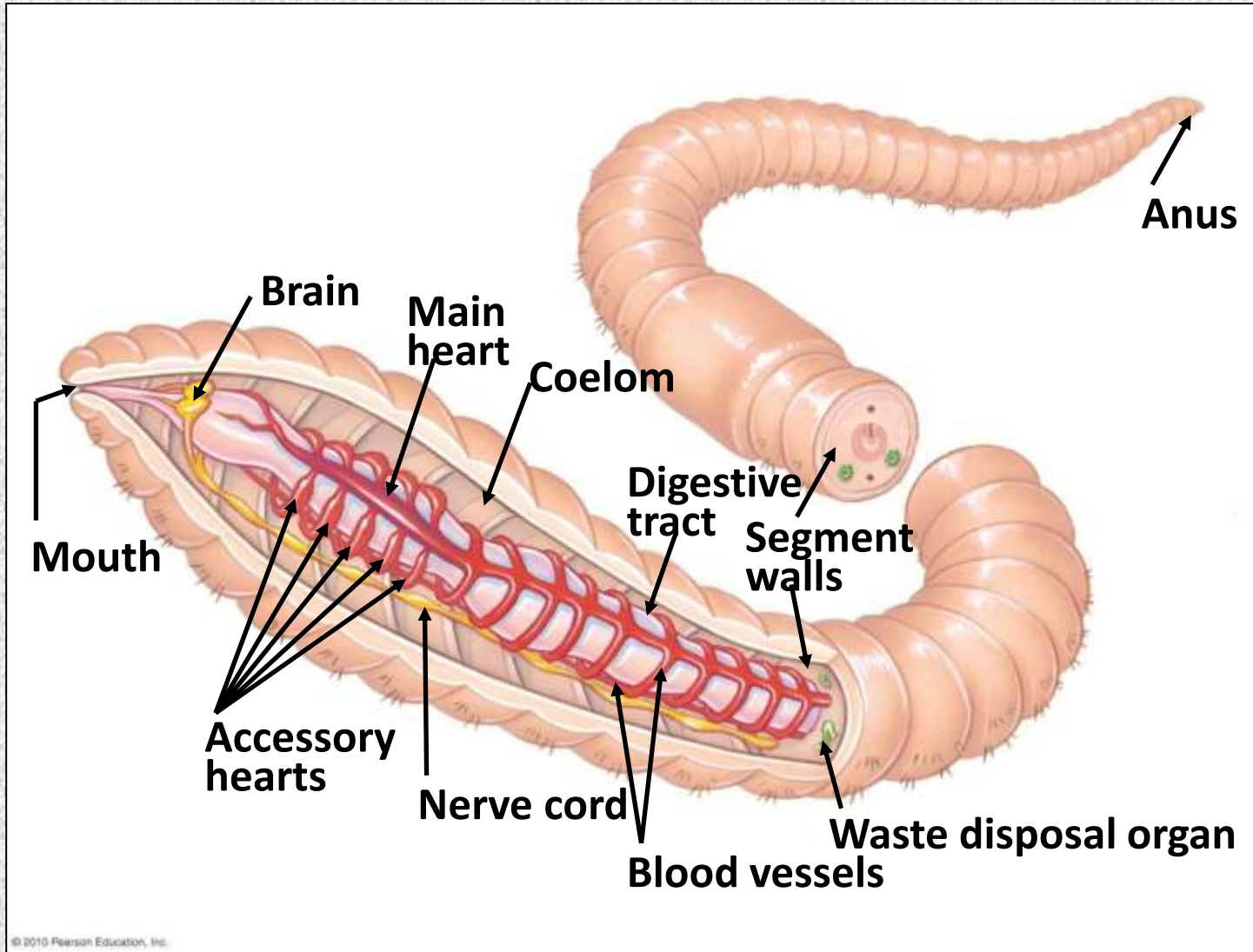
Segmentation – repetition of body parts



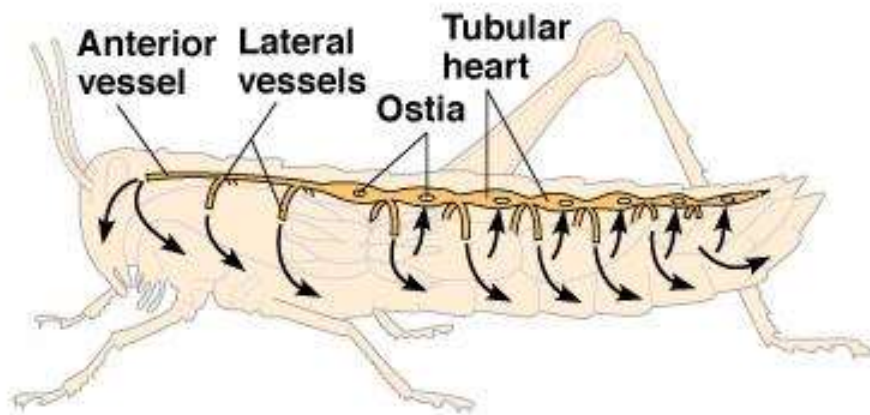
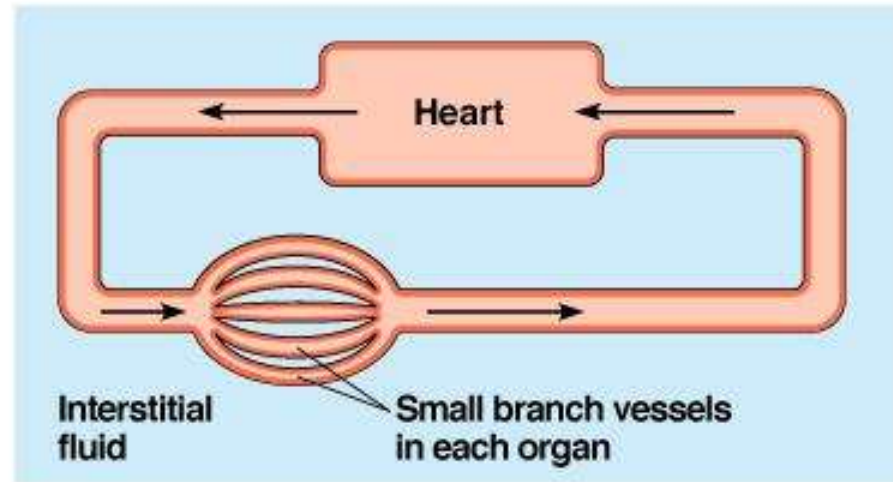
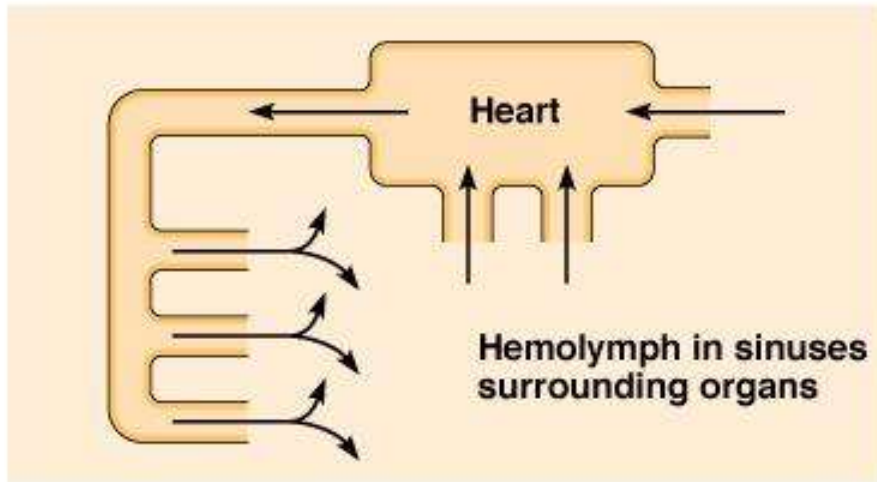
Each segment has a parapodia with numerous setae



