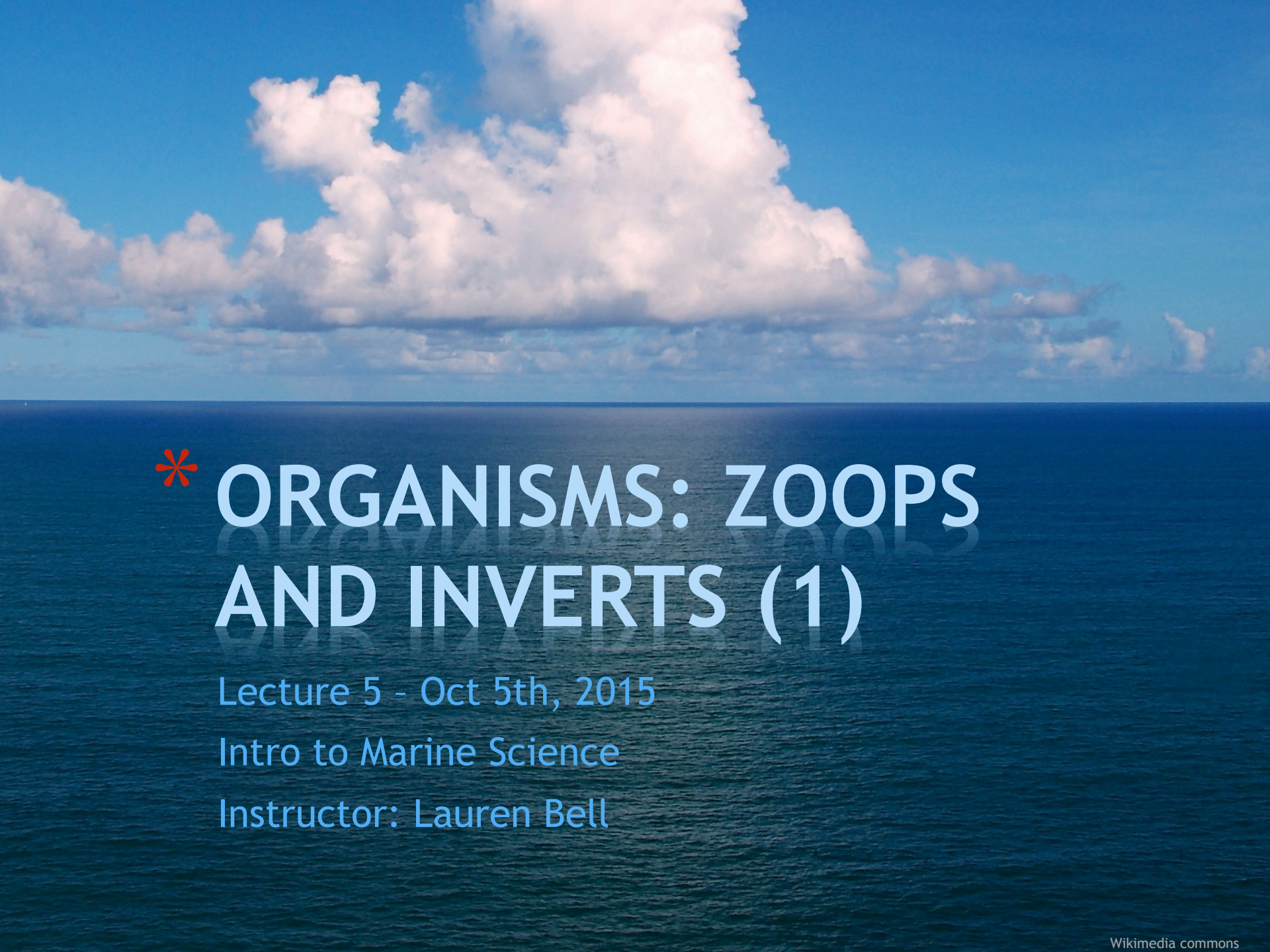


ORGANISMS: ZOOPS AND INVERTS (1)

Lecture 5 – Oct 5th, 2015

Intro to Marine Science

Instructor: Lauren Bell

Wikimedia commons

*Your ‘issues’ for next few wks

Daniel: Arctic Amplification (as if the world got 'stuck' in the negative AO phase)
Autumn Records: Pollution (noise, debris, etc)
Autumn Redmond: Warming water temperatures
Sawyer: Ocean acidification
Bryan: Increased terrestrial run-off/inputs to the sea

This week:
Sawyer, both Autumns: Macroalgae
Daniel, Bryan: Phytoplankton

*Your ‘issues’

“Arctic amplification causes the arctic regions to heat up by a greater percentage than the rest of the world. The reduction of ice definitely **means more phytoplankton production**. Some "climate scientists" claim that there are 50 fewer ice covered days in the artic for this very reasons. That is significant given that….**ice reflects the suns energy**. Increased temperatures and biomass will negatively affect the creatures that have adapted to the oxygen rich environments of the north, as well as lead to blooms taking off and 'crashing' as we say in the catfish farming world. Decomposition of all that biomass sucks the oxygen up fast and there is nothing left to do but turn on the aerators or the fish die. Only problem is there is no aerator to turn on in this situation.”

- Daniel Gilbert

*Your ‘issues’

“…In another study on untreated wastes effect on macroalgae in Northern Spain, researchers found that the pollution caused a **degradation of flora** which in turn resulted in **decreased species diversity and an excess of a few species** that had a high tolerance for the pollution and very high reproductive capabilities. These few species seemed to remain resilient in years after the pollution was significantly lower and further **prevented the full recovery of the area** due to their overpopulation. This shows just some of the immediate and long terms effects pollution on an environment when it causes algal blooms or a major degradation of the flora. ”

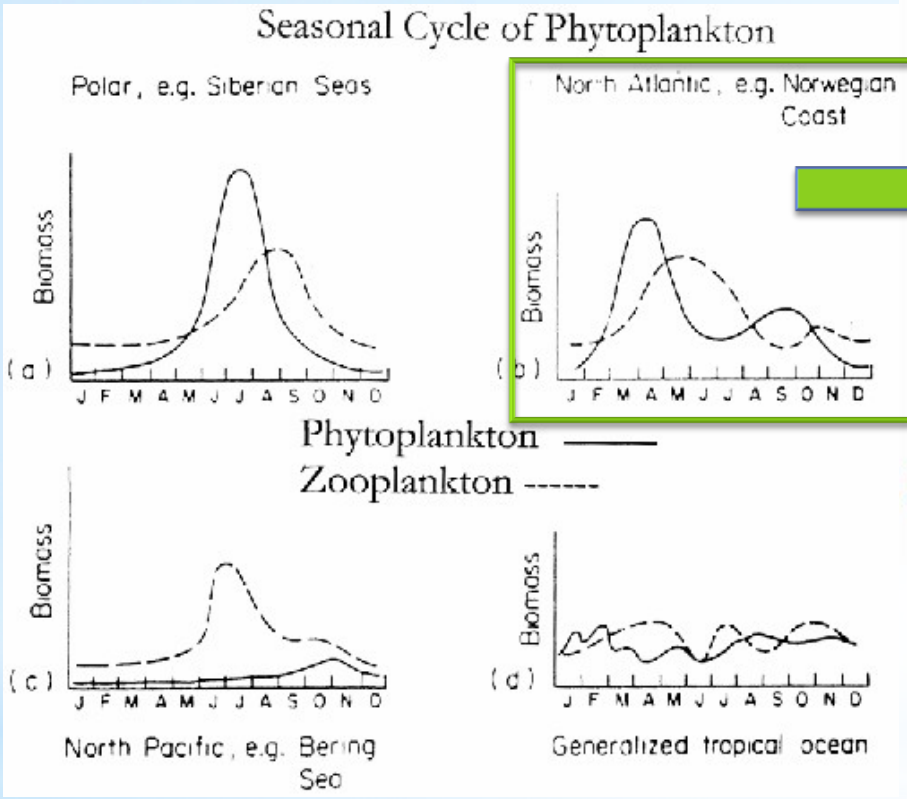
- Autumn Records

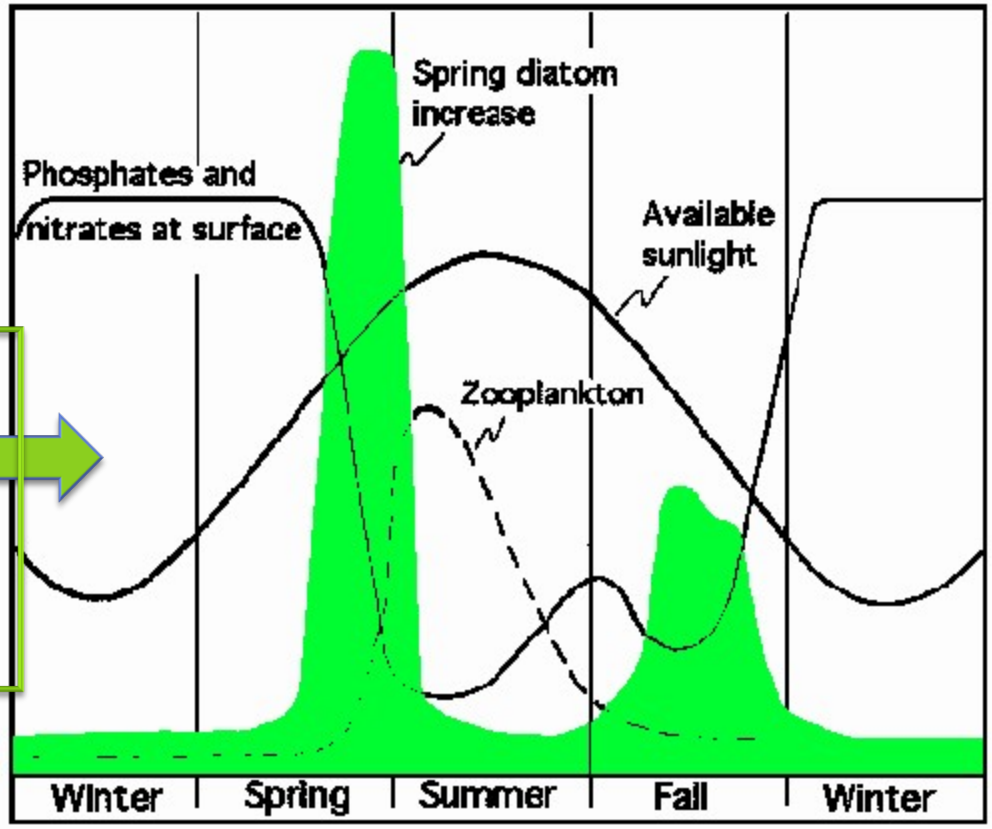
*Learning objectives

After this lesson, you will be able to:

- Describe the two primary types of zooplankton in the world's oceans, their feeding style, locomotion, and general morphologies
- List the defining characteristics separating the major invertebrate taxa
- Explain the general ecological function of each taxon
- Draw a marine taxonomic tree and describe the morphological divisions separating major taxonomic 'branches' (e.g., prokaryotes vs. eukaryotes, protostomes vs. deuterostomes, symmetry, etc.)

*Zooplankton





zoo = "animal" plankton = "drifter"

main consumers of phytoplankton

- phyto and zoop plankton blooms respond to each other
- also depends on availability/build up of nutrients and light
- timing – can bloom happen early enough in spring that still time for late summer bloom? (North Atlantic vs. Polar)
- what if zoops already present when phytos arrive? (North Pacific)

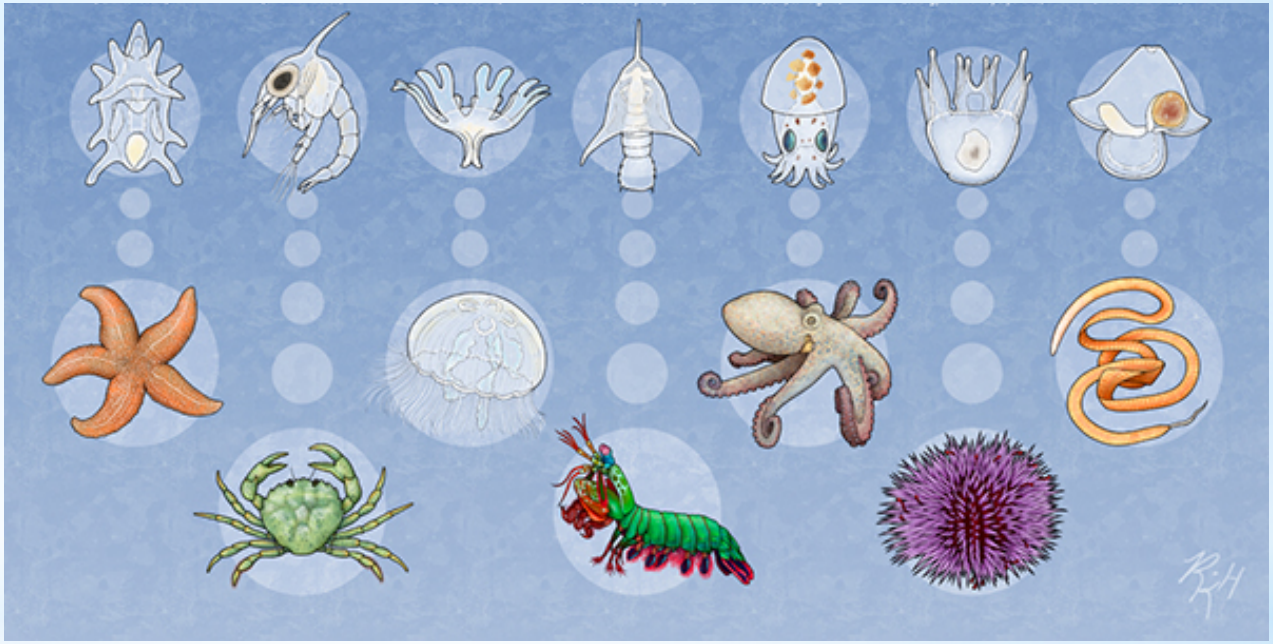
*"The drifters"

zooplankton represent **many different taxa**

include herbivores, carnivores, omnivores

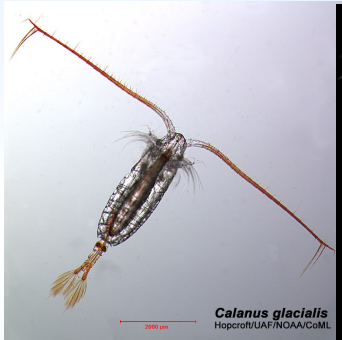
Meroplankton

Taxa that are planktonic only during their larval/dispersal life stage



Holoplankton

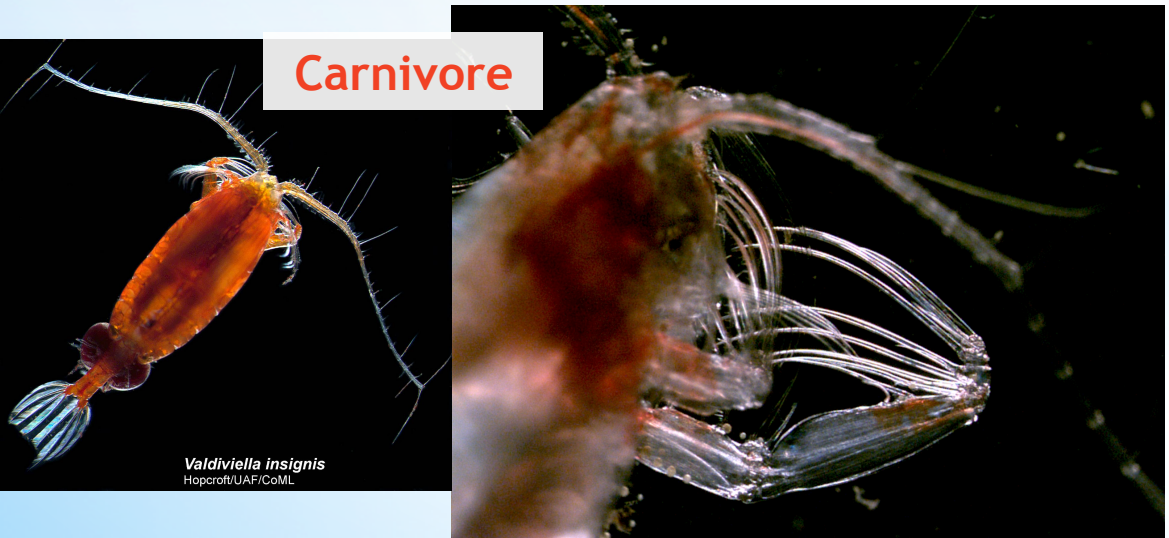
Taxa that spend their entire lives as plankton (e.g., copepods, euphausiids)



*Copepods = “oar feet”

- Most abundant multi-cellular taxa on earth – outnumber the insects in sheer # of individuals!
- Found EVERYWHERE in oceans (all depths + benthos)
- Crustaceans (related to crabs)
- Adult size range from 0.2 to 6 mm
- Antennae have chemo- and mechano-receptors

