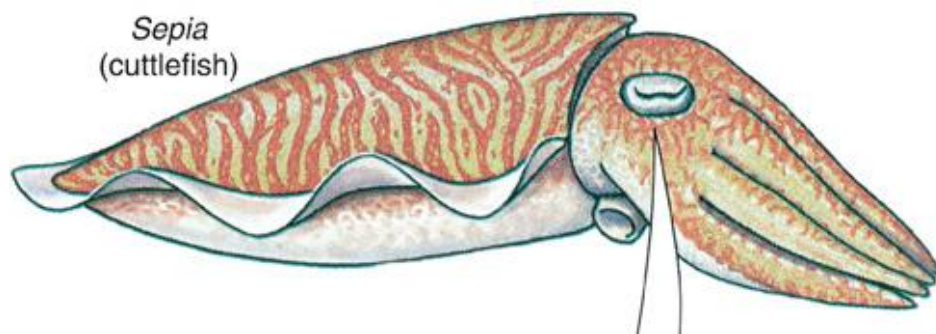


Molluscs



General Characteristics :

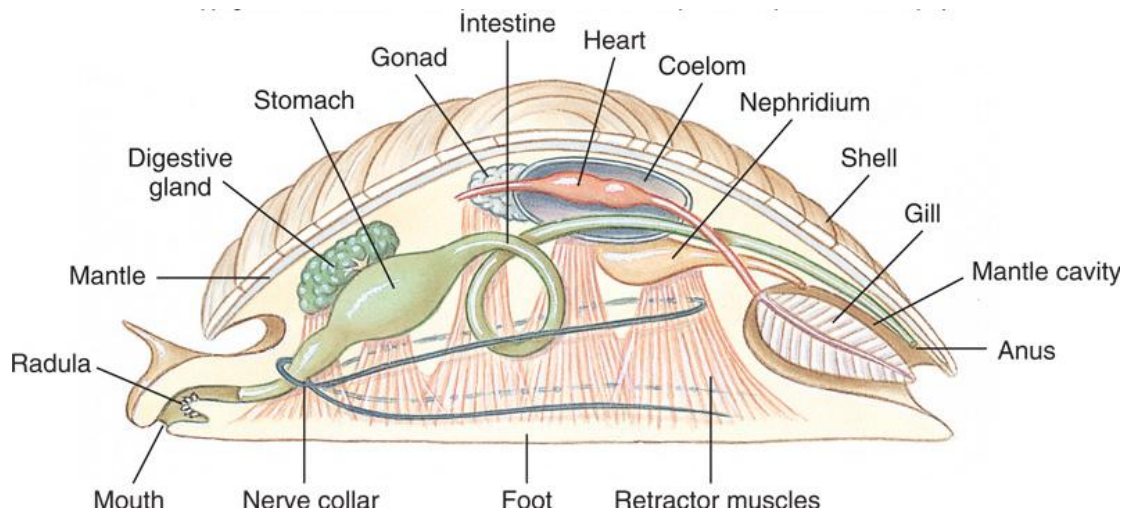
- **Phylum Mollusca** includes snails and slugs, oysters and clams, and octopuses and squids.
- Molluscs have a mesoderm lined body cavity – a **coelom**.
- They are **protostomes**
- Molluscs evolved in the sea and most molluscs are still marine.
- Some gastropods and bivalves inhabit freshwater.
- A few gastropods (slugs & snails) are terrestrial.

Humans & Molluscs :

- Humans use molluscs in a variety of ways:
 - As food – mussels, clams, oysters, squid, octopus, snails, etc.
 - Pearls – formed in oysters and clams.
 - Shiny inner layer of some shells used to make pearls.
 - A few are pests or introduced nuisances:
 - Shipworms – burrow through wood, including docks & ships.
 - Terrestrial snails and slugs damage garden plants.
 - Molluscs serve as an intermediate host for many parasites.
 - Zebra mussels – accidentally introduced into the Great Lakes and reeking havoc with the ecosystem.

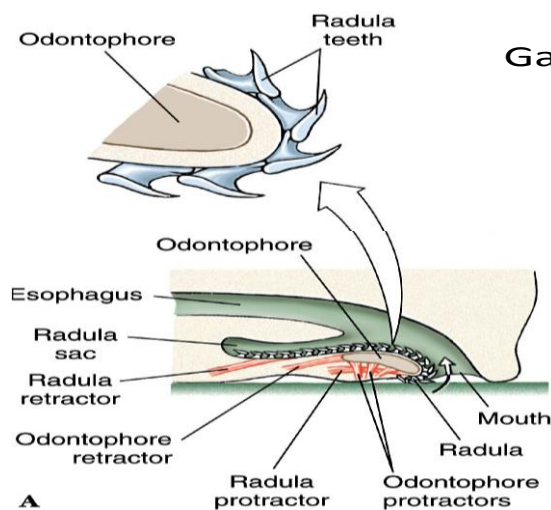
Mollusc Body Plan :

- All molluscs have a similar body plan with three main parts:
 - **A muscular foot**
 - **A visceral mass** – containing digestive, circulatory, respiratory and reproductive organs.
 - **A mantle** – houses the gills and in some secretes a protective shell over the visceral mass.
 - Most molluscs have separate sexes with gonads located in the visceral mass.



Head-Foot Region :

- Most molluscs have well developed head ends with sensory structures including photosensory receptors that may be simple light detectors or complex eyes (cephalopods).
- The **radula** is a rasping, protrusible feeding structure found in most molluscs (not bivalves).
- Ribbon-like membrane with rows of tiny teeth.
- The **foot** of a mollusc may be adapted for locomotion, attachment, or both.
- Pelagic forms may have a foot modified into wing-like parapodia.

