

# Warm-up discussion/brainstorm

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*What do a snail, slug, and octopus have in common?*

*What do you think are some characteristics of molluscs?*

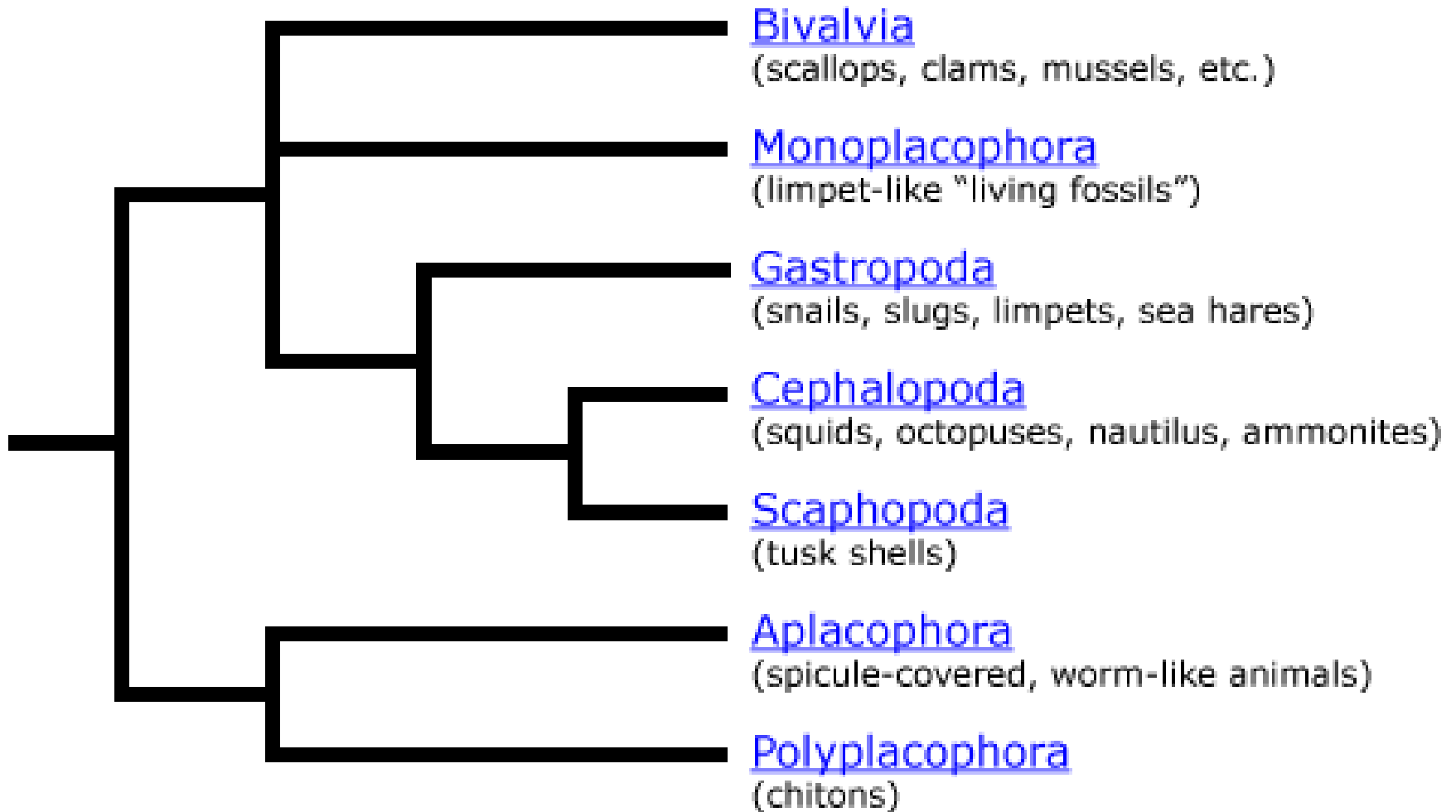
*What questions do you have about molluscs?*

# What's in a Name?

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Class Name	Meaning (Latin/Greek)
Aplacophora	
Monoplacophora	
Polyplacophora	
Scaphopoda	
Bivalvia	
Gastropoda	
Cephalopoda	

# MOLLUSCA

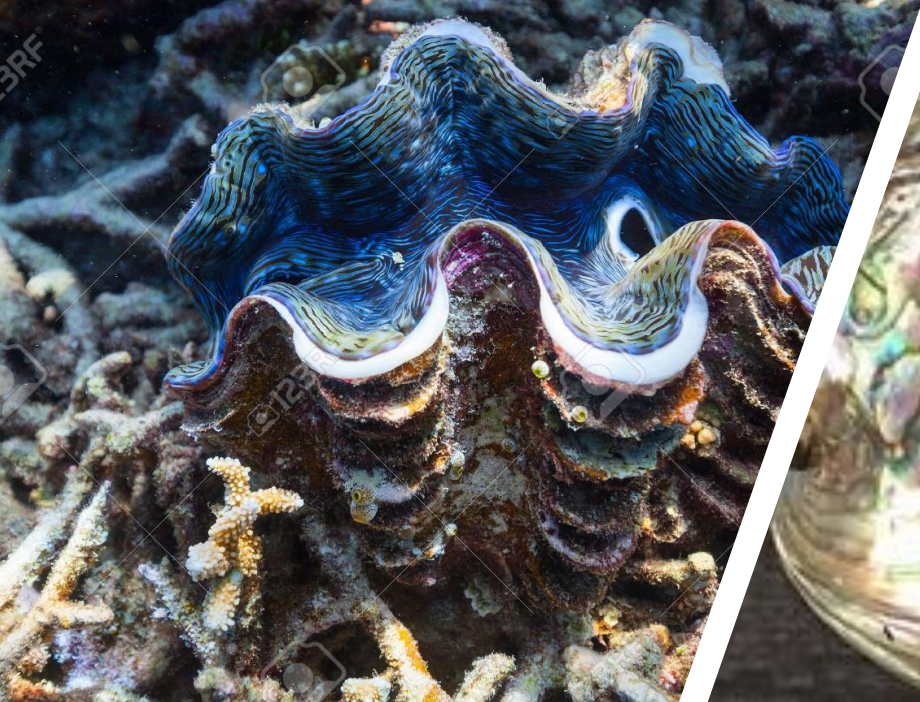




# Phylum Mollusca

NAUTILUS, SQUID, OCTOPUSES, SNAILS, SLUGS, SCALLOPS, CLAMS, OYSTERS, MUSSELS, NUDIBRANCHS











# Mollusca: overview

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- ❖ Enormous biodiversity
  - 90% are snails or bivalves
  - Cephalopods the most intelligent invertebrates
- ❖ Over 95,000 species: all habitats, but mostly aquatic
- ❖ Good fossil record: many secrete shells

# Mollusca: major characteristics

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- (Three germ layers: endoderm, mesoderm, ectoderm)
- Bilateral symmetry or asymmetrical
- Mantle (organs within cavity; can secrete shell)
- Muscular ventral foot: adapted for various functions
- Skeleton: hydrostatic, exoskeleton, endoskeleton
- Digestive system: complete gut, torsion, radula
- Life cycle: zygote → larvae → adult
- Respiratory system: lungs or gills
- Circulatory system: mostly open (closed for cephalopods)
- Nervous system: very simple → very complex

# Basic Body Plan

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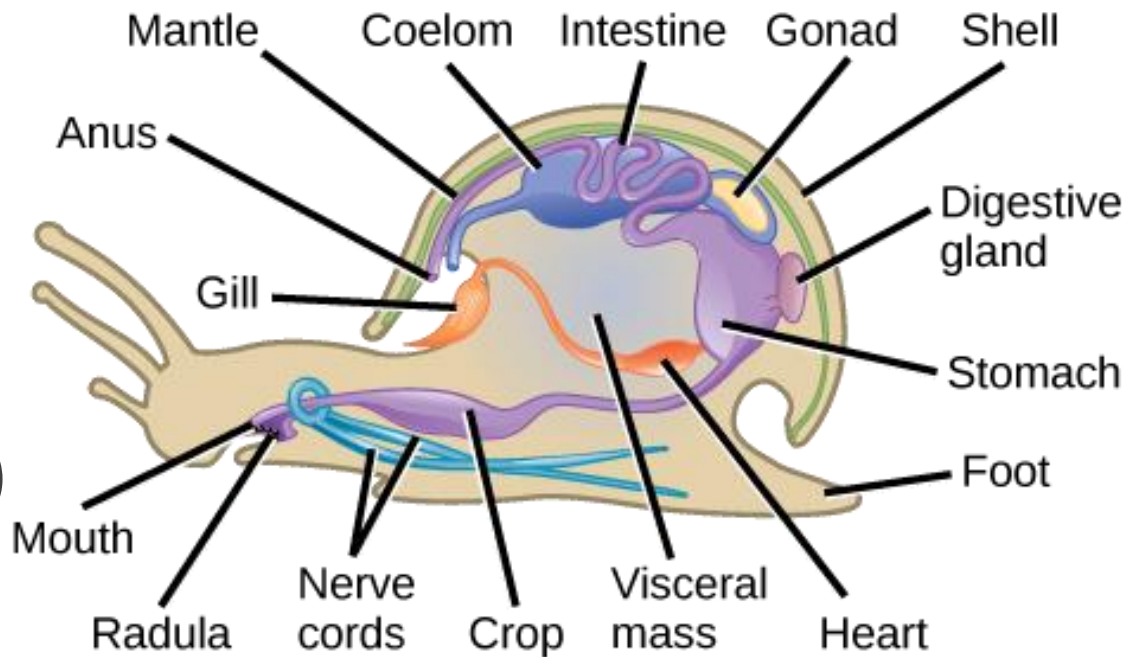
❖ **Head**

