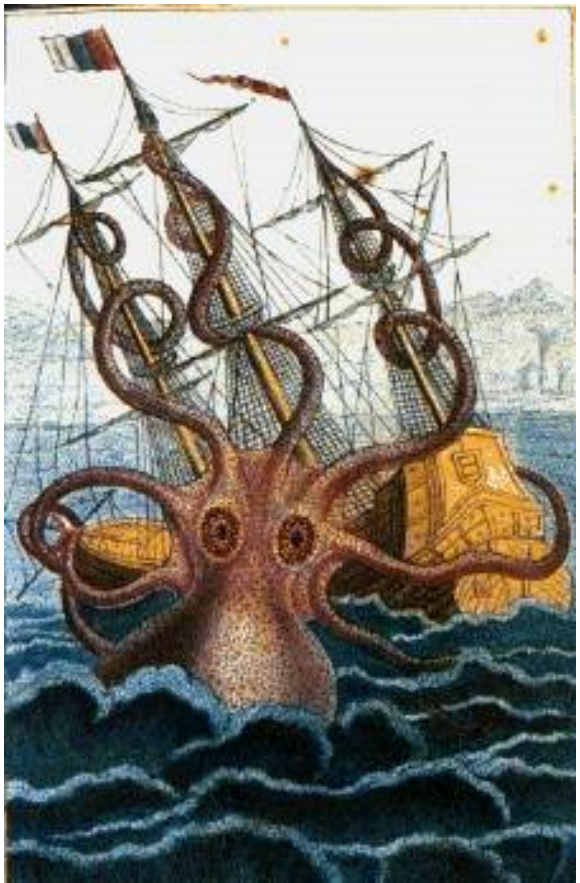
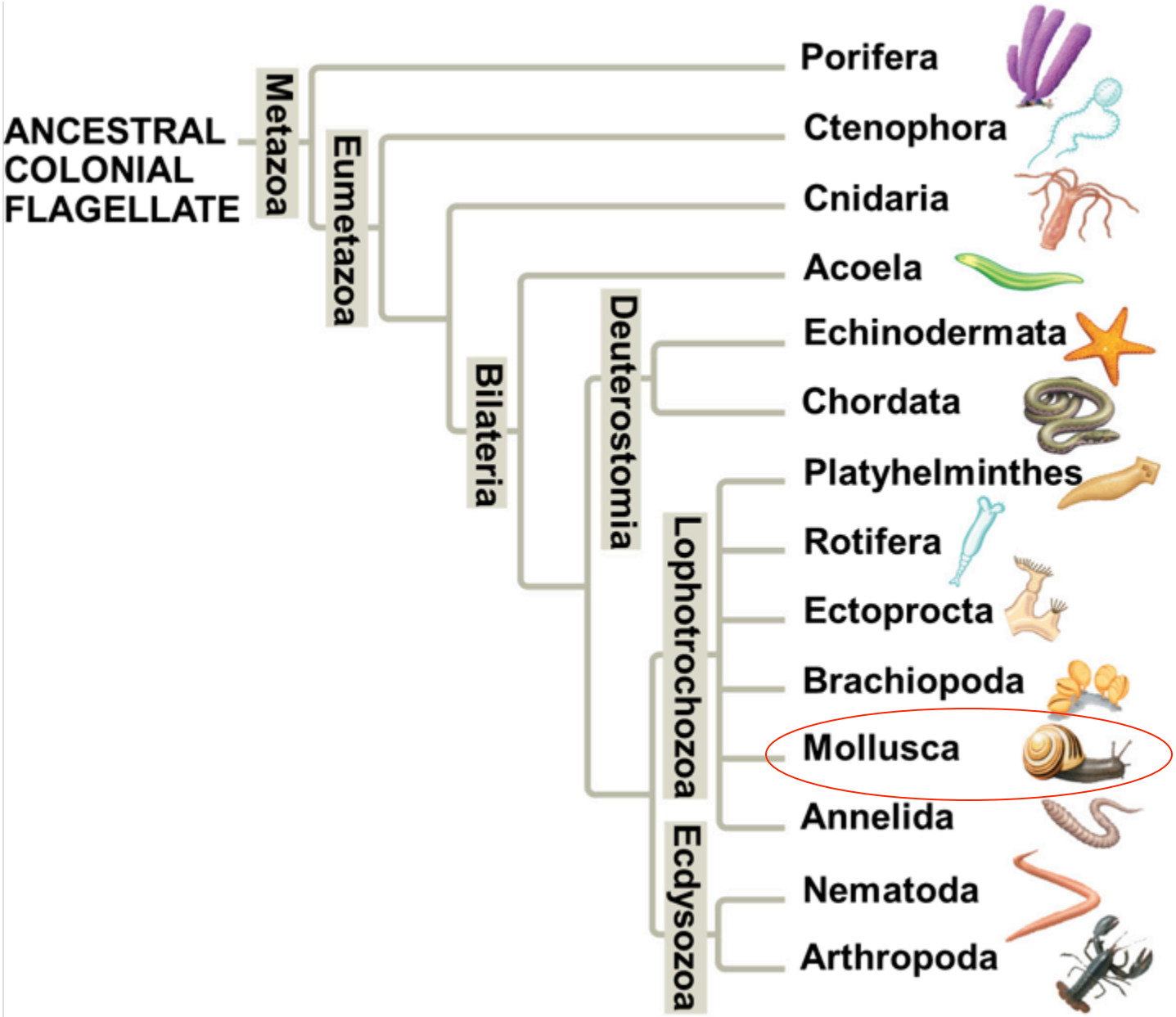
An Introduction to the Invertebrates: Phylum Mollusca

Reference: Chapter 33



Yet More Relationships



Molluscs - Overview

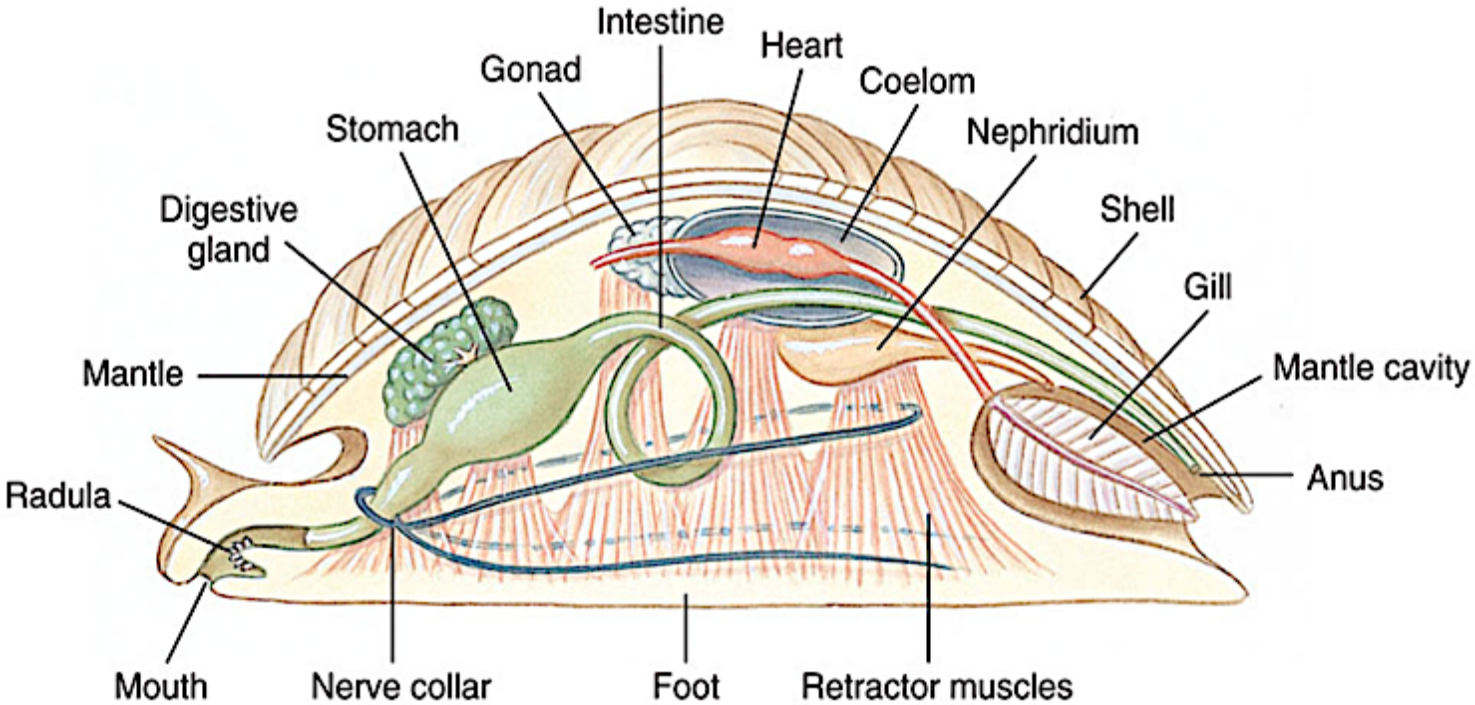
- Mollusca – “the soft things” (Aristotle)
- Phylum Mollusca includes snails and slugs, oysters and clams, and octopuses and squids
- Molluscs have adapted to a very wide variety of habitats
  - Most are marine and can be found in all ocean habitats
  - Many species of gastropod are freshwater and terrestrial
- Molluscs have evolved an array of highly diverse body plans

Mollusc Overview

- Video, molluscs (~15 min): http://shapeoflife.org/video/phyla/molluscs-survival-game

Mollusc Morphology – Basic Body Plan

- Triploblastic, bilaterian, eucoelomate, lophotrochozoan protostomes
- All molluscs have a similar body plan with **three main parts:**
  1. **Mantle**
  2. **Muscular foot**
  3. **Visceral mass**