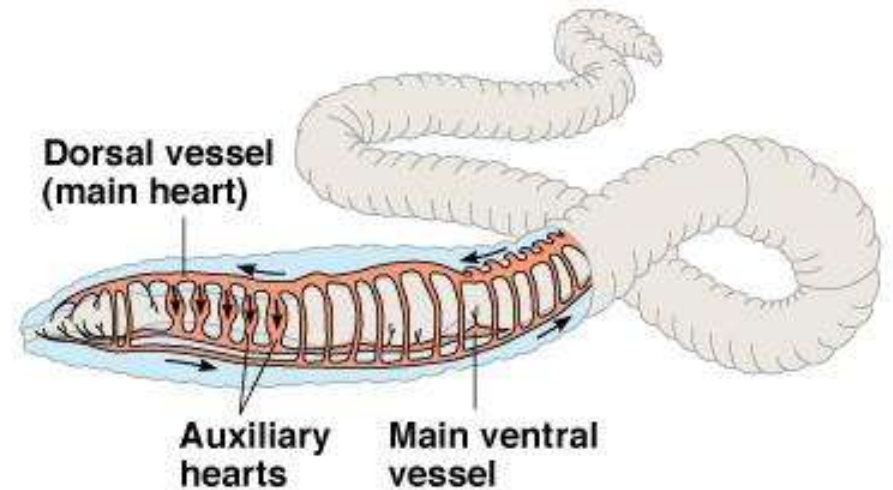
Closed circulatory system



Closed Versus Open Circulatory Systems

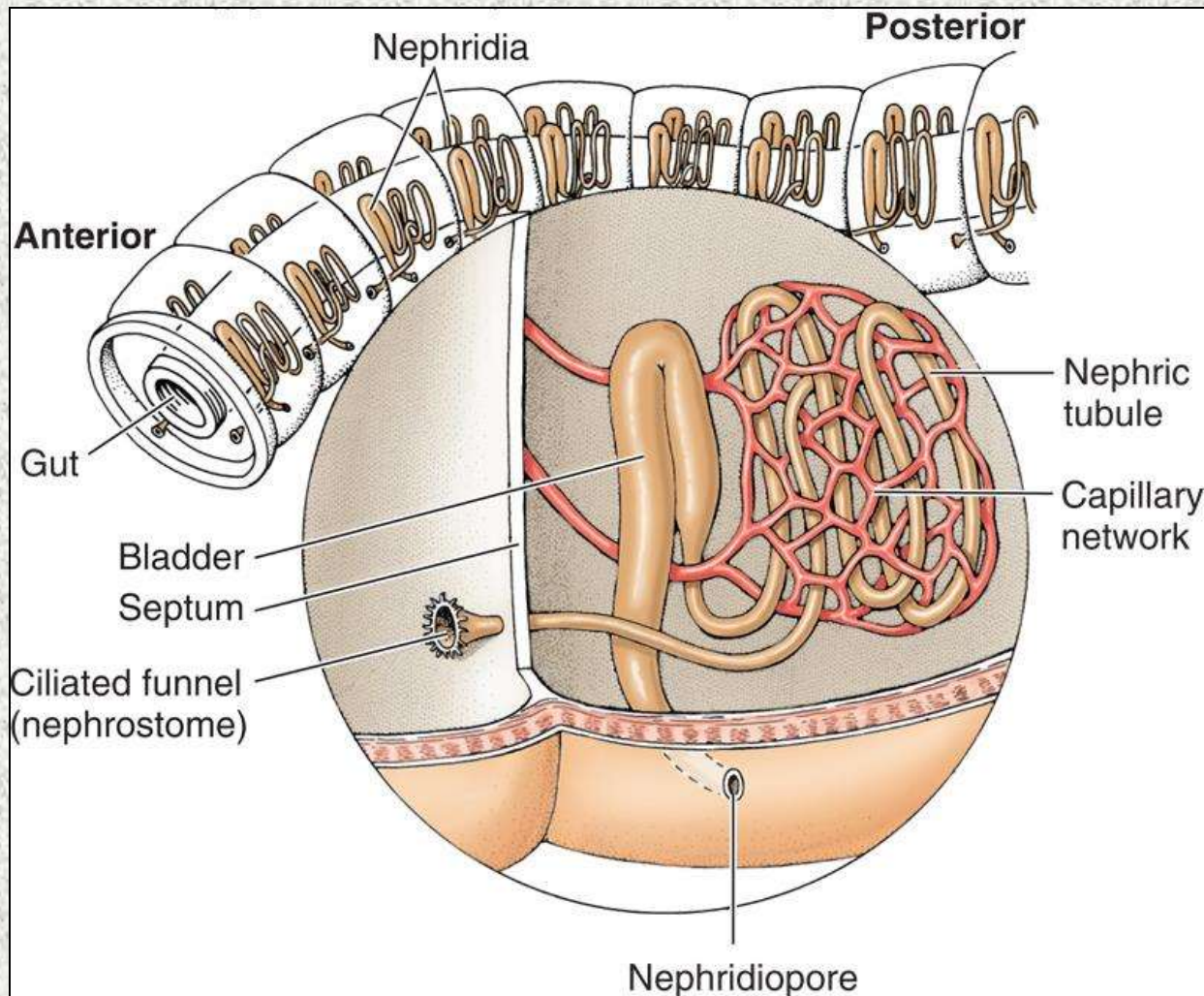


(a) Open circulatory system

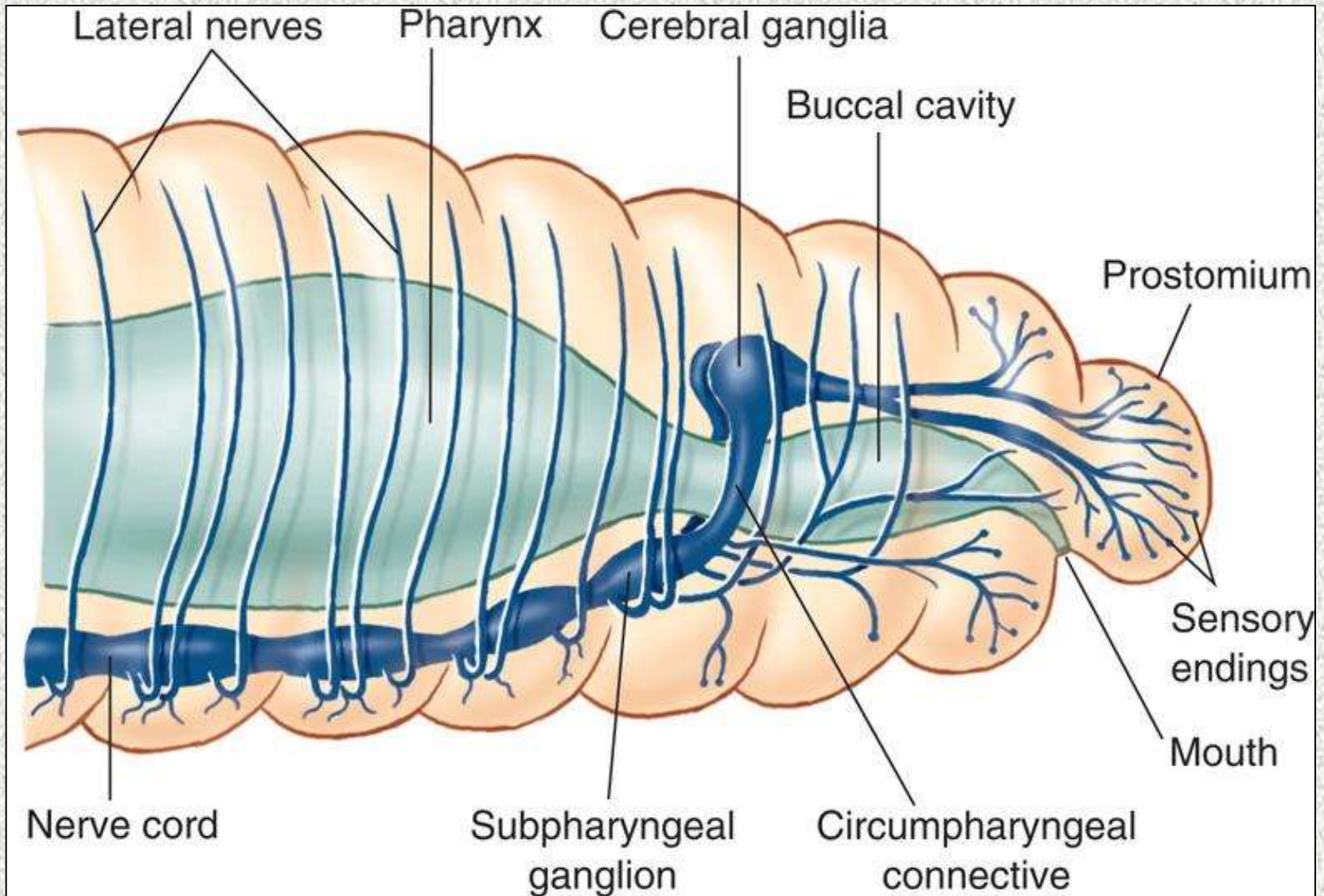


(b) Closed circulatory system

Excretory system, nephridia tubes paired in each segment



Nervous System



Annelids

The three main groups of annelids are:

