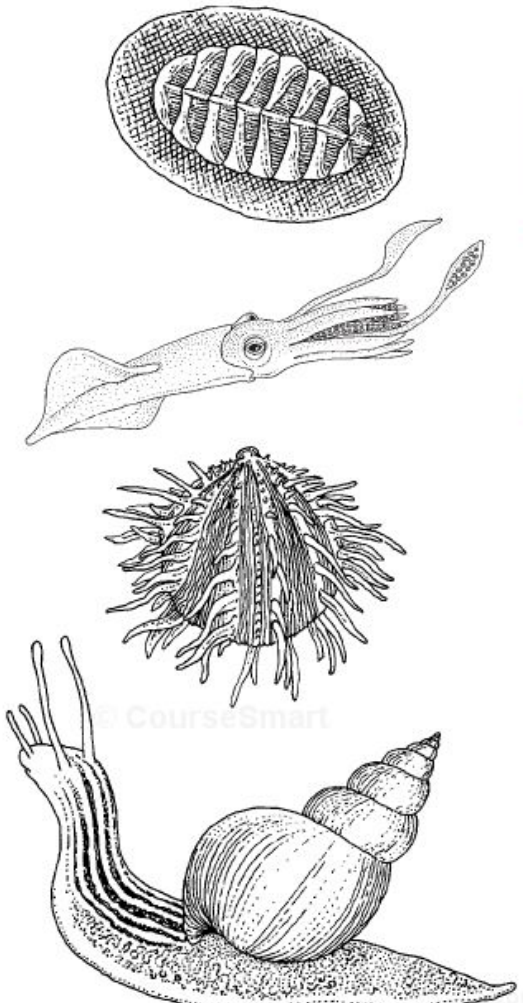
Phylum Mollusca

- General Introduction
- Ecology
- Economic Importance
- Taxonomy
- Anatomy

FISH310

Phylum Mollusca:

- Up to120K estimated with ~50K living species
- ~35K (up to >60K) extinct



Phylum Mollusca

Tremendous size range

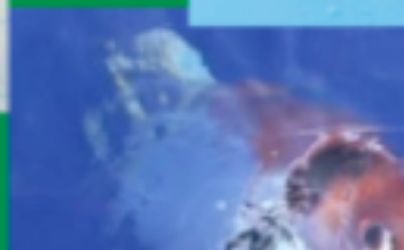
Great diversity of form


1078.
1093.
360.
91.

Who are these guys and gals?

Phylum Mollusca

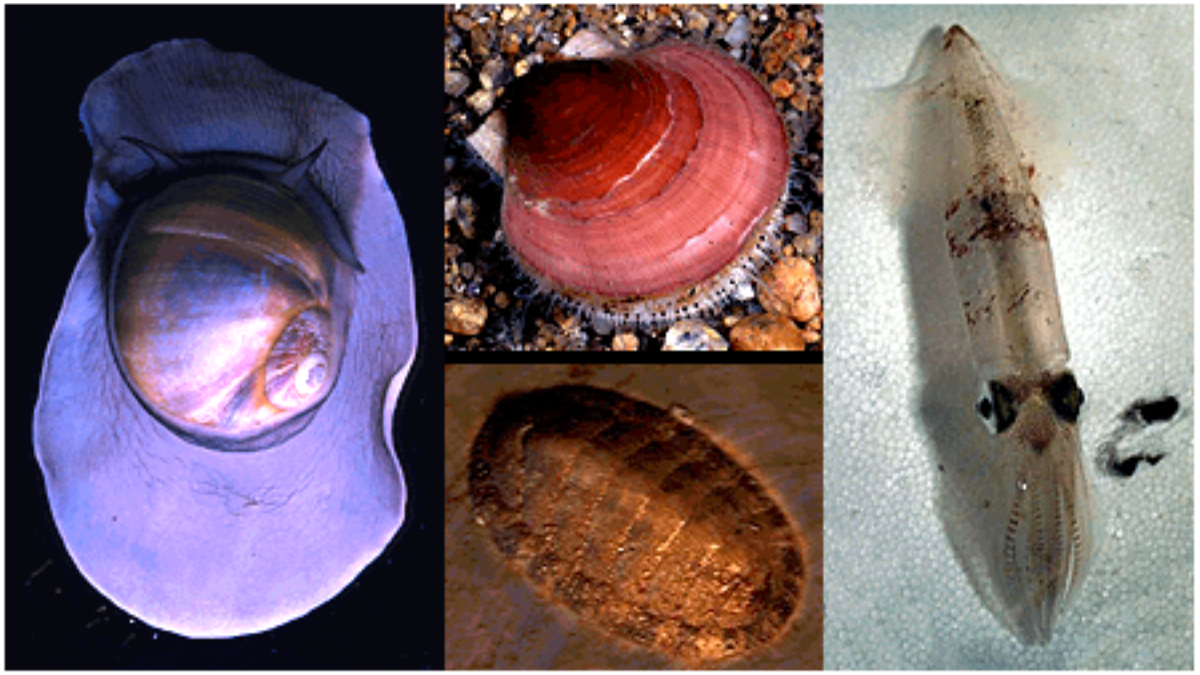
- Class Polyplacophora
- Class Gastropoda
- Class Bivalvia
- Class Cephalopoda



Who are these guys and gals?

Mollusca

Snails, clams, mussels, squids, octopi, chitons, and tusk shells



- Conchifera
  - Polyplacophora (chitons)
  - Monoplacophora (Tryblidia)
  - Bivalvia (mussels, clams, oysters, cockles, etc.)
  - Scaphopoda (tusk shells)
  - Gastropoda (snails, slugs, limpets, nudibranchs)
  - Cephalopoda (octopods, squids, nautiluses, etc.)

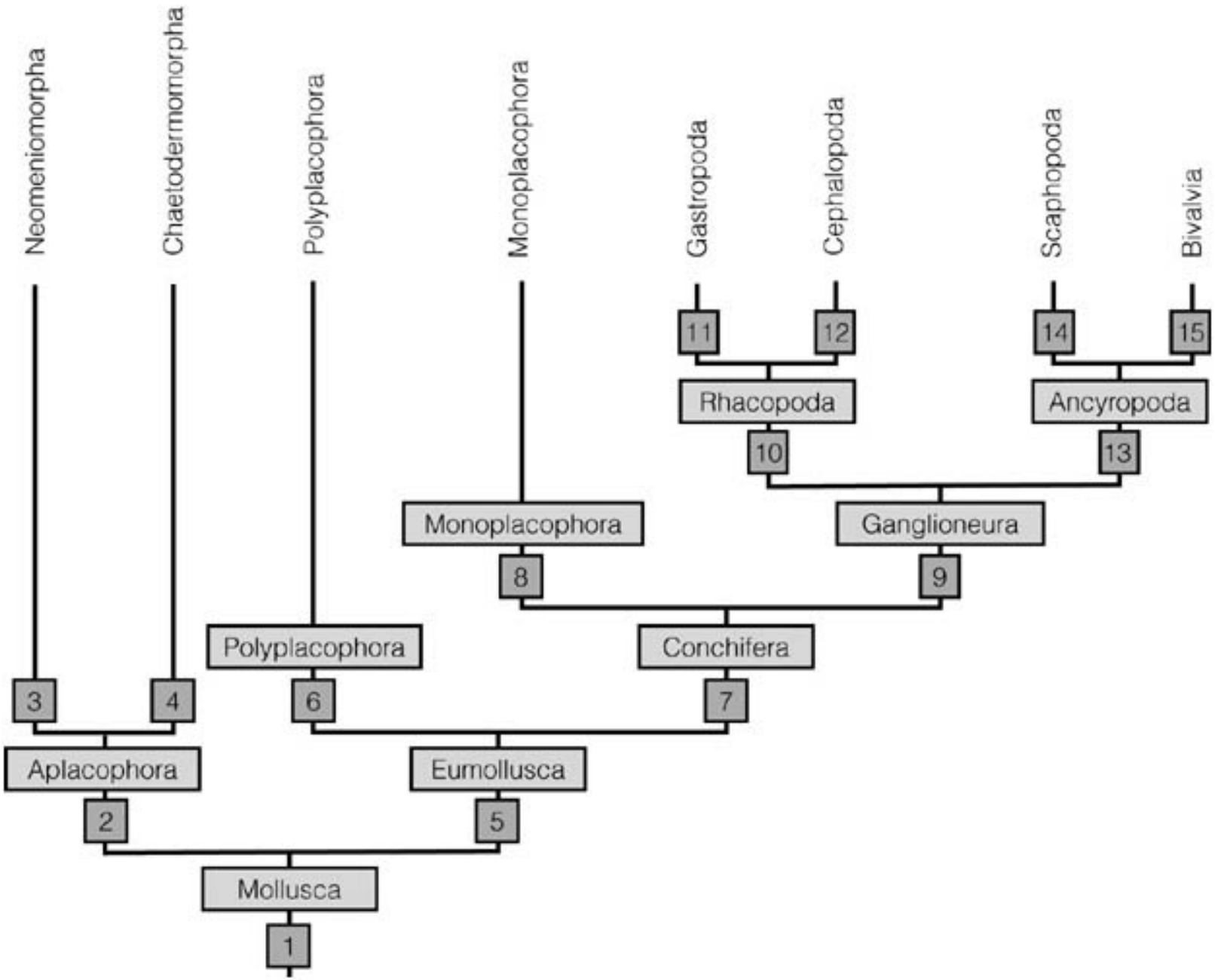


Figure 12-125: **A phylogeny of Mollusca.**

Ecological importance

What roles do molluscs play?

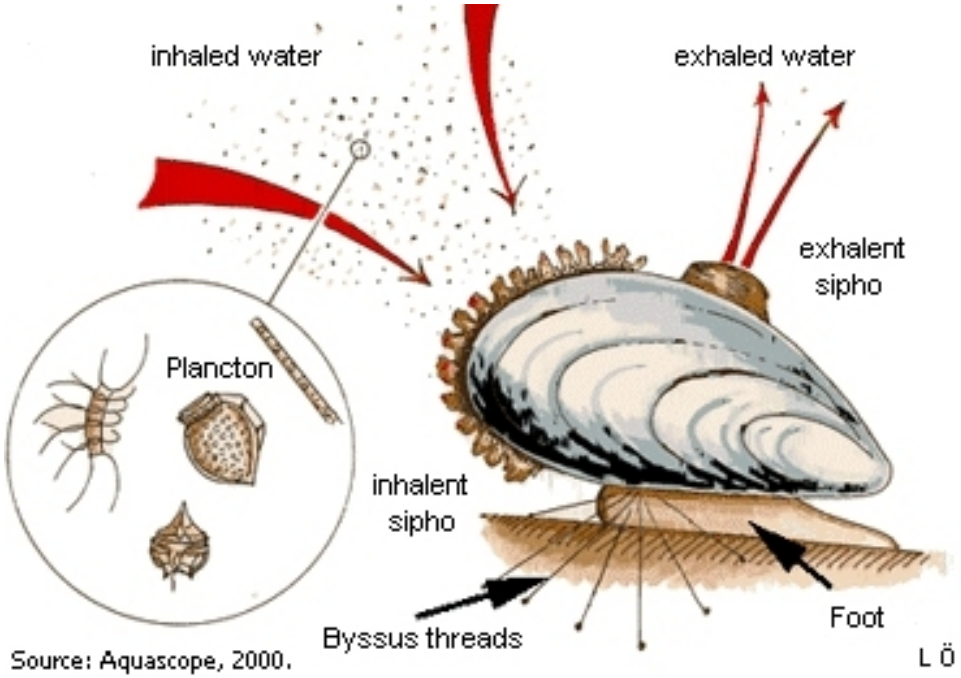
via wikipedia: Ecology is the scientific study of the relation of living organisms with each other and their surroundings

Ecological importance

What roles do molluscs play?

www.fishingnj.org/prosquid.htm

Siphonaria pectinata striped false limpet (Pulmonata: Basommatophora: Siphonariidae).



Source: Aquascope, 2000.

L Ö

Ecological importance- Predators

Odostomia impressa **feeding on the edge of an oyster shell (Heterostropha: Pyramidelloidea). The proboscis is visible extending over the edge of the shell to reach the mantle of the oyster.**

Phylum Mollusca

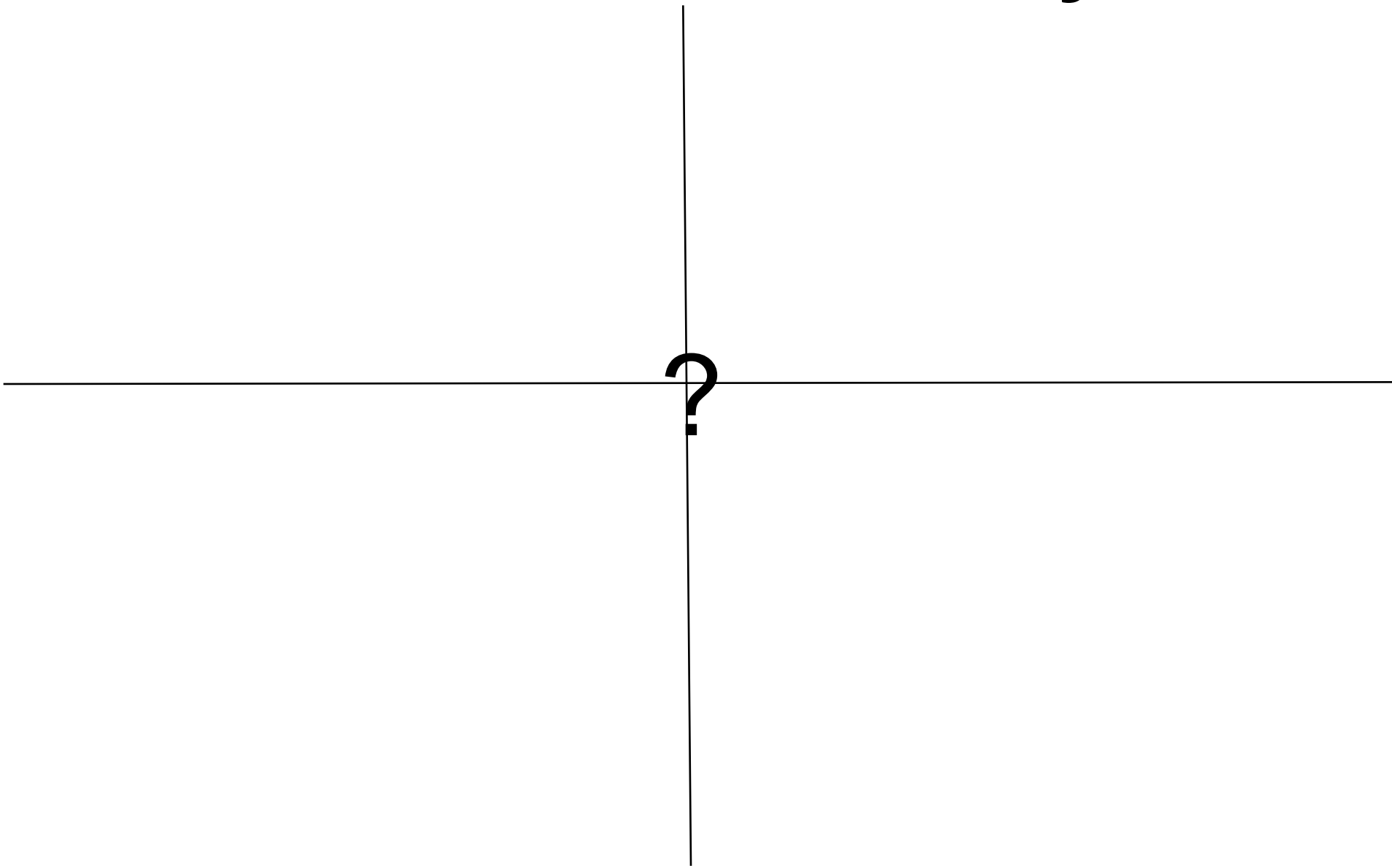
Tremendous economic importance

What sources of revenue come from molluscs?