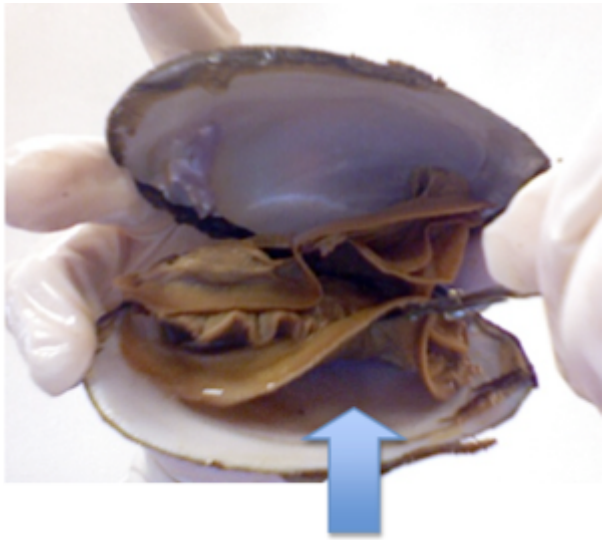


Mollusc Morphology – Mantle

- Mantle
  - Muscular layer of tissue which forms the major covering of the body
  - In some groups portions have evolved into siphons
  - Epithelial cells secrete the shell in shelled molluscs

Mollusc Morphology – Mantle Cavity

- Mantle Cavity
  - Internal cavity generated by folds in the mantle
  - NOT the coelom (which is much reduced)
  - Encloses respiratory organs in most
  - Lined with epidermal cells and exposed to external environment

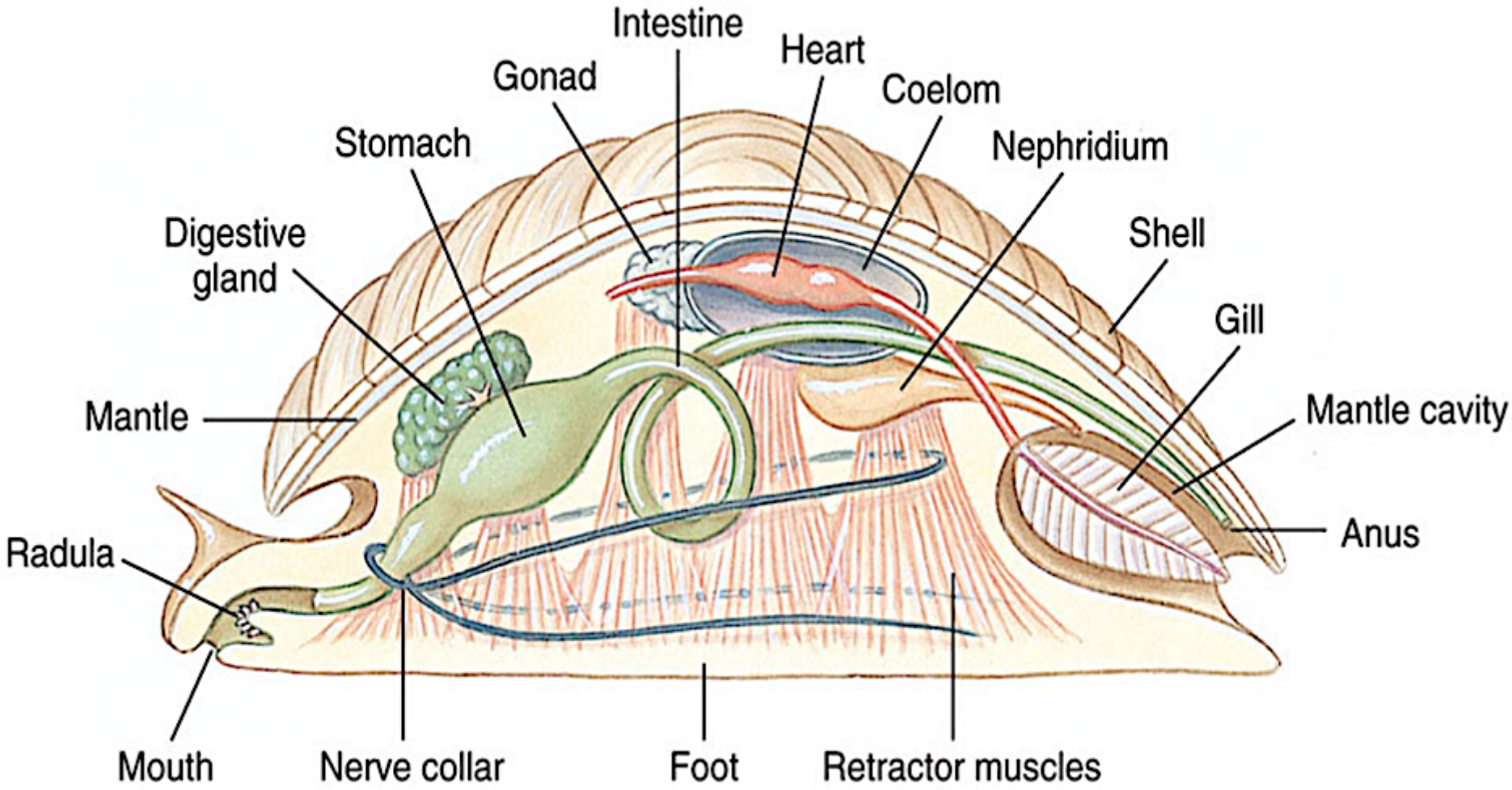


Mollusc Morphology – Muscular Foot

- "Base" of the mollusc body
- Contains statocysts
  - Sensory cells that assist with balance
  - May function as "ears" for some
- Adapted in various ways
  - Locomotion in gastropods
  - Tentacles in cephalopods
  - Burrowing in bivalves

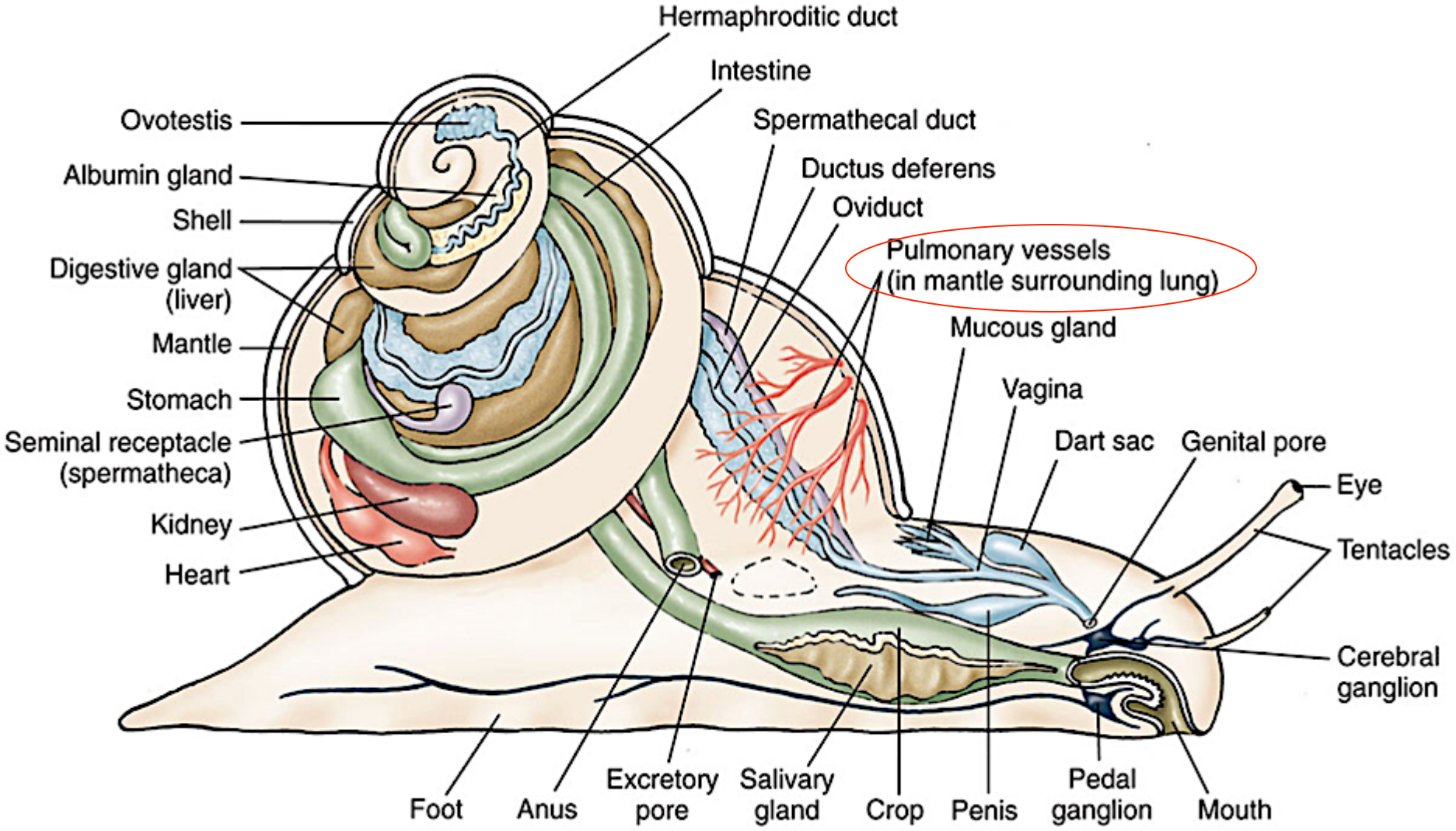
Mollusc Morphology – Visceral Mass

- Internal organs, arranged in various ways within the body
- Coelom is reduced to open space surrounding heart and gonads



