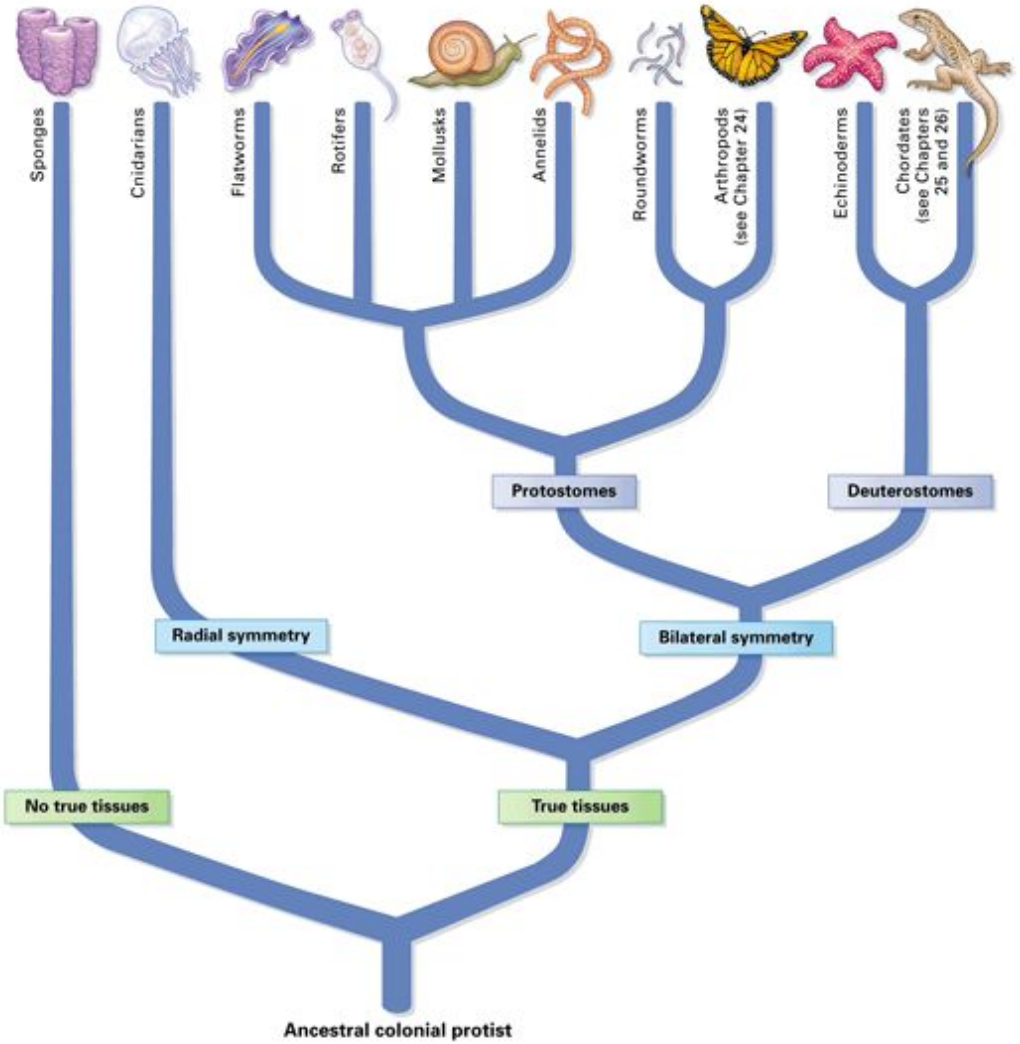
Animals


Sponges
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Flatworms
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Mollusks
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Echinoderms
Chordates (see Chapters 25 and 26)
Protostomes
Deuterostomes
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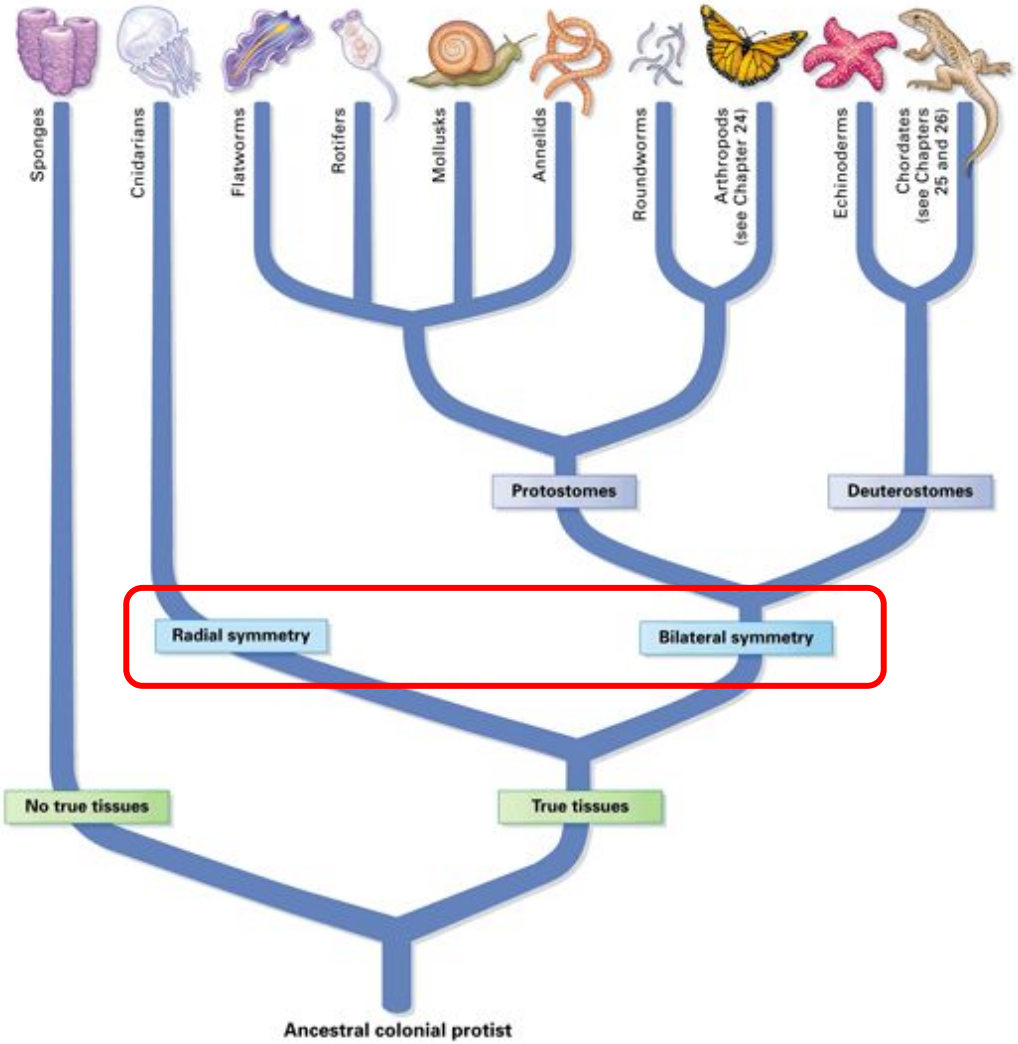
Bilateral symmetry
No true tissues
True tissues
Ancestral colonial protist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BILATERAL
SYMMETRY

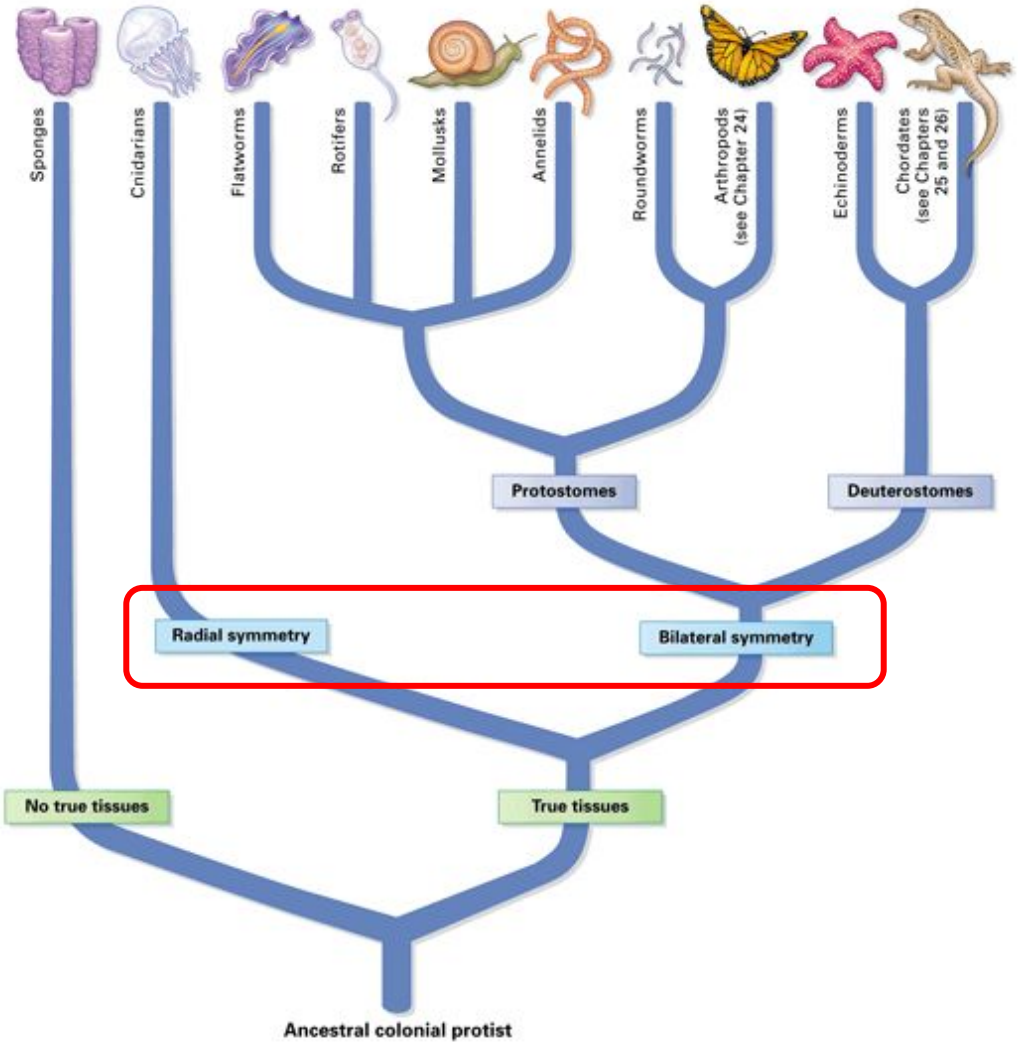
BILATERAL SYMMETRY

RADIAL SYMMETRY

BILATERAL SYMMETRY

RADIAL SYMMETRY

ASYMMETRY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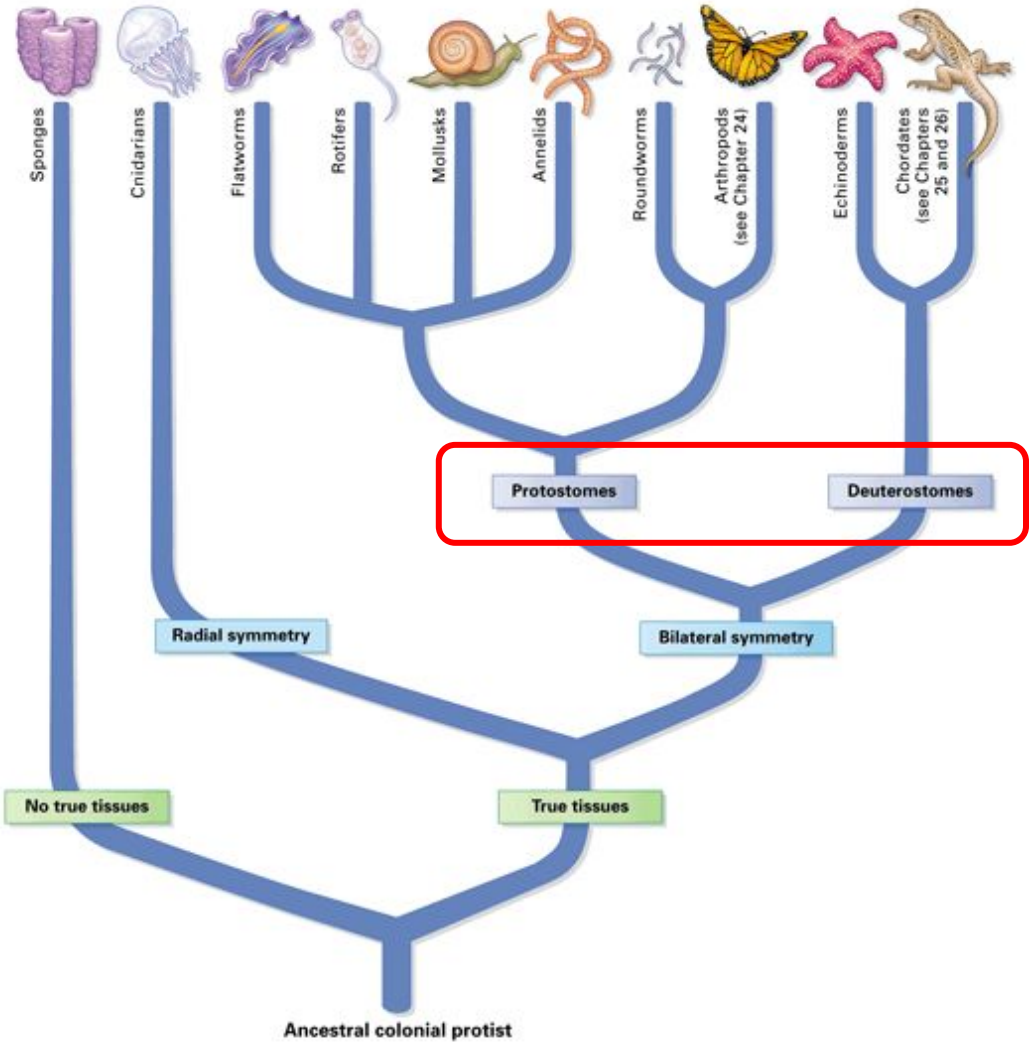
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Patterns of Animal Development

Development = Process by which a single celled **Zygote** is transformed into an adult organism

Embryology is the study of the early stages of development, before birth in (most) mammals and before hatching in oviparous animals.

Patterns of Animal Development

Fertilization > Cleavage > [growth/differentiation/morphogenesis)

1) **Growth** is an increase in size and/or number of cells [Why?]
2) **Differentiation** is the process by which cells of a developing organism assume different and highly specialized forms and functions [Do different cells have different genes?]
3) **Morphogenesis** is the process by which the cells of a developing organism take up their proper places or positions with respect to one another [Why?]