Science and Society

?

Science and Society



characteristics

Science and Society

Medical applications

Conus spp. venom

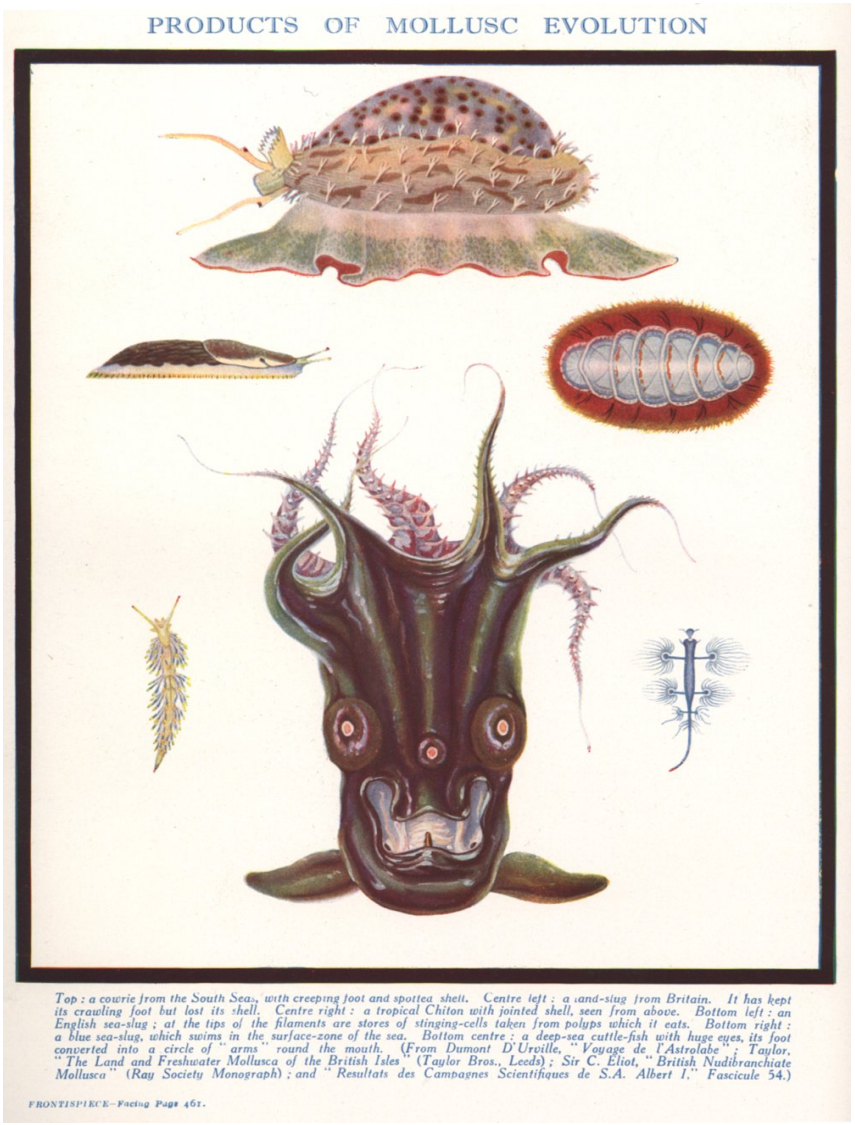
December, 2004, the FDA, approved the global first marine peptide medicine called Prialt (trade name is zicontotide) from *Conus* toxin

Used as a final option analgesic substitute for terminal cancer and AIDS patients

Molluscs are successful

Live in nearly every habitat

- **oceans**
  - shallow tidal pools to deep trenches
- fresh water
- on land
  - cannot cope well in very arid regions
  - ***Can you think of why this is?***



The Science of Life by H. G. Wells, Julian Huxley and G. P. Wells (1929-39), vol 2.

Molluscan Characteristics

Possess some or all of these characters

What characteristics does your text book say are Molluscan DEFINING CHARACTERISTICS?

Molluscan Characteristics

Possess some or all of these characters

What characteristics does your text book say are Molluscan DEFINING CHARACTERISTICS?

Defining Characteristics:[1] 1) Dorsal epithelium forming a mantle, which secretes calcareous spicules or one or more shells; 2) cuticular band of teeth (radula) in the esophagus, used for feeding (not present—lost?—in bivalves); 3) ventral body wall muscles develop into a locomotory or clinging foot

Molluscan characters

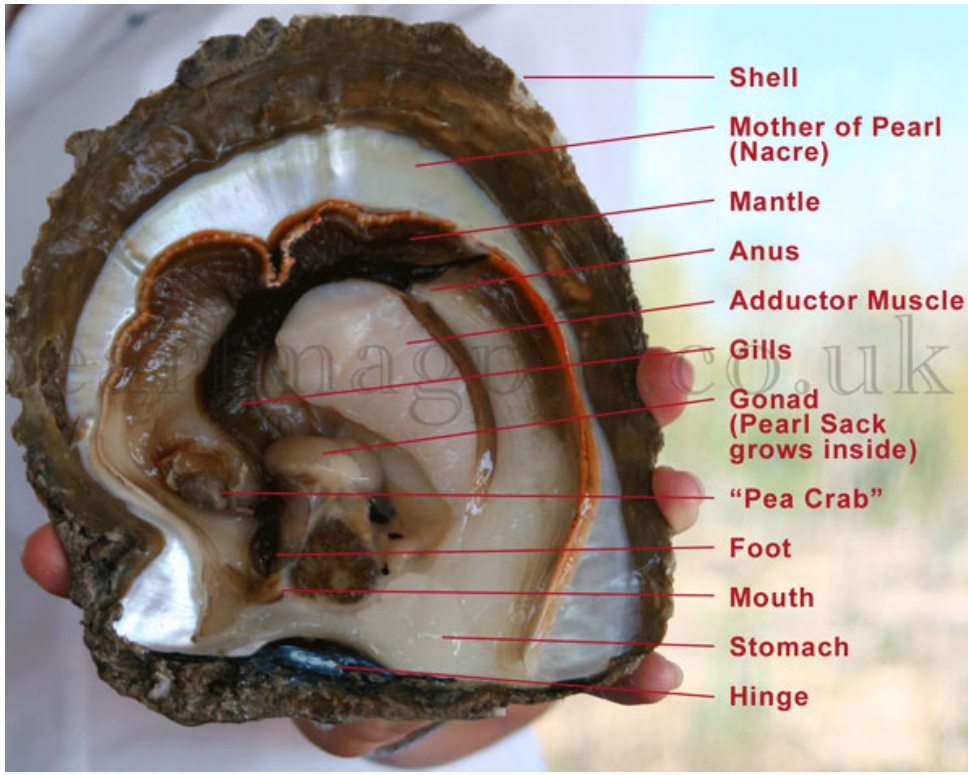
Defining Characteristics:[1] 1) Dorsal epithelium forming a mantle, which secretes calcareous spicules or one or more shells; 2) cuticular band of teeth (radula) in the esophagus, used for feeding (not present—lost?—in bivalves); 3) ventral body wall muscles develop into a locomotory or clinging foot

Mantle

- epithelium enclosing body and forms a cavity: **pallial cavity**
- secretes shell

Mantle (pallial) cavity

- Gills
- osphradium sensory
- excretory openings
- reproductive openings



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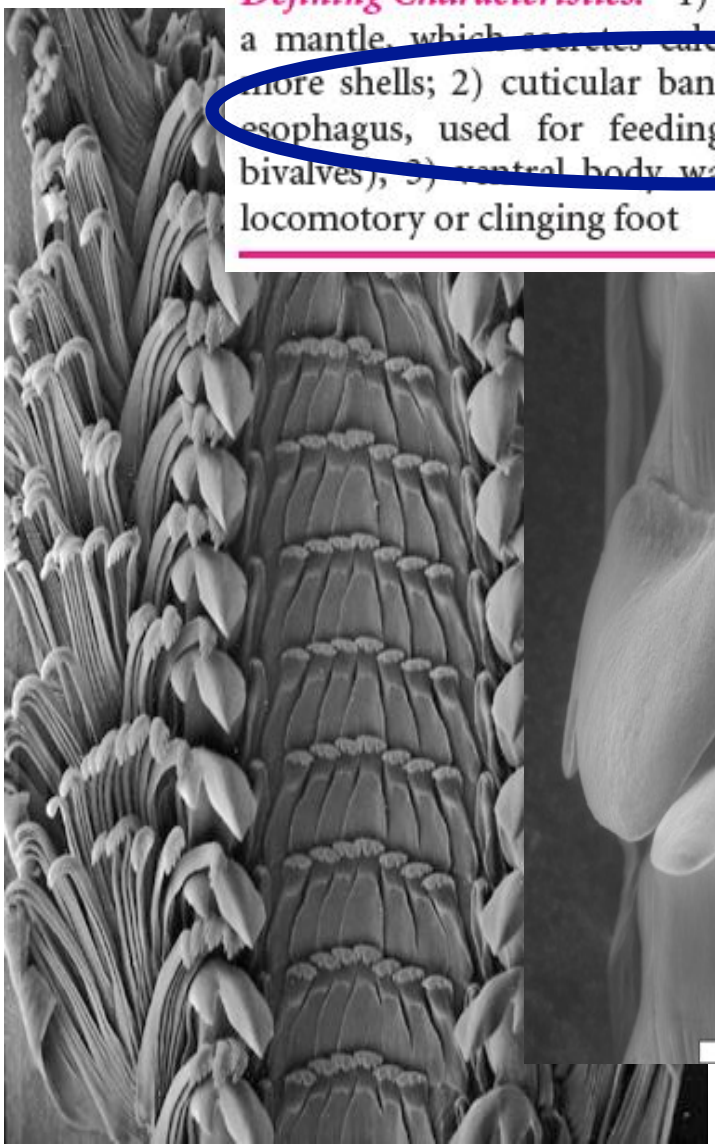
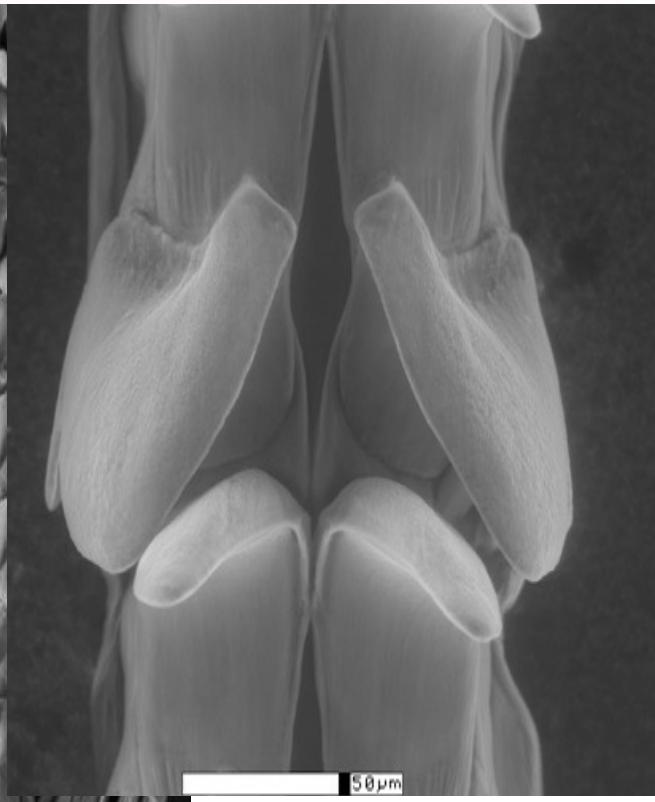
Radula

- Chitinous teeth supported by odontophore (connective tissue)
- Occ. hardened with iron or silica
- In all but