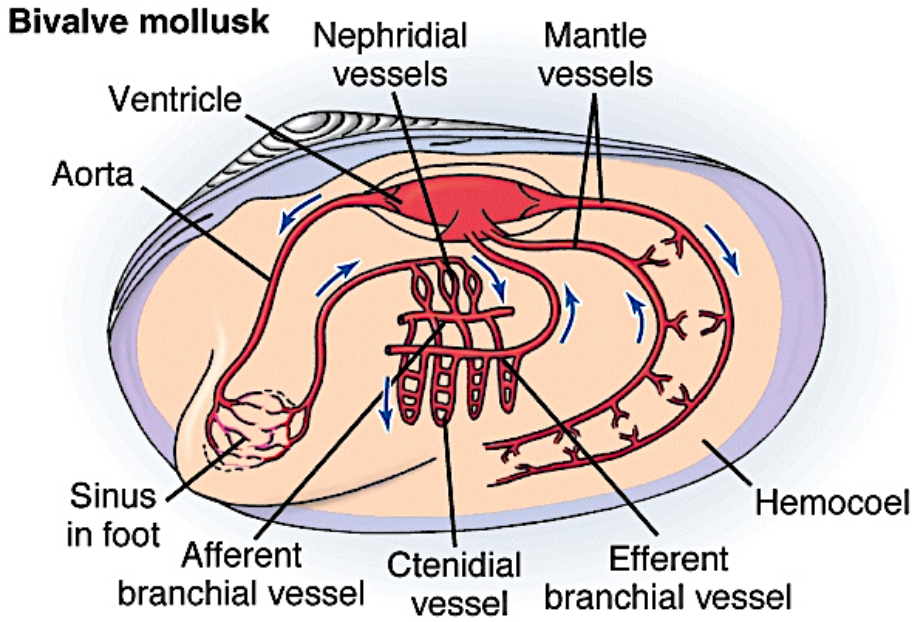
Mollusc Morphology – Respiration

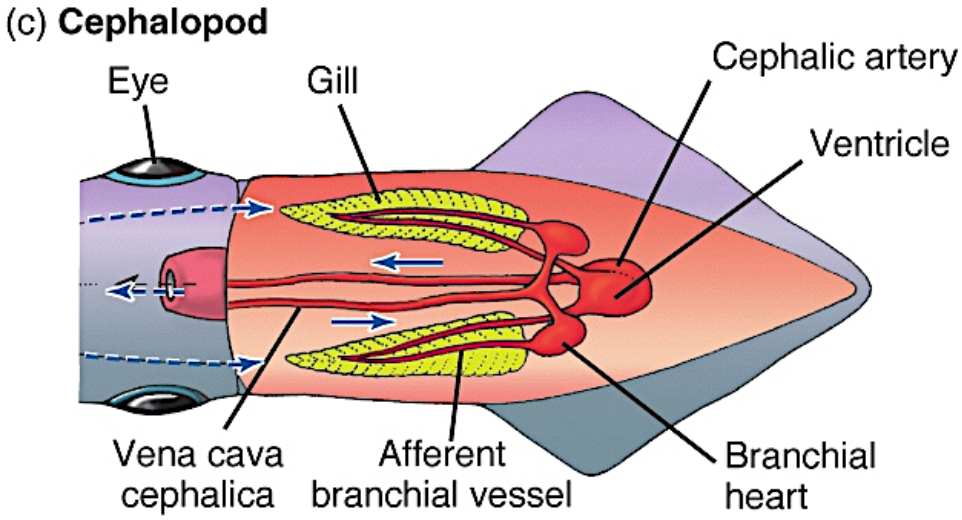
- Aquatic species have gills enclosed within the mantle cavity
- Terrestrial snails and slugs have a modified lung



Mollusc Morphology – Circulation

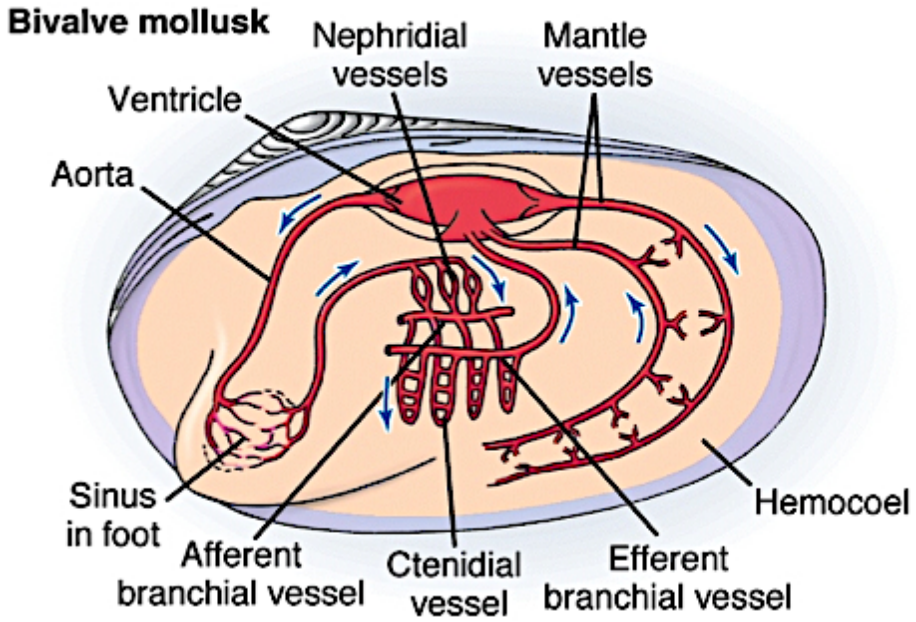
- Circulatory system
  - Open (except in cephalopods)
    - Open circulatory system is one in which blood is released directly into organs and body cavities (hemocoel)
    - No clear distinction between blood and interstitial fluid – Blood is known as hemolymph
  - Hemolymph contains **hemocyanin** to transport oxygen; appears blue when exposed to air

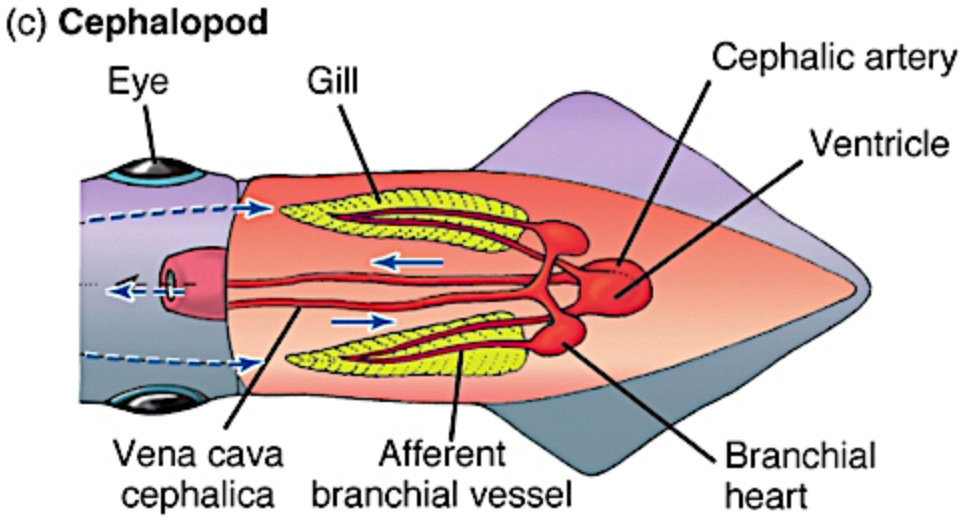




Mollusc Morphology – Circulation

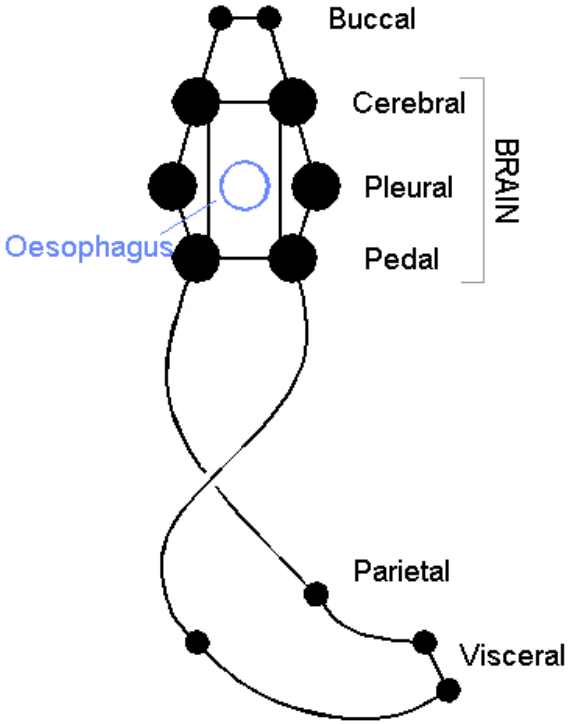
- Circulatory system includes beating heart
  - When relaxed, oxygenated hemolymph flows into the heart
  - Hemolymph is pushed out of the heart through the veins during contractions