❖ **Mantle, mantle cavity**

❖ **Shell**

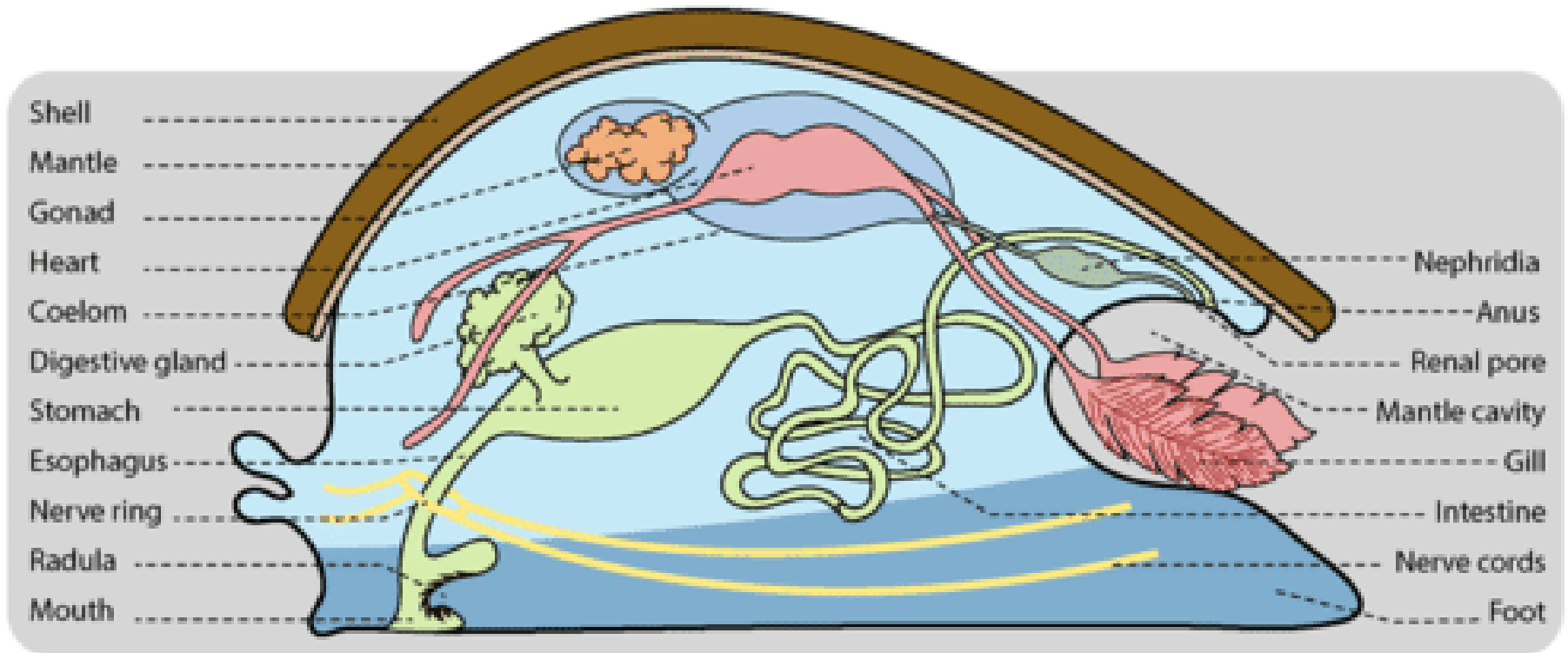
❖ **Visceral mass**  
(internal organs)

❖ **Muscular foot**




# Basic Body Plan

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# Basic Body Plan

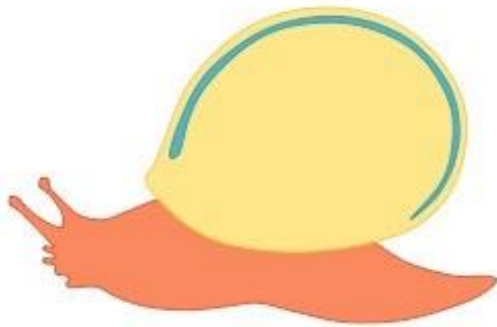
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 Muscular Foot

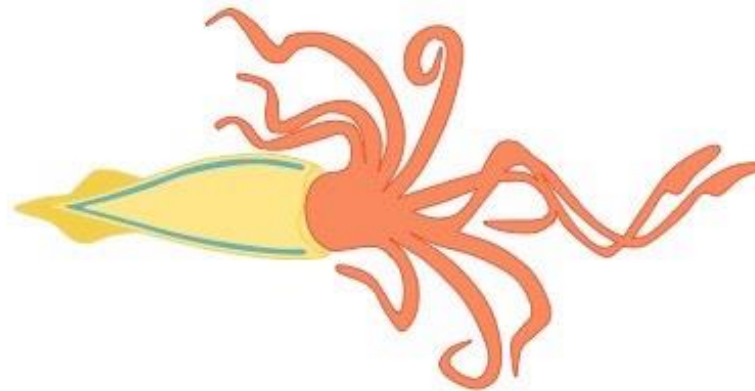
 Mantle

 Visceral Mass

 Shell



**Snail**  
*(shell removed)*



**Squid**

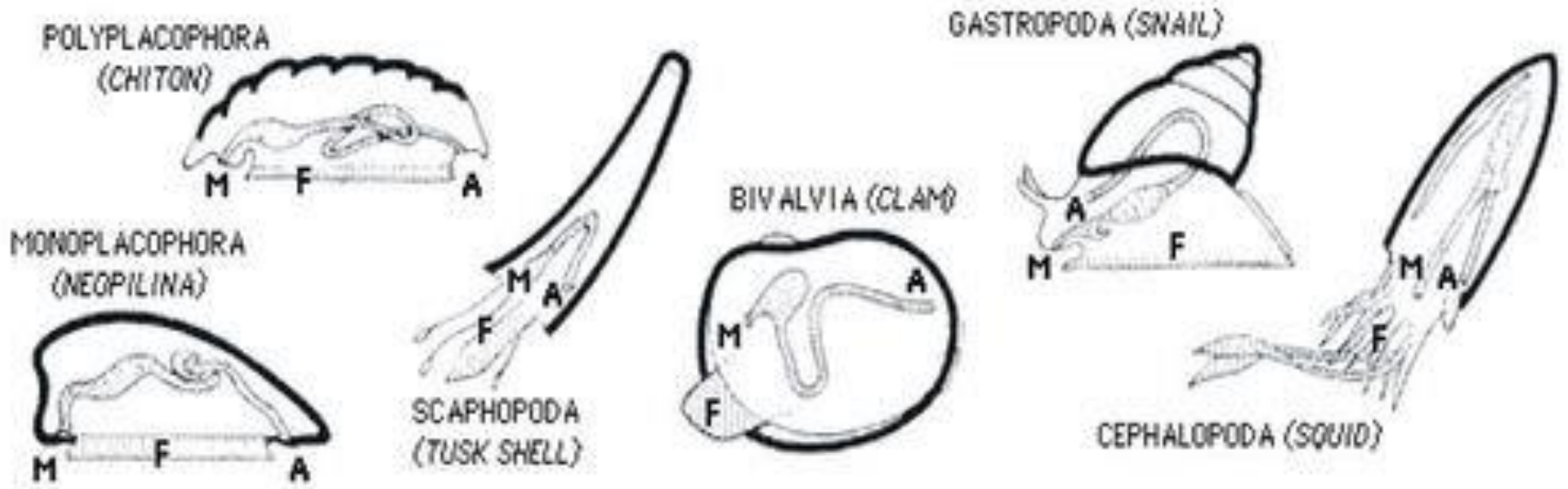


**Bivalve (e.g. oyster)**  
*(shown as cross-section)*

# Basic Body Plan

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## Classes of Mollusks



# Basic Body Plan

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## Mantle

- ❖ Layer of epidermis
- ❖ Contains sense organs, glands, including:
  - **Shell gland** (produces shell)
  - **Mucous gland**



# Basic Body Plan

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## Mantle cavity

- ❖ Region covered/protected by mantle
- ❖ Waste and gametes empty into mantle cavity before release
- ❖ Some molluscs retract head or foot into mantle cavity

# Basic Body Plan

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## Shell

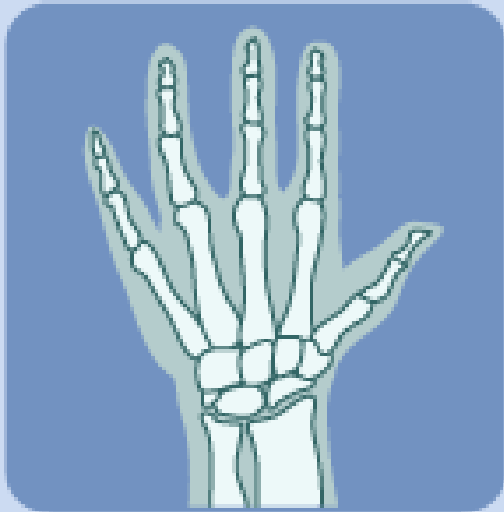
- ❖ Secreted by mantle
- ❖ Made of **calcium carbonate** ( $\text{CaCO}_3$ )
- ❖ Key trait, used to distinguish between molluscan taxa
- ❖ Adapted for many purposes



# Skeleton

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## Endoskeleton



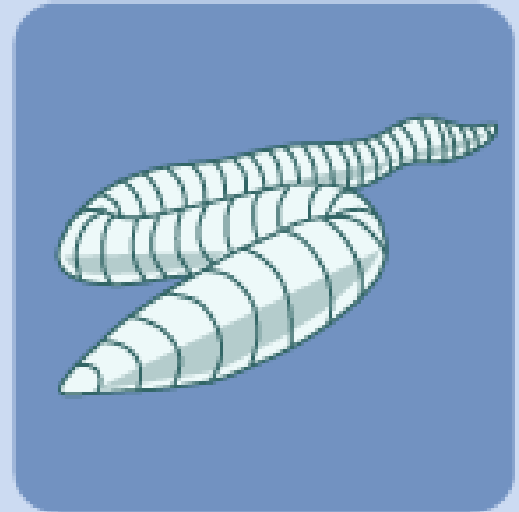
bones inside the  
human hand

## Exoskeleton



the shell outside  
a snail

## Hydrostatic skeleton

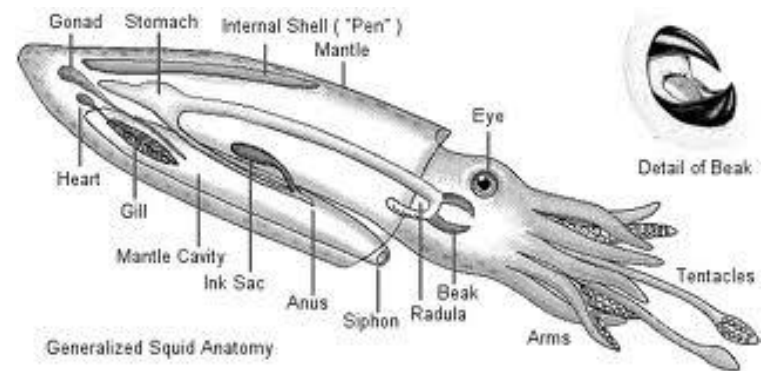


water pressure  
inside an earthworm

# Skeleton

Shell adapted for many structural/protective purposes:

- ❖ Gastropods and bivalves: outer shell for protection (**exoskeleton**)
- ❖ Squid: reduced **endoskeleton**, for structural support only
- ❖ No shell in octopus
  - Relies on **hydrostatic skeleton only**
  - Flexible body ([video](#))



# Basic Body Plan

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## Visceral Mass

- ❖ Contains most of the body organs (reproductive, excretory, circulatory, etc)
- ❖ In most molluscs, protected by shell

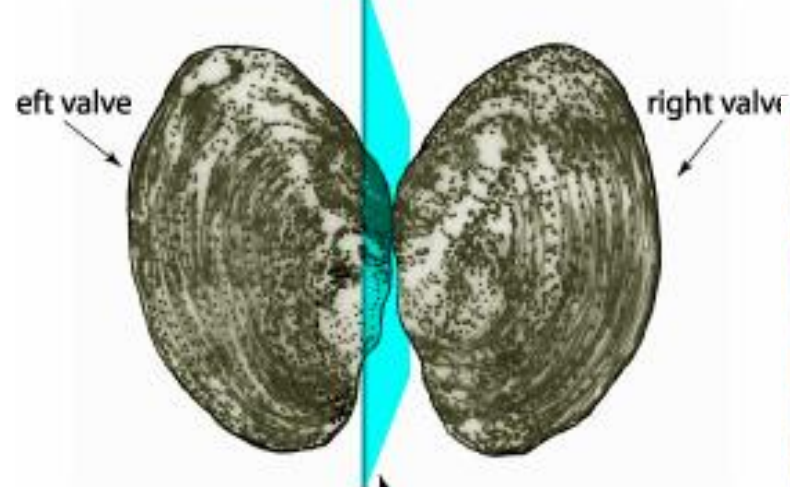
## Foot

- ❖ Varies greatly in shape/function
- ❖ Generally used for locomotion, to anchor animal to surfaces