Animal Development: Sea Star Embryos

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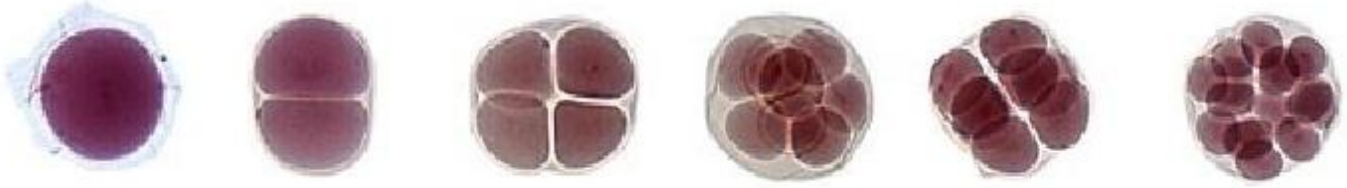

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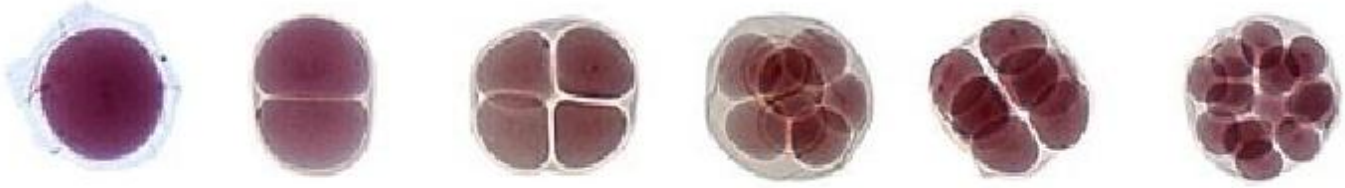

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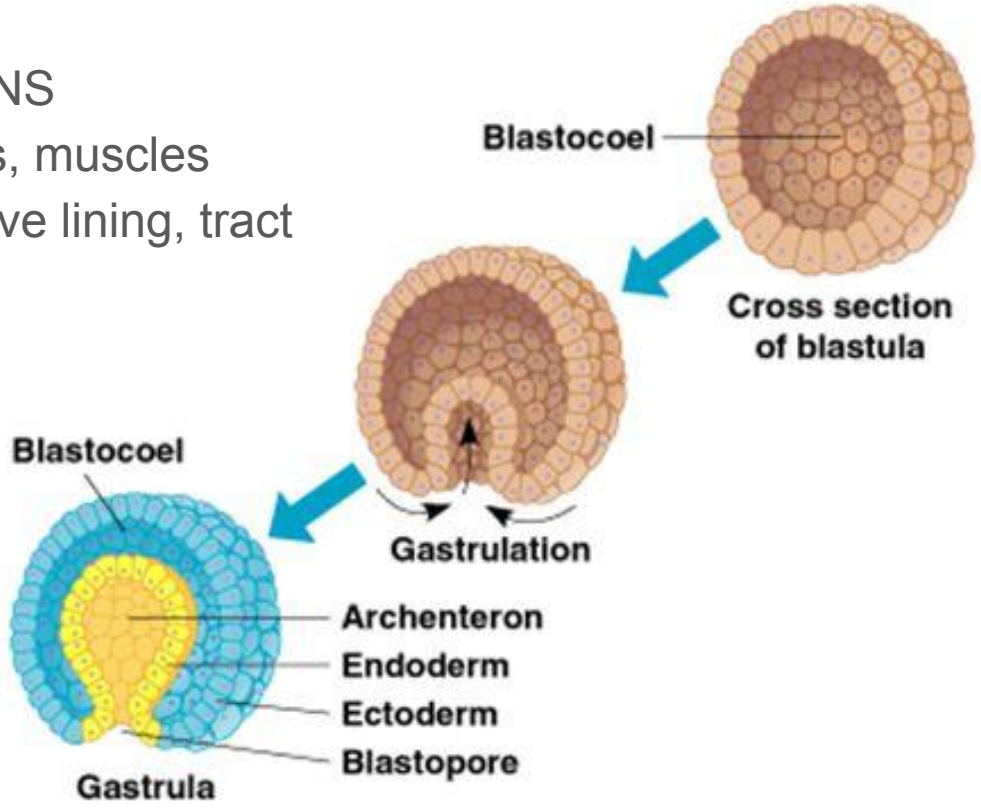
Animal Development: Sea Star Embryos

1) **Ectoderm** becomes skin, CNS
2) **Mesoderm** becomes organs, muscles
3) **Endoderm** becomes digestive lining, tract



Protostomes VS Deuterostomes

Protostomes (chordates and echinoderms)can be separated at early stages of cleavage and separated cells may still develop into viable organisms. This is called **indeterminate cleavage**

Deuterostomes (arthropods, annelids, molluscs) will not develop into viable organisms if cells separate early in development. This is called **determinate cleavage.**

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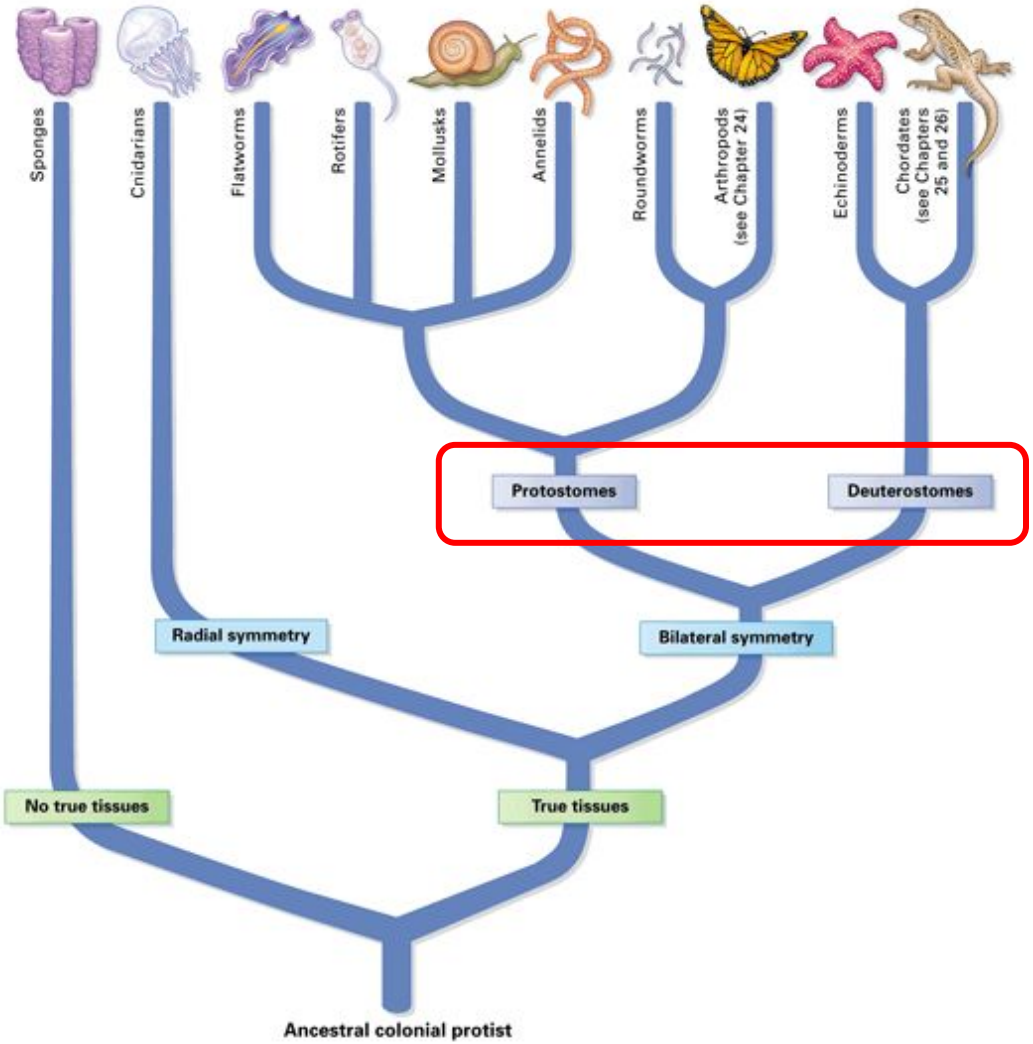
Question: “Can a cricket have an identical twin?”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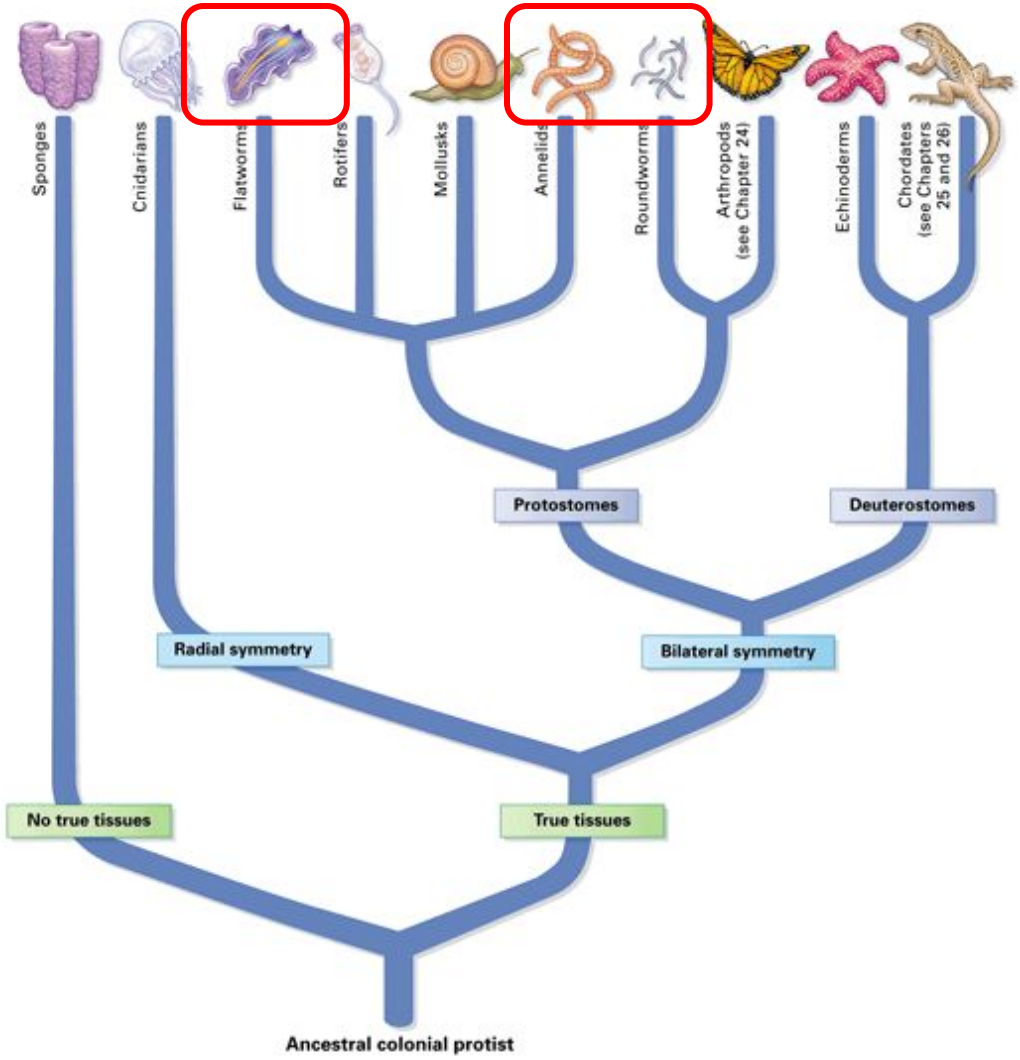
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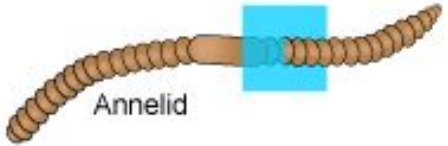
Coelomate



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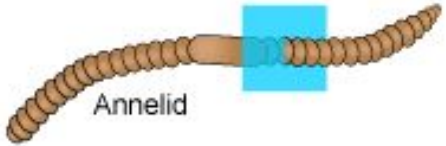
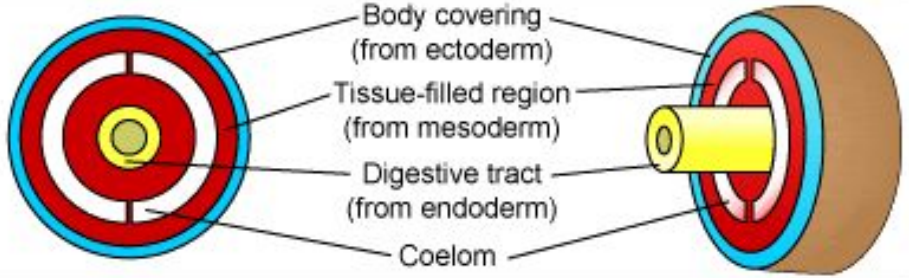
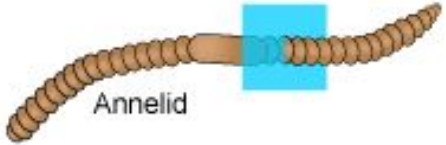
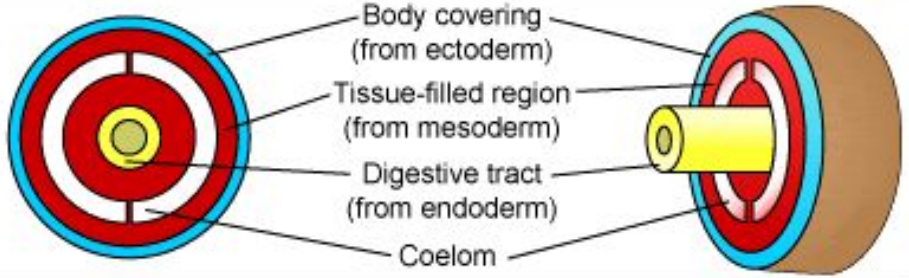

Annelid

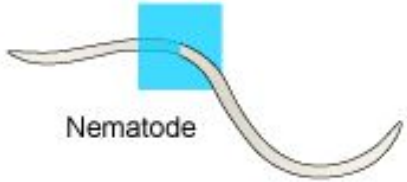

Body covering
(from ectoderm)
Tissue-filled region
(from mesoderm)
Digestive tract
(from endoderm)
Coelom

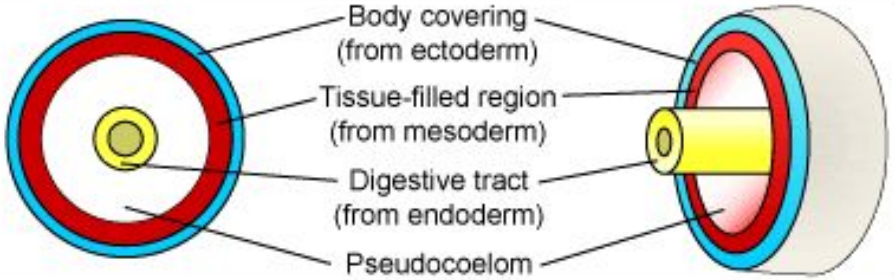
Coelomate





Pseudocoelomate





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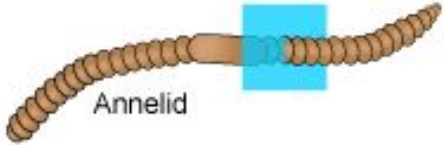

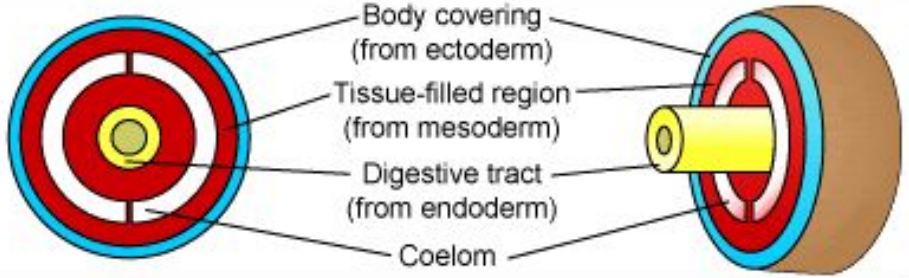

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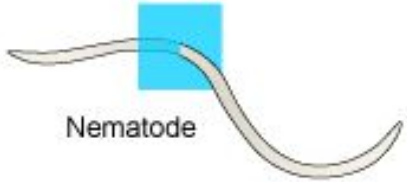
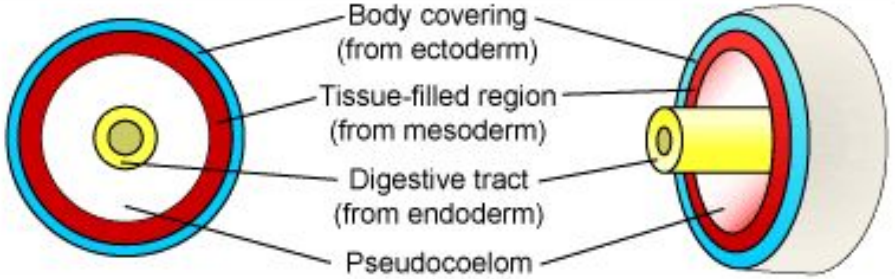
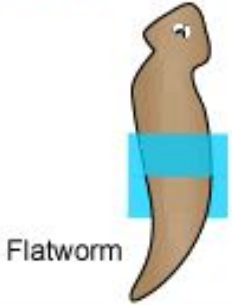
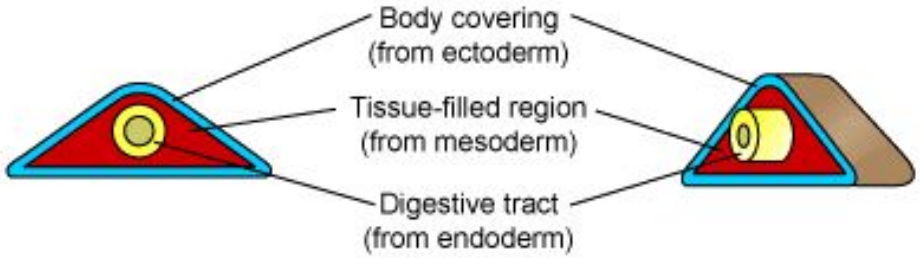