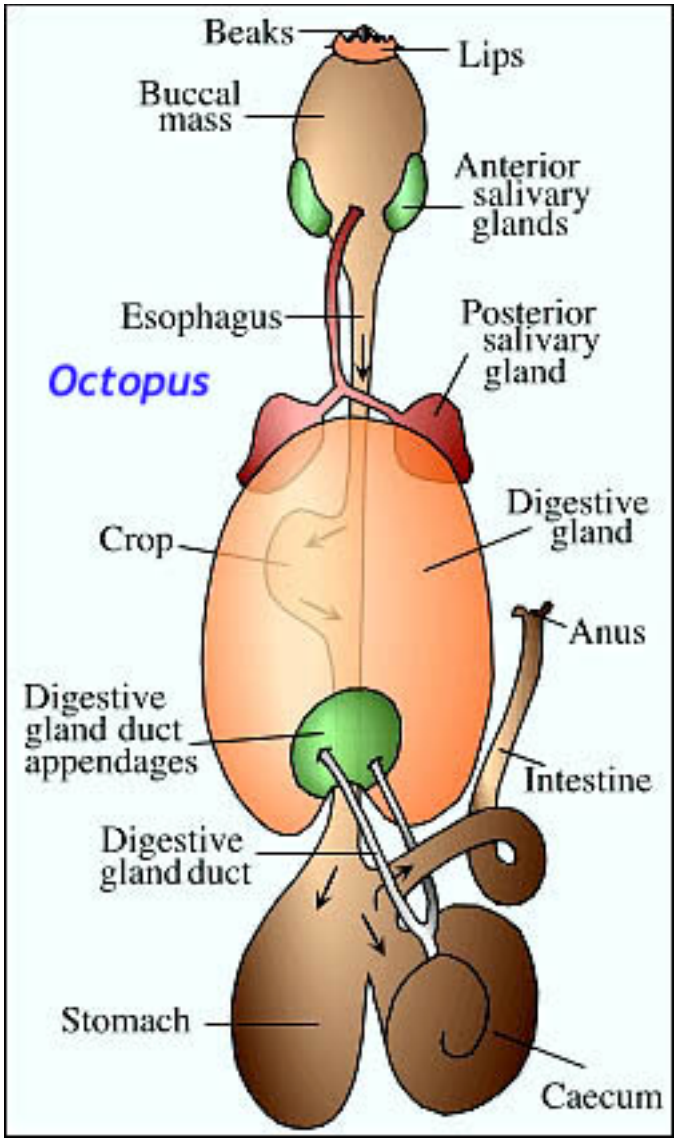
Mollusc Morphology - Nervous System

- Nervous System
  - Two nerve cords and a brain (more or less)
  - Some groups have well-developed eyes



Mollusc Morphology – Digestive System

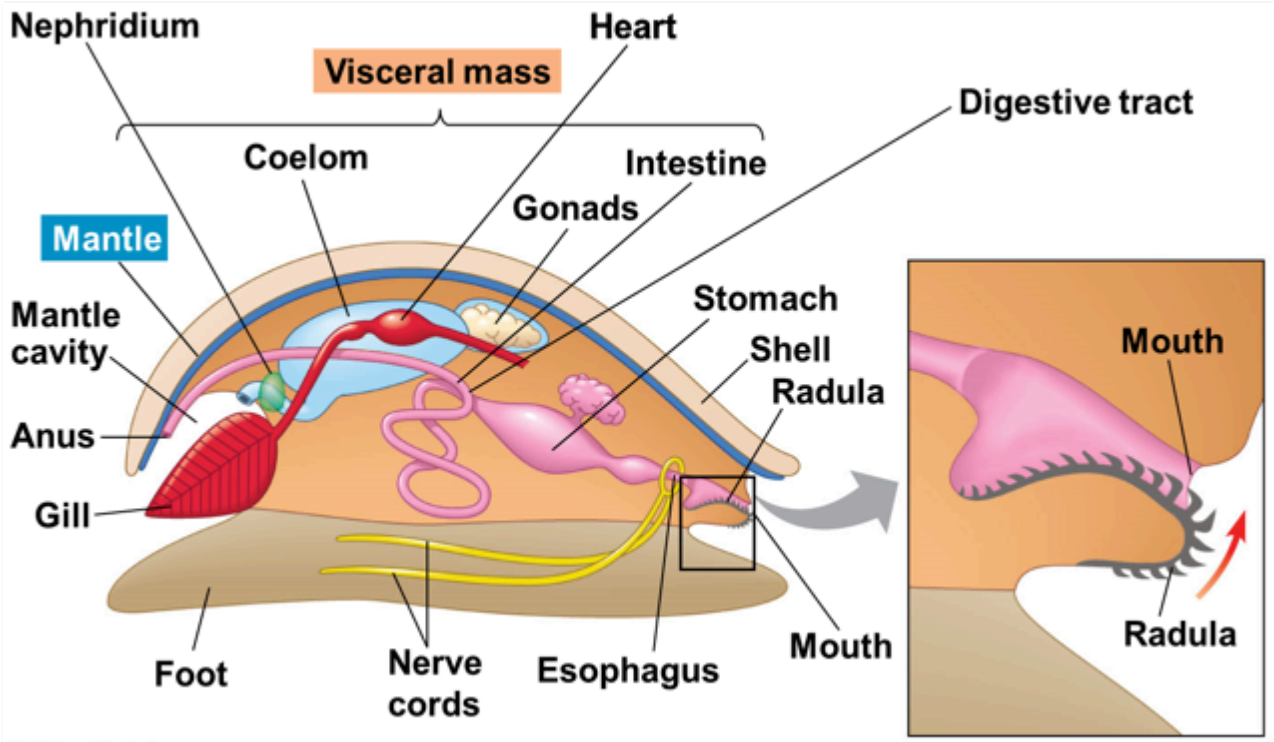
- Digestive System
  - Radula (surrounded by beak in some)
  - Complete gut
  - Well-developed digestive gland in most



Video- What the vampire squid really eats (~5 min)
https://www.youtube.com/watch?v=X8oWnbcLI40

Mollusc Morphology – Digestion

- Digestive System consists of a complete gut
  - Mouth, stomach, intestine, anus
  - Various mucous and digestive glands
  - Some groups have pouches (cecum)
  - Much of the lining of the gut is ciliated



- Radula
  - Stiff, serrated structure
  - Adapted for scraping or grabbing
  - Used to inject venom in some groups

Mollusc Morphology – Excretion

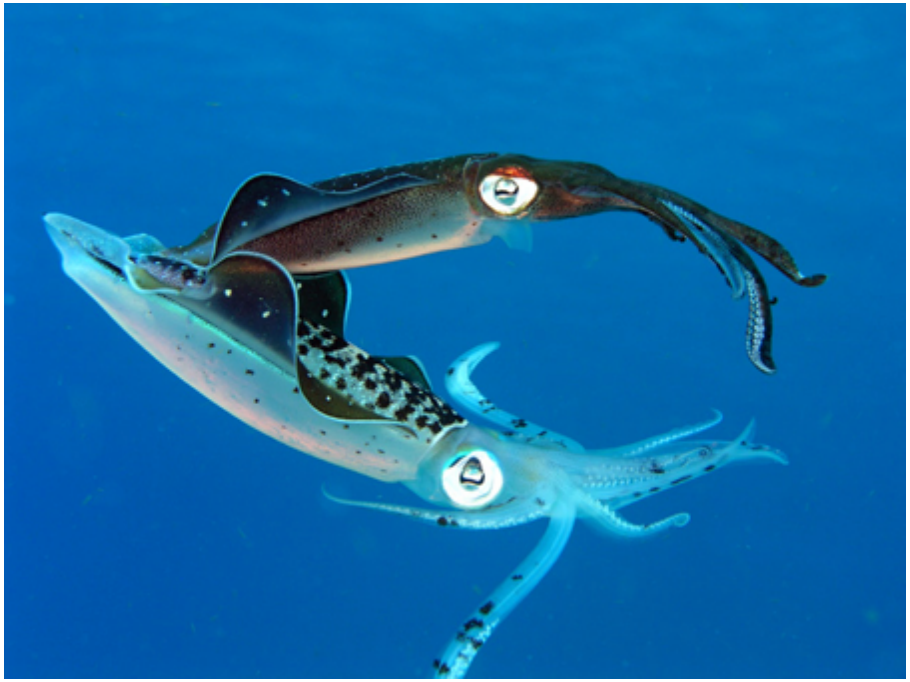
- **Excretory system – heart and nephridia ("little kidneys")**
  - The heart filters waste from hemolymph and releases it into coelom as urine
  - The nephridia reclaim usable material from the urine, inject more wastes into it, and eject it into the mantle cavity for excretion into the environment
  - Example of mollusc "multi-tasking" – using organ systems for more than one purpose

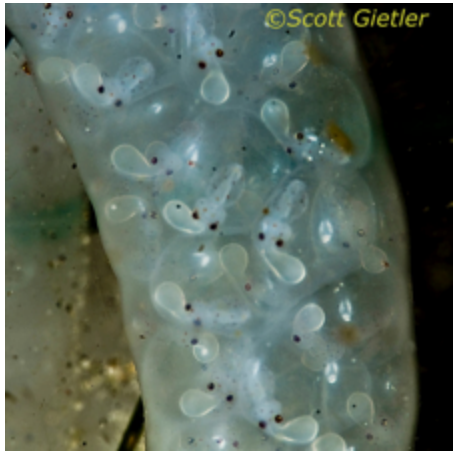
Mollusc Morphology – Support

- Hemocoel(s) can function as **hydrostatic skeleton**
  - Can be filled with water or gas and exert pressure that provides structure and support to the body
- Shells
  - Calcium carbonate with protein
  - Secreted by the mantle
  - Sometime internal (cuttlefish)

Mollusc Morphology –Reproduction

- **Reproduction**
  - Some groups maintain separate genders (cephalopods); some are hermaphroditic (gastropods)
  - Fertilization internal or external, depending on group

