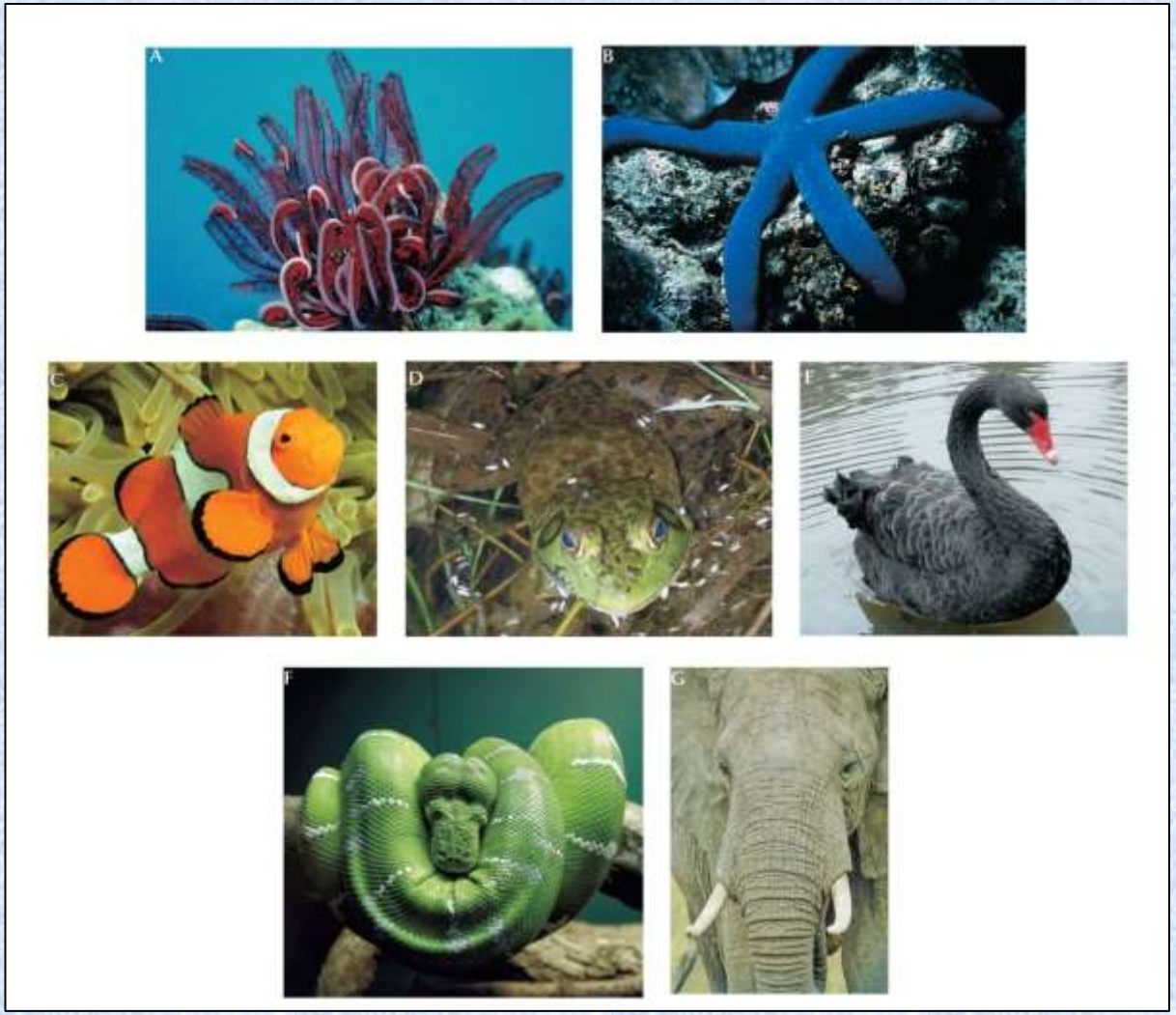
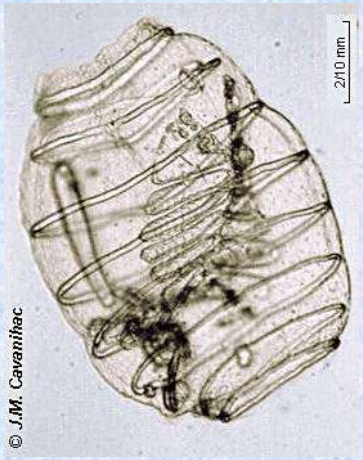
Deuterostome Animals
Echinoderms and Chordates



Deuterostome Roots

- We deuterostomes develop butt-first, and we're proud of it..
- But not many other clades of animals develop this way…



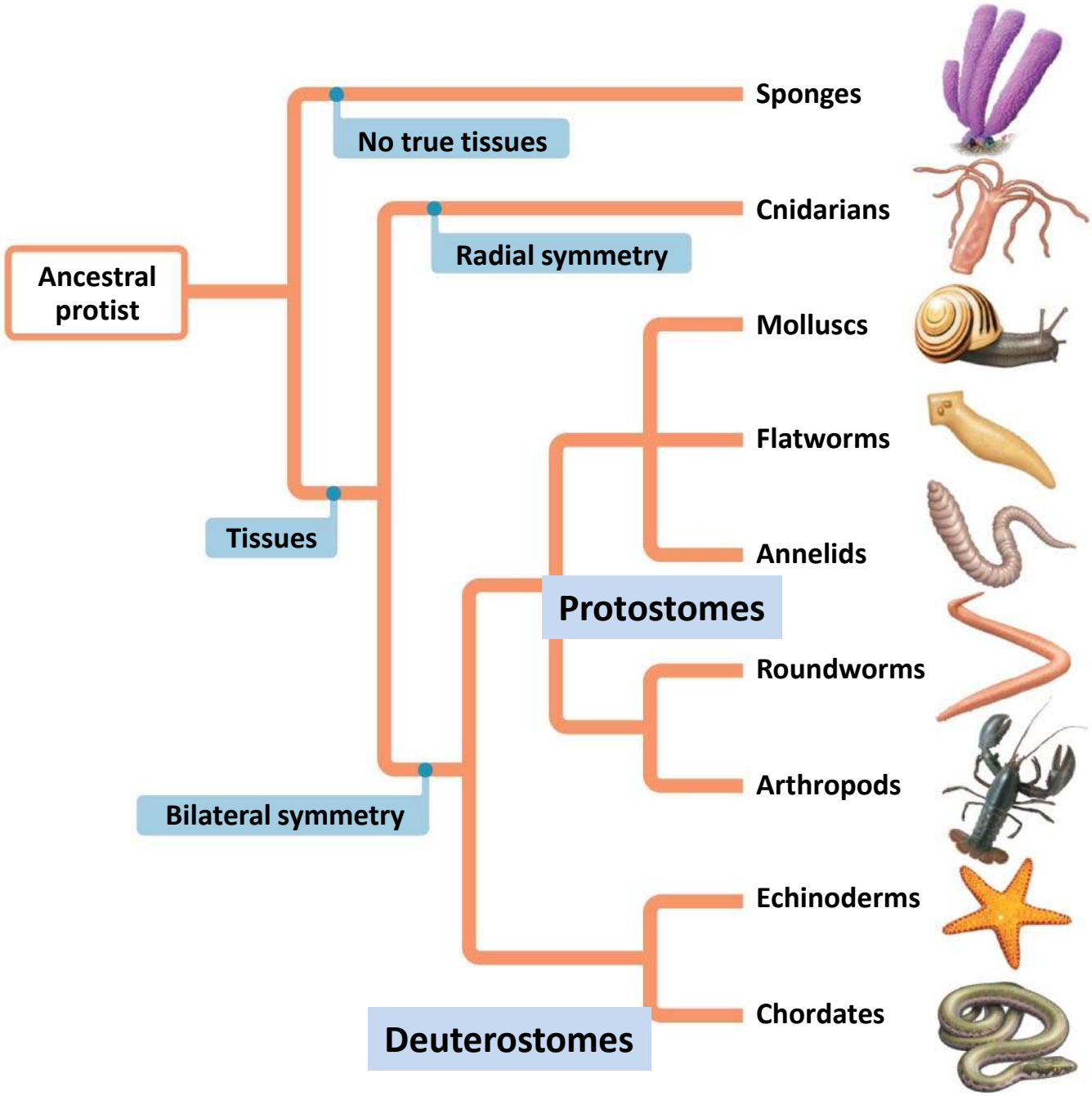
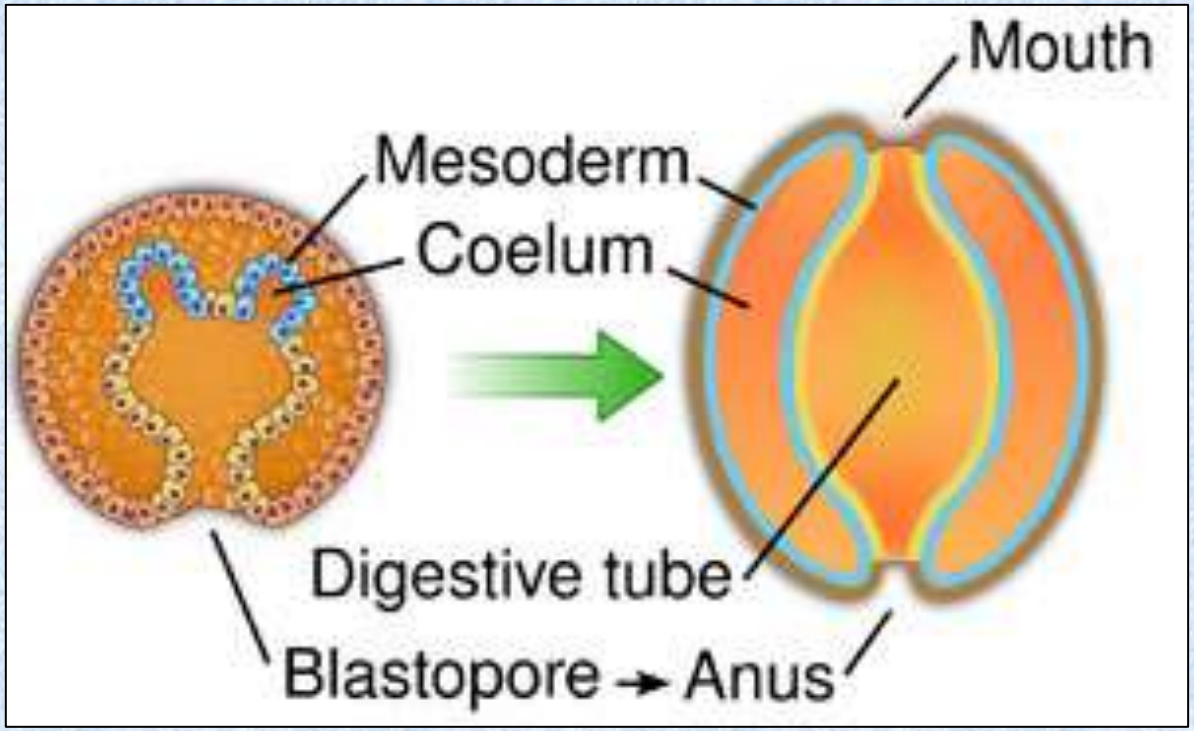


Figure 17.5

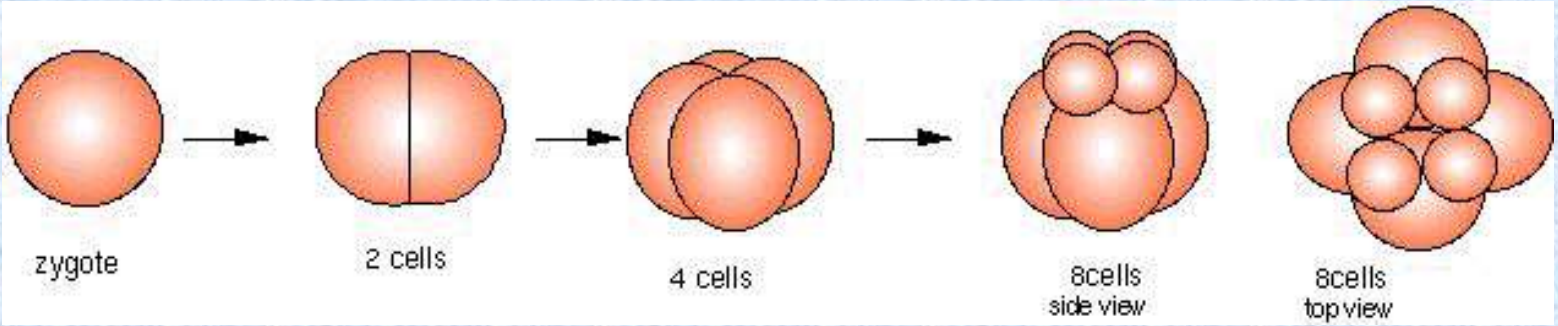
Two major kinds of Coelomates:

- **Protostome** – mouth develops from blastopore.
  Rotifers, Flatworms, Annelids, Molluscs, Arthropods