Acoelomate

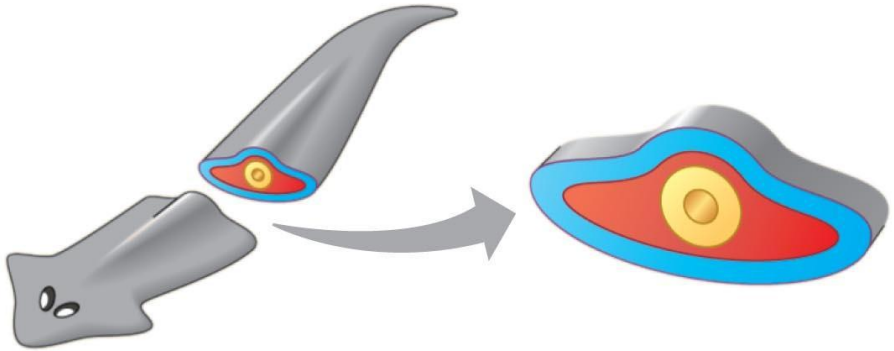




Platyhelminthes (flatworms)

Acoelomate, no cavity inside. Mesenchyme skeleton

Has both longitudinal and circular muscles



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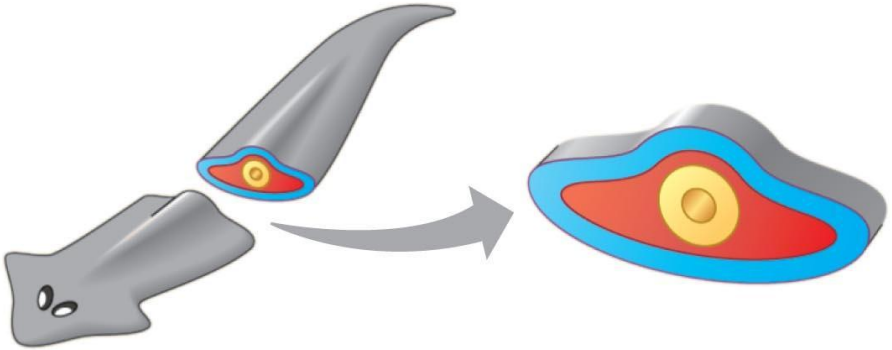

Nematodes (roundworm)

Pseudocoelomate, cavity between meso and endoderm

Only longitudinal muscle present

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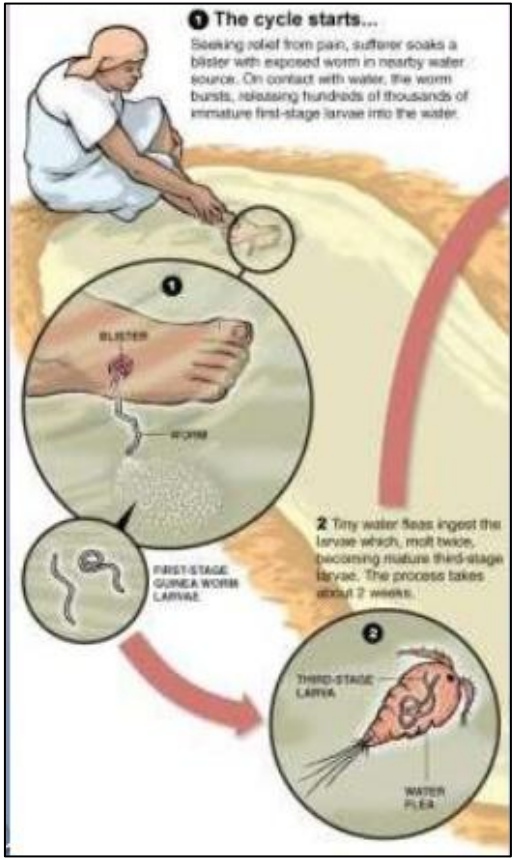
I.g. Guinea worm (*Dracunculus medinensis*)



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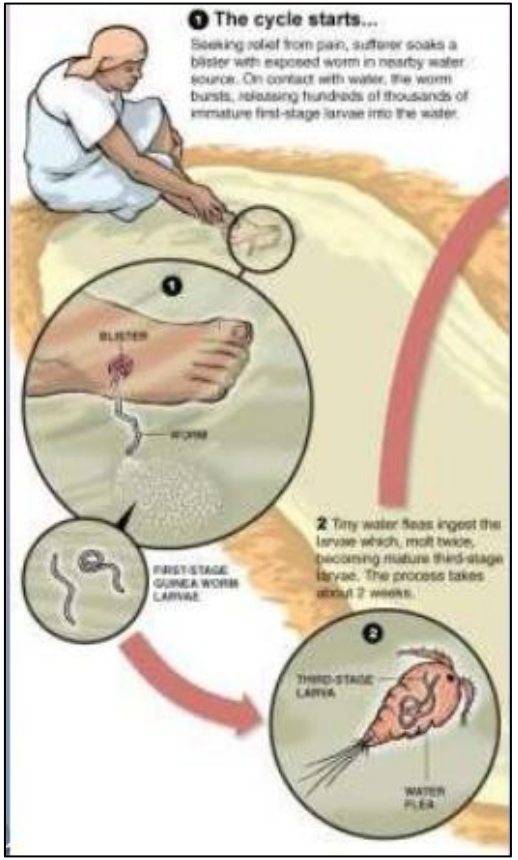

Annelids (earthworm)

Has both longitudinal and circular muscles

Has segments, and sometimes setae too

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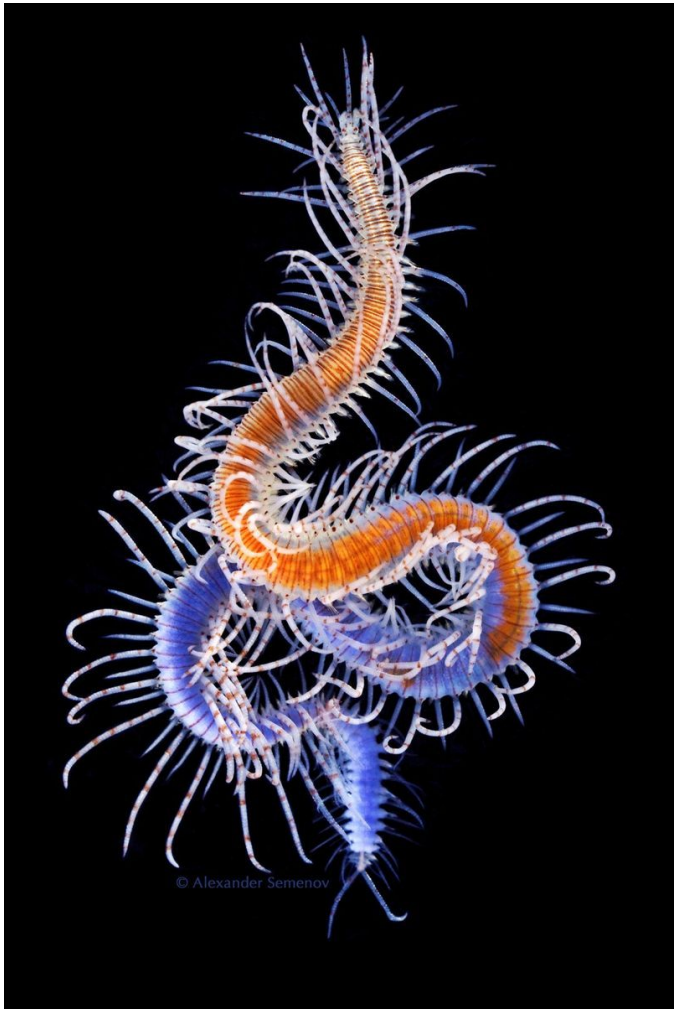
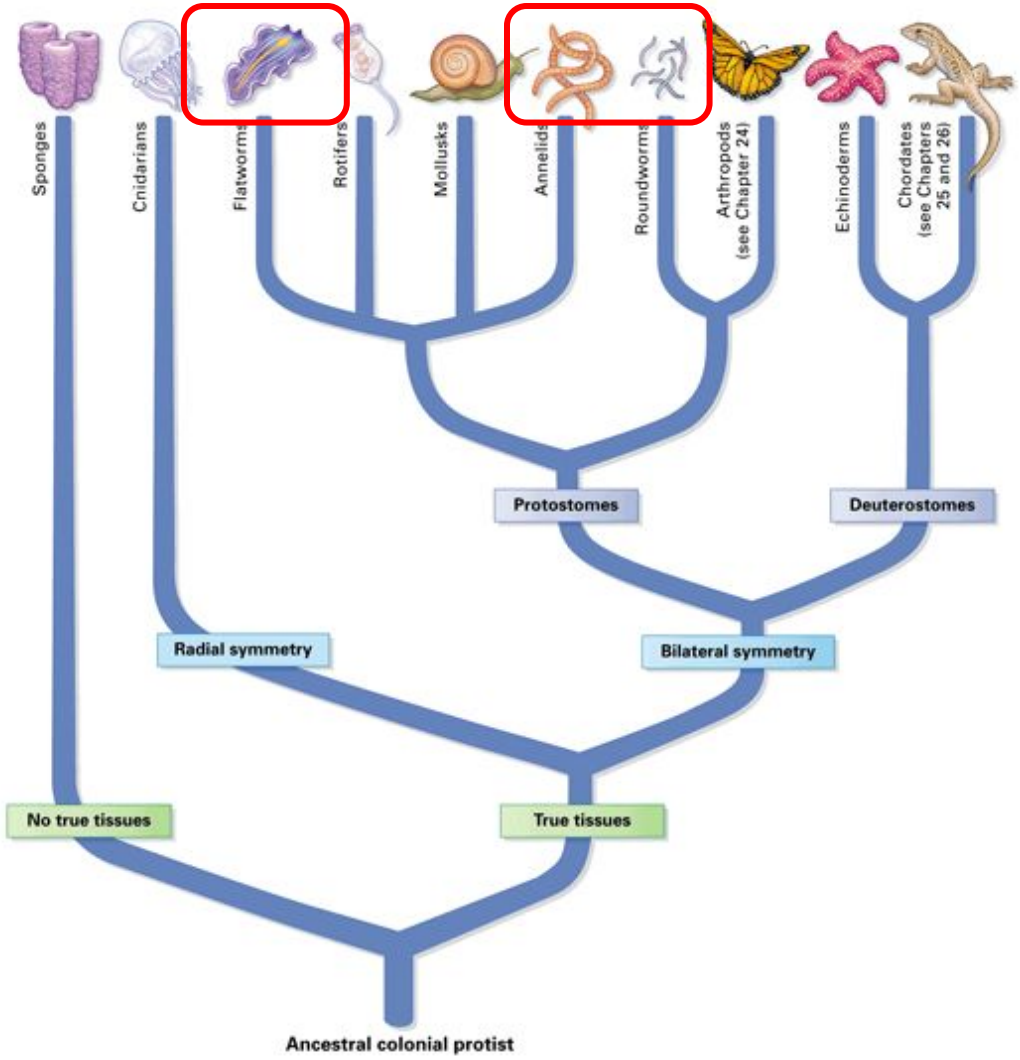
Has both longitudinal and circular muscles