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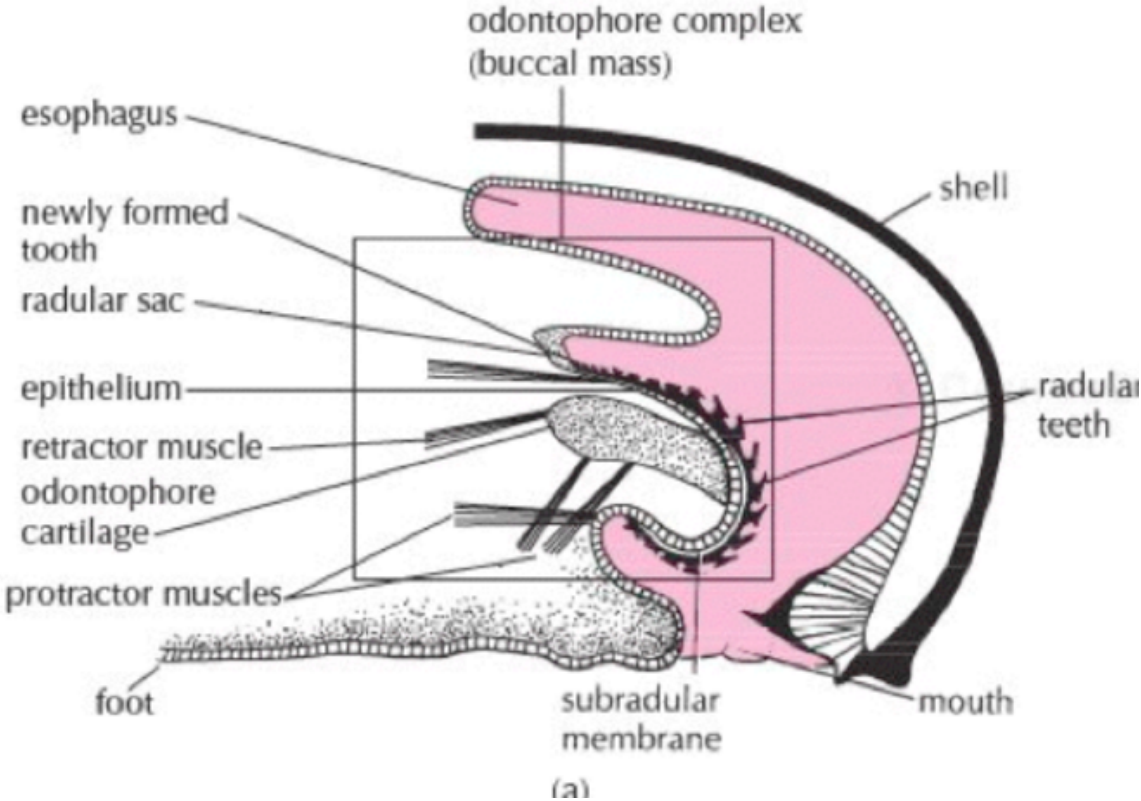


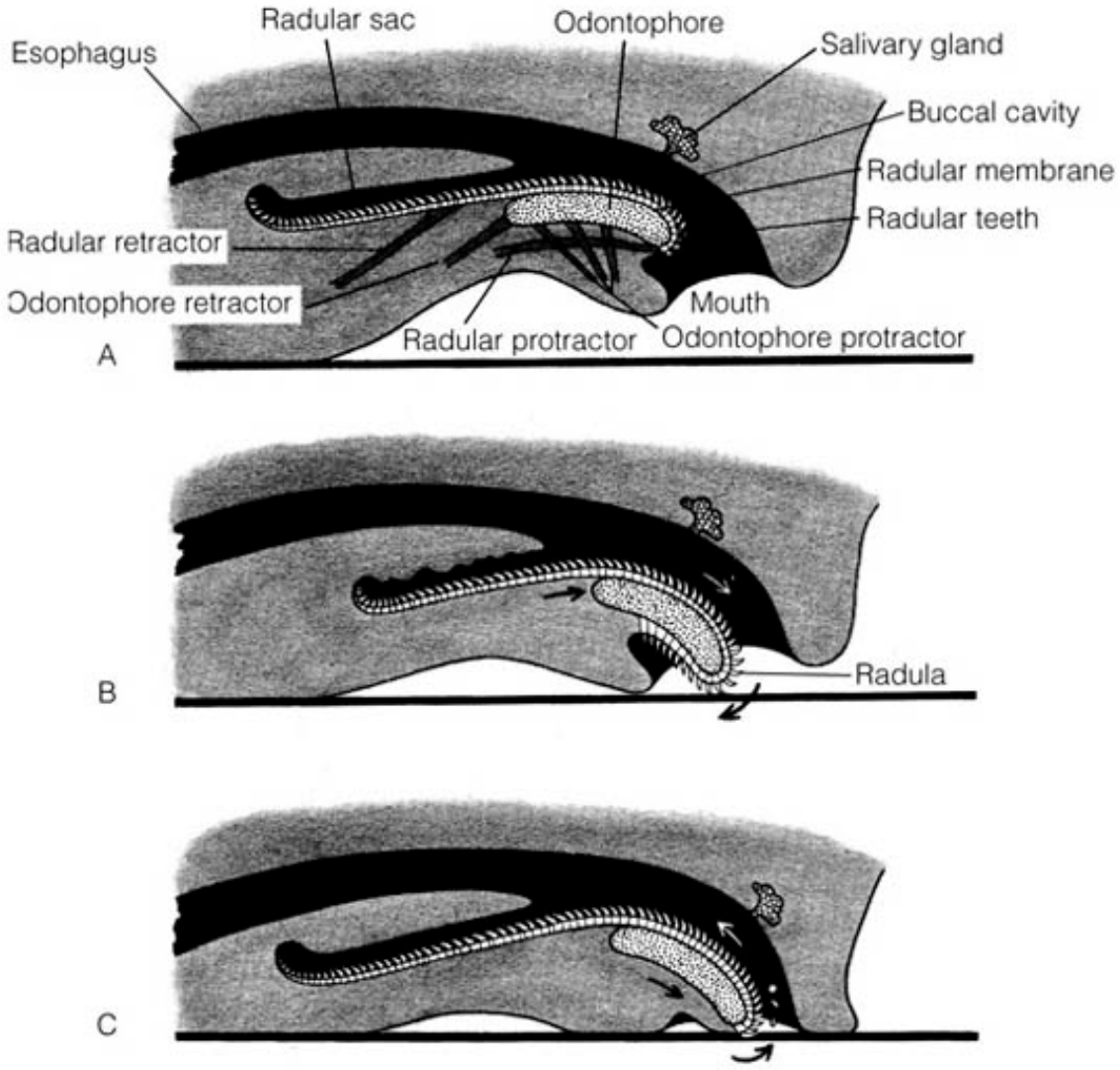


Figure 12-2: **Molluscan radula.**

- Contains many teeth
- Some species capped with magnetite
- Scrapings pulled into buccal cavity, mixed with mucus, forming a food string
- In general molluscs, while food is moving towards the stomach, esophageal glands secrete amylase
- In stomach mixed with proteolytic enzymes

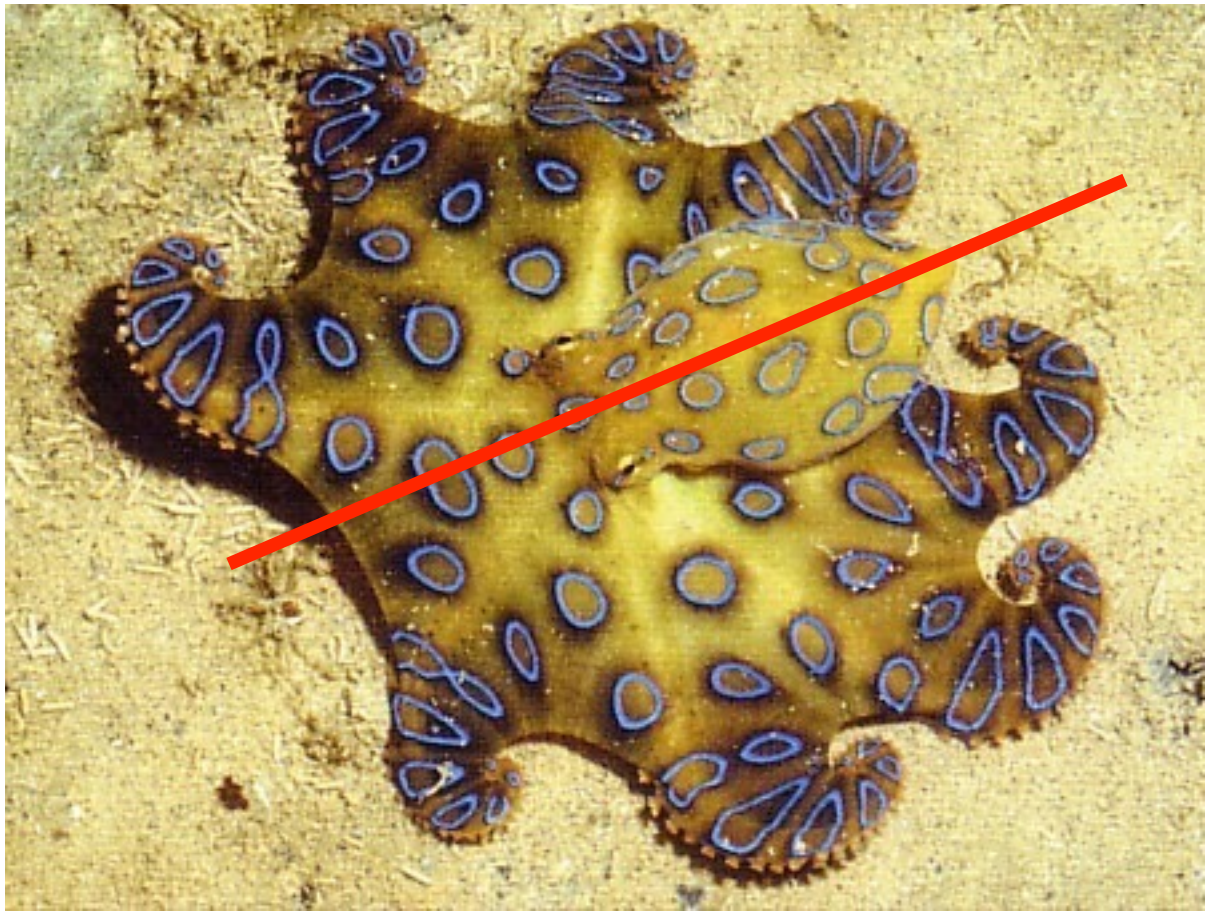
Molluscan characters

Large, muscular foot

Defining Characteristics:[1] 1) Dorsal epithelium forming a mantle, which secretes calcareous spicules or one or more shells; 2) cuticular band of teeth (radula) in the esophagus, used for feeding (not present—lost? -in bivalves); 3) ventral body wall muscles develop into a locomotory or clinging foot

Molluscan characters

Bilateral symmetry



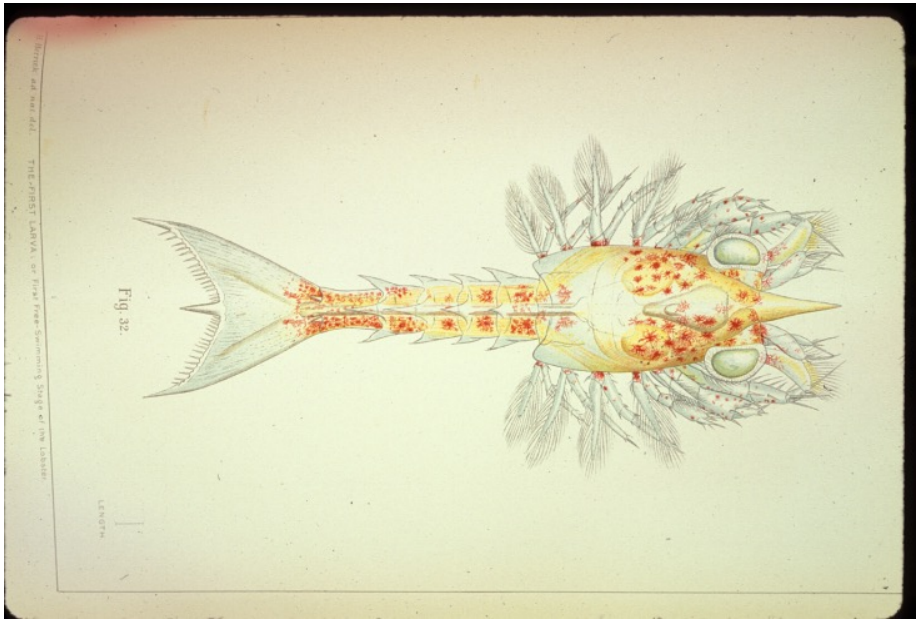
Molluscan characters

No segmentation

Segmentation

Polychaete worm

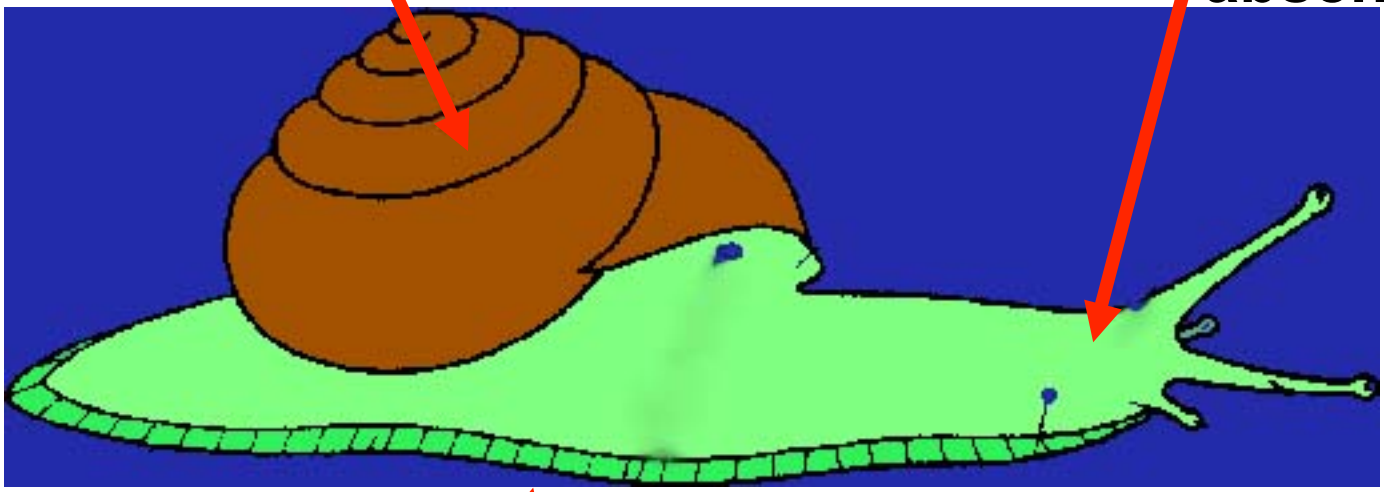
Larval Lobster (crustacean)



Molluscan characters

Visceral mass (inside shell)

Head (may = reduced or absent)



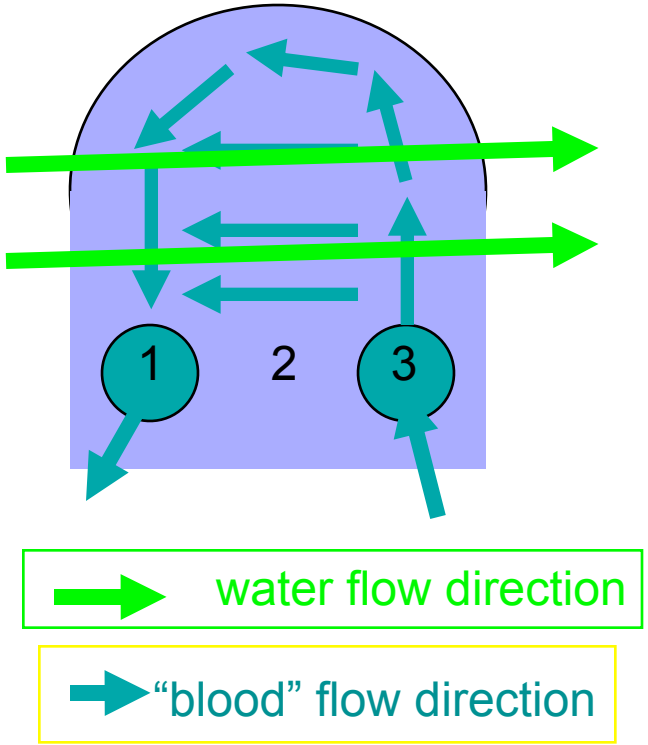
Foot

Three main body regions

Molluscan characters - Gills

Use counter current exchange to maximize gas diffusion

Why do they need to do this?