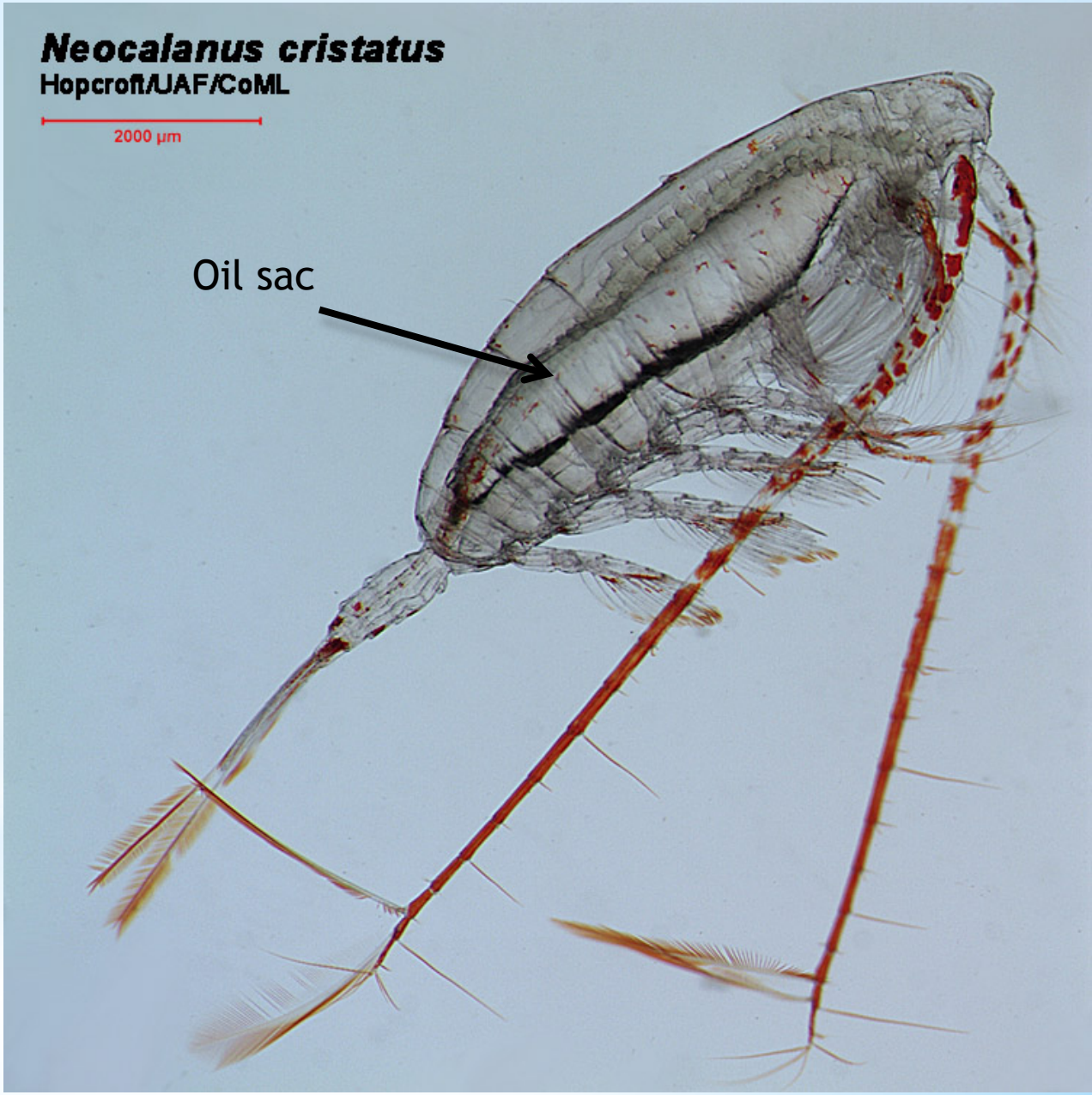
Carnivore



Herbivores

*Oil sacs

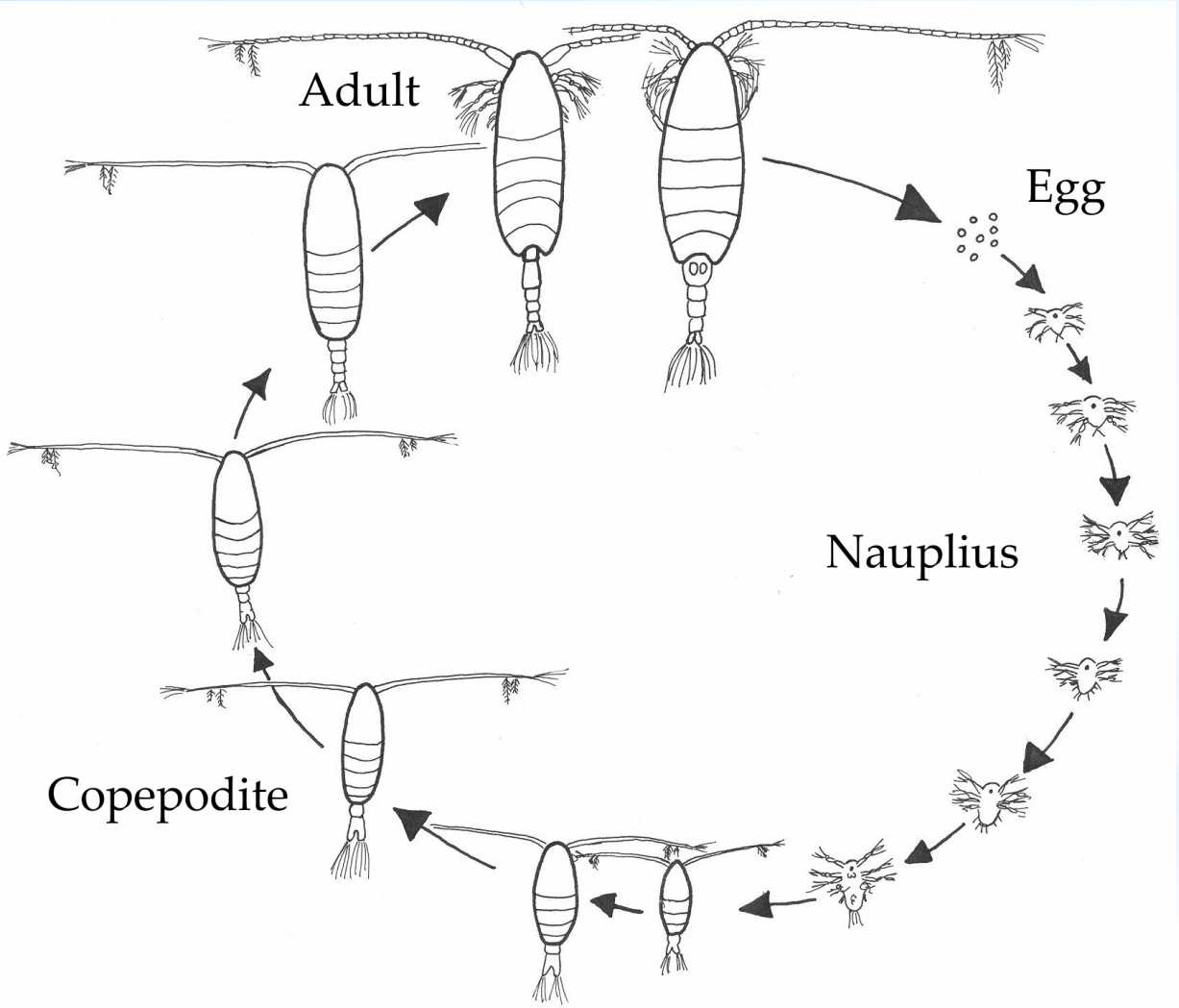
Can store lipids in oil sac, which can vary in size and be up to 20% body mass



Importance:

- Energy reserve
  Extra food when times are scarce (like over-winter in the Arctic)
- Buoyancy
  Allow copepods to control location in water column

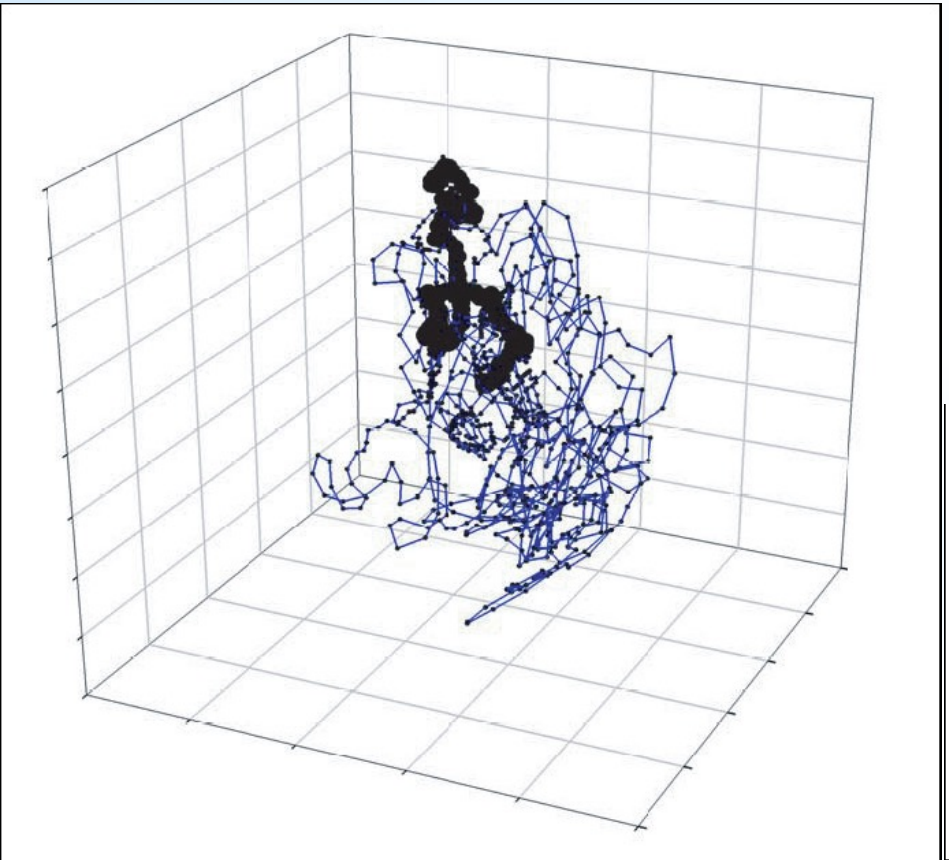
*Life cycle

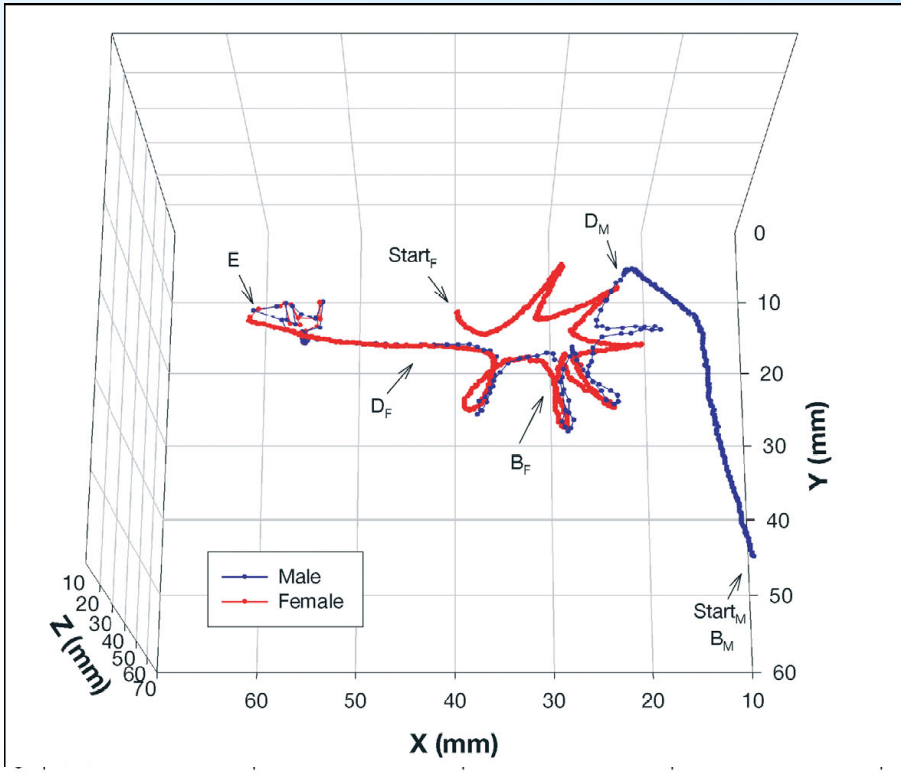


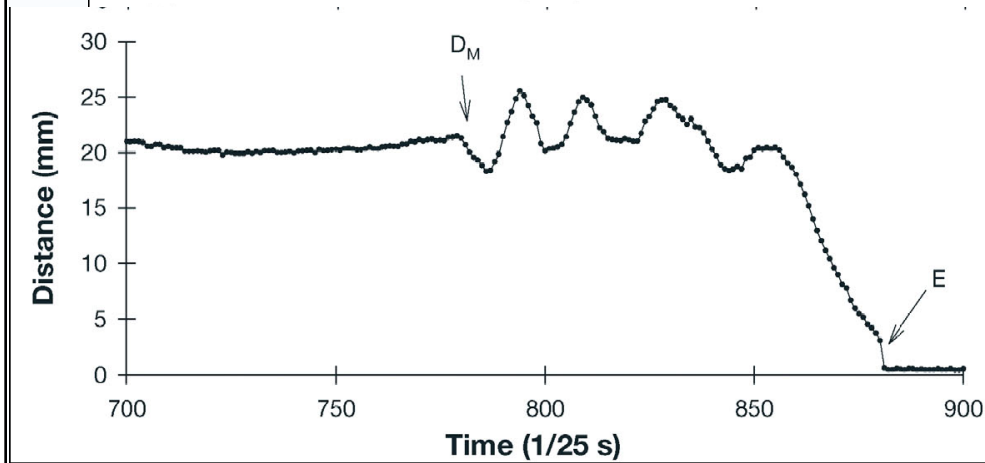
- **Females either carry or scatter eggs**
  - ✧ scattered eggs can ‘rest’ at benthos for extended periods
- **Adult life span can last from one week to two years**
- **Molt to increase size (like crabs), until reach ‘adulthood’**

*Finding that special someone

- Chemoreception trails and clouds (smell)
- Mechanoreception (hearing/vibration)







*Euphausiids, a.k.a. Krill

- Only 86 species, avg. 5-15 cm long, can live up to 25 years! (avg. 5 yrs)
- In polar/sub-polar waters, euphausiids can rival copepods in biomass
- Few euphausiids in tropical waters

(Why?)