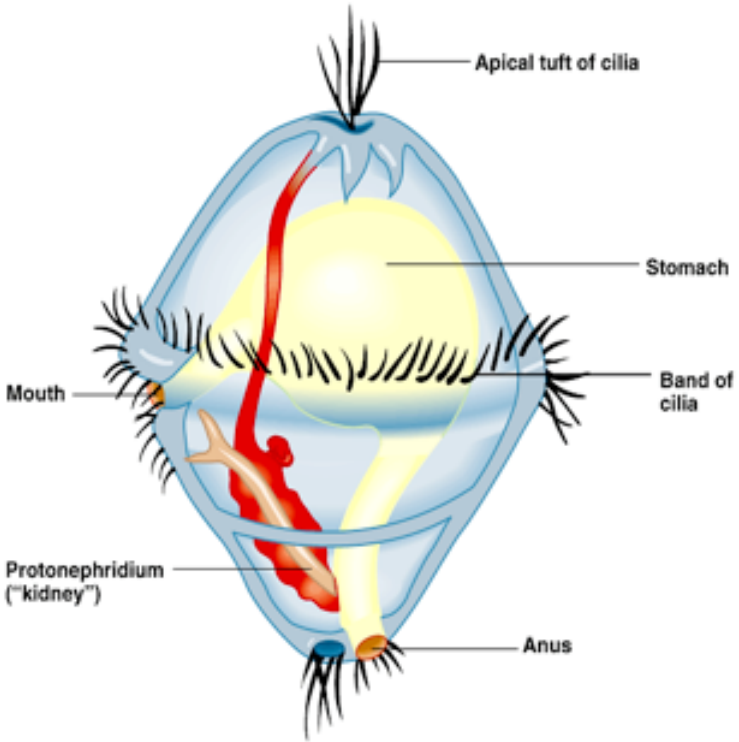


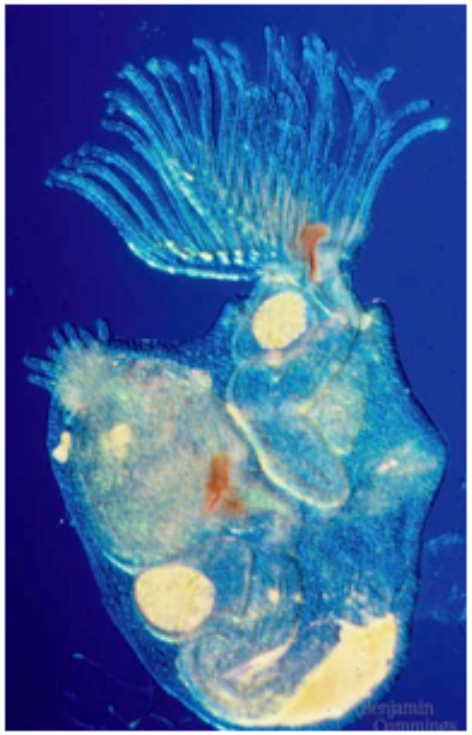


- Octo-mom video (~5 min): https://www.youtube.com/watch?v=lFCQltYMLQk

Mollusc reproduction

- Most molluscs have separate sexes with gonads located in the visceral mass, but many gastropods are hermaphrodites
- All groups lay eggs
- The life cycle of many molluscs includes a ciliated larval stage called a **trochophore** (this is why they are classified as lophotrochozoa!)





Mollusc Taxonomy

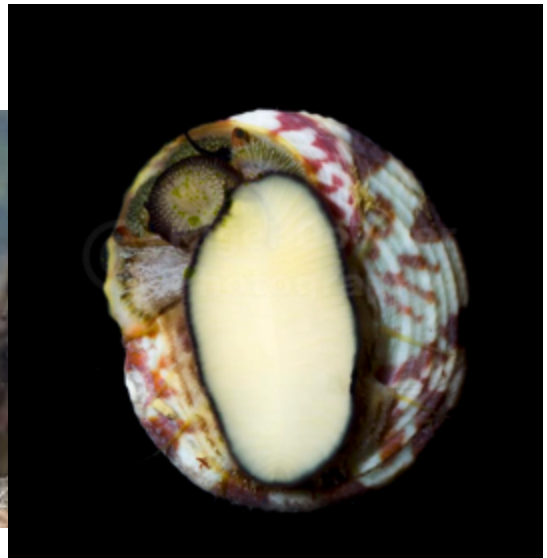
- Four major classes of molluscs are
  - **Polyplacophora** (chitons)
  - **Gastropoda** (snails, nudibranchs and slugs)
  - **Bivalvia** (clams, oysters, and other bivalves)
  - **Cephalopoda** (squids, octopuses, cuttlefish, and chambered nautiluses)

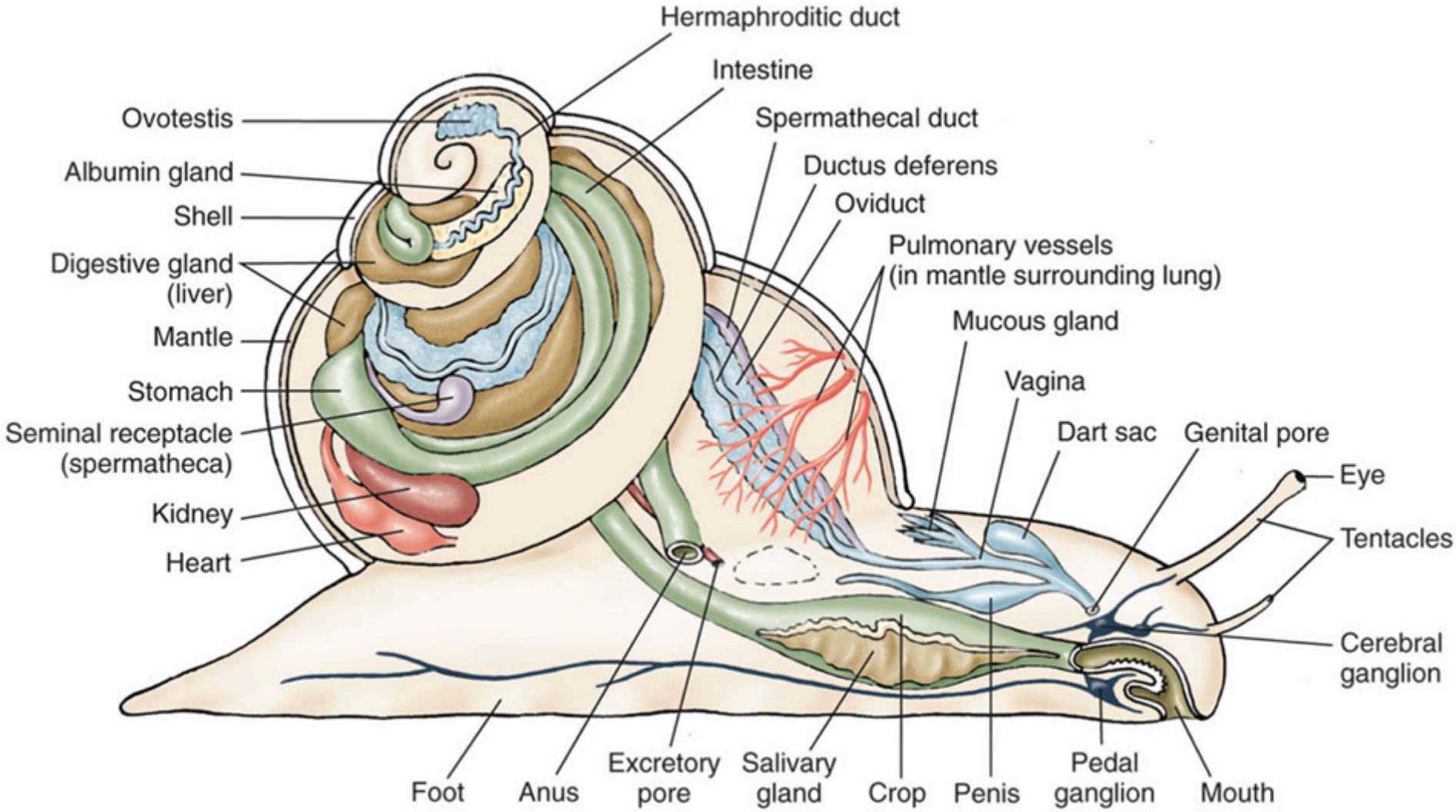
Polyplacophora - Chitons

- Chitons are oval-shaped marine animals encased in an armor of eight dorsal plates
- They use their foot like a suction cup to grip rock, and their radula to scrape algae off the rock surface

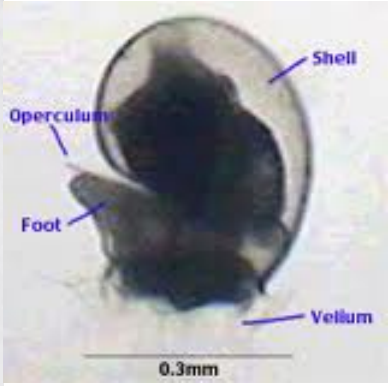
Gastropoda – "stomach foot"

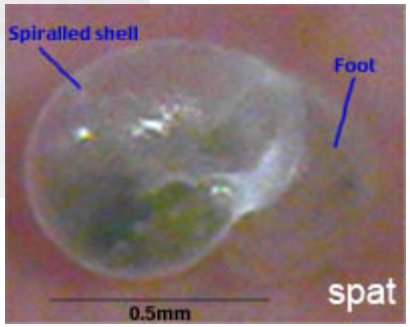
- About three-quarters of all living species of molluscs are gastropods – only insects have more
- Most gastropods are marine, but many are freshwater and terrestrial species
- Most gastropods have a single, spiraled shell
- Slugs lack a shell or have a reduced shell

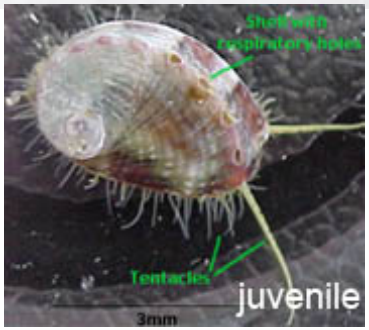



Hermaphroditic duct
Intestine
Ovotestis
Spermathecal duct
Albumin gland
Ductus deferens
Shell
Oviduct
Digestive gland (liver)
Pulmonary vessels (in mantle surrounding lung)
Mantle
Mucous gland
Stomach
Vagina
Seminal receptacle (spermatheca)
Dart sac
Genital pore
Eye
Kidney
Tentacles
Heart
Cerebral ganglion
Foot
Anus
Excretory pore
Salivary gland
Crop
Penis
Pedal ganglion
Mouth