Has segments, and sometimes setae too

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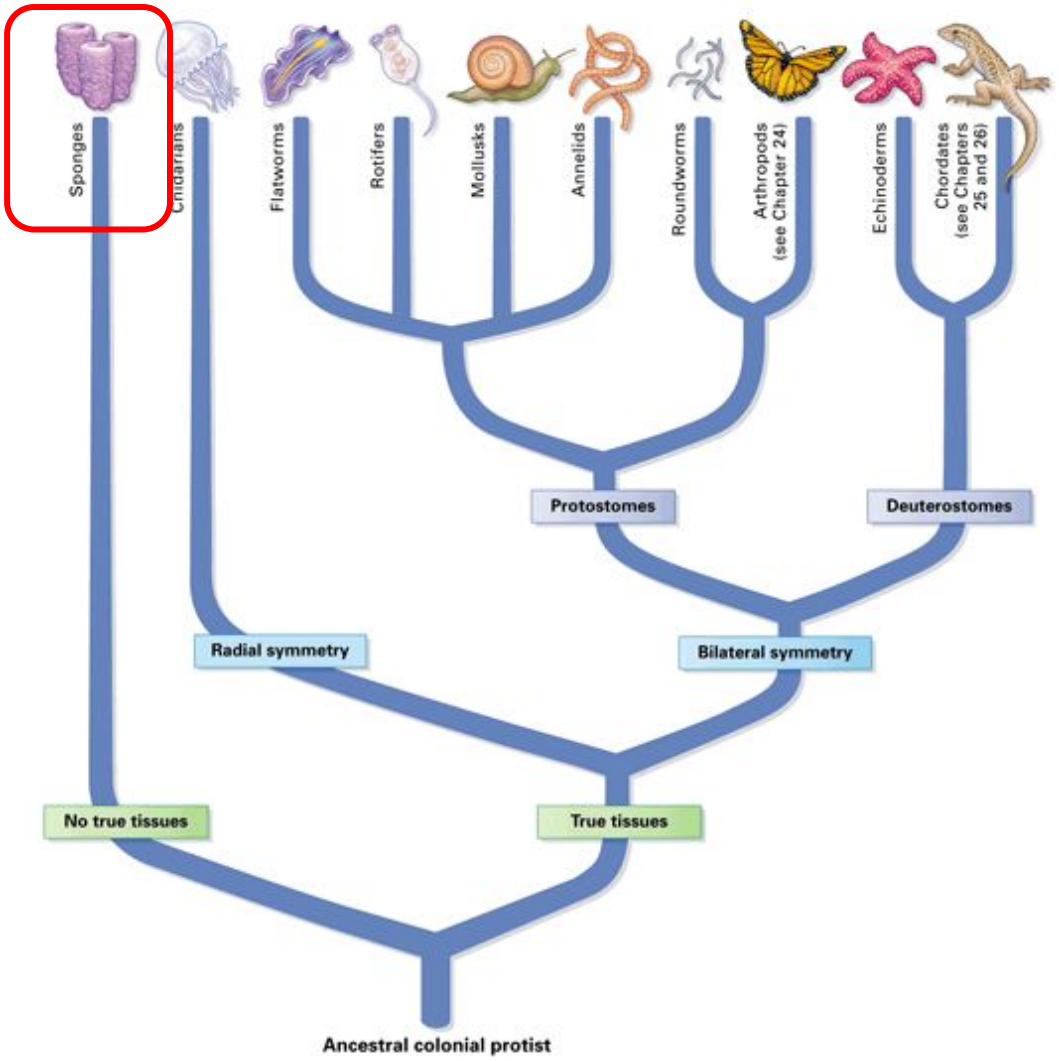
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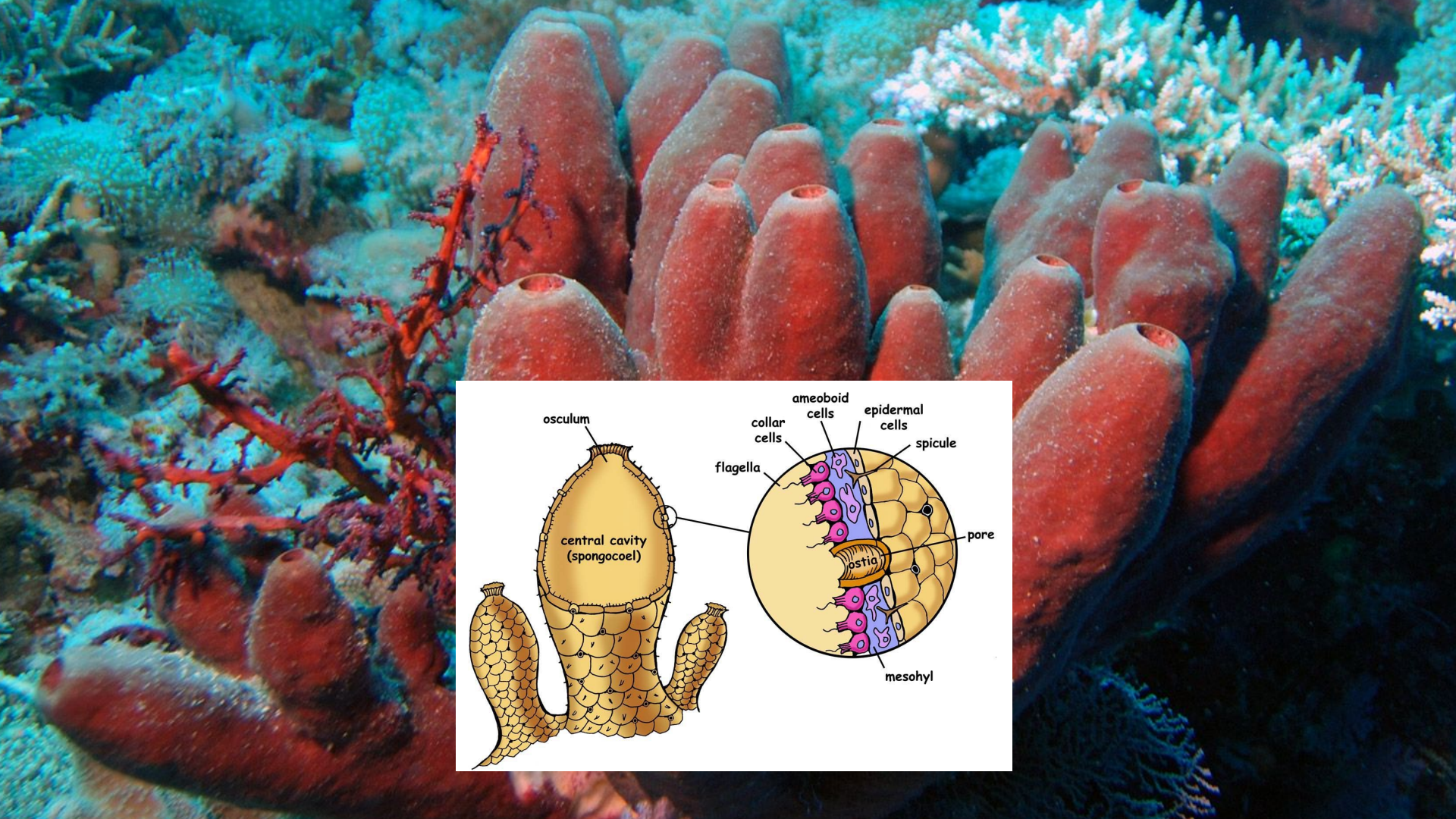
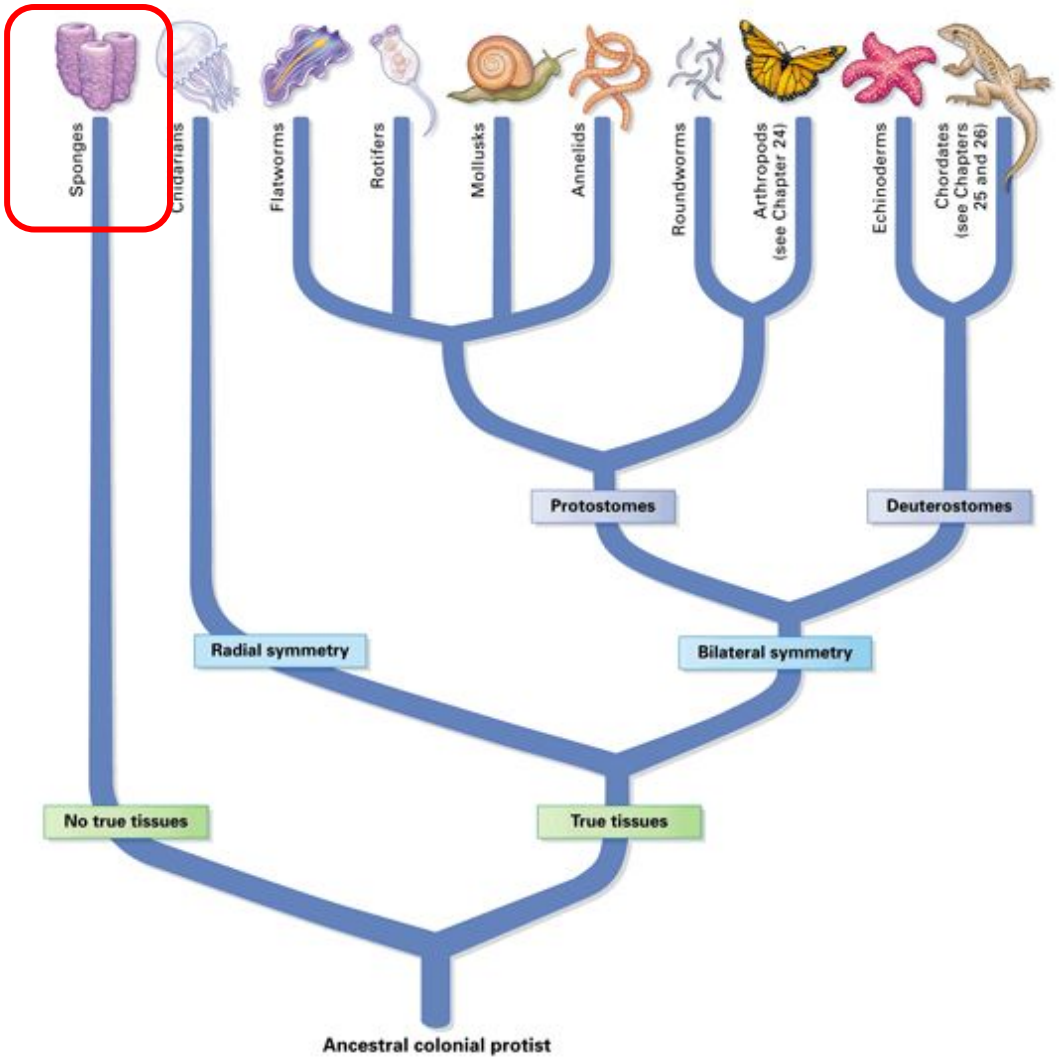

osculum
central cavity
(spongocoel)
ameoboid
cells
epidermal
cells
collar
cells
spicule
flagella
pore
ostia
mesohyl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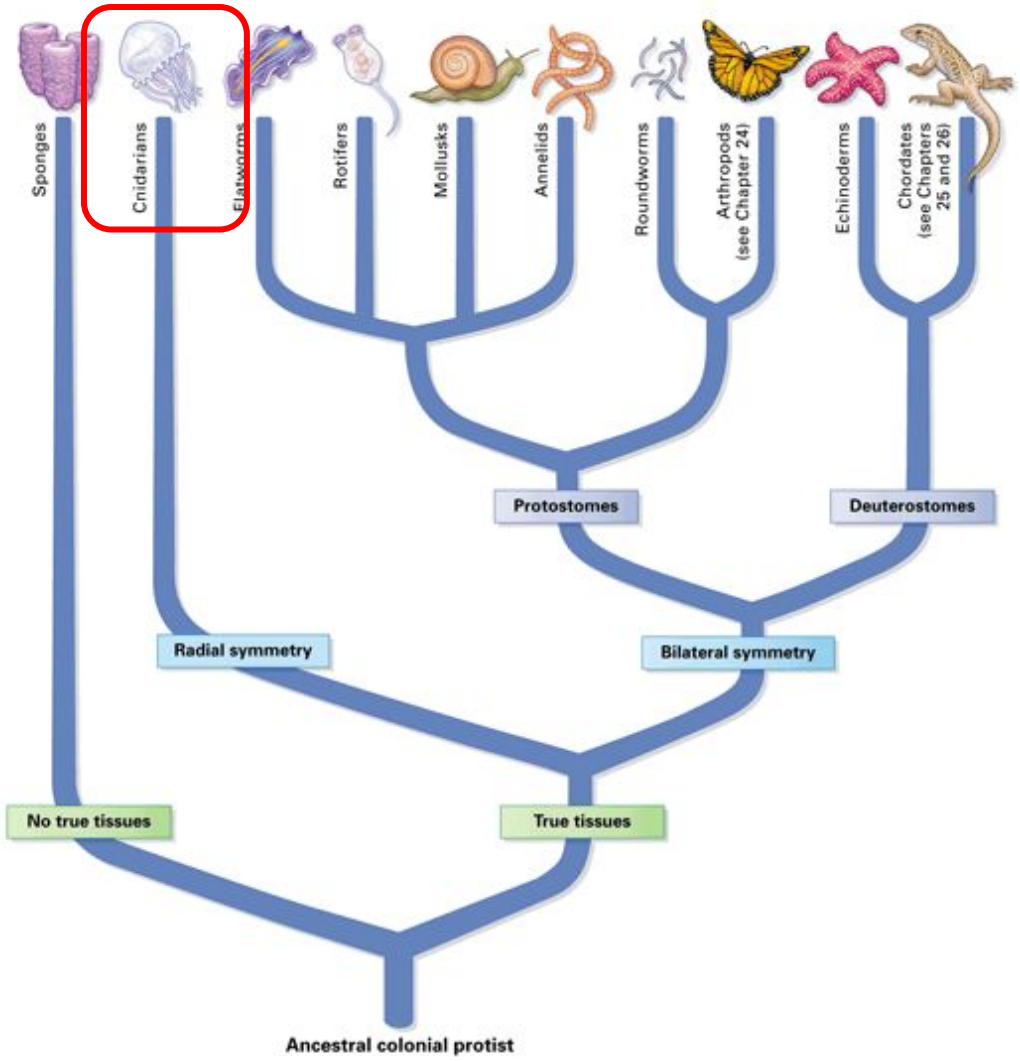
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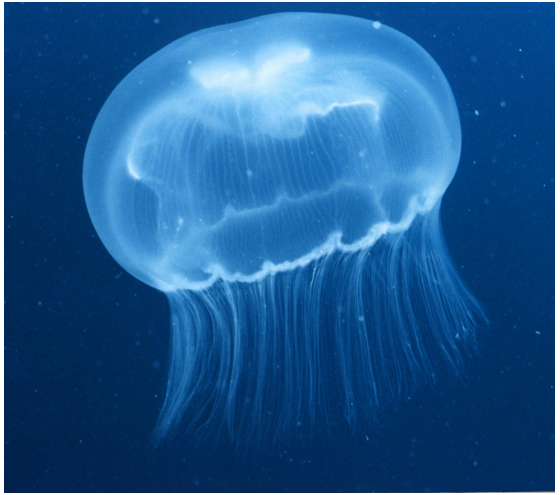
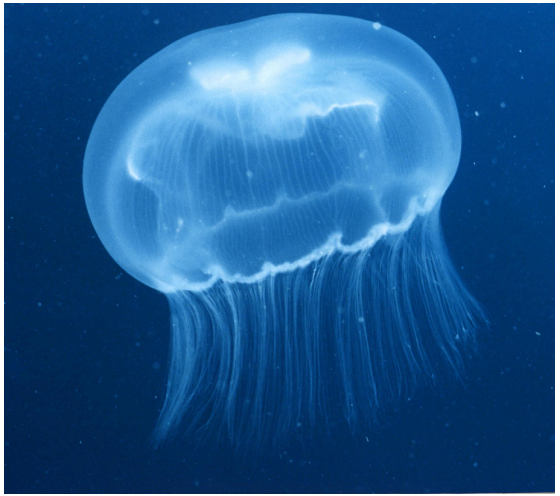


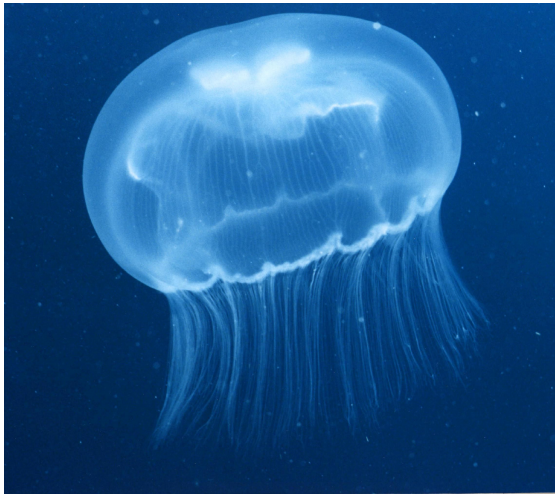
Cnidarians

Body Structure	Hydrostatic Skeleton



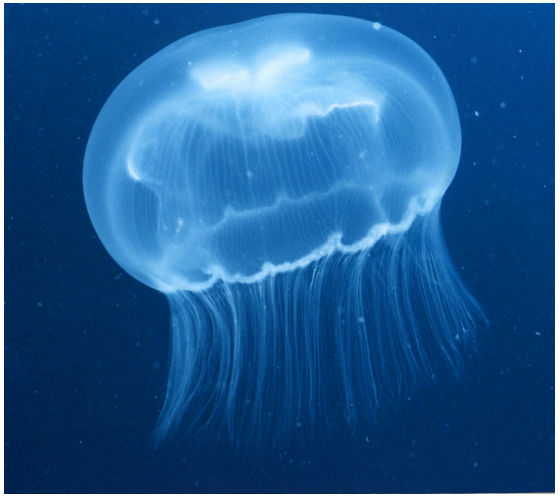
Cnidarians

Body Structure	Hydrostatic Skeleton
Polyp	Stalk holds tentacles upwards



Cnidarians

Body Structure	Hydrostatic Skeleton
Polyp	Stalk holds tentacles upwards
Medusa	Free living bell-like form



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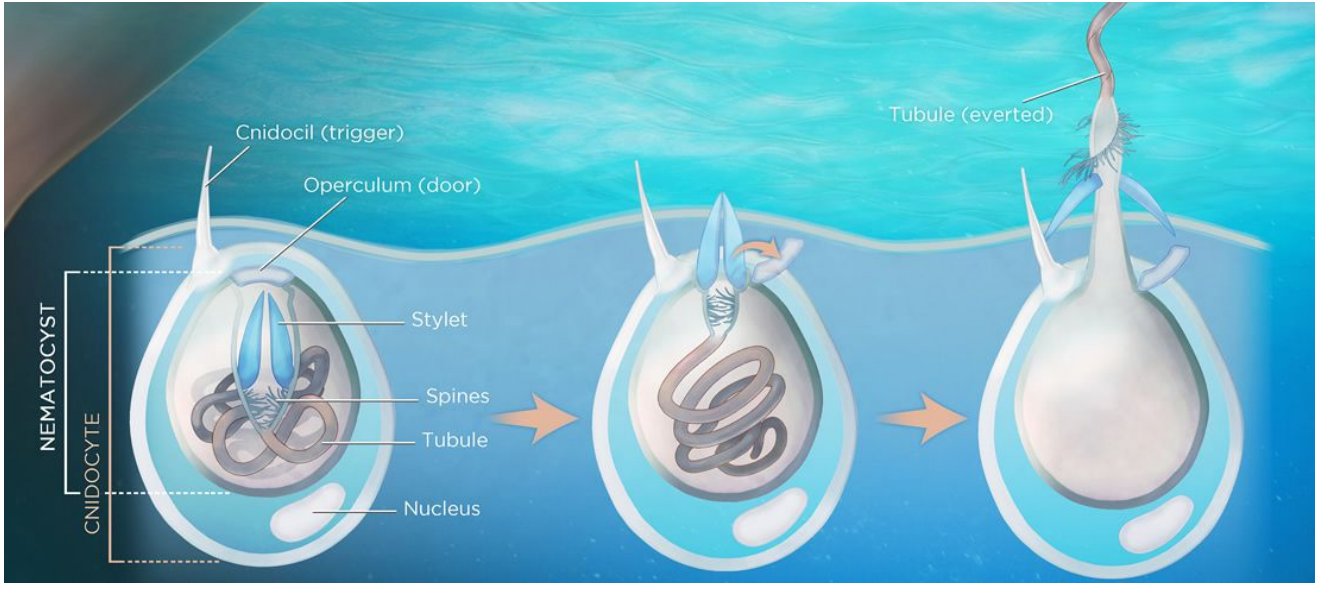
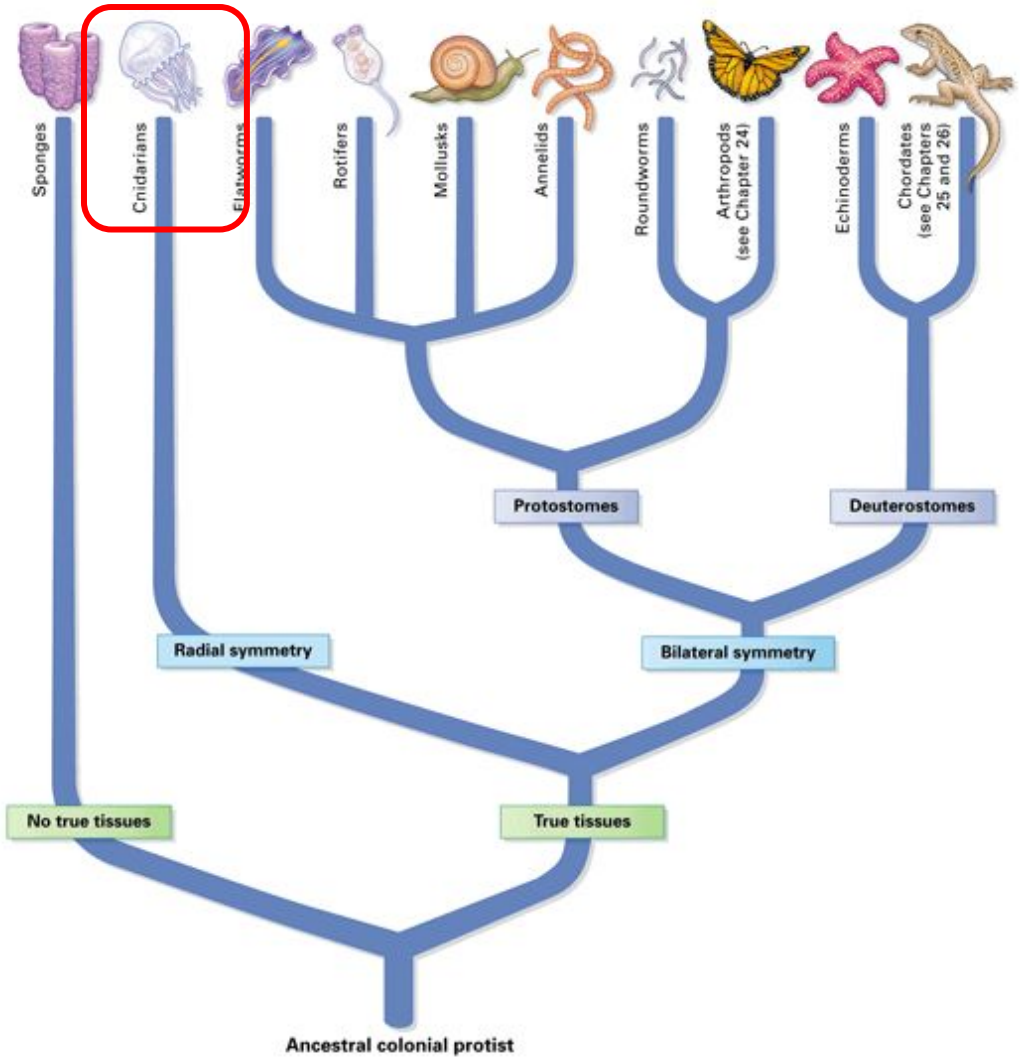
Body Structure	Hydrostatic Skeleton
Polyp	Stalk holds tentacles upwards
Medusa	Free living bell-like form
Stinging Cells	cnidocytes, nematocysts