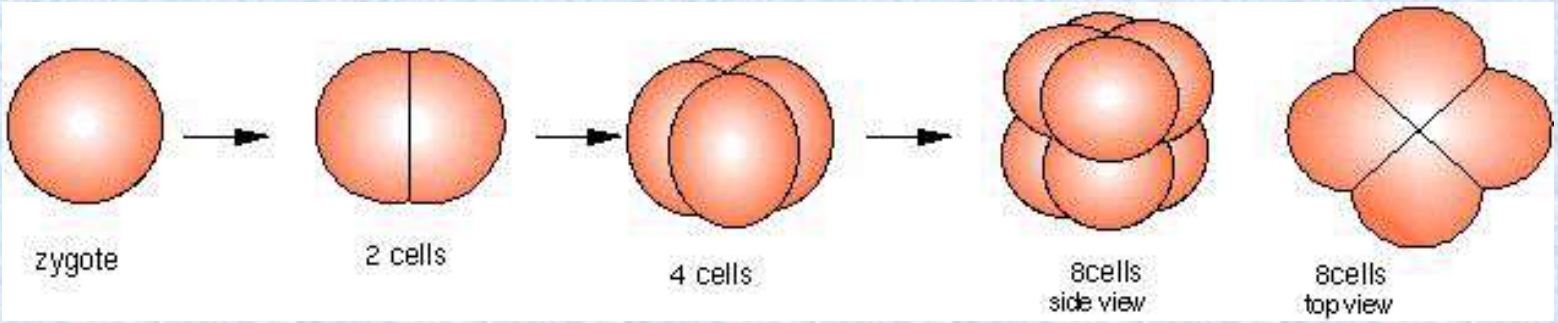
- **Deuterostome** – anus forms from blastopore
  Echinoderms, Chordates



Cleavage



Spiral- third division and subsequent are unequal…typical of protostomes



Radial- third division is equal…typical of deuterostomes

Blastopore

becomes the mouth

becomes the anus

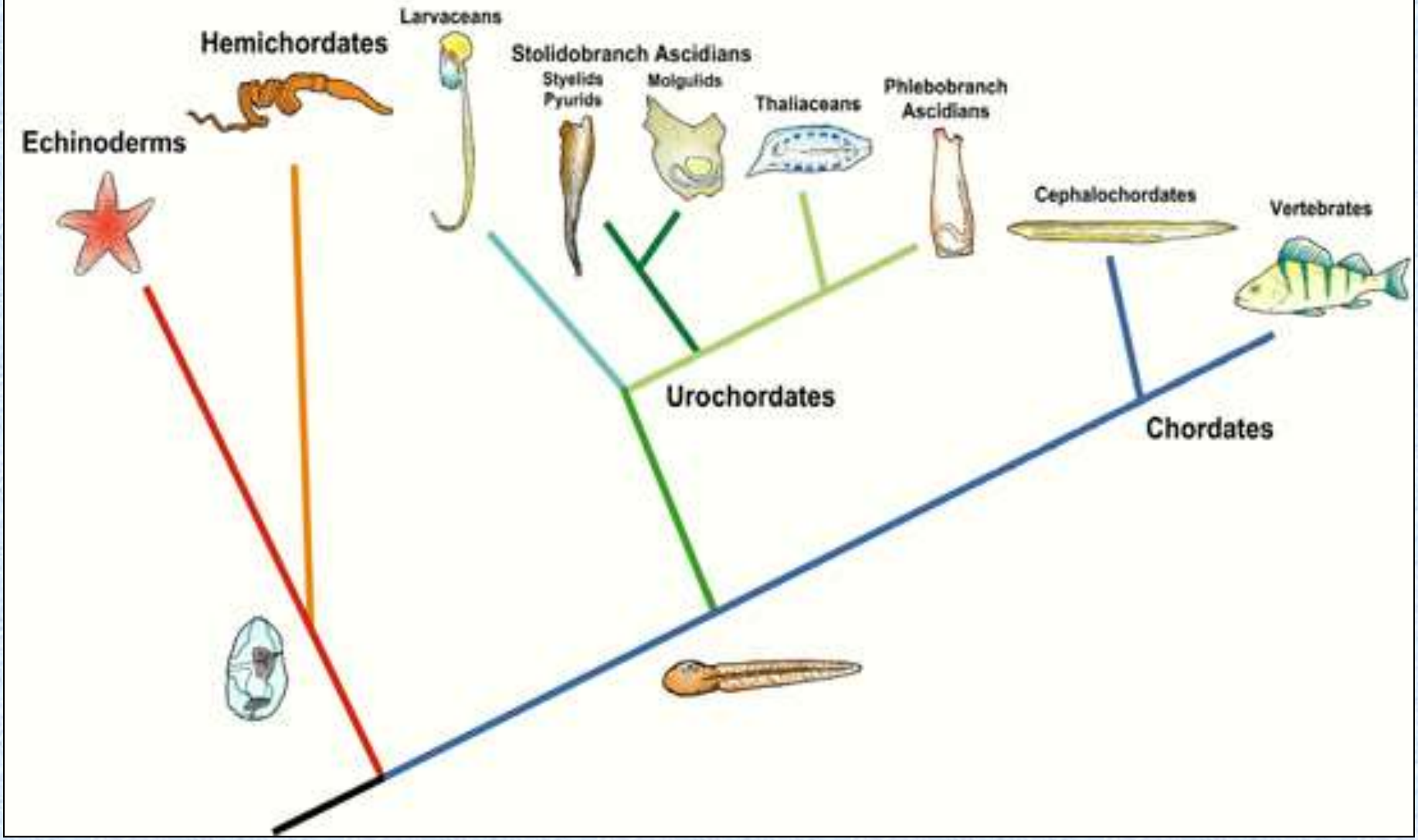
Annelida
Mollusca
Onycophora
Arthropoda

Protostomes

Deuterostomes

Echinodermata
Chordata

Deuterostome Evolution



Based mainly on 18S RNA, Cameron et al. 2000 PNAS 97(9): 4469-4474

Deuterostome Phyla

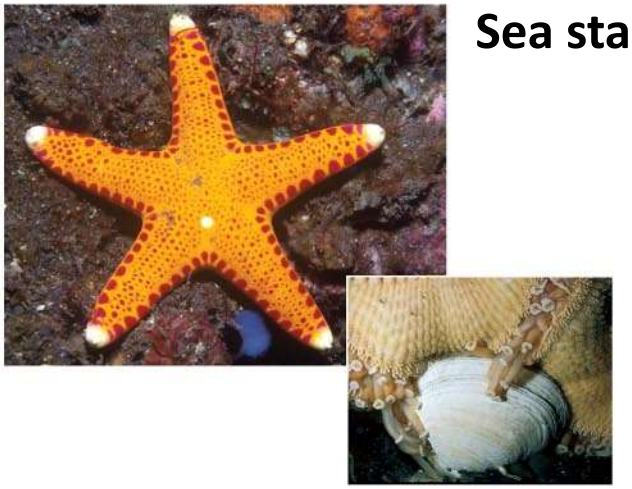
- Echinodermata (sea stars, urchins, crinoids)
- Hemichordata (acorn worms, pterobranchs, extinct graptolites)
- Urochordata (tunicates, salps)
- Chordata (cephalochordates, vertebrates)

Phylum Echinodermata

Sea stars, sea urchins, sea cucumbers, sand dollars

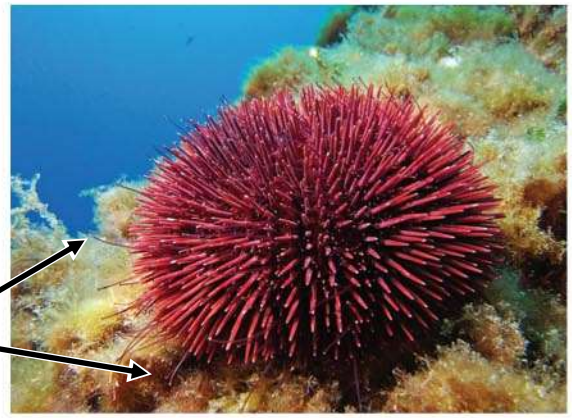
Marine animals with:

- Spiny “skin”
- Water vascular system
- Tube feet
- Endoskeleton plates
- Radial symmetry as adults
- Bilateral symmetry as larvae