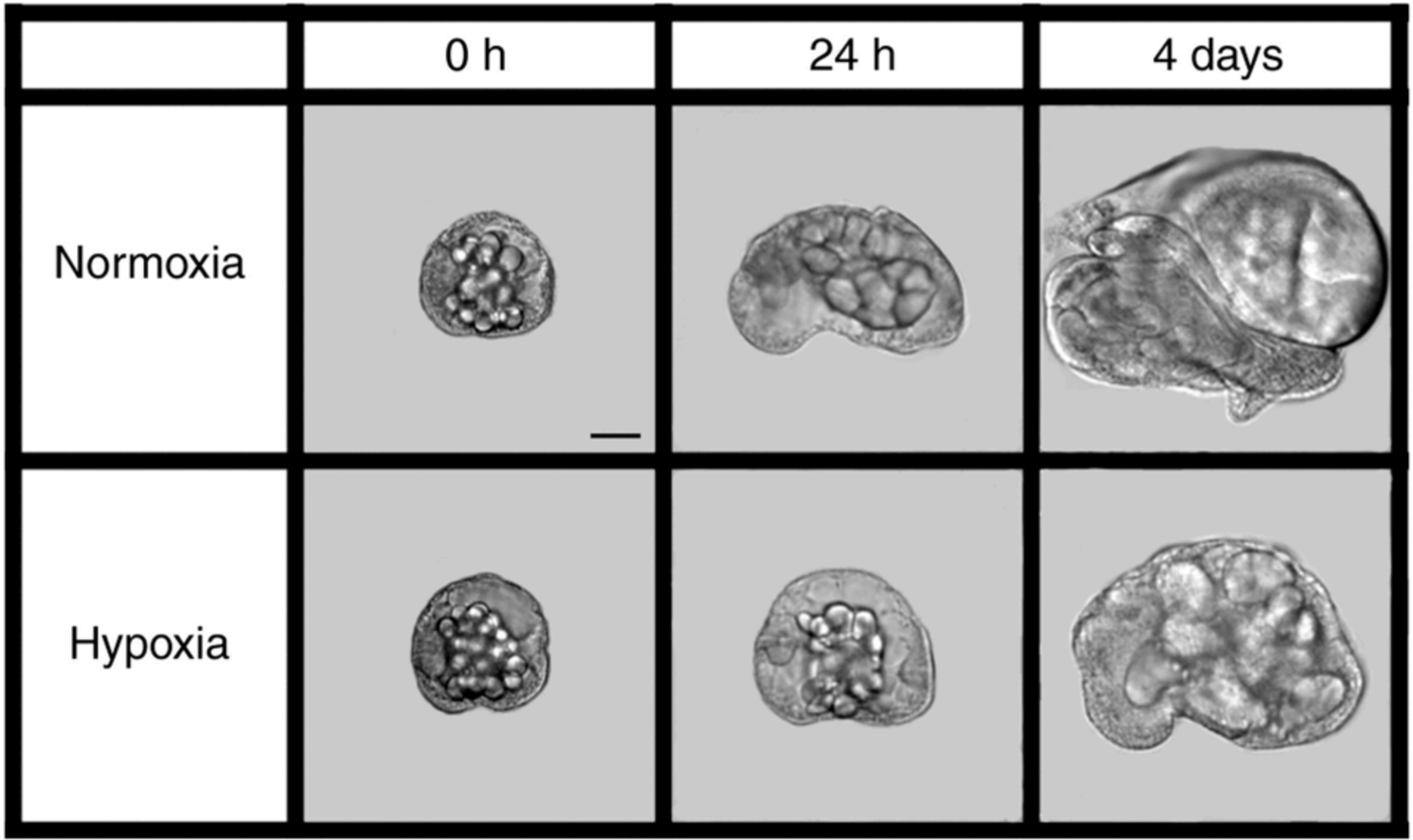
Gastropod Development





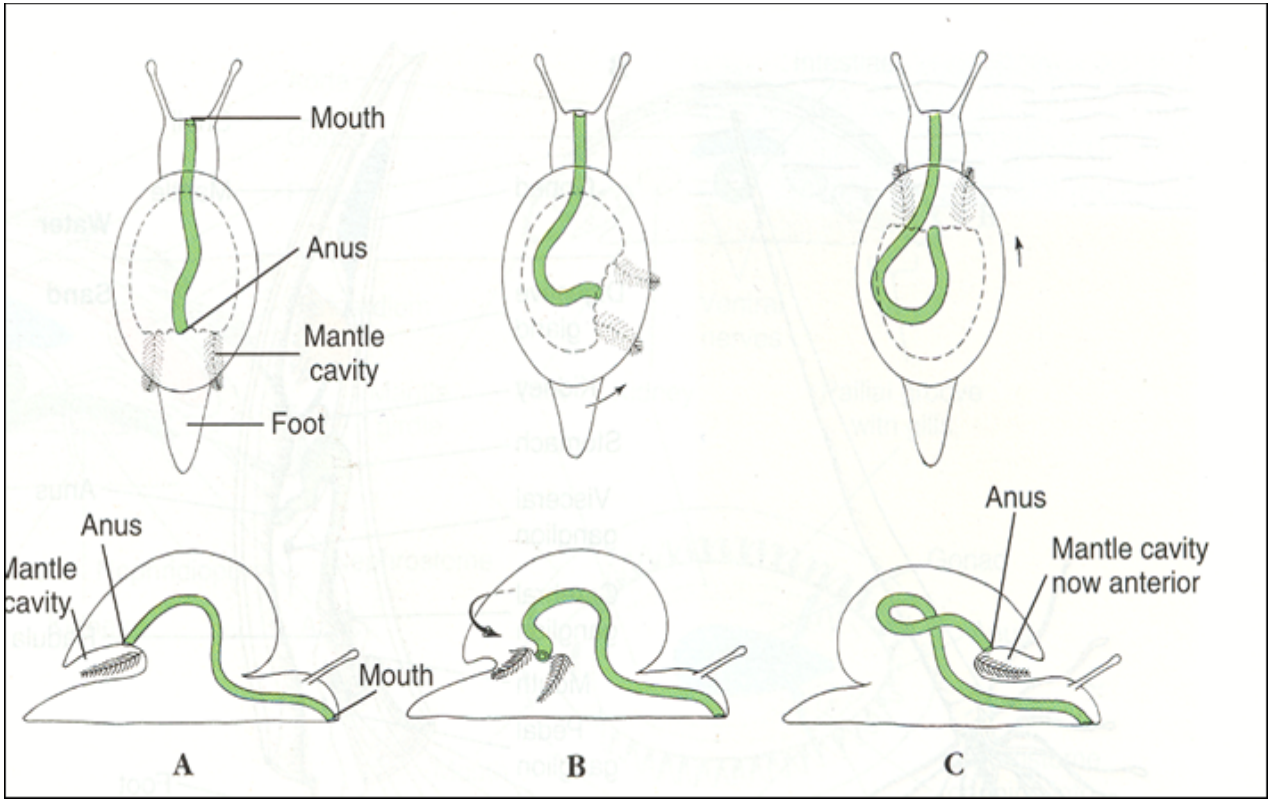


Snails need oxygen to develop properly!



Gastropod Development - Torsion

- **Torsion**
  - Occurs during development (veliger stage)
  - Visceral mass rotates 180 degrees relative to head
  - causes the animal's anus and mantle to end up above its head
- Pro's
  - Protection
  - Balance
- Con's
  - Animal dispels wastes on its head

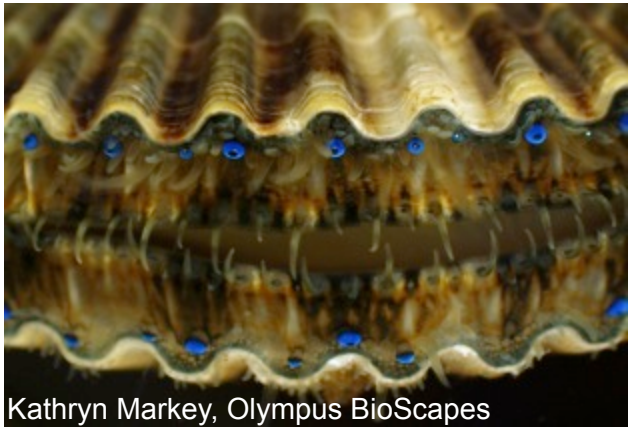


Gastropoda - Nudibranchs

- Special case – secondary **detorsion**
  - Restores “normal” gut morphology
- Some species are strong swimmers

Bivalvia

- Bivalves are marine and include many species of clams, oysters, mussels, and scallops
- They have a shell divided into two halves drawn together by adductor muscles
- The mantle cavity of a bivalve contains gills that are used for feeding as well as gas exchange
- **Incurrent/excurrent siphons** move water across the gills
- The foot is adapted for burrowing in sediment
- Some bivalves have eyes and sensory tentacles along the edge of their mantle