Sponges
Cnidarians
Flatworms
Rotifers
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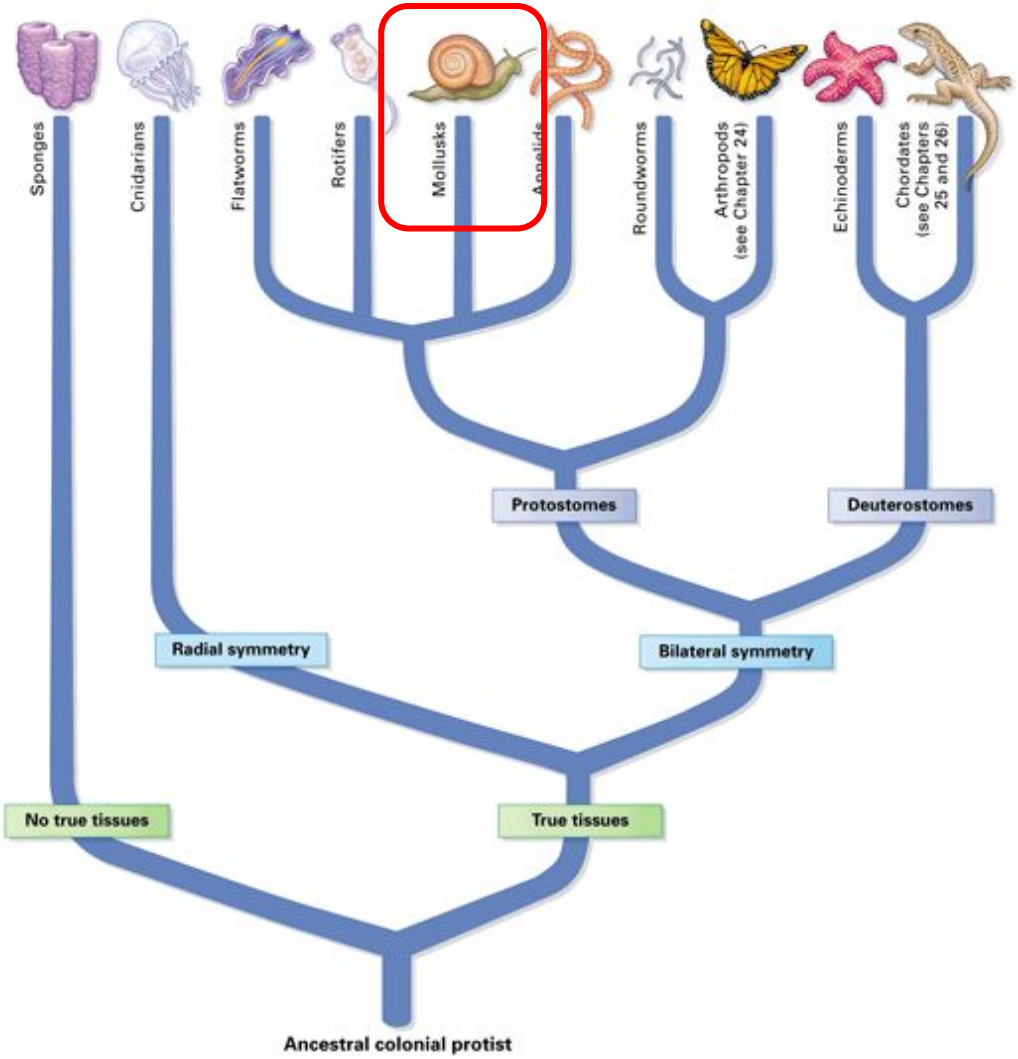
Roundworms
Arthropods (see Chapter 24)
Echinoderms
Chordates (see Chapters 25 and 26)
Protostomes
Deuterostomes
Radial symmetry
Bilateral symmetry
No true tissues
True tissues
Ancestral colonial protist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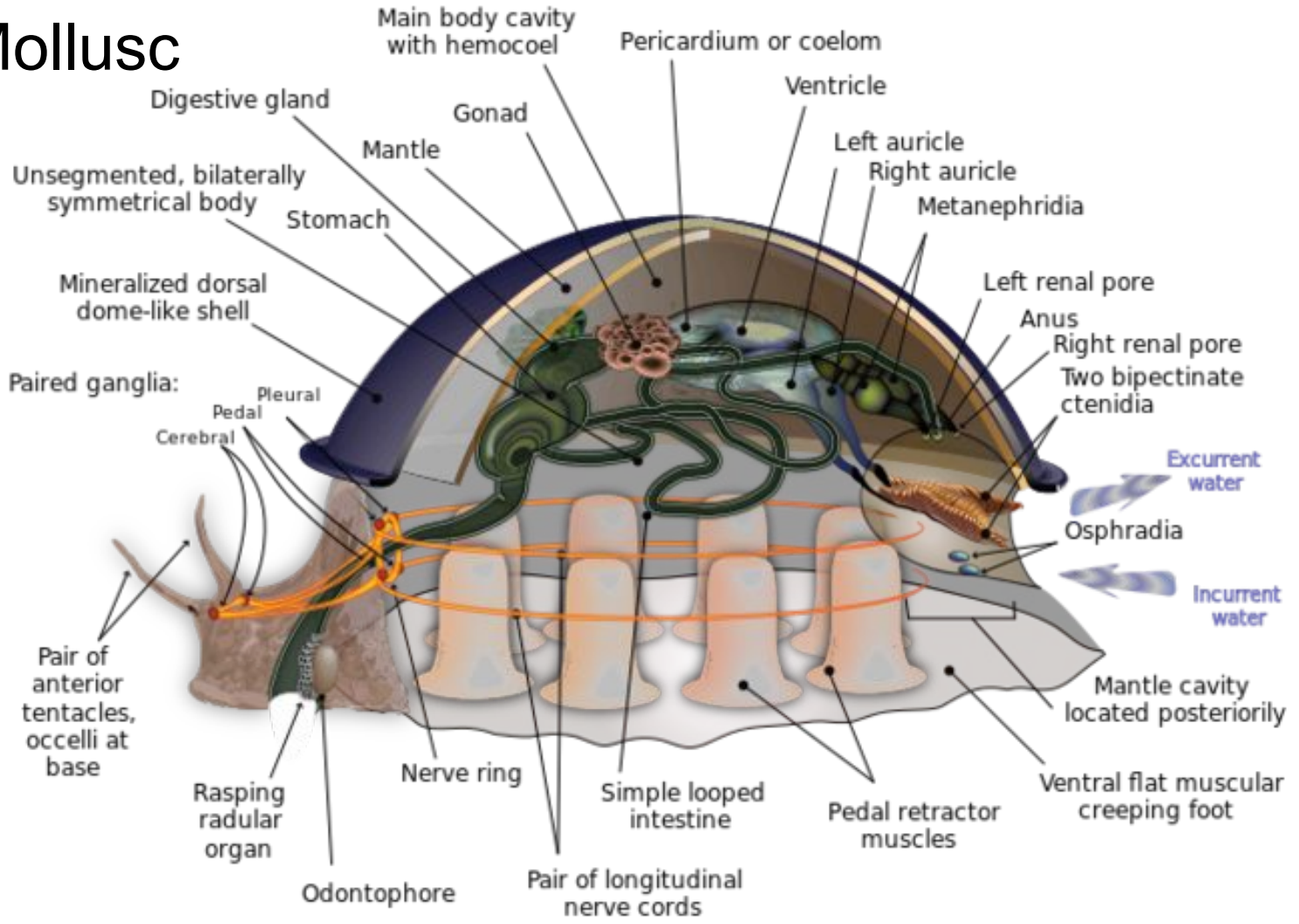
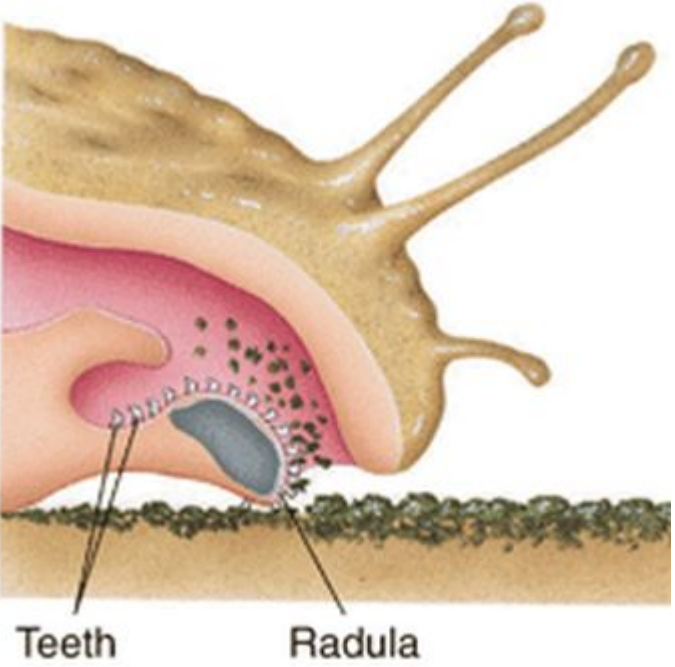
Archetype Mollusc



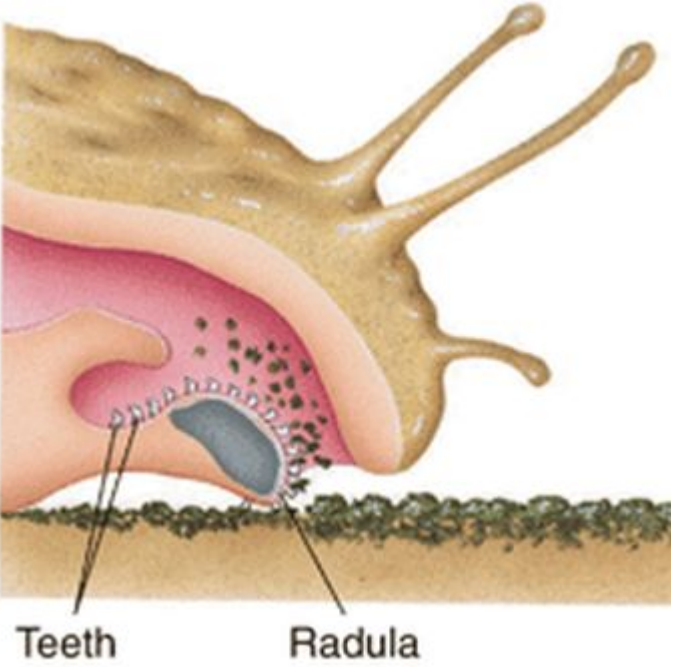
Radula:

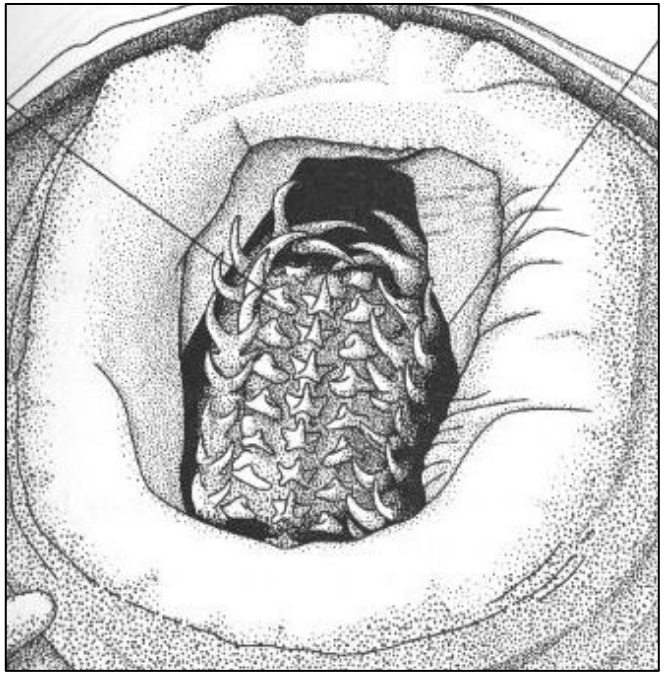
Rasping organ

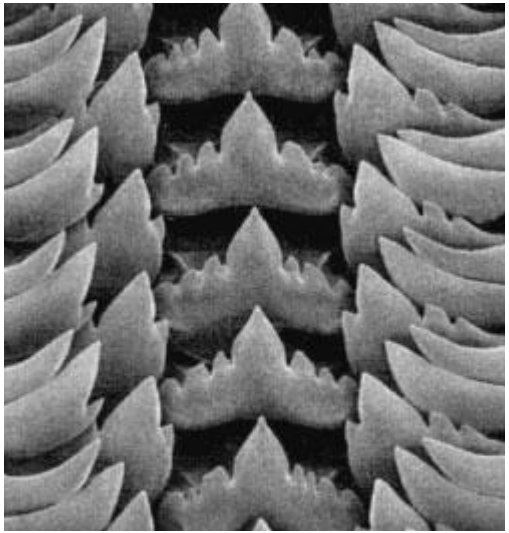


Radula:

Rasping organ







Class: Bivalvia

-Two-part valve

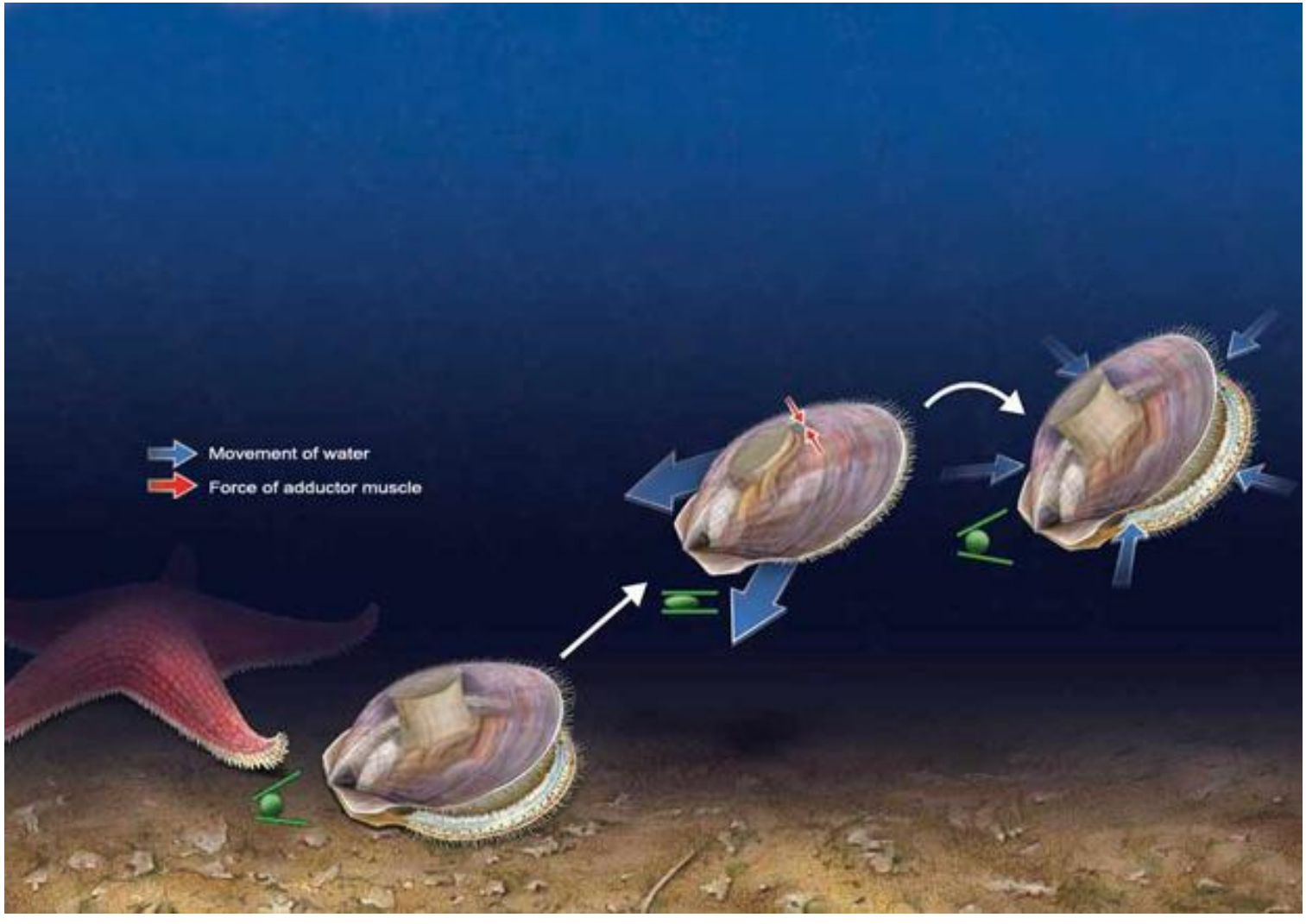
-hinge with interdigitating teeth

-ancestral foot is now blade like (for digging)

- some use ctenidia for filter feedings

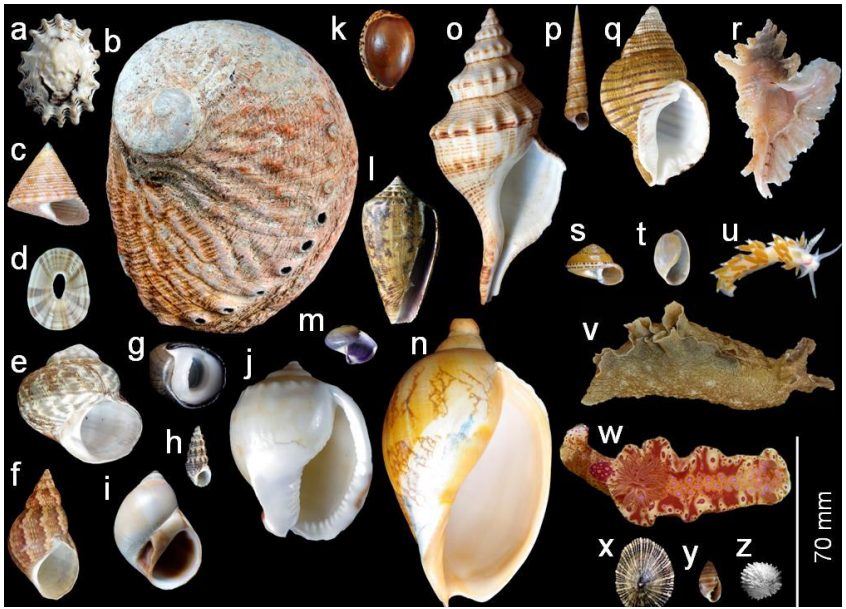
-some can swim

Tridacna gigas


Movement of water
Force of adductor muscle

Class: Gastropoda

-Highly diverse (radiation)



Physalia physalis

Glaucus atlanticus

Physalia physalis

Glaucus atlanticus

Physalia physalis

Class: Gastropoda
Subclass: Pulmonata

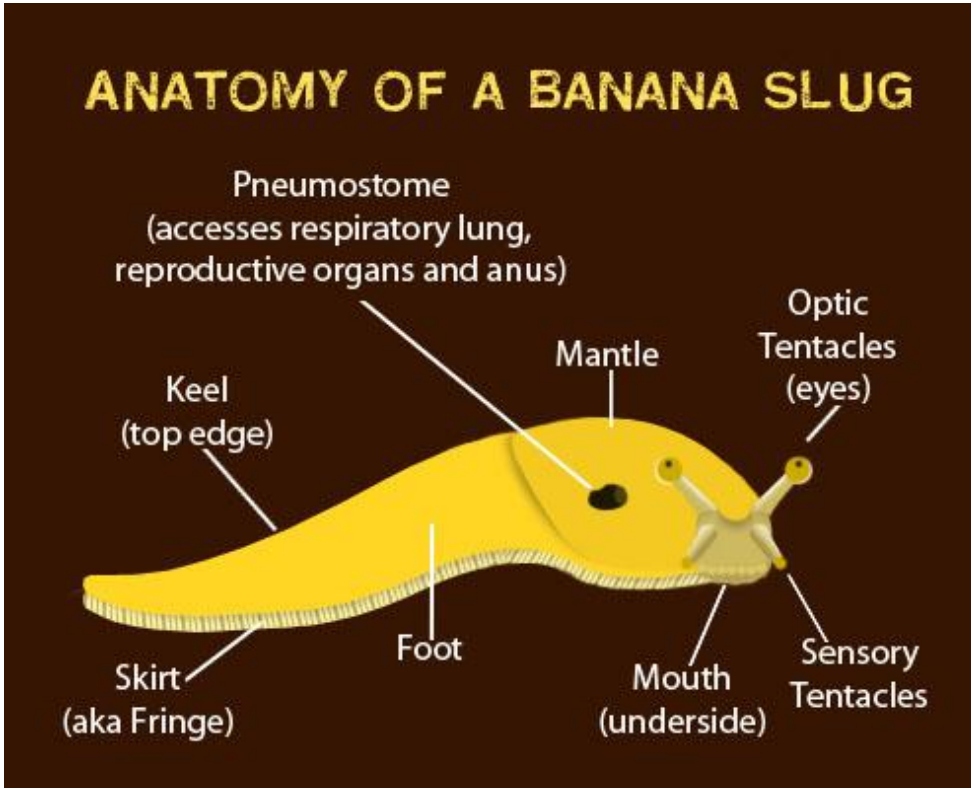
-Terrestrial and Freshwater Gastropods

-Many have lost their shells (slugs)

-Mantle cavity functions as a lung, breathing through an opening called a **pneumostome . (learn how this process works)**

-

Ariolimax californicus



Class: Cephalopoda

-Cephalo= Head, Poda= Foot

-Shell is present, often reduced

-Zoologists contend that a snail-like marine ancestor evolved an ability to adjust gas levels their shells, making their shells more buoyant and eventually giving them the ability to float/swim. This opened up a new dimension of niches for evolution to take its course

Class: Cephalopoda: The Octopus

-Lack a shell, mantle cavity is carried like a bag behind head

-8 arms

-center of arms contain mouth and beak

-small radula

-produces venom that enters wounds through glands in mouth

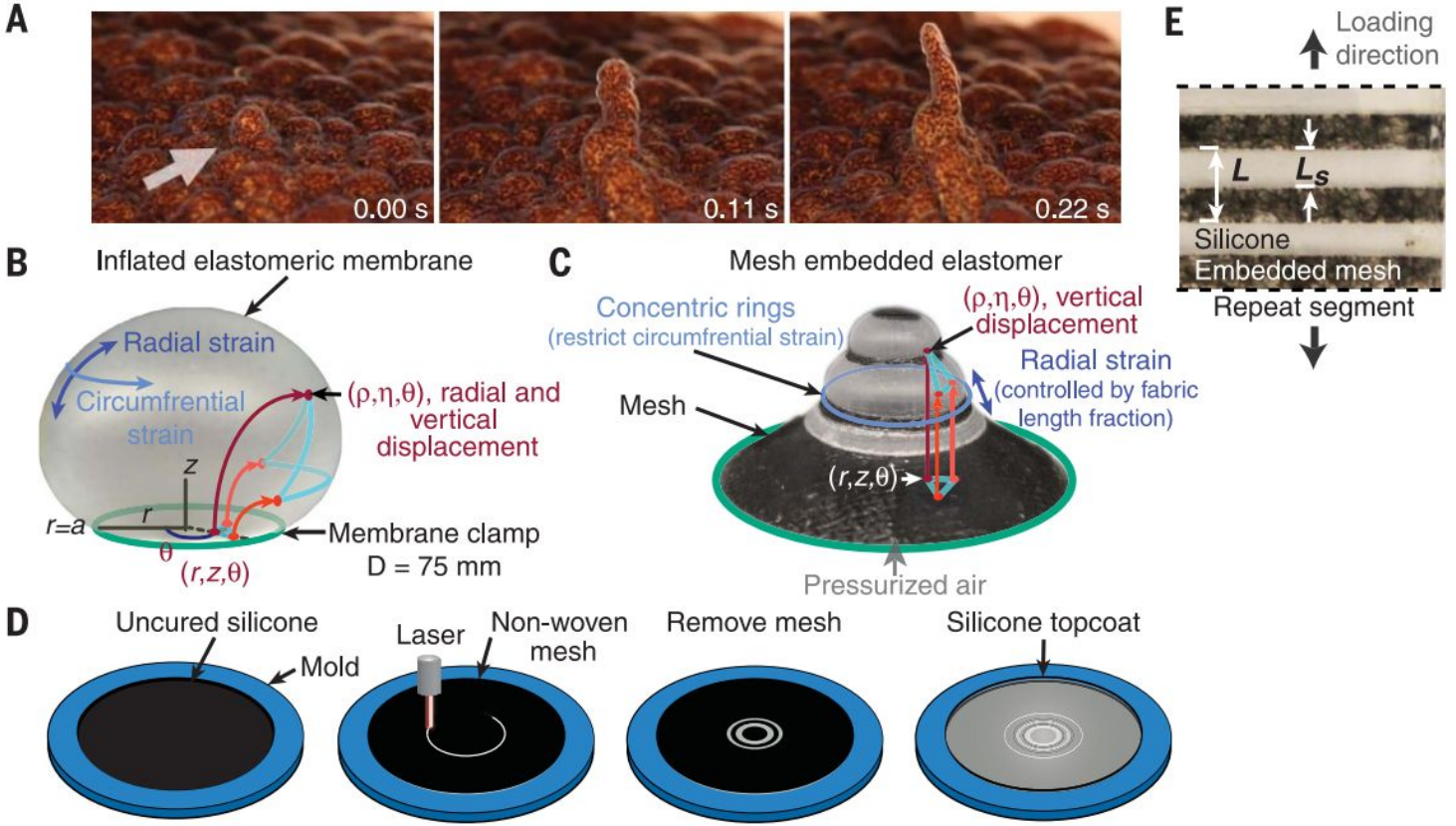
-complex eye, independently evolved from the eyes of chordata

-propels itself using siphon (jet propulsion)

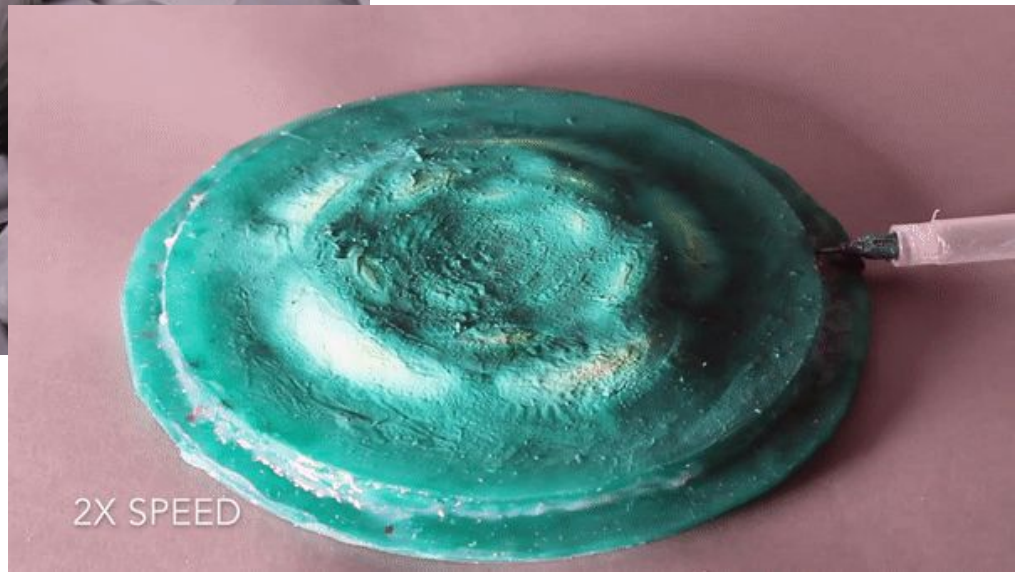
-can change color of skin rapidly

Class: Cephalopoda: The Octopus

Class: Cephalopoda: The Octopus



Class: Cephalopoda: The Octopus



Stretchable surfaces with programmable 3D texture morphing for synthetic camouflaging skins

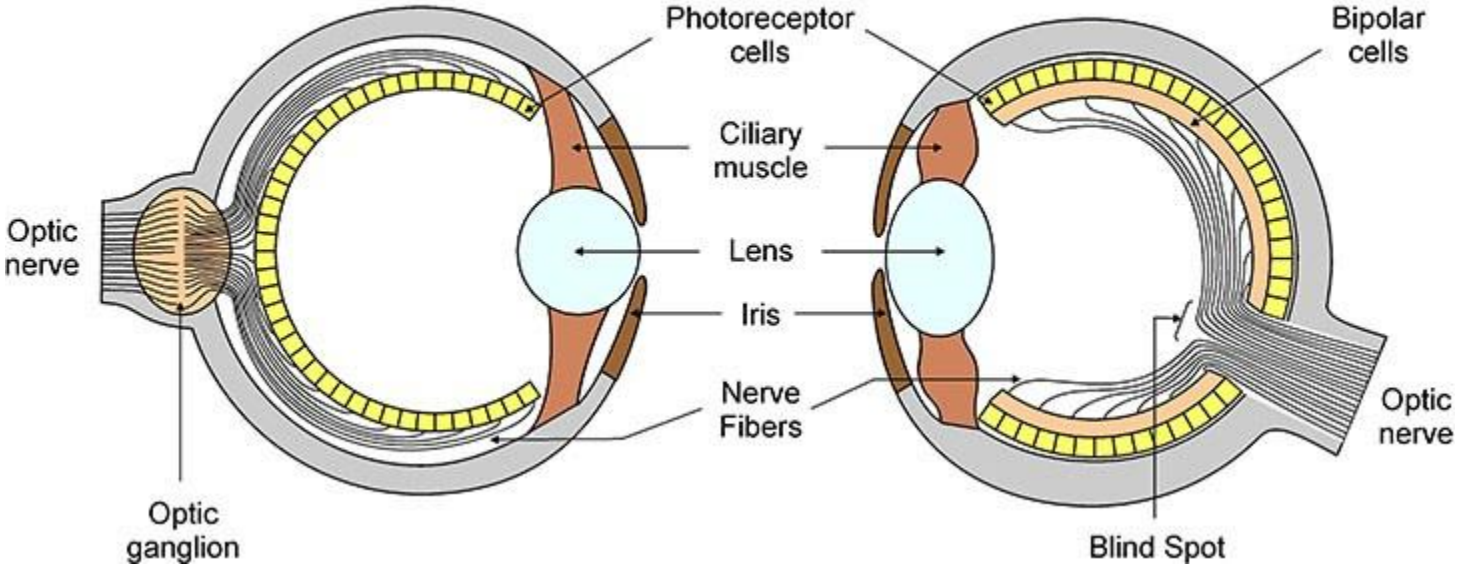
J. H. Pikul[1,2], S. Li[3], H. Bai[1], R. T. Hanlon[4], I. Cohen[2], R. F. Shepherd[1,3,*]