Sea star

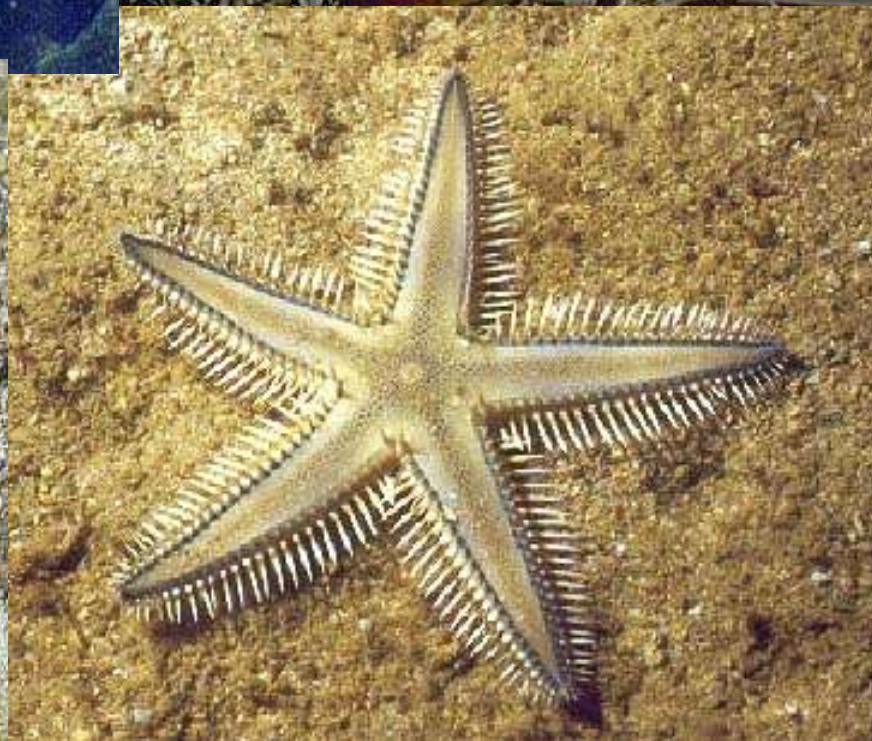
Tube feet



Sea urchin

Sea cucumber

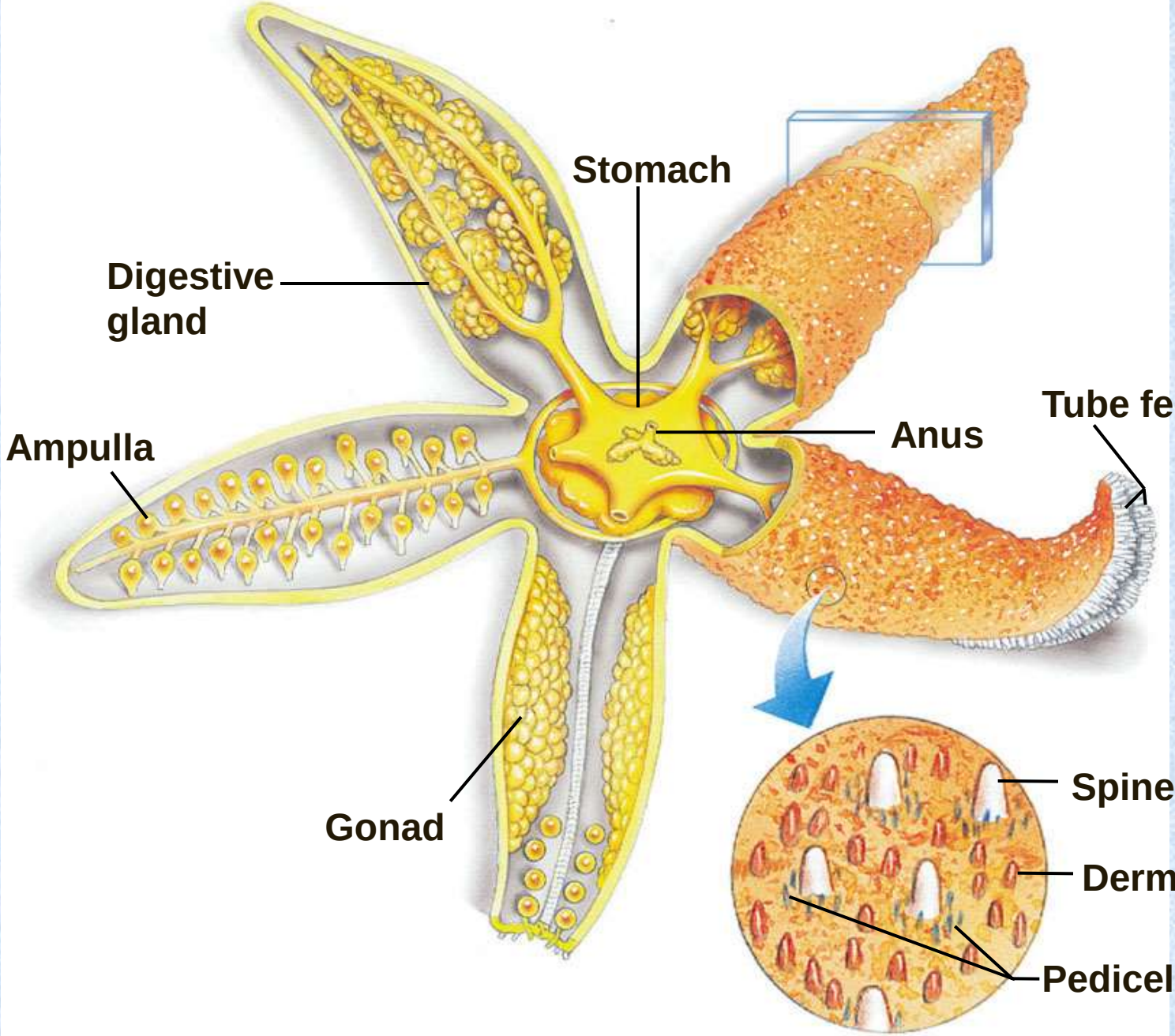
Sand dollar



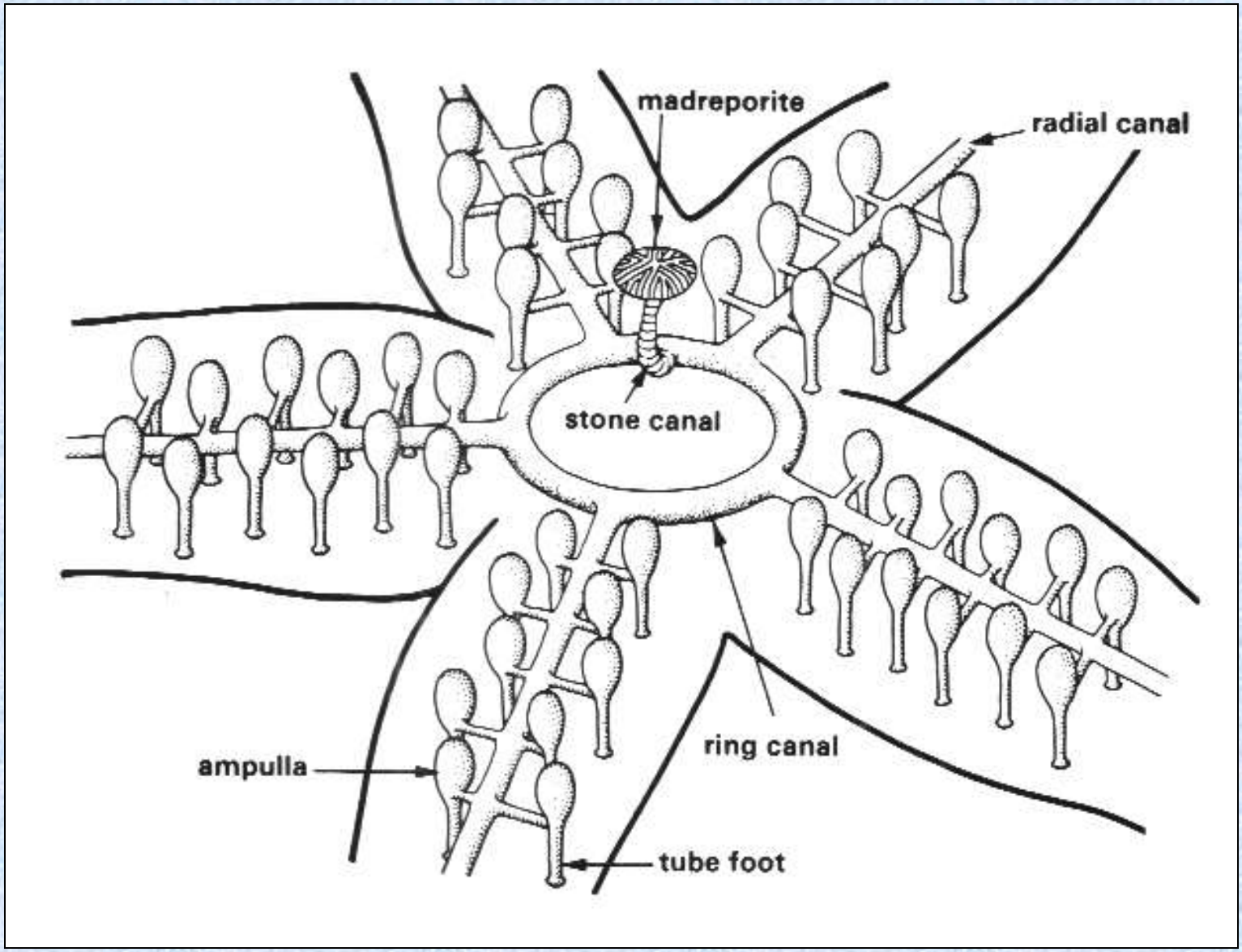
Class Asteroidea (Sea Stars)

- Mainly carnivorous – evert stomach to carry out digestion.
- Locomotion mainly by tube feet- arms move only slowly
- Arms are short and thick, with coelomic extensions containing digestive glands and gonads

Sea stars in time lapse
https://www.youtube.com/watch?v=CYN0J3HCihI
Star Fish Eating Clam
https://www.youtube.com/watch?v=4dkieg7F37c
sea-stars eating mussels
https://www.youtube.com/watch?v=2DFXGafpGkQ



Echinoderm water vascular system



A seastar (*Asterias*) opening a bivalve

Starfish facts: 11 facts about Sea Stars
https://www.youtube.com/watch?v=I8as-z-EShc

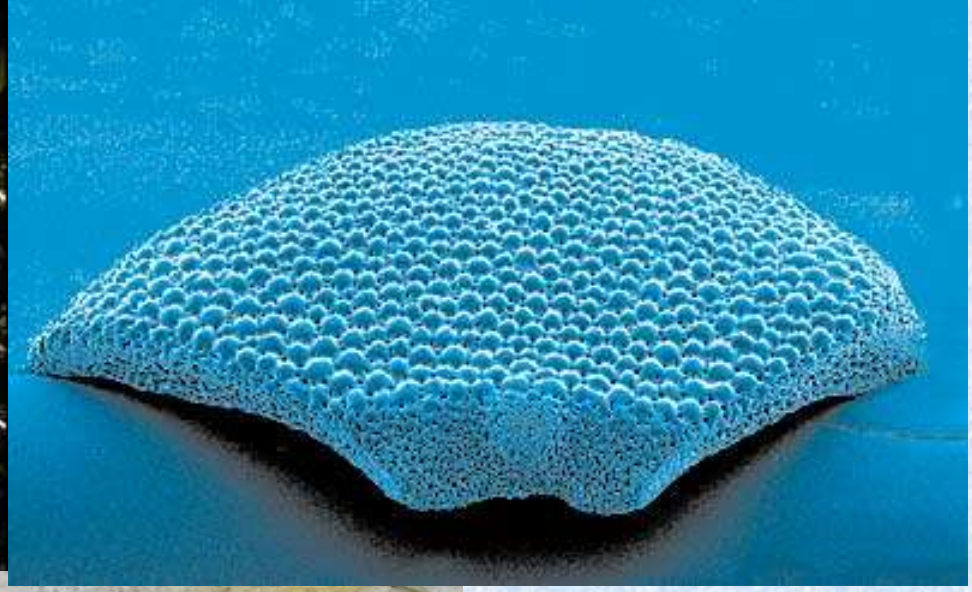
Sea Star Time-lapse: Eating Mussel
https://vimeo.com/45154593

Zombie Starfish - Nature's Weirdest Events: Series 4
https://www.youtube.com/watch?v=KrfcglOmBYw

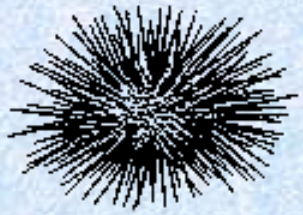
Class Ophiuroidea - Brittle stars

- central disc containing the organ systems
- arms longer, more slender than sea stars
- use arms for locomotion, capable of rapid movement by muscle action
- tube feet lack suckers
- No anus.
- Deposit, detritus, and suspension feeders

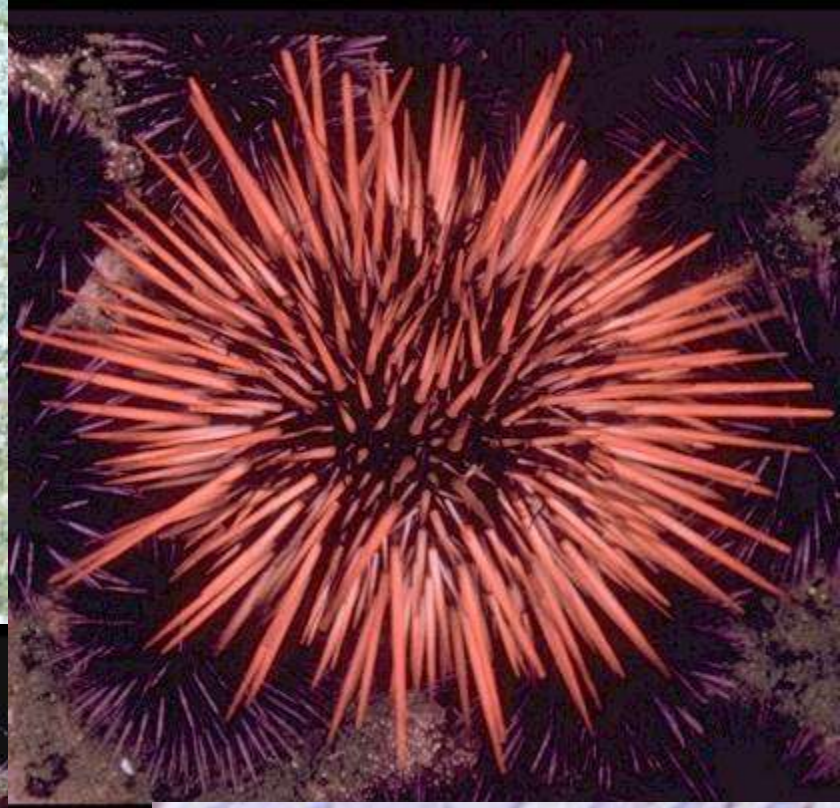
(c) Ophiuroidea



Class Echinoidea (sea urchins, et al.)



- Globular or flattened, without arms
- Complex 5-part jaw apparatus (“Aristotle’s Lantern”)
- Mainly grazers on algae, a few feed on bryozoans or sponges.
- Some species harvested as food (the roe is eaten)



Class Holothuroidea - Sea Cucumbers

- Elongated flexible bodies, propelled by 3 to 5 rows of tube feet
- Circle of modified tube feet surrounds mouth
- Gut has branches for respiration

Sea Cucumber
https://www.youtube.com/watch?v=vsLBOkYLLeI

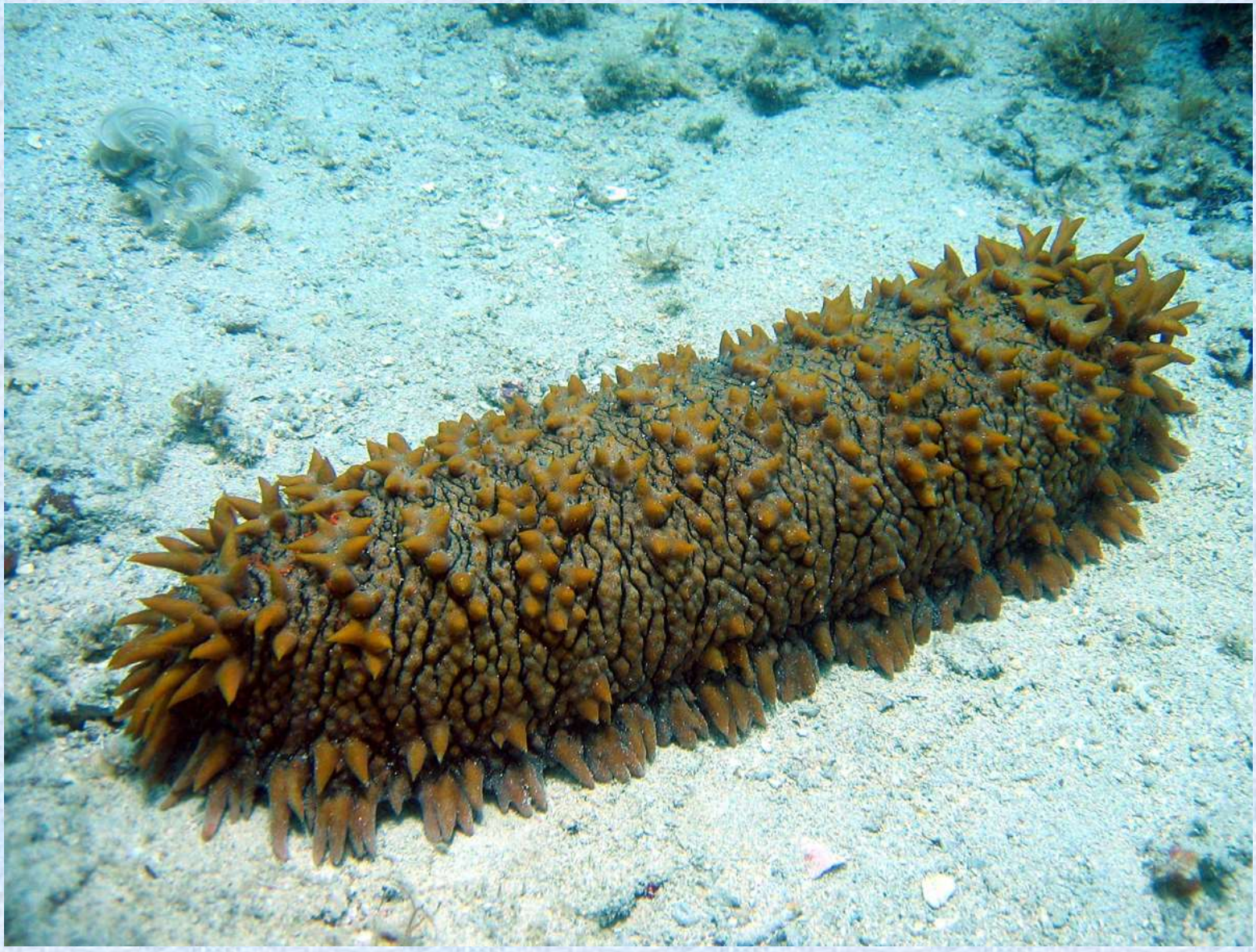
Sea Cucumber Fights with Guts
https://www.youtube.com/watch?v=wXf_YodWw40