- **Polychaetes**, marine worms with segmental appendages for movement and gas exchange
- **Earthworms**, which eat their way through soil
- **Leeches**, typically free-living carnivores but with some bloodsucking forms

Annelids

- Class Polychaeta
- Class Oligochaeta
- Class Hirudinea



*Hirudo
medicinalis*



Polychaetes

- Feather Duster worms, Clam worms, Christmas Tree worms
- Mostly marine and free-living
- Many setae, on fleshy lateral outgrowths of the body wall known as parapodia
- Head bearing appendages, well developed
- Sexes separate, with a free-swimming trochophore larva
- 8,000 species
- Common in shore lines

Nereis

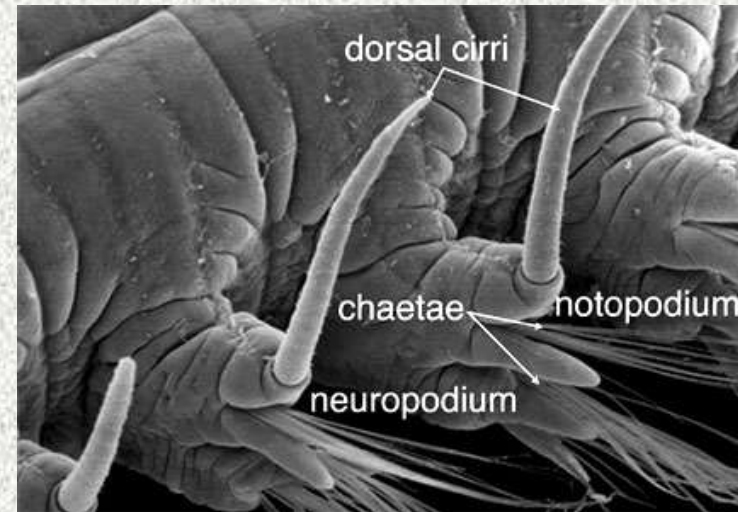


Polychaetes

Polychaetes have paddle-like parapodia that work as gills and aid in locomotion



parapodia



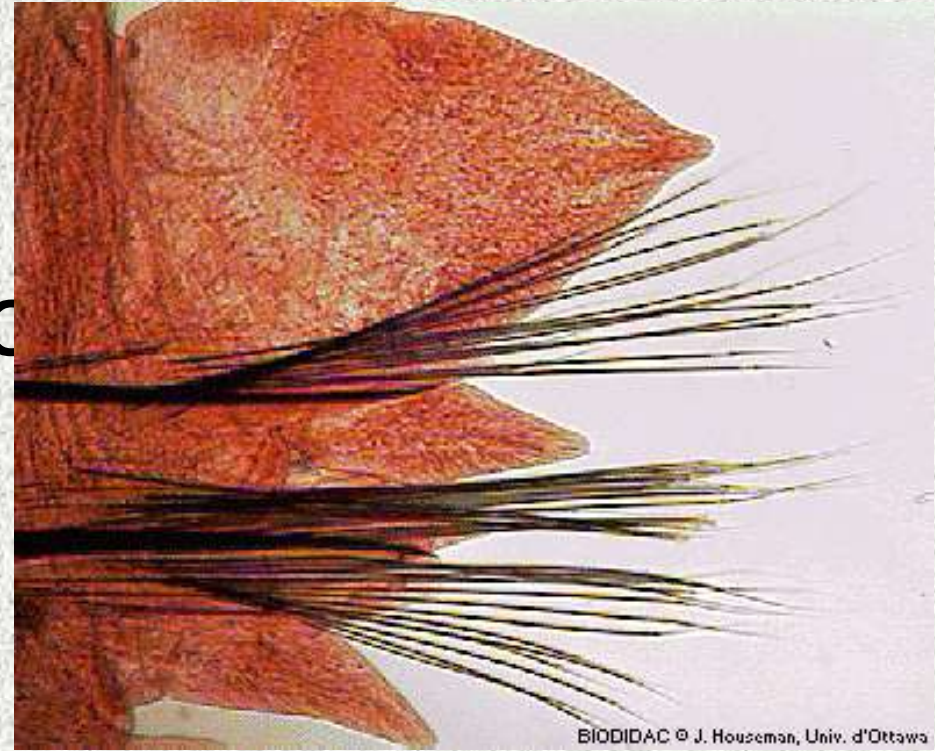
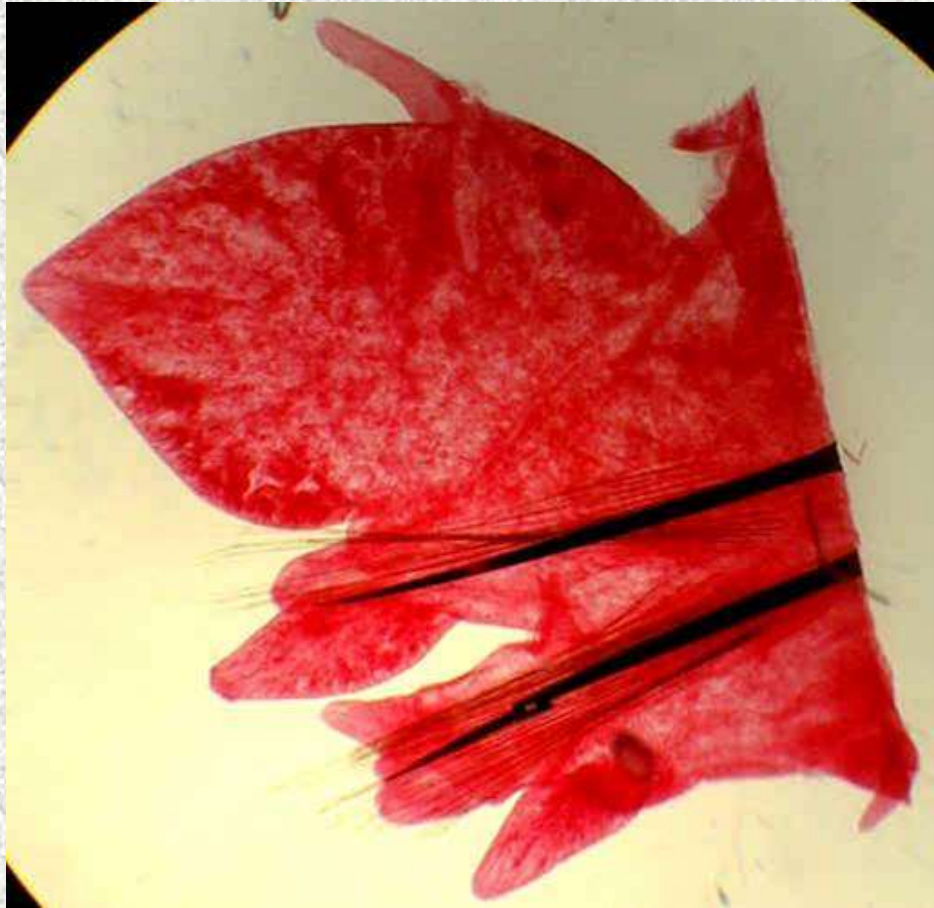
dorsal cirri