Molluscan characters

"Open" circulatory system

= no capillaries

Cephalopods (squid, octopus, nautilus, cuttlefish) have closed blood system – hydrostatic skeleton

Molluscan characters

Veliger larva

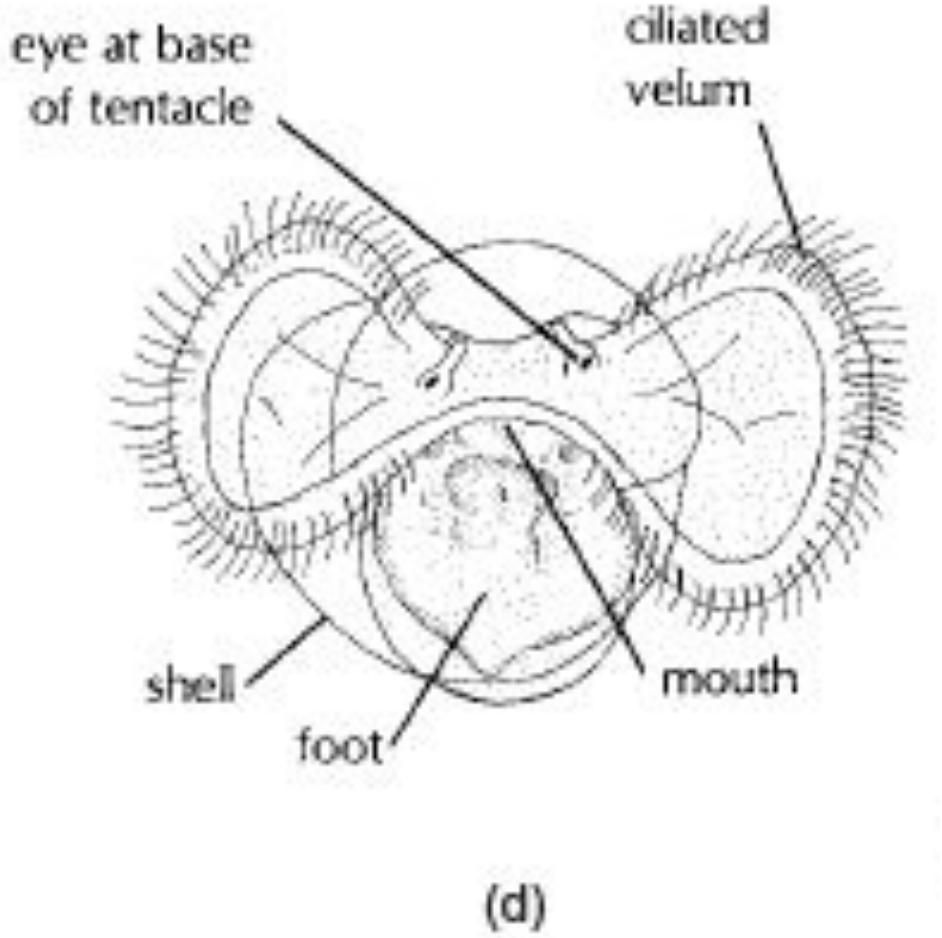
Molluscan characters

Veliger larva

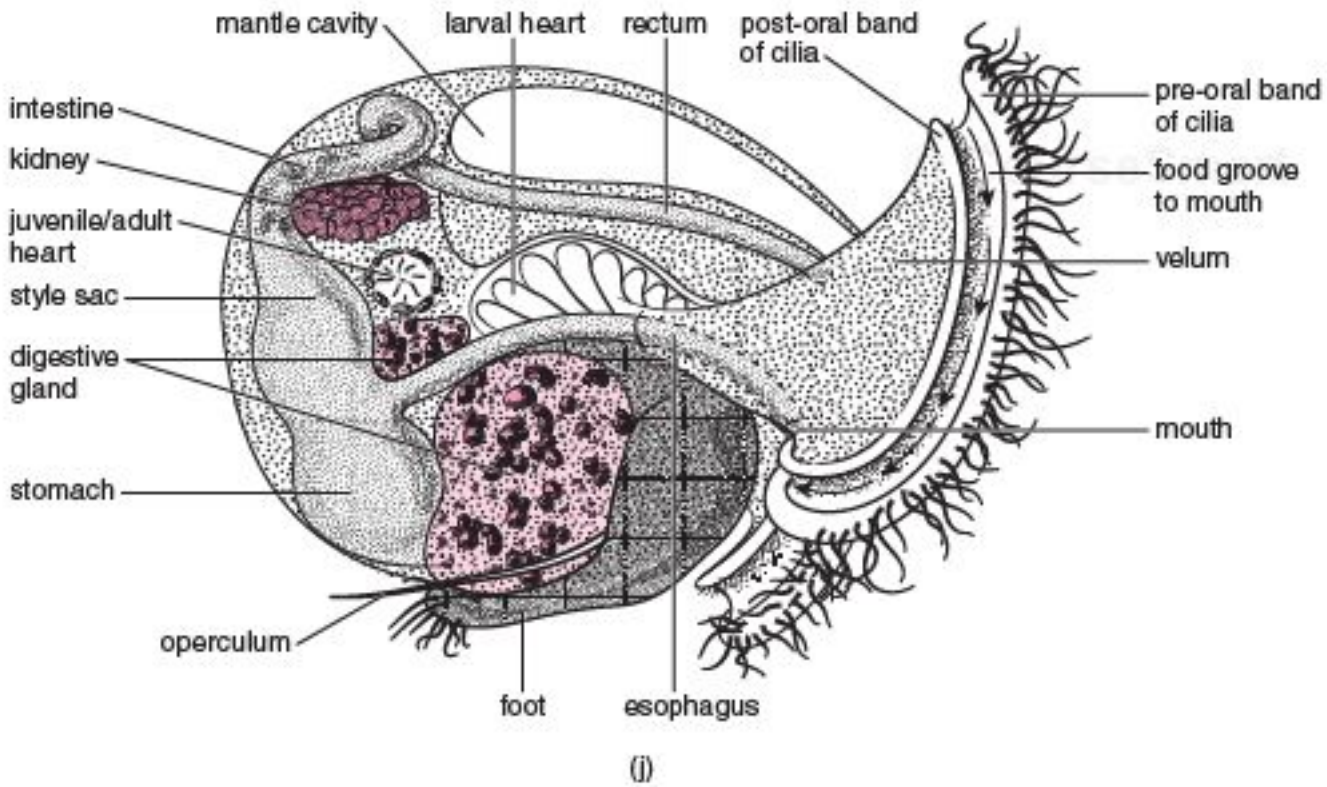
Velum

be used for locomotion, food (phytoplankton) collection, and gas exchange and is lost upon metamorphosis to adult form. Veligers may spend hours, days, weeks, or months swimming in the plankton before metamorphosing.

Veliger larva



Veliger larva



Text

Types of Larvae -
advantages, disadvantages

Veliger larva

What about freshwater bivalve species?

Veliger larva

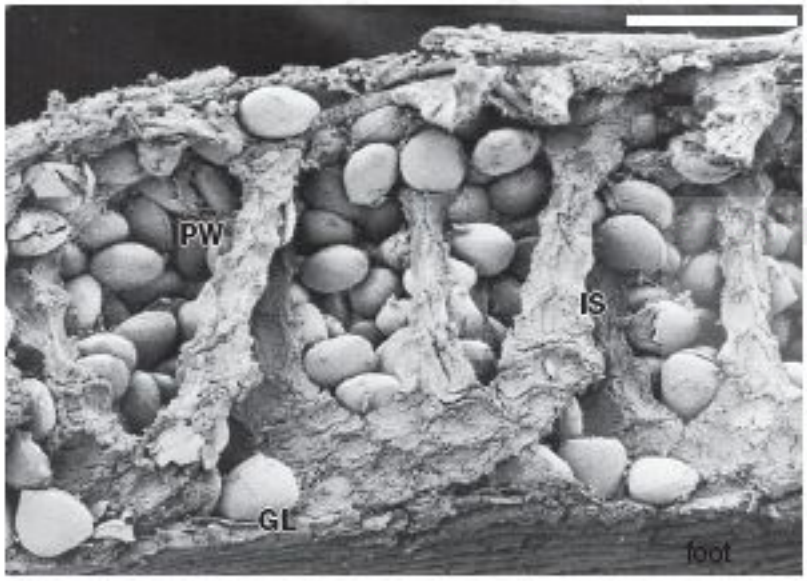
What about freshwater bivalve species?

glochidium

Veliger larva

What about freshwater bivalve species?

glochidium



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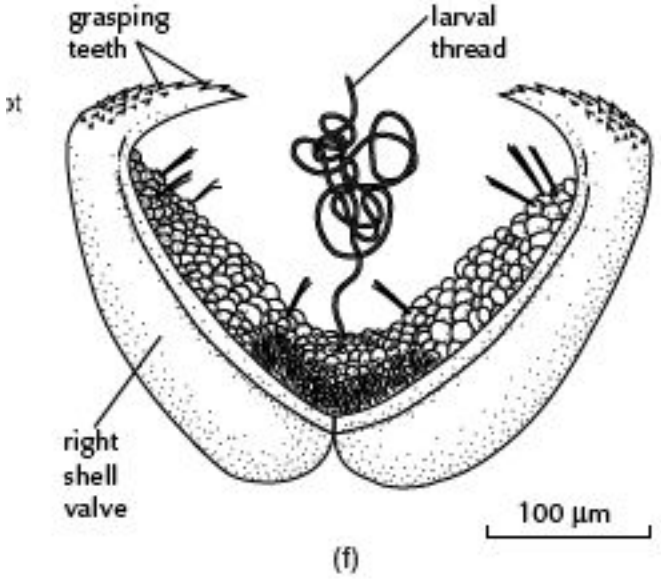


(f)

Feeding Molluscs in General

Microphagous browsers, herbivores, carnivores, omnivores, scavengers, deposit feeders, suspension feeders…

Mollusc Feeding Common Features

- Gut: mouth, buccal cavity, esophagus, stomach, intestine, rectum, anus
- Radula is usually used
- Digestion is always at least partly extracellular
- Enzymes produced by salivary glands, esophageal pouches, digestive ceca, or combination
- Stomach is site of extracellular digestion and digestive ceca (digestive gland) is site of absorption and intracellular digestion

Shell

Main component calcium carbonate

Three layers:

- **Periostracum**
- **Prismatic**
  - sometimes called the ostracum
- Inner layer may = **Nacreous**
  - sometimes called the hypostracum

Shell

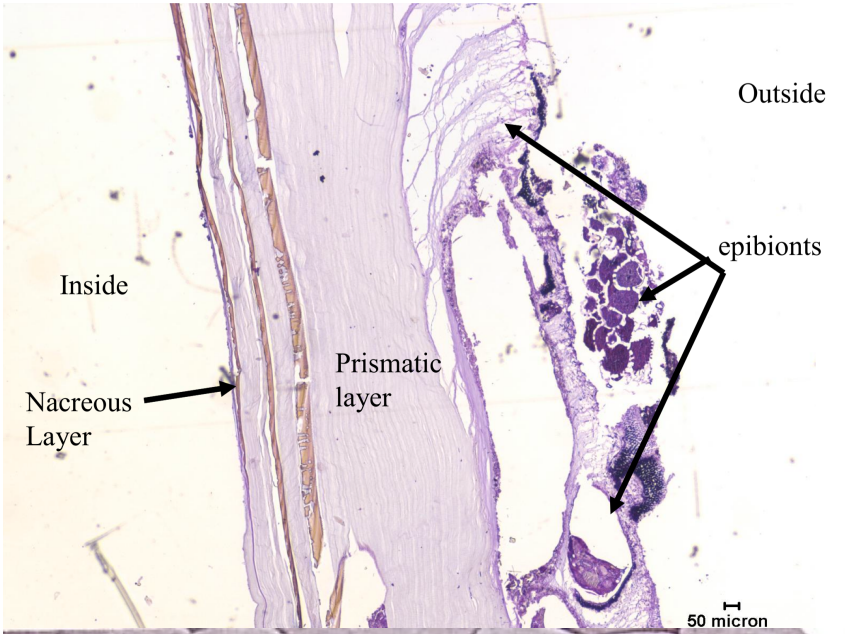
Periostracum:

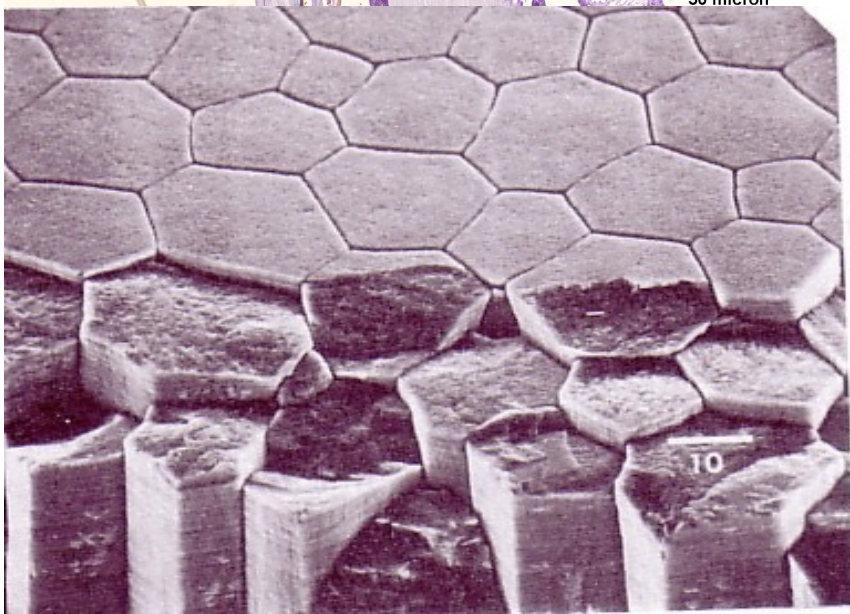
- organic layer
  - Conchiolin – quinone-tanned protein
- not repaired
- camouflage
- protects shell from dissolution

Shell

- **Prismatic layer**
  - **Calcium carbonate – calcite (or aragonite) crystals**
  - **Only formed at mantle edge**
  - **Usually the thickest layer**
  - **Shell extension (horizontal growth in abalone)**

Abalone





Shell Nacreous Layer

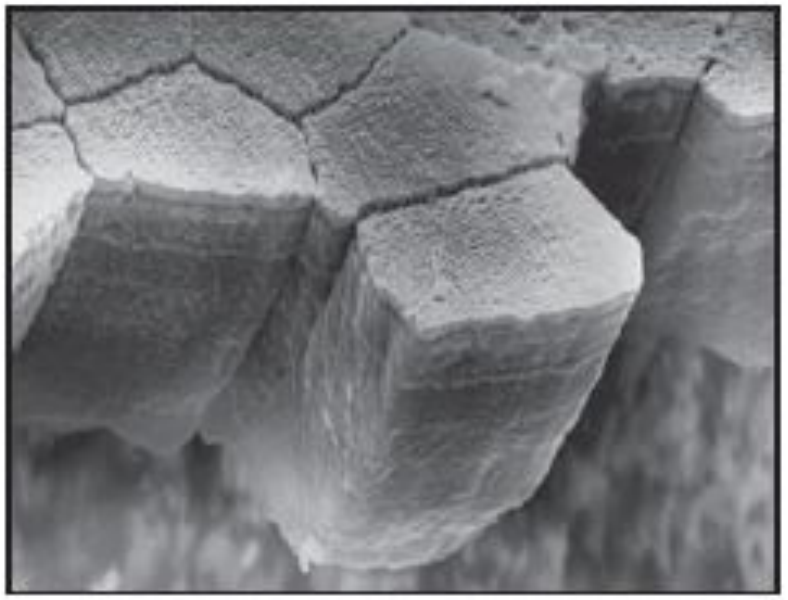
In monoplacophorans (ancestral type mollusc), gastropods, cephalopods and bivalves inner layer may be Nacreous, if so:

- **Always aragonite**
- **“mother of pearl”**
  - **Thick, straight: like porcelain**
  - **Thin, wavy: iridescent**
- **Formed continuously**
- **Strongest, but most “expensive”**

periostracal spines

(a)

prismatic layer



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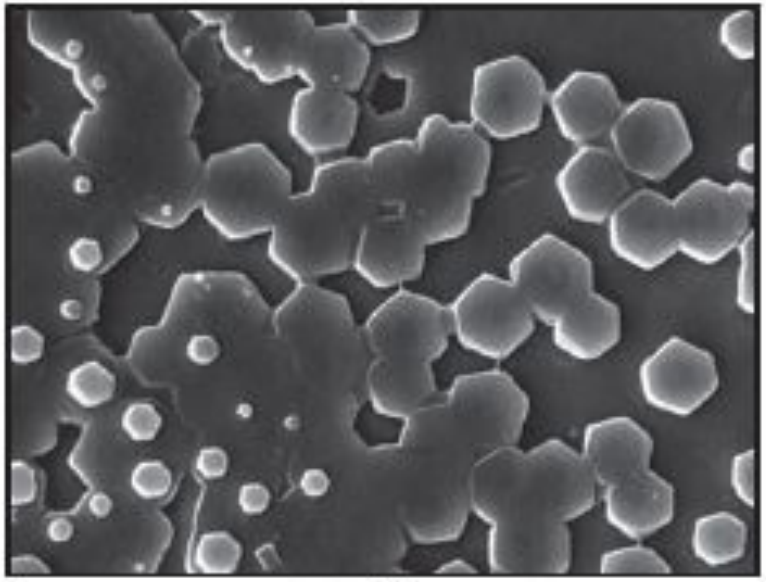
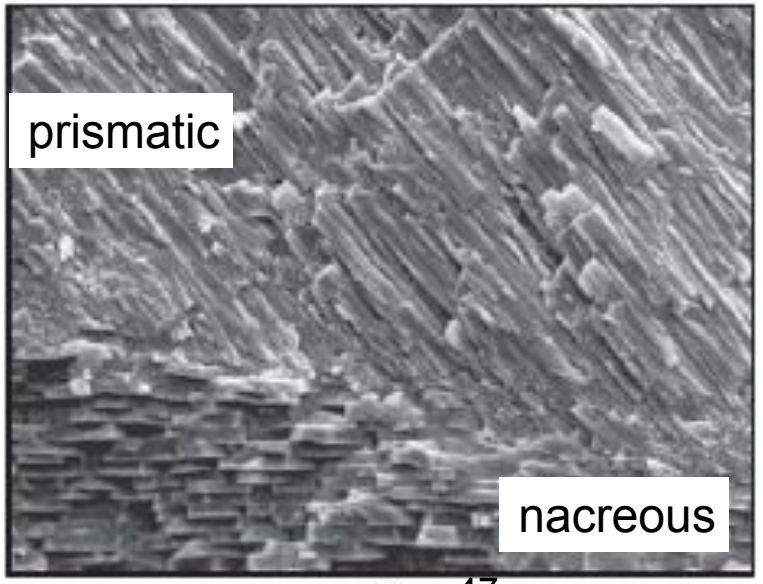


(c)



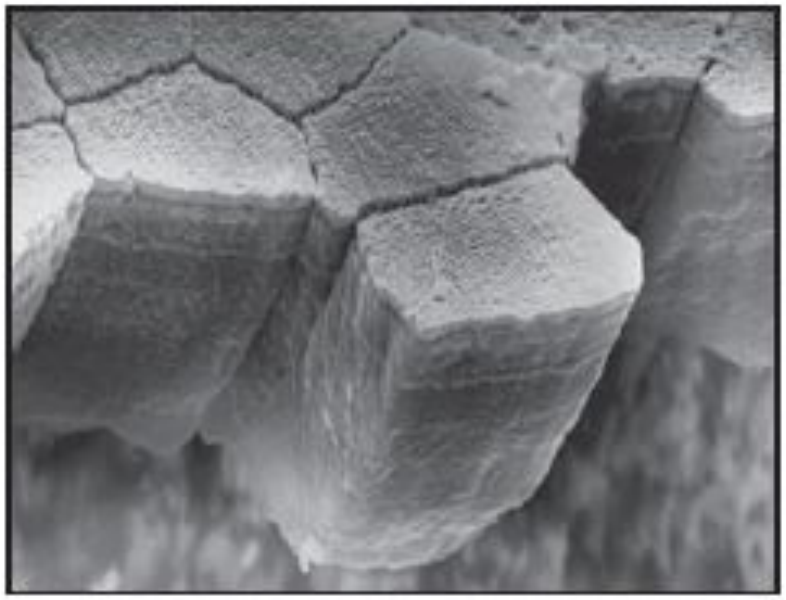
(d)

Ca tablets - nacreous

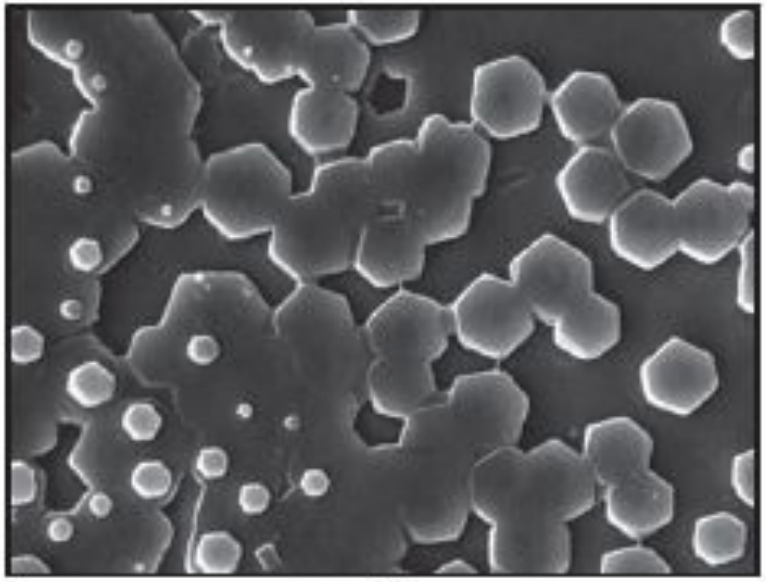
periostracal spines

(a)

prismatic layer



(b)



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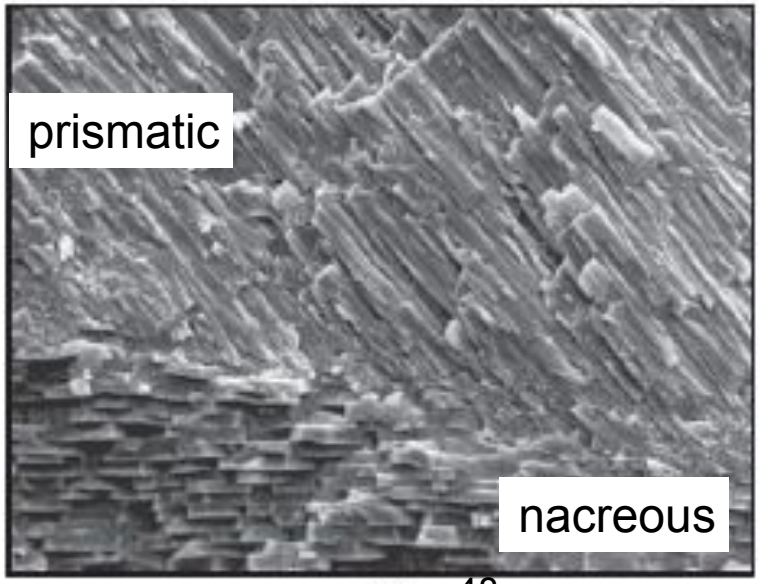


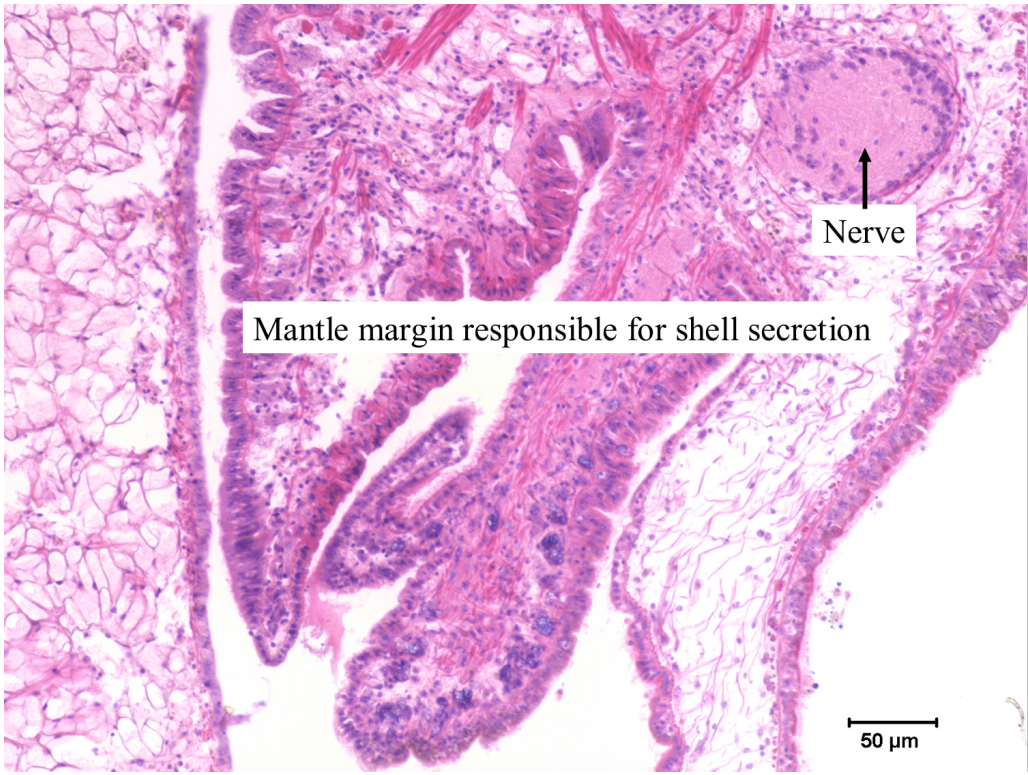
(d)

Ca tablets - nacreous

Shell formation

- Thin space between mantle and shell is where shell formation occurs (= extrapallial space)