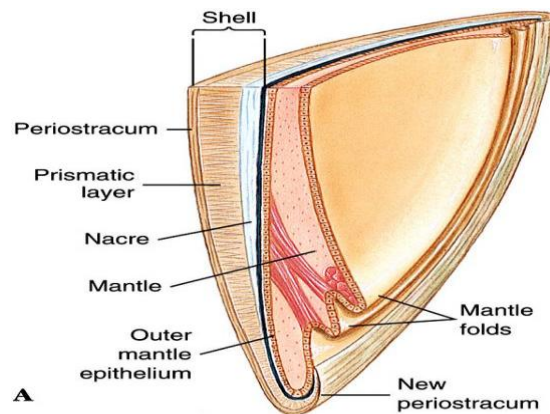


Gastropod Feeding Apparatus

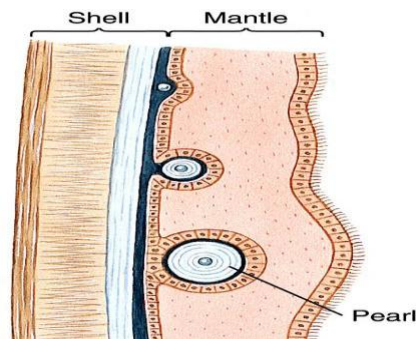
Shells :

- When present, the calcareous **shell** is secreted by the **mantle** and is lined by it. It has 3 layers:
 - **Periostracum** – outer organic layer helps to protect inner layers from boring organisms.
 - **Prismatic layer** – densely packed prisms of calcium carbonate.
 - **Nacreous layer** – lining layer secreted continuously by the mantle – surrounds foreign objects to form pearls in some.

Shell Structure & Formation



A Pearl Among the Swine

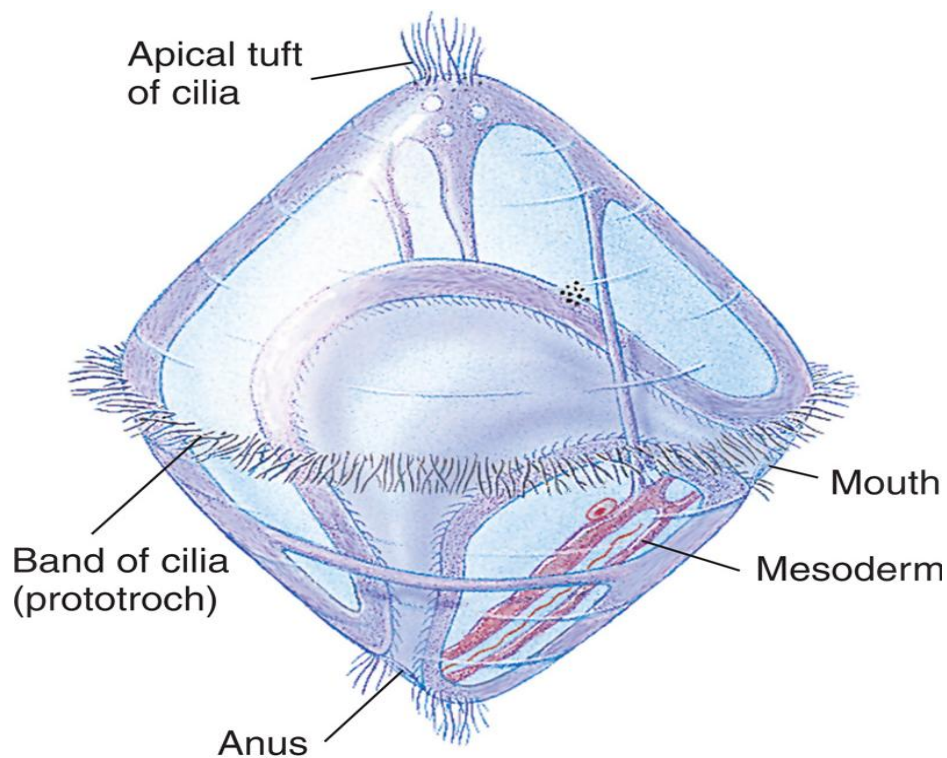


Mantle Cavity :

- The space between the mantle and the visceral mass is called the **mantle cavity**.
- The respiratory organs (gills or lungs) are generally housed here.

Internal Structure & Function :

- Many molluscs have an **open circulatory system** with a pumping heart, blood vessels and blood sinuses.
- Most cephalopods have a **closed circulatory system** with a heart, blood vessels and capillaries.
- Most molluscs are dioecious, some are hermaphroditic.
- The life cycle of many molluscs includes a free swimming, ciliated larval stage called a **trochophore**.
- Similar to annelid larvae.
- The trochophore larval stage is followed by a free-swimming **veliger** larva in most species.