chaetae

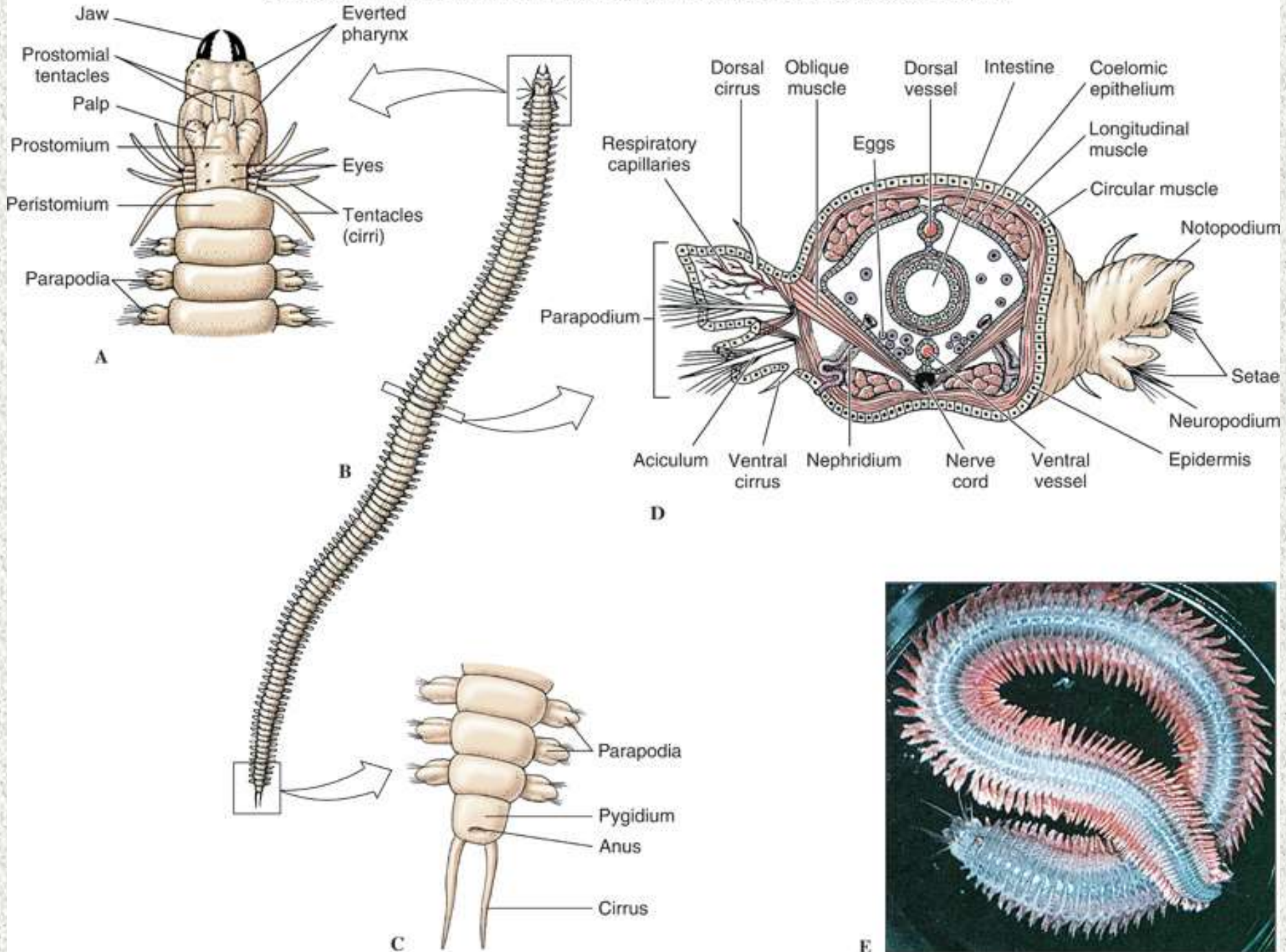
neuropodium

notopodium

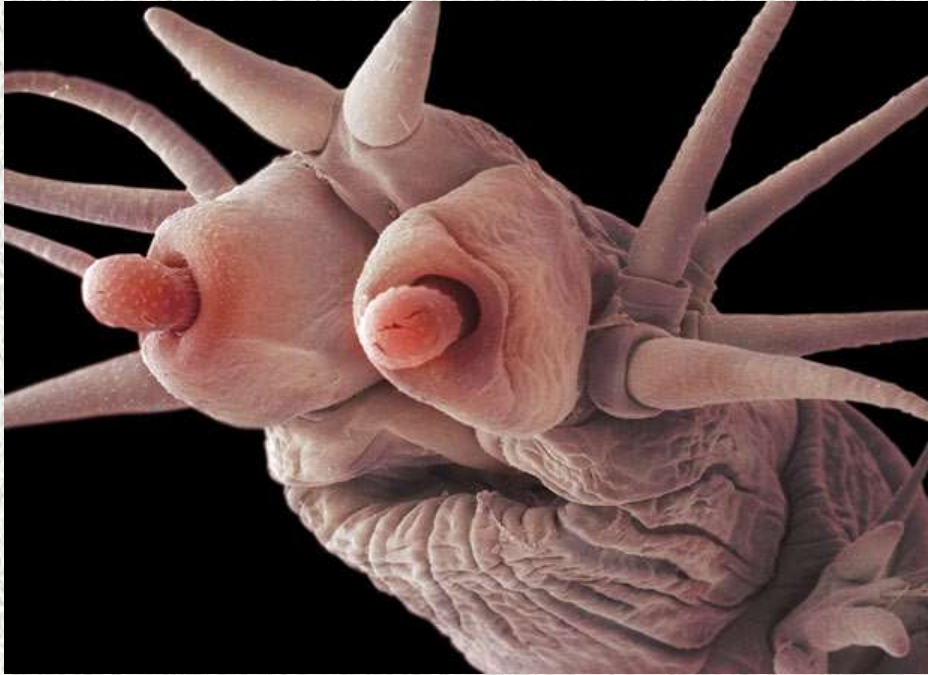
Parapodia



BIODIDAC © J. Houseman, Univ. d'Ottawa

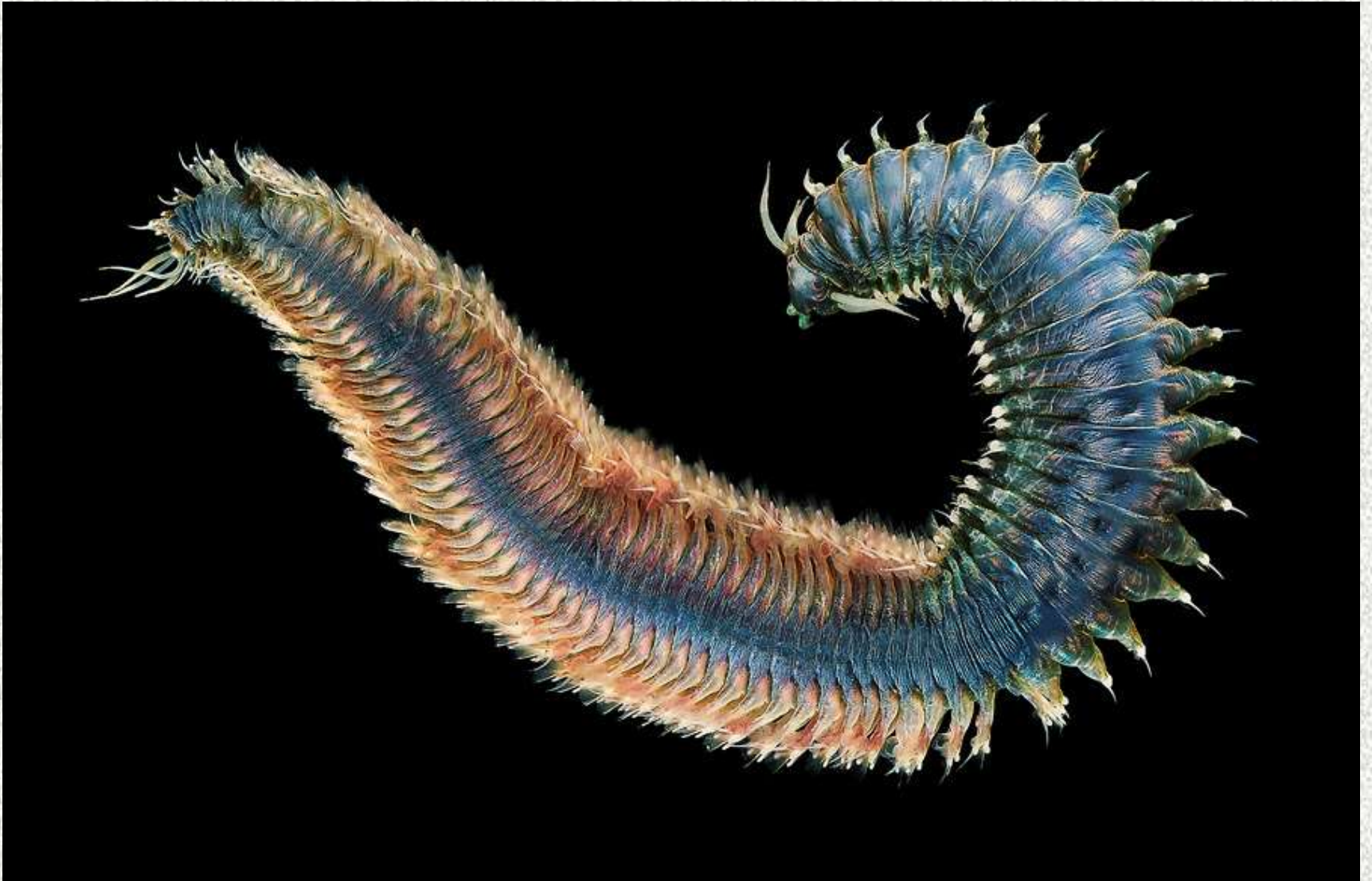


Terrifying Polychaete heads





Nereis pelagica

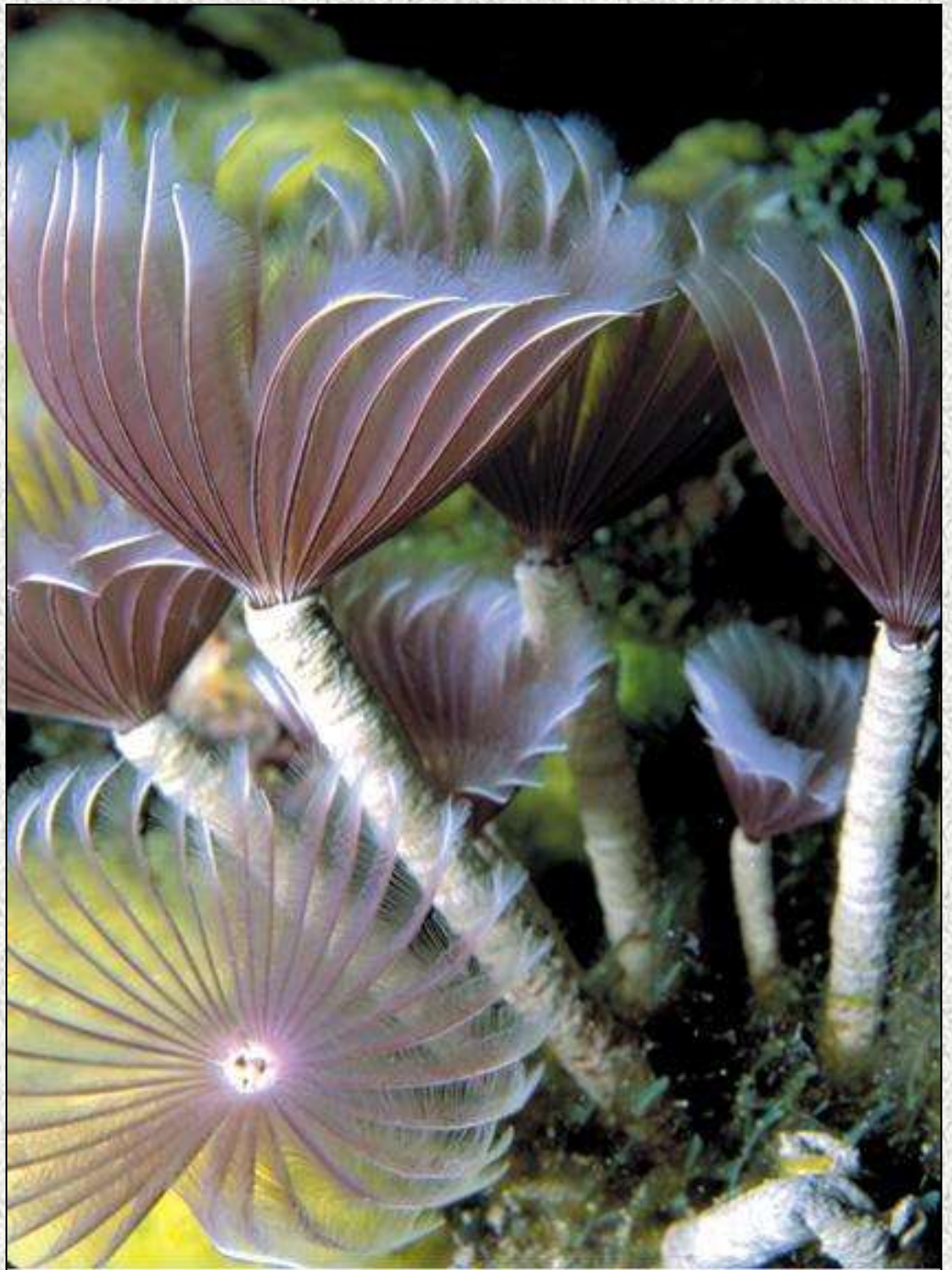


Polychaete – Feather Duster

