Molluscs and the Intertidal

Lab 5

Phylum Mollusca

- Over 100,000 species
  - Includes snails, clams, octopuses and chitons
- Marine, freshwater and terrestrial
- Soft bodied, unsegmented
- Open circulatory system
- Similar body plan
  - Muscular foot
  - Visceral mass
  - Mantle
  - Radula (except bivalves)
- Exoskeleton
  - Shells of calcium carbonate

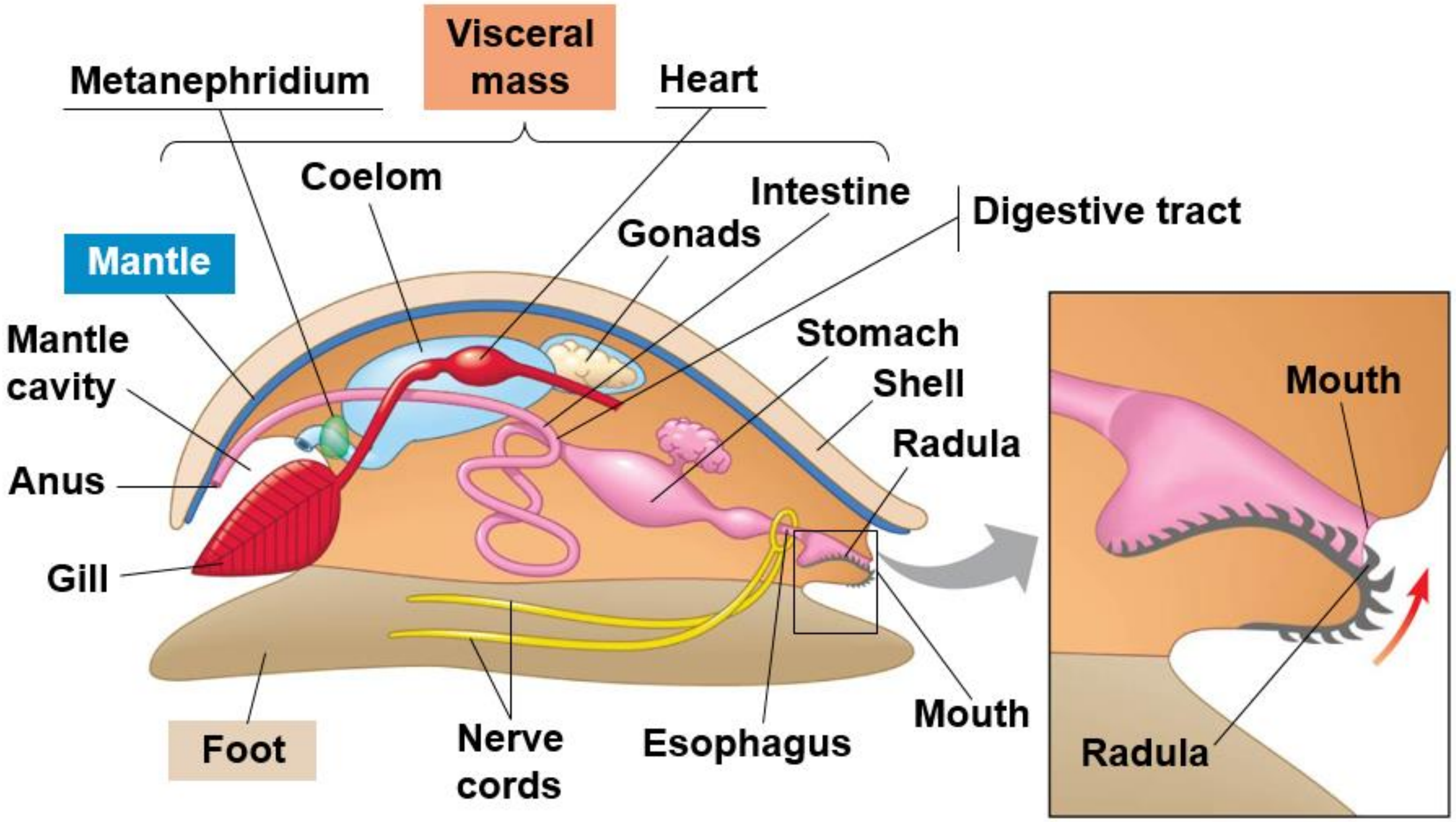
Mollusc Body Plan

Visceral mass: contains internal organs

Muscular foot: used for locomotion

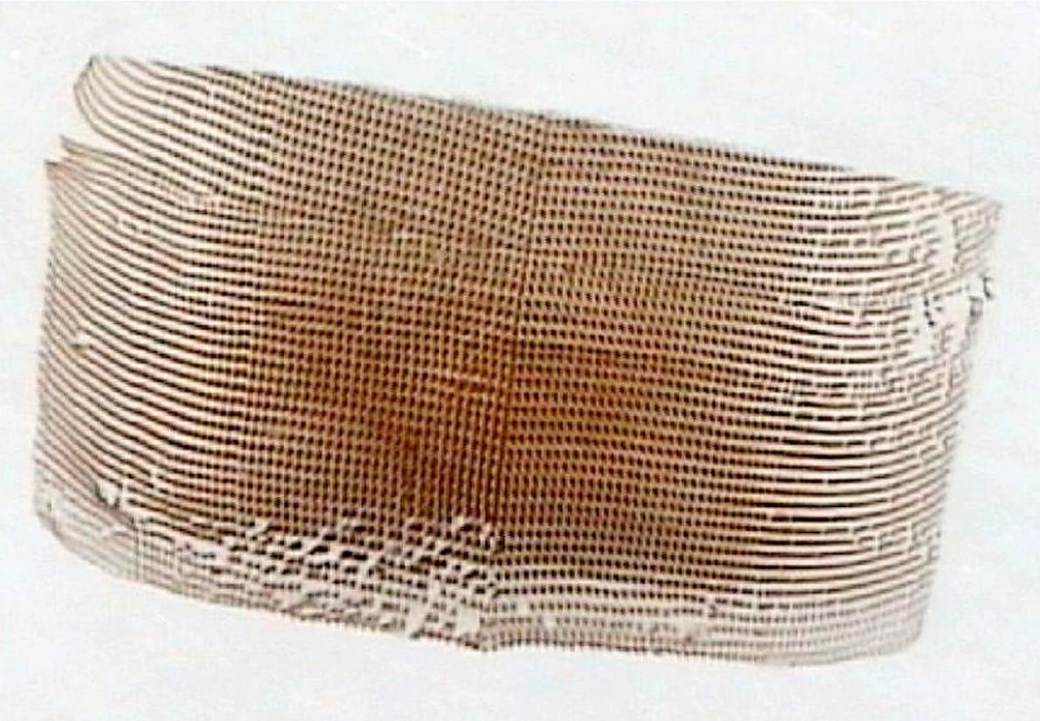
Mantle: <u>secretes calcium carbonate shell</u>

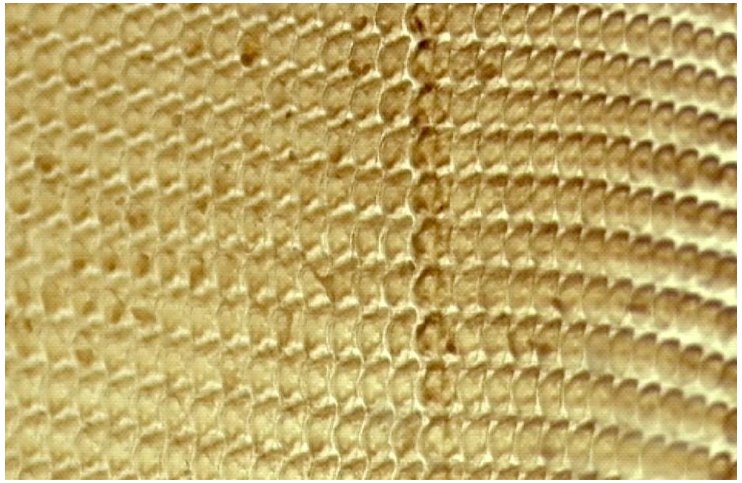
Radula: specialized feeding structure

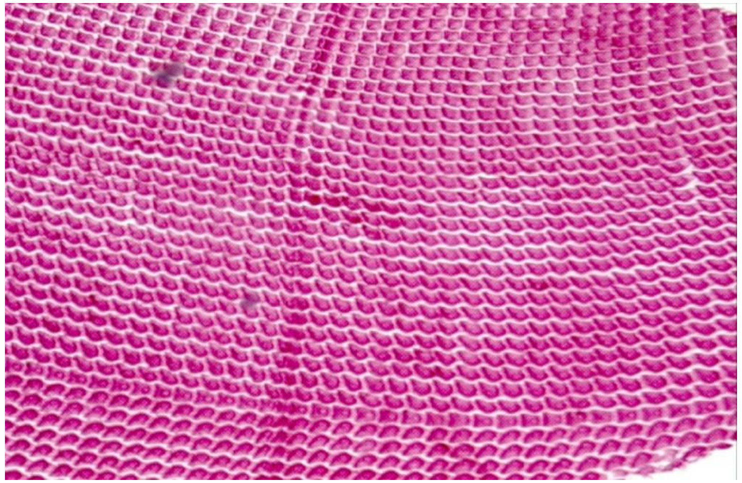


Mollusc Body Plan

- Radula: feeding structure comprising tiny, tooth-like projections used to scrap or cut food







Phylum Mollusca, Class Gastropoda

- Snails, slugs, limpets, nudibranchs
  - ~ ¾ of all molluscs
- Marine, Freshwater, and Terrestrial
- Shell coiled
  - Reduced or absent in some
- Asymmetrical due to <u>torsion</u>
- Foot for locomotion
- Radula present
- Most herbivores (some carnivores)

Phylum Mollusca, Class Polyplacophora

- Chitons
- Shell with eight overlapping plates
  - Unsegmented body
- Marine
- Foot used for locomotion
- Head reduced
- Radula used to scrap algae off rocks
- Intertidal zone

Phylum Mollusca, Class Bivalvia

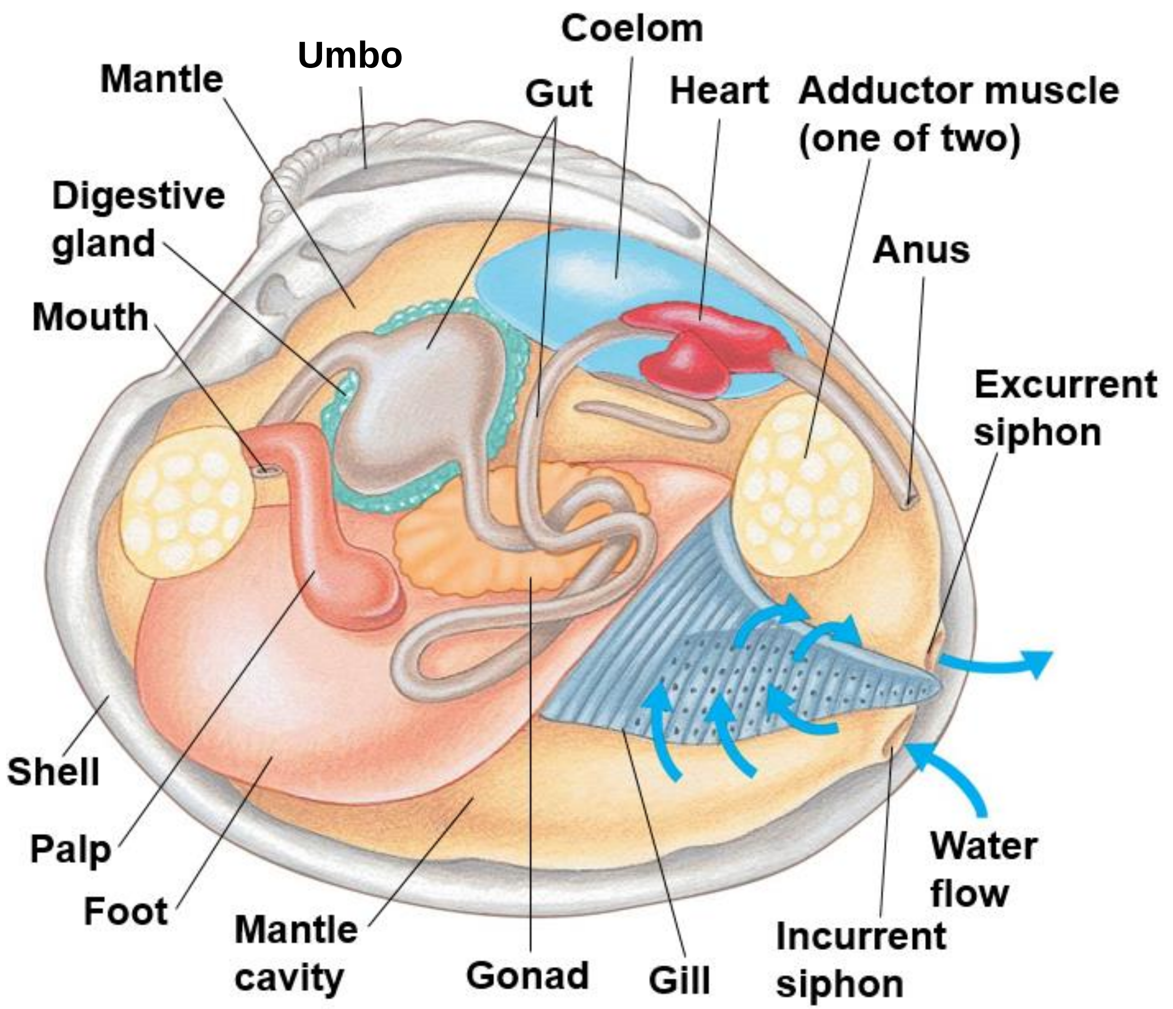
- Clams, oysters, mussels and scallops
- Marine and Freshwater
- Flattened shell with two valves
- Head reduced
- Filter feeders (siphons)
- <u>No radula</u>