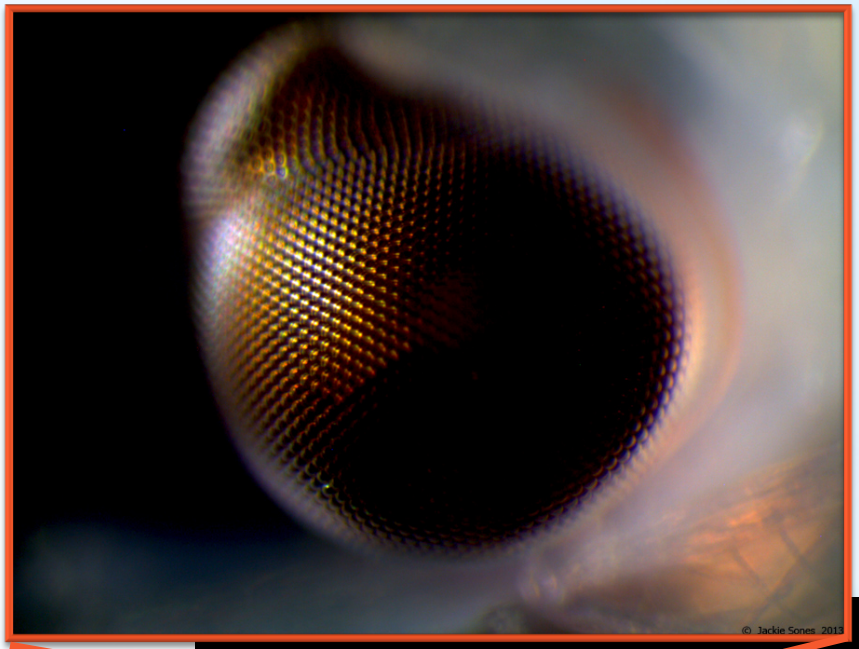
Øystein Paulsen

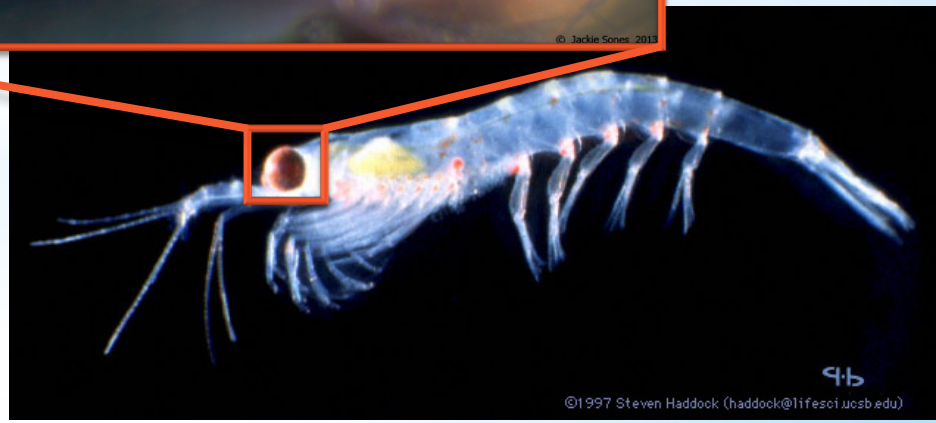
*The better to see you with…

All species synthesize and store Vitamin A

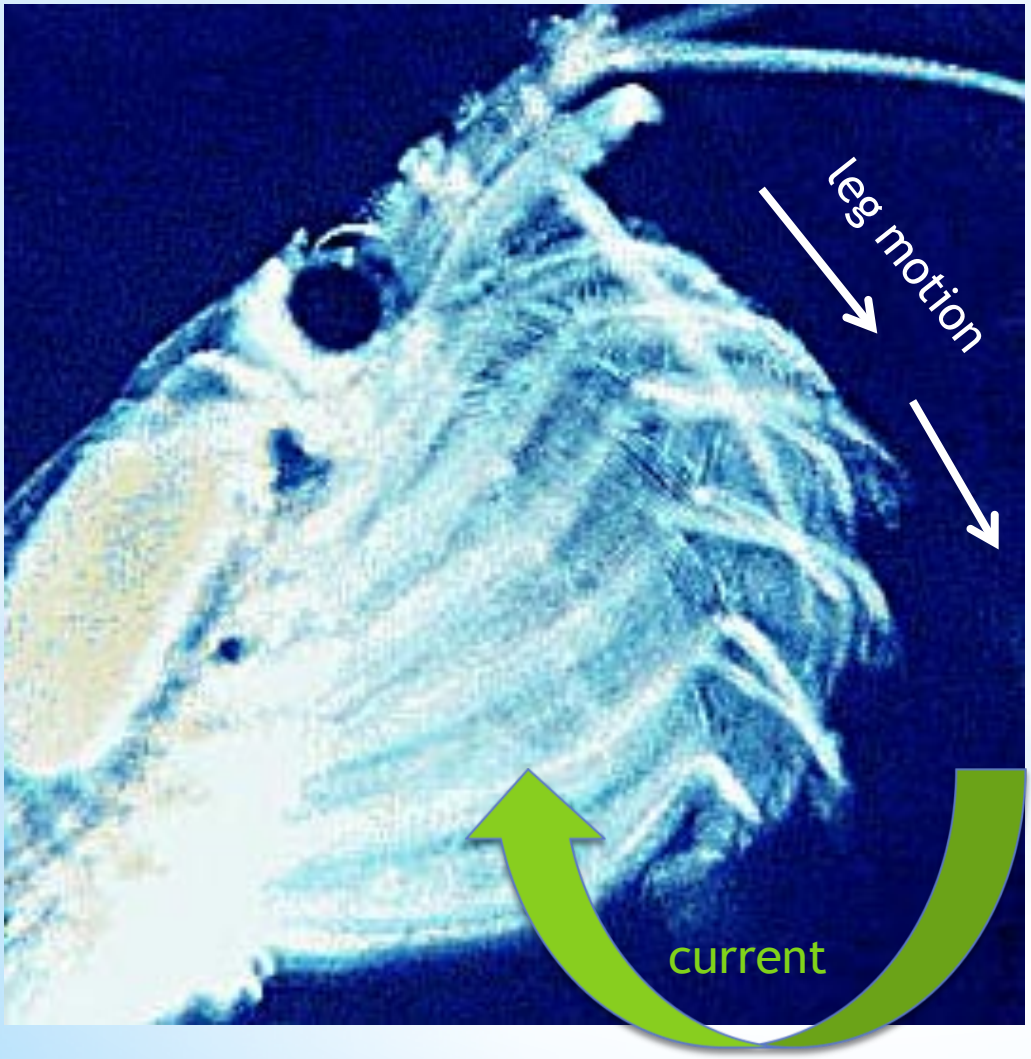
Contribute greatly to Vitamin A cycle in oceans

Vitamin A very important to eyesight in low-light conditions (think carrots!); euphausiids have compound eyes



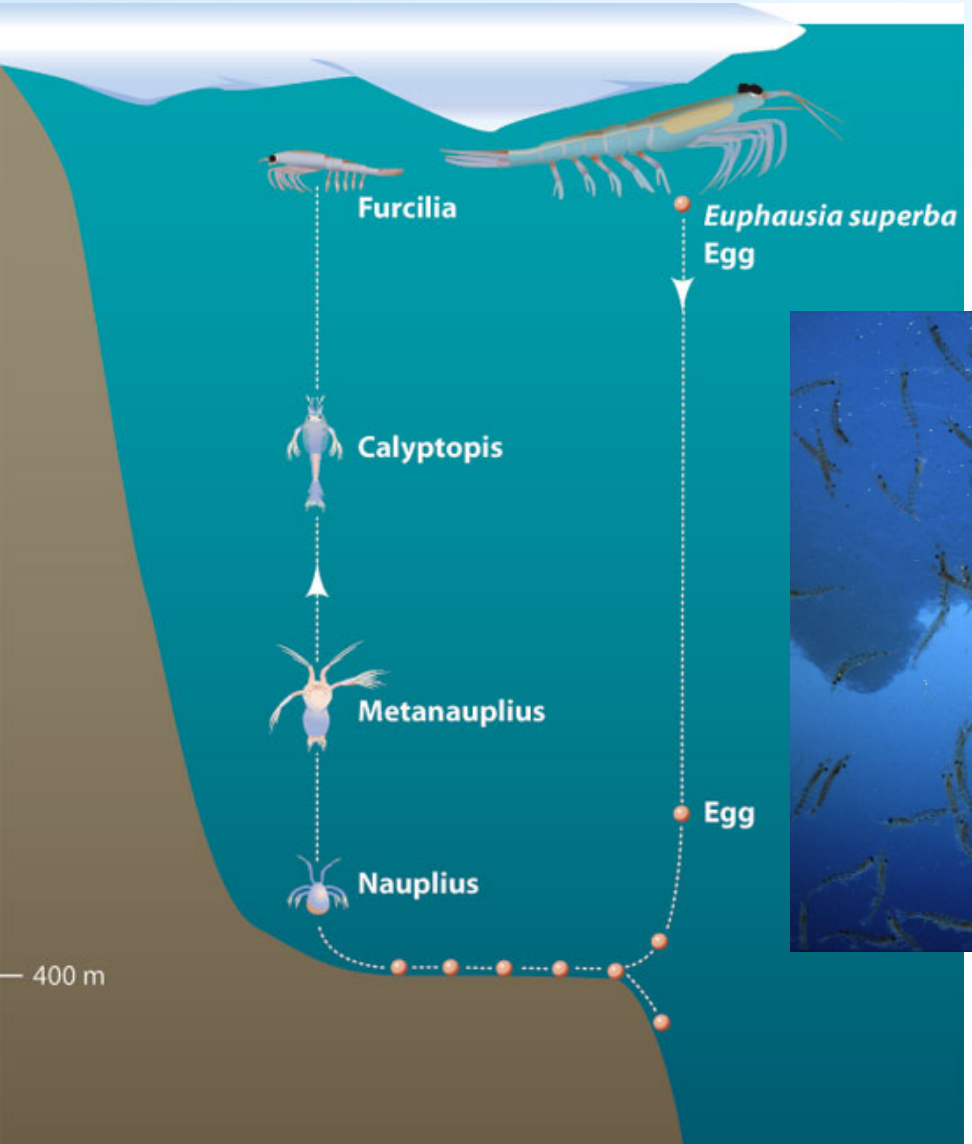


*Feeding



- Filter-feeding basket created by front legs
- Movement of legs forces water through, capture algae, other plankton, and detritus
- Accessory legs draw food toward mouth

*Life cycle - Antarctic krill



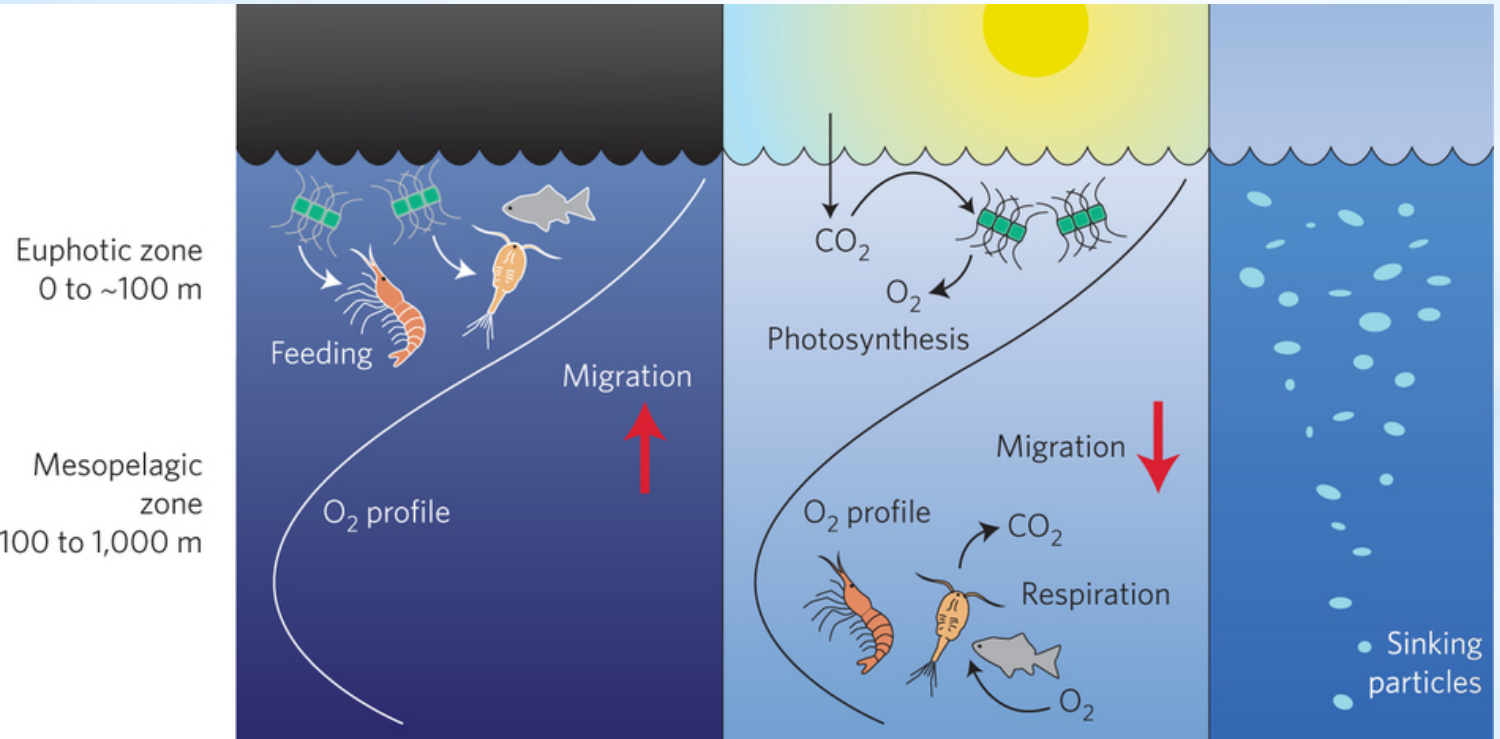
- Animals **diapause**/rest over winter at depth
  - In spring accumulate near ice edge, often forming huge swarms, but still generally undergo diel migration
  - Initially feed on phytoplankton, but switch to copepods as algae biomass falls

*Diel vertical migration

unlike most phytoplankton, zoops are relatively mobile

- at night, zoops near surface to feed
- during day, zoops move down (some can migrate 100's of meters!)

WHY? predator avoidance (easier to see in daylit surface waters)
UV damage avoidance (sun's rays too intense for some plankton)
metabolic advantages (active in warm waters, rest in colder)
dispersal/transport (surface currents stronger, "**active transport**")



Zoops bring fecal pellets down with them – speeds up microbial processing

In terms of total biomass, largest migration in the world!

*Ecological role of zoops

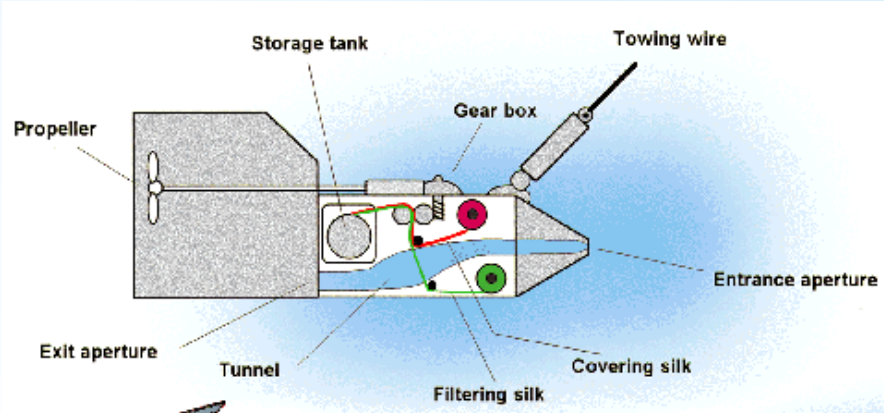
- Form largest animal biomass on earth
- Important to carbon cycle in upper layers of ocean
  - ✧ incorporate organic carbon from phytos, who grew from photosynthesizing
  - ✧ are either eaten by larger animals and pass energy up food chain, or export carbon to depth where processed by microbial loop
- Major prey items of fish, whales, seabirds
- Some (krill) are economically important as protein supplement or omega-3 fat source

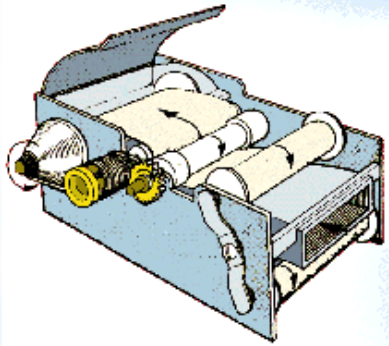
*Zoop collection methods

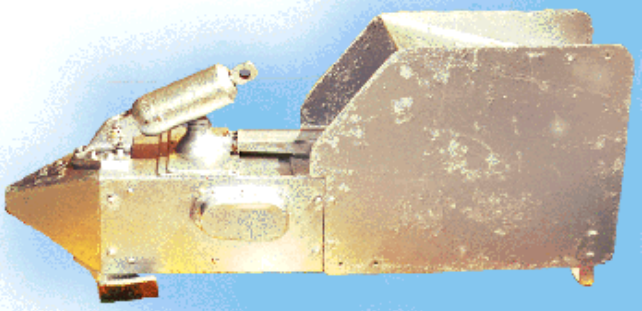
- No one instrument works for all zooplankton
- Nets invariably damage animals during collection

Nets (larger zoops)

Niskin bottles (small zoops)







Continuous plankton recorder

Invented in 1930's, dragged behind merchant ships

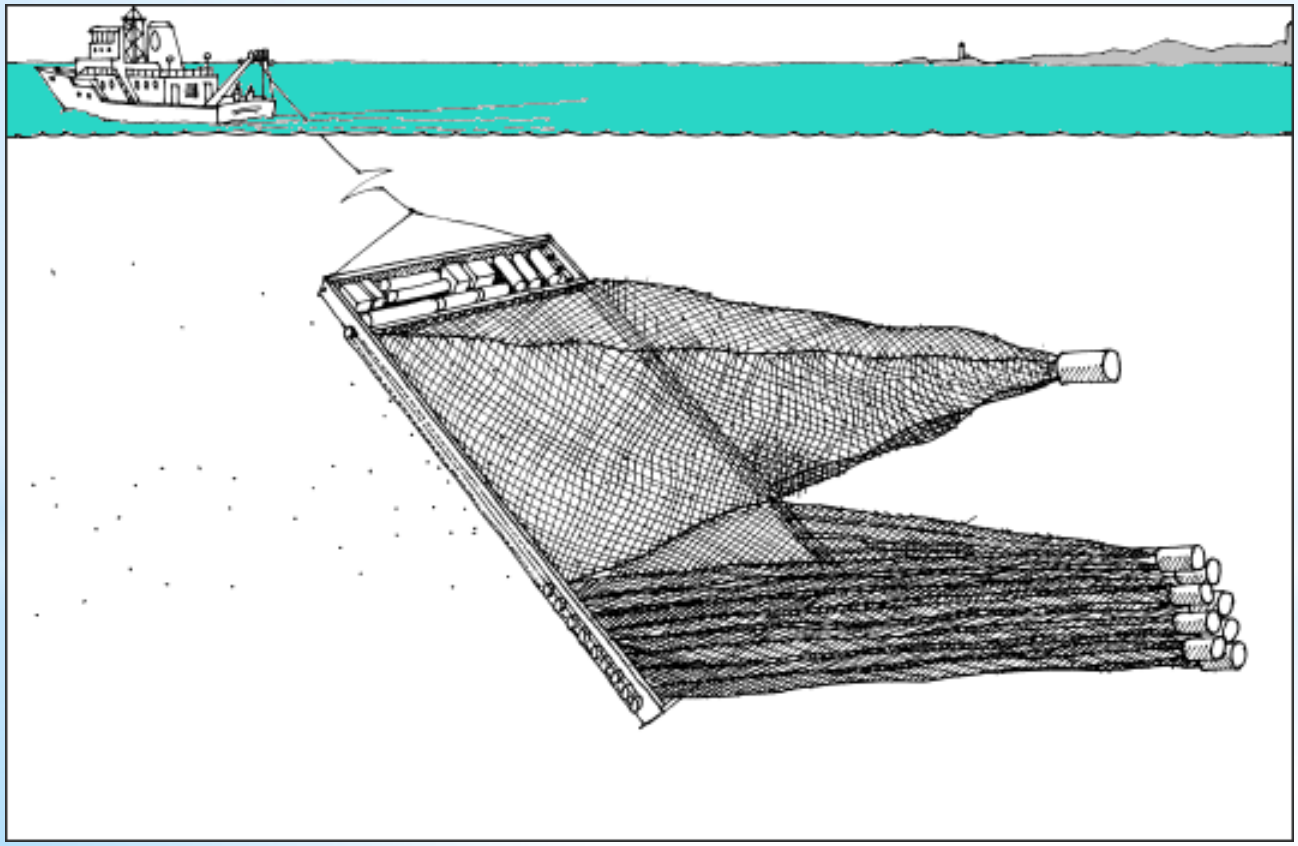
Rolls plankton onto mesh, then preserved