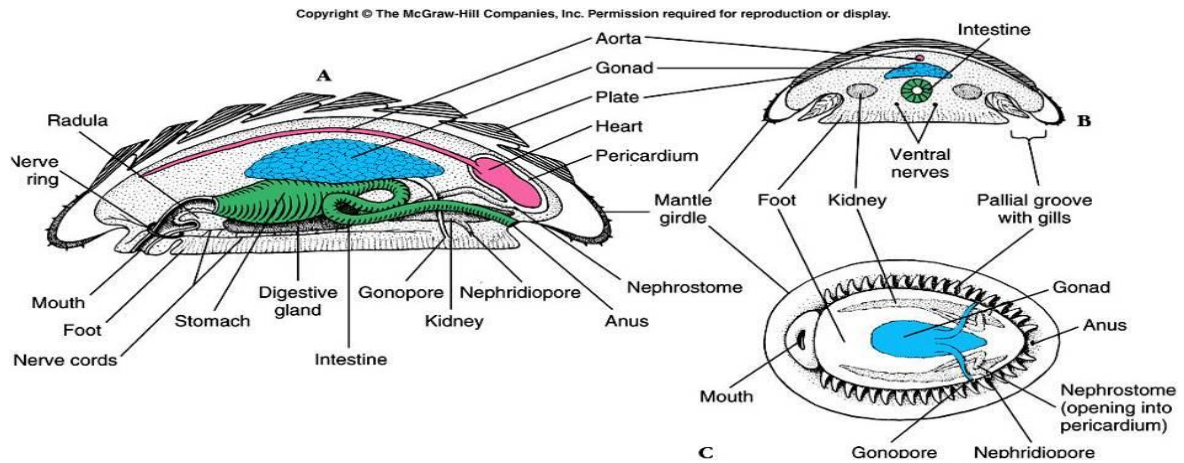
Four major classes of molluscs:

- **Class Polyplacophora** – the chitons
- **Class Gastropoda** – snails & slugs
- **Class Bivalvia** – clams, mussels, oysters
- **Class Cephalopoda** – octopus & squid

Class Polyplacophora :

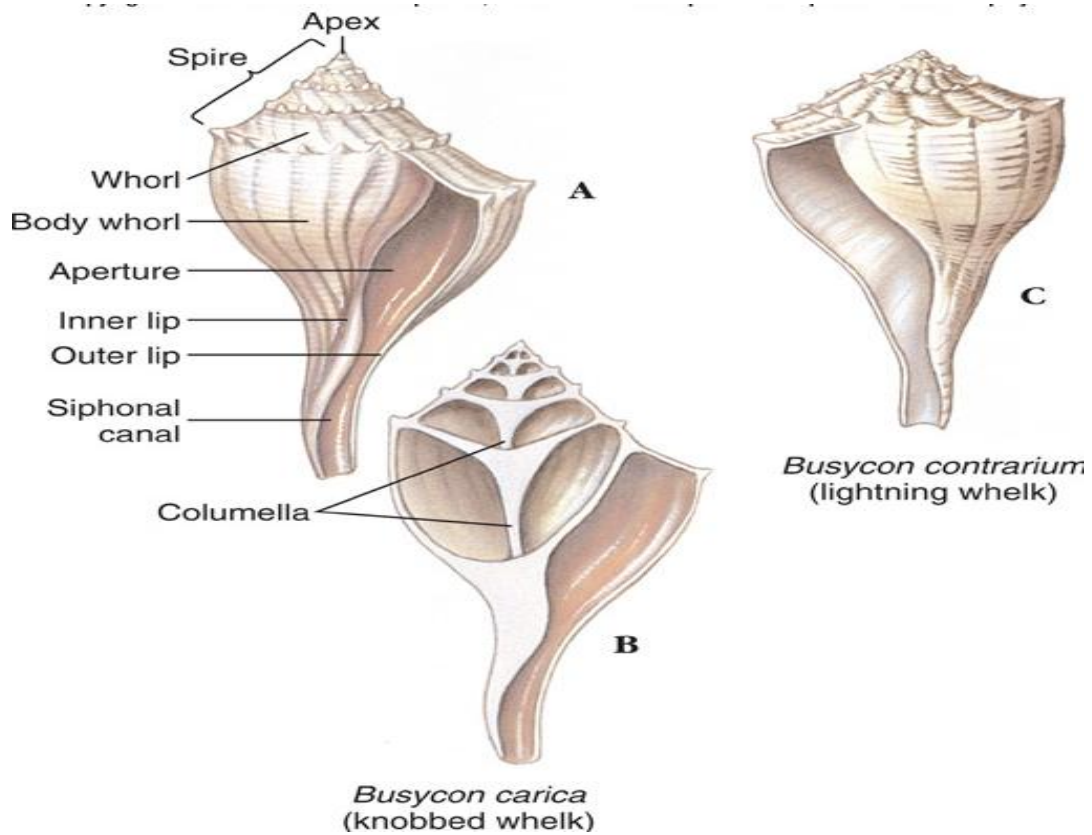
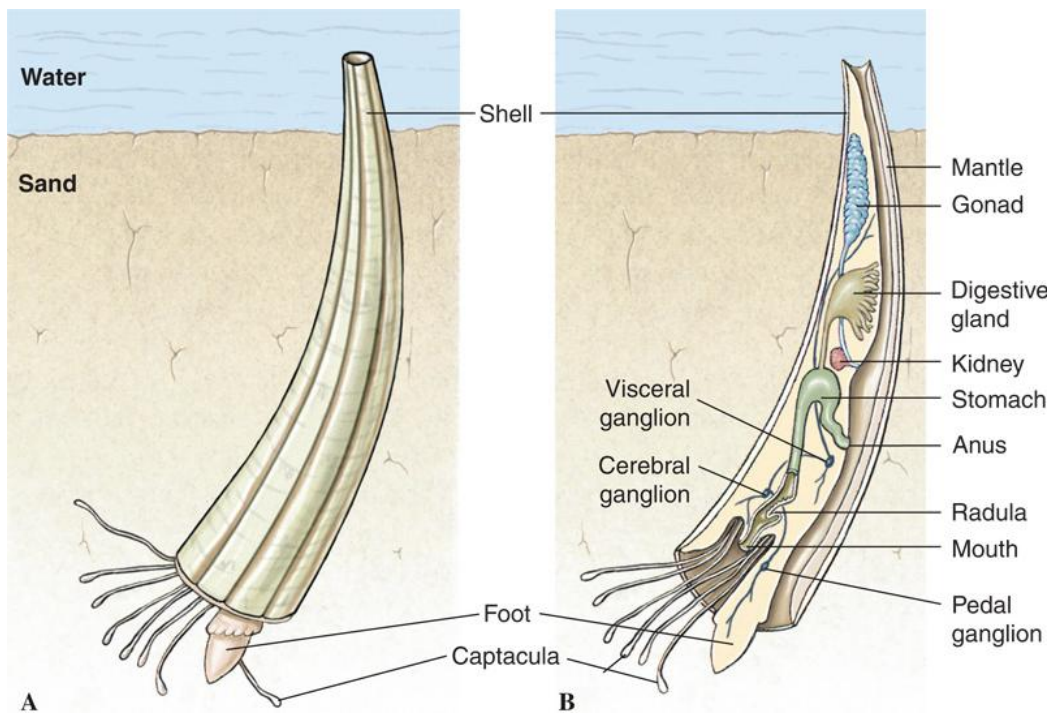
- **Class Polyplacophora** includes the **chitons**.
 - Eight articulated plates or valves.
 - Live mostly in the rocky intertidal.
 - Use **radula** to scrape algae off rocks.
- Gills are suspended from roof of mantle cavity.
 - Water flows from anterior to posterior.
- Pair of **osphradia** serves as sense organ.
- Light sensitive **plates** form eyes in some species.
- Blood pumped by a three-chambered heart.
 - Travels through aorta and sinuses to gills.
- Pair of **metanephridia** carries wastes from pericardial cavity to exterior.
- Sexes are separate.
- **Trochophore** larvae metamorphose into juveniles without a veliger stage