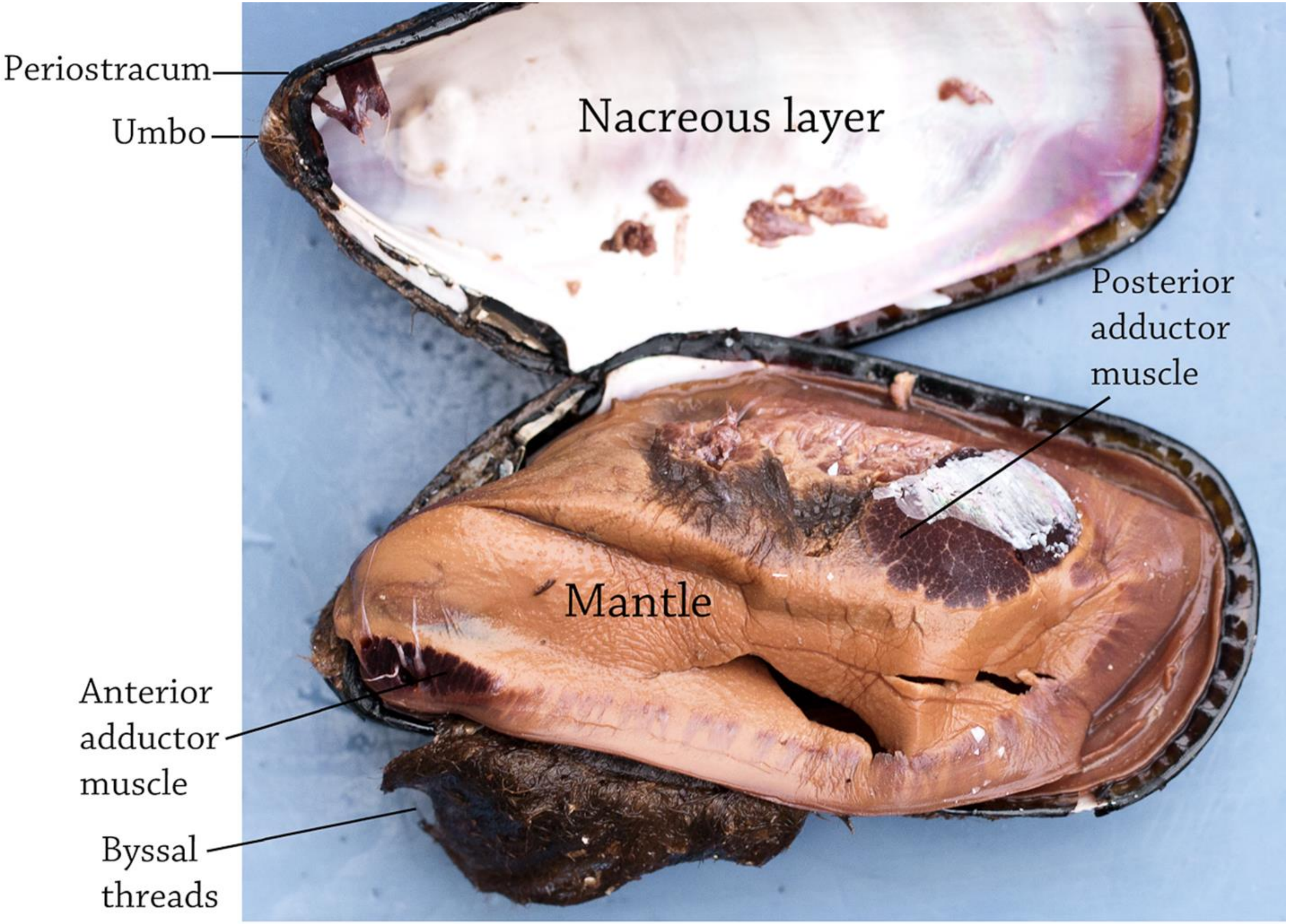
Bivalve Anatomy

- Gas exchange and feeding occur across the gill surface

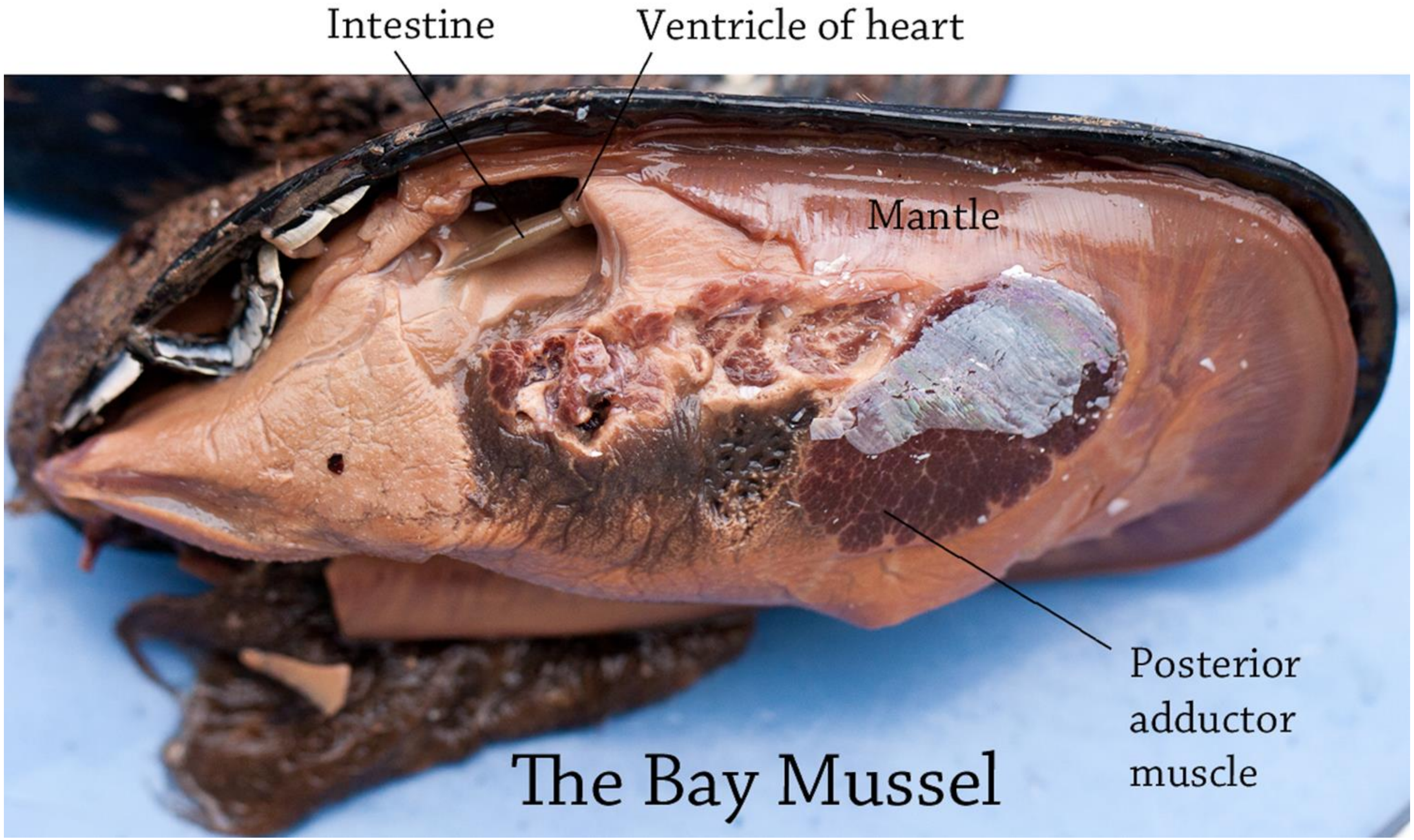
Water movement

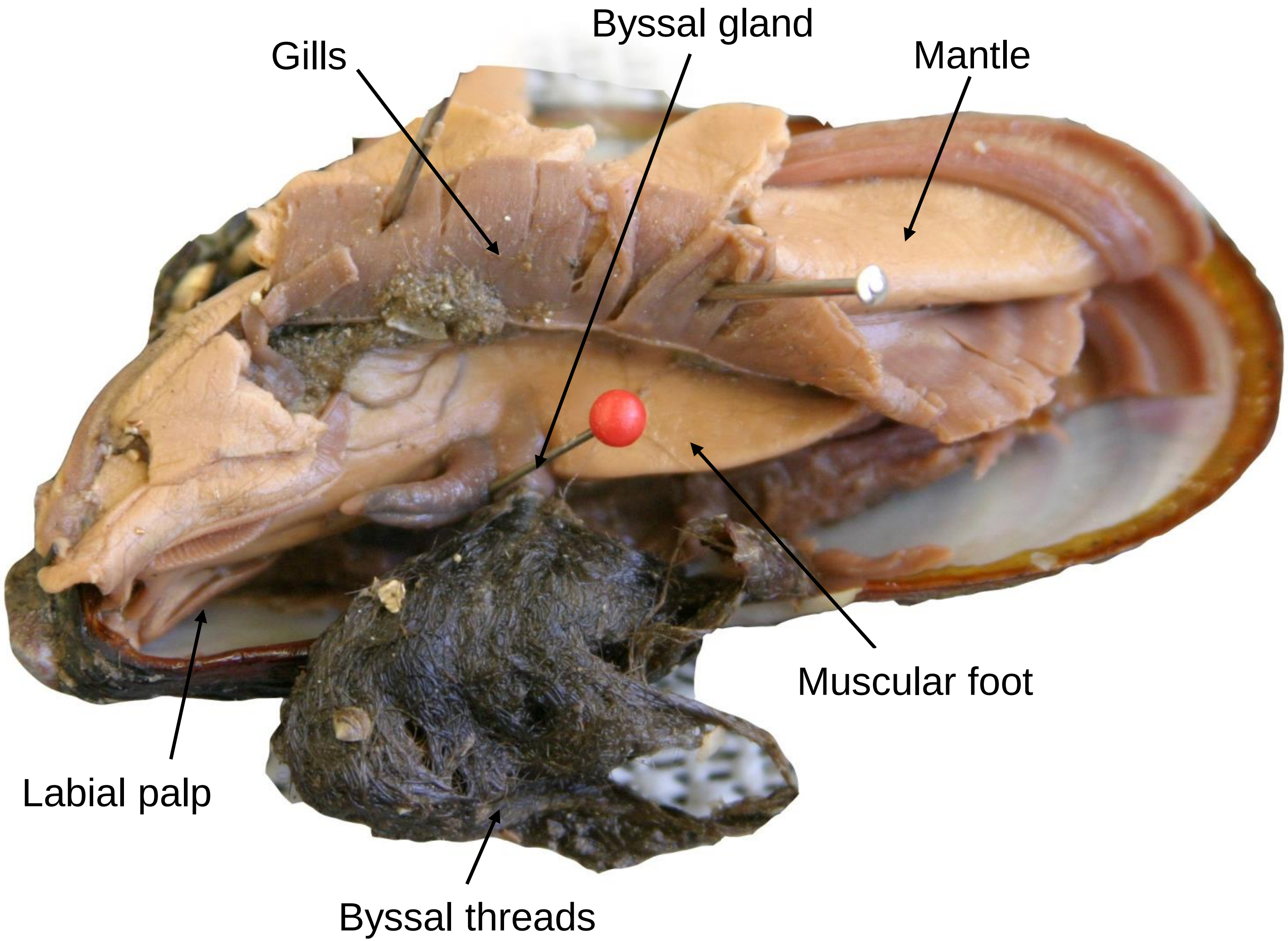
- Incurrent siphon → Gill surface → Excurrent siphon