Broad scale, many taxa covered

*Zoop collection methods

MOCNESS

Multiple Opening & Closing Net Environmental Sensing System

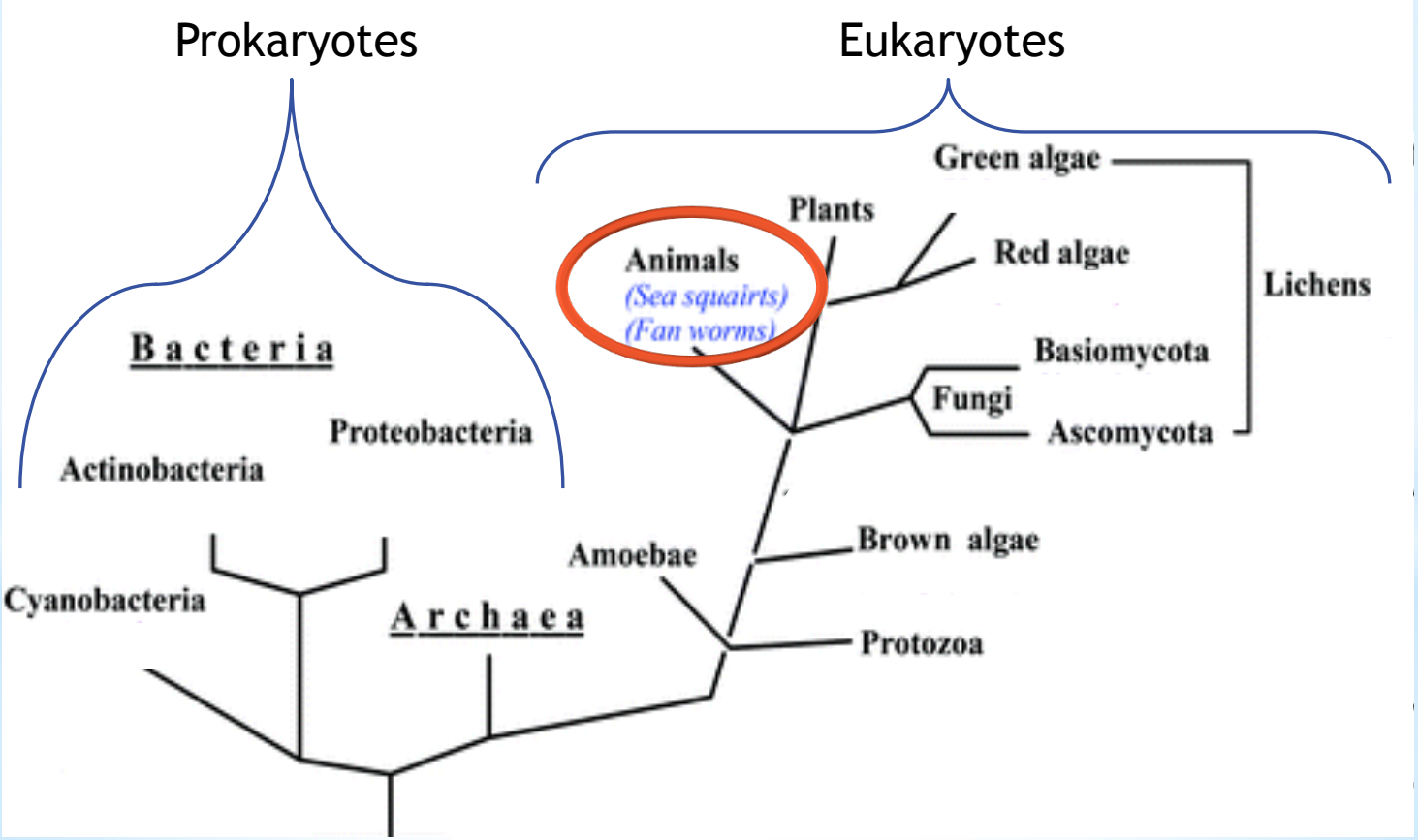


- Towed package
- Up to 10 nets
- Real-time data about temperature, salinity, depth
- Integrated flow meter determines volume filtered by each net
- Nets triggered electronically by operator
- Can capture zoops from specific “zones”

*TAXONOMIC TREE

let's put some order in our lives

Moving into the ANIMALS



*Invert taxonomic tree

Cnidaria
(true jellyfish
& anemones)

Nemertea
(ribbon worms)

Mollusca
(snails, clams,
cephalopods)

Annelids
(worms w/
lots of legs)

Lophophorates
(bryozoans)

Chordates
(have backbone)

segmentation

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chordate
attributes in
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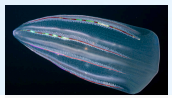

Ctenophora
(comb jellies)

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Echinoderms
(stars, cucumbers,
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segmentation

protostomes

deuterostomes

Porifera
(sponges)

pseudocoelomates

coelomates

acoelomate

radial symmetry

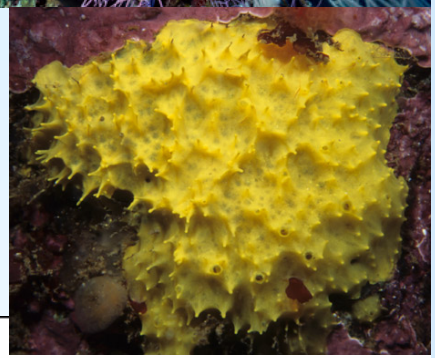
bilateral symmetry

no true tissues

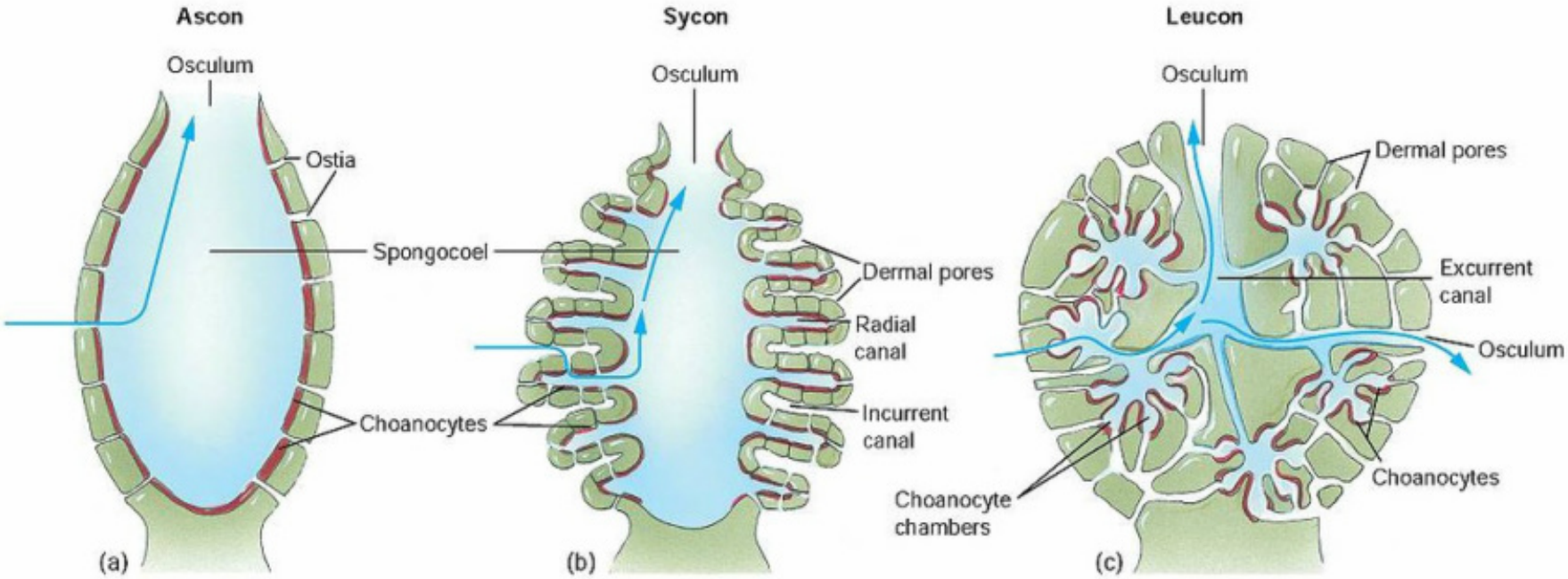
true tissues

multicellularity

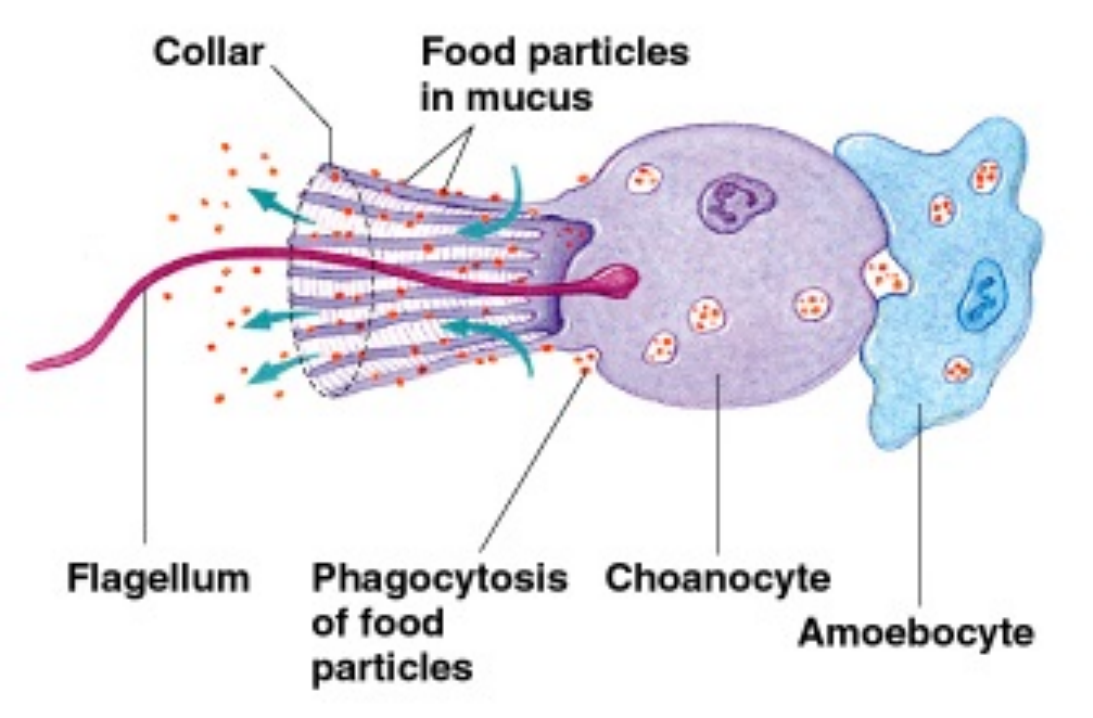
*Porifera (sponges)



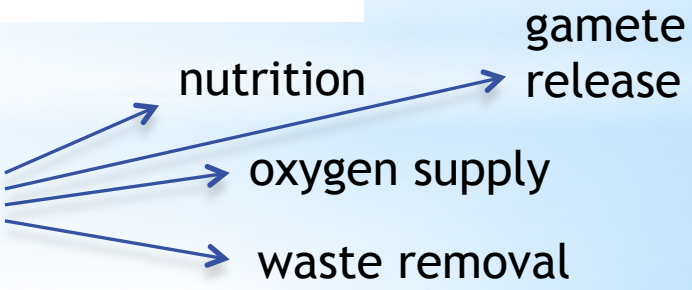
- Radial symmetry
- No true tissues - can “regenerate”
- Made up of one or multiple chambers through which water circulates to enable filter feeding
- Can be encrusting or upright, long-lived



*Master filter feeders



- **<u>Choanocytes</u>: water pumps**
  - ✧ flagella beat to produce current



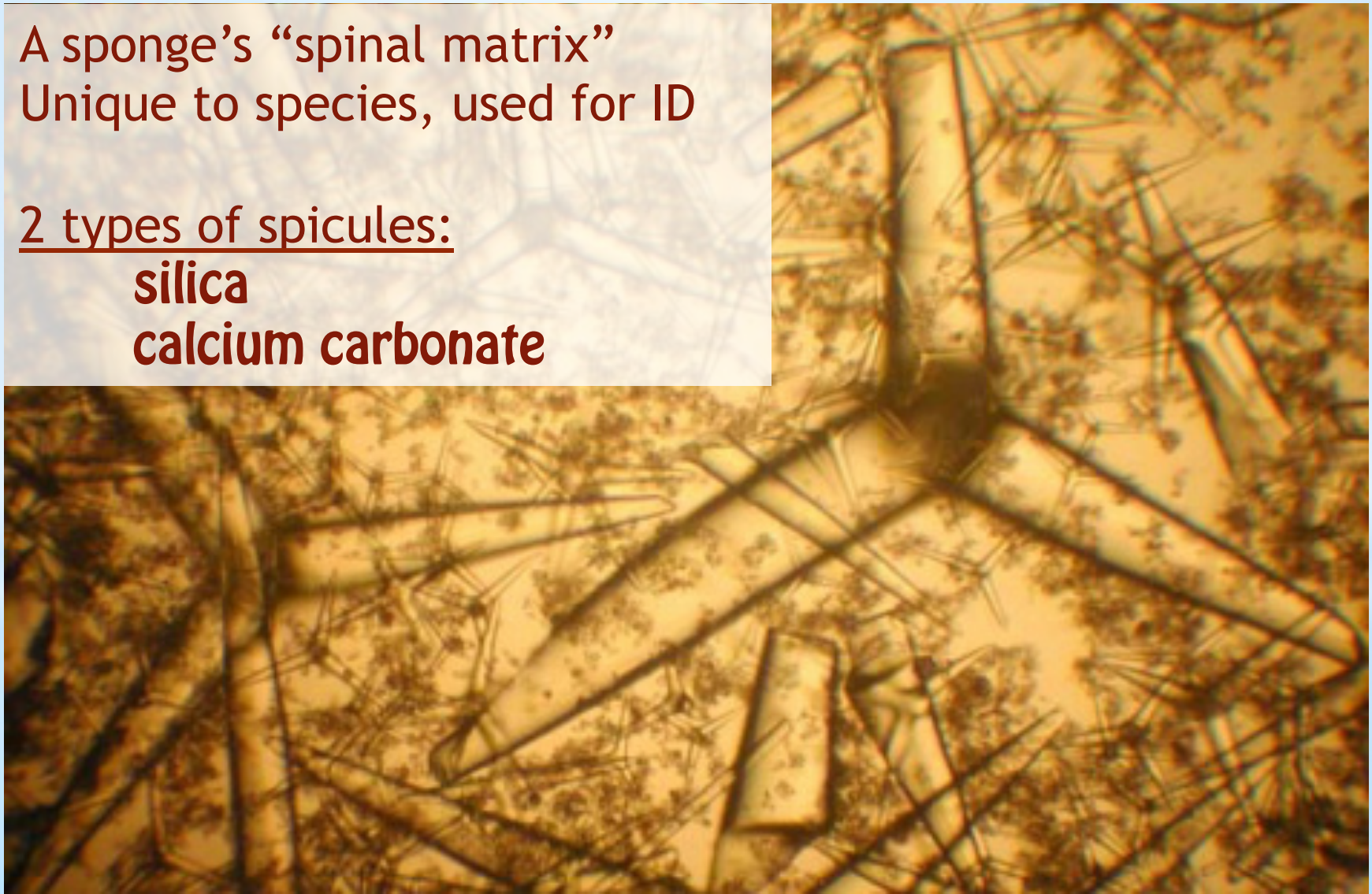
Also get additional nutrition through symbiotic organisms (algae and bacteria)

*Spicules

A sponge's "spinal matrix"
Unique to species, used for ID

2 types of spicules:

- **silica**
- **calcium carbonate**



*Ecological role

- Filter feeders = important in cycle of particulate organic matter
- Create structure in marine habitats
- Symbiotic relationships can make up 40% of nutrition
- Serve as food for nudibranchs, fishes, sea stars, and turtles
- Often used as refuge by shrimp, amphipods, fish

*Invert taxonomic tree

Cnidaria
(true jellyfish
& anemones)

Nemertea
(ribbon worms)

Mollusca
(snails, clams,
cephalopods)

Annelids
(worms w/
lots of legs)

Lophophorates
(bryozoans)

Chordates
(have backbone)

segmentation

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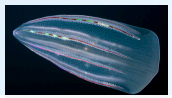

Ctenophora
(comb jellies)

Nematoda
(round worms)