Bivalve reproduction/development

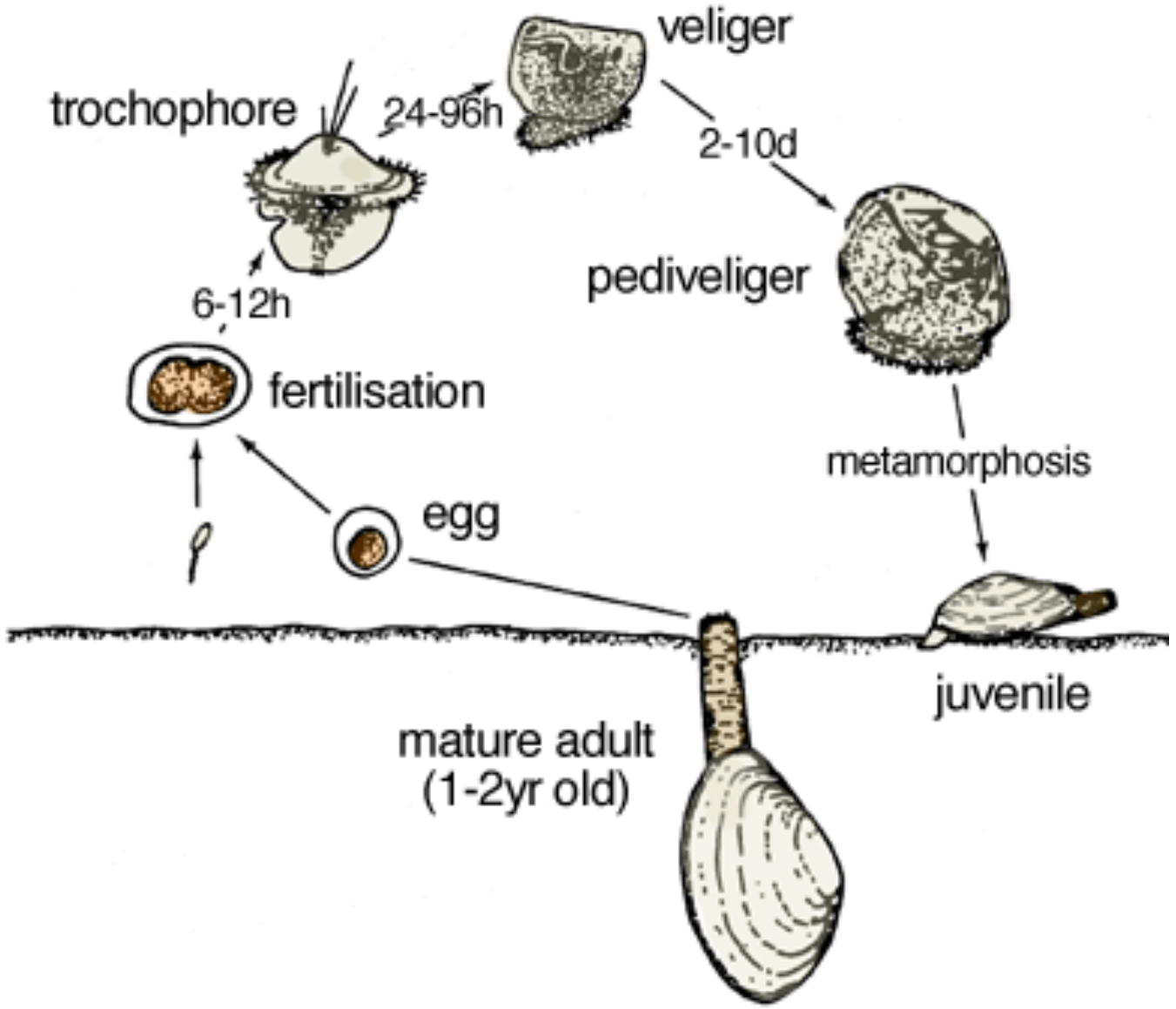
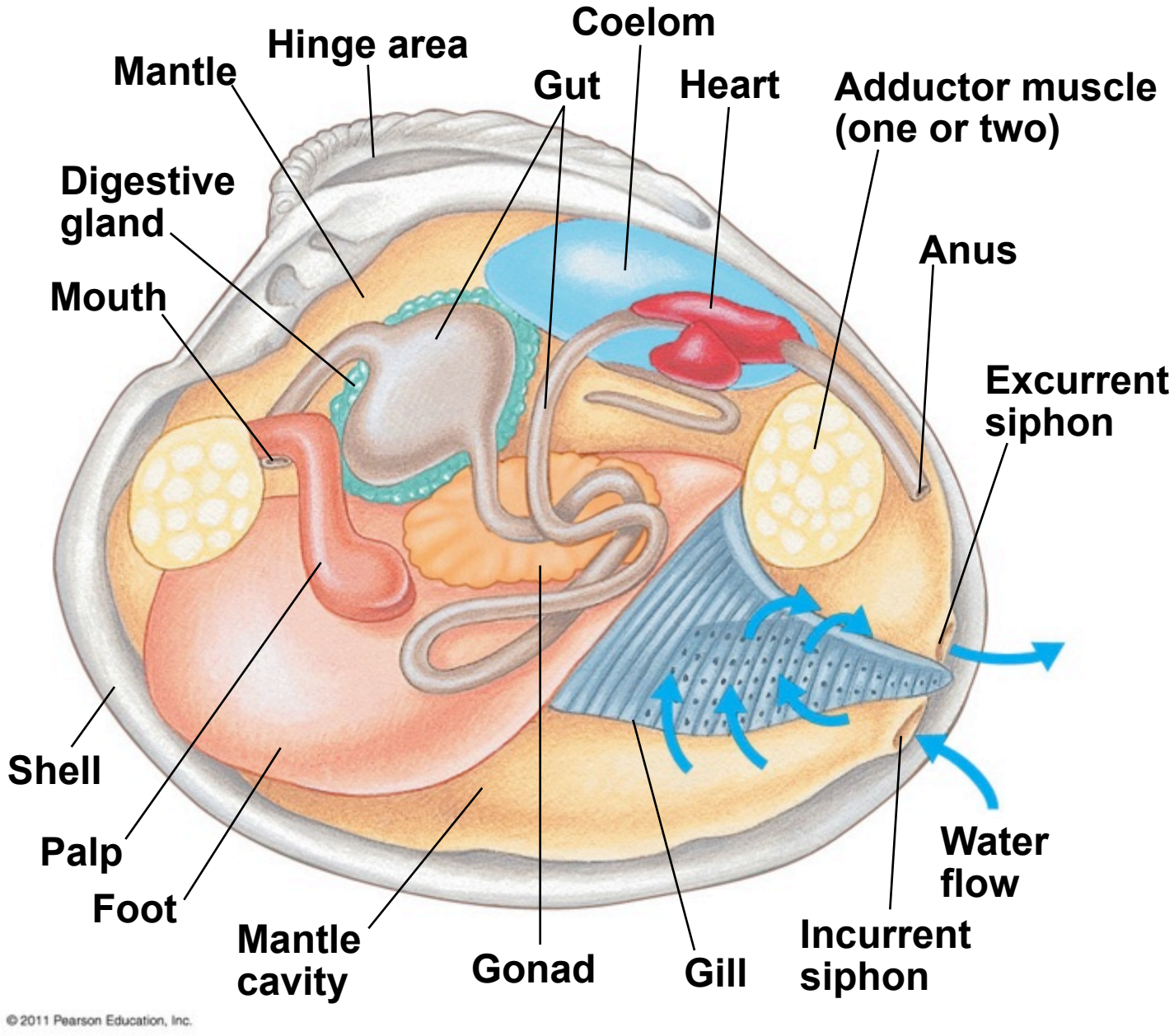
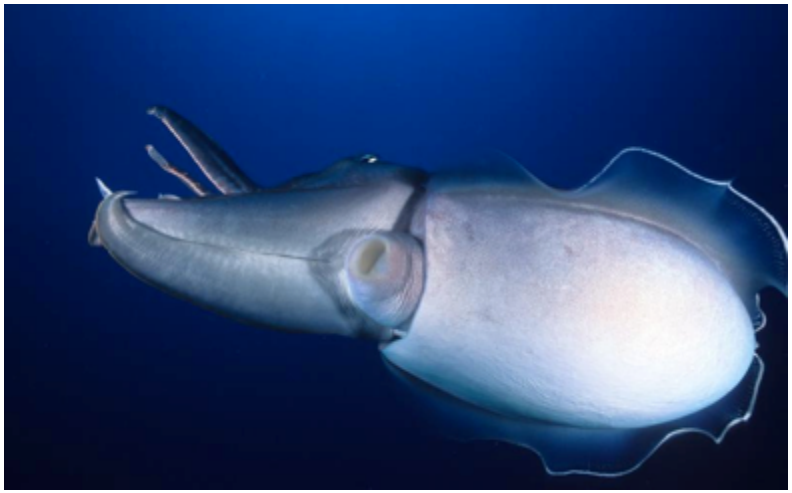


Figure 33.20



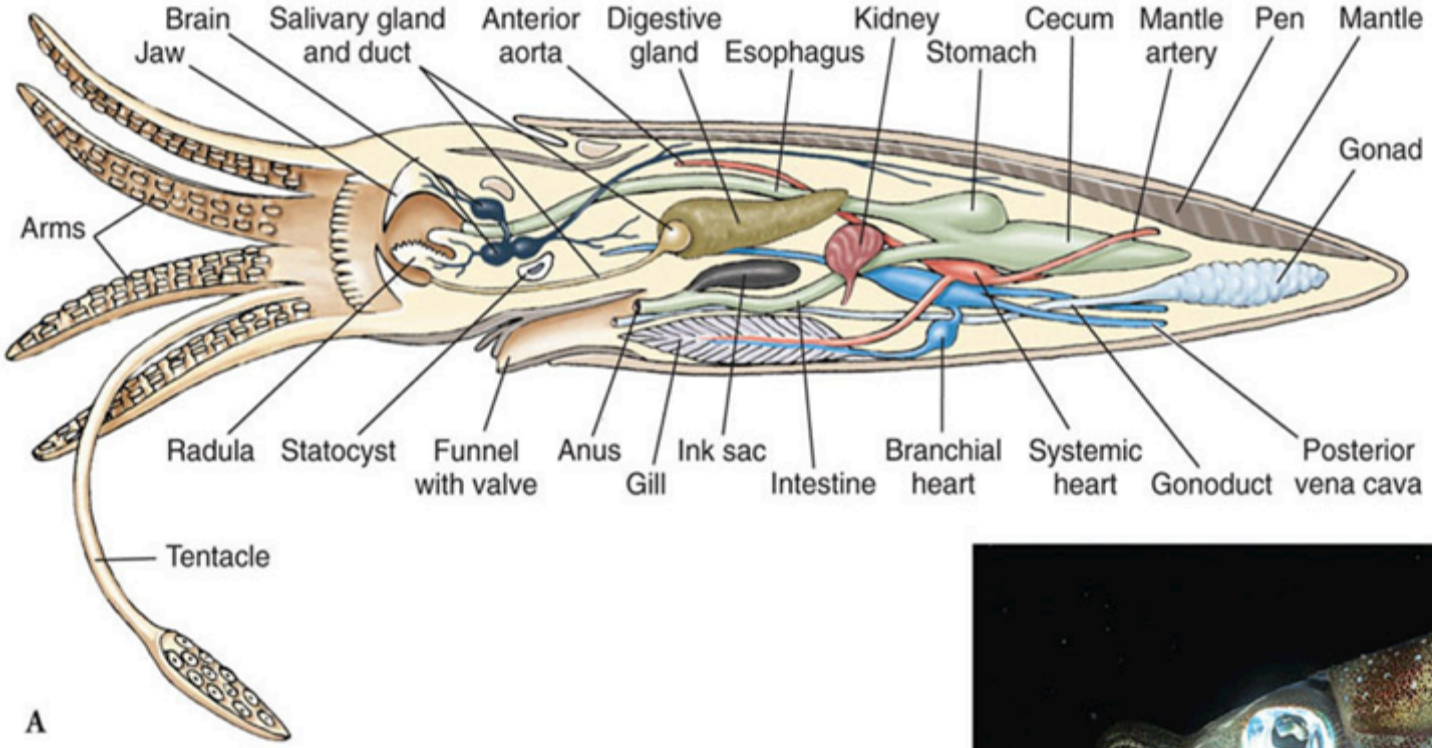
Cephalopoda – "head foot"