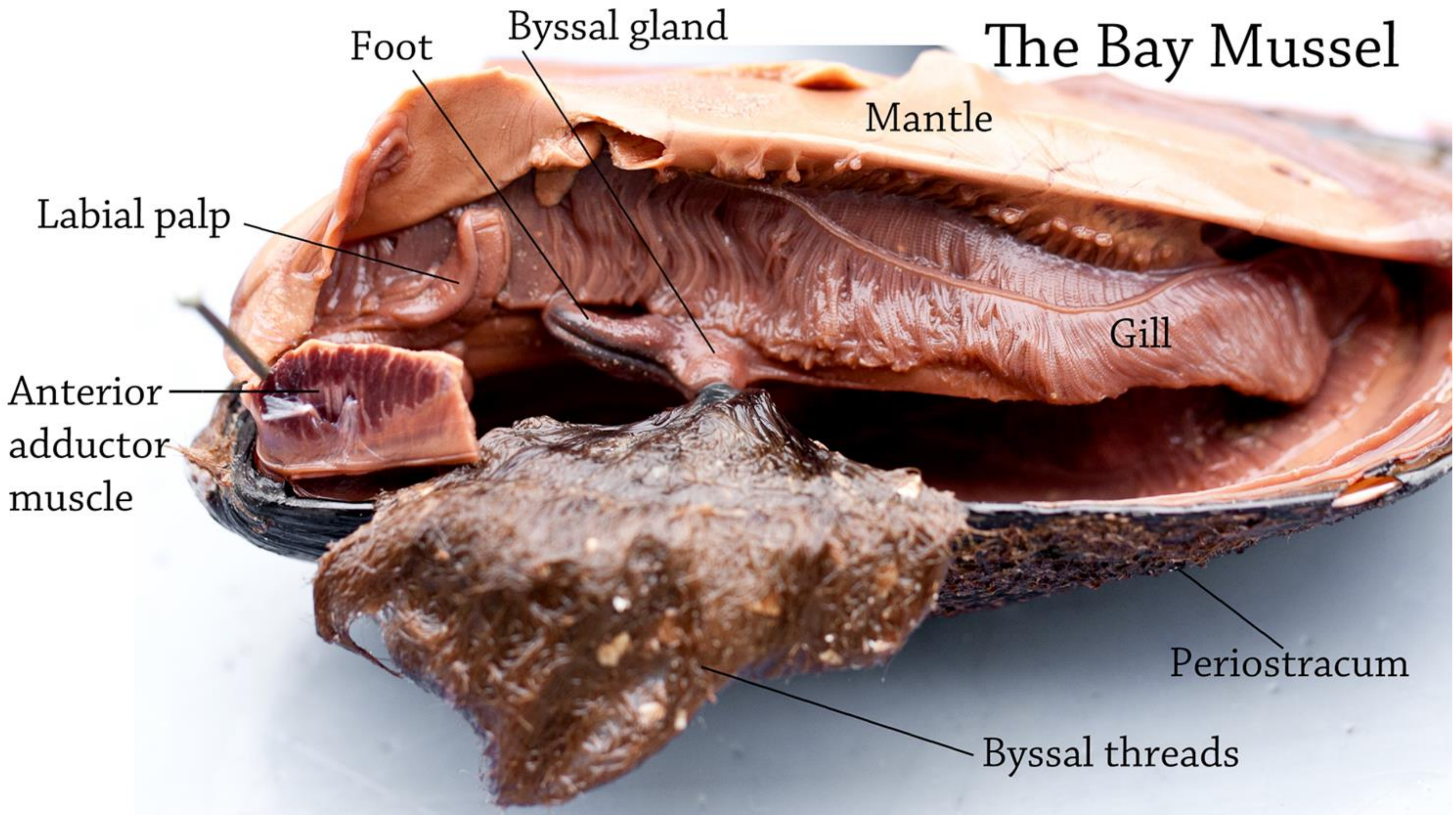


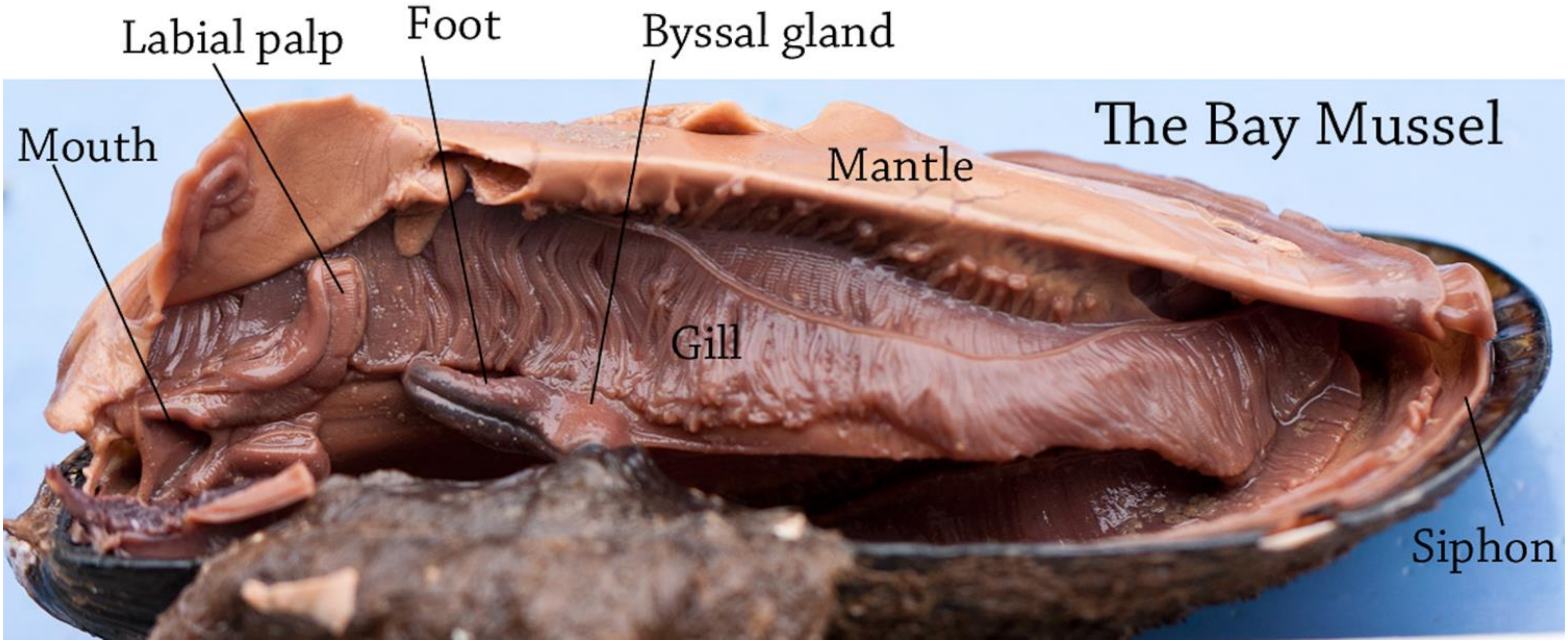


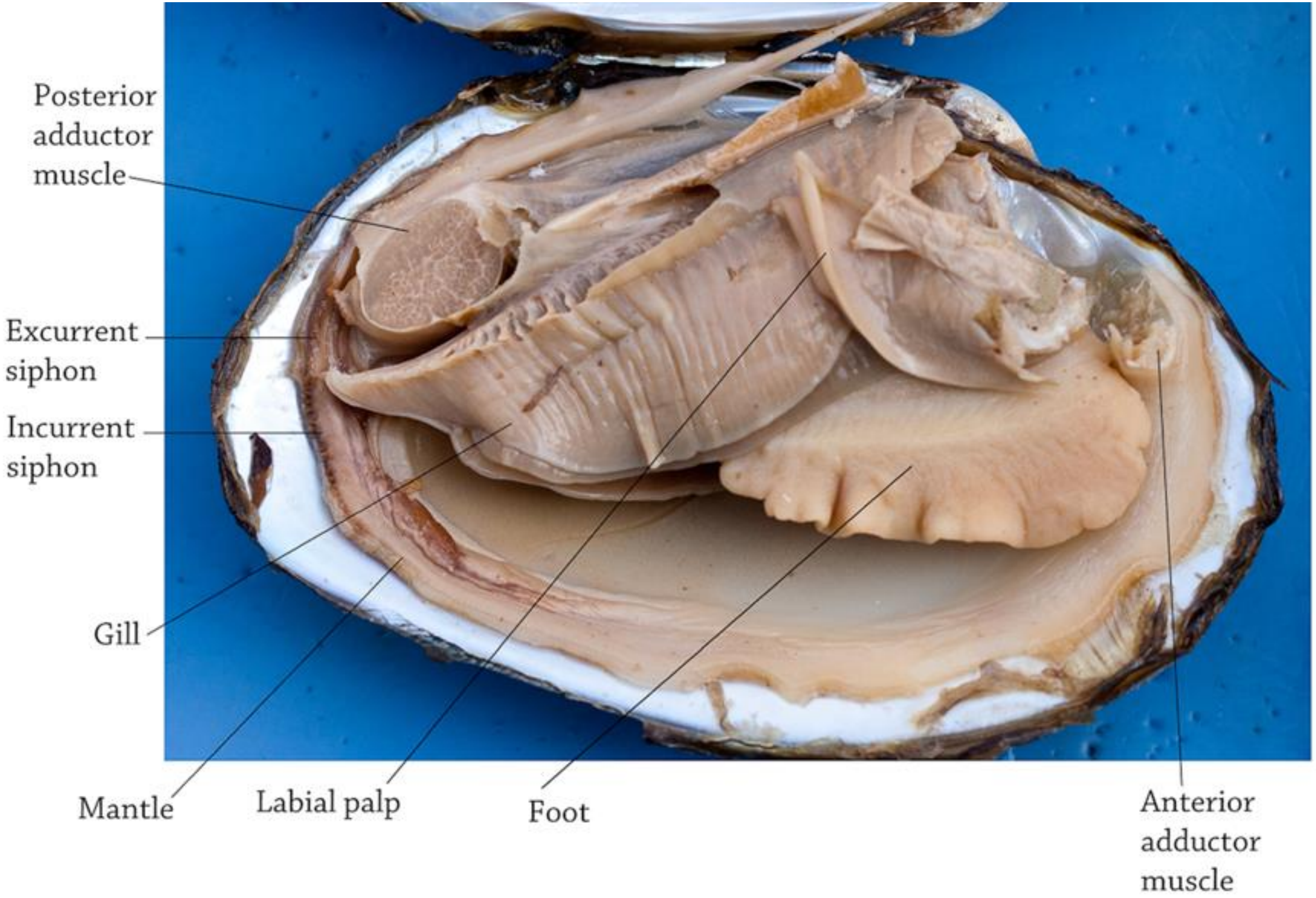
Internal Anatomy of the Bay Mussel

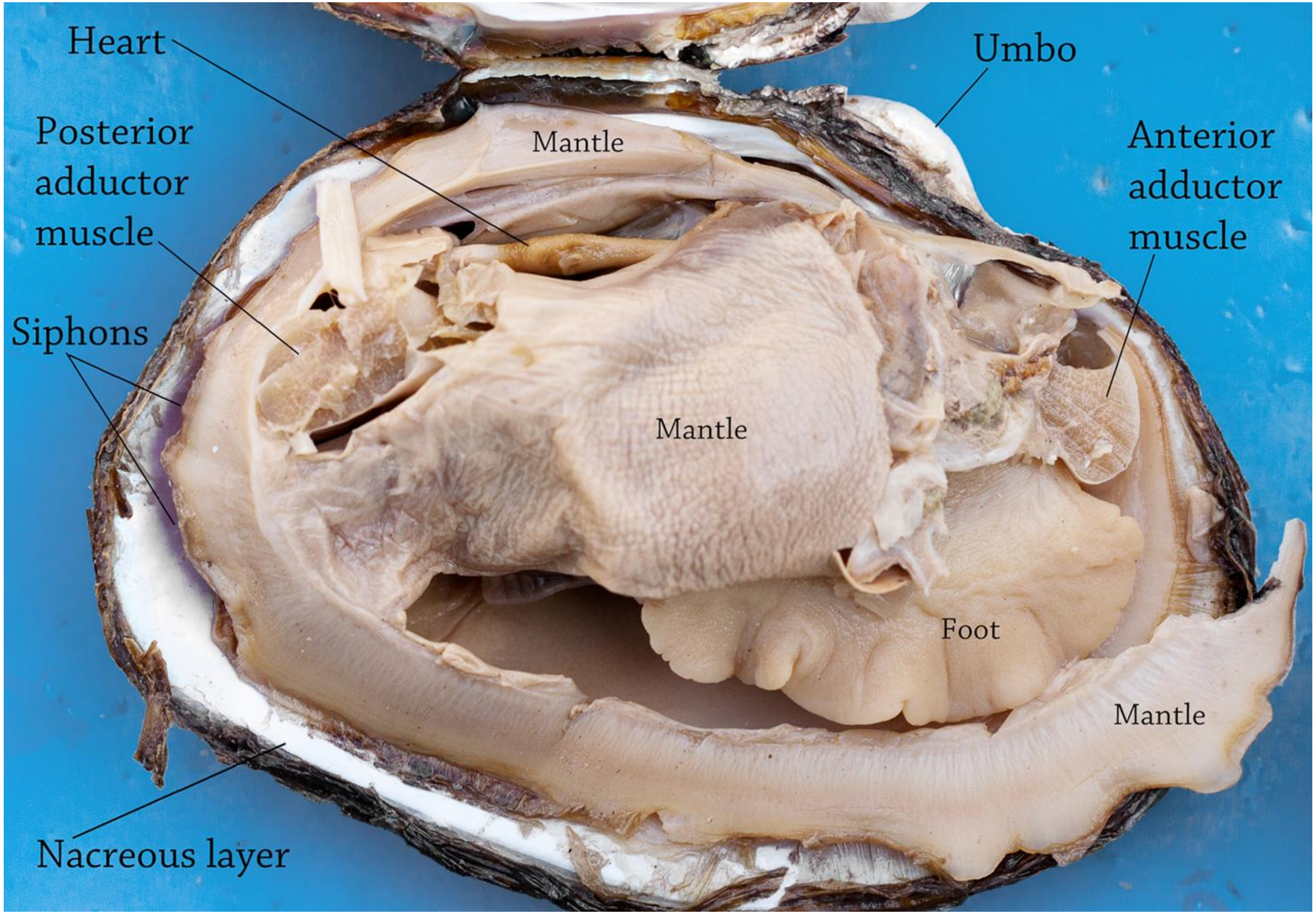

Intestine
Ventricle of heart
Mantle
Posterior adductor muscle
The Bay Mussel

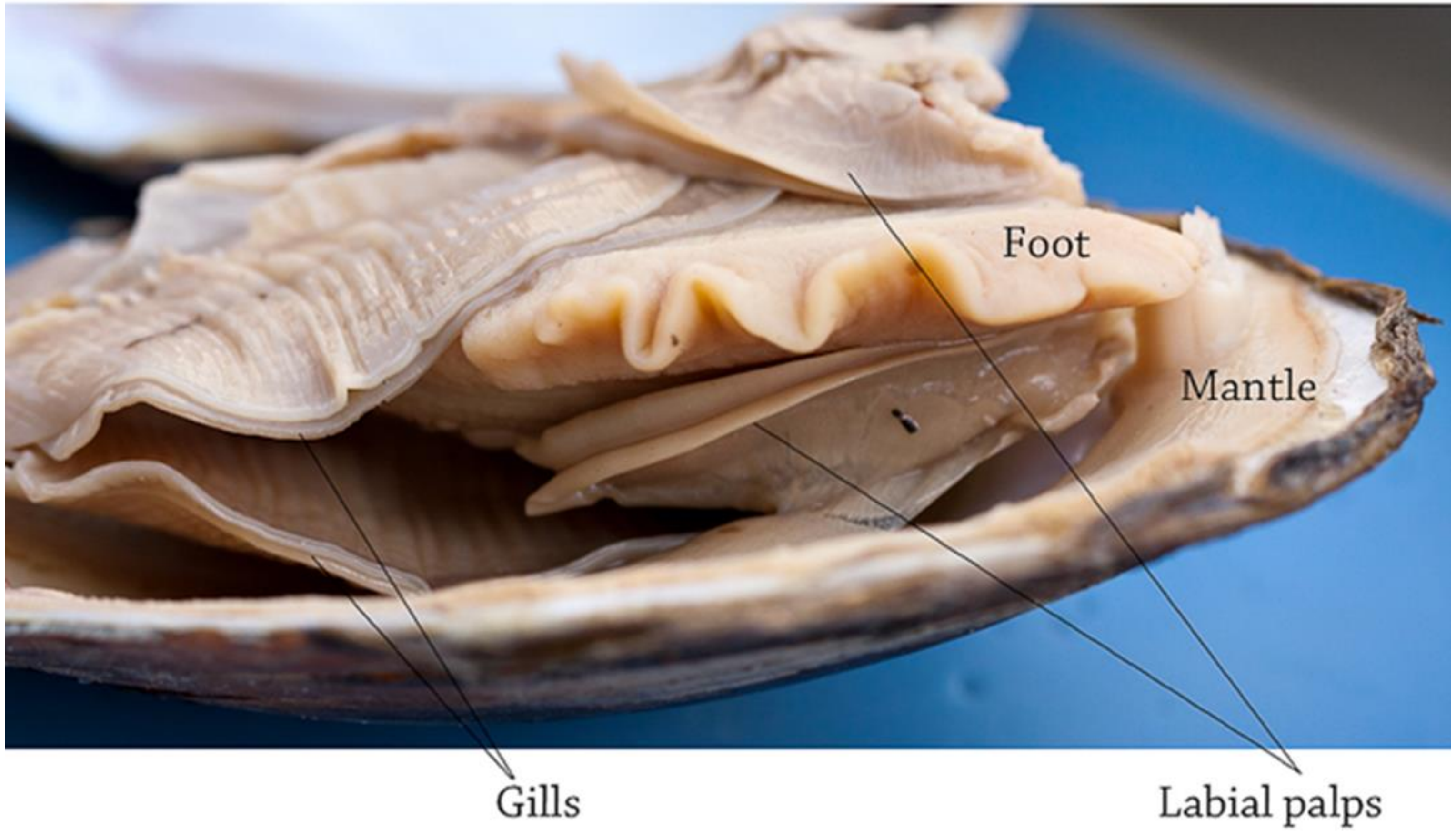

Gills
Byssal gland
Mantle
Muscular foot
Labial palp
Byssal threads


The Bay Mussel
Foot
Byssal gland
Mantle
Labial palp
Gill
Anterior adductor muscle
Periostracum
Byssal threads


Labial palp
Foot
Byssal gland
The Bay Mussel
Mouth
Mantle
Gill
Siphon


Posterior adductor muscle
Excurrent siphon
Incurrent siphon
Gill
Mantle
Labial palp
Foot
Anterior adductor muscle

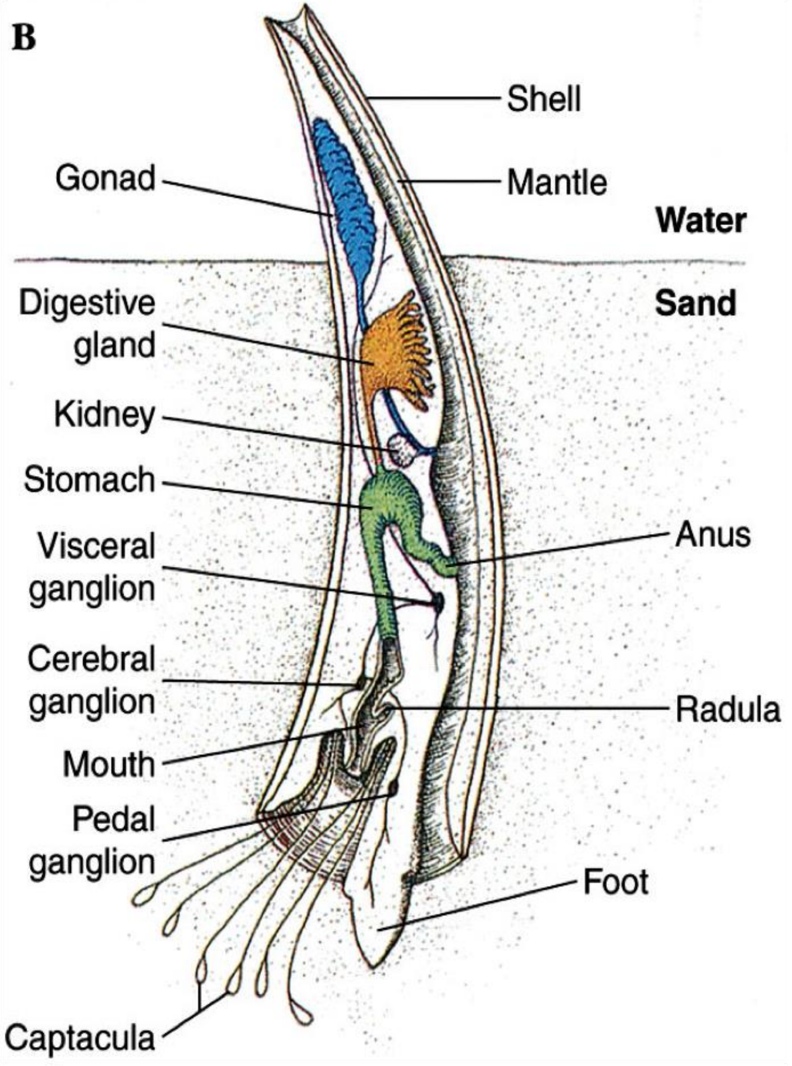

Heart
Umbo
Posterior
adductor
muscle
Mantle
Anterior
adductor
muscle
Siphons
Mantle