Arthropods
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Echinoderms
(stars, cucumbers,
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segmentation

protostomes

deuterostomes

Porifera
(sponges)

pseudocoelomates

coelomates

acoelomate

radial symmetry

bilateral symmetry

no true tissues

true tissues

multicellularity

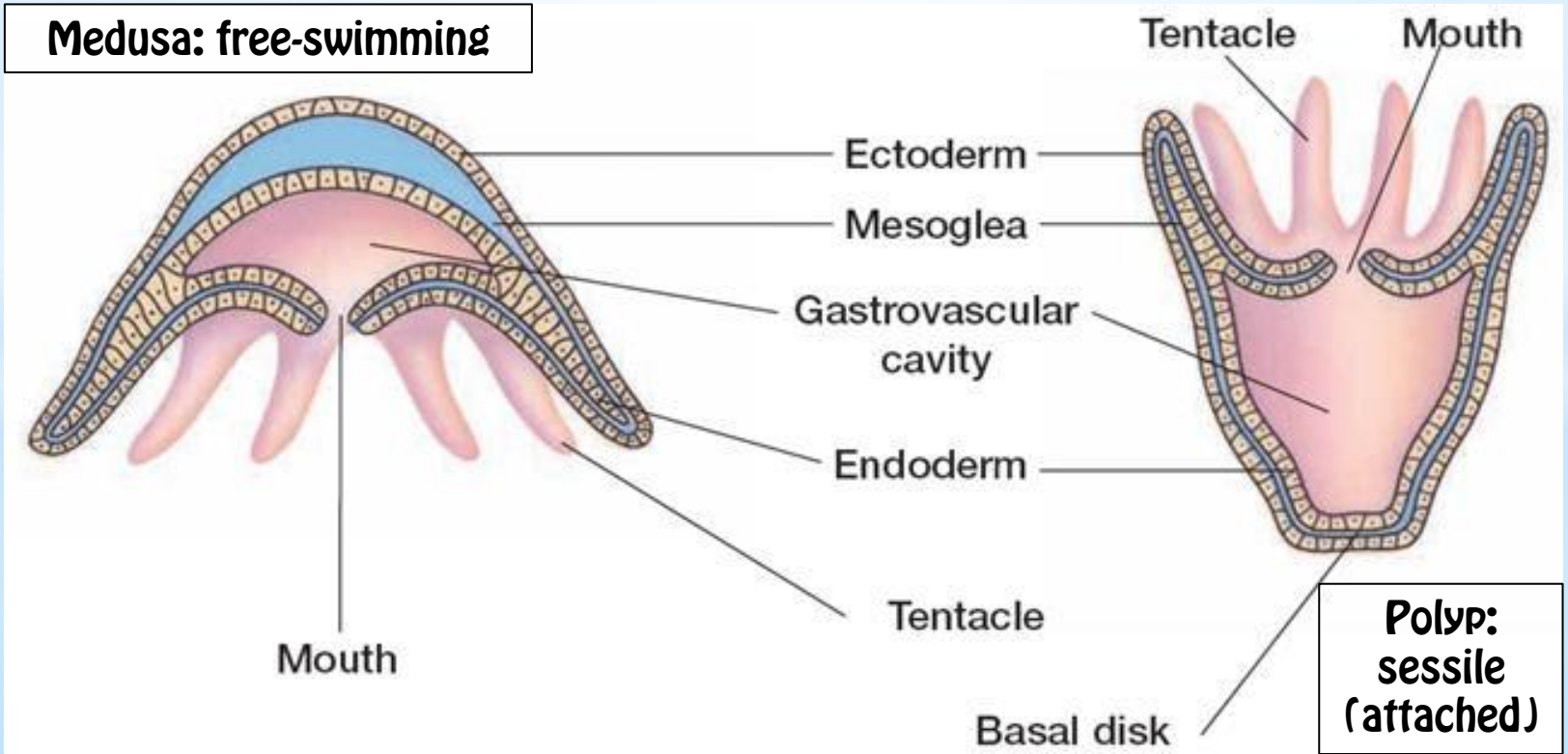
*Cnidaria - the "true" jellyfish, hydroids, anemones, corals

TWO basic body plans: Medusa & Polyp

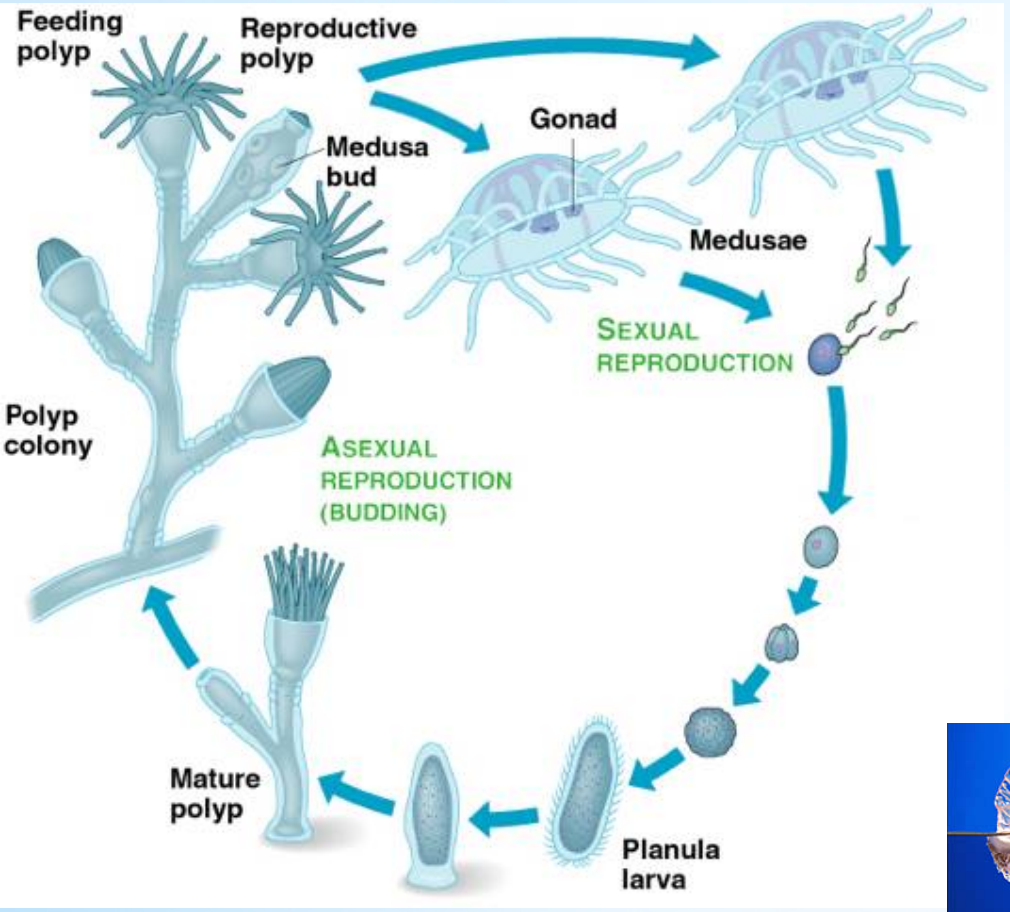
- alternate during life history, but reduced in some groups
- radial symmetry; mouth present but no anus
- two tissue layers but no organs

Mesoglea: water (90%) w/ collagen

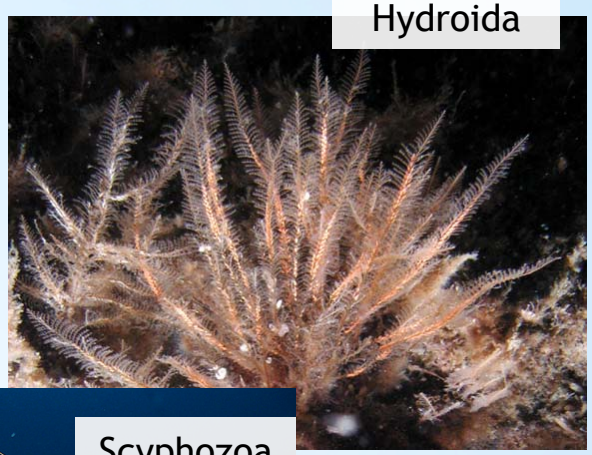
- ✧ aids in buoyancy & locomotion ("structure" in place of skeleton



*Wide variety of species

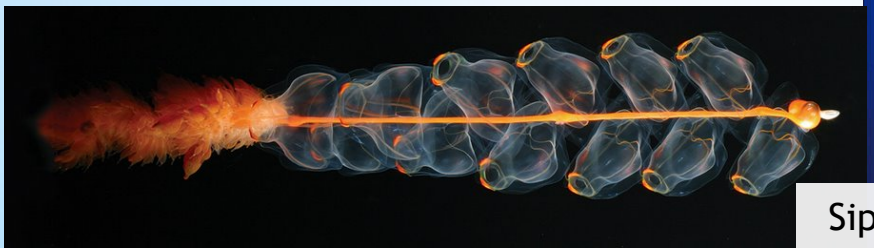


Hydroida



Scyphozoa

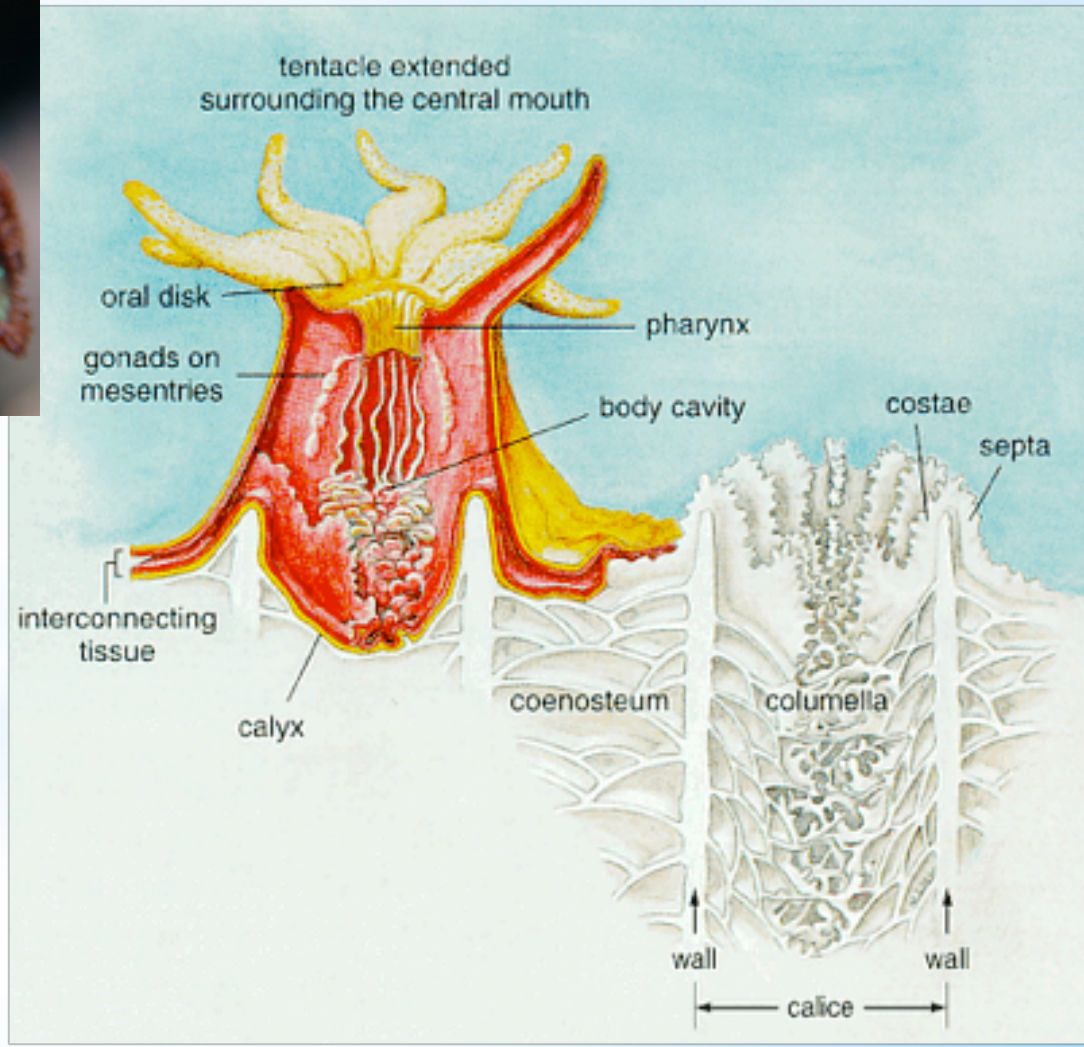
Siphonophora



Actinaria

*Corals and zooanthids

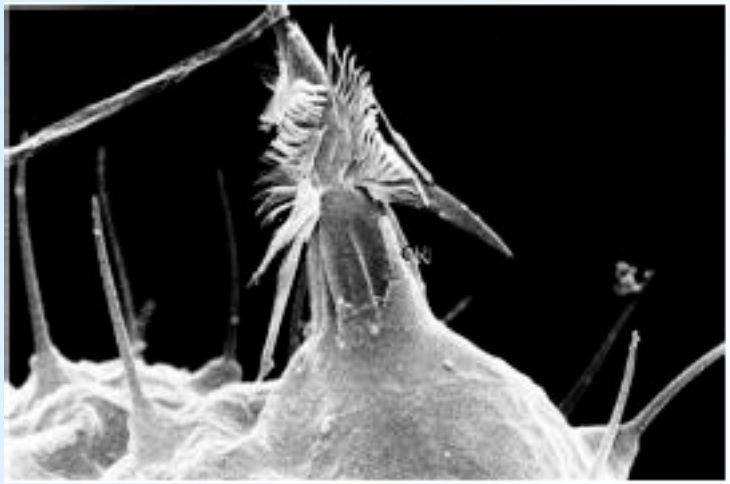
Colonial, sessile cnidarians

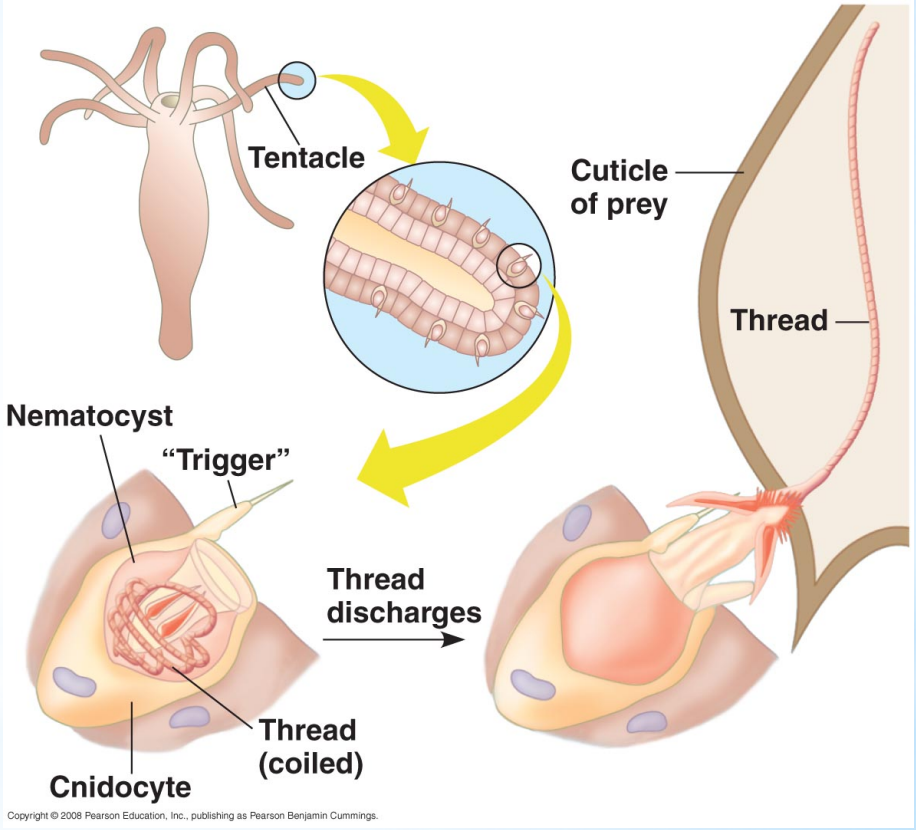


- Can share nutrition across interconnecting tissue/canals
- In some, “nerve-net” extends throughout colony, can share sensory information
- Can secrete external $CaCO_3$ skeleton = ‘reef building’

*Nematocysts

Every cnidarian has these!