- Calcium from seawater + carbon dioxide from respiration = calcium carbonate



Molluscan Characteristics Review Sheet

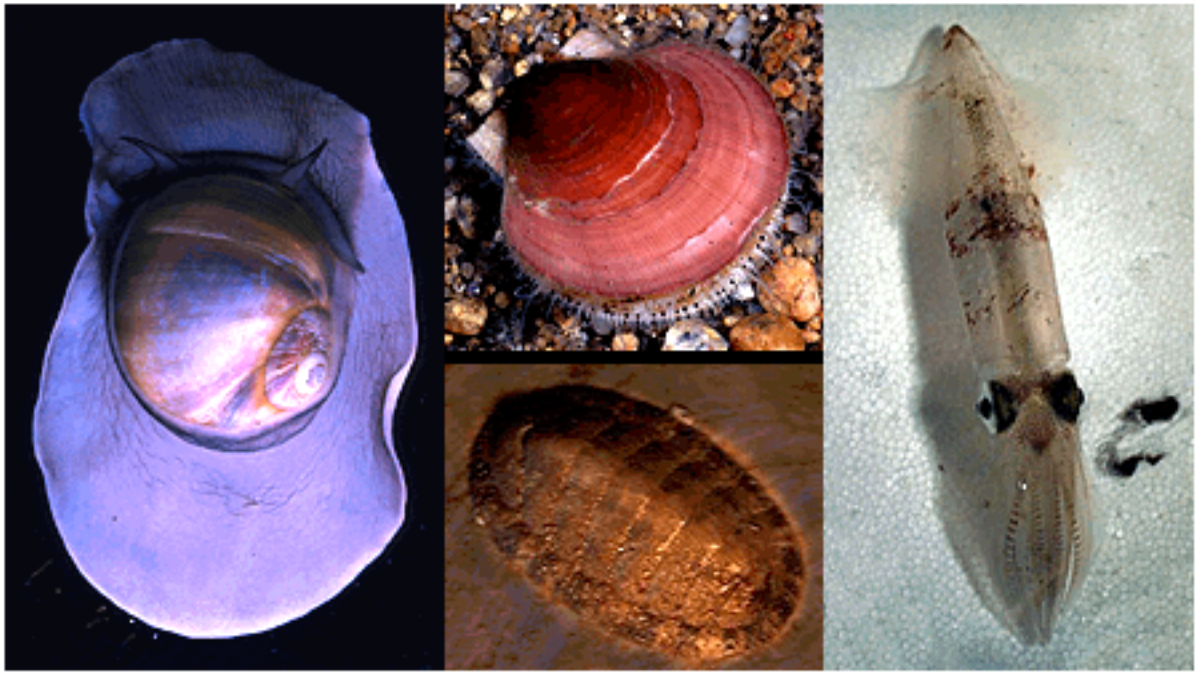
- All mollusks possess ***some or all*** of the following characteristics:
- **Bilateral symmetry** and lack segmentation
- Muscular foot which is modified into tentacles in cephalopods
- **Visceral mass** containing the digestive, excretory and reproductive organs
- **Mantle**, usually two folds that enclose the gills (**branchial or pallial cavity**) or lungs, and secretes the shell
- **Radula**, a zipper-like organ (built-in saw equipped with rows of microscopic teeth)
- Gills for respiration (the **ctenidium**)-counter current exchange
- Open circulatory system – no capillaries but has vessels except in cephalopods = considered closed
- **Veliger** larvae
- Shell made of calcium carbonate → fossils

Classification

7 classes

Mollusca

Snails, clams, mussels, squids, octopi, chitons, and tusk shells



- Polyplacophora (chitons)
- Conchifera
  - Monoplacophora (Tryblidia)
  - Bivalvia (mussels, clams, oysters, cockles, etc.)
  - Scaphopoda (tusk shells)
  - Gastropoda (snails, slugs, limpets, nudibranchs)
  - Cephalopoda (octopods, squids, nautiluses, etc.)

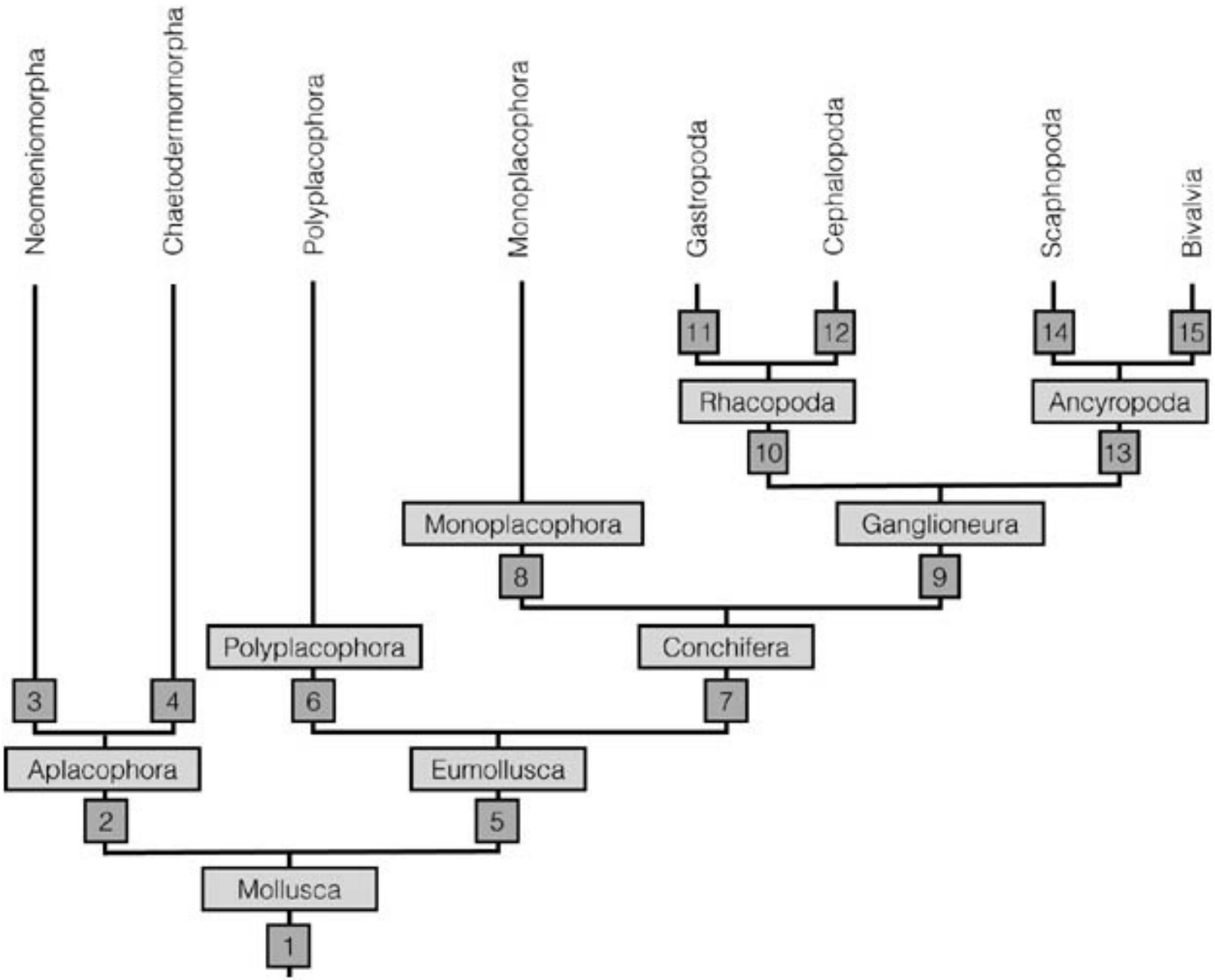
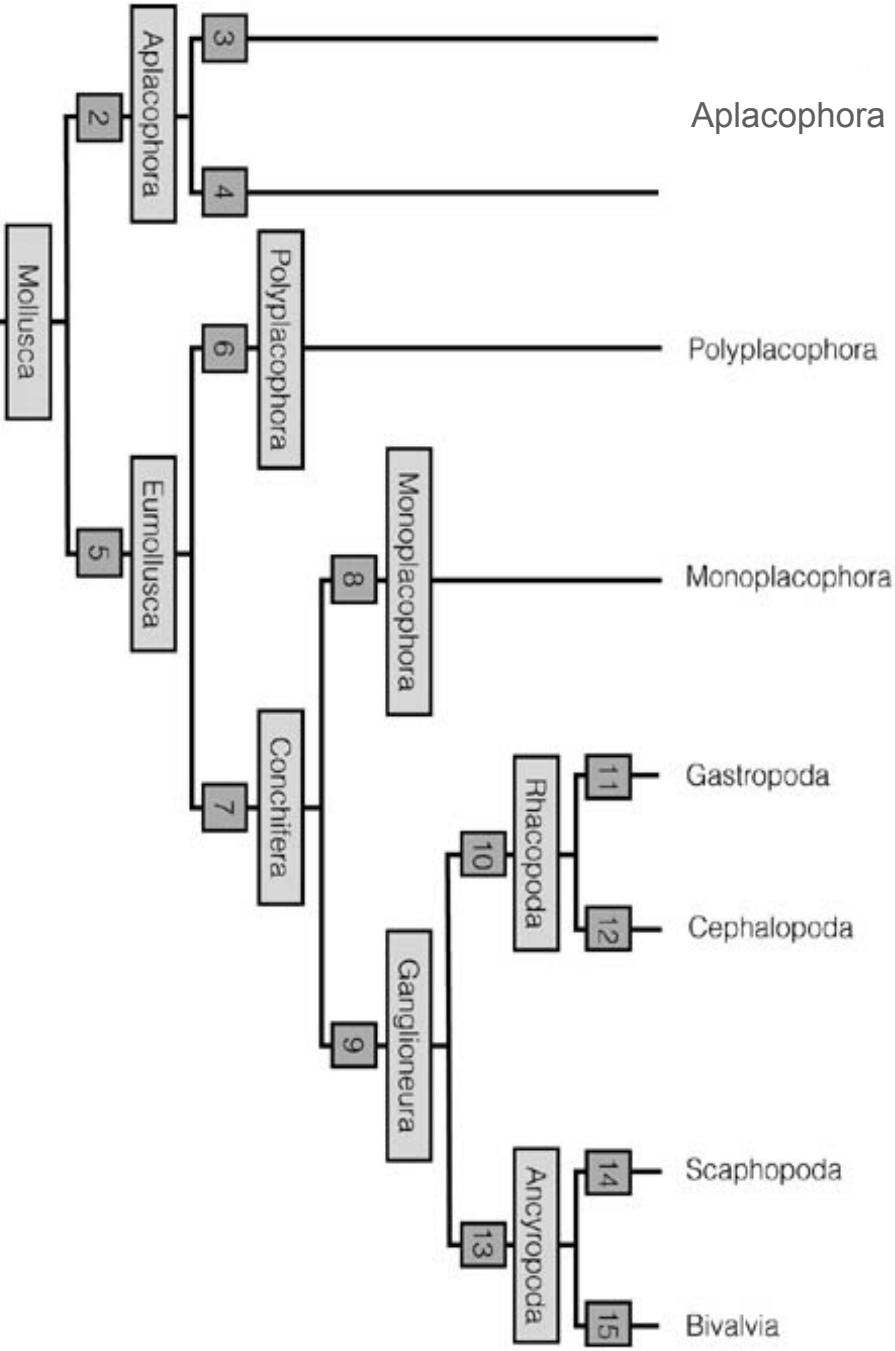


Figure 12-125: **A phylogeny of Mollusca.**



http://goo.gl/qDCWB

Aplacophora

- Defining Characteristics
  - Cylindrical, **vermiform** body with foot that is reduced or absent

Aplacophora

Mostly deep sea benthic animals

~320 extant species

Usually a few mm to 5 cm (up to 30 cm)

Lack a shell → spicules (only class w/o fossil record)

Reduced or absent foot

Gills as mantle folds or external

Aplacophora

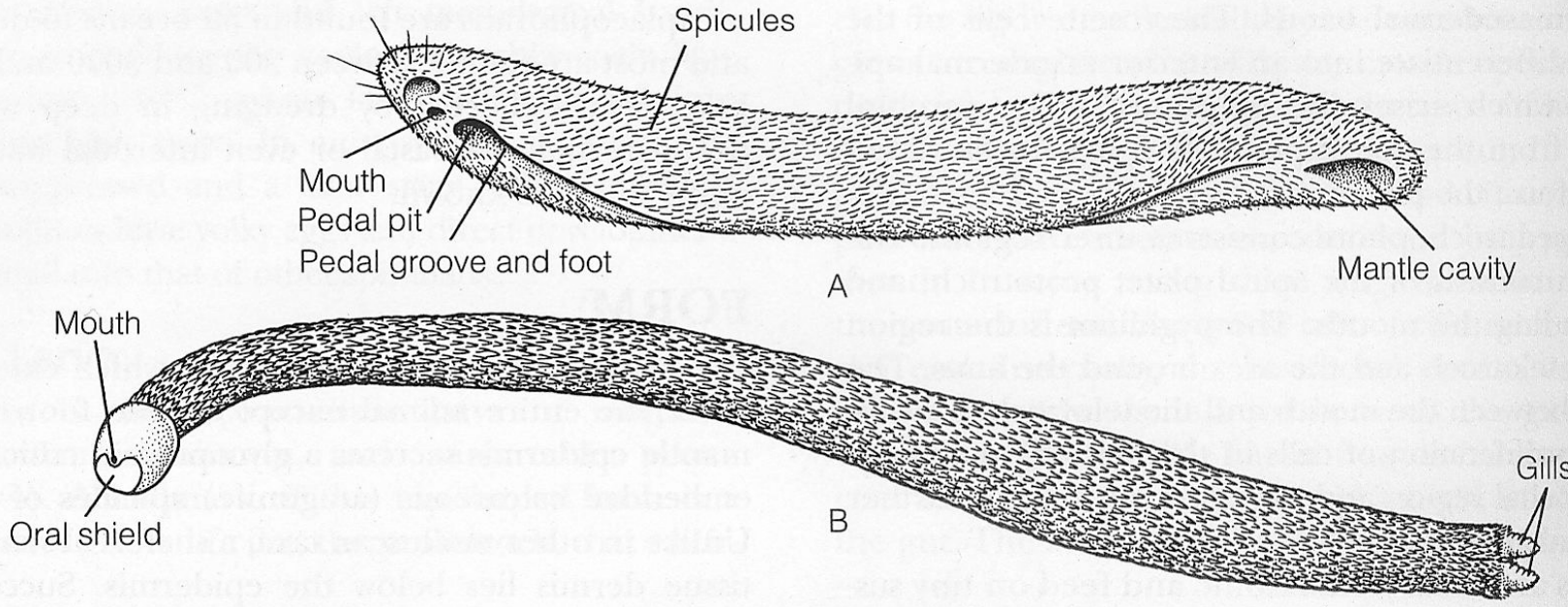


FIGURE 12-5 External anatomy of aplacophoran molluscs. **A,** A neomeniomorph. **B,** A chaetodermomorph. *(Redrawn and modified from Salvini-Plawen, L. V. 1972. Zur Morphologie und Phylogenie der Mollusken: Die Beziehungen der Caudofoveata und der Solenogastres als Aculivera, als Mollusca und als Spiralia. Z. wiss. Zool. 184:205–394)*