# Germ Layers

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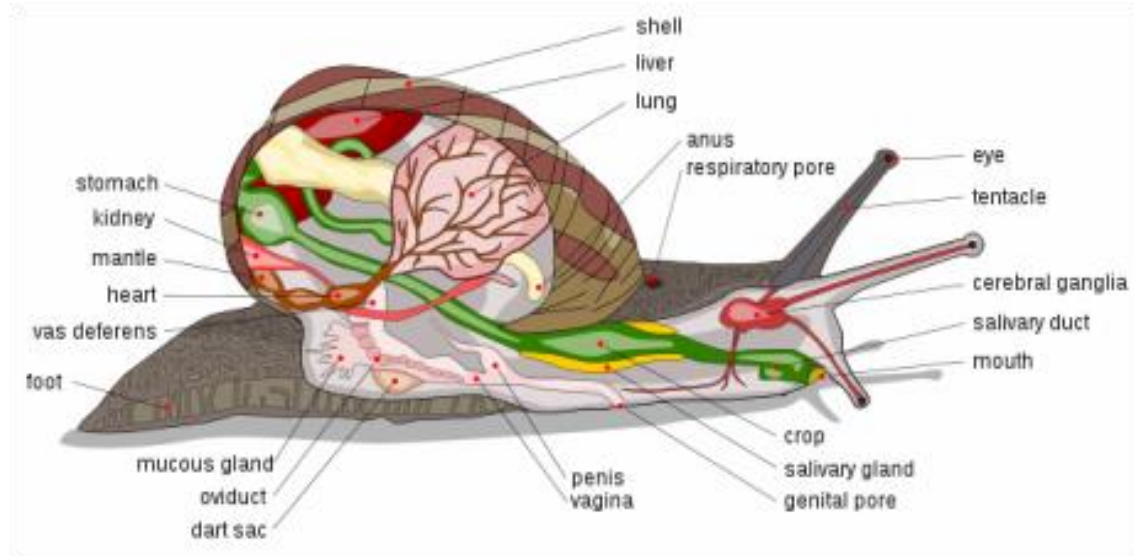
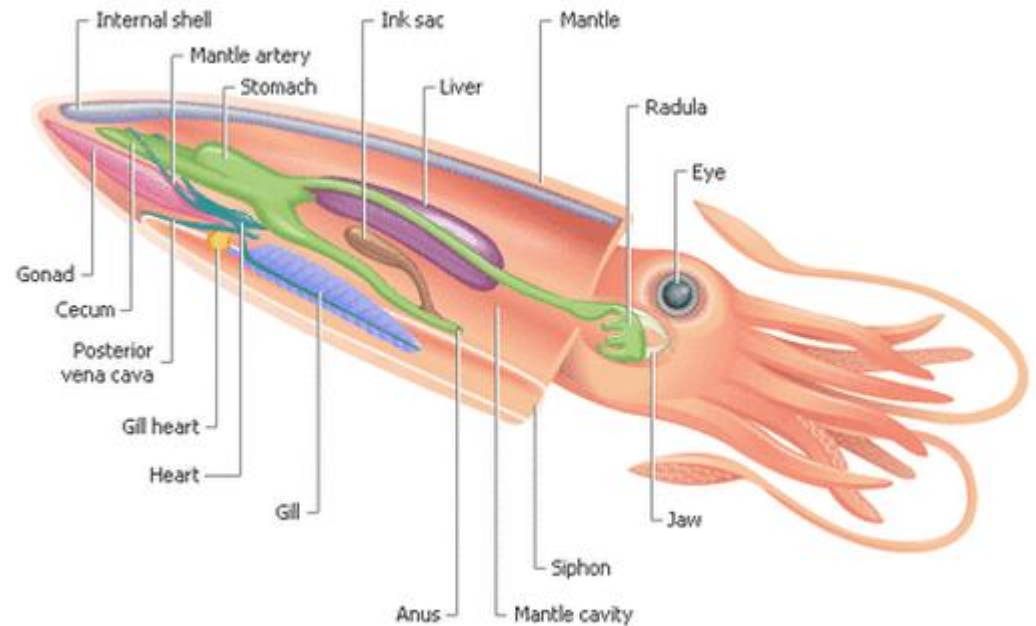
- ❖ 3 germ layers: **endoderm, mesoderm, ectoderm**
- ❖ Origin of some structures:
  - **Mantle, Nervous System – ectoderm**
  - **Gills/Lungs – mesoderm**
  - **Digestive System – endoderm**
- ❖ Most structures ambiguous (don't memorize):
  - **Foot** – mesoderm, ectoderm
  - **Visceral mass** – a combination of different layers



Molluscs have **bilateral symmetry** or **asymmetry**

# Digestive System Overview

- ❖ **Complete gut** (separate mouth and anus)
- ❖ **Torsion** in most gastropods
- ❖ **Radula** adapted for many functions





# The Tale of Two Gastropods

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Garden Snail  
(has torsion)

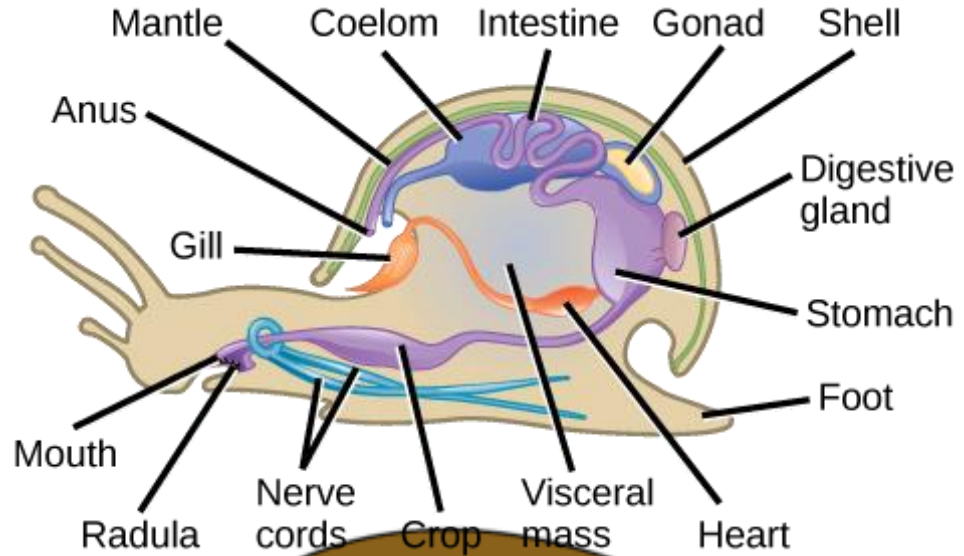


Nudibranch  
(no torsion)

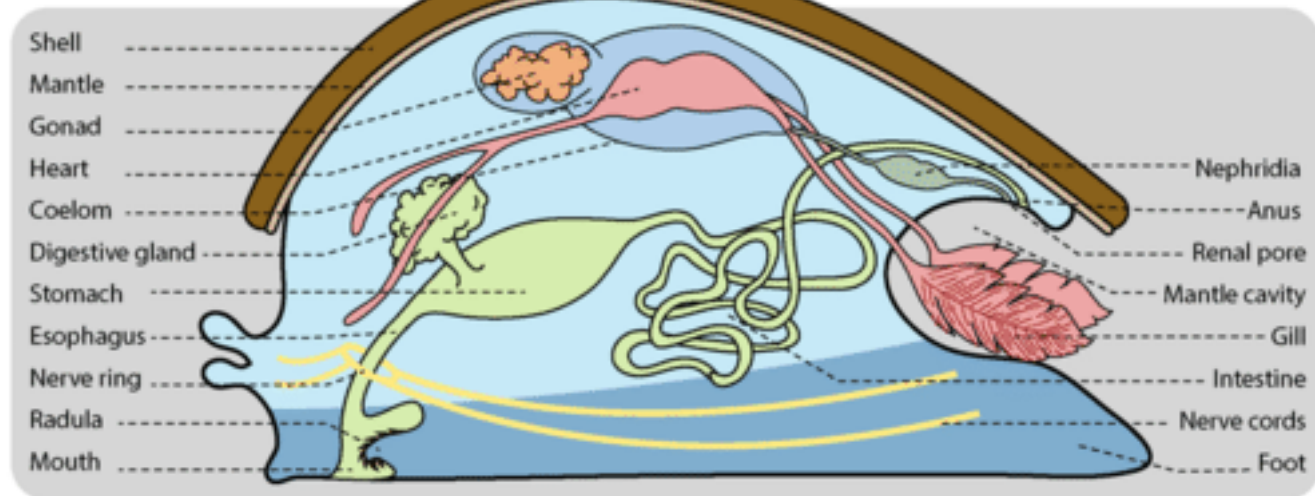


# The Tale of Two Gastropods

Garden Snail  
(has torsion)



Nudibranch  
(no torsion)



Why does the garden snail “poop on its head”?