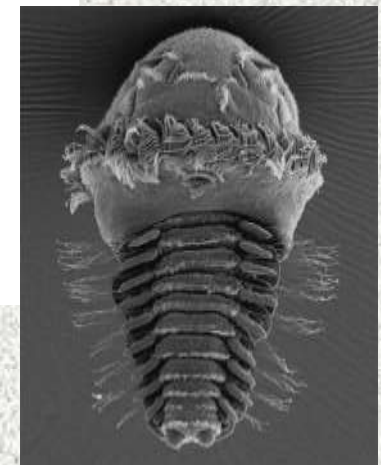
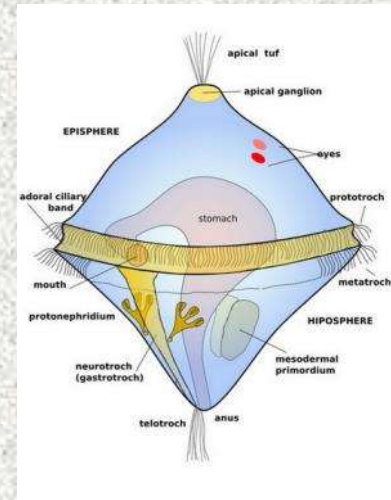
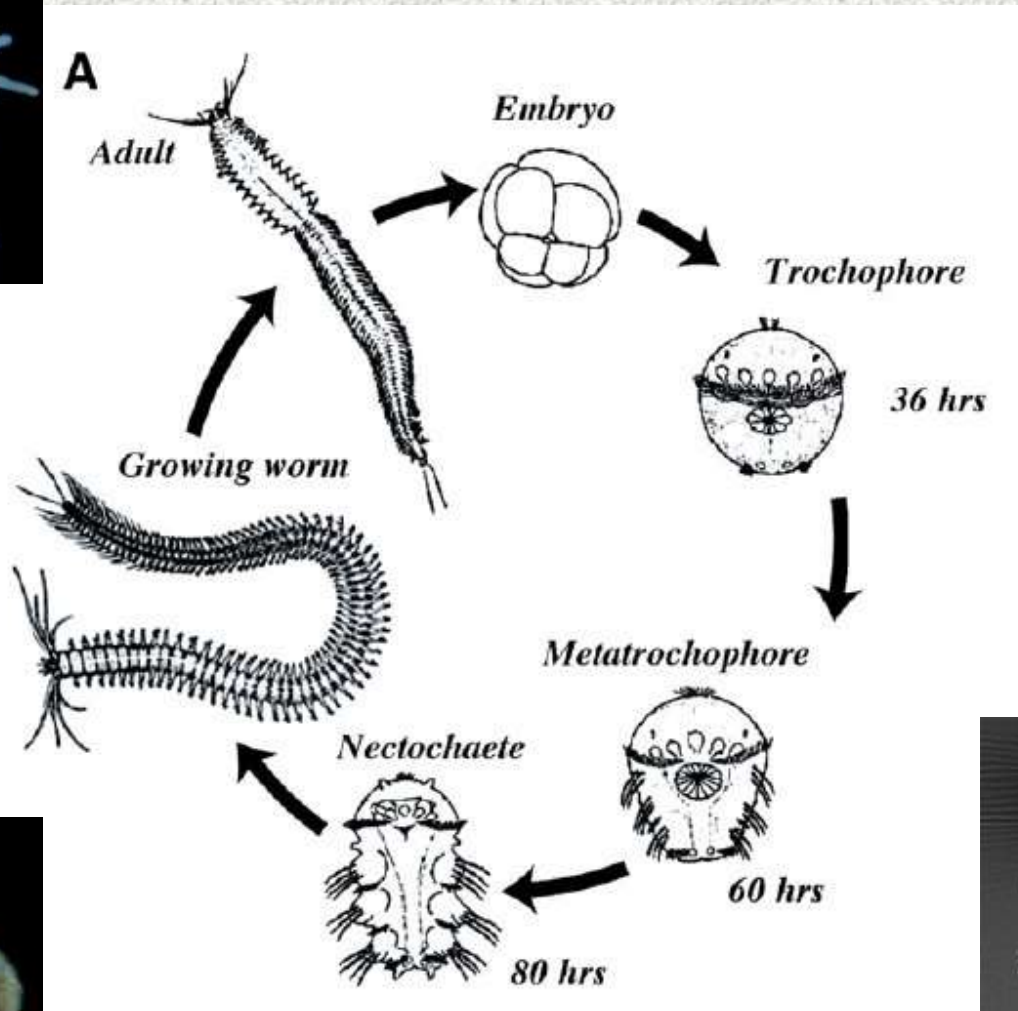
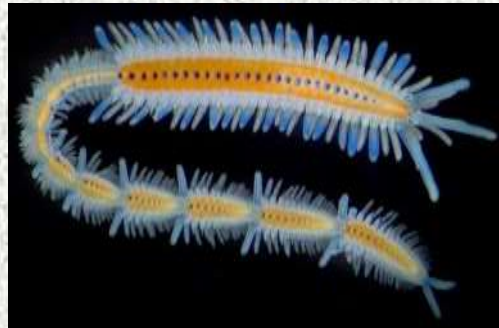


Sessile Polychaetes have large spirals of feather-like tentacles, often brilliantly colored and quite beautiful. With these, the worm fans the water for food particles and small critters.