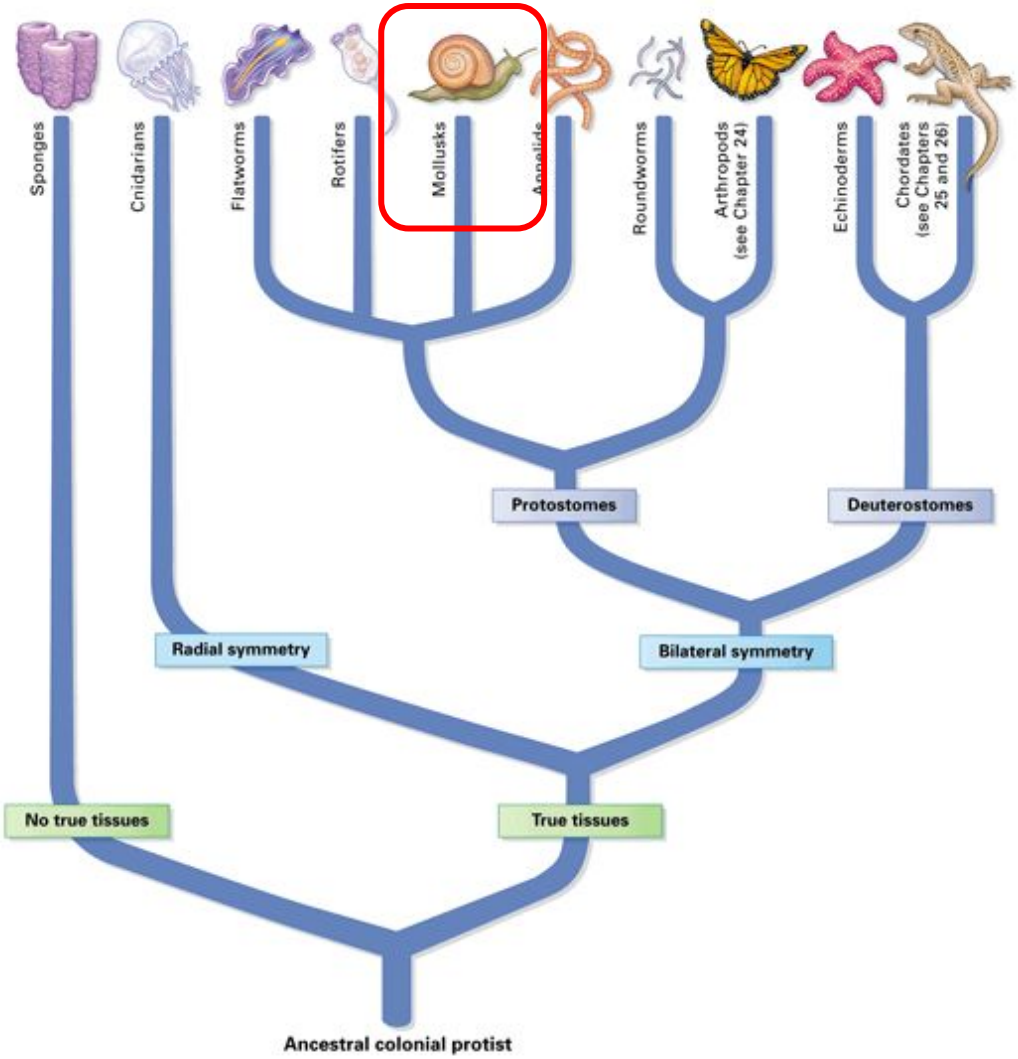
+ See all authors and affiliations

Analogous structures

Octopus

Vertebrate

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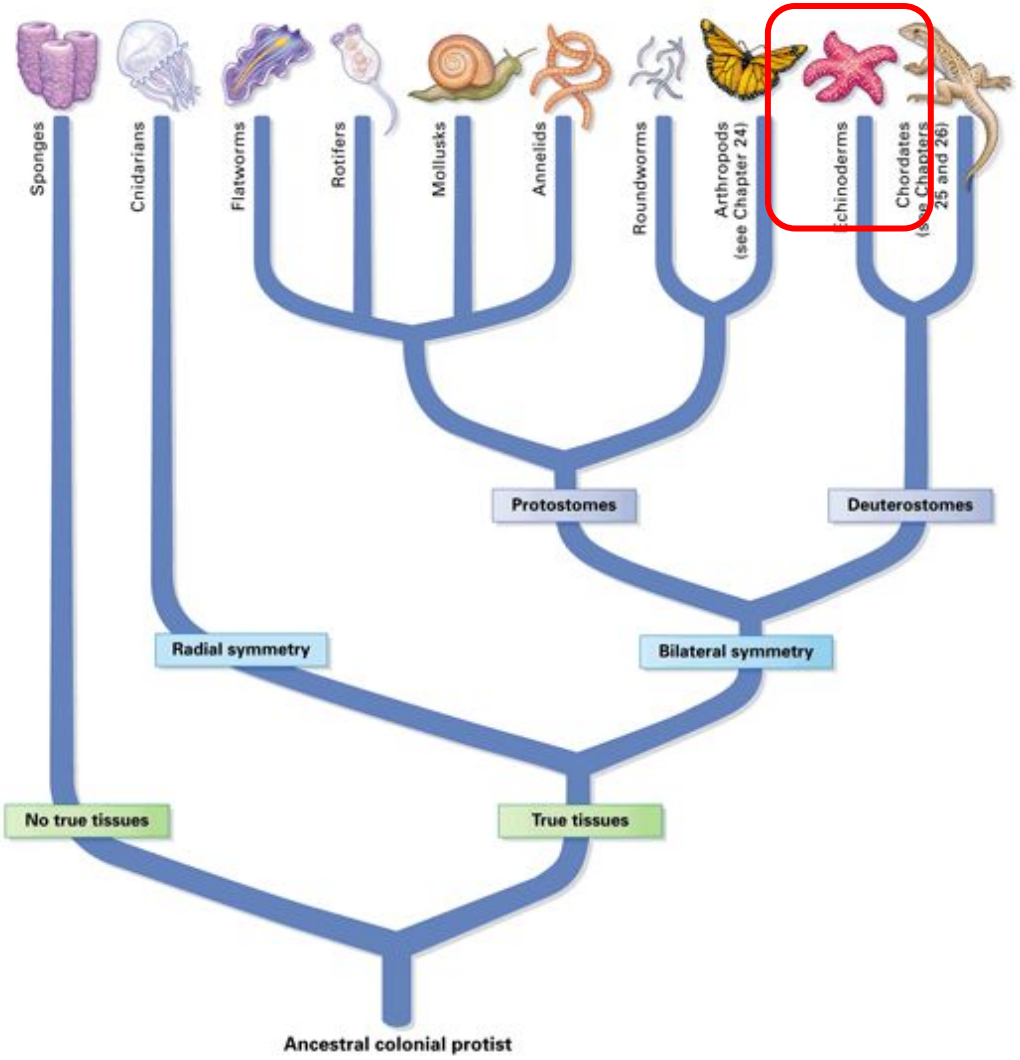
Deuterostomes
Radial symmetry
Bilateral symmetry
No true tissues
True tissues
Ancestral colonial protist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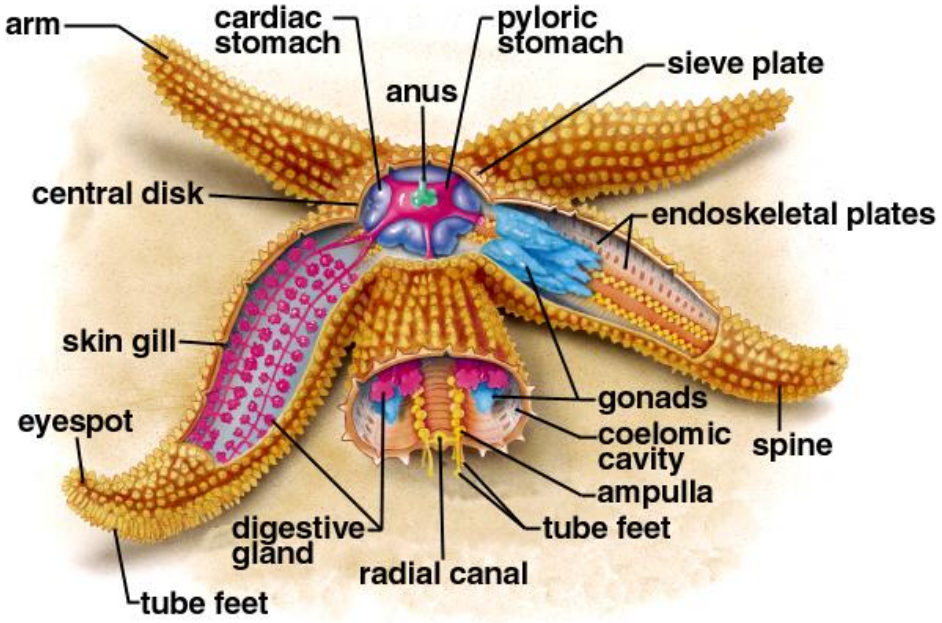
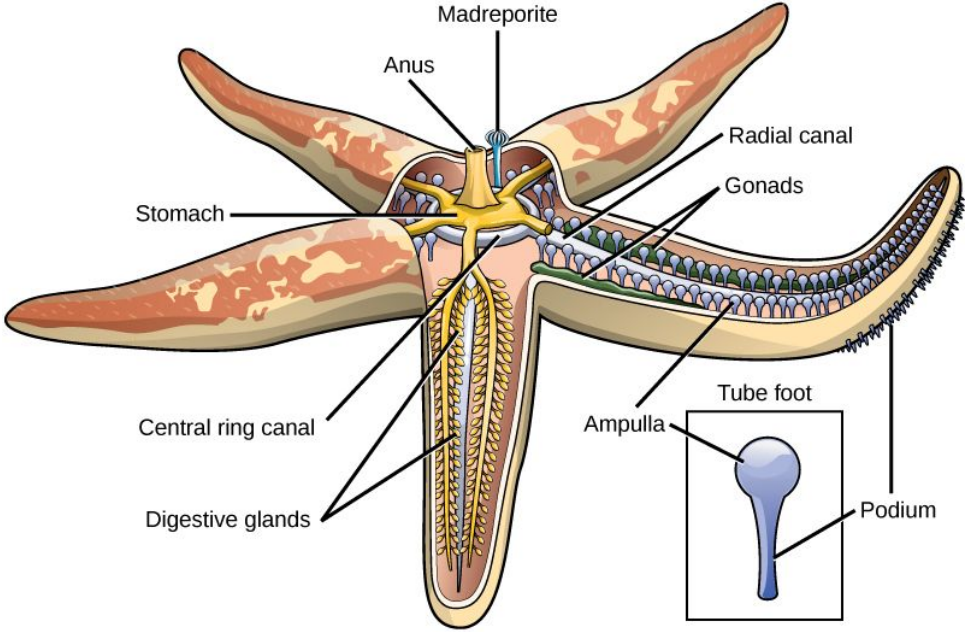
Water Vascular System

Echinoderms use water pumps to move

Water is pumped out of the tube feet

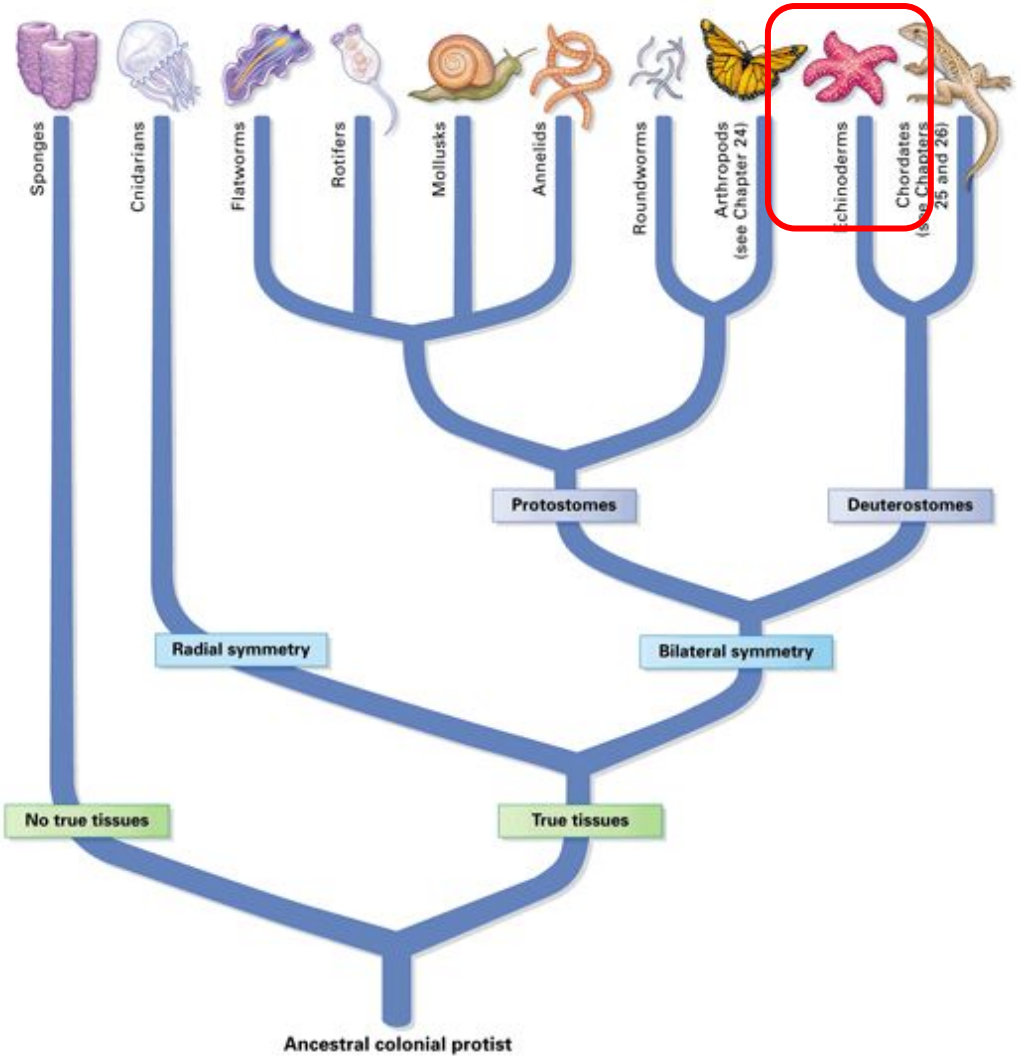
Where does the water come from?