# Thought Experiment

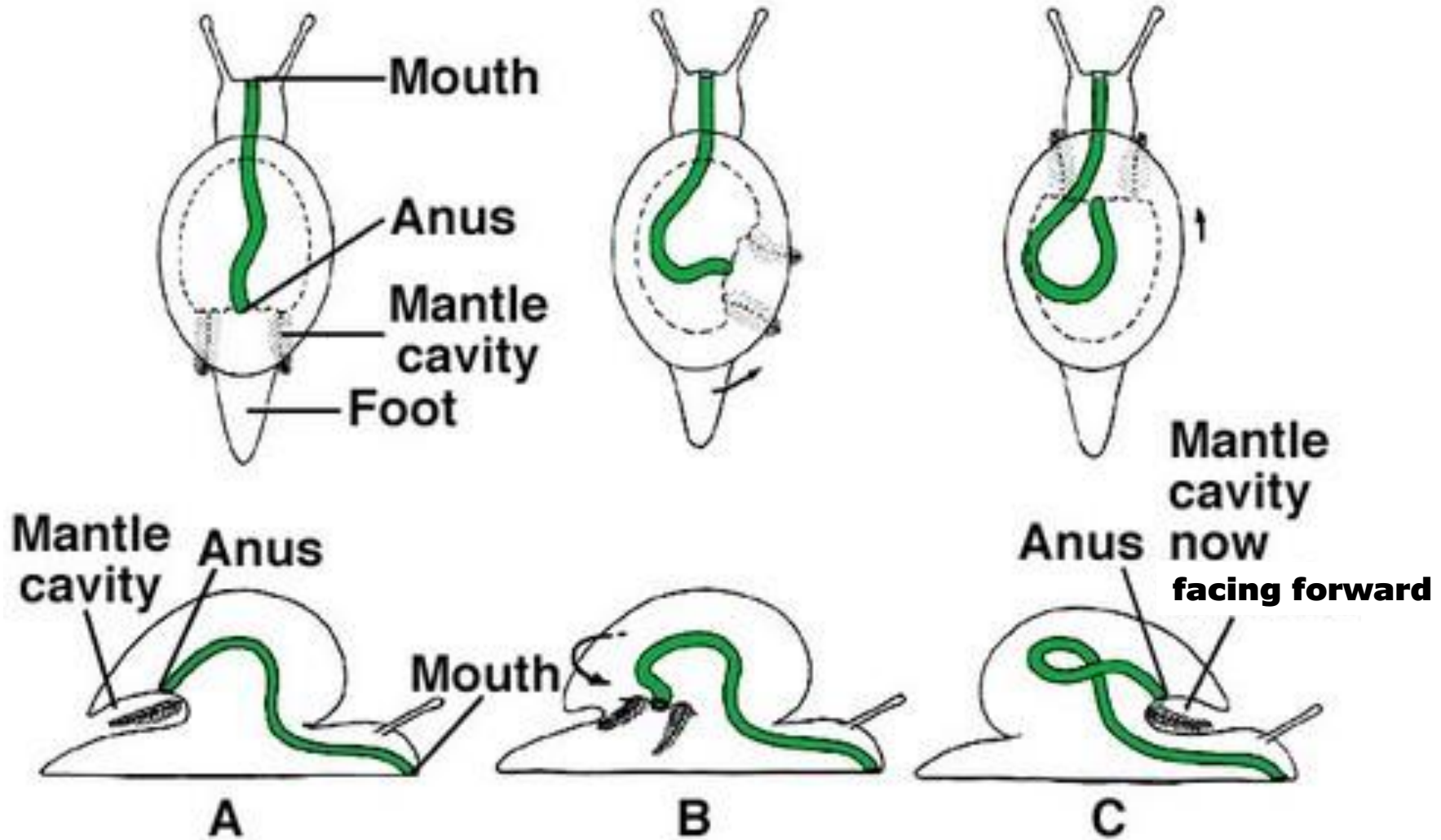
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Would you rather?

- Lose your head OR
- Lose your hypothetical tail

What body part do you protect first in an earthquake?

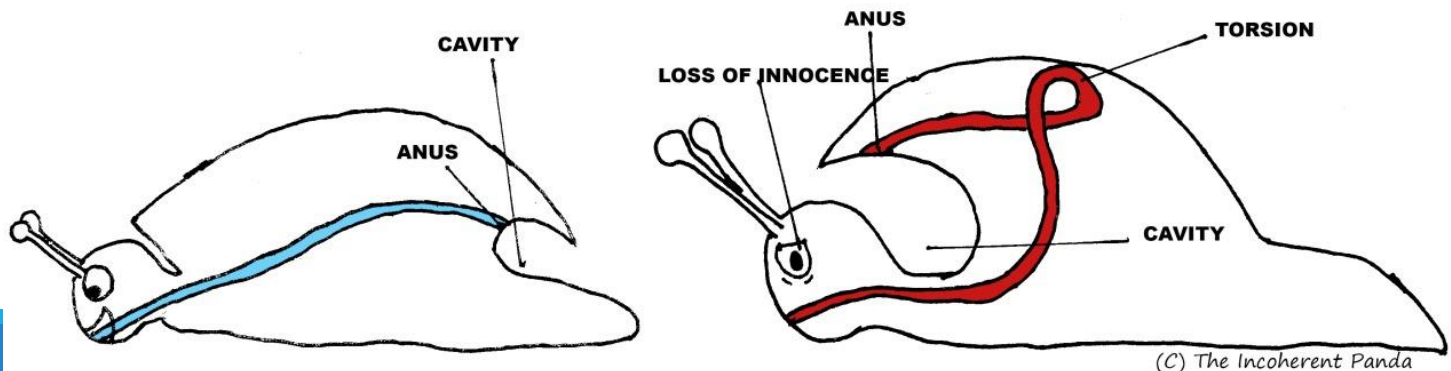
# Torsion in gastropods



# Torsion (gastropods only)

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- ❖ During development, mantle cavity faces backward
  - Tuck in tail before head
- ❖ **Torsion**: twist entire mantle/mantle cavity/shell to face forward
  - Tuck in head before tail...better protection!
  - Unfortunate side effect: a snail's anus empties near its head and gills



(C) The Incoherent Panda

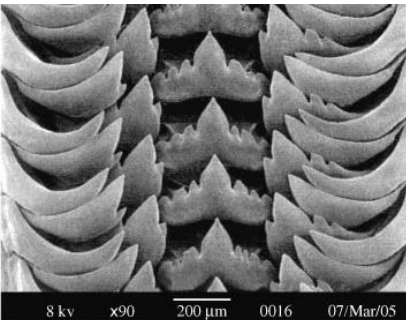
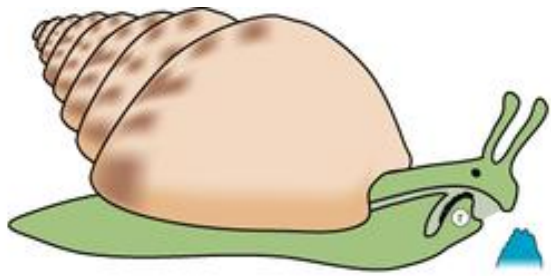


Figure 1. Radula of *Buccinum undatum*.

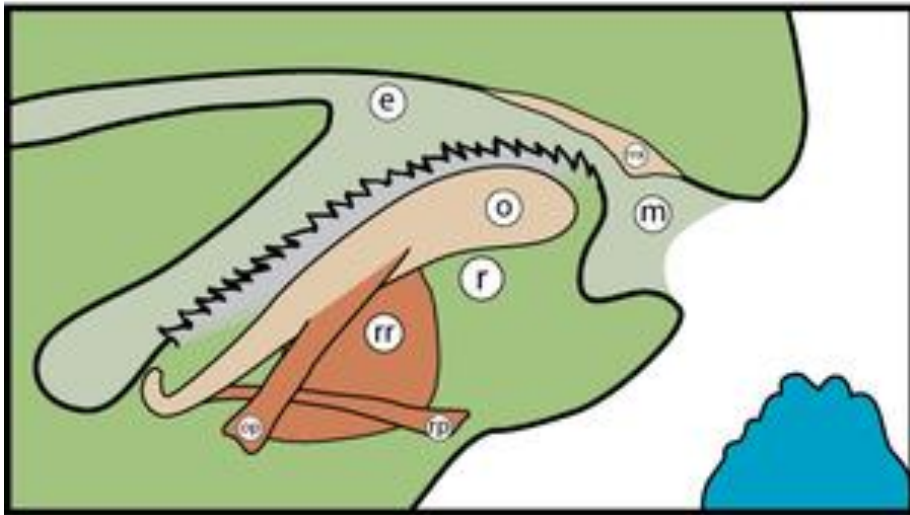
# Digestive System: Radula

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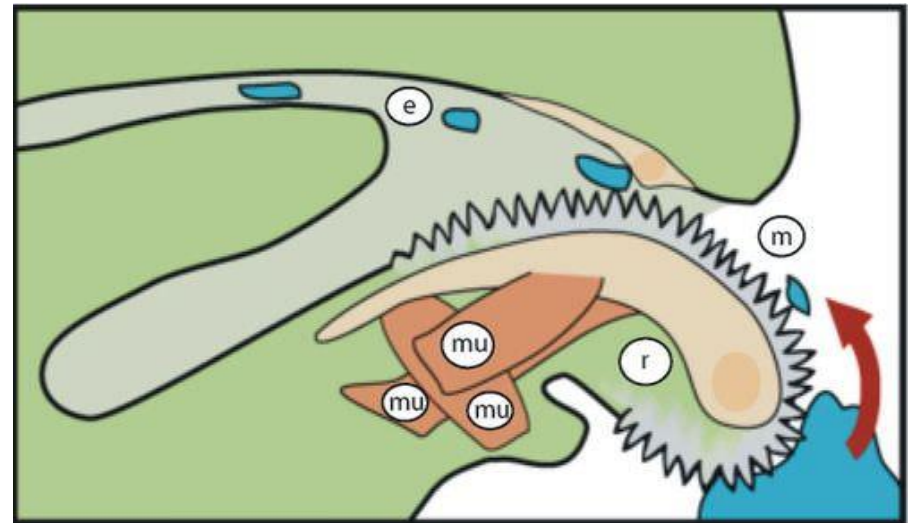
- ❖ Unique to molluscs
- ❖ Tonguelike rasping organ in mouth, a “conveyor belt of teeth”
- ❖ Scrapes/cuts food before enters esophagus



# Digestive System: Radula



m = mouth  
e = esophagus  
r = radula  
mu (rr/op/rp) = muscle



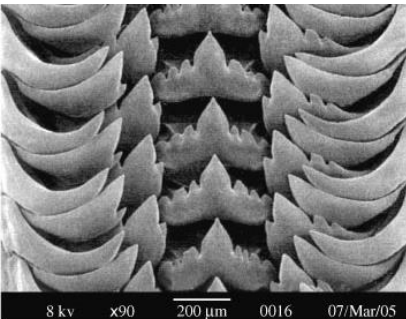


Figure 1. Radula of *Buccina undulata*.

# Digestive System: Radula

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## Adaptations (not testable):

- Scrape algae off of rock (e.g. snails)
- Poisoned harpoon teeth (e.g. predatory marine snails)
- Cutting prey (e.g. squid, octopus)
- Drill holes in the shells of prey (e.g. moon snails)