Sea Cucumber expelling its intestines
https://www.youtube.com/watch?v=aCxKFc3XtJs

Seaview Science Video: Sea Cucumbers
https://www.youtube.com/watch?v=MVNrbyU-Vck

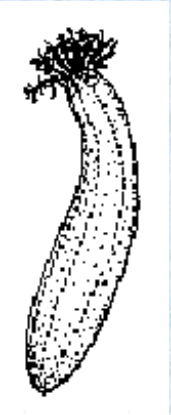
(e) Holothuroidea

Class Holothuroidea - Sea Cucumbers

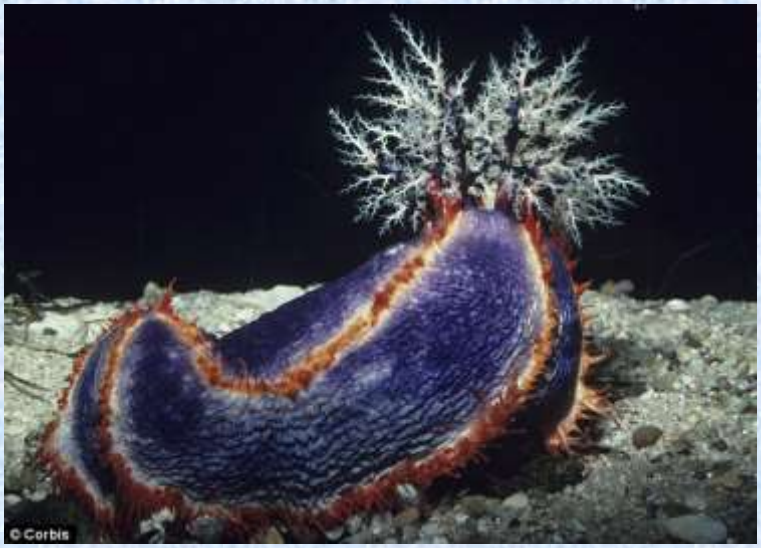


Class Holothuroidea
sea cucumbers

Class Holothuroidea - Sea Cucumbers



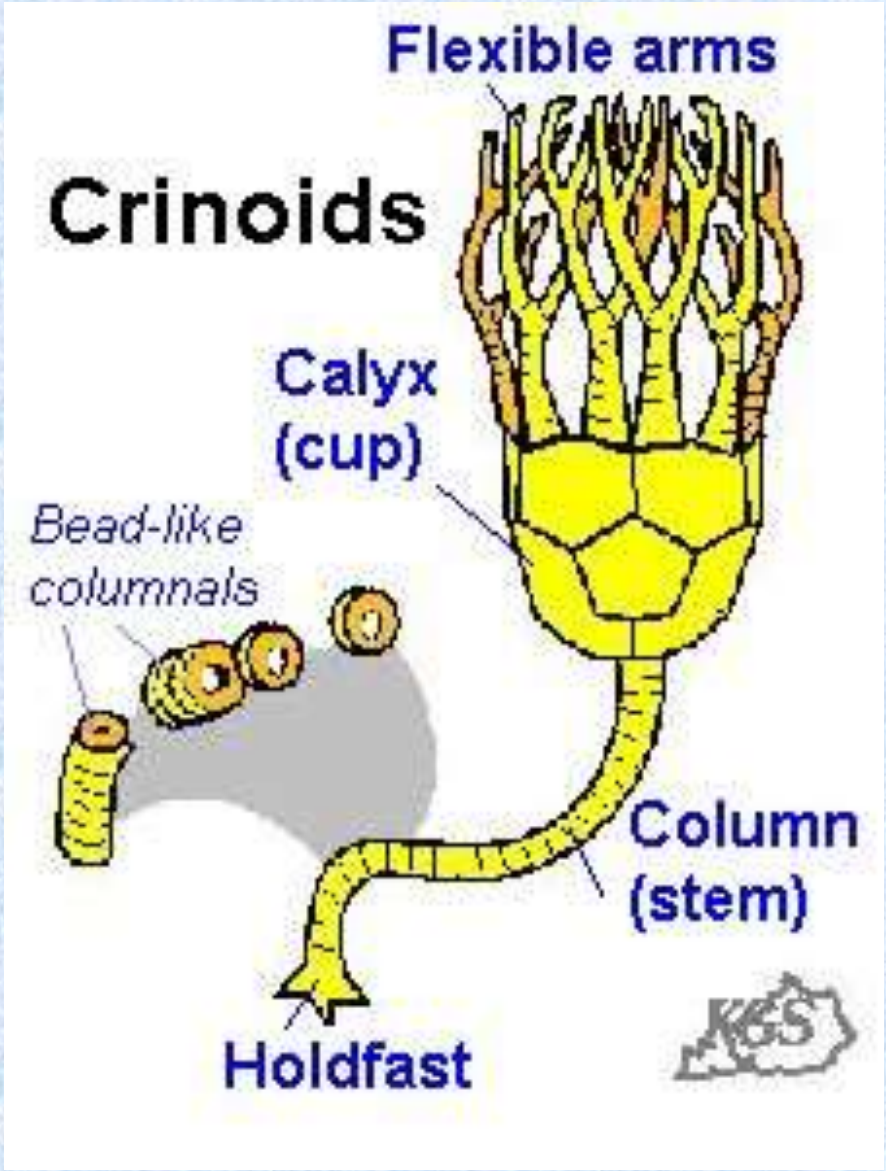
- Tube feet around mouth form feeding tentacles, gather food and transfer to mouth.
- Gut has branches for respiration, and Cuvierian threads expelled for defense



Class Crinoidea - Sea lilies, feather stars

- Feather stars (unstalked) and sea lilies (stalked, attached).
- globular body (calyx) partially encased in skeletal plates
- exaggerated, branched arms used for suspension feeding
- oral surface turned upward
- greatest diversity in Paleozoic

(a) Crinoidea


Crinoids
Flexible arms
Calyx
(cup)
Bead-like
columnals
Column
(stem)
Holdfast
KGS


KGS

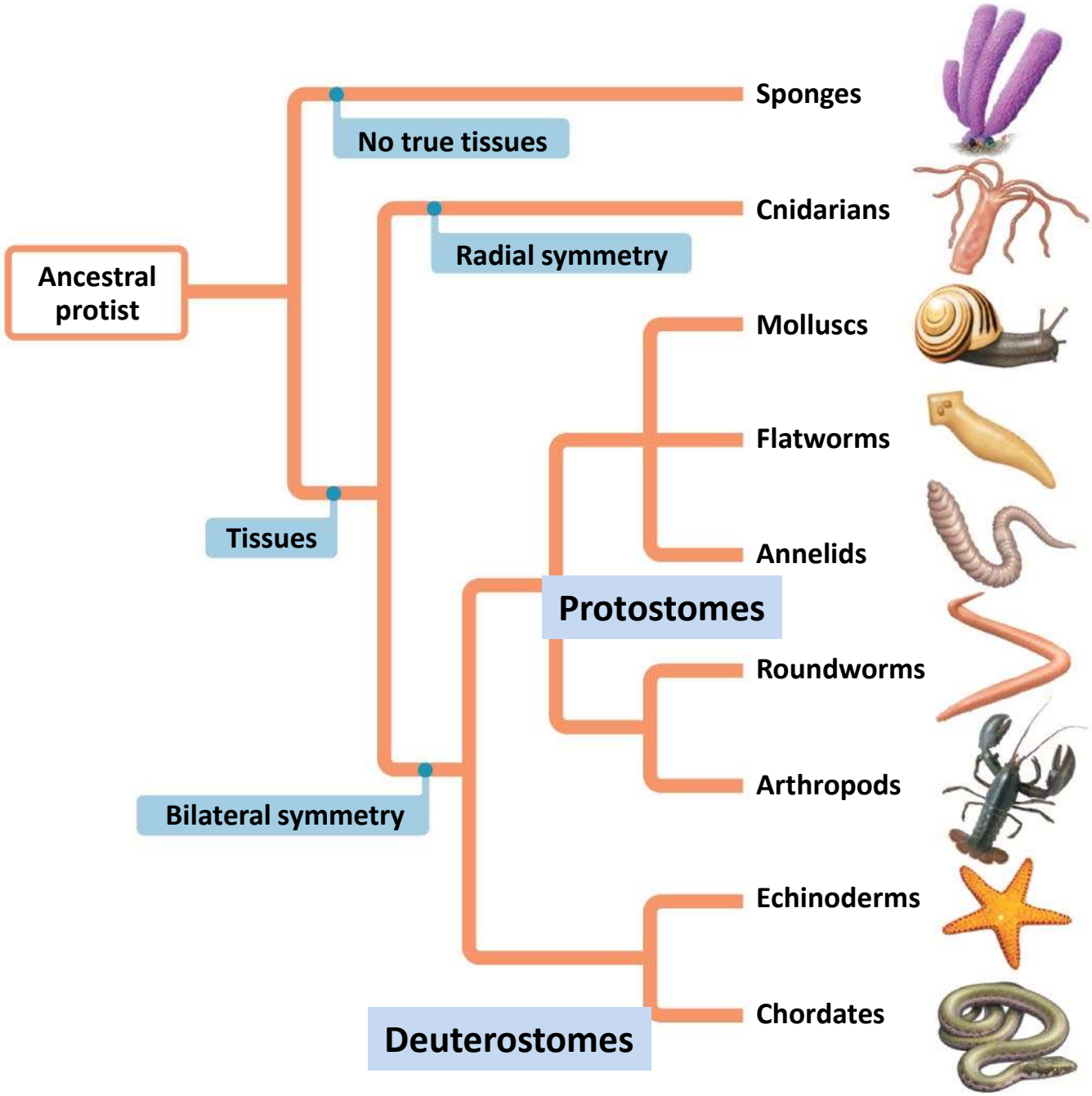


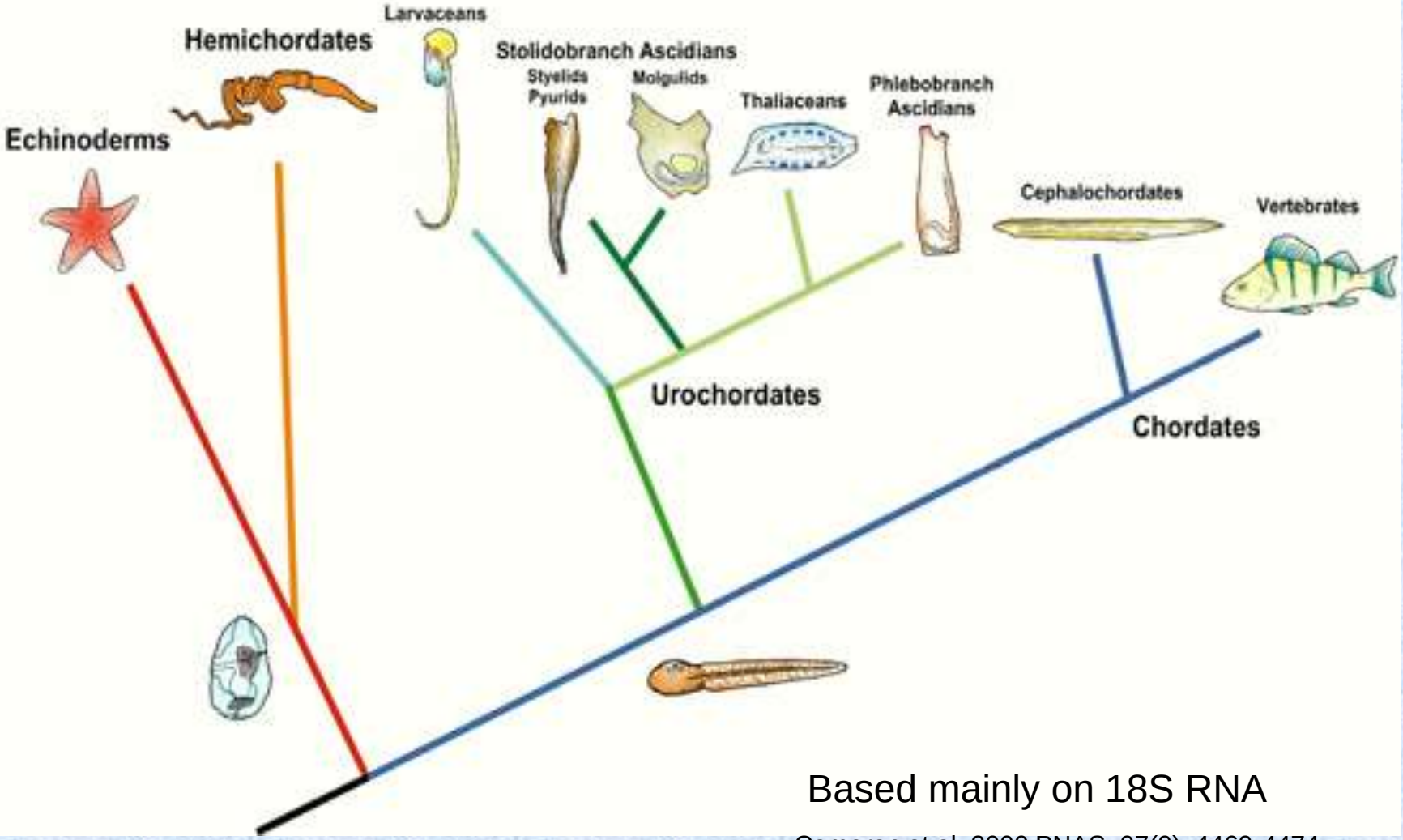
Figure 17.5

Phylum Chordata

- ~45,000 species, 97% of them are vertebrates

- Subphylum Urochordata
- Subphylum Cephalochordata
- Subphylum Vertebrata

Deuterostome Evolution



Based mainly on 18S RNA

Cameron et al. 2000 PNAS 97(9): 4469-4474,

The invertebrate chordates

The chordates include all of the vertebrates (fish, amphibians, reptiles, mammals and birds), but also two non-vertebrate subphyla:

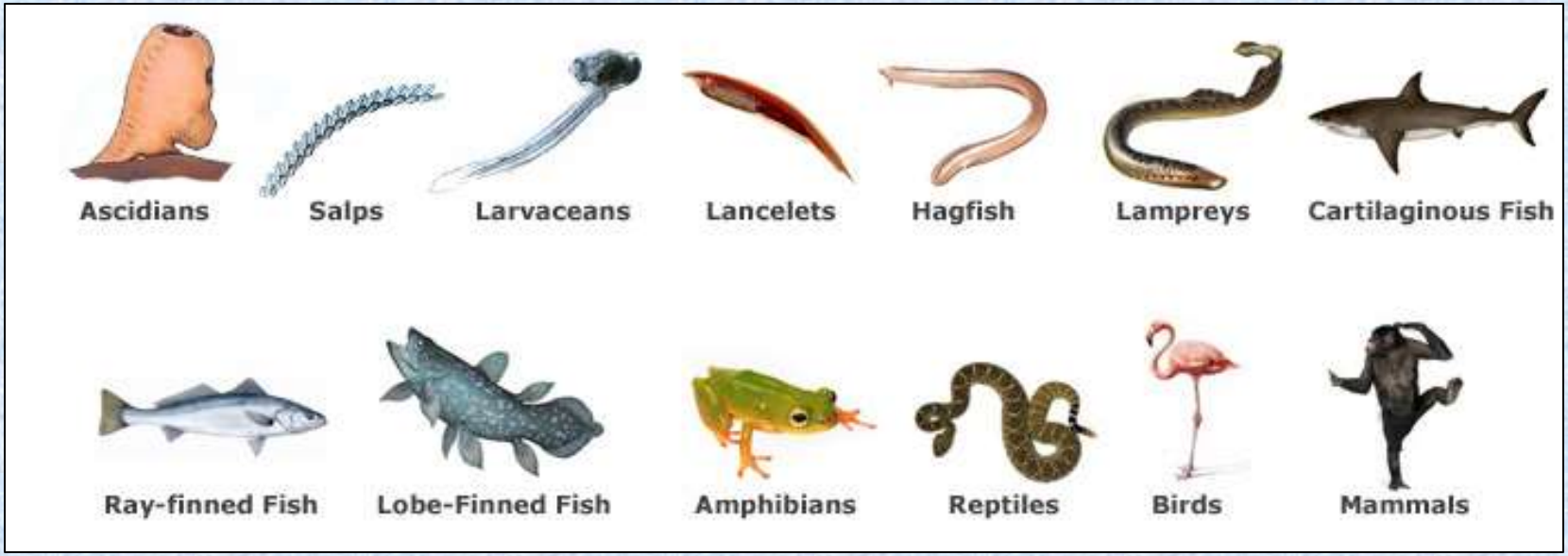
the Urochordata and

the Cephalochordata

never develop a vertebral column

Characteristics of the Chordata

- bilaterally symmetrical
- triploblastic
- have a well developed coelom
- have a complete digestive system

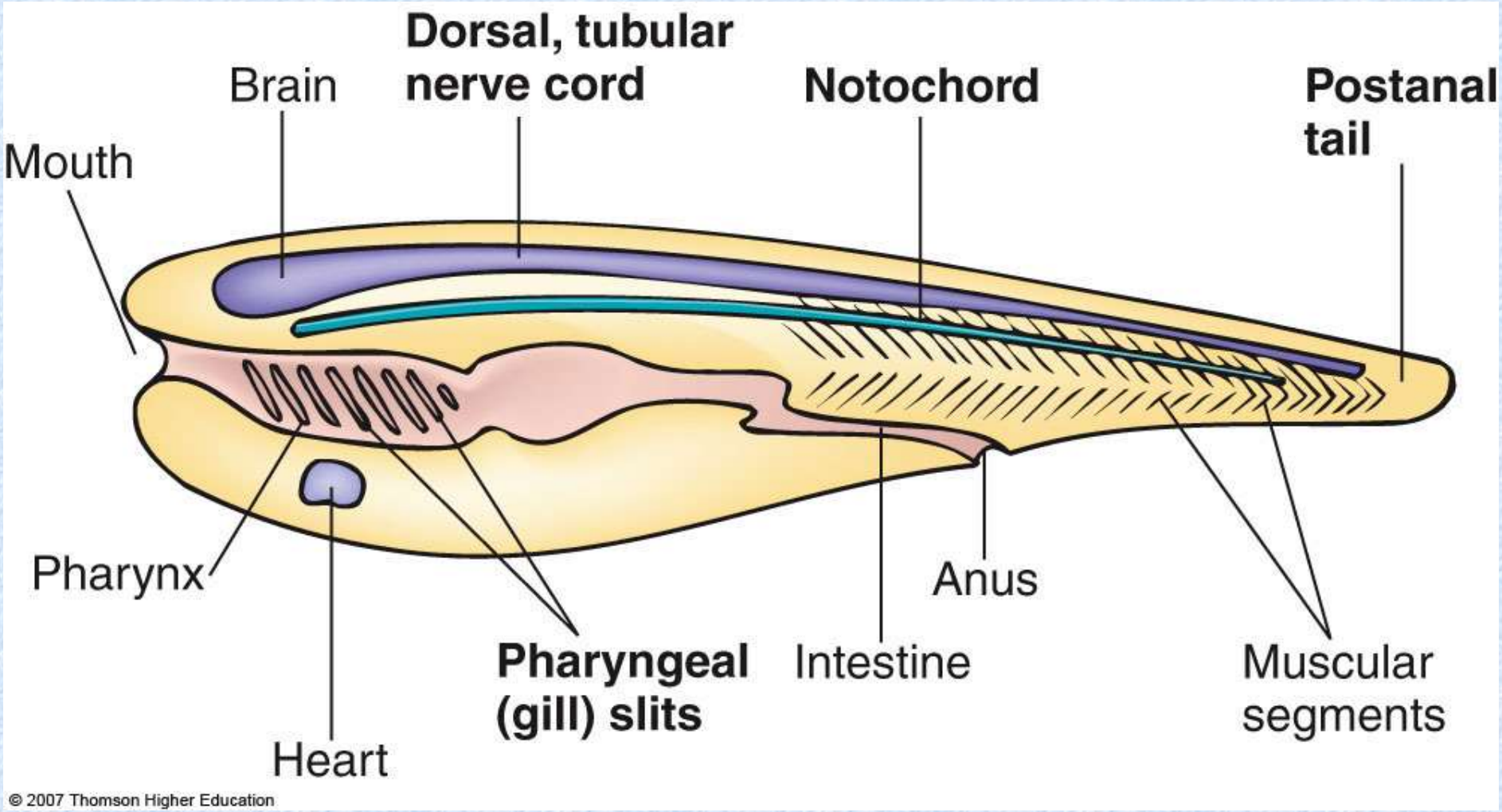


Characteristics of the Chordata

- Notochord
- Dorsal, tubular nerve cord
- Pharyngeal pouches or gill slits
- Post anal tail (extends beyond anus)

Not all of these characteristics are apparent in adult organisms and may appear only in the embryonic or larval stages.

Chordate Body Plan

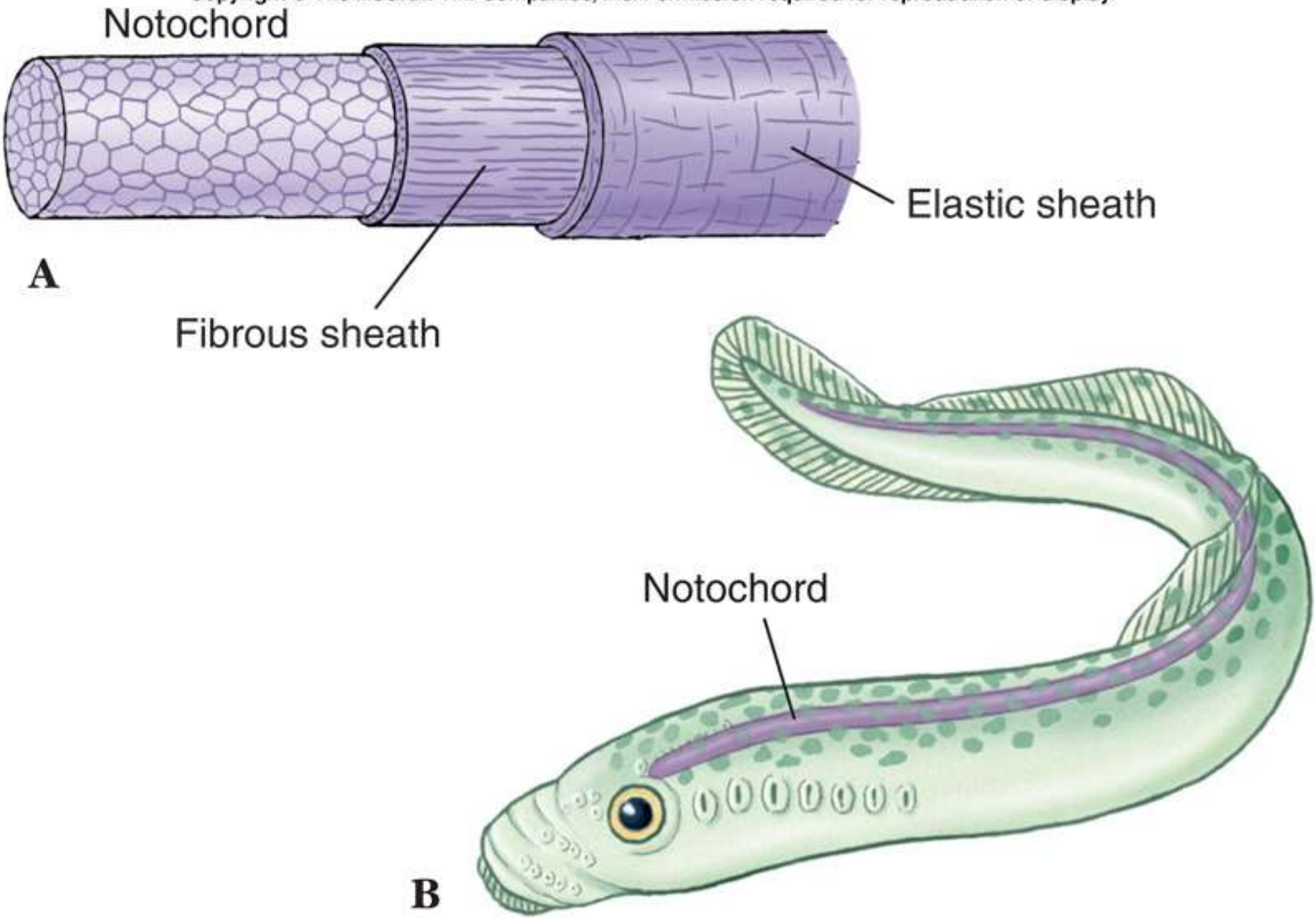


Notochord

- **Notochord**: the notochord is a flexible, rodlike structure. It extends the length of the body and is an anchor point for muscles.

- The notochord bends without shortening so it permits the animal to undulate.

Figure 23.01



Notochord

- In nonvertebrates and the jawless vertebrates the notochord is present throughout life.