Foot
Mantle
Nacreous layer



Foot
Mantle
Gills
Labial palps

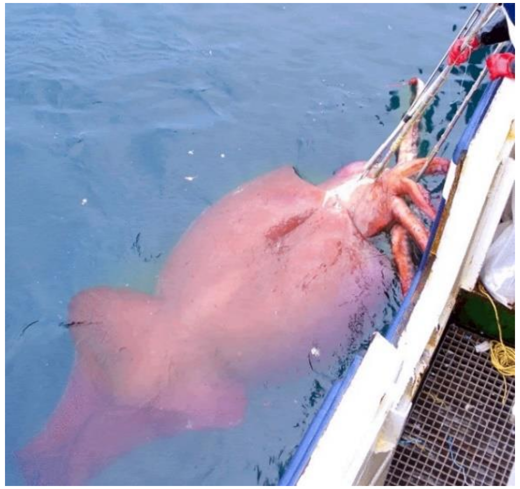
Phylum Mollusca, Class Scaphopoda

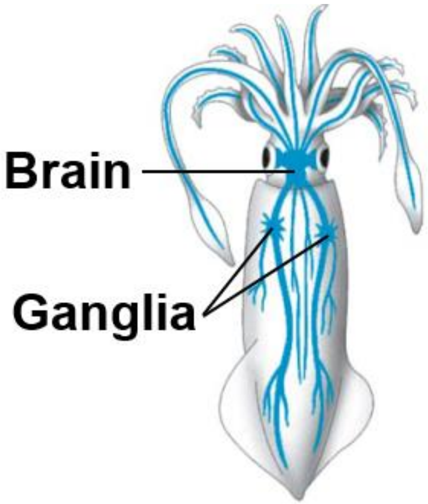
- Tusk shells
- <u>Benthic</u>
  - Burrow into sand using foot
- <u>Filter feeders</u>
  - Sift through sediment and move food to gizzard using its radula

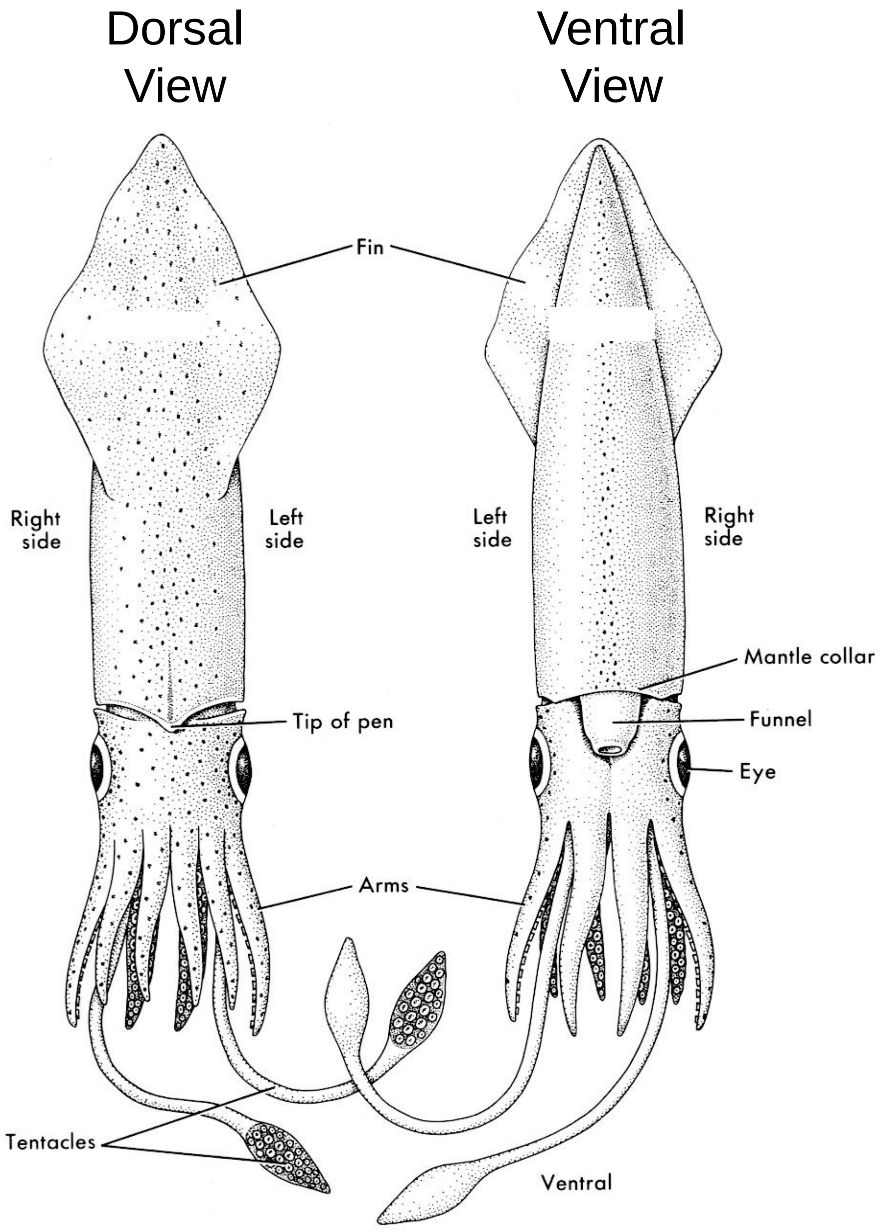


Phylum Mollusca, Class Cephalopoda

- Octopuses, squid, nautilus
- All Marine
- Shell external, internal or absent
- Mouth with radula and beak
- Locomotion by <u>siphon</u>
- Chromatophores
- <u>Closed</u> circulatory system
- Most developed invertebrate nervous system
  - Complex brain
  - Camera eye






Dorsal
View
Ventral
View
Fin
Right
side
Left
side
Left
side
Right
side
Mantle collar
Tip of pen
Funnel
Eye
Arms
Tentacles
Ventral