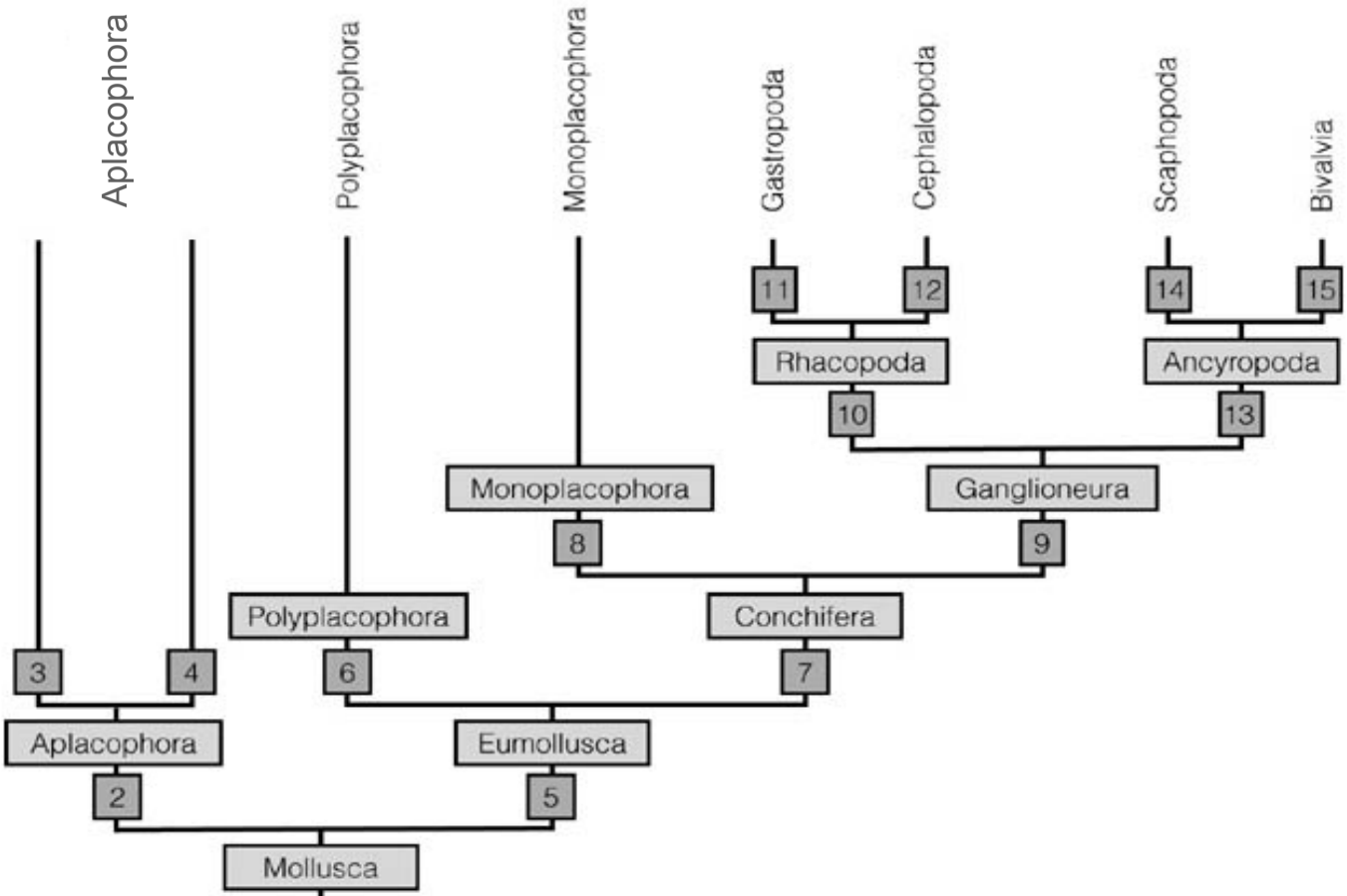
Ruppert, Fox, and Barnes 2004

Aplacophora Feeding

- Most have radula
  - Some have converted buccal cavity into sucking pump
- Linear gut
  - Some with a style sac and may have gastric shield
    - Style sac – part of gastrointestinal tract that is internally ciliated and rotates a style (mucus and protein rod) to help grind and digest food
    - Gastric Shield – chitin coating of stomach and style sac to help protect from style and to help grind food

Aplacophora Locomotion

- Foot, when present, is not muscular and locomotion is typically ciliarly
  - Use pedal cilia to glide over the sediment along a mucous trail they secrete
  - Some meander in or along mud
- Some live on cnidarians on which they feed and foot plays role in moving over cnidaria


Aplacophora
Polyplacophora
Monoplacophora
Gastropoda
Cephalopoda
Scaphopoda
Bivalvia
11
12
14
15
Rhacopoda
Ancyropoda
10
13
Monoplacophora
Ganglioneura
8
9
Polyplacophora
Conchifera
3
4
6
7
Aplacophora
Eumollusca
2
5
Mollusca

Polyplacophora

Chitons

Defining Characteristic

- Shell forms series of 7-8 separate, overlapping plates

Katharina tunicata

Tonicella

Polyplacophora

Cryptochiton stelleri **in ventral view.**

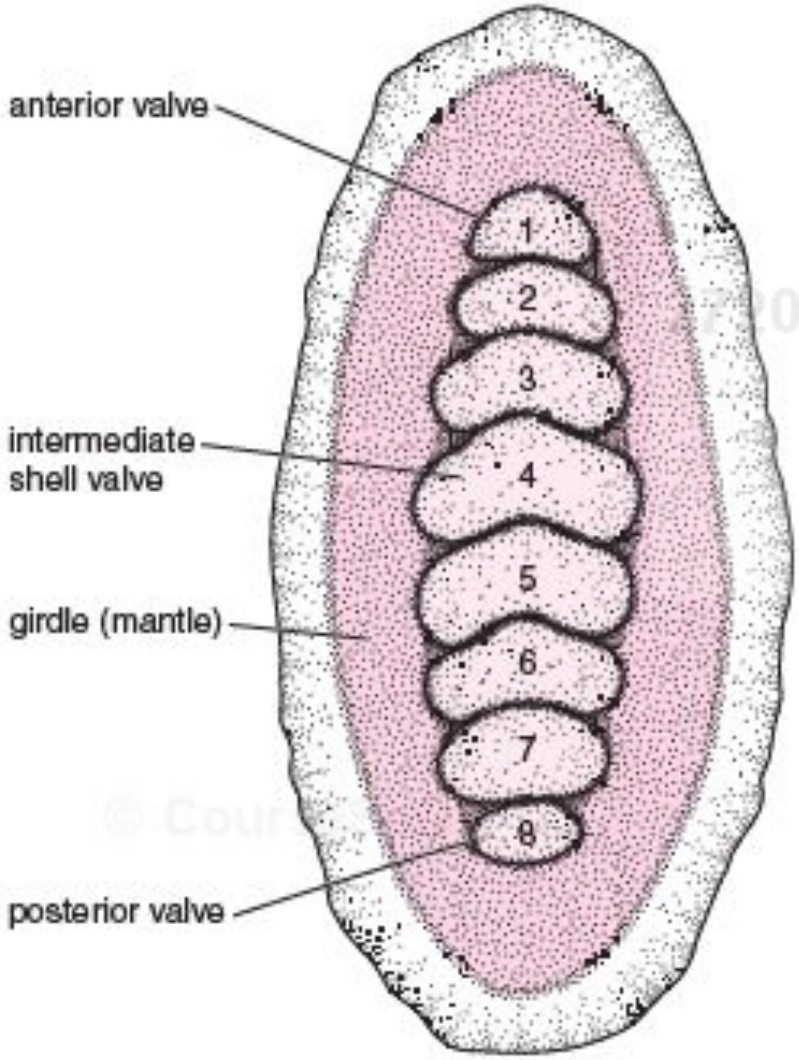
Friday Harbor, Washington.

Cryptochiton stelleri**, giant pacific chitin (Polyplacophora: Acanthochitonina), in dorsal view. Friday Harbor, Washington**

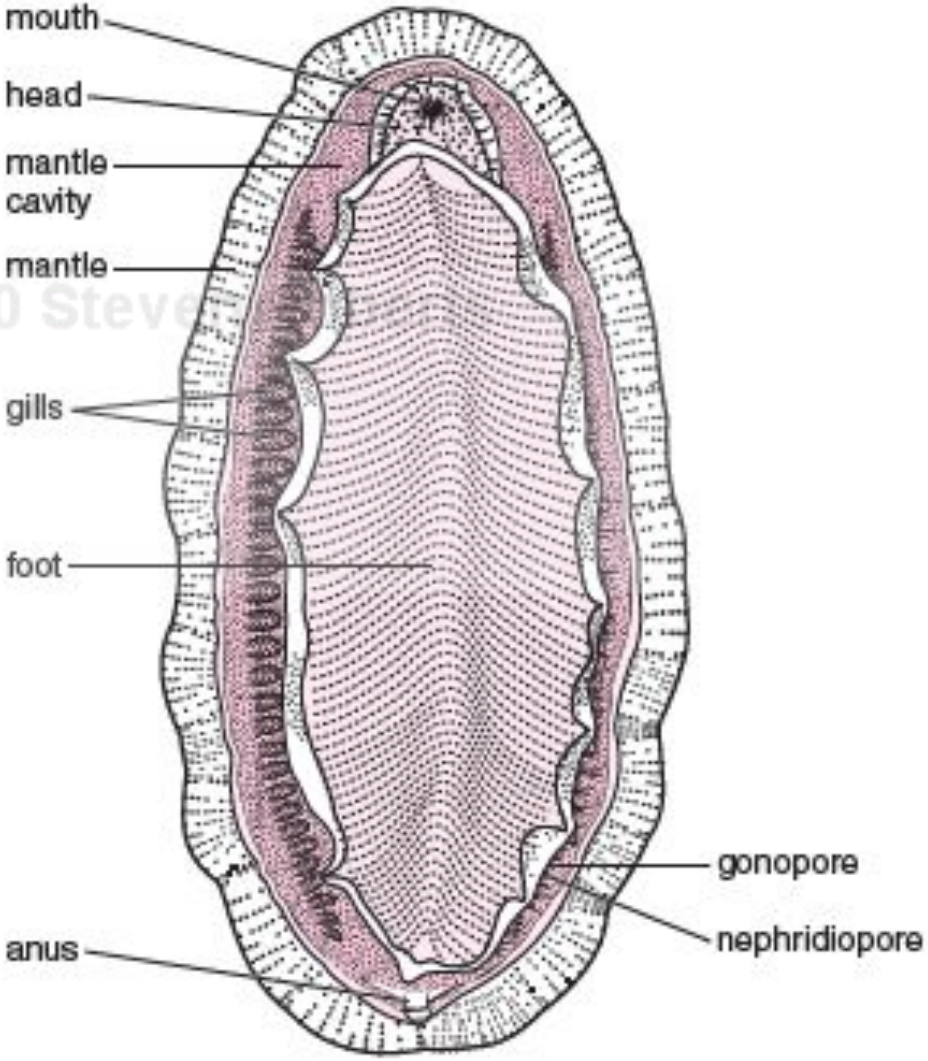
Polyplacophora

- ~800 extant species, ~350 fossil spp.
- Usually 3-10 cm in length, 40 cm max size
- All marine; most near shore – some deep

Polyplacophora

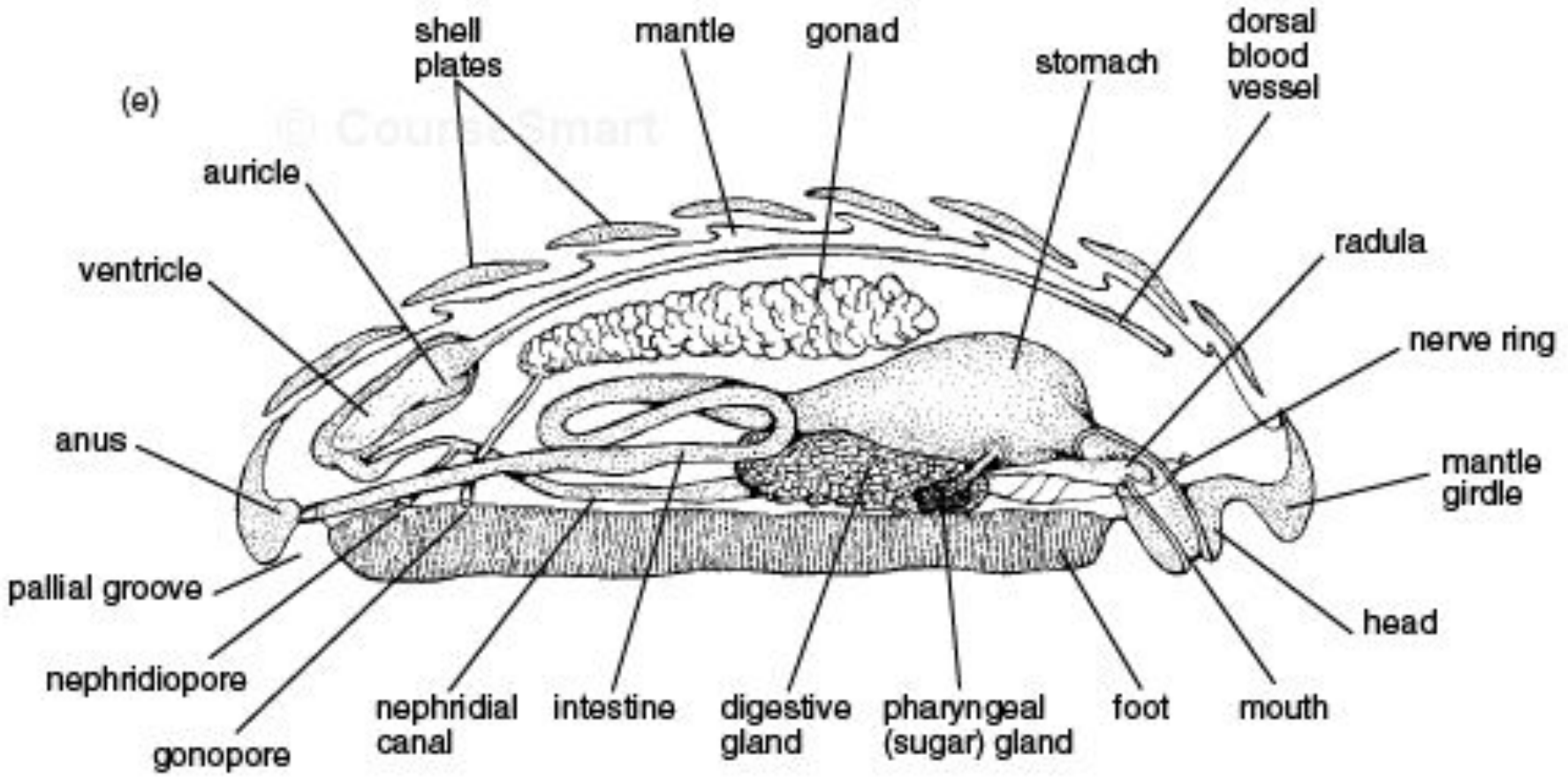


(a)