Polyplacophoran Anatomy



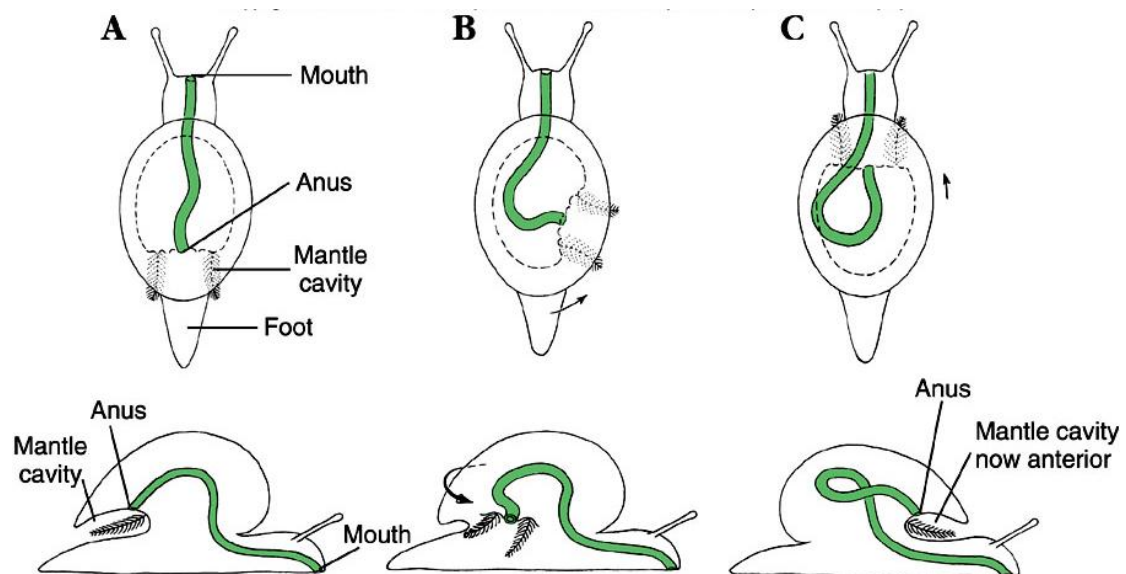
Class Scaphopoda :

- Found in subtidal zone to 6000 m deep.
- Mantle wraps around visceral mass and is fused, forming a tube
- **Gastropoda** is the largest of the molluscan classes.
- 70,000 named species.
- Include snails, slugs, sea hares, sea slugs, sea butterflies.
- Marine, freshwater, terrestrial.
- Benthic or pelagic
- Gastropods show bilateral symmetry, but due to a twisting process called **torsion** that occurs during the veliger larval stage, the visceral mass is asymmetrical.
- The shell of a gastropod is always one piece – **univalve** – and may be coiled or uncoiled.
- The **apex** contains the oldest and smallest **whorl**.
- Shells may coil to the right or left – this is genetically controlled.
- Many snails can withdraw into the shell and close it off with a horny **operculum**.