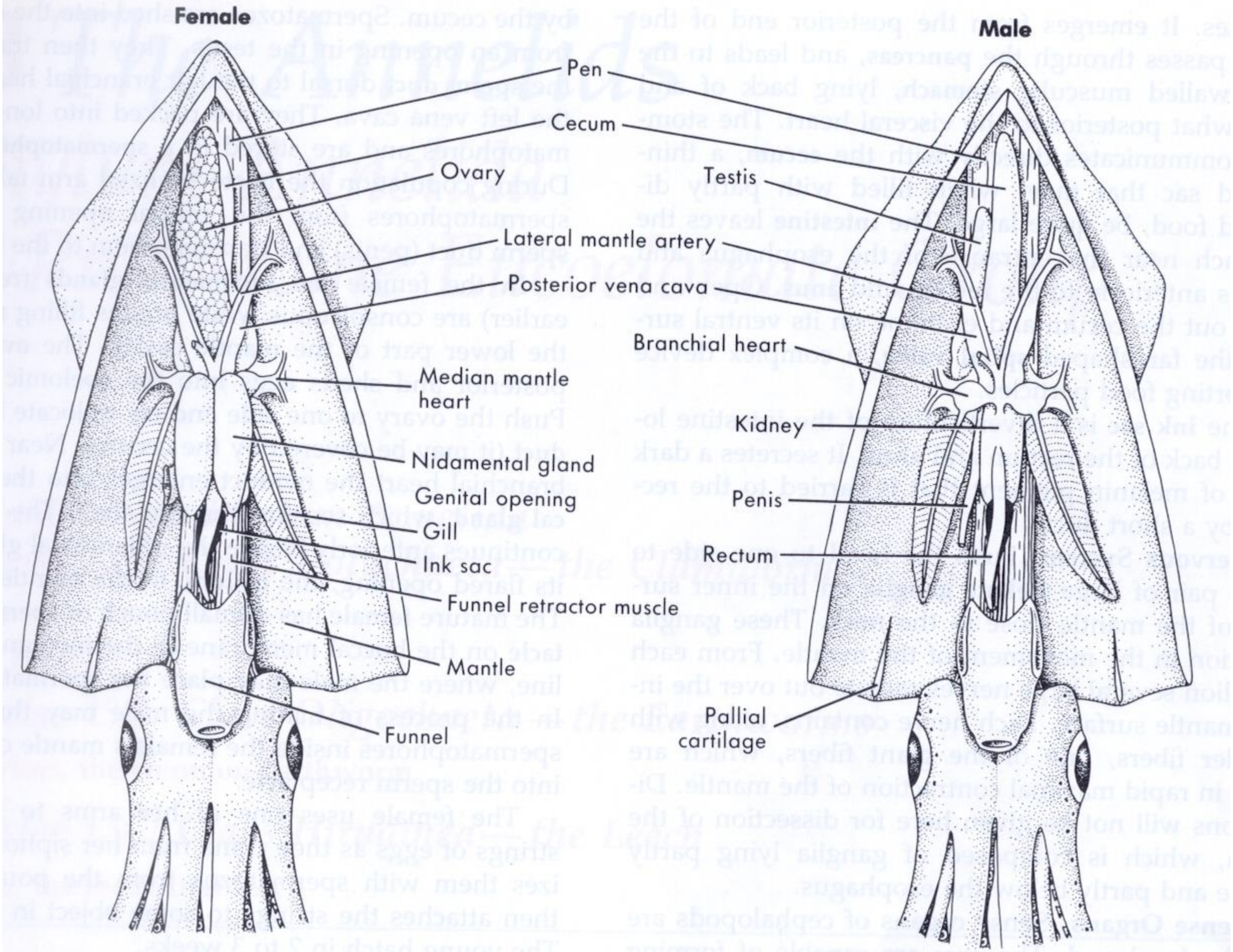
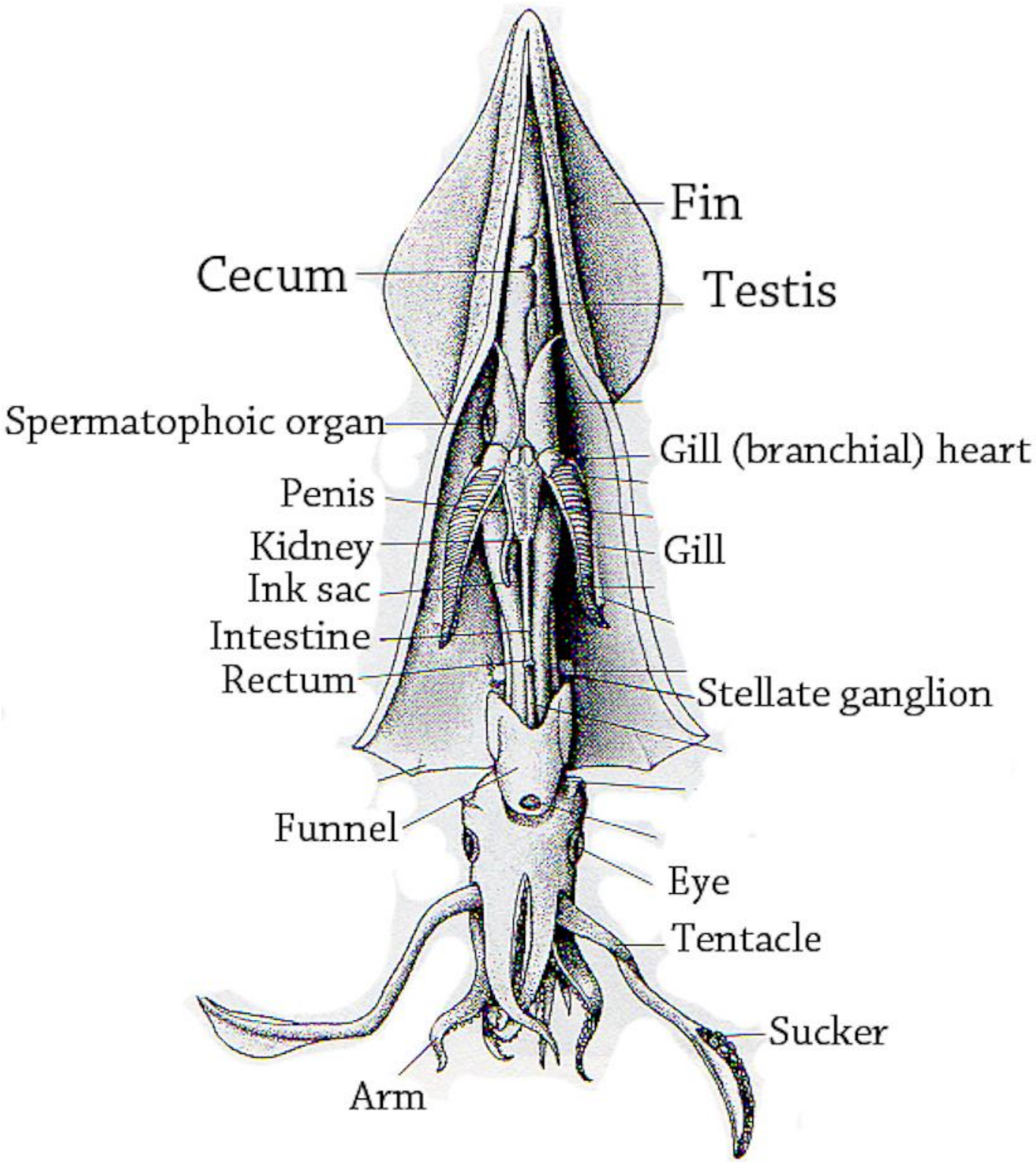
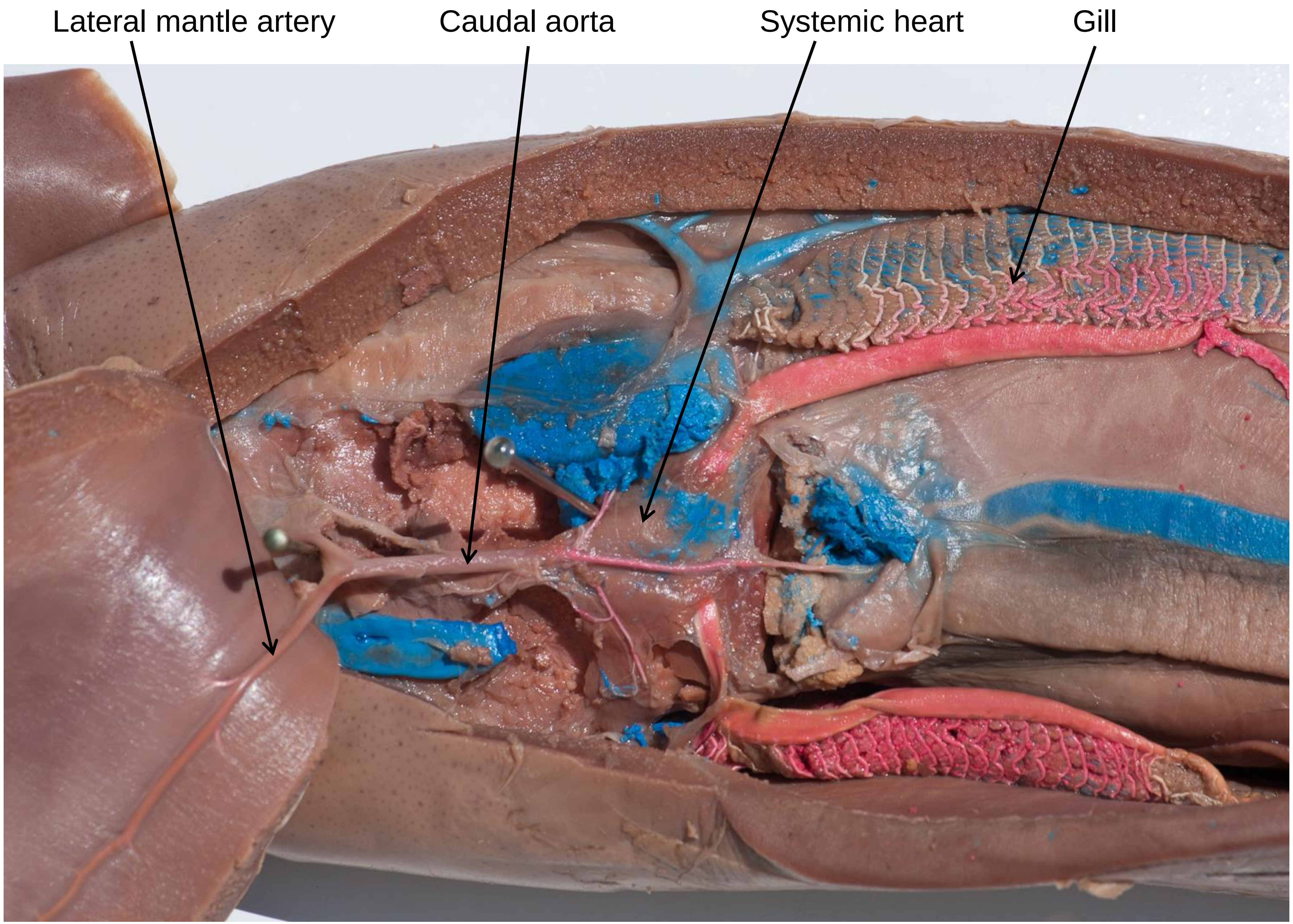
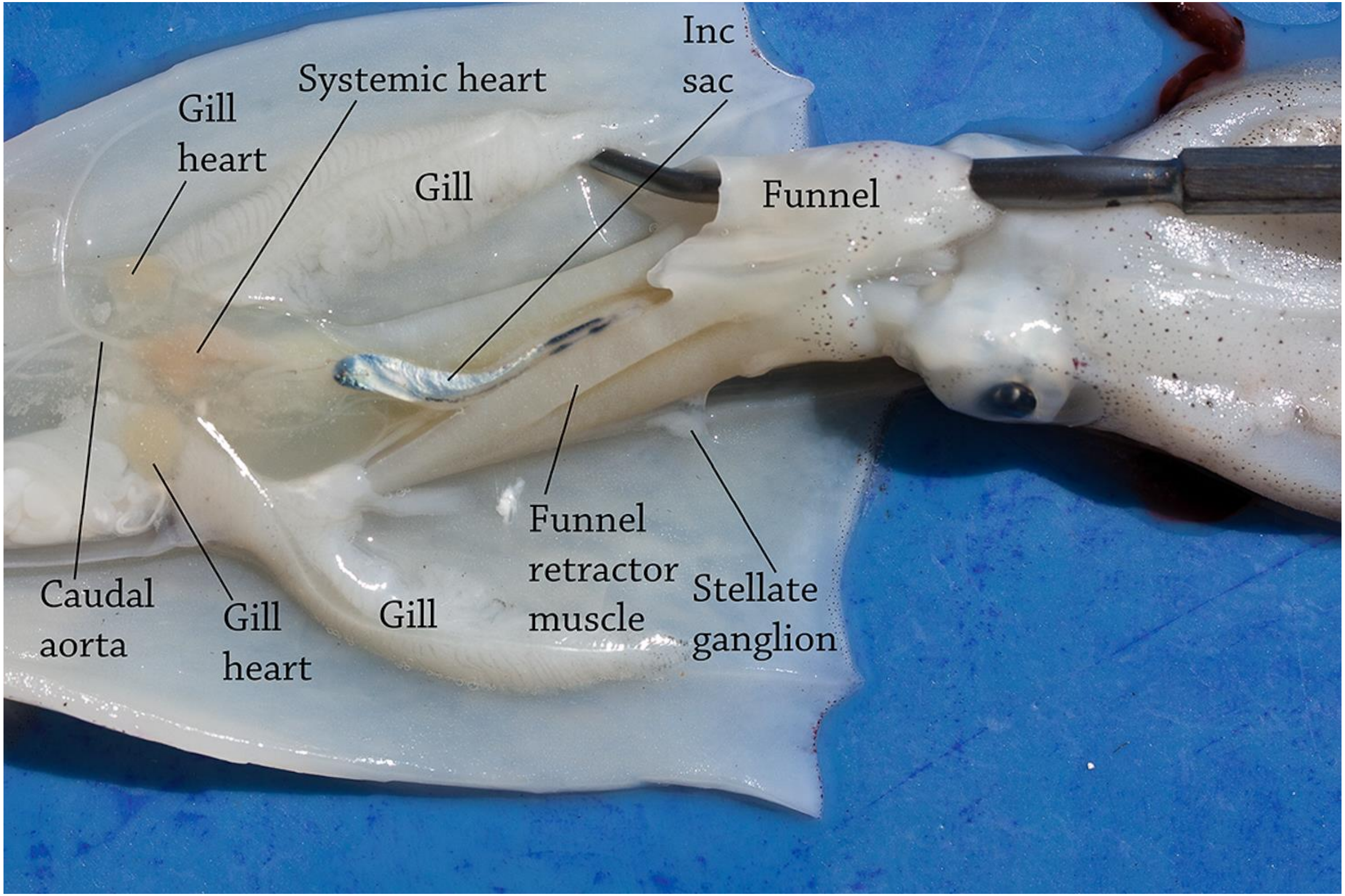