(b)

Polyplacophora



Polyplacophora - nervous system

Ladder-like

Sense organs limited:

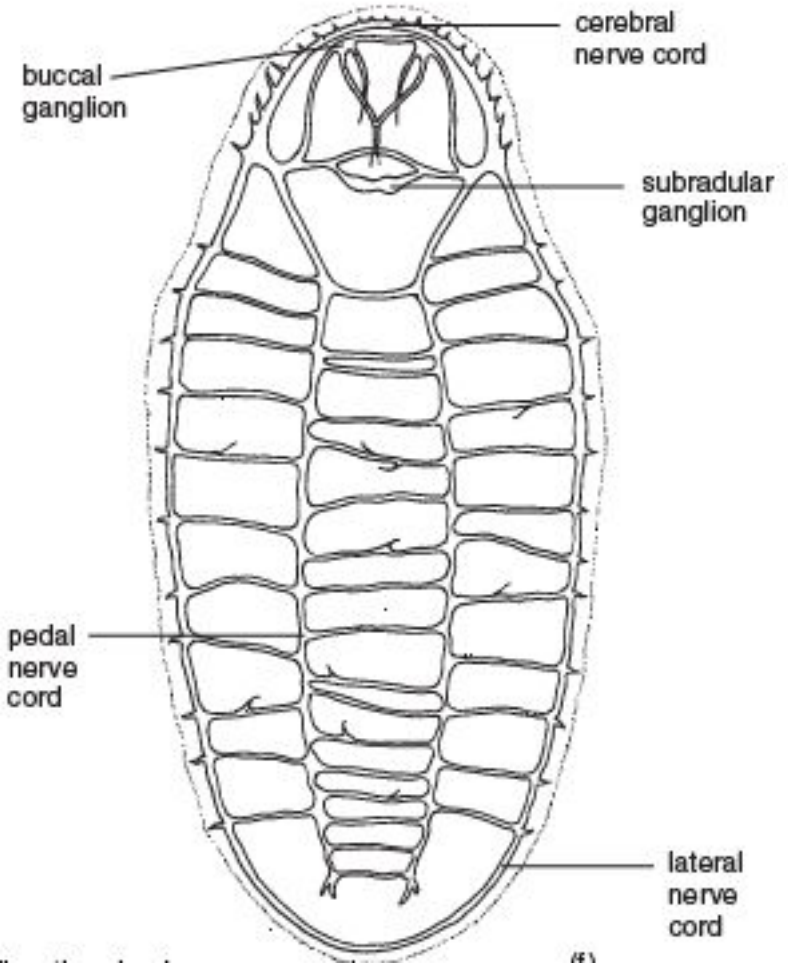
subradular organ (tongue-like chemsensory organ for feeding),

mantle receptors

Aesthetes

some with **osphardium**

(tests water)



lack statocysts, tentacles, and eyes on head

STUDIES ON HOMING IN THE CHITON *ACANTHOZOSTERA GEMMATA*

By M. J. THORNE*

Feeding excursions are made only at night while uncovered by the tide. One or two excursions may be made per night, depending on the tide times. When the time between onset of darkness and cover by the tide was 40 min, chitons did not move from their homesites, but when there was an interval of 90 min between dusk and cover by the tide, 12 out of 20 chitons in a marked group moved out to feed. The distances travelled were small (20 cm or less) and all but two individuals returned to their homesites before tidal cover. These two chitons were still active after one hour's cover by the tide.

TABLE 1

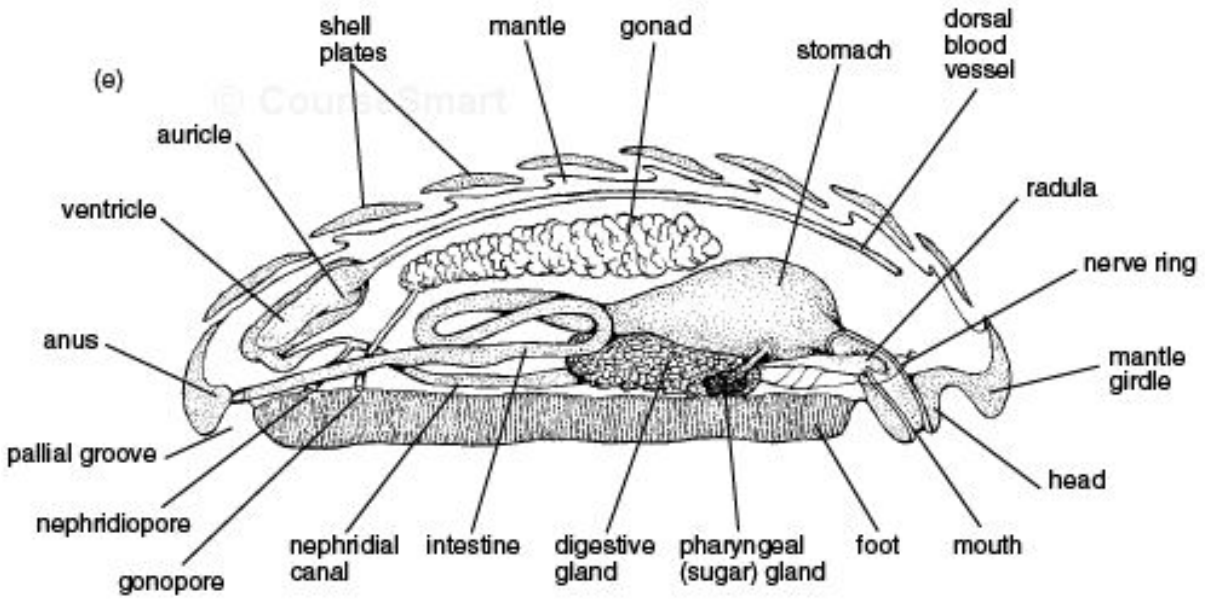
DISTANCE TRAVELLED (cm) FROM HOMESITE AND HOMING ABILITY OF A. GEMMATA

No. of Chiton	Distance Travelled	Return to Homesite	No. of Chiton	Distance Travelled	Return to Homesite
A1	84	yes	A19	79	yes
A2	133	yes	A20*		
A3	39	yes	A21	28	yes
A4*			A22	49	yes
A5*			A23	34	yes
A6	24	yes	A24	21	yes
A7	44	yes	A25	0	—
A8	41	yes	A26	0	—
A9*			A27	82	yes
A10	66	yes	A28	29	yes
A11	79	yes	A29	30	yes
A12	24	yes	A30	18	yes
A13	34	yes	A31	41	yes
A14	60	yes	A32	26	yes
A15	0	—	A33	24	yes
A16	49	yes	A34	46	yes
A17	51	yes	A35	42	yes
A18	41	yes			

* Chiton and homesite marked in the afternoon but chiton could not be found that night or subsequently.

- Chitons moved at an average speed of 0.24 cm/min
- *Fasted recorded speed 3 cm/min*

Polyplacophora - feeding



- 'Linear' digestive tract – mouth and anus at opposite ends
- Most use radula (often tipped with iron-oxide) for feeding
- Salivary glands
- Paired esohageal glands (sugar glands) secrete amylase into posterior esophagus → stomach

Polyplacophora - repro

-Nearly all dioecious

(gonochoric)

-Single central gonad -
Release gametes into exhalent chamber of mantle cavity via two **gonoducts**

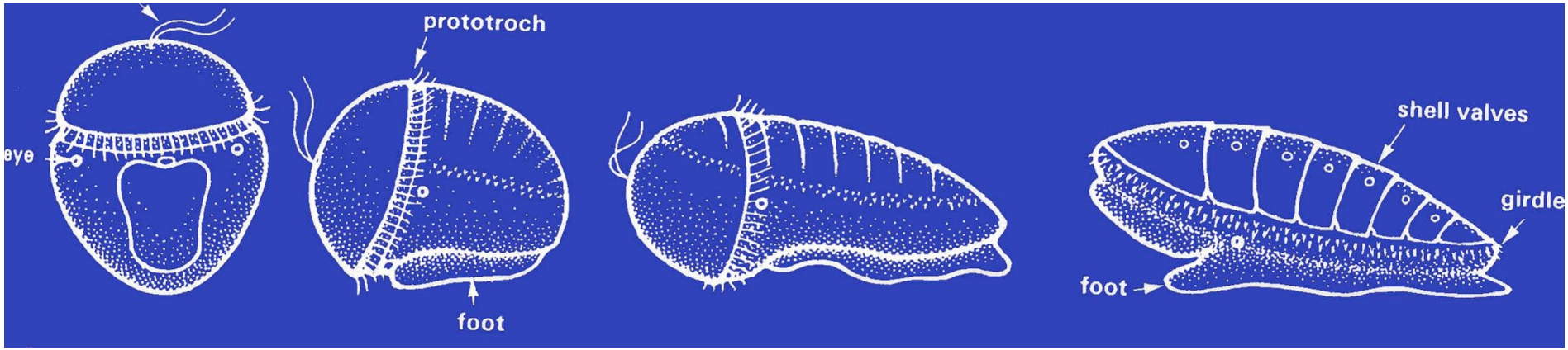
Not through pericardial cavity or nephridium

-External fertilization in the sea or female's mantle cavity

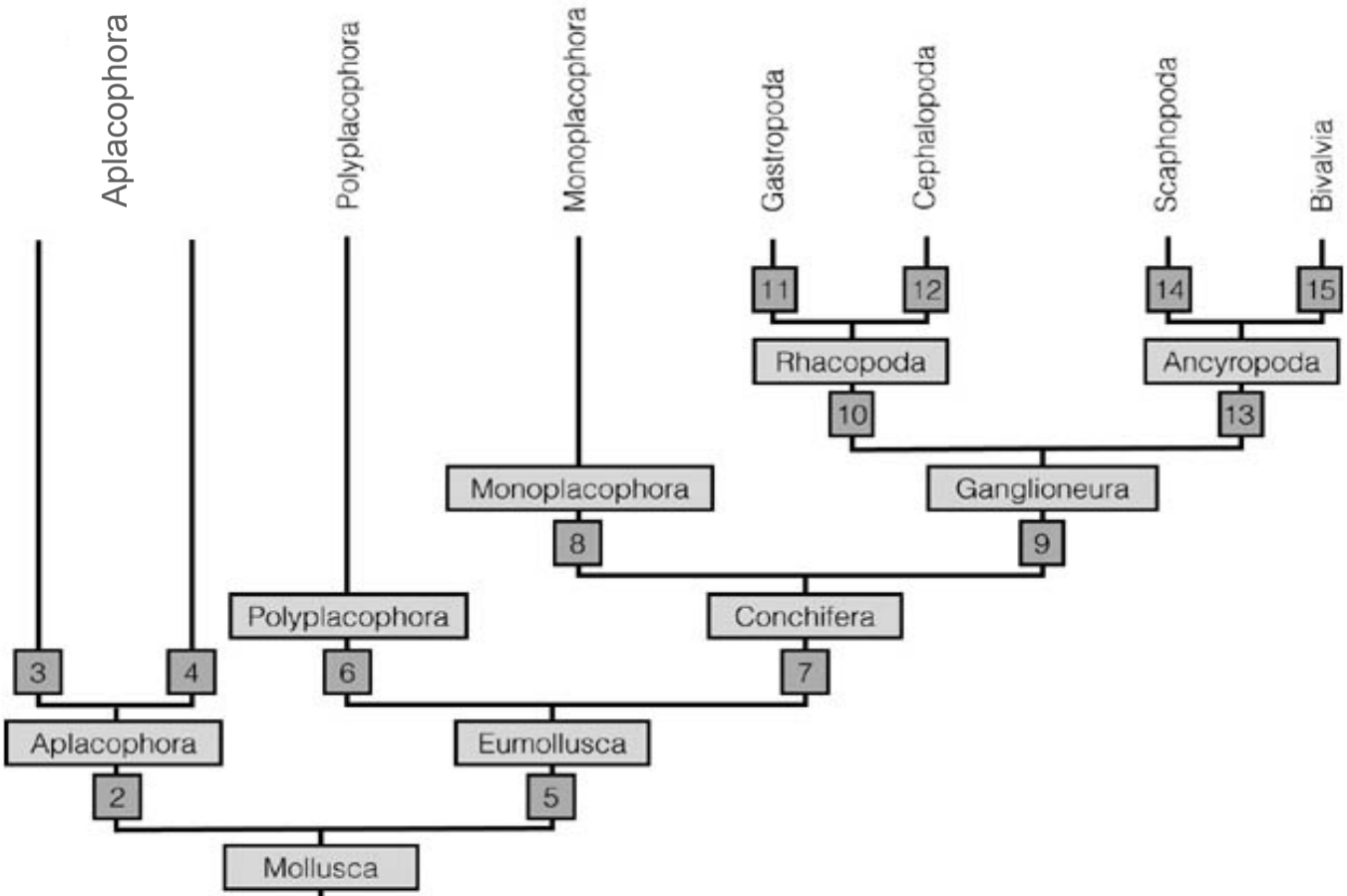
-Lecithotrophic trochophore larvae (**no veliger**)

~30 spp. eggs brooded in female mantle cavity; development is direct

Polyplacophora - development



trochophore **juvenile**


Aplacophora
Polyplacophora
Monoplacophora
Gastropoda
Cephalopoda
Scaphopoda
Bivalvia
11
12
14
15
Rhacopoda
Ancyropoda
10
13
Monoplacophora
Ganglioneura
8
9
Polyplacophora
Conchifera
3
4
6
7
Aplacophora
Eumollusca
2
5
Mollusca