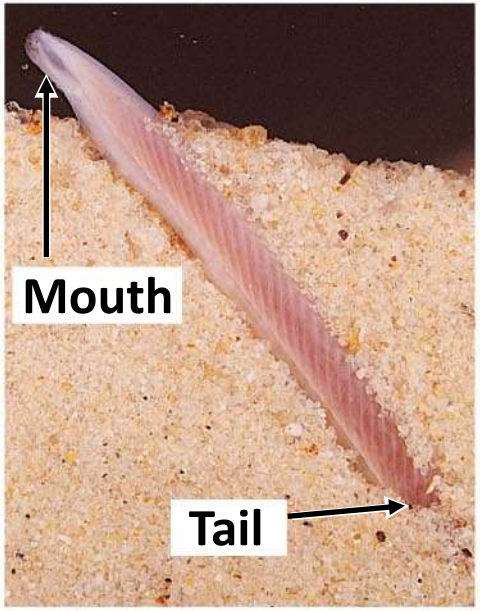
- However, in the jawed vertebrates it is replaced by the vertebral column; the remnants of the notochord being found in the intervertebral disks.

Chordates

- Chordates consists of three groups of invertebrates:
  - Tunicates, or sea squirts, also lack a cranium
  - Lancelets are bladelike animals without a cranium.
  - Hagfishes are eel-like forms that have a cranium.
- All other chordates are vertebrates.

Tunicates

Lancelets



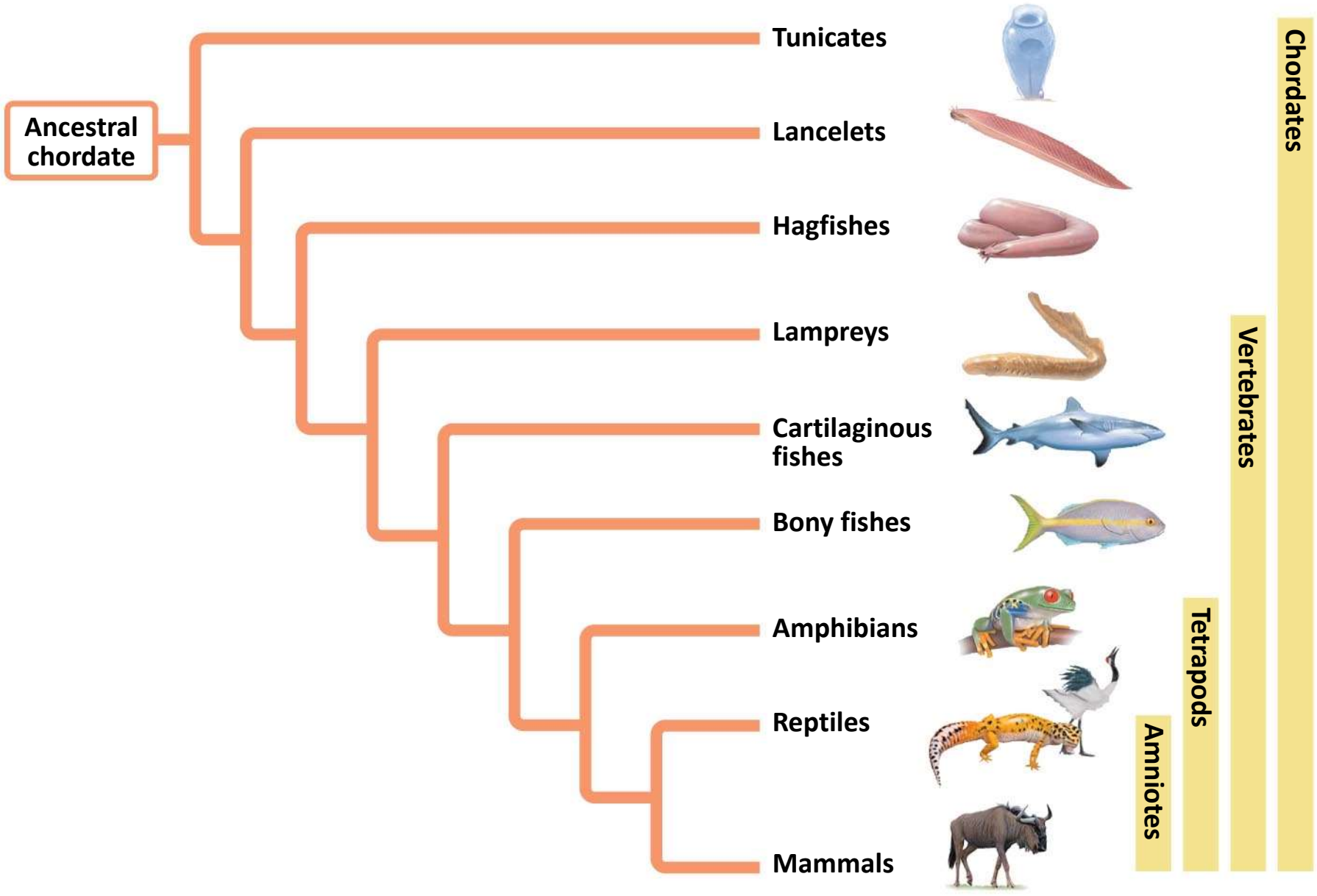
Lancelet

Tunicates

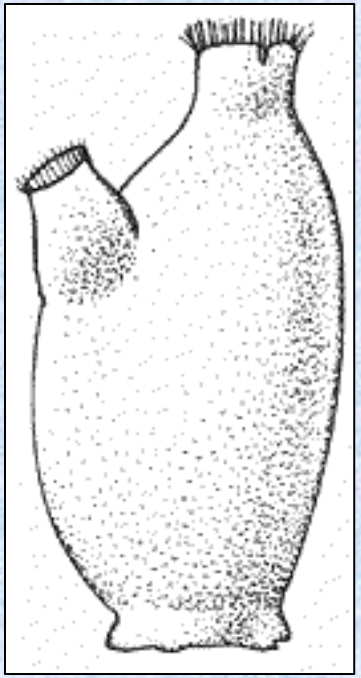
https://www.youtube.com/watch?v=2VravyjZta0

https://www.youtube.com/watch?v=2wJP_iB1hyc

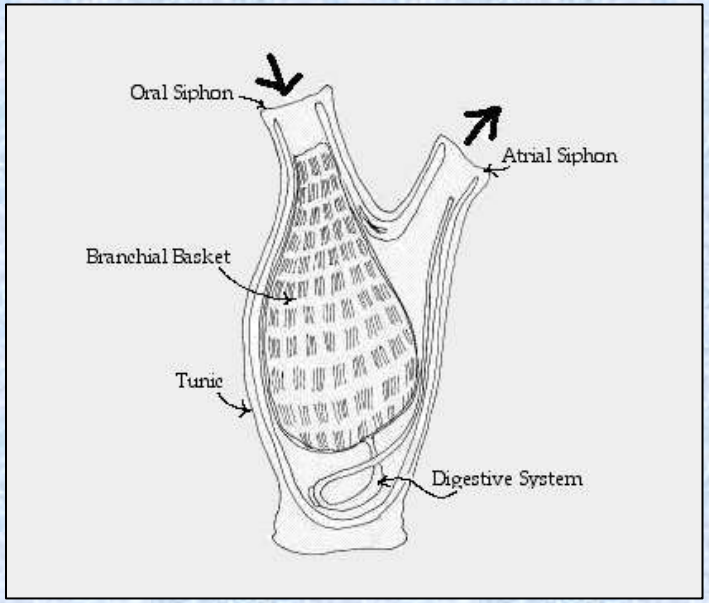
Hagfish



Tunicates
Subphylum Urochordata



- Marine animals with tough tunics
- Suspension-feeders
- Adult is sessile and feeds via pharyngeal slits
- Larvae are free swimming
  - dorsal tubular nervous system
  - notochord and
  - gill slits



Sea squirts (Class Ascidiacea, Tunicates)

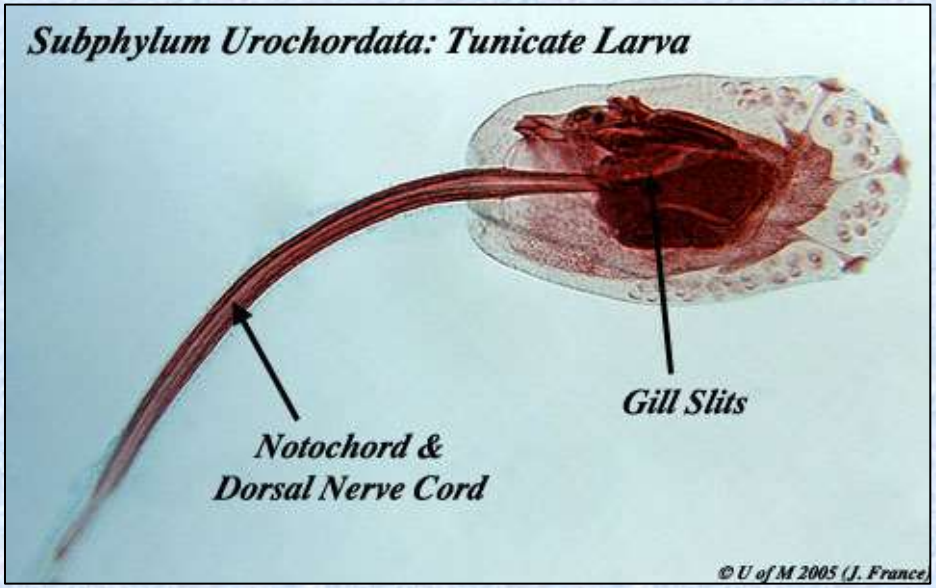
- Adults are marine, sessile, filter feeding organisms that live either solitarily or in colonies.

Ciona intestinalis
(a solitary sea squirt)

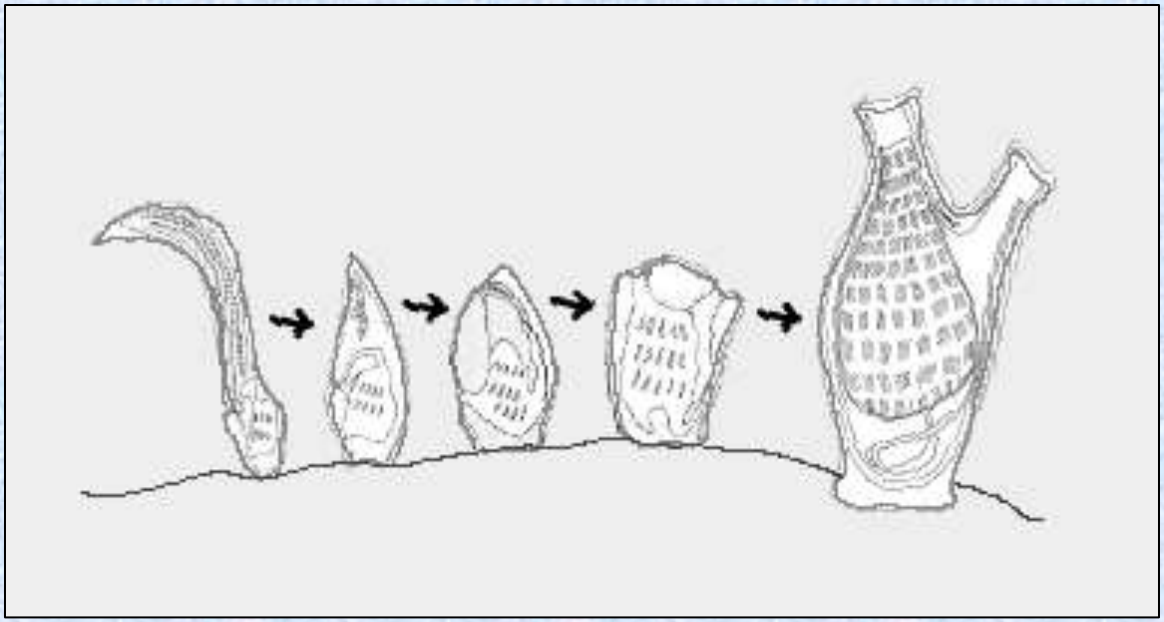
Tunicate larvae (tadpole)

Free-swimming,

- dorsal tubular nervous system
- notochord and
- gill slits



Searches for a place to settle and then attaches and metamorphoses into an adult



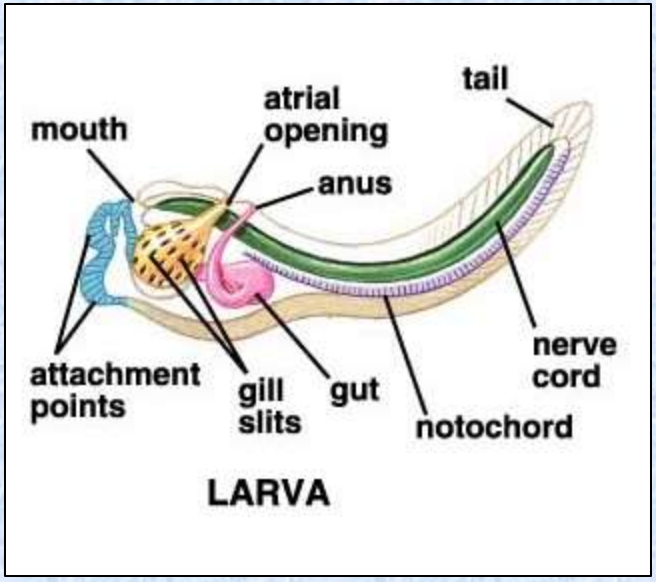
Salps

- Barrel-shaped, planktonic tunicates, drift through the open ocean
- Moves by contracting, thus pumping water through its gelatinous body