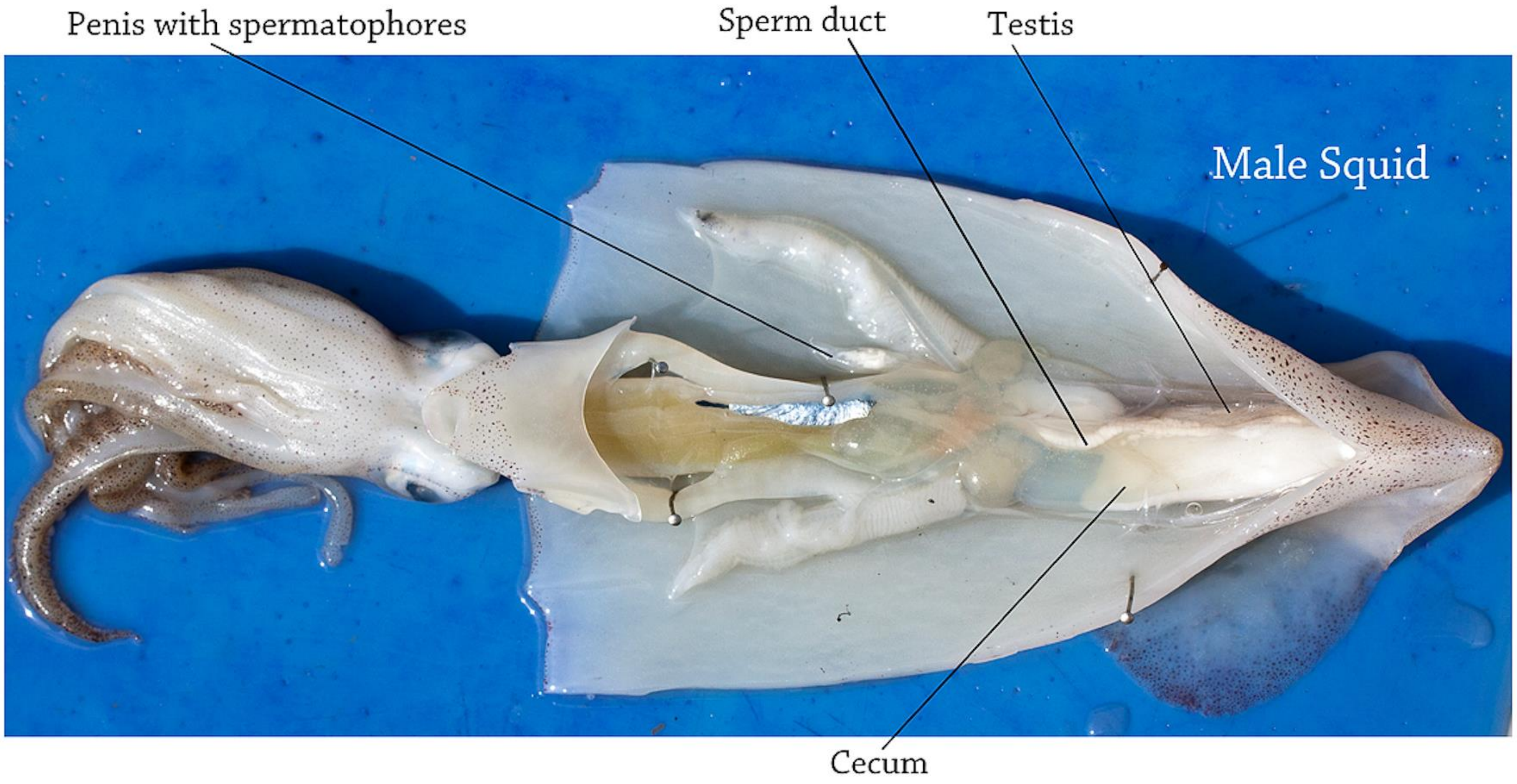
FIGURE 12-13 Posterior view of mantle cavity of a squid. **Left, female. Right, male.**



Fin
Cecum
Testis
Spermatophoic organ
Gill (branchial) heart
Penis
Kidney
Gill
Ink sac
Intestine
Rectum
Stellate ganglion
Funnel
Eye
Tentacle
Sucker
Arm


Lateral mantle artery
Caudal aorta
Systemic heart
Gill


Inc
sac
Systemic heart
Gill
heart
Gill
Funnel
Funnel
retractor
muscle
Stellate
ganglion
Caudal
aorta
Gill
heart
Gill


Penis with spermatophores
Sperm duct
Testis
Male Squid
Cecum


Nidamental gland
Ovary with eggs
Female Squid

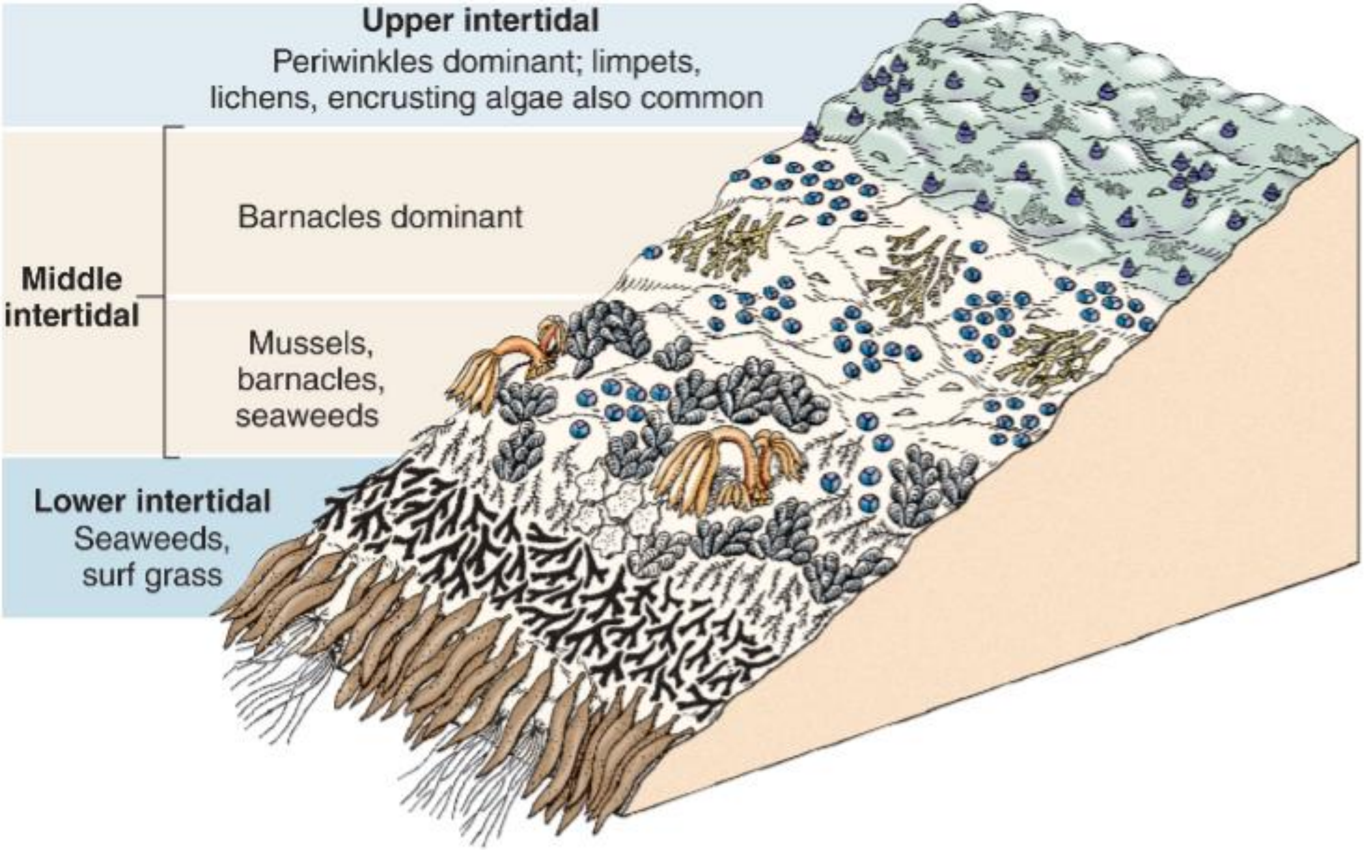
Intertidal Communities

- The intertidal zone is the area between the mean low tide and mean high tide.
  - The intertidal zone is exposed during low tide.
- Intertidal zone substrate can be rocky or soft bottom.
  - Rocky substrate can vary as to the type of rock and the slope angle.
  - Soft bottoms can vary from sand to silt or a mixture (mud).

Zonation in the Intertidal

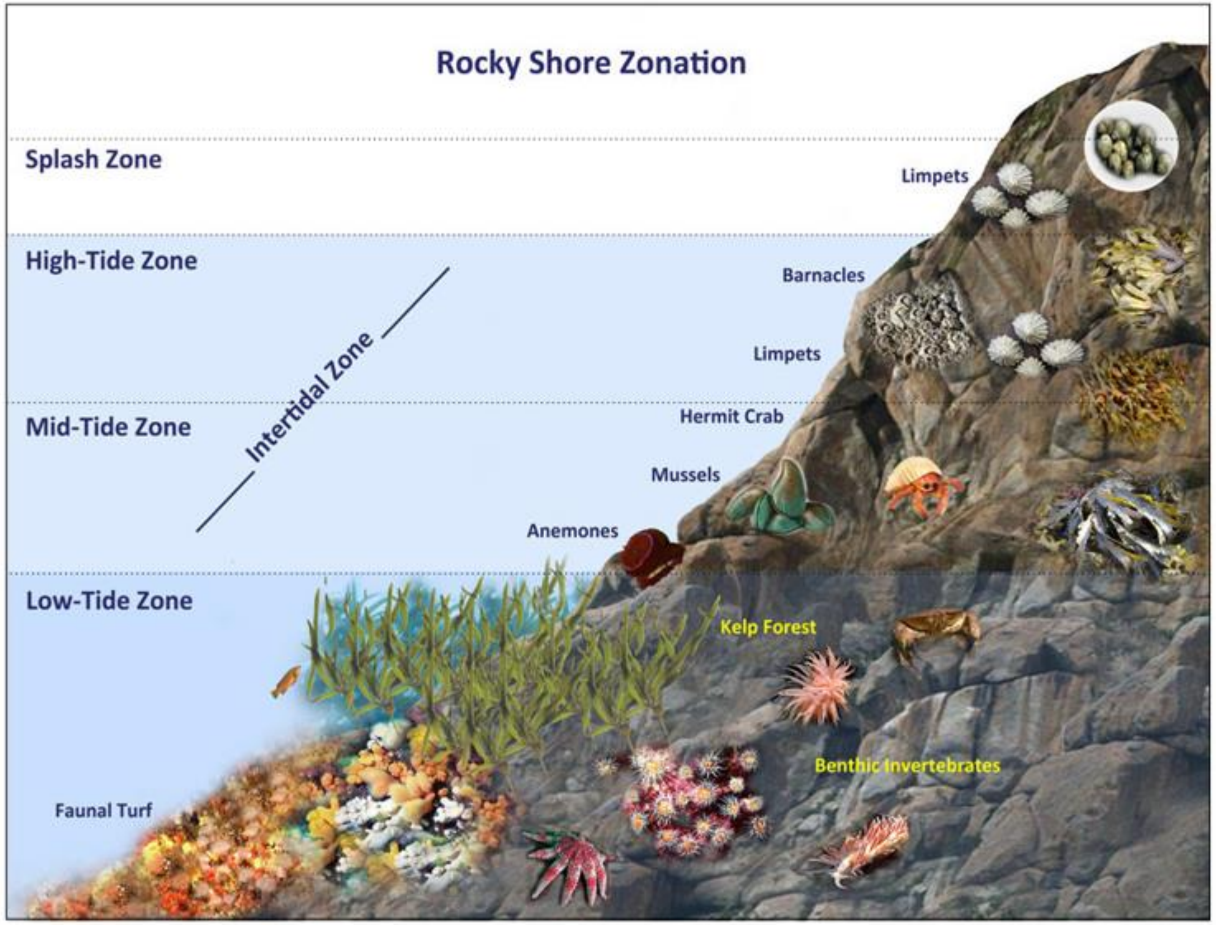
- Intertidal organisms typically occupy distinct bands or vertical zones within the intertidal ecosystem

- Zonation is due to varying degrees of exposure
  - Upper intertidal (most exposed)
  - Middle and lower intertidal (least exposed)