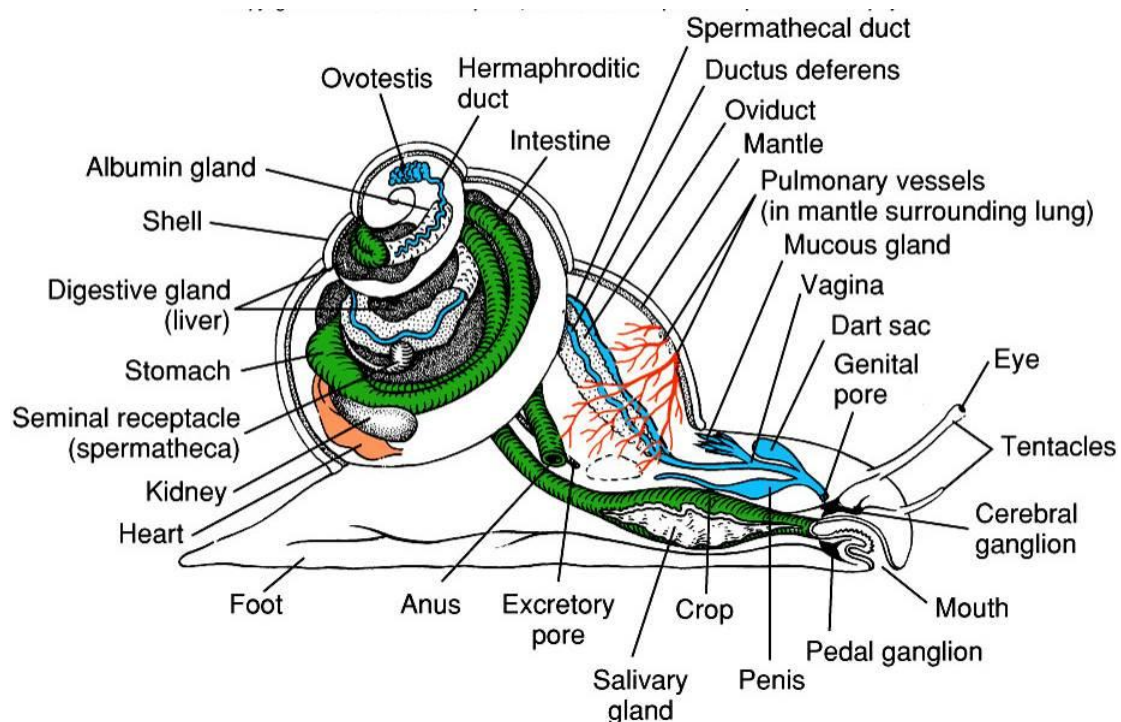
Gastropod Feeding Habits :

- Most gastropods are **herbivores** and feed by scraping algae off hard surfaces using the **radula**.
- Some are **scavengers** of dead organisms, again tearing off pieces with radular teeth.
- Some are **carnivores** and have a radula modified into a drill to bore through the shells of other molluscs. They use chemicals to soften the shell.
- Snails in the genus *Conus* feed on fish, worms, and molluscs.
- Highly modified radula used for prey capture.
- They secrete a toxin that paralyzes their prey.
- Some are painful, even lethal, to humans.



Internal Form and Function :

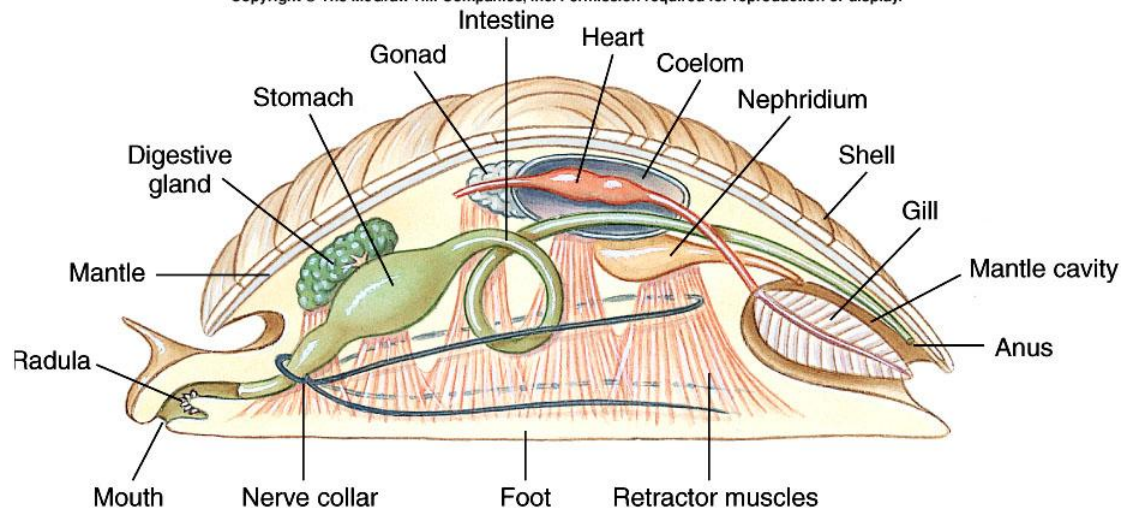
- Pulmonates lack gills.
 - Have a highly vascular area in mantle that serves as lung.
 - Lung opens to outside by small opening, the pneumostome.
 - Aquatic pulmonates surface to expel a gas bubble and inhale by a siphon.
 - Most have a single **nephridium** and well-developed circulatory and nervous systems.
 - Sense organs include eyes, statocysts, tactile organs, and chemoreceptors.
 - Eyes vary from simple cups holding photoreceptors to a complex eye with a lens and cornea.
 - Sensory osphradium at base of the incurrent siphon may be chemosensory or mechanoreceptive.
 - Monoecious and dioecious species.
 - Young may emerge as veliger larvae or pass this stage inside the egg.
 - Some species, including most freshwater snails, are ovoviviparous.