- Specialized stinging cells for defense and prey capture
- Usually concentrated in tentacles
- Nematocyst cell under elevated pressure, when triggered barbs stick into prey, thread shoots out and uncoils *inside* prey
- End of thread has toxins or glue

Can reproduce new nematocysts but can't "recharge" old ones

*Ecological role

- Evolved to have many different life strategies – found everywhere in marine world
- High rate of symbiotic relationships with other organisms
- Occur from intertidal to deep-sea
- Important predators on other inverts in water-column and benthos
- Food for fish, turtles, nudibranchs, crustaceans

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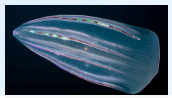

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no true tissues

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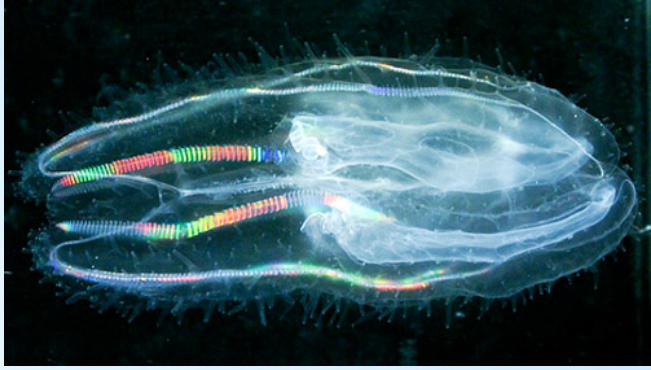
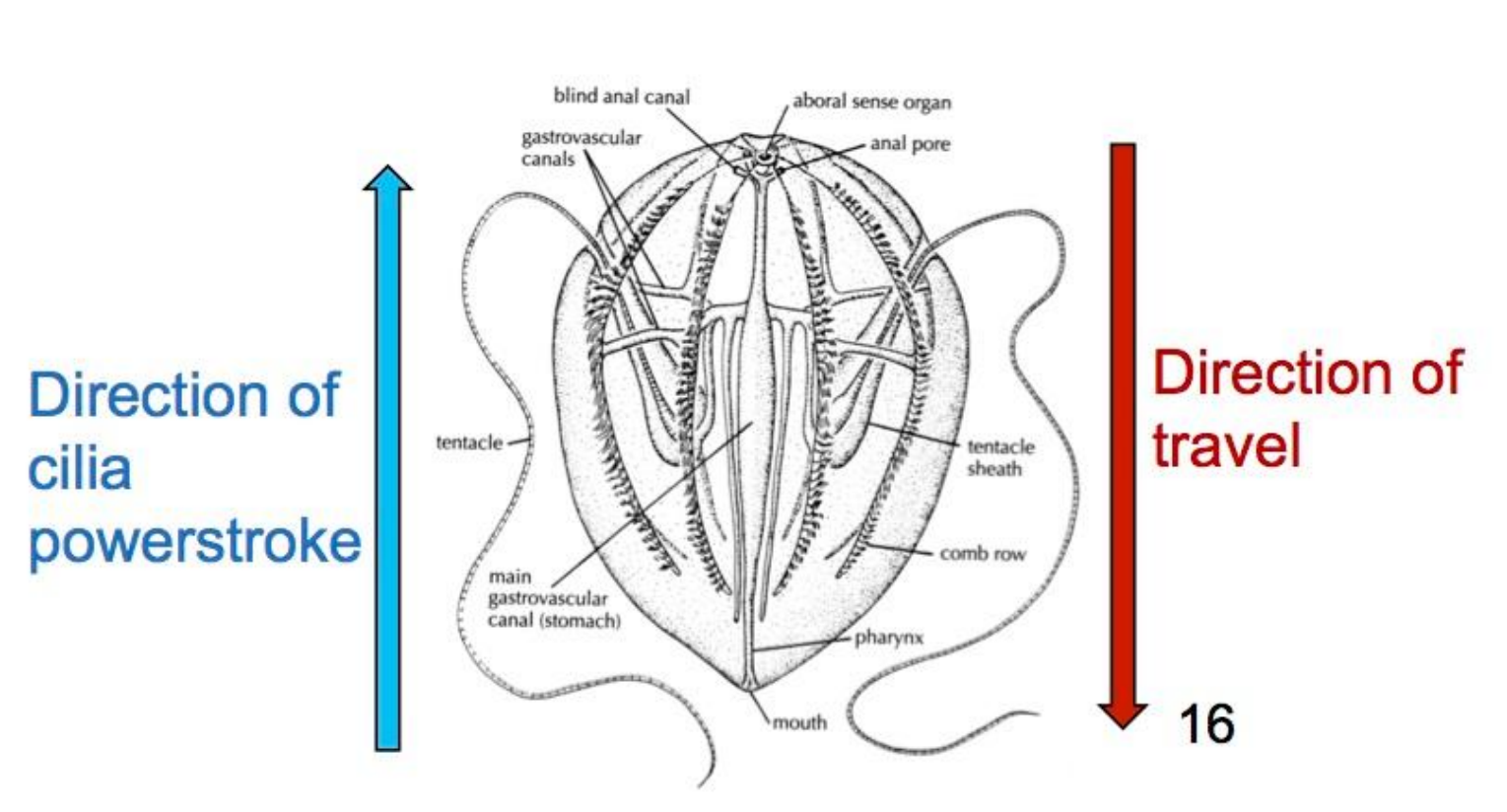
*Ctenophora – the box jellies



- *Bi*-radial symmetry (divide in two planes)
- Also only two tissues, with **mesoglea**
- Movement by ciliary action = <u>combs/ctenes</u> (instead of jet propulsion)
- Can alternate direction of ciliary movement
- Some have a **statolith** – suspended $CaCO_3$ crystals – for 'balance'



*Colloblasts

Instead of nematocysts, have colloblasts – "sticky" not stingy

- On tentacles, specialized cells for food capture
- Have coiled thread with sticky granules at end
- Fire on contact with prey, stick and immobilize prey
- Can retract tentacles with fired colloblasts into mouth for feeding on prey
- Entire tentacle can be shed and renewed (in Cnidaria, only nematocysts are renewed)

CTENOPHORA (BOX JELLIES)

*Invert taxonomic tree

Cnidaria
(true jellyfish
& anemones)

Nemertea
(ribbon worms)

Mollusca
(snails, clams,
cephalopods)

Annelids
(worms w/
lots of legs)

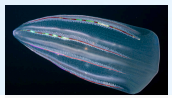
Lophophorates
(bryozoans)

Chordates
(have backbone)

segmentation

Urochordates
(tunicates)

chordate
attributes in
larval stage



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(stars, cucumbers,
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segmentation

protostomes

deuterostomes

Porifera
(sponges)

pseudocoelomates

coelomates

acoelomate

radial symmetry

bilateral symmetry

no true tissues

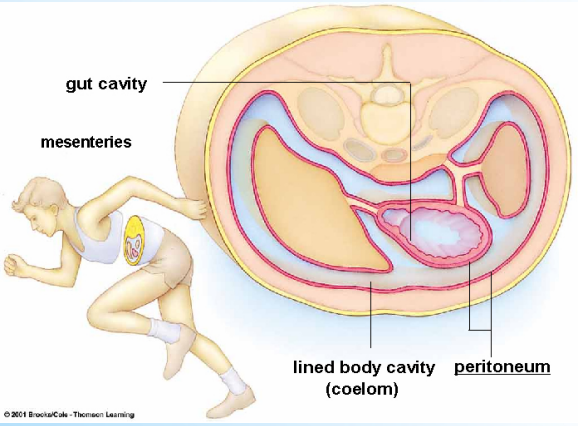
true tissues

multicellularity

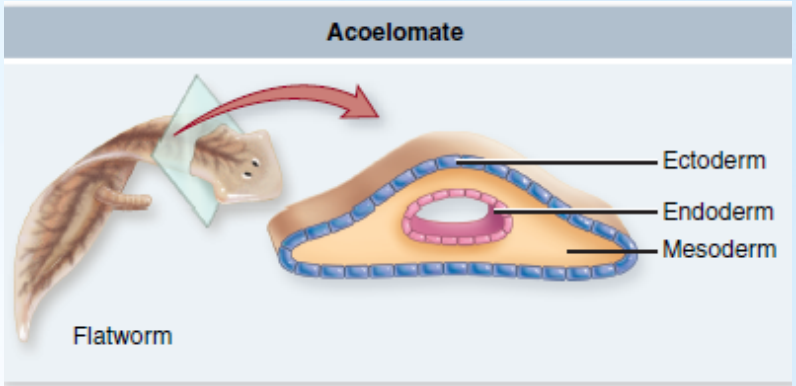
*COELOM – what the heck is it.

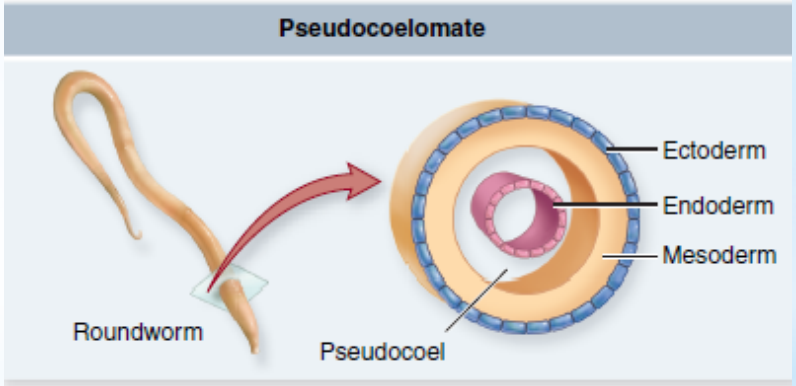
A **coelom** is the main body cavity possessed by most multi-cellular animals, positioned inside the body to surround and contain the digestive tract and other organs

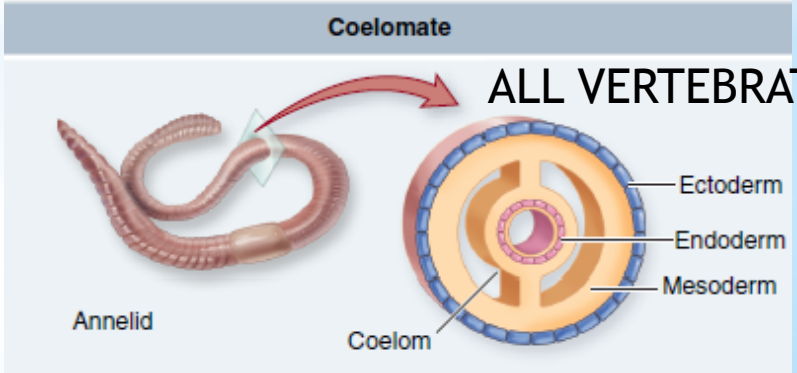
- Fluid-filled, provides 'hydrostatic skeleton'
- Allows free-movement of internal organs
- Transports gases, nutrients, waste products throughout body



In humans: same as "body cavity"



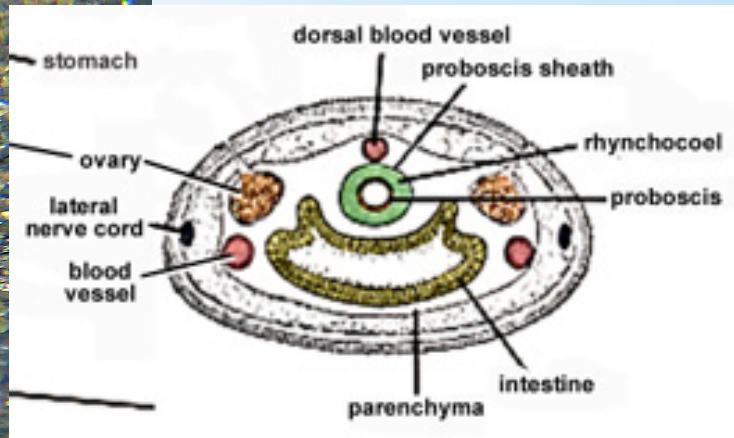




*Nemertea – ribbon worms

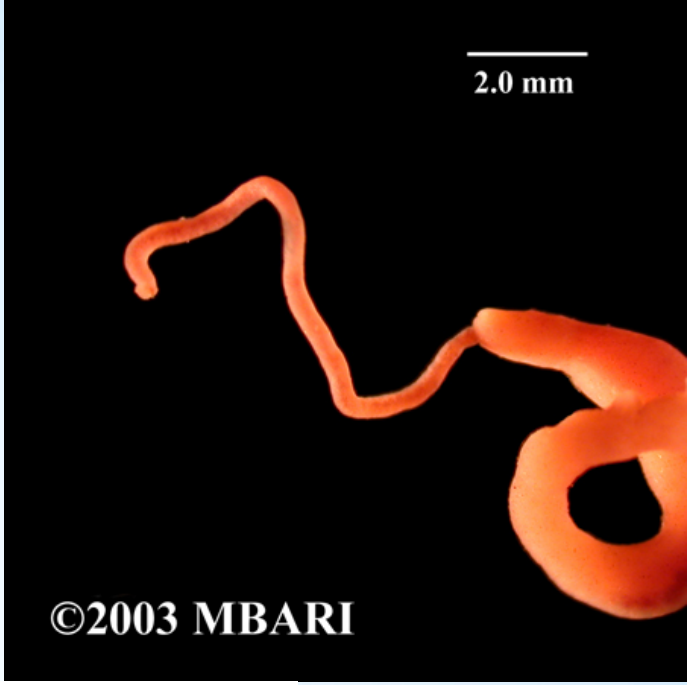
- **ACOELOMATE** – no body cavity (filled with cells)
- Mostly benthic, but can 'swim'
- Has brain and two lateral nerve strands
- Circulation via two lateral blood vessels
- Blood moves through muscular contraction of body
- Asexual (fragmentation) and sexual reproduction

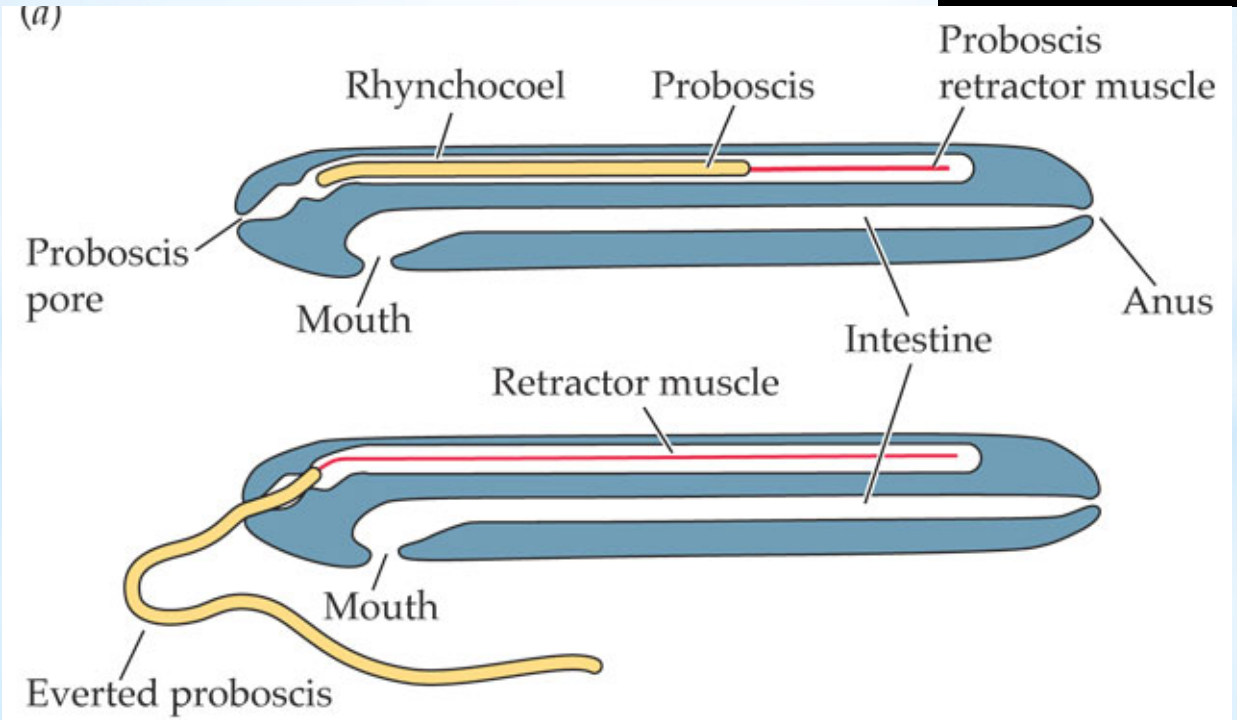
- Depend on diffusion for gas exchange



*Proboscis

- Used for prey capture
- Can sense prey with sight/smell/touch (photo-, chemo-, mechano-receptors)
- Proboscis can be armed or unarmed
- Ribbon worms are <u>important predators</u> of polychaetes (annelid worms) and barnacles





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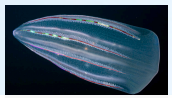

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coelomates

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bilateral symmetry

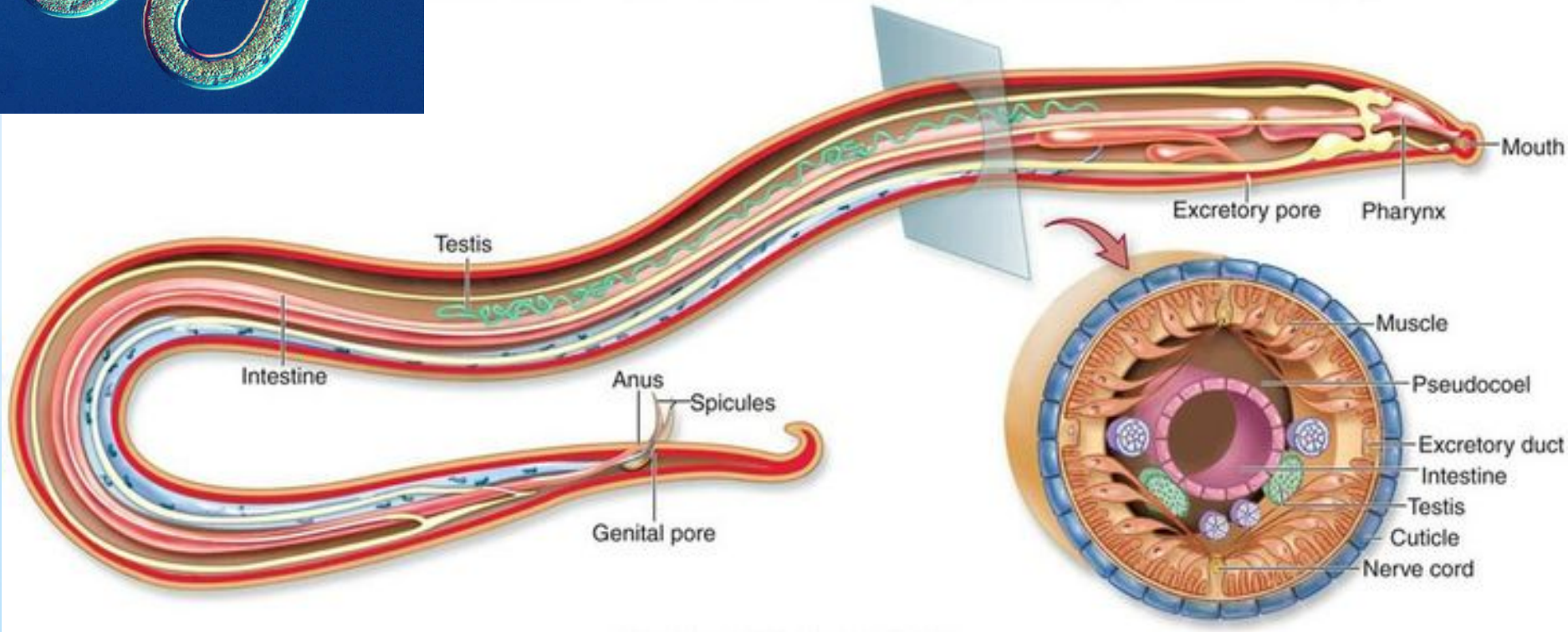
no true tissues

true tissues

multicellularity

*Nematoda – roundworms

- **PSEUDOCOELOMATE** – have body cavity, but organs held loosely and not well organized within cavity
  - 12,000+ spp. found all over land and sea
  - Have 'open circulatory system'
  - Depend on diffusion for gas exchange
  - Sensory complex at head – mechano/chemo-reception