Radioles
Ciliated mouth
appendages

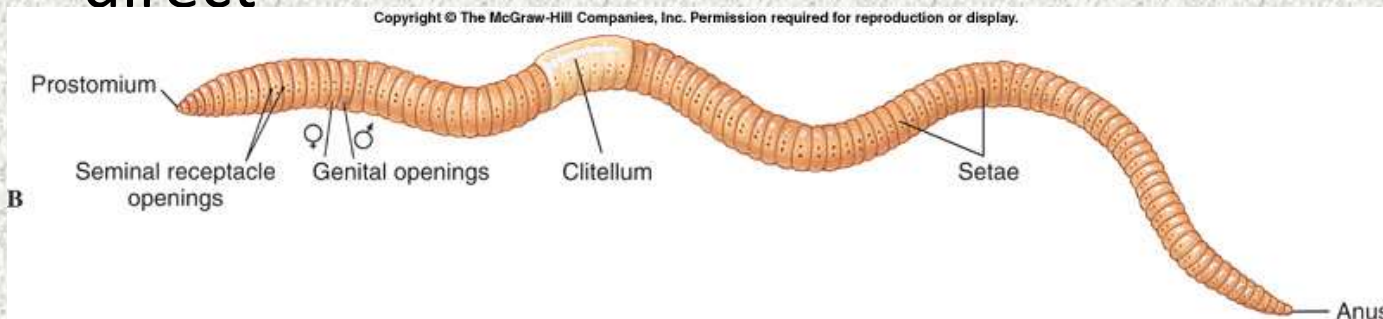


Polychaete Reproduction

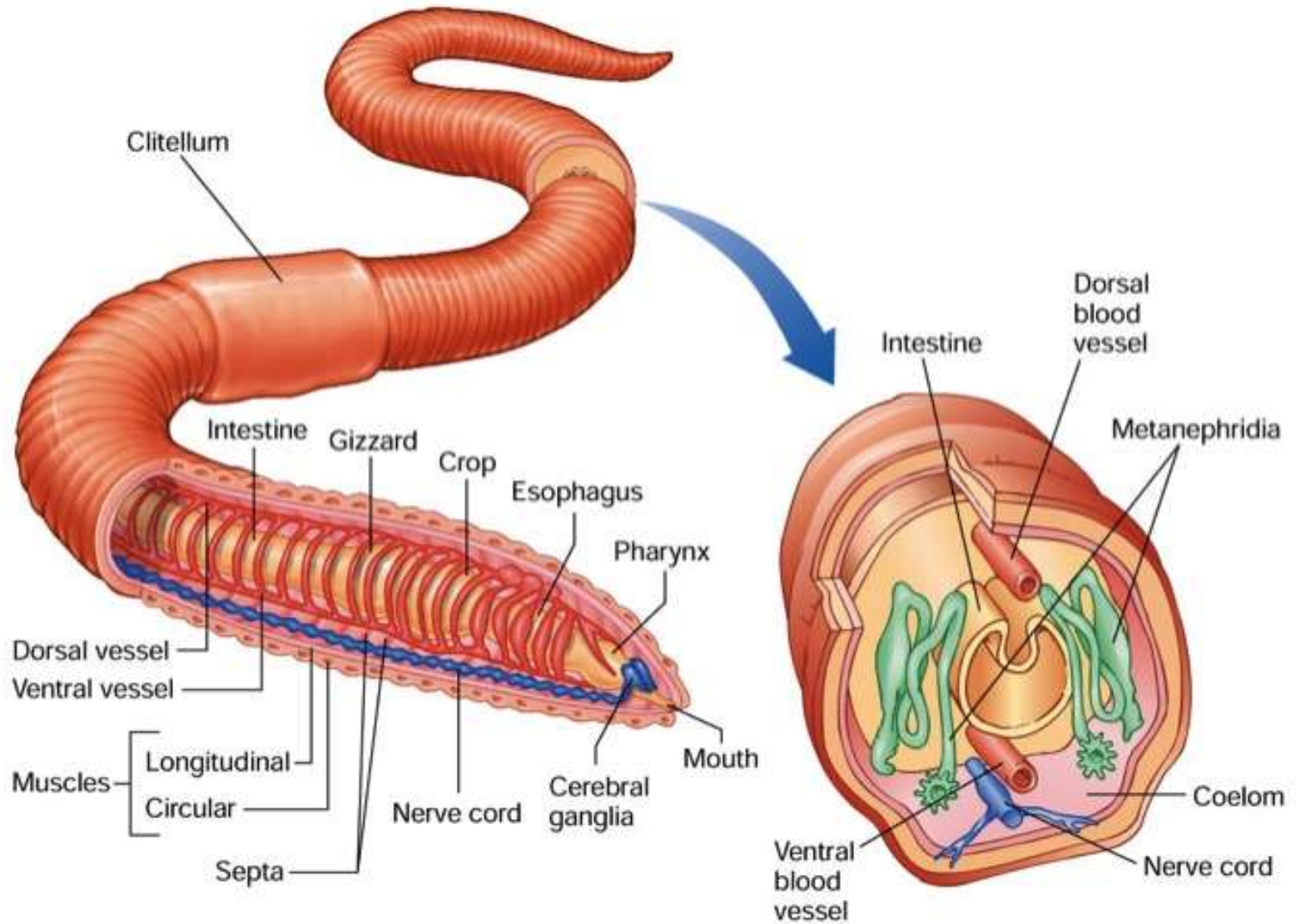


Oligochaetes - Earthworms

- Terrestrial, a few freshwater
- Few setae and no parapodia
- No distinct head appendages
- Eat through soil, extracting nutrients as the soil moves through the alimentary canal
- Hermaphrodites, copulation required
- Clitellum present, fused midbody segment
- Eggs are deposited in a cocoon and development is direct