# Digestive System: Radula



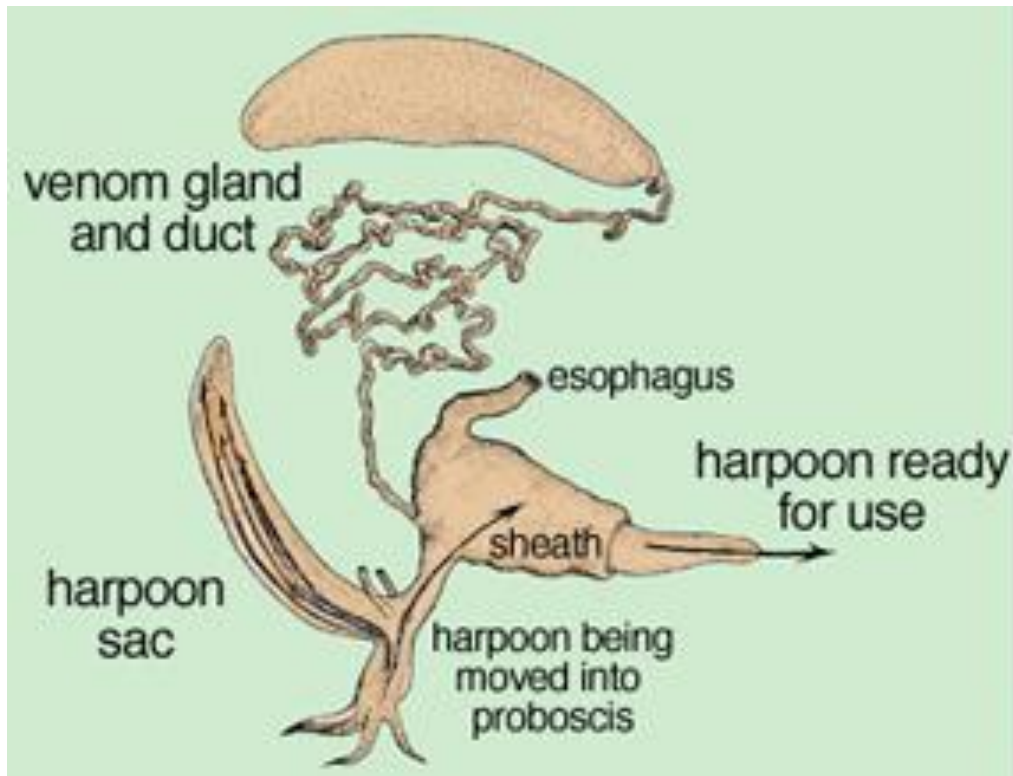


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# Digestive System: Radula

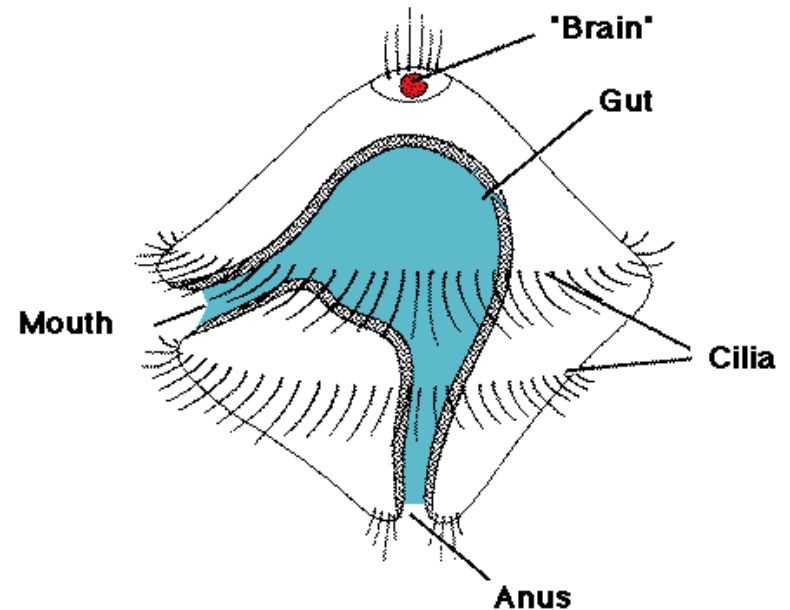
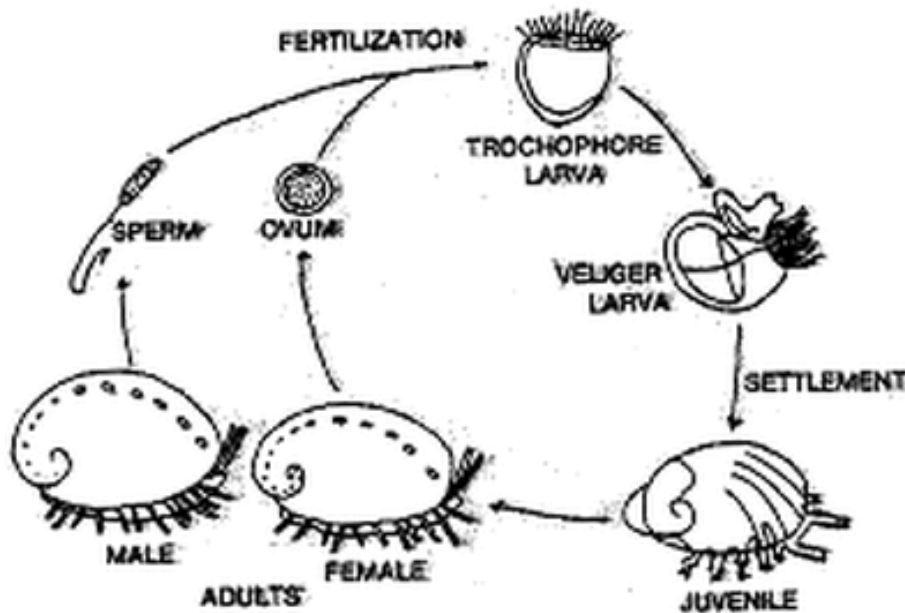
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harpoon at end of proboscis ready for use

# Life Cycle & Reproduction

- ❖ Most molluscs have male and female forms
- ❖ Mostly sexual reproduction
- ❖ Zygote → Larvae → Adult



# Circulatory System

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- ❖ What is the purpose of a circulatory system?
- ❖ Draw a human circulatory system to the best of your ability.

# Complete Circulatory System

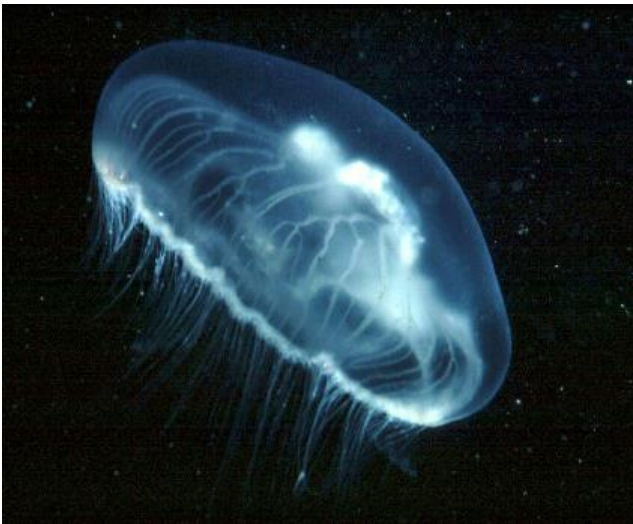
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## Circulatory system:

- Transports nutrients (e.g. oxygen, sugar) to all body cells
- Transports wastes (e.g. carbon dioxide, nitrogen) away from cells

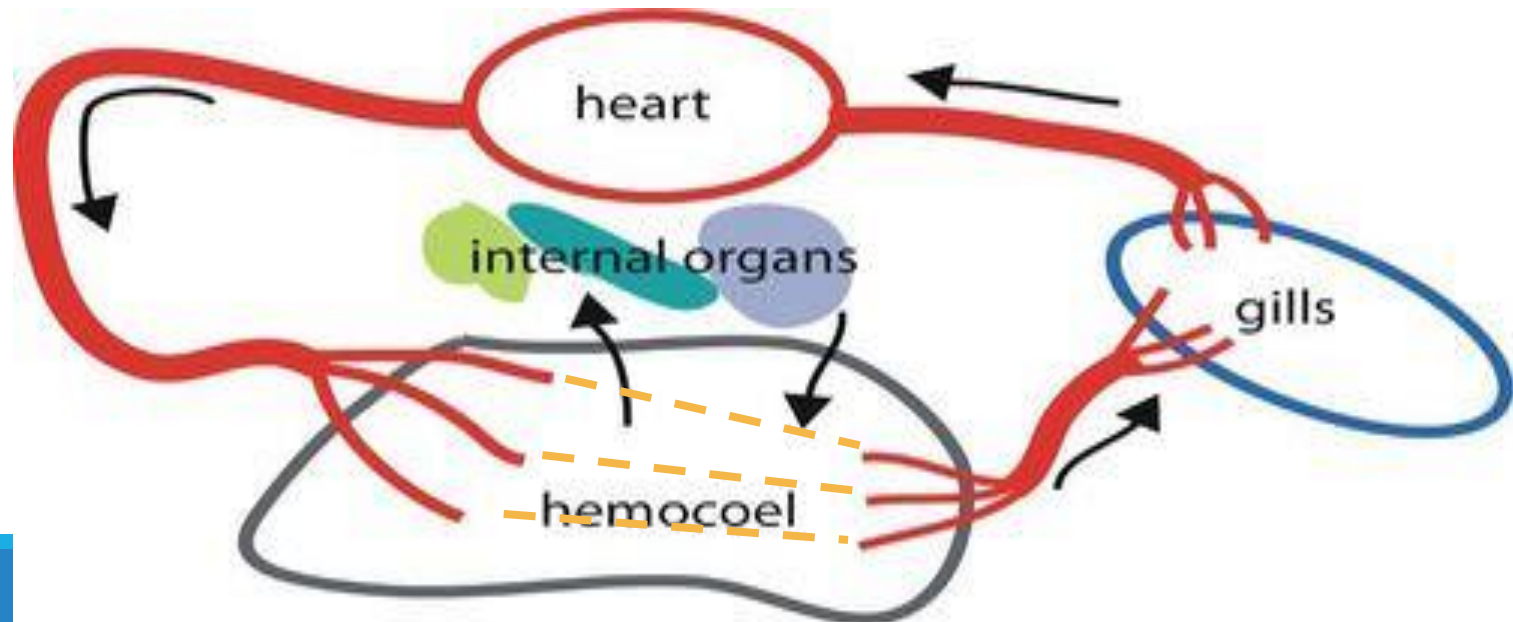
(In comparison, sponges and cnidarians have no circulatory system and rely on diffusion of oxygen and wastes)



# Circulatory System

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- ❖ **Open circulation** in most molluscs
- ❖ **Closed circulation** in cephalopods (open circulation too slow; not enough for fast-moving, intelligent cephalopods)





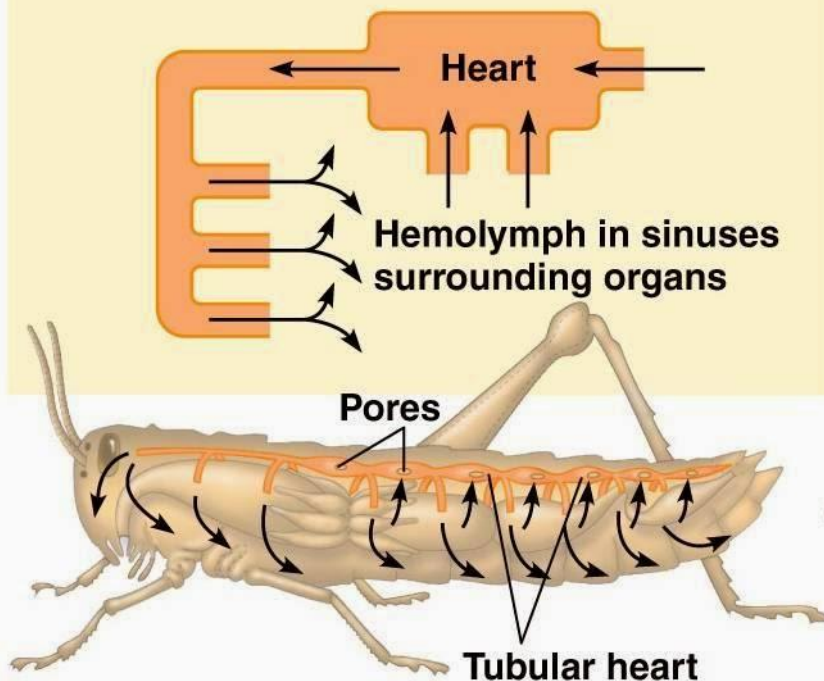
## Open Circulatory System:

- Tissues 'bathed' in blood
- Heart pumps blood between body compartments
- Nutrients/wastes diffuse directly between blood cells and body cells

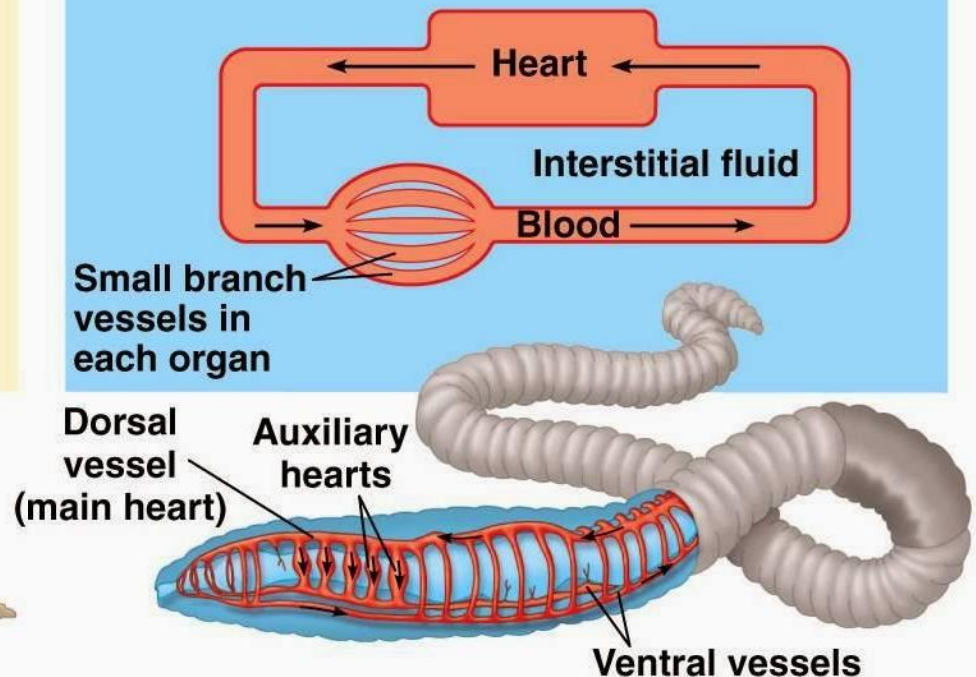
## Closed Circulatory System:

- **Heart(s)** pumps blood through vessels
- Blood contained within **vessels**
- Nutrients/wastes diffuse between blood cells and body cells through vessel wall

(a) An open circulatory system

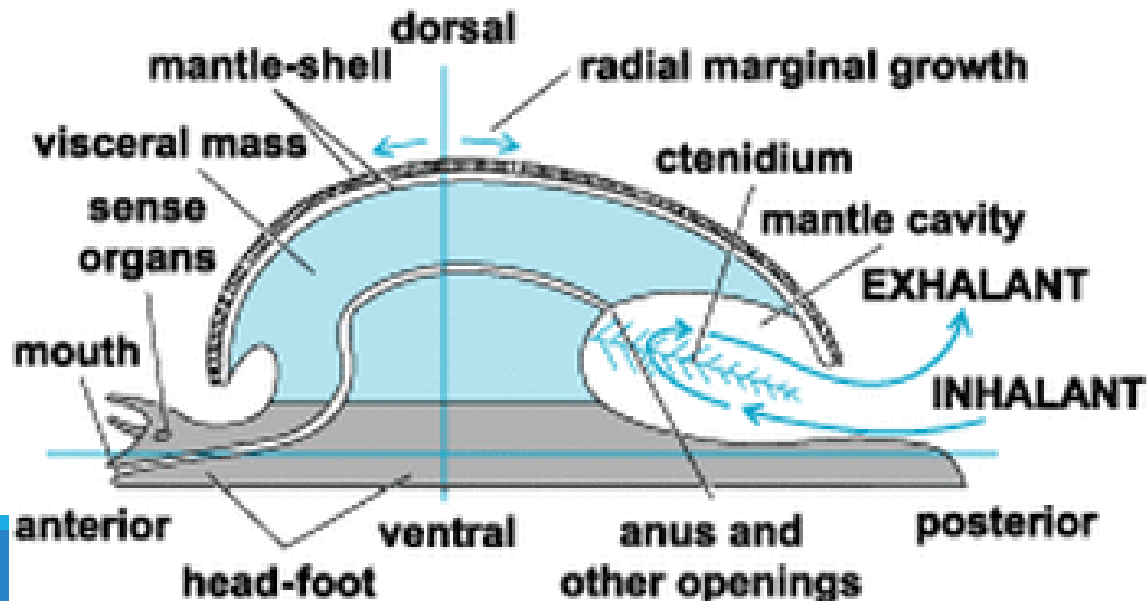


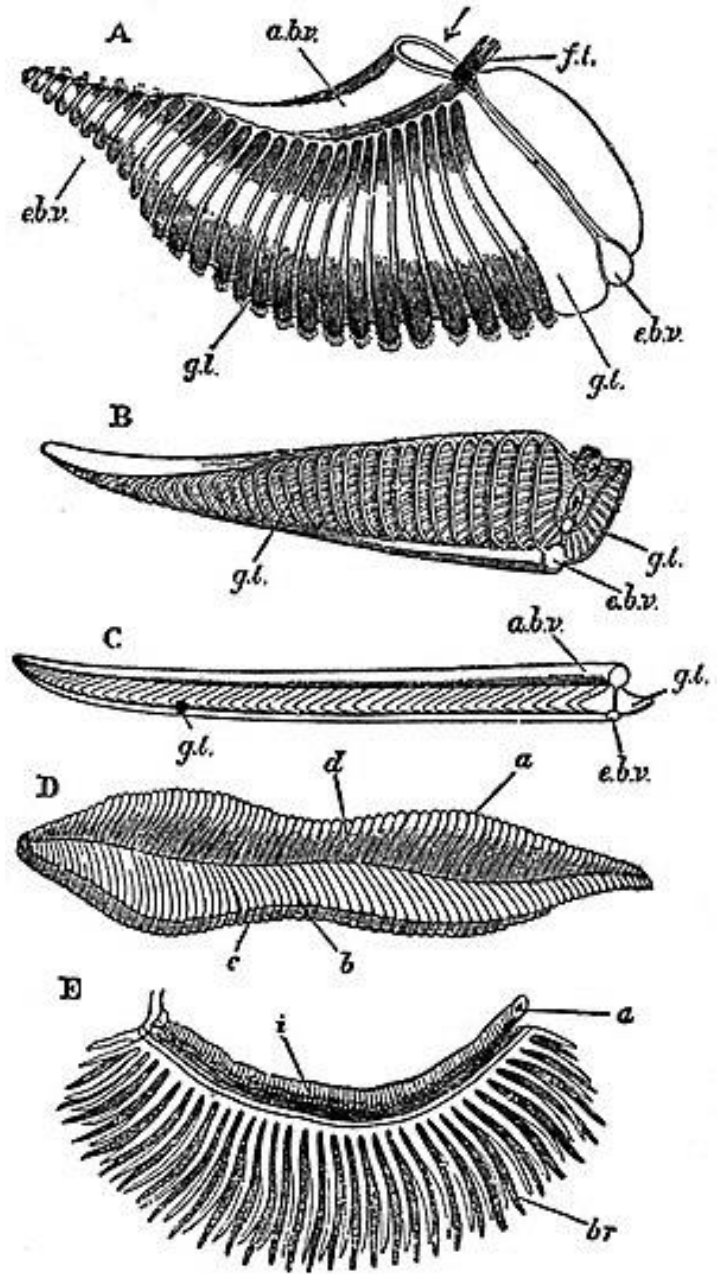
(b) A closed circulatory system



# Respiratory System

- ❖ Terrestrial molluscs have primitive **lungs** (absorb oxygen directly from air)
- ❖ Aquatic molluscs have gills called **ctenidia**: absorb oxygen from water, transfer to bloodstream

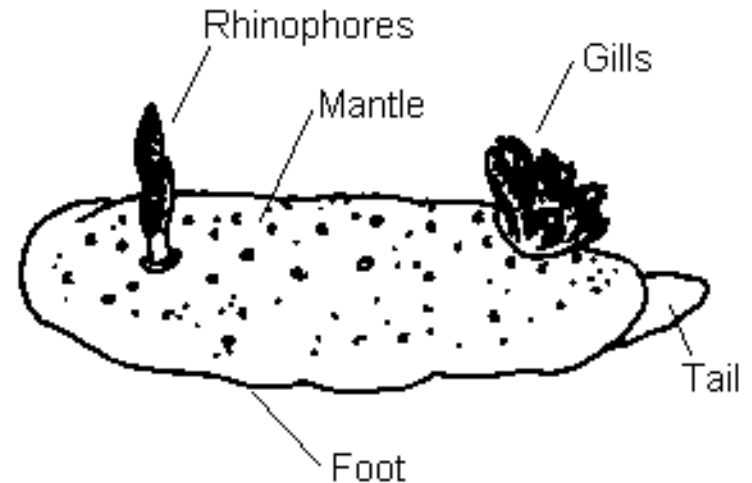




# Respiratory System

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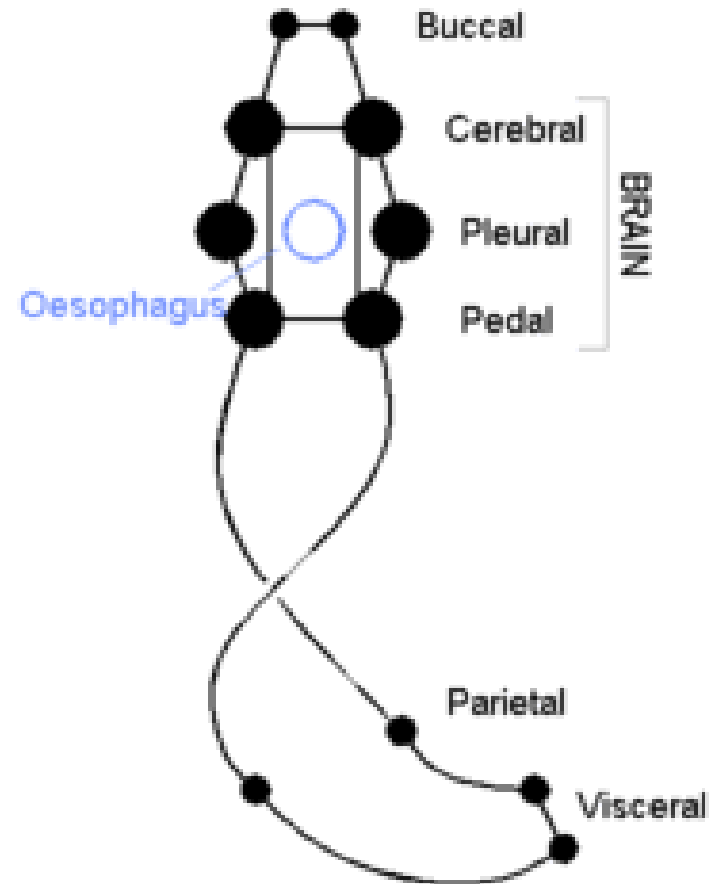
- ❖ **Nudibranch** (“nudi-” = naked; “branch-” = gills) species have their gills completely exposed and unprotected



# Nervous system

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- ❖ **Ladder-like nervous system:** ring of ganglia in head area connected by neurons in a ladder
- ❖ A **ganglion** (pl. ganglia) is a cluster of neurons



# Nervous system

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## ❖ Sensory organs:

- Locations and appearance vary widely
- Have eyes, sense of smell/taste, etc.