Ecological role: **Predators, parasites, grazers** of organic matter in sediment – nutrient cyclers of the benthos

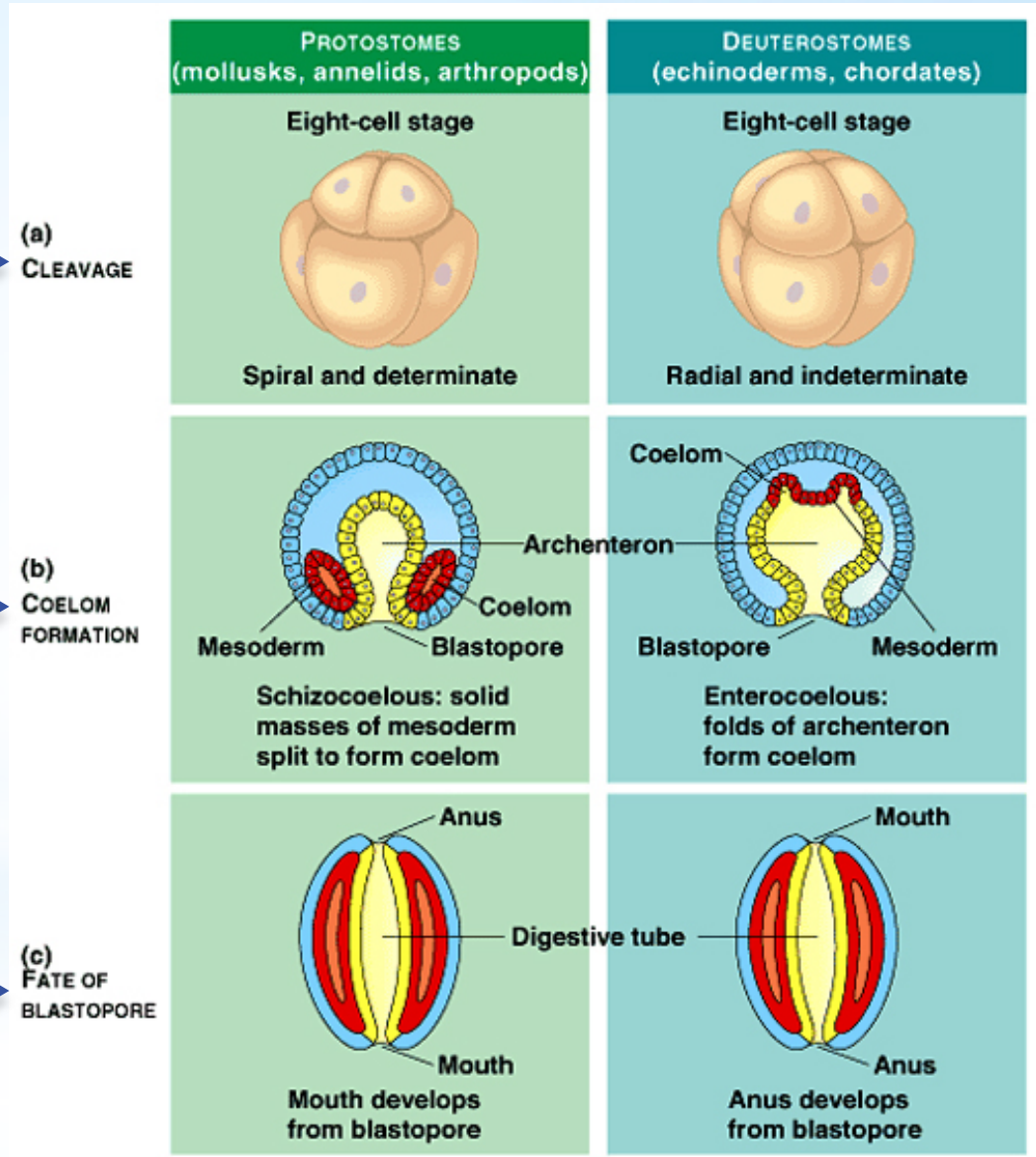
*Protostomes vs. deuterostomes

Represent two main patterns of embryonic development

three determining characteristics:

Protostomes: Mollusca
Annelida
Arthropoda

Deuterostomes: Echinodermata
Chordata



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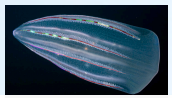

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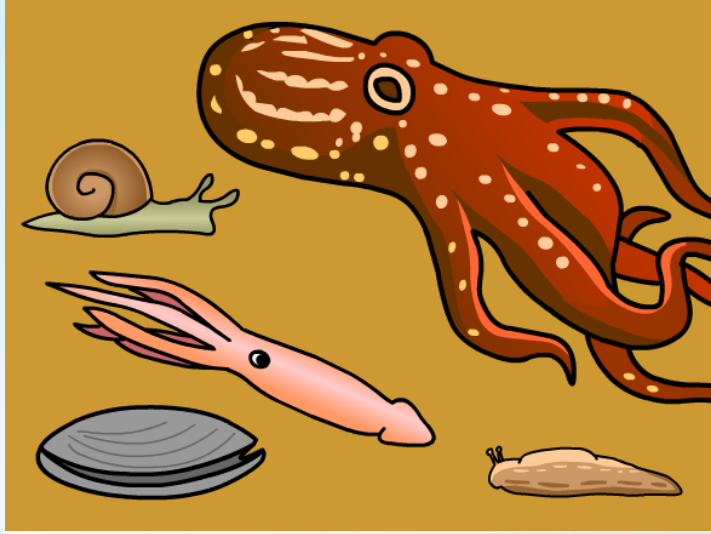
*Mollusca - the snails, chitons, clams, nudibranchs, and cephalopods

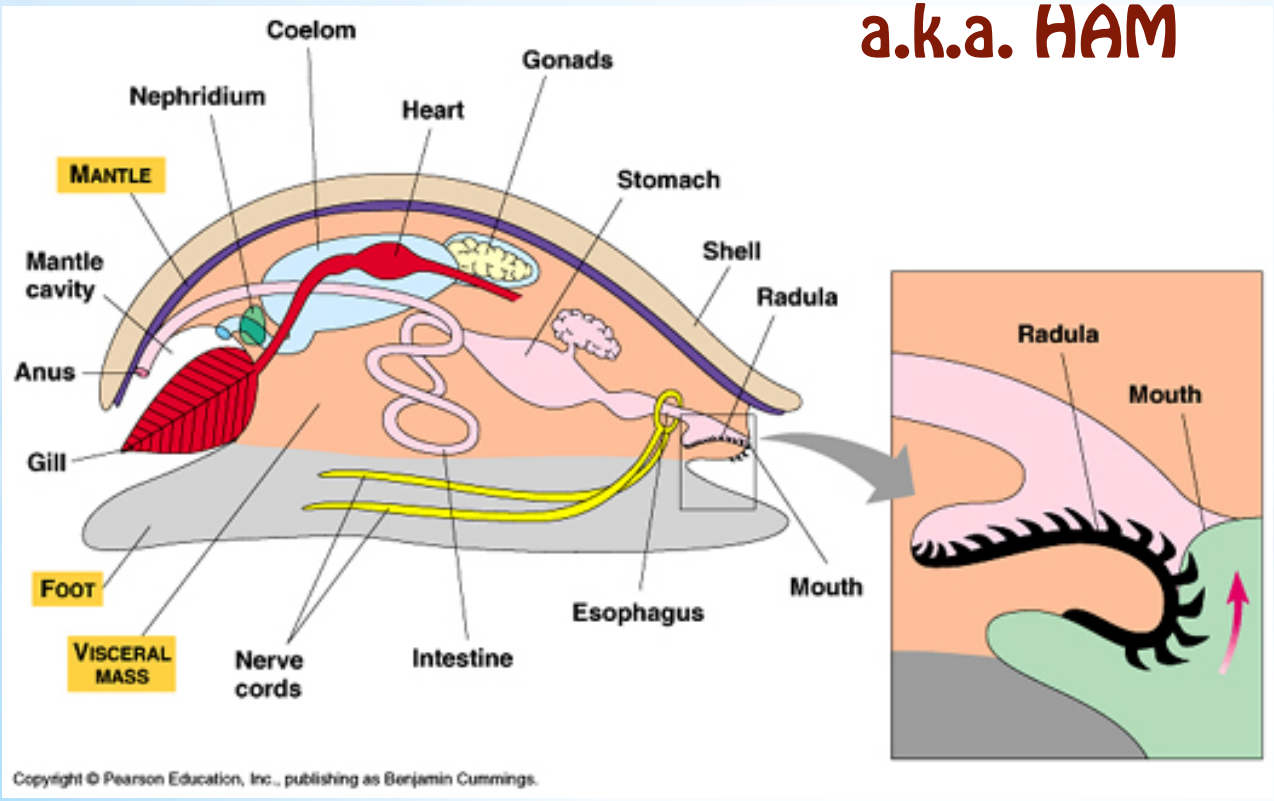


- Largest marine phylum (23% all marine critters)
- Highly diverse – ecologically important everywhere!!

It all started with….

The Hypothetical Ancestral Mollusc!

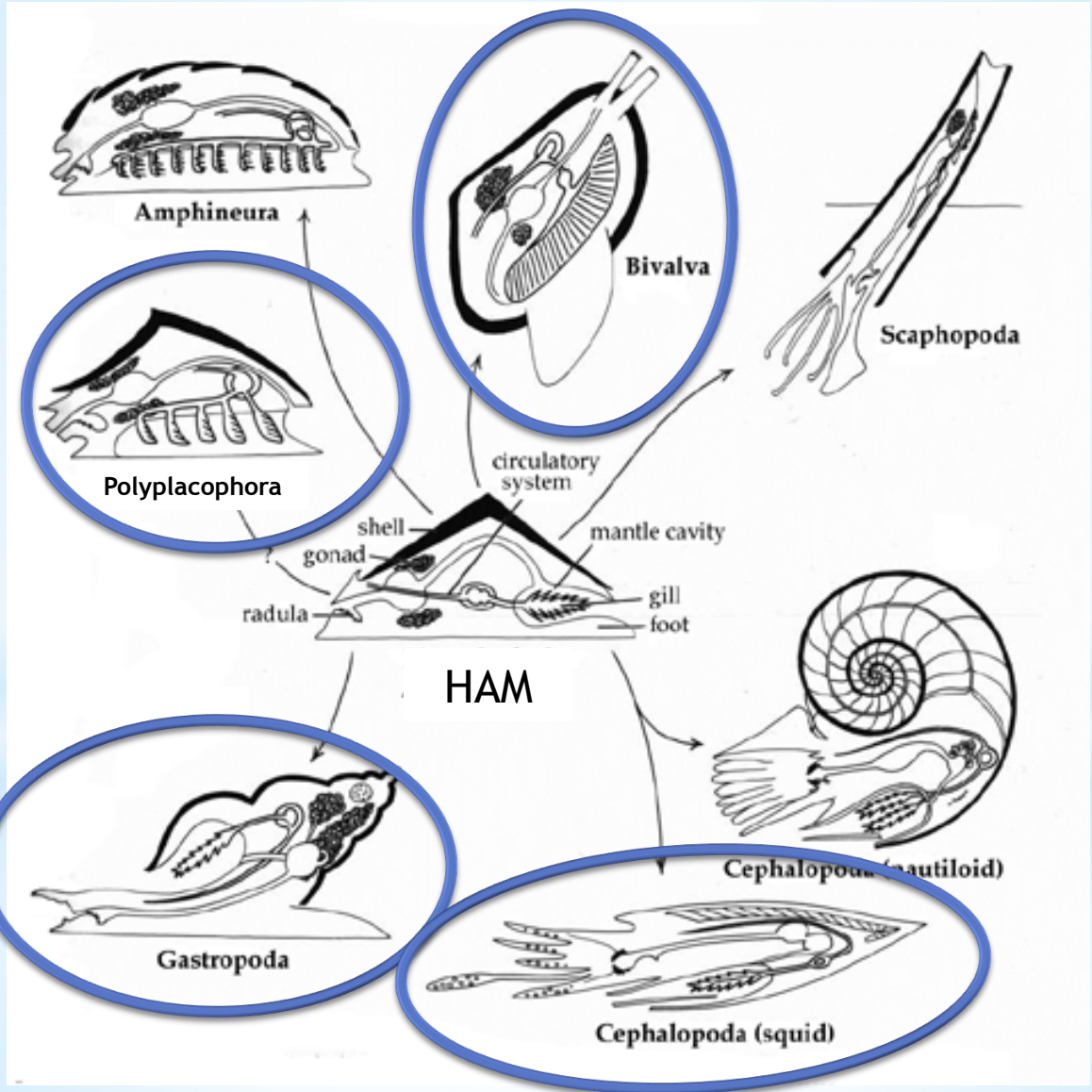
a.k.a. HAM



Common characteristics of all molluscs:

- Coelomate protostomes
- Unsegmented, bilateral symmetry
- Muscular mantle that can secrete a shell
- Mantle cavity containing paired gills
- Radula for feeding
- Visceral mass (body + organs)

*Adaptive radiation



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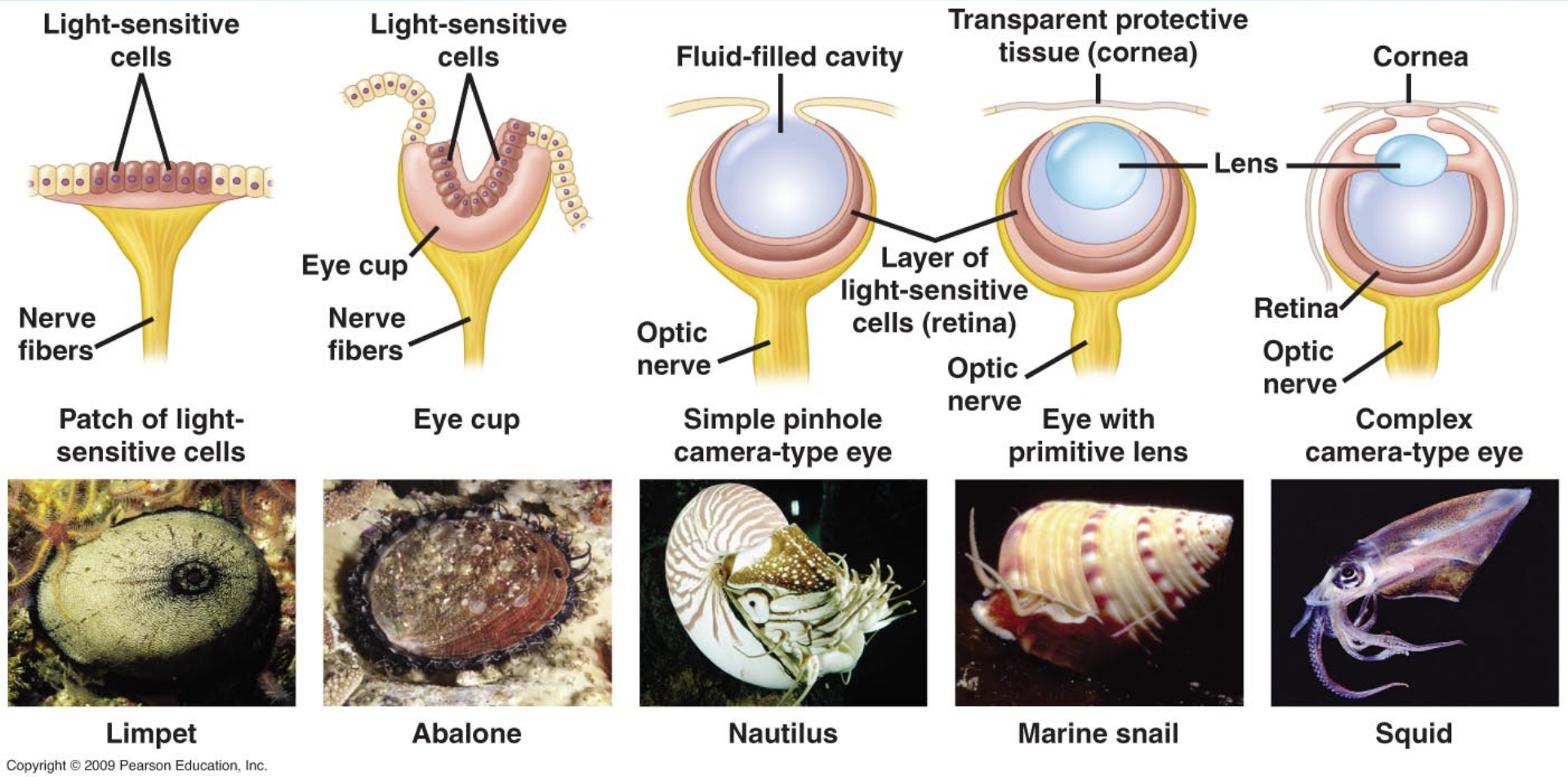
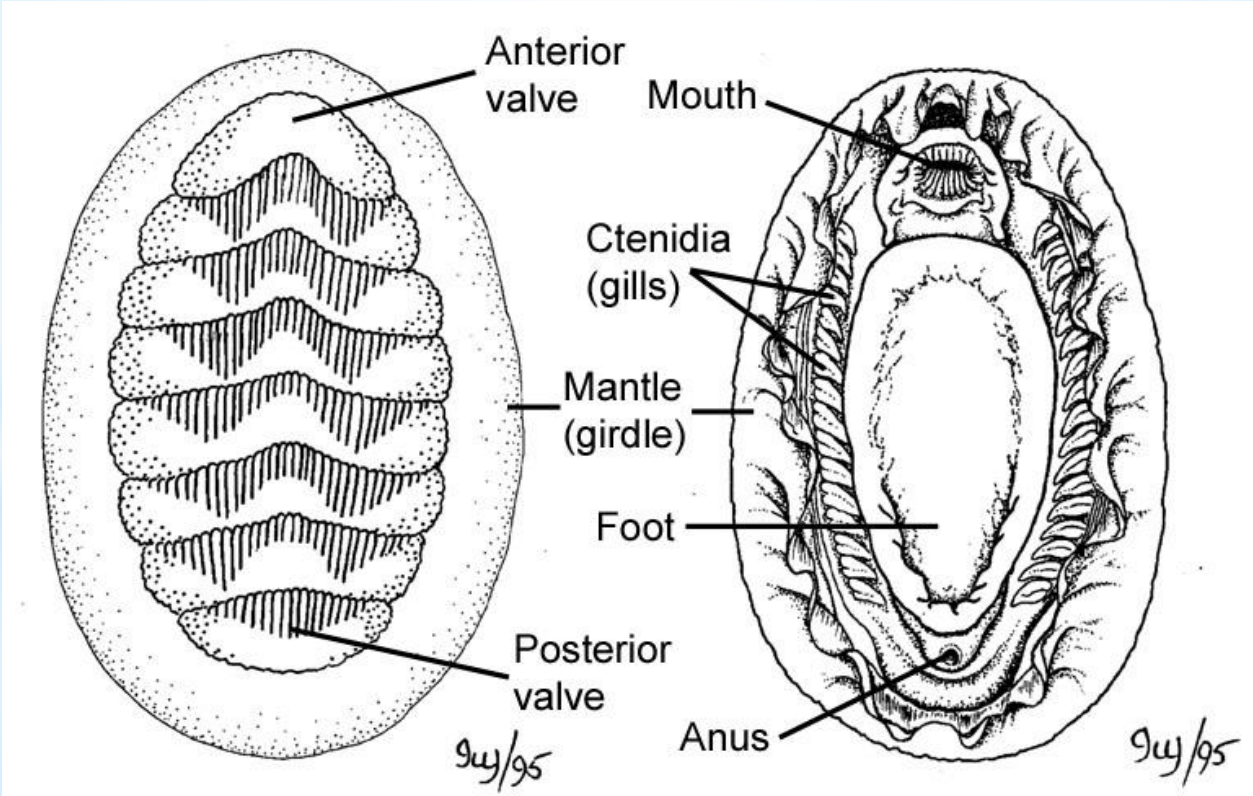