- Traditional classification has recognized three subclasses of Gastropoda:
 - Prosobranchia
 - Opisthobranchia
 - Pulmonata.
 - **Prosobranchia** includes most marine snails and some freshwater and terrestrial gastropods.
 - Mantle cavity is anterior due to torsion.
 - Long siphons may separate incurrent and excurrent flow.
 - Have one pair of tentacles, separate sexes, and usually an operculum.
 - **Opisthobranchia** includes sea slugs, sea hares, sea butterflies, and canoe shells.
 - Most are marine, shallow-water.
 - anus and gill(s) are displaced to right side.
 - Two pairs of tentacles, one pair modified to increase chemo-absorption.
 - Shell is reduced or absent.
 - Monoecious
 - **Pulmonata** includes land and most freshwater snails and slugs.
 - Ancestral ctenidia have been lost and the vascularized mantle wall is now a lung.
 - Air fills lung by contraction of mantle floor.
 - Anus and nephridiopore open near the pneumostome
 - Aquatic species have one pair of tentacles.
 - Landforms have two pair of tentacles and the posterior pair has eyes.

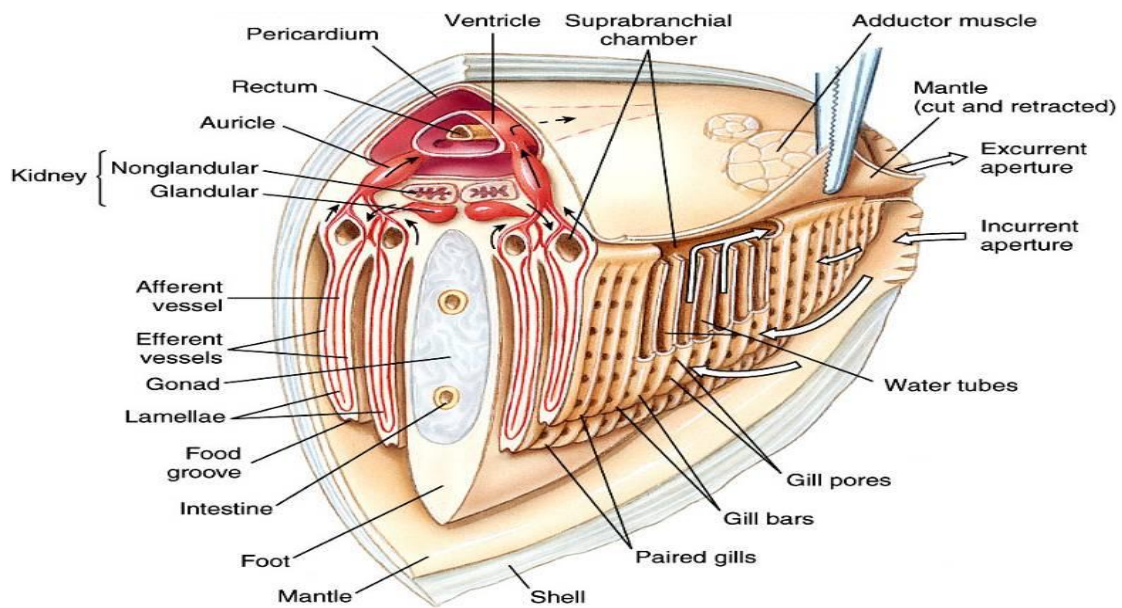
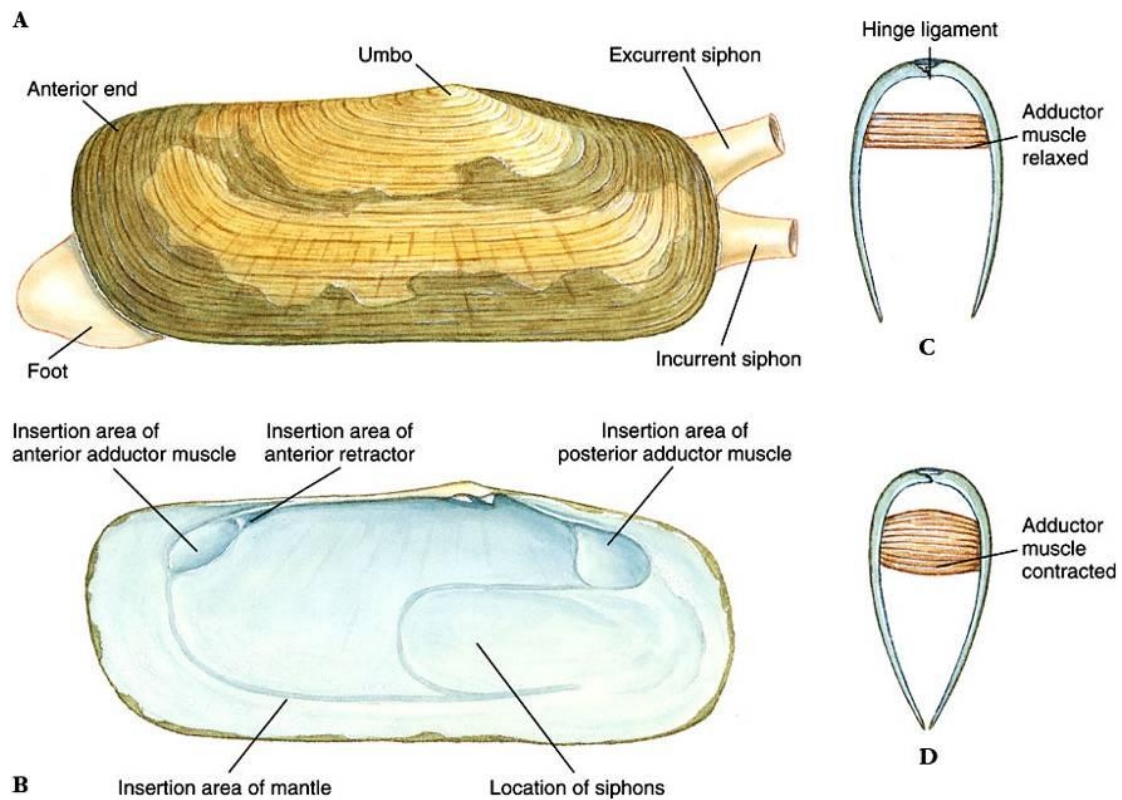
Generalized Mollusc Anatomy