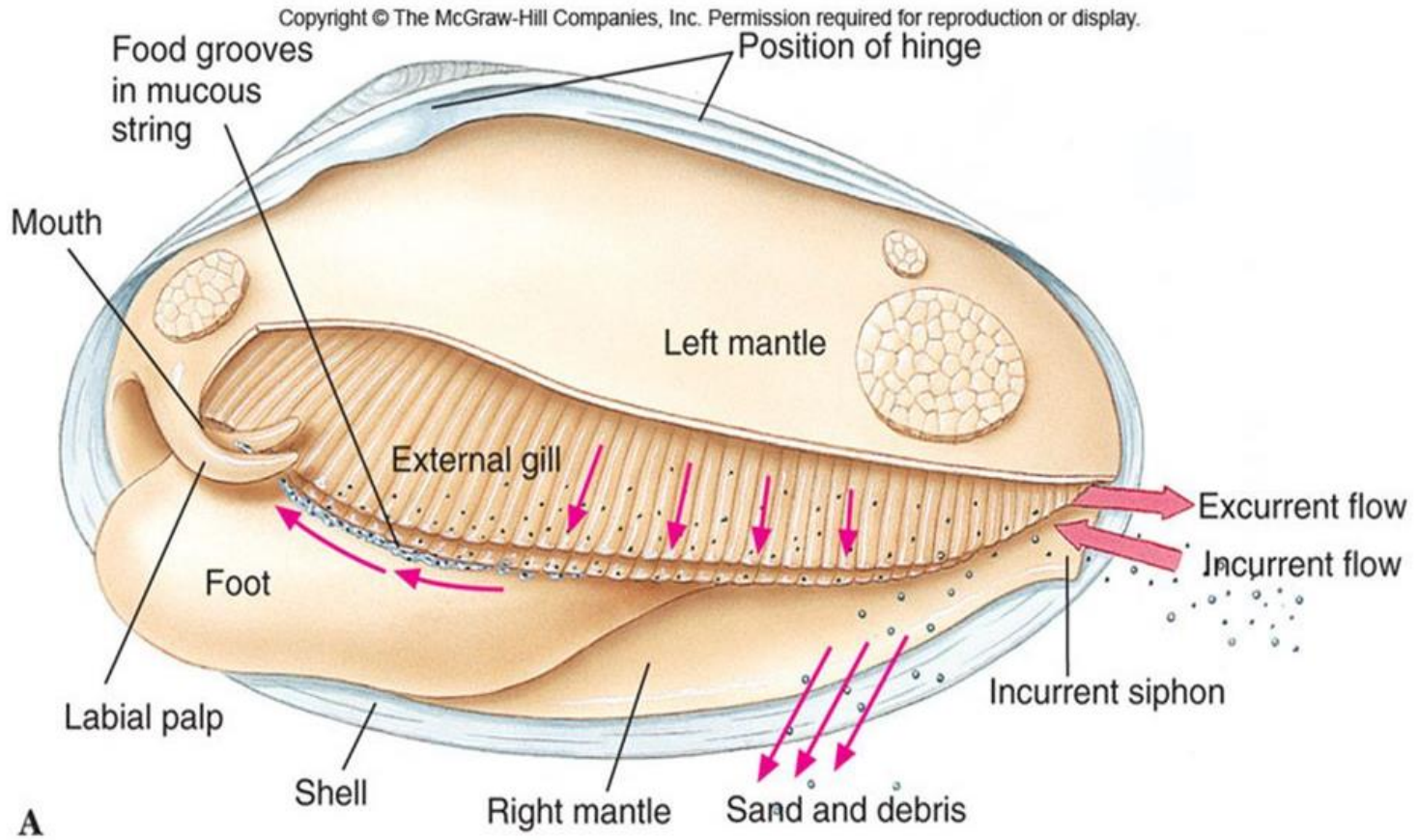


# Class Bivalvia

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- ❖ Have two shells (*bi* = “two”; *valve* = “shell”)
- ❖ Clams, oysters, mussels, scallops, etc
- ❖ **Filter feeders**
- ❖ Pump water in one direction over gills and **mucous string** (where food particles are trapped)

# Class Bivalvia

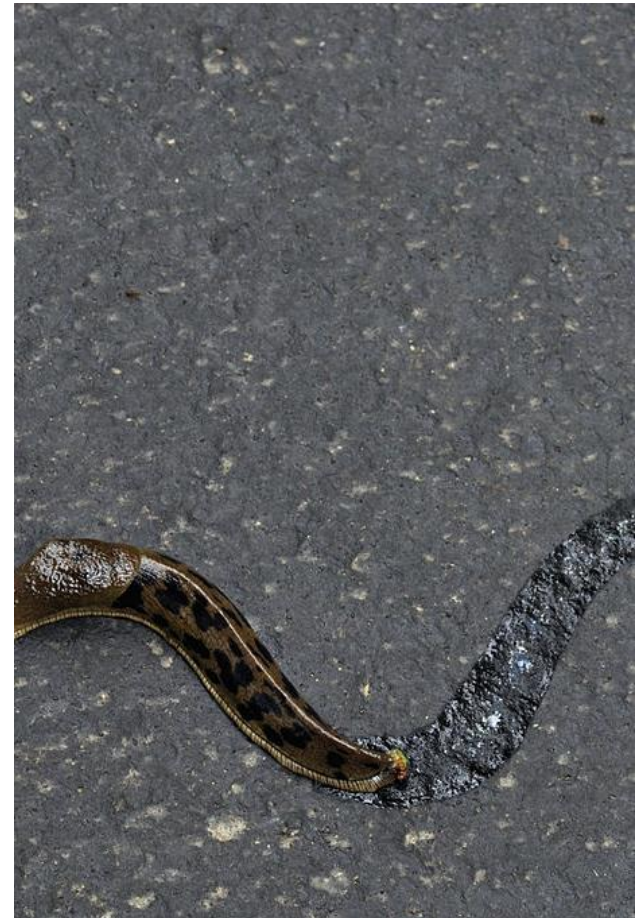




# Class Gastropoda

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- ❖ “Stomach-foot”: foot located on underside and used for locomotion
- ❖ Snails, slugs, nudibranchs
- ❖ **Torsion**
- ❖ Secrete slime trails (using **mucous gland**) to aid with locomotion



# Class Cephalopoda

- ❖ Squid, nautilus, octopus
- ❖ **Closed circulatory system**
- ❖ Highly developed nervous system:
  - Large image-forming eyes
  - 1 central brain + 8 ganglia (one per arm!)
  - Most intelligent of invertebrates

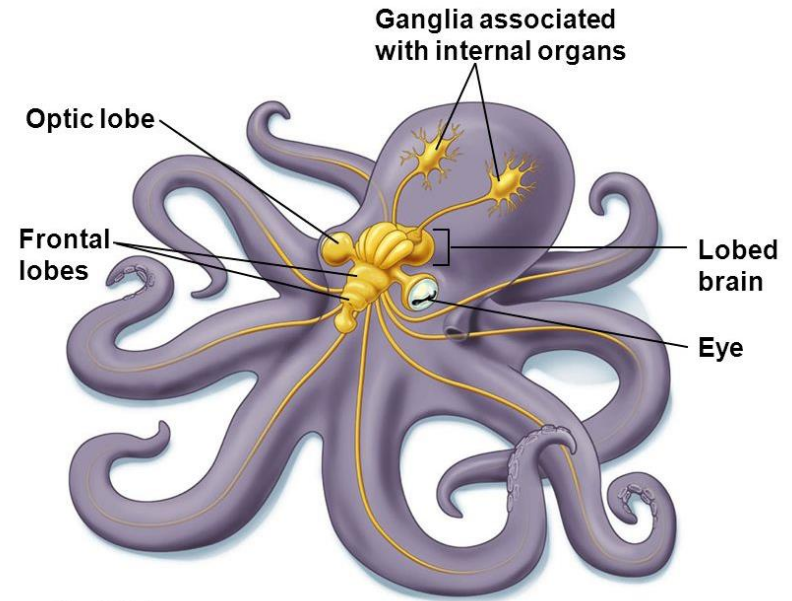
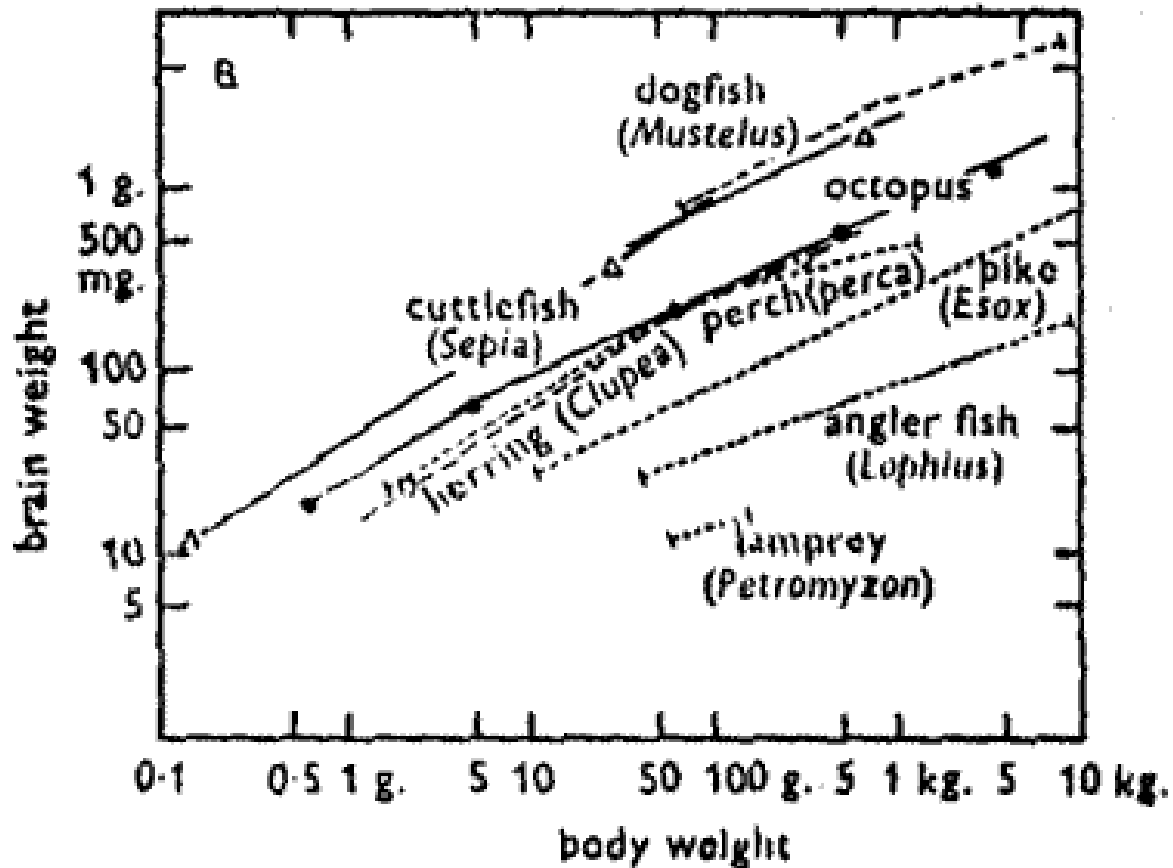