*Chitons

a.k.a. Class Polyplacophora

Pretty similar to HAM

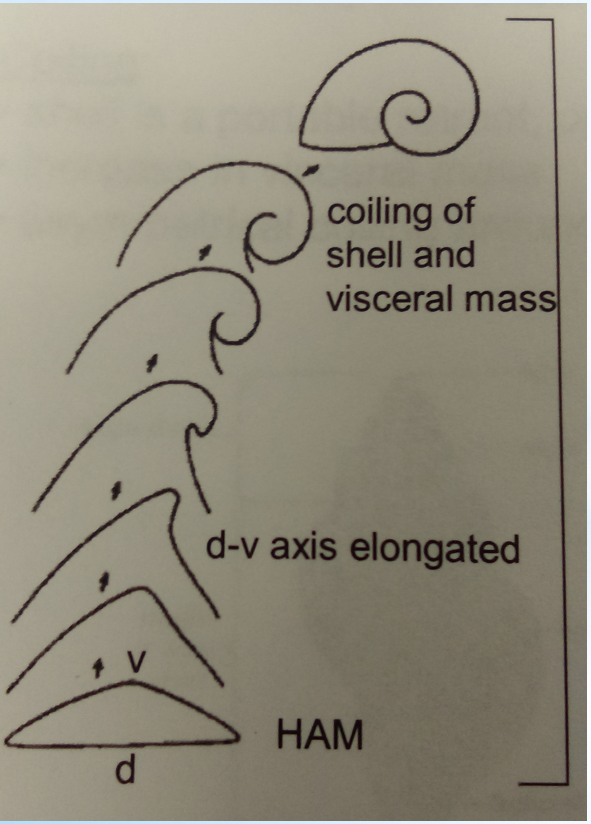
- Grazers
- Overlapping plates
- Flexible body
- Adapted for life in the intertidal and subtidal

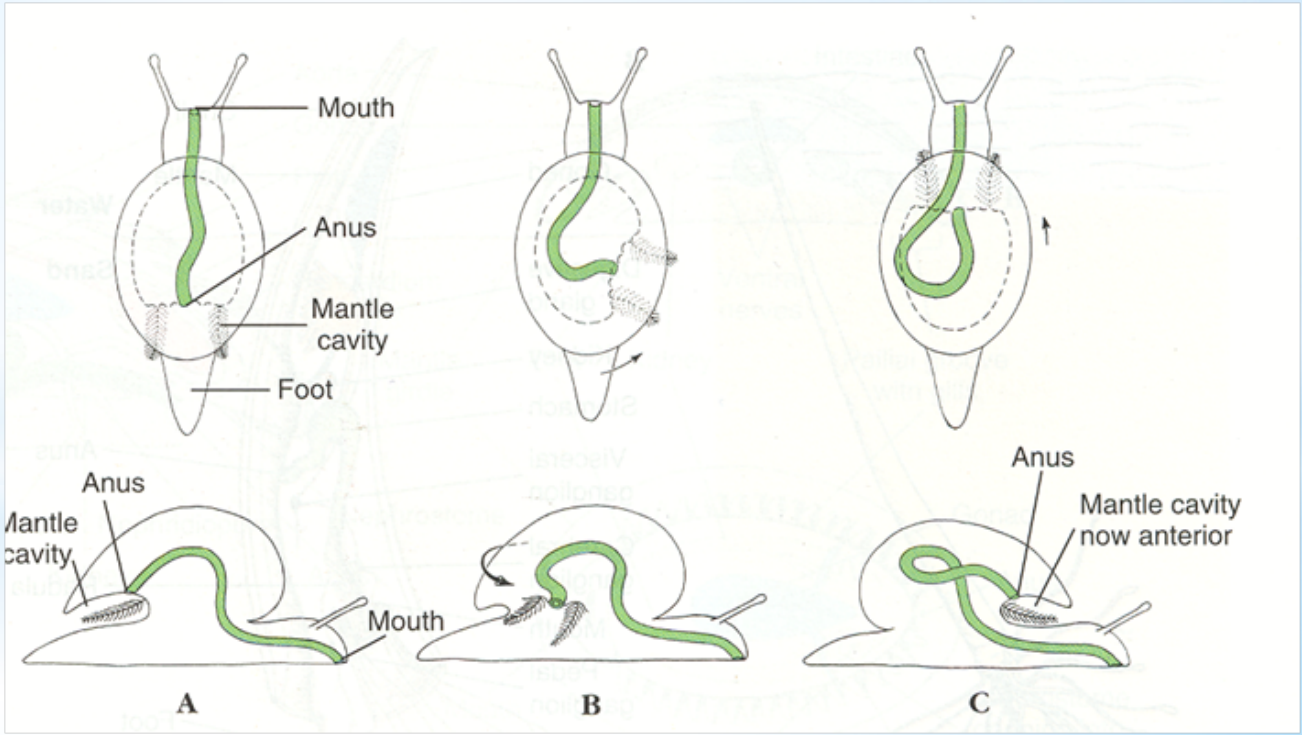


*Class Gastropoda (snails, nudis, limpets)

Three big differences from HAM:

1) Dorsoventral elongation (can grow bigger)
2) Coiling
3) Torsion (mantle cavity rests above head, can retract!
   → also brings all organs nearer to brain

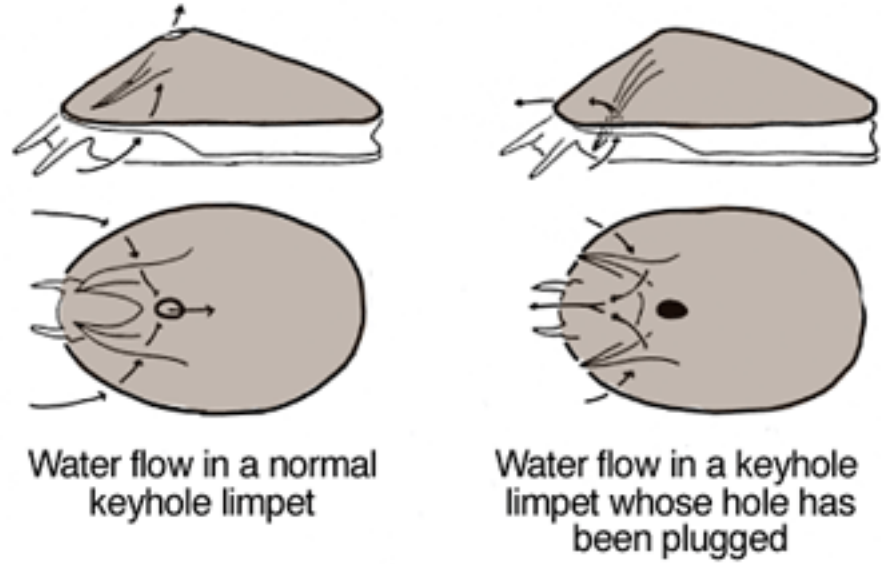


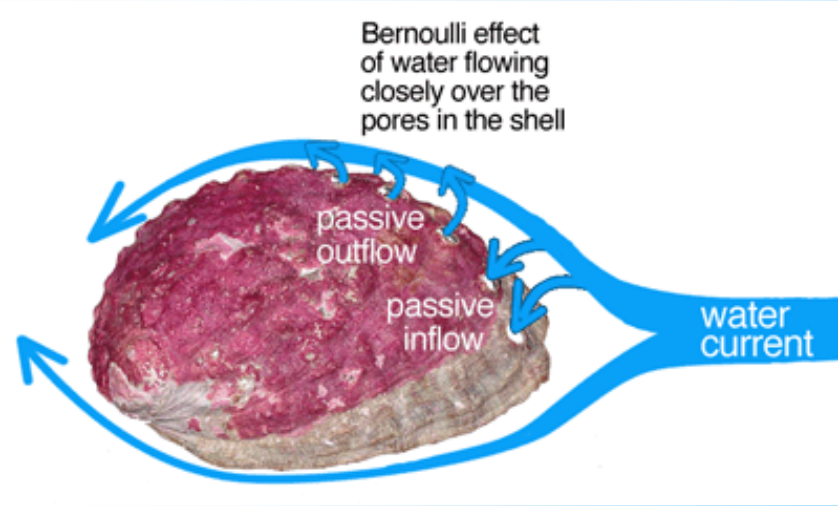


*Class Gastropoda

Limpets and Abalone and Snails = Prosobranchia "gills before heart"

- Limpets = no spiral, no interior structure to stabilize, so are size limited; max out on how tall can get before unstable
- Keyhole limpets and abalone have holes in shell for water movement, abalone can clamp down completely on rocks and still filter
- Some grazers (herbivores) some carnivores who drill through shells with radula

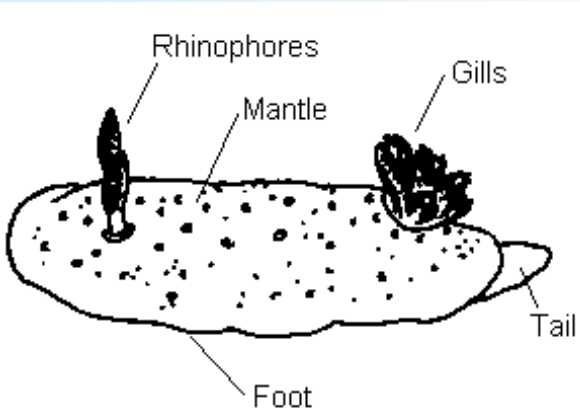


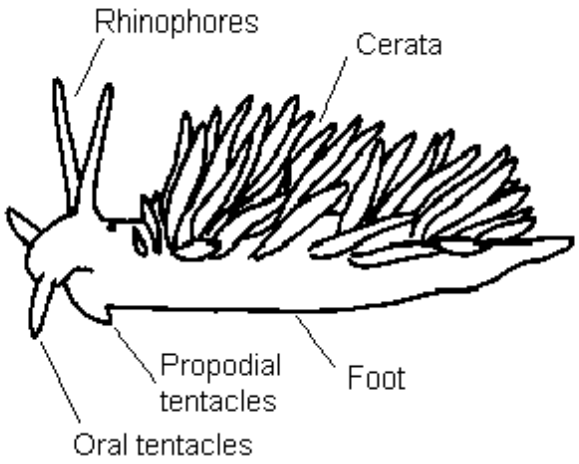


*Class Gastropoda

Nudibranchs = Opisthobranchia "gills behind heart"

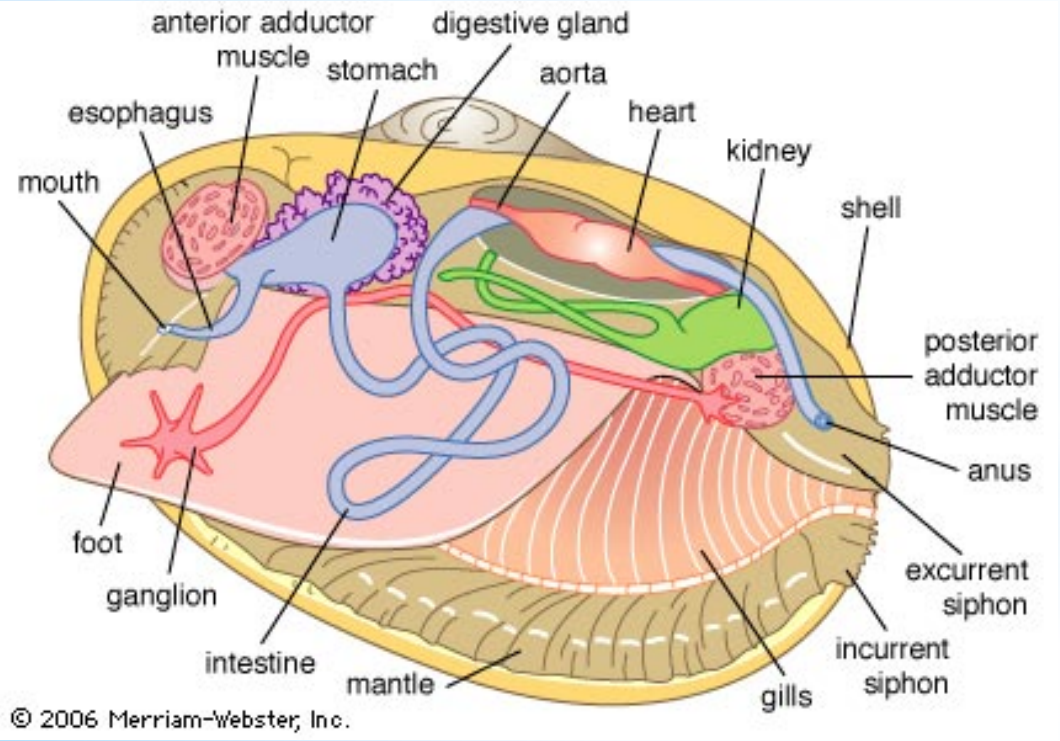
- De-torsion!
- No, or very reduced shell
- Gill tufts can be exterior to body
- Mostly carnivores (don't be fooled by how cute they are)
- **Rhinophores** for chemoreception
- **Cerrata** for gas exhange
- Sexual reproduction, internal fertilization
- Benthic and some pelagic (pteropods)

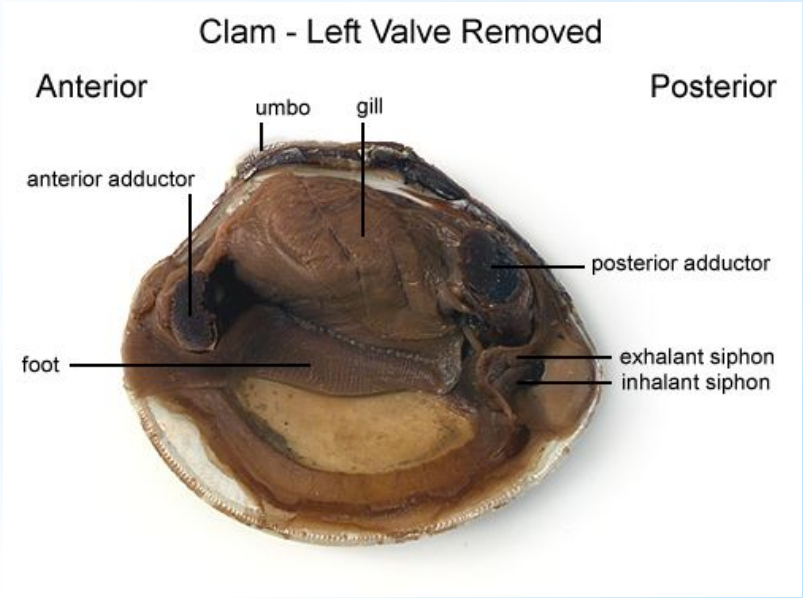




*Class Bivalvia

- Two piece shell, laterally compressed
- **Adductor muscle** for opening/closing shells
- Well developed foot (why?)
- Can have **byssal threads** to attach to substrate
- Can have feeding palps and/or crystalline style to pull-in food
- Open circulatory system, reduced head but nerve strands throughout





*Class Cephalopoda

….next time!

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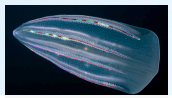

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ORGANISMS: ZOOPS AND INVERTS (1)

See you next week – Oct. 12th

Start thinking about midterm and reviewing lectures

Time for questions, clarification of midterm format at end of next class

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