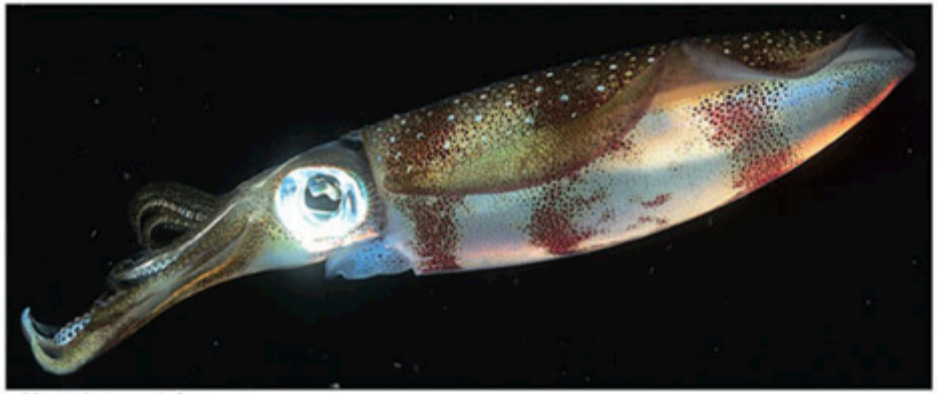
- Cephalopods have a body plan greatly modified from the basic mollusc body plan
  - The muscular foot has been modified into tentacles
  - The mouth is equipped with a hinged, chitin beak
    - Some groups have greatly reduced radula
  - Most cephalopods use a **siphon** for locomotion, a specialized structure that pumps water through the body and propels the animal backwards through the water



Cephalopoda – "head foot"

- Cephalopods have a closed circulatory system, well-developed sense organs, and a complex brain
- Nautilus retains a shell
- Cuttlefish retain an internal shell
- Most cephalopods have distinct sexes





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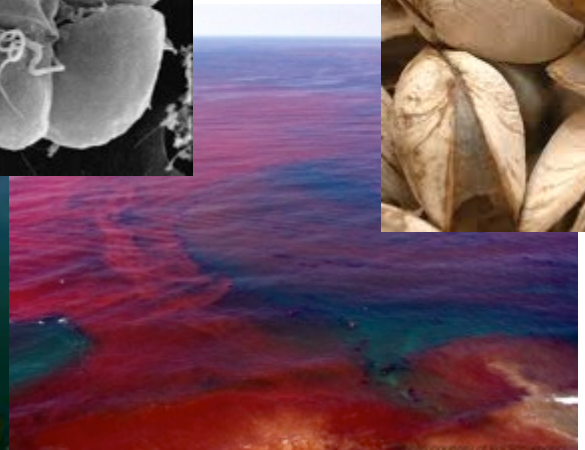
True facts about the octopus:
https://www.youtube.com/watch?v=st8-EY71K84

Molluscs behaving badly - PSP

- Seasonal influx of nutrients cause phytoplankton populations to soar
  - Pigmented algae can cause the water to turn color – red tides, yellow tides, etc.
- Dinoflagellates and other algae can produce powerful neurotoxins – saxitoxin is the most common
- Suspension feeding molluscs concentrate toxins in their tissues
- When ingested, can result in PSP – paralytic shellfish poisoning
  - Severe illness
  - Can be fatal

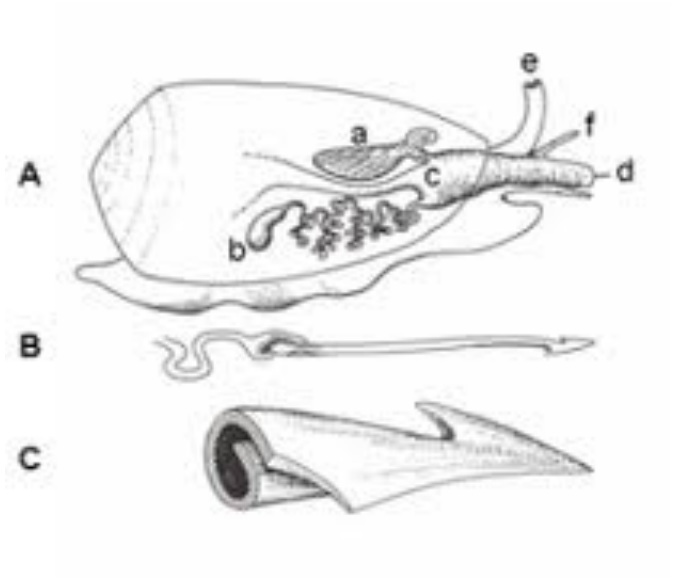


Molluscs behaving badly - Humboldt Squid

- Eastern Pacific – South America → Alaska
  - Most common in southern portion of range
  - Generally passive and curious, but can be extremely aggressive if disturbed while feeding
  - Tentacles have “teeth” on suckers that cause serious lacerations

Molluscs behaving badly – Cone Snails

- Extremely venomous



Love amongst the molluscs

- Molluscs have some of the most bizarre courtship and mating rituals known
- Love darts
- Color patterns in cuttlefish
- Parental Care

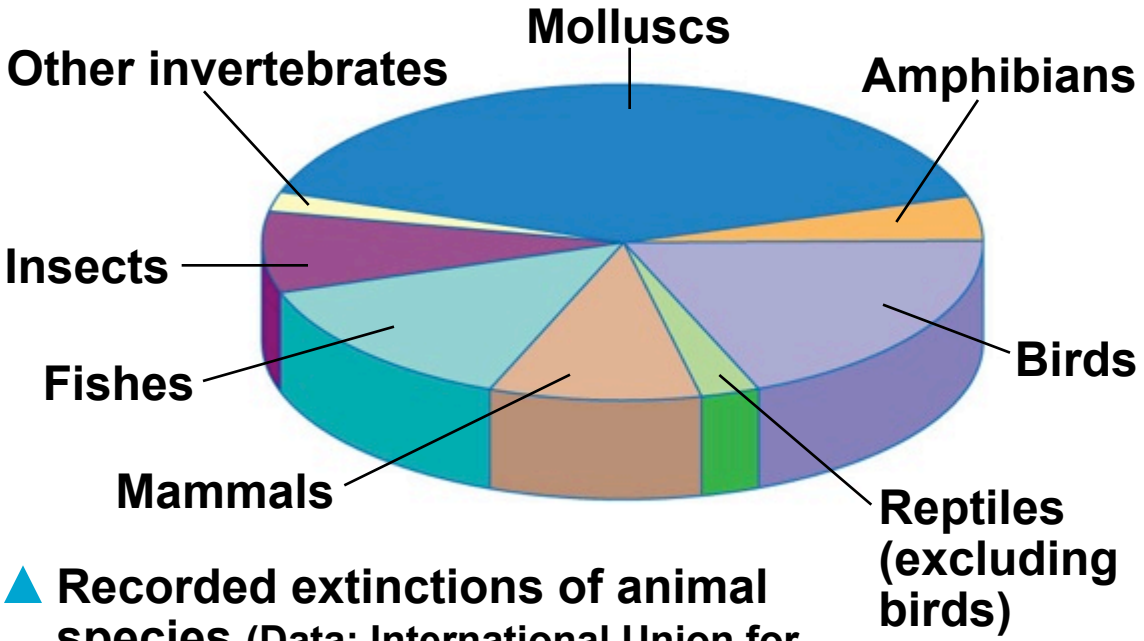
Love darts:
https://www.youtube.com/watch?v=VTV23B5gBsQ

Protecting Freshwater and Terrestrial Molluscs

- Molluscs are the animal group with the largest number of recent extinctions
- The most threatened groups are
  - Freshwater bivalves, including pearl mussels
  - Terrestrial gastropods, including Pacific island land snails
- These molluscs are threatened by habitat loss, pollution, and non-native species
- Other species are threatened by climate change
  - Ocean acidification and warming – Humboldt Squid

Figure 33.22

▲ An endangered Pacific island land snail, *Partula suturalis*



▲ Recorded extinctions of animal species (Data: International Union for Conservation of Nature, 2008)

◀ Workers on a mound of pearl mussels killed to make buttons (ca. 1919)

Summary of Relationships