Giant Pyrosome and Salps - pelagic sea squirts
https://www.youtube.com/watch?v=5EQGA_4BZ5s
Sea Salps
https://www.youtube.com/watch?v=-Jooz4gz264

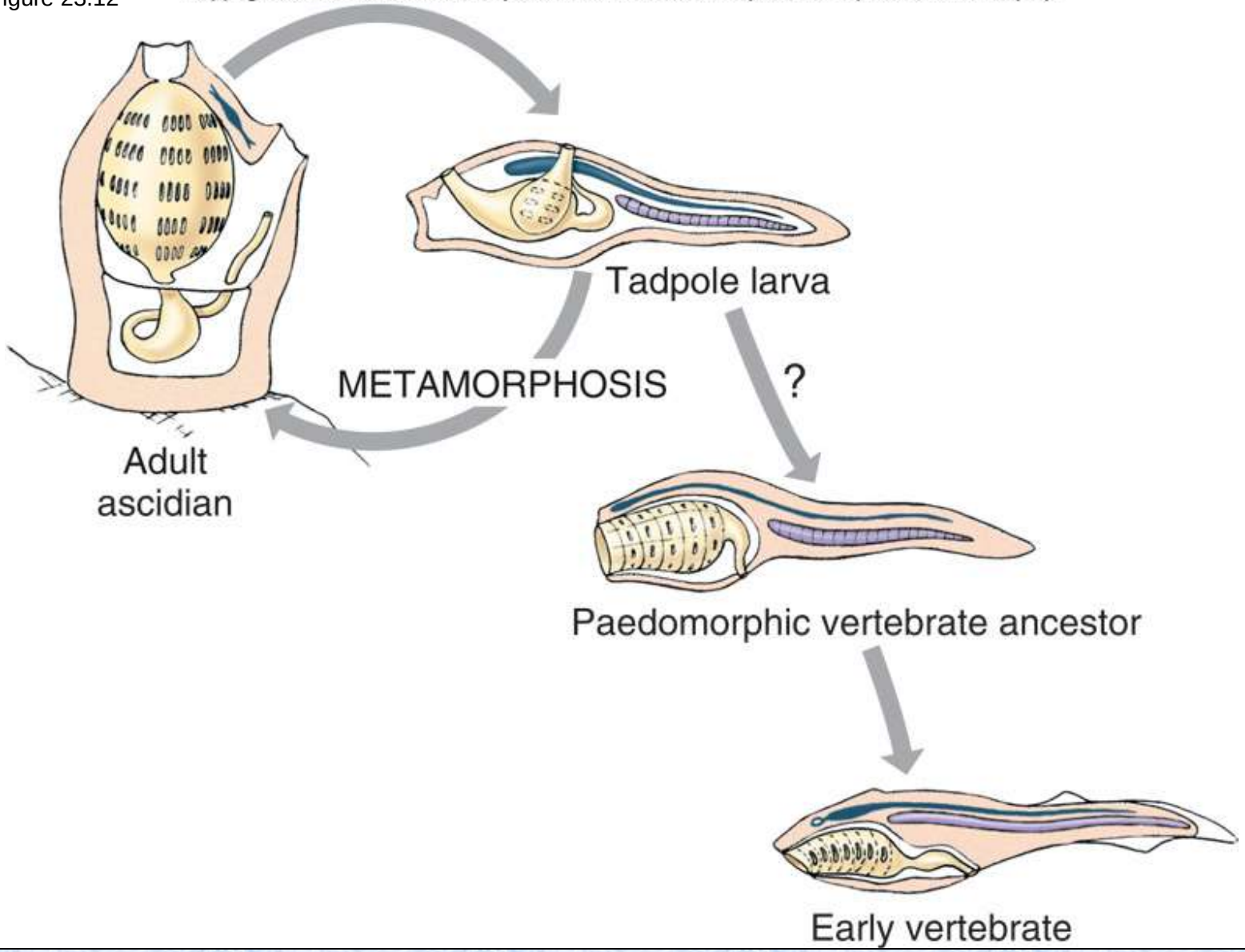
Garstang's hypothesis of chordate larval evolution

- In the 1920's it was proposed that the vertebrates were derived from an ancestral ascidian that retained its characteristics into adulthood (the process by which juvenile characteristics are retained into adulthood is referred to as paedomorphosis).



Garstang's hypothesis of chordate larval evolution

Figure 23.12

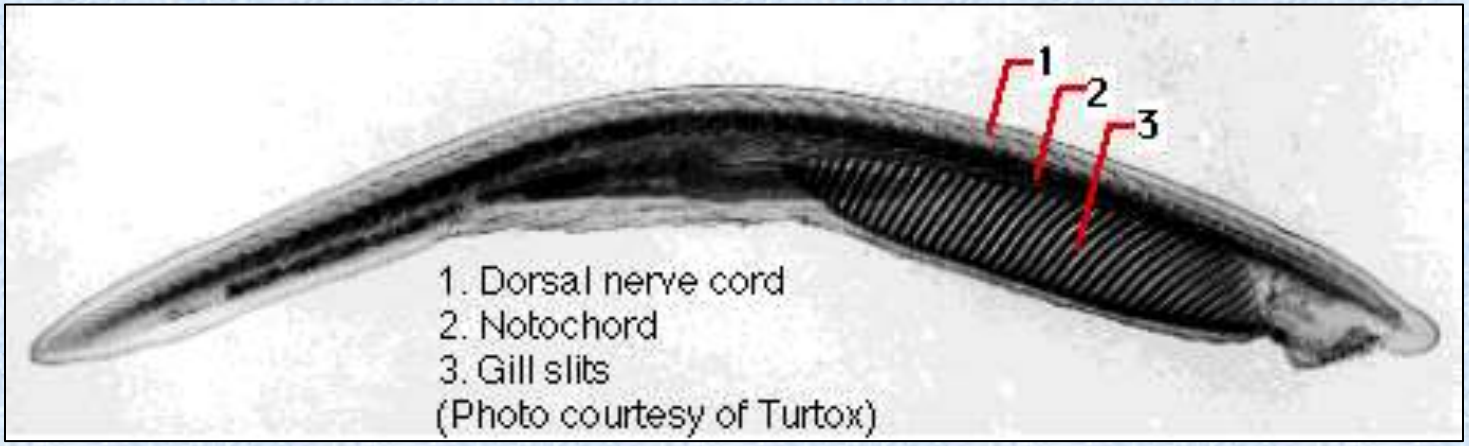


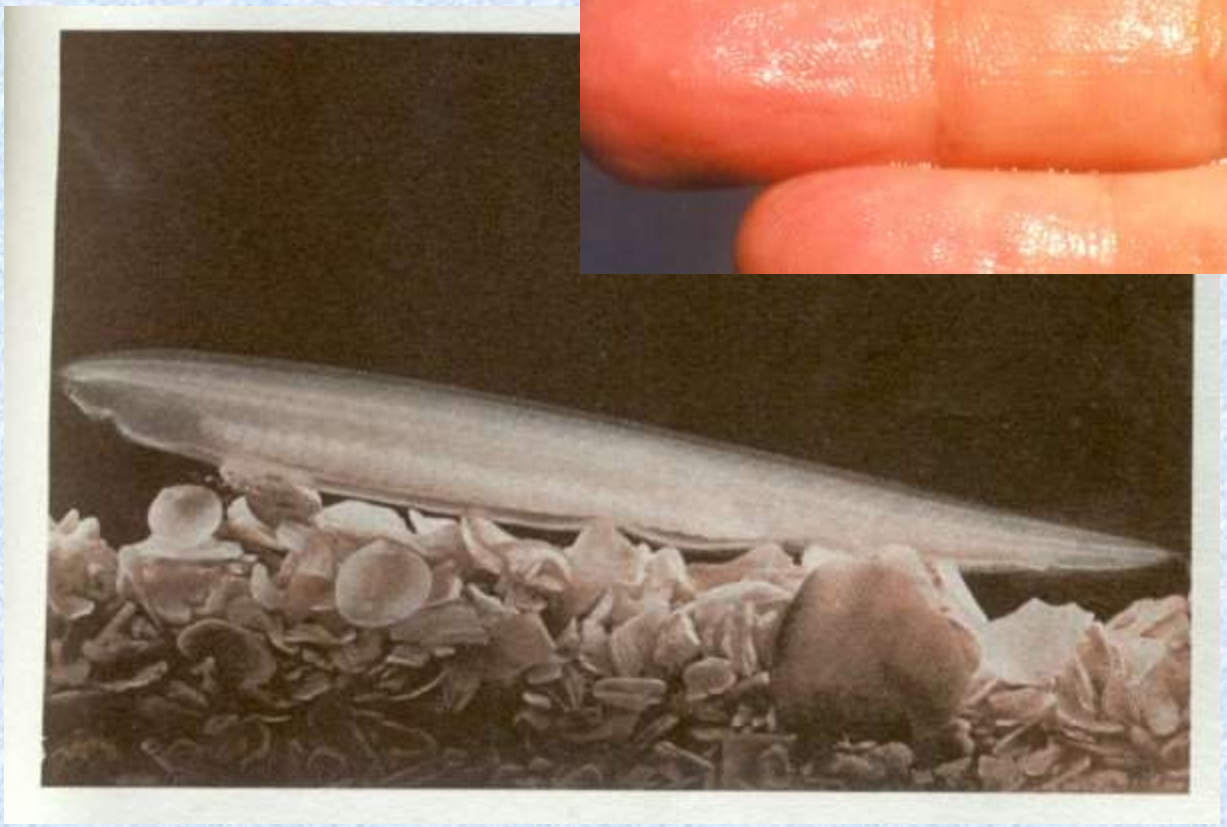
Garstang's hypothesis of chordate larval evolution

- Garstang's hypothesis is supported by embryological evidence, but more recently molecular analyses have suggested that sessile ascidians are a derived form and that the free-living Cephalochordates are more likely to be the closest relatives of the chordates.

Subphylum Cephalochordata - Lancelets

- Invertebrates most similar to vertebrates
- Small segmented fishlike animals that inhabit sandy sediments of coastal waters.
- Lack a distinct head and have no cranium
- Burrowing filter-feeders
- 29 species