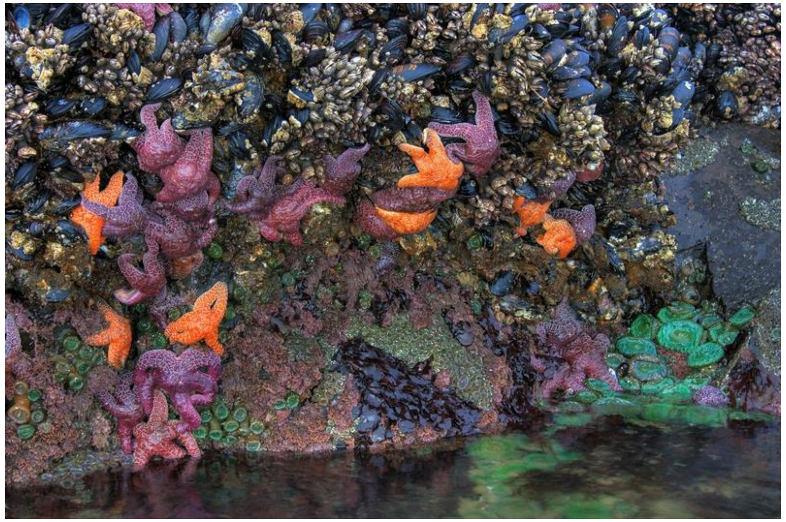
Intertidal Zonation

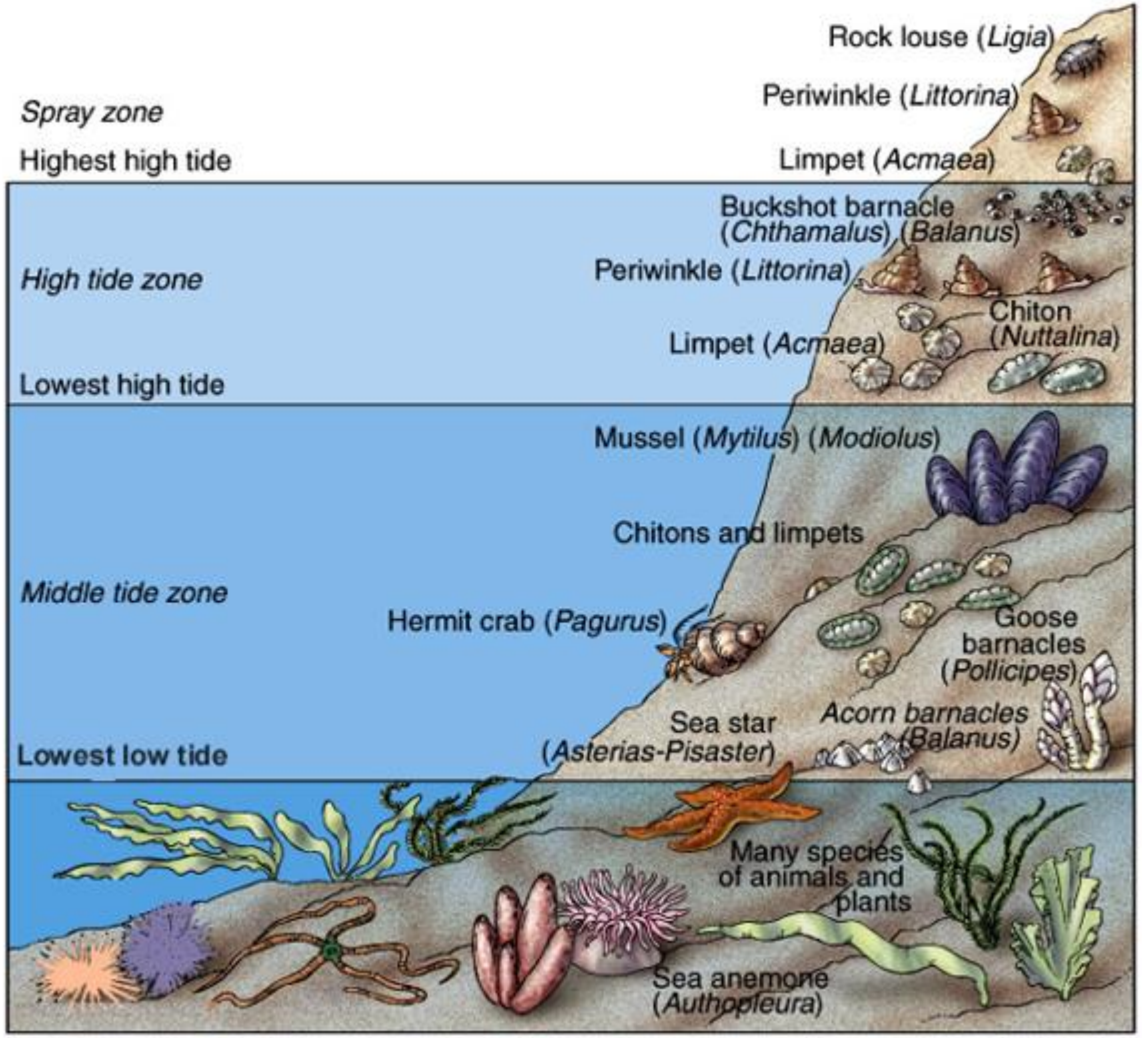
- Splash zone: ~5ft above see level. Only inundated during highest high tides.
- High-tide zone: ~2 to 5ft above sea level. Inundated during high tide and exposed to air during low tide.
- Mid-tide zone: 0 – 2ft above sea level. Exposed to air only during low tide.
- Low-tide zone: Below sea level. Only exposed to air during lowest low tides.



Marine Organisms and Tides

- Intertidal organisms deal with periods of exposure during low tide, wave action, and changes in salinity and temperature.





Mostly shelled organisms

Many soft-bodied organisms and algae

Splash Zone and Upper Intertidal

Upper and Middle Intertidal

Middle and Lower Intertidal

Intertidal Zonation

Splash zone: ~5ft above see level.

- Only inundated during highest high tides.
- Organisms sprayed with water during high tide but are rarely submerged

Organisms found in splash zone

- Periwinkle snails
- Small acorn barnacles

Periwinkle snails

Small acorn barnacles

Intertidal Zonation

High-tide zone: ~2 to 5ft above sea level.

- Inundated during high tide and exposed to air during low tide.

Rough chiton

Organisms found in high-tide zone

- Large acorn barnacle
- Chiton
- Limpets
- Shore crabs

Shore crab

Intertidal Zonation

Mid-tide zone: 0 – 2ft above sea level.

- Exposed to air only during low tide.

Sea stars and sea anemones

Organisms found in mid-tide zone

- Sea star
- California mussel
- Gooseneck barnacles
- Hermit crabs
- Sea anemones

California mussels and gooseneck barnacles

Intertidal Zonation

Low-tide zone: Below sea level.

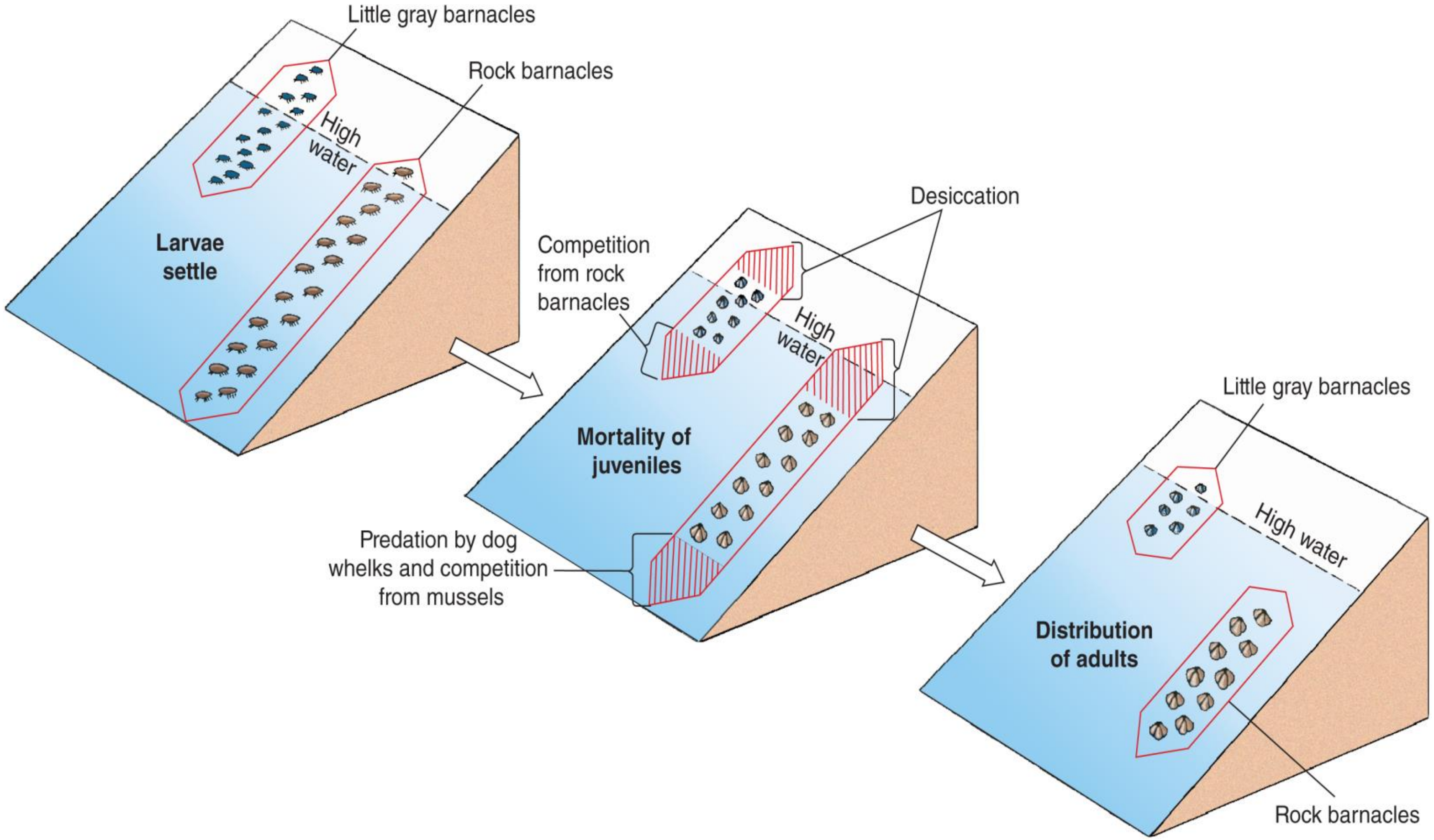
- Only exposed to air during lowest low tides.

Organisms found in low-tide zone

- Brown algae
- Opaleyes
- California sea hare
- Two spotted octopus
- Sea urchins

Zonation in the Intertidal

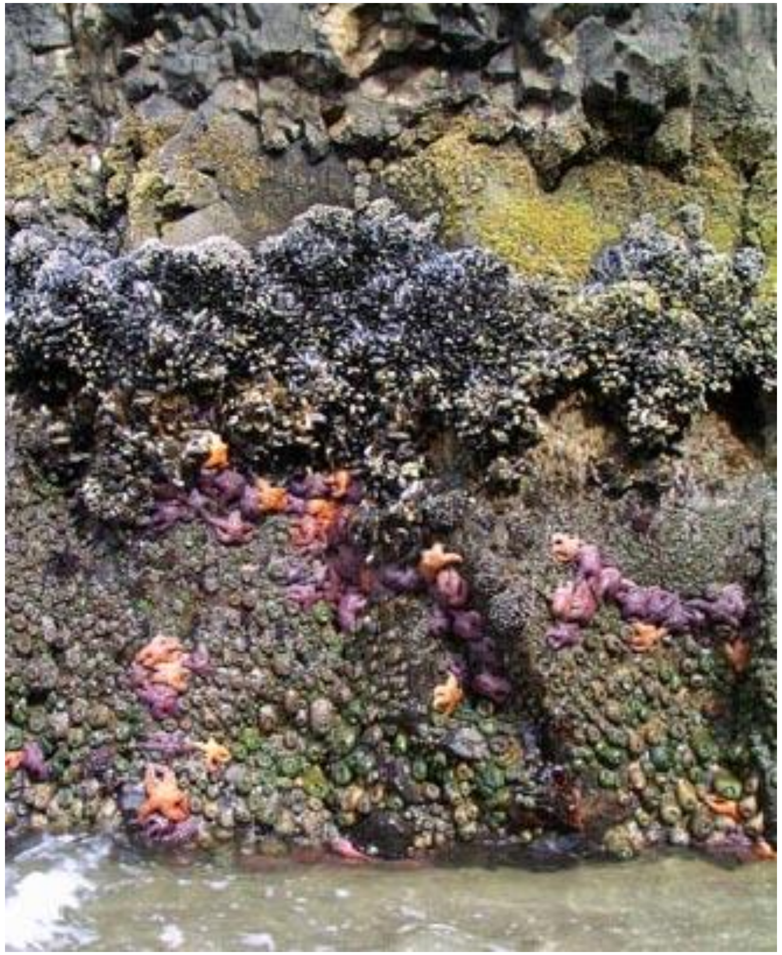
- Biological interactions (competition for space, predation, grazing) are often important factors in determining lower limit of rocky intertidal organisms, while physical factors (desiccation) often determine upper limit.



Zonation in the Intertidal

- Competition is greatest in the lower intertidal because it is exposed to a lesser degree than the upper intertidal.