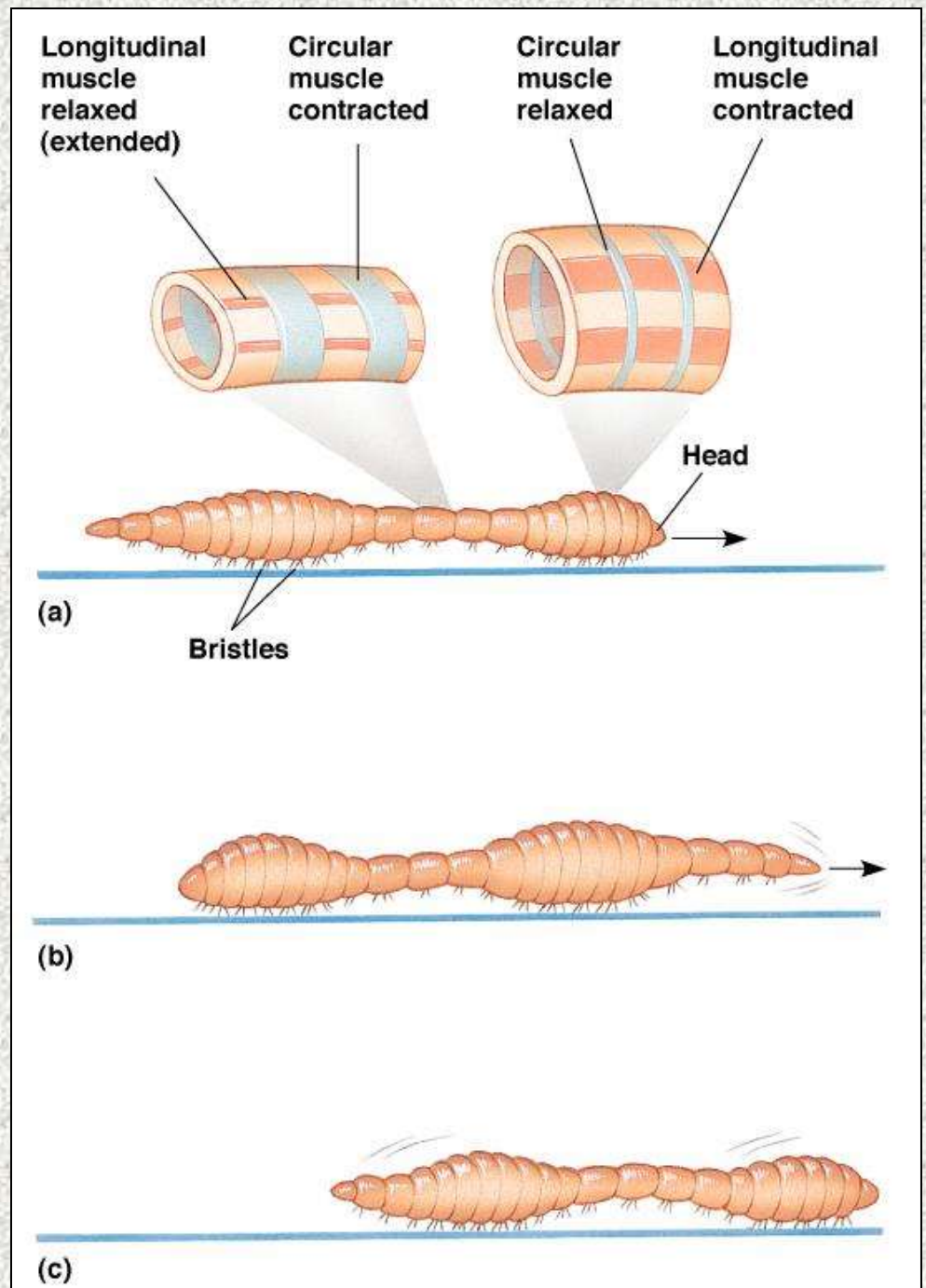


Oilgochaete Anatomy



Hydrostatic Skeleton

Move by squeeze muscles and fluid in segments



Earthworm Ecology

- Spend the day in the burrow, feed on organic debris in the soil, emerge at night or when wet
- Fecal casts deposited at entrance of burrow
- Important in aerating and enriching the soil



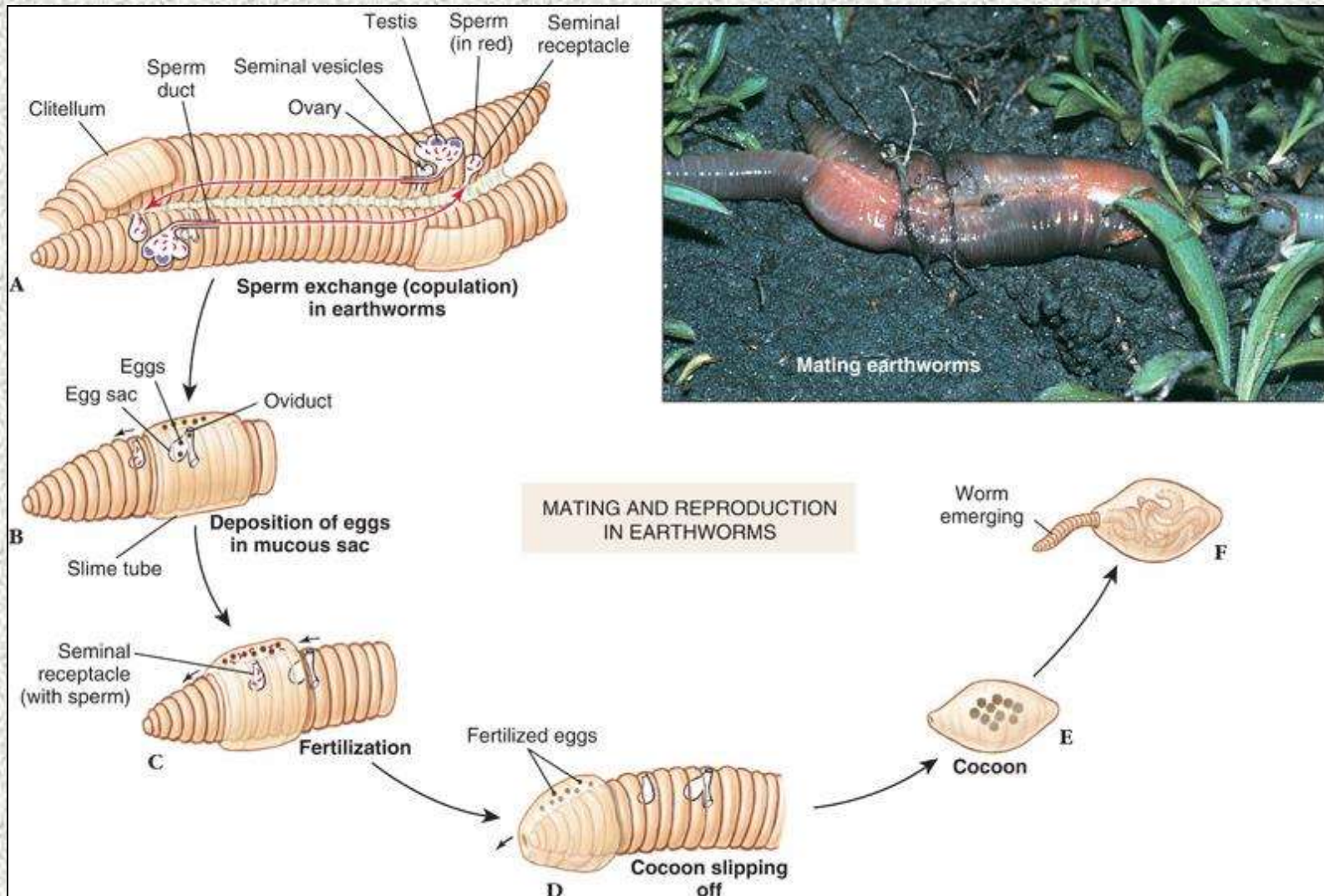
Earthworm Reproduction

- Worms lay side by side, sperm passed from each worm
- Clitellum secretes mucous, protects from drying



Earthworm Reproduction

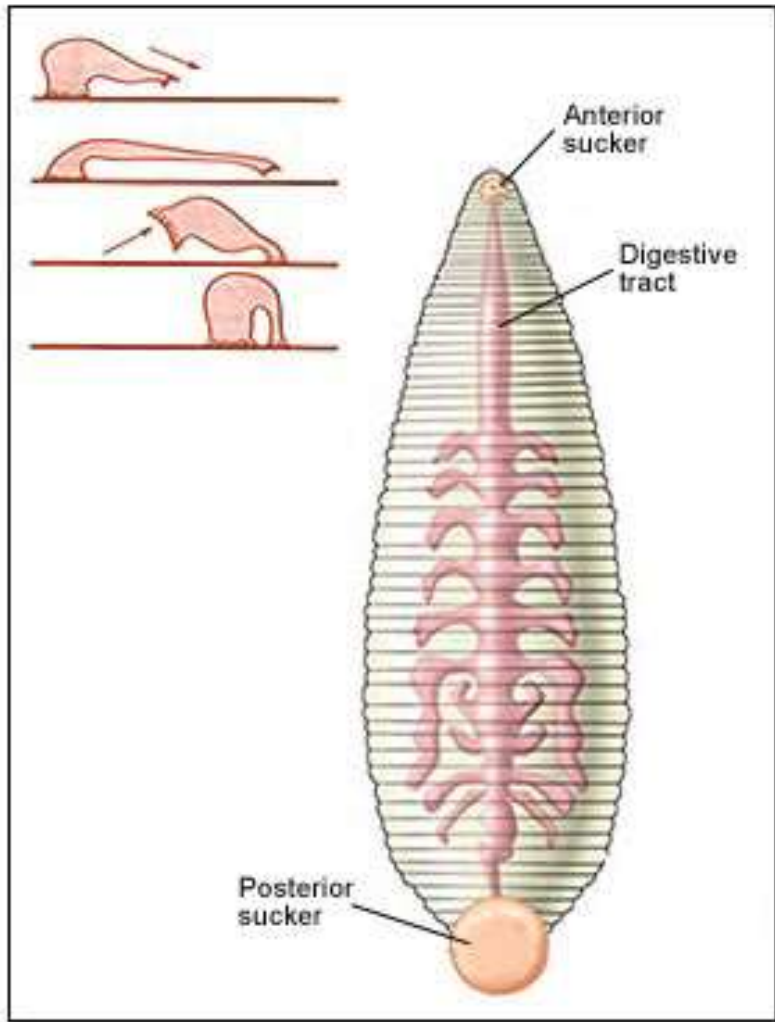
- Clitellum produces slime tube, eggs and sperm are fertilized
- Slime tube with eggs slips off and forms a cocoon, no larval stage