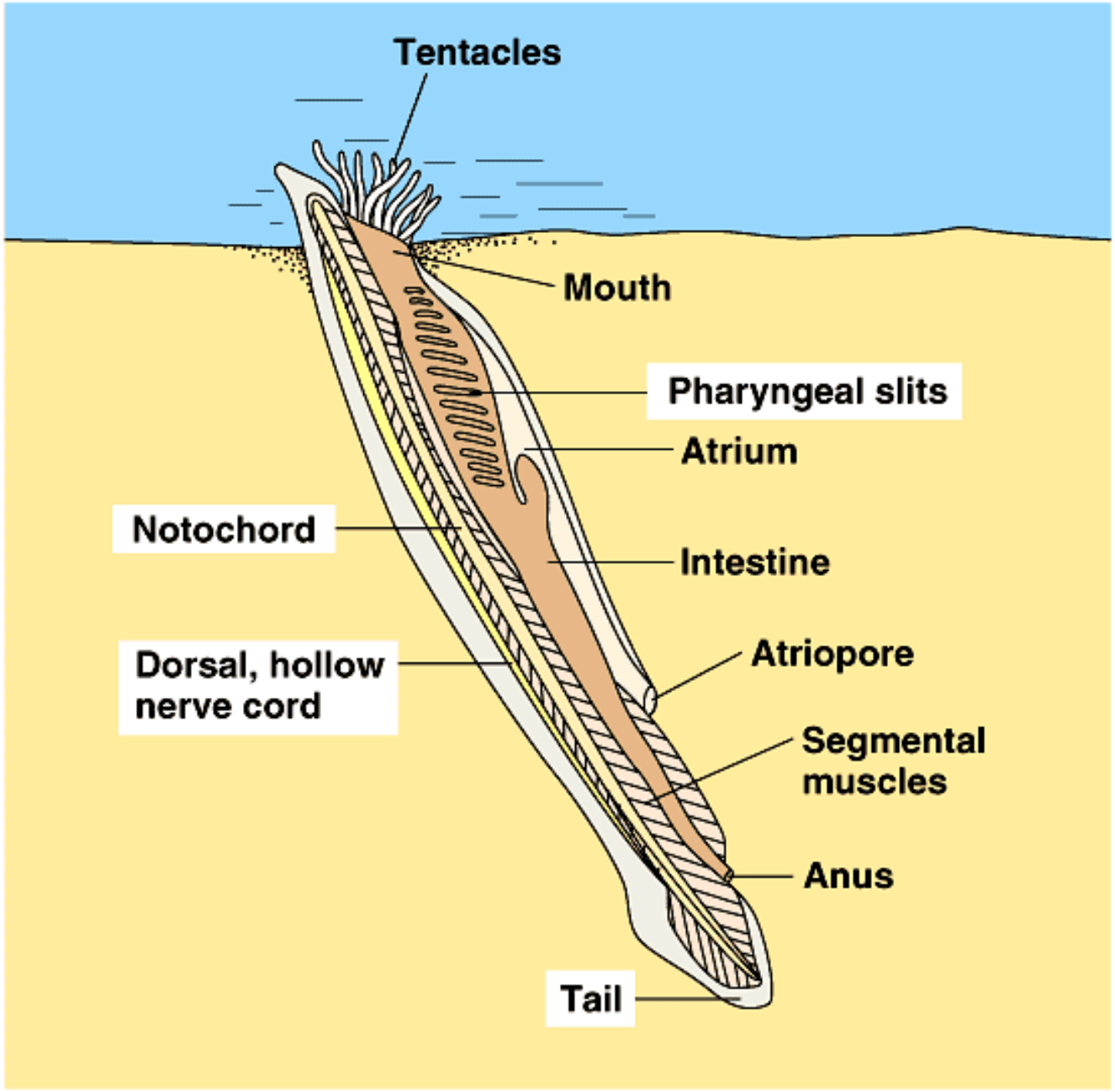


Subphylum Cephalochordata: the lancelet

Amphioxus (*Branchiostoma)*

Subphylum Cephalochordata: the lancelet

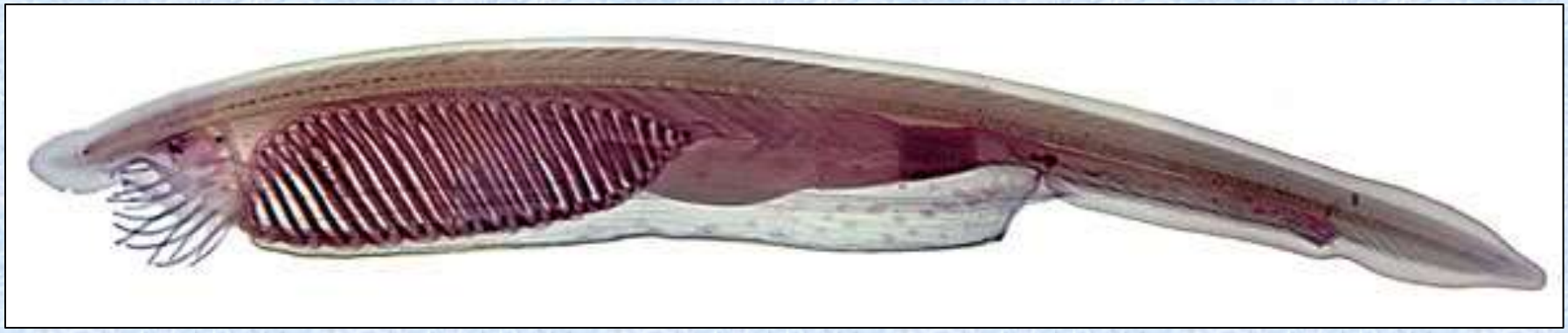
Amphioxus (*Branchiostoma)*



(a)

Amphioxus

- Amphioxus is a filter feeder.
- Water enters the mouth and then is moved by beating cilia through the pharyngeal slits, where food is trapped in mucus. Cilia then move the food to the gut.

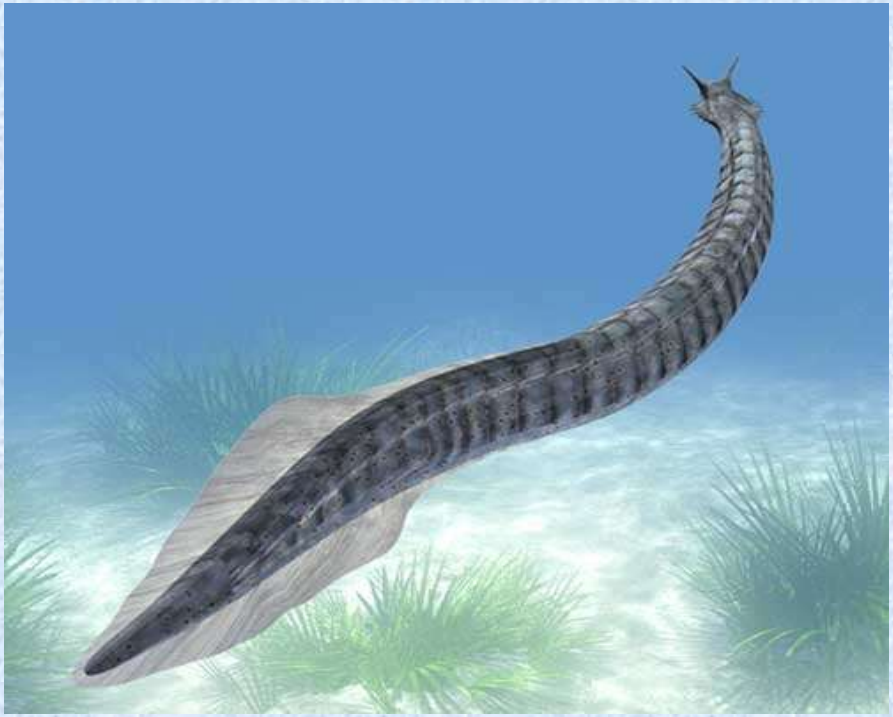


Amphioxus

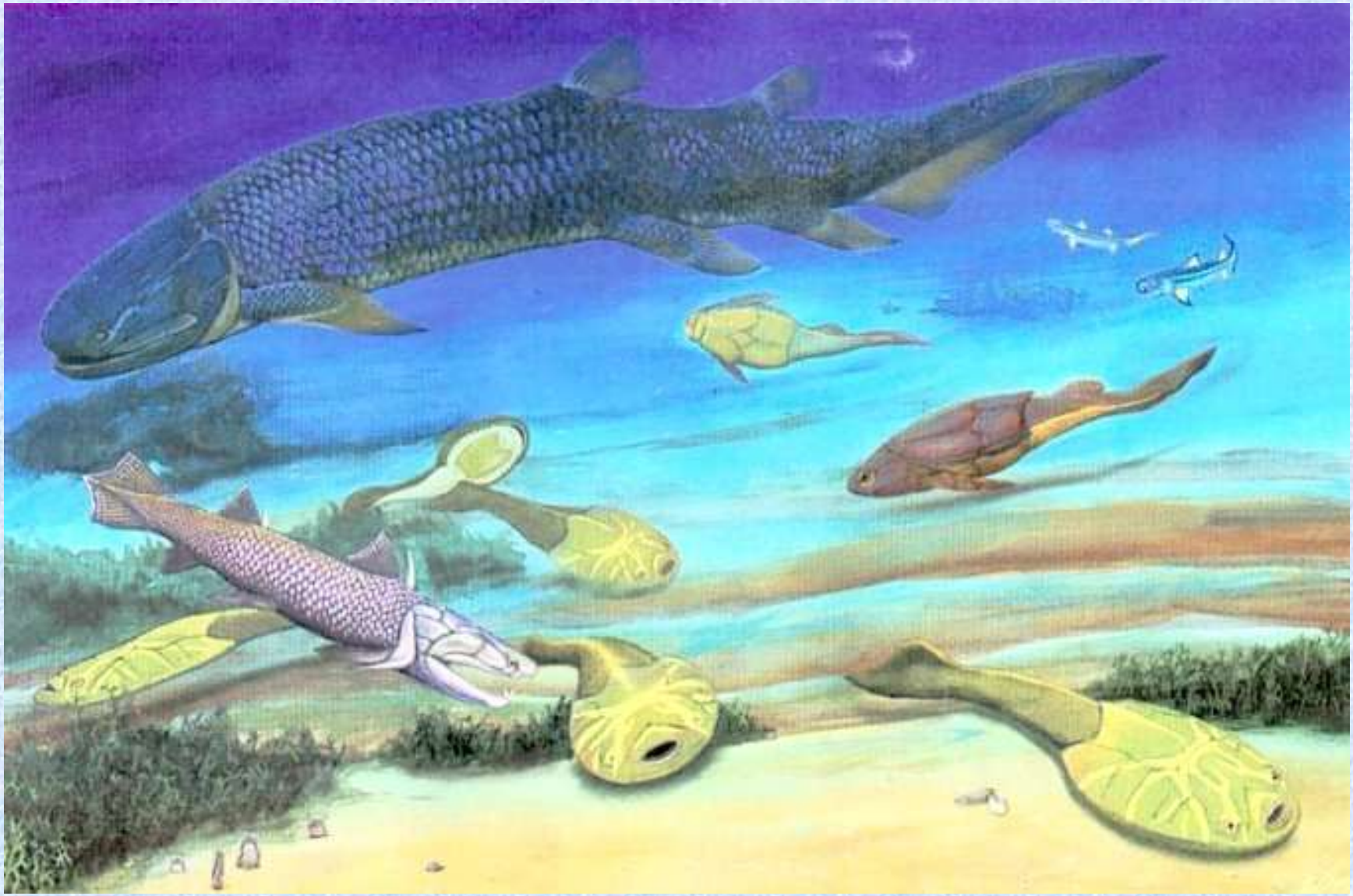
- Amphioxus is considered to be the closest living relative of the vertebrates
- Shares several characteristics with vertebrates that Urochordates do not possess.
  - Segmented blocks of striated muscle
  - Dorsal and ventral aortas
  - Branchial (gill) arches (blood vessels running over the gills

Pikaia

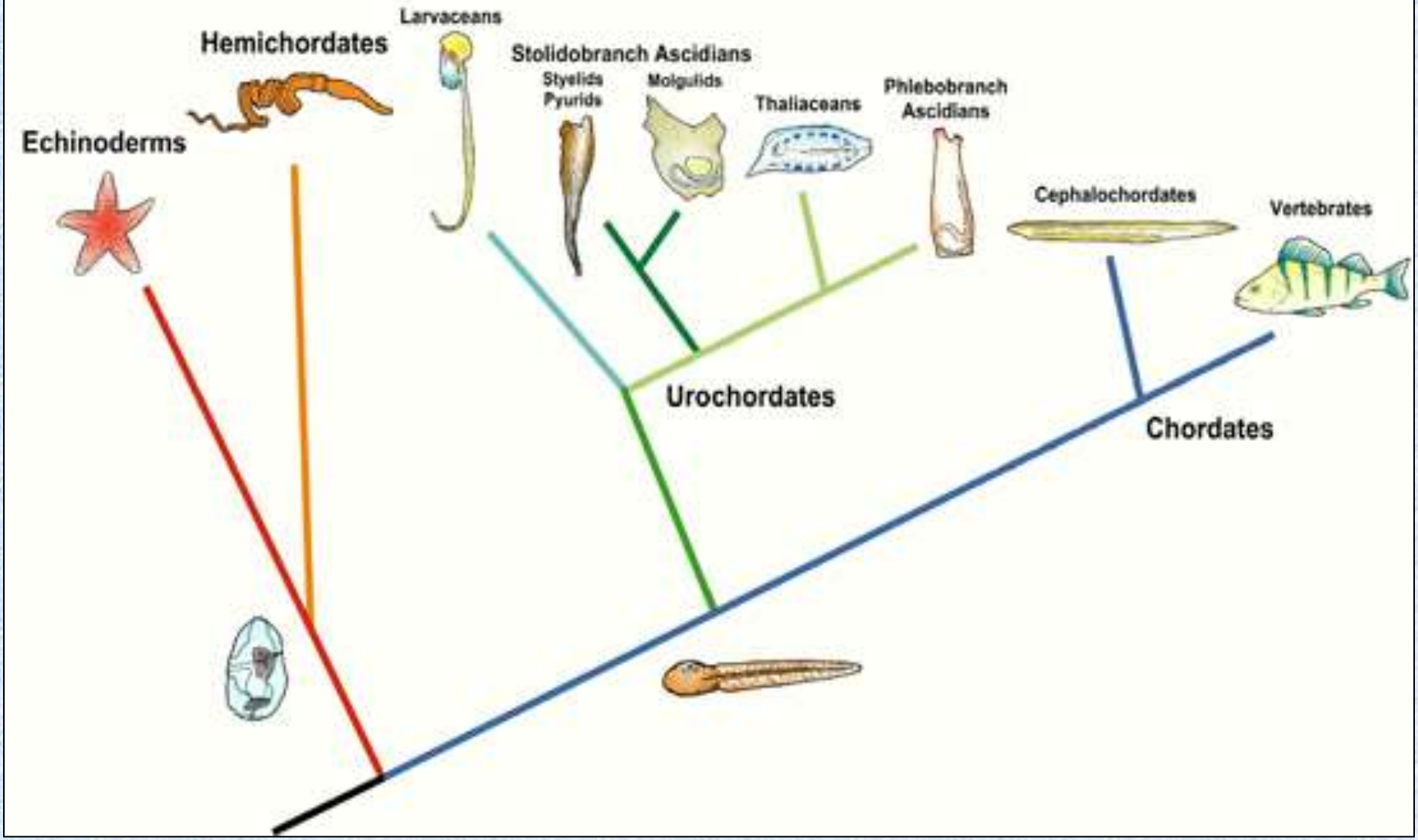
- Paleozoic fossil, 505 MYA
- Rod running along its back resembled a backbone-like structure.
- Markings on the sides typical shape of chordate muscle bundles



Devonian - Age of Fish



Deuterostome Evolution



Based mainly on 18S RNA, Cameron et al. 2000 PNAS 97(9): 4469-4474

End