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Class Bivalvia :

- **Bivalved molluscs** have two shells (valves).
- Mussels, clams, oysters, scallops, shipworms.
- Mostly sessile **filter feeders**.
- No head or radula.
- Bivalves are laterally (right-left) compressed and their two shells are held together by a **hinge ligament** on the dorsal surface.
- The **Umbo** is the oldest part of the shell, growth occurs in concentric rings around it.
- Part of the mantle is modified to form **incurrent** and **excurrent siphons**.
- Used to pump water through the organism for gas exchange and filter feeding.
- Sometimes used for jet propulsion.

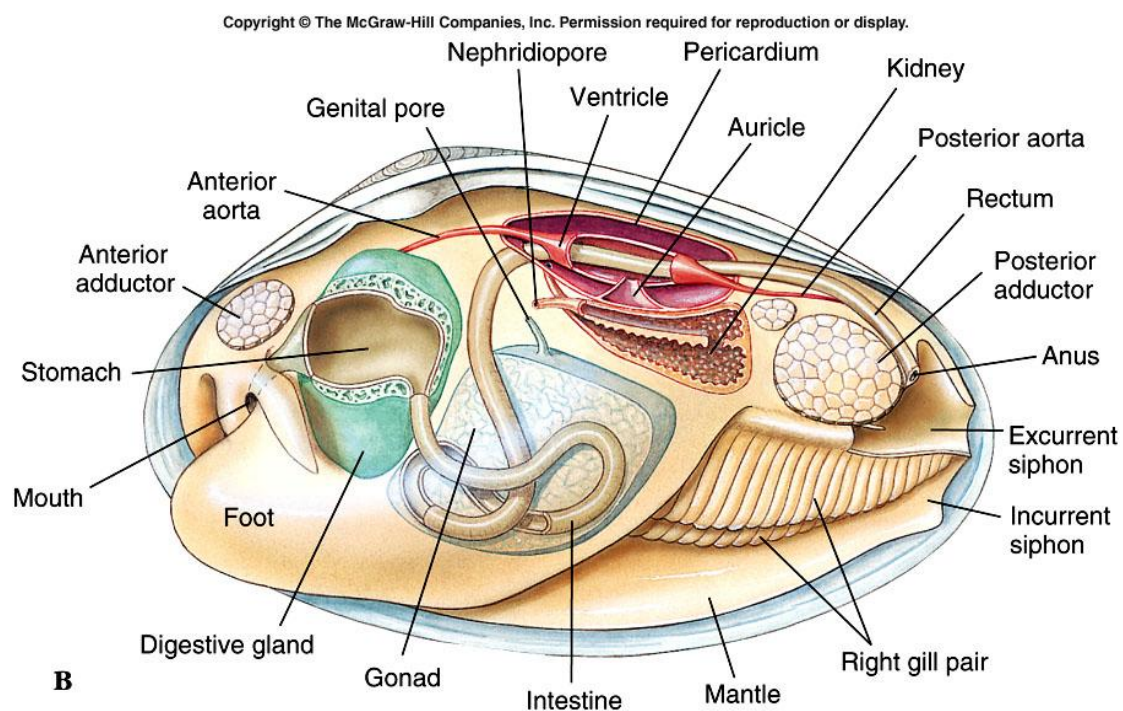


Class Bivalvia :

- The valves have tiny teeth that act as wood rasps and allow these bivalves to burrow through wood.
- They feed on wood particles with the help of symbiotic bacteria that produce cellulase and fix nitrogen.
- Native freshwater clams in the U.S. are more than 300 species
- Sensitive to water quality changes, including pollution and sedimentation.
- Zebra mussels are a serious exotic invader into the Great Lakes Region.

Class Bivalvia – Locomotion :

- Bivalves move around by extending the muscular foot between the shells.
- Scallops and file shells swim by clapping their shells together to create jet propulsion.
- Like other molluscs, bivalves have a **coelom** and an **open circulatory system**.
- The mantle cavity of a bivalve contains gills that are used for feeding as well as gas exchange.



General Characteristics :

- Scallops have a row of small blue eyes along the mantle edge. Each eye has a cornea, lens, retina, and pigmented layer.
- Pair of U-shaped kidneys is ventral and posterior to heart.
- Nervous system has three pairs of widely separated ganglia connected together.
- Sense organs are poorly developed.
- Statocysts in the foot.
- Osphradia in the mantle cavity (chemoreceptive).
- Pigment cells on the mantle.
- Some mantle eyes have a cornea, lens, retina and pigmented layer.
- Tentacles may have tactile and chemoreceptor cells.
- Suspended organic matter enters incurrent siphon.
- Gland cells on gills and labial palps secrete mucus to entangle particles.
- Food in mucous masses slides to food grooves at lower edge of gills.
- Cilia and grooves on the labial palps direct the mucous mass into mouth.
- Some bivalves feed on deposits in sand.