- The lower intertidal has the greatest number of species because it is the least extreme of the zones



Intertidal Zone Organisms

- **Epifauna:** organisms that live on the surface of the substrate
  - More common in rocky intertidal
    - Ex: mud snails on soft bottoms, barnacles on hard substrates

- **<u>Infauna</u>:** organisms that live in the substrate
  - More common in sandy intertidal
    - Ex: clams burrowing in soft bottoms

Challenges of the Intertidal Zone

- **Desiccation**: drying out during low tide.
- **Wave action and tides**: impacts from waves and other objects. Wear from sandy water
- **Exposure**: exposure to heat and UV from sun.
- **Temperature changes**: drastic shifts in air and water temperature
- **Salinity changes**: evaporation from pools changes salinity
- **Predation**: intertidal predators including octopus, sea stars and fish
- **Limited space**: intertidal organisms compete for space on the substrate
- **Oxygen availability**: lack of oxygen in the water when exposed

Challenges of the Intertidal Zone

Desiccation: drying out during low tide

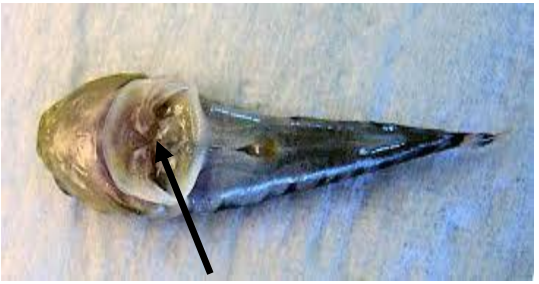
- Bivalves close shells
- Snails secrete slime
  - Operculum seals shell
- Anemones close tentacles
- Limpets and chitons trap moisture under shell
- Motile organisms move to lower tide zones

Challenges of the Intertidal Zone

Wave shock: impacts from waves and other objects. Wear from sandy water.

- Hard external skeleton
  - Shells or exoskeleton

- Attachment to rocks
  - Byssal threads in mussels
  - Tube feet in echinoderms
  - Muscular foot in molluscs
  - Pelvic fins of cling fish



Modified pelvic fins to form sucking disc

Challenges of the Intertidal Zone

Exposure: exposure to heat and UV from sun.

- Barnacles and muscles cluster together to reduce individual exposure
- North side of rocks in northern hemisphere
- Move out of most exposed area

Challenges of the Intertidal Zone

Temperature changes: drastic shifts in air and water temperature

- Ectothermic
  - Can withstand a wide range of temperatures
- Ridges in shell aid in evaporative cooling

Challenges of the Intertidal Zone

Salinity changes: evaporation from pools or rain can change salinity

- Alter solute concentration in cells making them isotonic to sea water
  - **Euryhaline**: broad range of salt tolerances
- Salt excretion

Challenges of the Intertidal Zone

Predation: intertidal predators including octopus, sea stars and fish

- Enclose themselves in hard shell
  - Mussels and barnacles
  - Snails and hermit crabs
- Hide in rock crevices
- Firmly attach to rocks
- Ink (sea hare)

Challenges of the Intertidal Zone

Limited space: intertidal organisms compete for space on the substrate

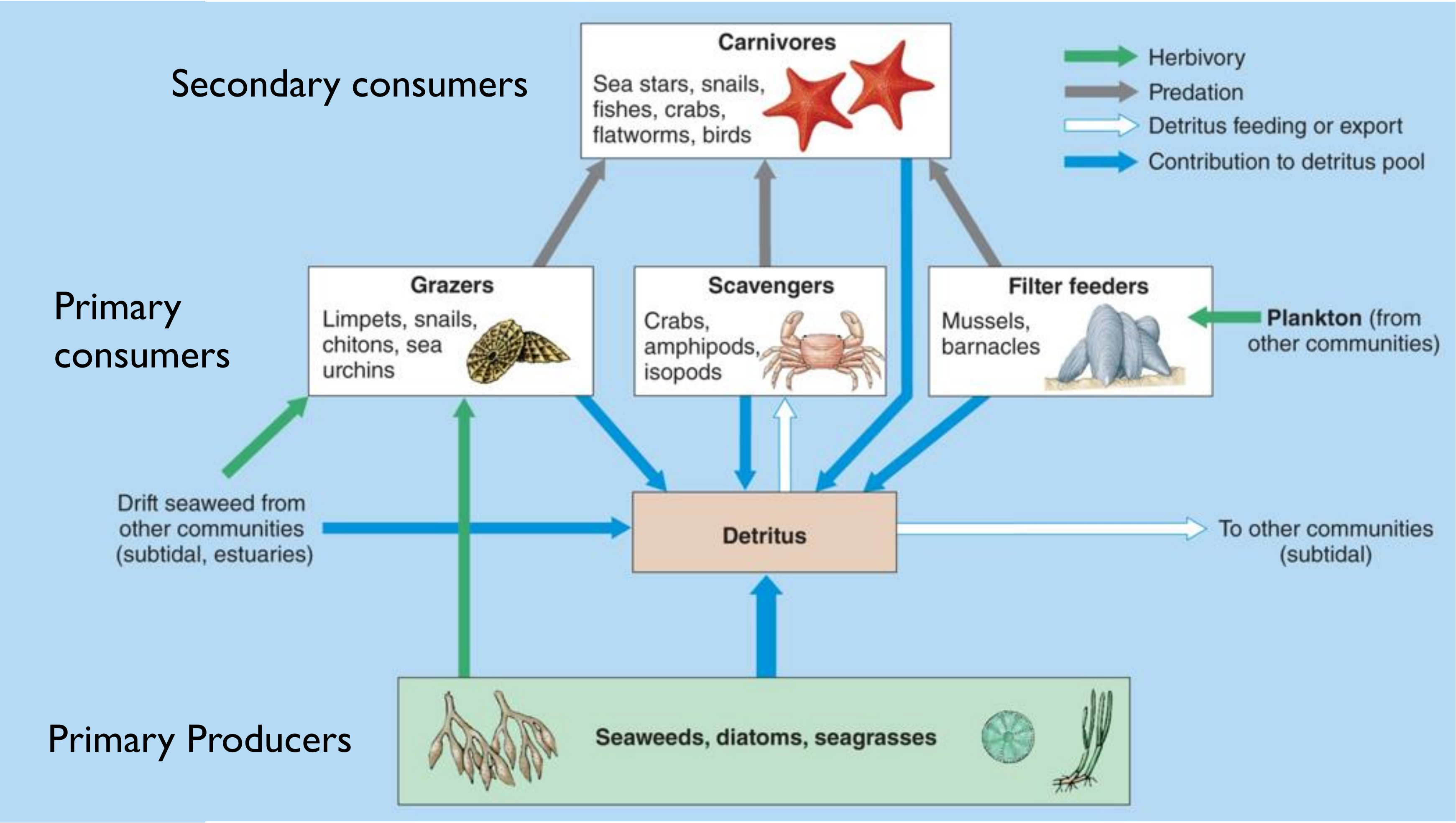
- Efficient dispersal
  - Asexual reproduction (budding) in aggregate anemone
- Strong attachment to the substrate
  - Mussels and barnacles

Challenges of the Intertidal Zone

Oxygen availability: lack of oxygen in the water when exposed or when there is a high density of organisms and a lack of photosynthetic algae

- Breathe atmospheric air in oxygen poor water
  - Tide pool sculpin and juvenile opaleye

Rocky Intertidal Food Web

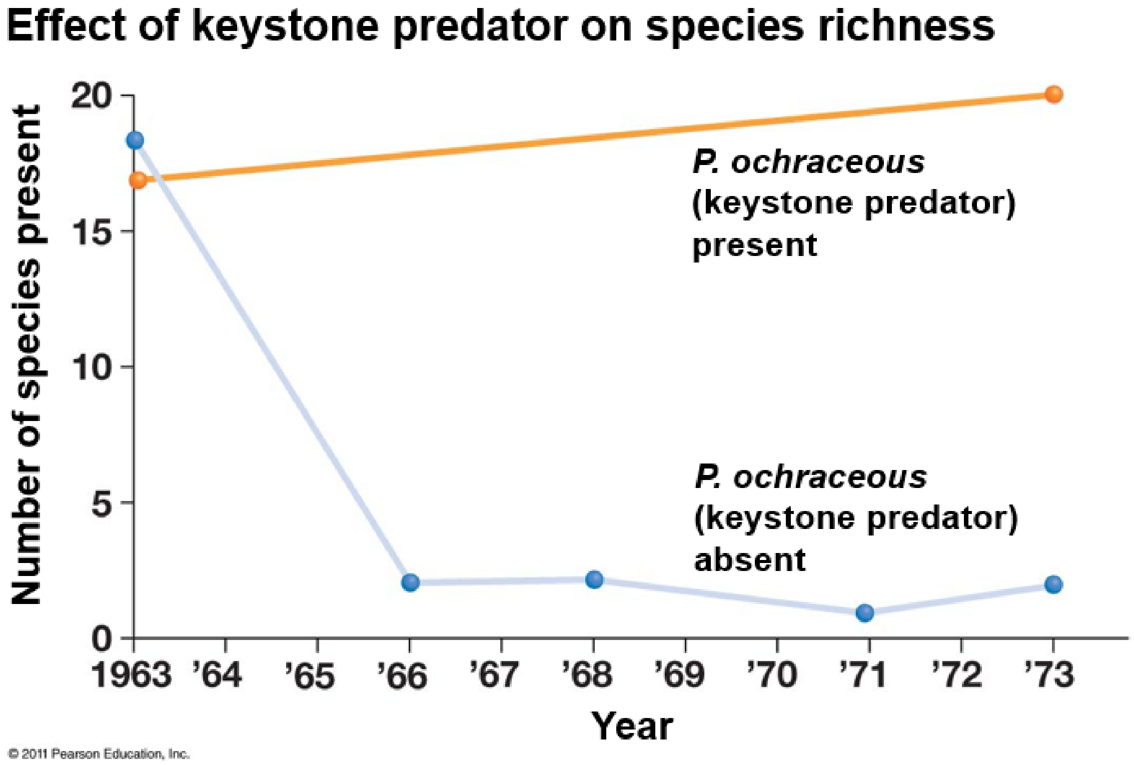


Rocky Intertidal Food Web

- Predators act to control prey populations
  - <u>**Keystone species**</u>: a species whose absence in the community would bring about significant change in that community

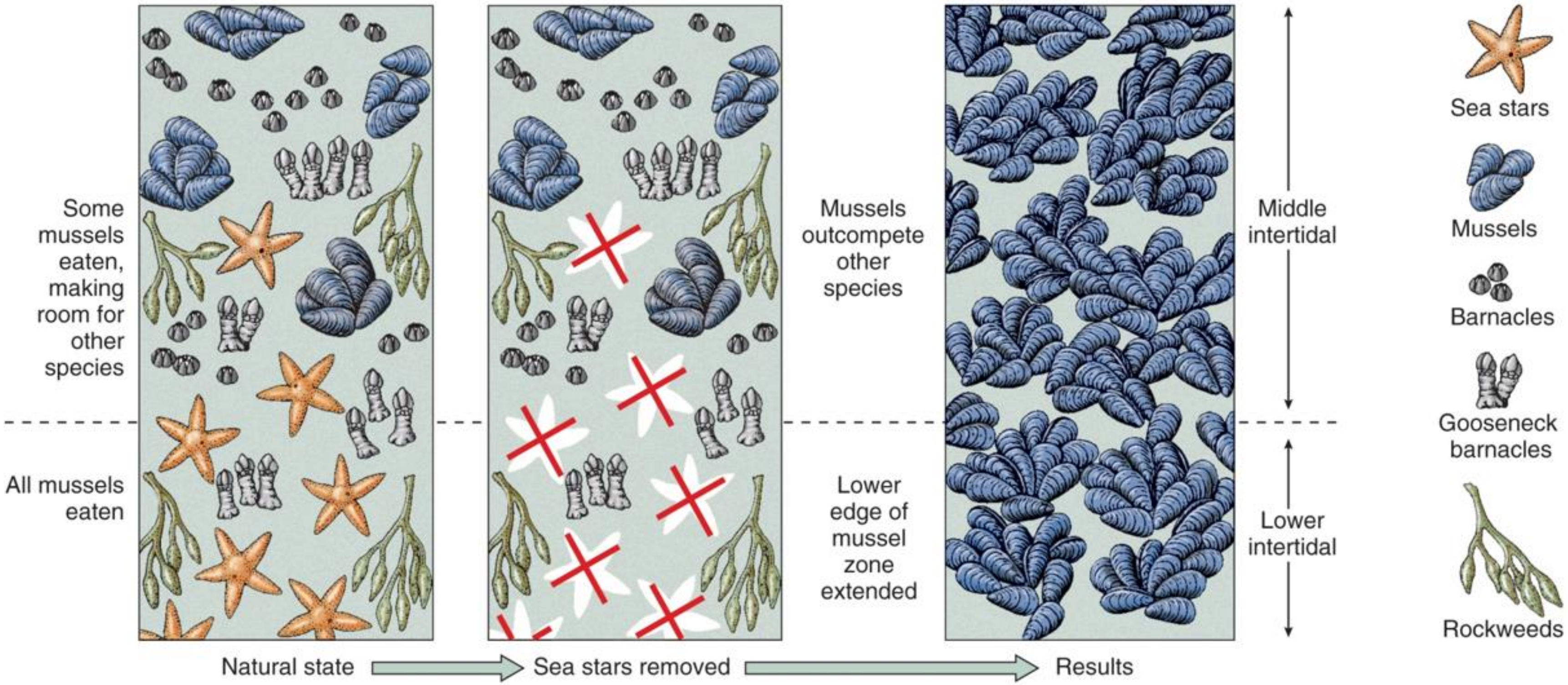
Predator:
Pisaster ochraceous

Prey:
Mytilus californianus



Rocky Intertidal Food Web

- Sea stars are especially important in controlling California mussel populations in the lower intertidal zone. The absence of sea stars can lead to the expansion of the mussel beds into the lower intertidal.



Sea Star Wasting Disease

Sea Star Wasting Disease (SSWD) is a disease that affects various echinoderm species causing them to decay and die

- Some areas in southern California experienced a 99% decline in sea star populations
- Sea water temperature may be correlated with the spread of the disease
- Cause of the disease has yet to identified