Leeches

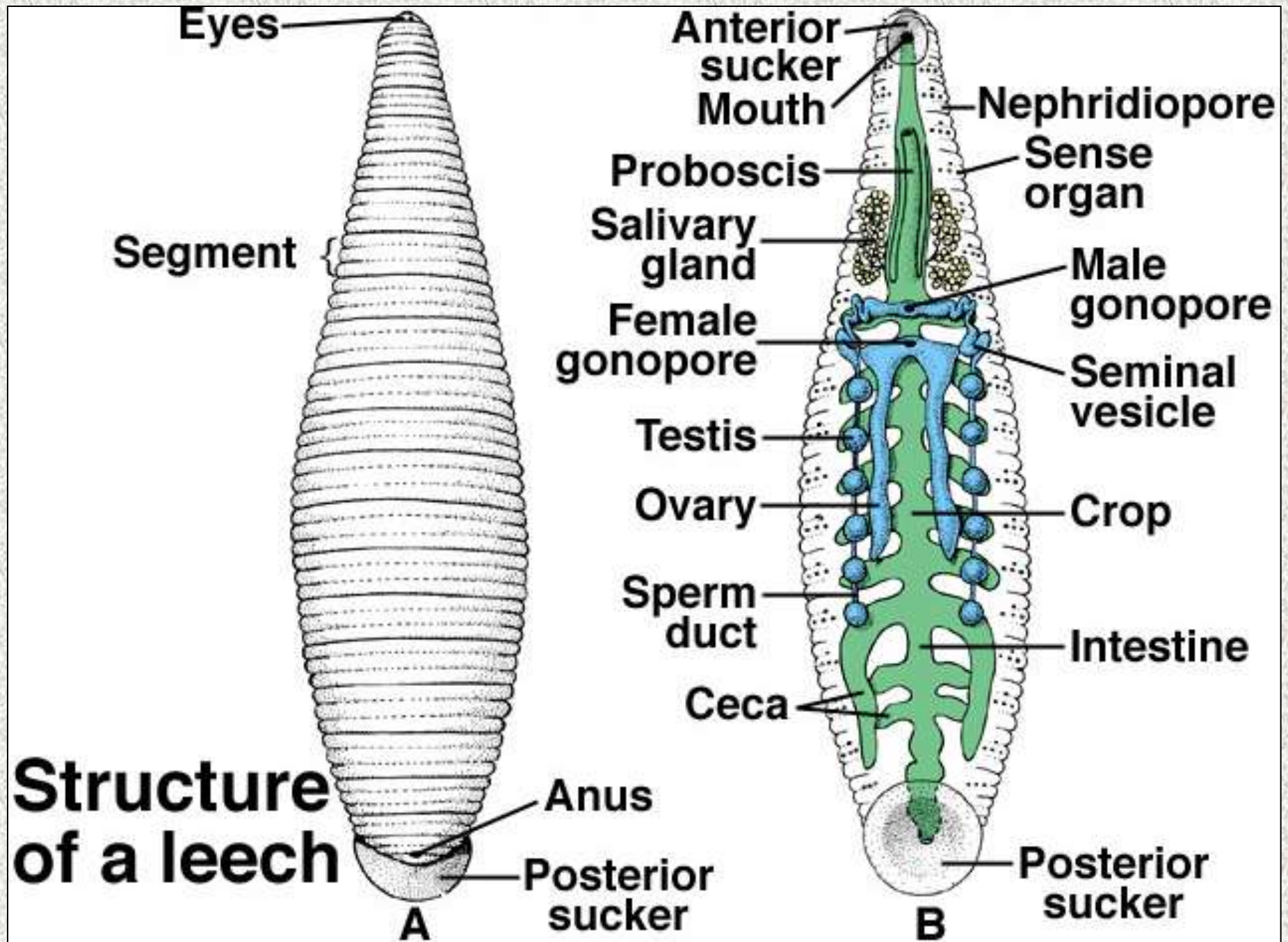


Leeches – Class Hirudinea

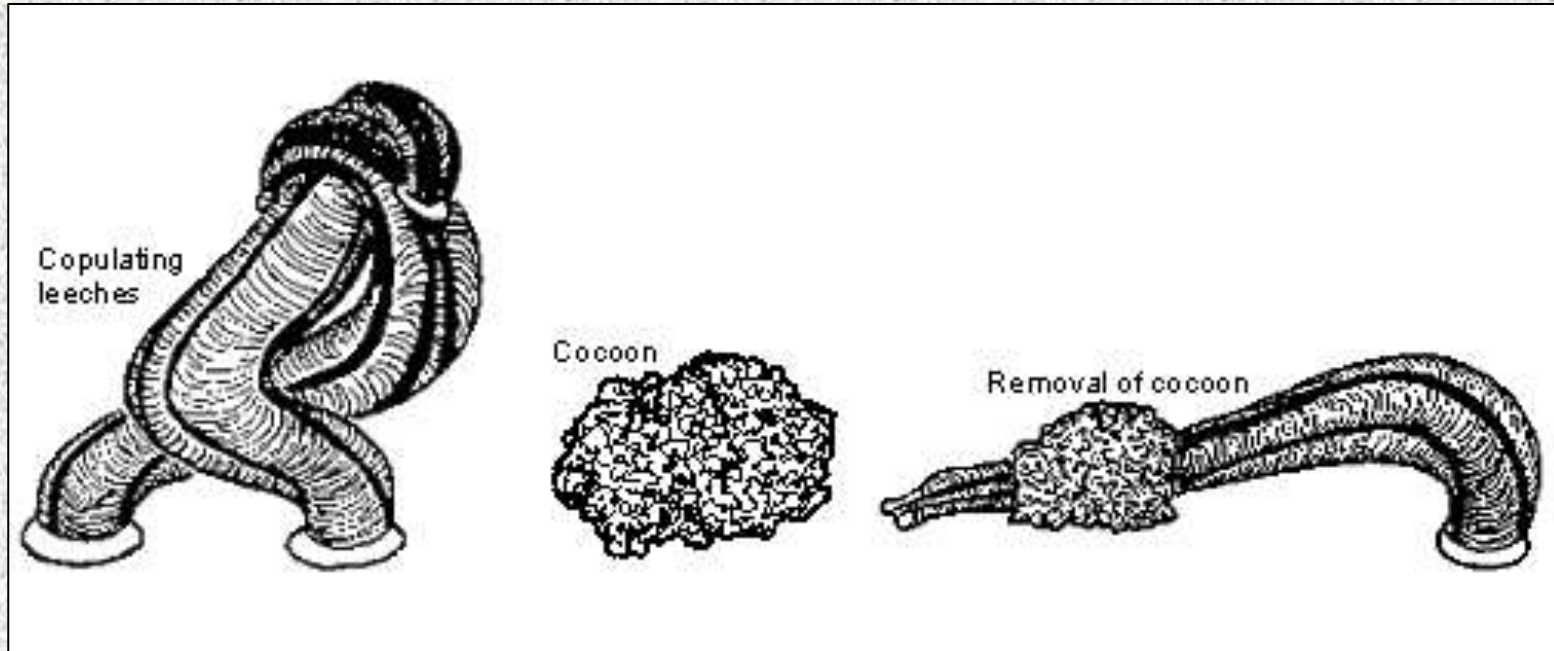


Leeches – Class Hirudinea

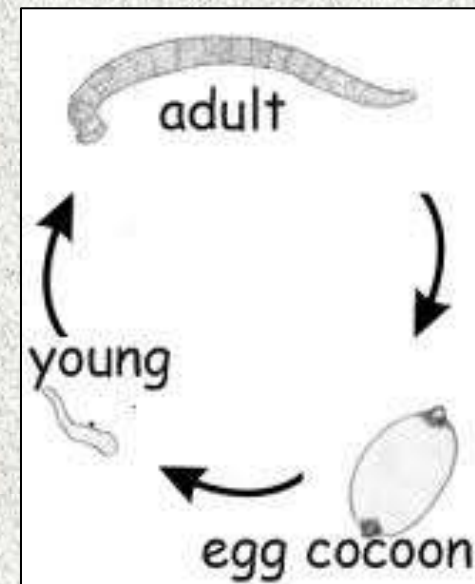
- Scavengers, predators, or parasites. Some have become blood-sucking
- Freshwater or wet forests
- Dorso-ventrally flattened with fixed number of body segments (34)
- Jawed or jawless
- No setae or parapodia
- Clitellum present only during reproduction
- Two suckers – anterior and posterior



Leech Reproduction



- Hermaphrodites
- Reciprocal fertilization
- Sperm transfer during copulation
- Clitellum forms cocoon



Leeches

- Secrete a chemical called hirudin to prevent blood from coagulating, also releases anesthetic, no pain
- Has bacteria in gut to help digest blood, antibiotic inhibits other bacteria
- Takes about 15 ml blood, can live on this for months.



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Leech therapy

Ancient practice, sometimes used today

Used to treat skin conditions, healing,

Used to reattaching body parts. Leeches prevent clotting in small capillaries



End