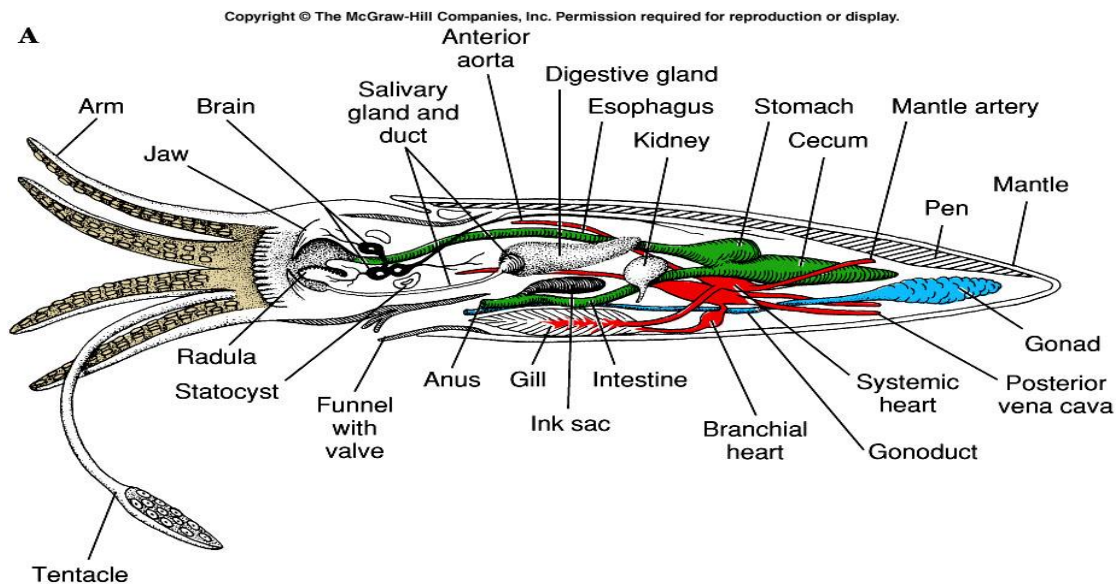
Class Bivalvia – Reproduction :

- Bivalves usually have separate sexes.
- Zygotes develop into **trochophore**, **veliger**, and **spat** (tiny bivalve) stages.
- Internal fertilization
- Early development in brood chamber (region of mantle cavity)
- In freshwater clams, fertilized eggs develop into **glochidium** larvae which is a specialized veliger.
- Glochidia live as parasites on fish and then drop off to complete their development.

Class Cephalopoda :

- **Cephalopods** include octopuses, squid, nautilus and cuttlefish.
- Marine carnivores with beak-like jaws surrounded by tentacles of their modified foot.
- Modified foot is a funnel for expelling water from the mantle cavity.
- Cephalopod fossils go back to Cambrian (570 mya) times.
- The earliest had straight cone-shaped shells.
- Later examples had coiled shells similar to *Nautilus*.
- Ammonoids were a very successful group, some had quite elaborate shells.
- Shells were made buoyant
- by a series of **gas chambers**.
- Nautilus shells differ from those of a gastropod because they are divided into chambers.
- The animal lives in the last chamber.
- A cord of living tissue extends through each chamber.
- Cuttlefishes have a small curved shell, completely enclosed by the mantle.
- In squid, the shell has been reduced to a small strip called the **pen**, which is enclosed in the mantle.
- In squid, the shell has been reduced to a small strip called the **pen**, which is enclosed in the mantle.

Cephalopod Anatomy



Class Cephalopoda – Locomotion :

- Cephalopods swim by expelling water from the mantle cavity through a ventral funnel.
 - They can aim the funnel to control the direction they are swimming.
 - Cephalopods have a **closed circulatory system**.
 - Nervous and sensory systems are more elaborate in cephalopods than in other molluscs.
 - The brain is the largest of any invertebrate.
 - Most cephalopods have complex eyes with cornea, lens, chambers, and retina

Class Cephalopoda – Communication :

- Visual signals allow cephalopods to communicate.
 - Movement of body and arms
 - Color changes effected by **chromatophores** (cells in the skin containing pigment granules).
 - Chromatophores can change shape alternately dispersing and concentrating pigment.

- Most cephalopods have an **ink sac** that secretes **sepia**, a dark fluid containing the pigment melanin.
 - When a predator tries to attack, the animal ejects the ink into the water where it hangs between the animal and the predator screening a quick escape.

Class Cephalopoda – Reproduction :

- Sexes are separate in cephalopods.
- Juveniles hatch directly from eggs – no free-swimming larvae.
- One arm of male is modified as an intromittent organ, the **hectocotylus**.
 - Removes a spermatophore from mantle cavity and inserts it into female.

Class Cephalopoda :

- Most octopuses creep along the sea floor in search of prey.
- Squids use their siphon to fire a jet of water, which allows them to swim very quickly.
- One small group of shelled cephalopods the nautilus, survives today.

Phylogeny :

- The first molluscs probably arose during Precambrian times.
 - Diverse molluscs found in the early Cambrian.
- It is likely that molluscs split off from the line that led to annelids after coelom formation, but before segmentation appeared.
- Hypothetical Ancestral Mollusc”
- Probably lacked a shell or crawling foot.
- Probably small (about 1 mm).
- Likely was a worm-like organism with a ventral gliding surface.
- Probably possessed a dorsal mantle, a chitinous cuticle and calcareous scales.