Fig. 38.1e, p. 869

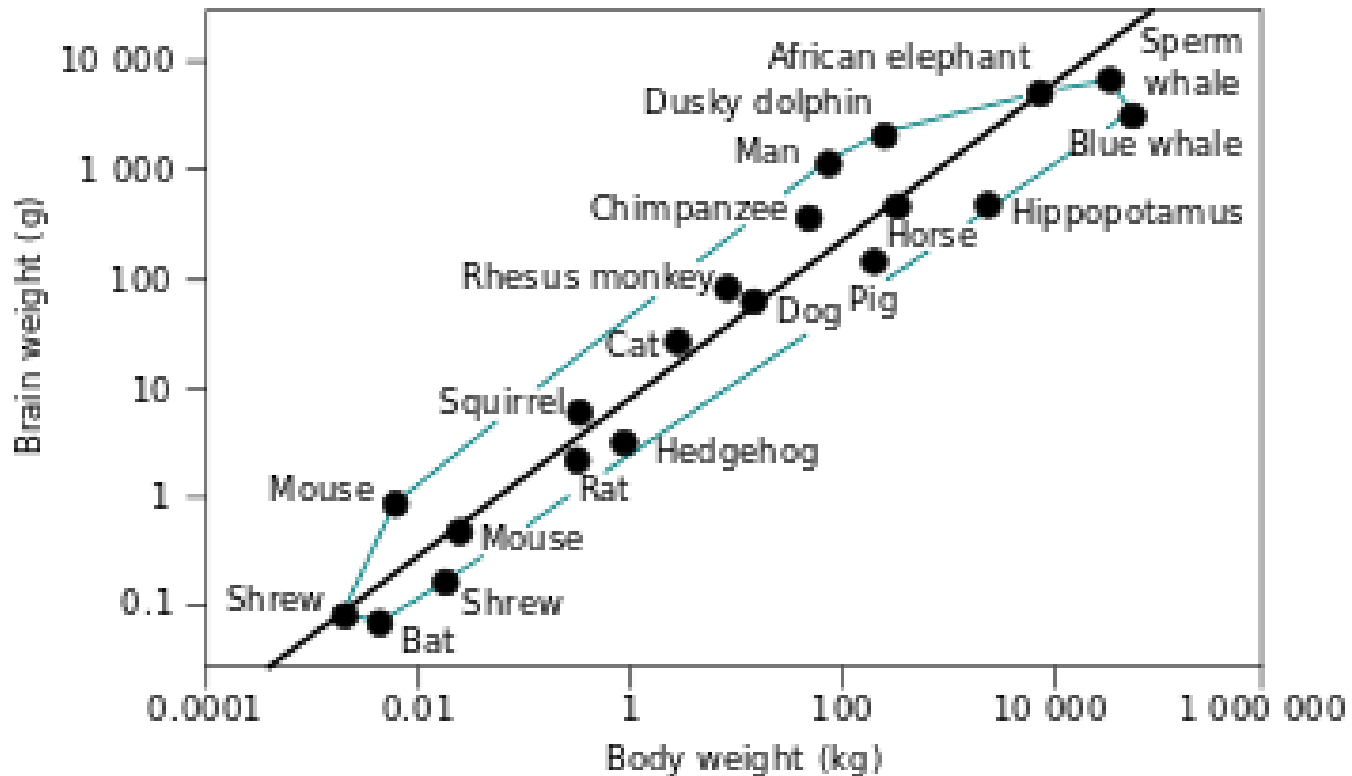
# Class Cephalopoda

Cephalopods' brain to body mass ratio is comparable to vertebrates



# Class Cephalopoda

Cephalopods' brain to body mass ratio is comparable to vertebrates



# Class Cephalopoda (cont.)

- ❖ Squid, nautilus, octopus
- ❖ **Closed circulatory system**
- ❖ Highly developed nervous system:
  - Large image-forming eyes
  - 1 central brain + 8 ganglia (one per arm!)
  - Most intelligent of invertebrates
- ❖ **Chromatophores:** specialized cells capable of colour change for camouflage

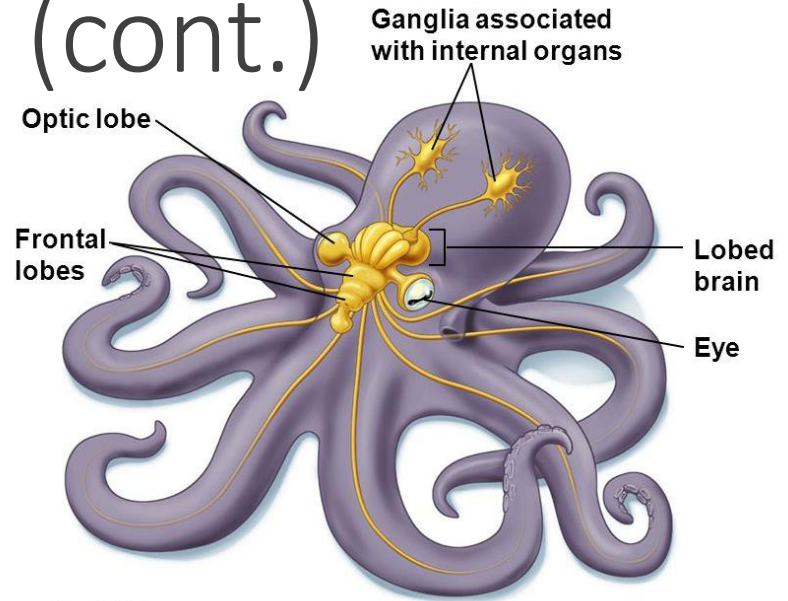
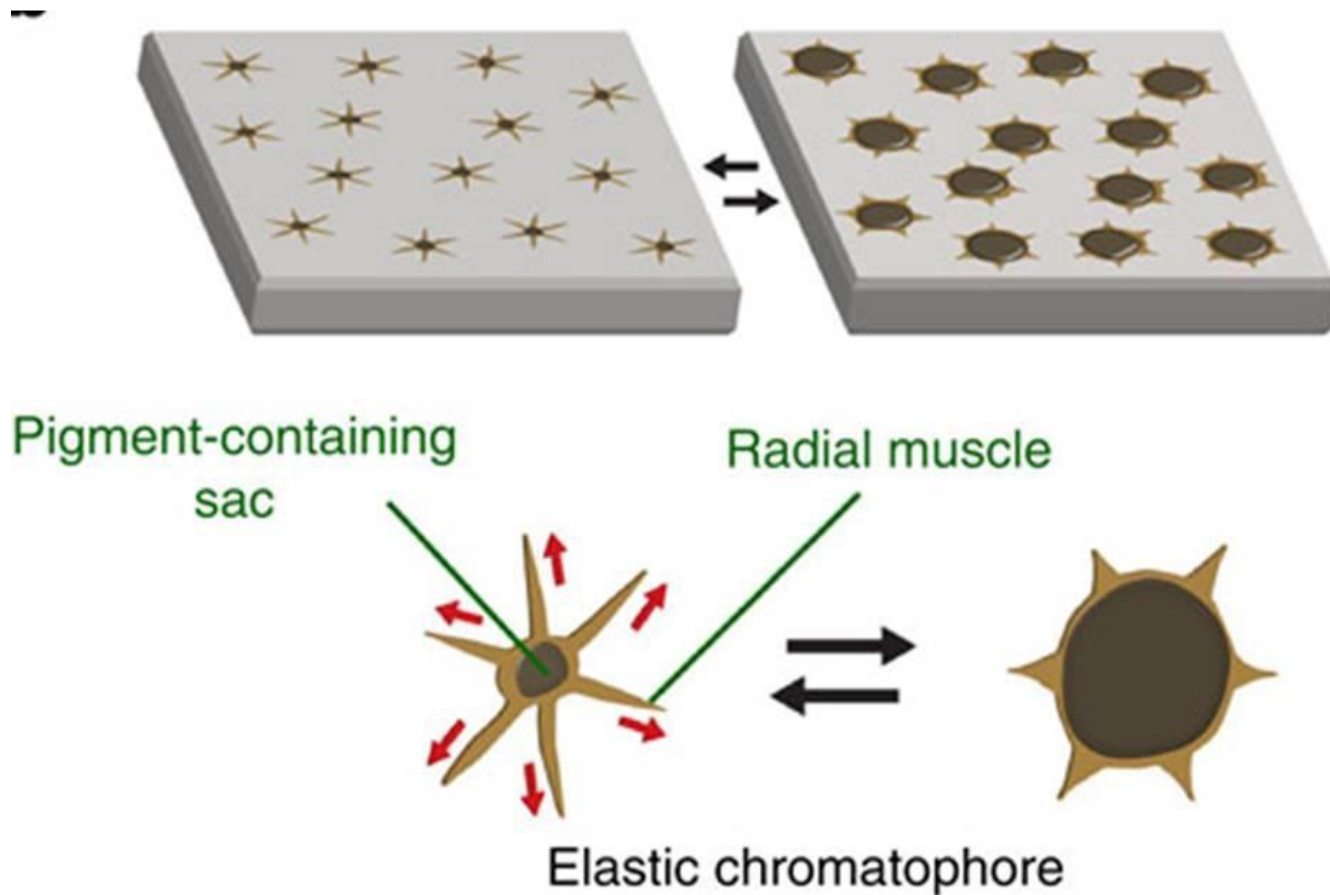


Fig. 38.1e, p. 869

# Class Cephalopoda: Chromatophores



# Chromatophore video

<https://www.youtube.com/watch?v=G-OVrI9x8Zs>



Video of camouflaged octopus

[https://www.youtube.com/watch?v=q8xJ13pAZNw&ab\\_channel=DiscoverMagazine](https://www.youtube.com/watch?v=q8xJ13pAZNw&ab_channel=DiscoverMagazine)

Camouflaged Octopus Makes Marine Biologist Scream Bloody Murder



ROGER T. HANLO

▶ ▶ 🔊 0:25 / 1:15



⏸ CC ⚙️ 🔍 Loop 12:00 12:00



# Mollusc evolution

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## Selective pressures:

1. Competition among seafloor-dwellers
2. Competition for food
3. Defense against predators

## Adaptations:

- Floating (1)
- Specialization of radula (2)
- Specialization/adaptation of shell shape (3)
- Camouflage (cephalopods) (3)
- Toxicity (nudibranchs) (3)
- Intelligence (2, 3)
- Foot structure, function (1, 2, 3)

Note: based off of “Molluscs Survival Game” video

# Further reading: molluscs

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- ❖ <https://www.ck12.org/biology/mollusk-structure-and-function/lesson/Mollusk-Structure-and-Function-Advanced-BIO-ADV/>