Madreporite
Anus
Radial canal
Gonads
Stomach
Central ring canal
Digestive glands
Tube foot
Ampulla
Podium

Leptasterias hexactis 3X
— madreporite

BBC one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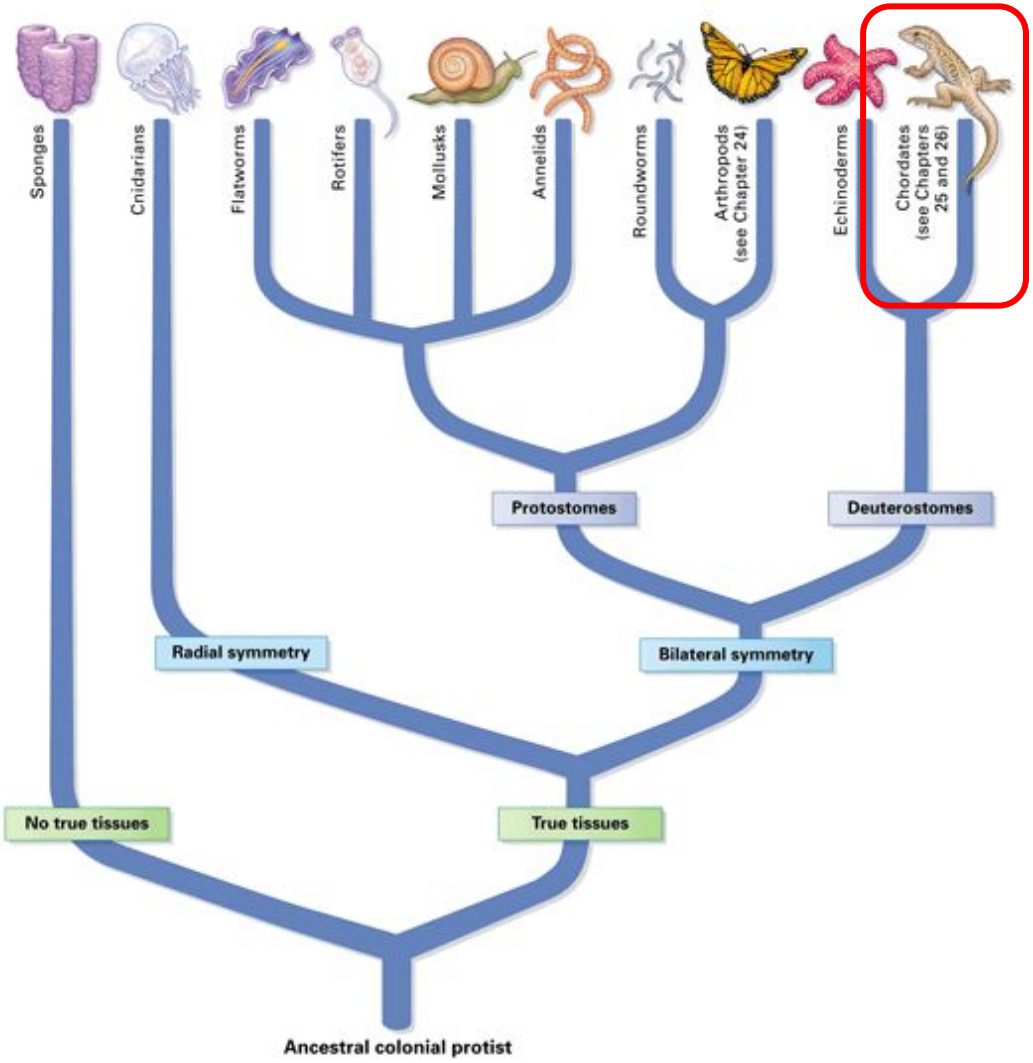
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Deuterostomes
Radial symmetry
Bilateral symmetry
No true tissues
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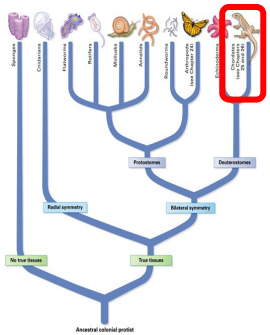
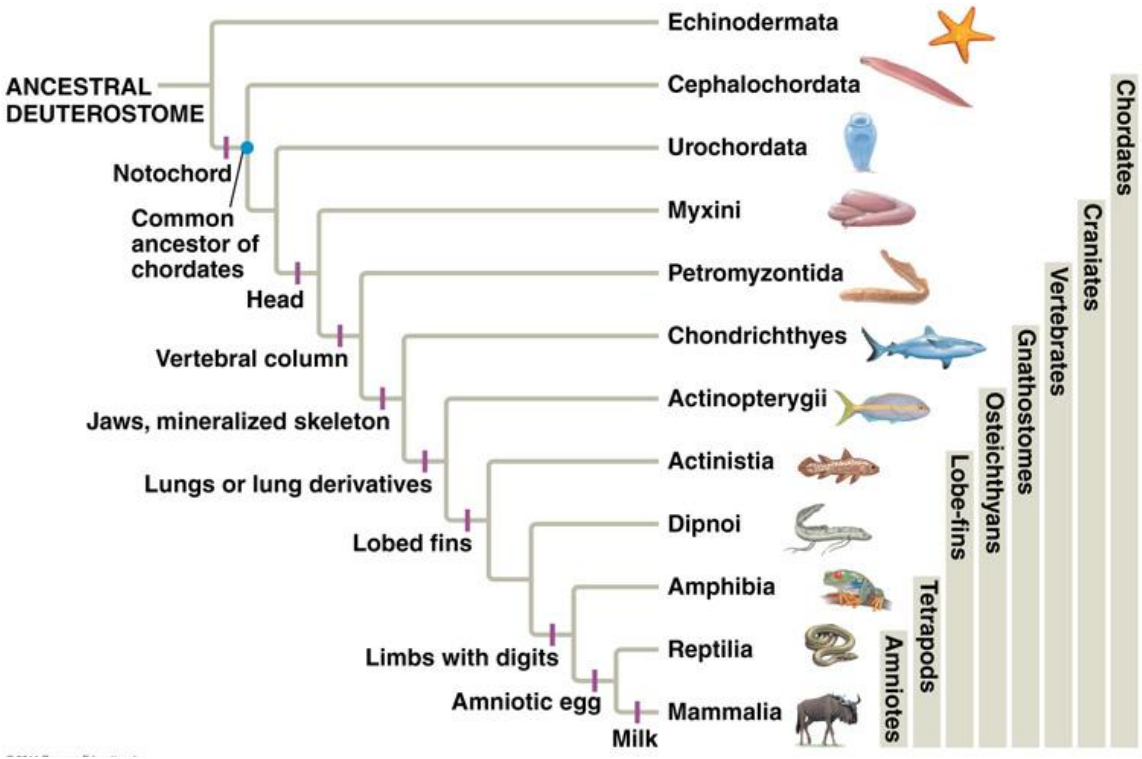
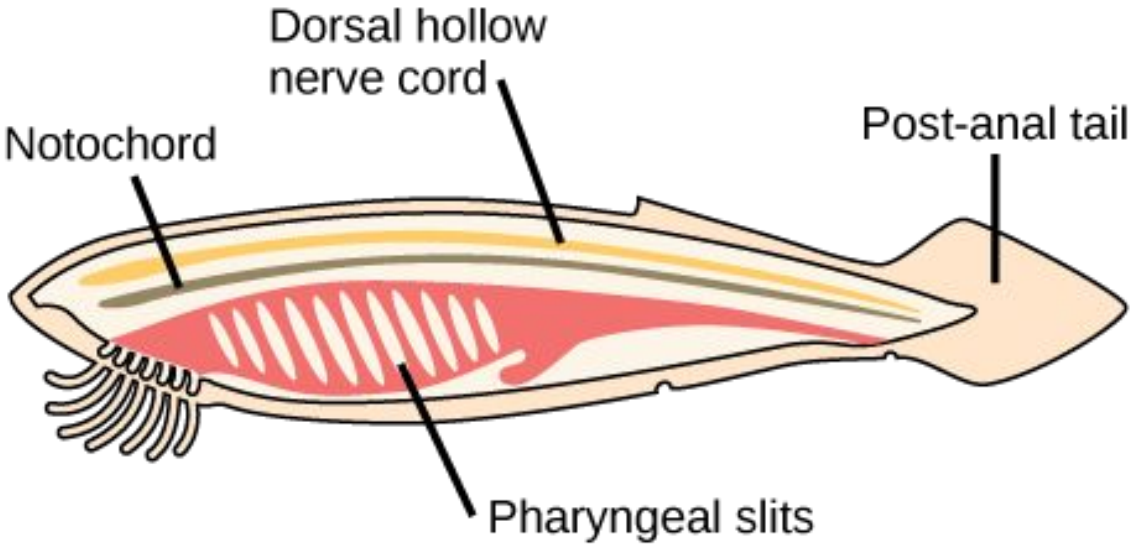
And now, the CHORDATES!





Chordata Characteristics

- These characteristics are only present during embryonic development in some chordates.



Chordata Characteristics

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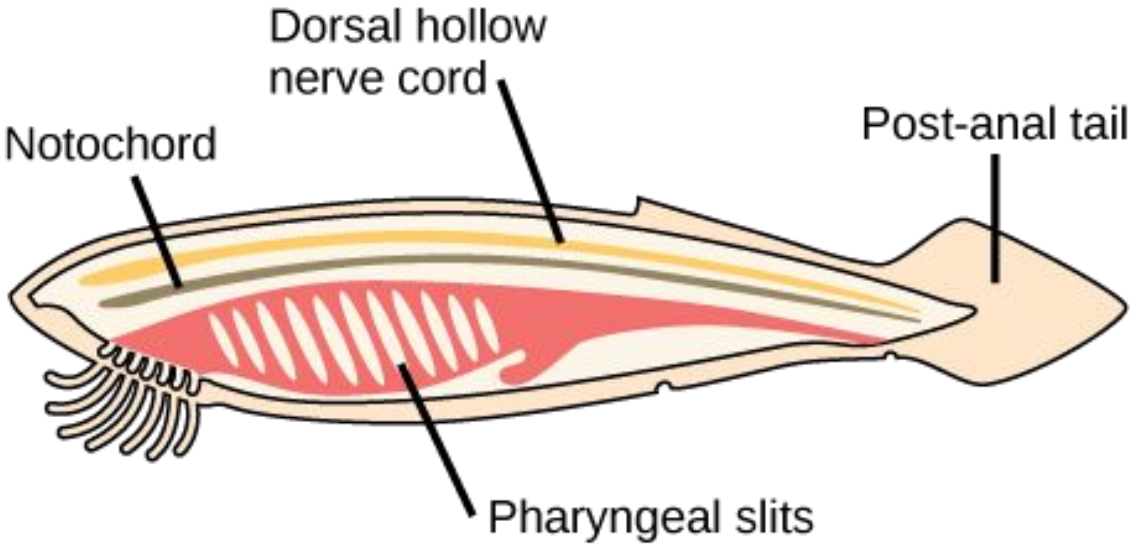
1. Notochord



Chordata Characteristics

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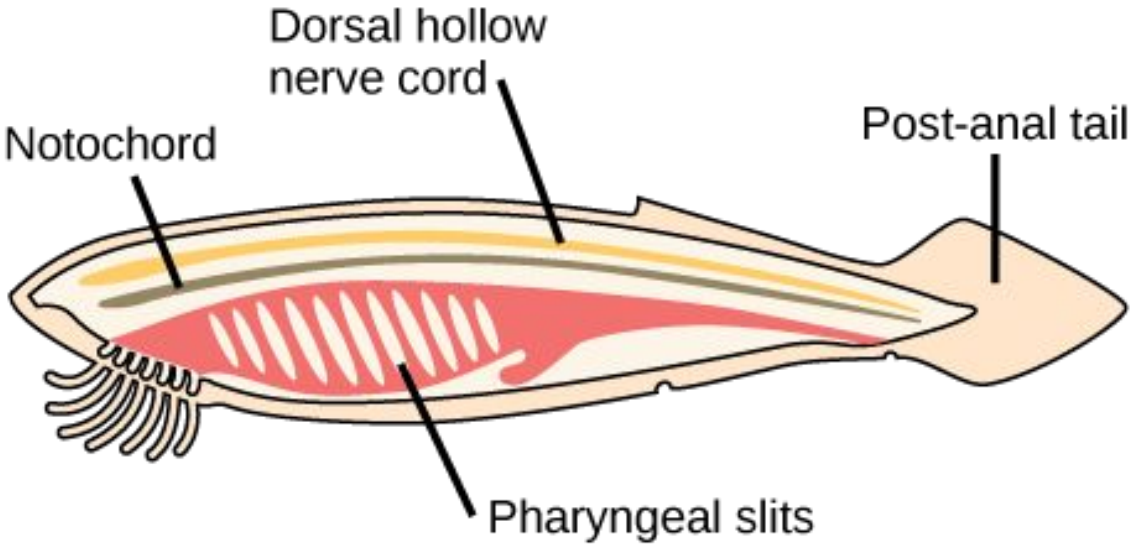
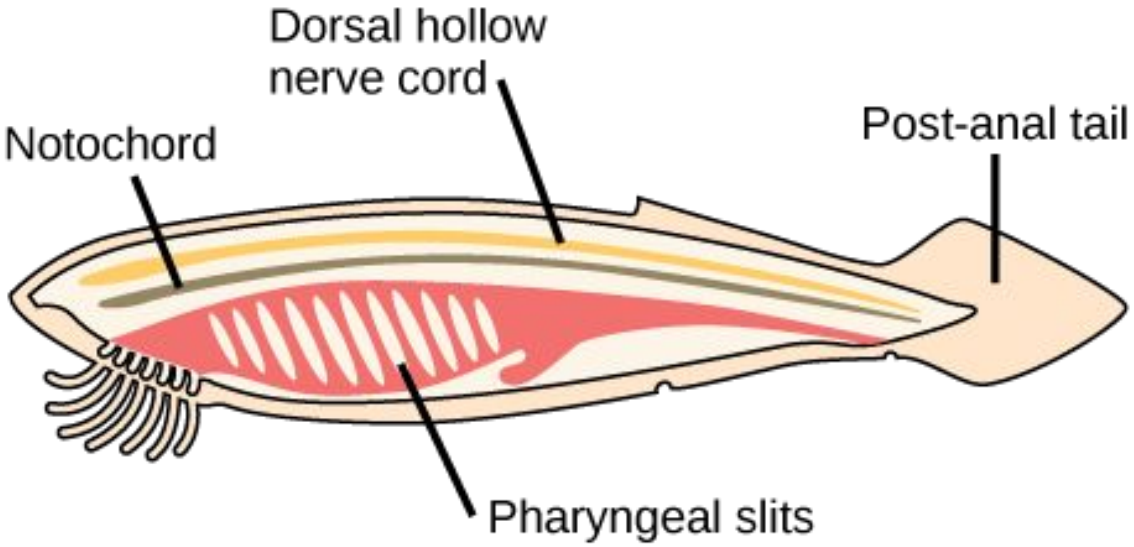
1. Notochord
2. Dorsal hollow nerve cord



Chordata Characteristics

- These characteristics are only present during embryonic development in some chordates.

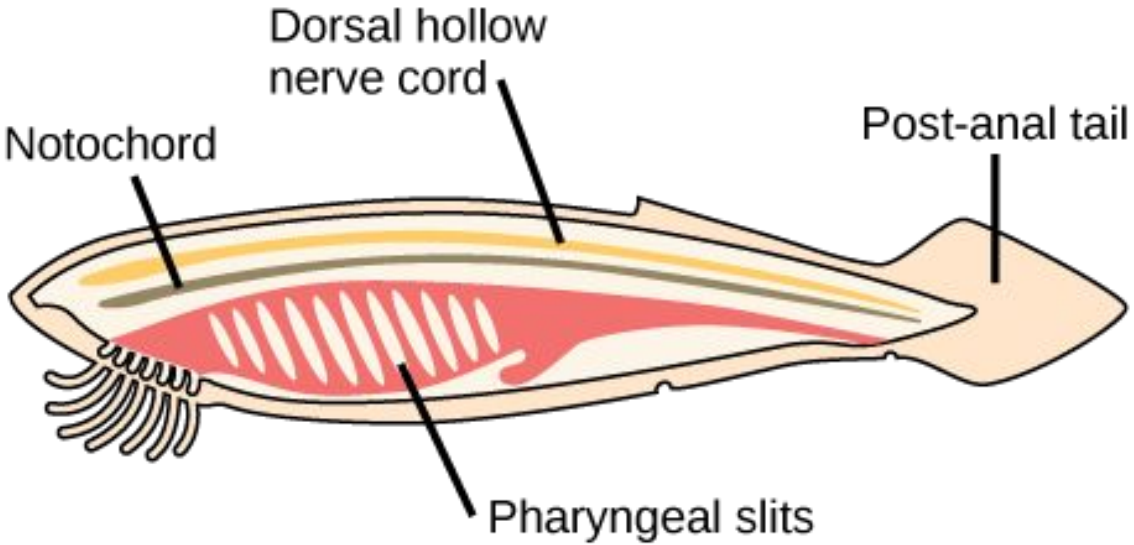
1. Notochord
2. Dorsal hollow nerve cord
3. Pharyngeal slits



Chordata Characteristics

- These characteristics are only present during embryonic development in some chordates.

1. Notochord
2. Dorsal hollow nerve cord
3. Pharyngeal slits
4. Post anal tail



Chordata Characteristics

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1. Notochord
2. Dorsal hollow nerve cord
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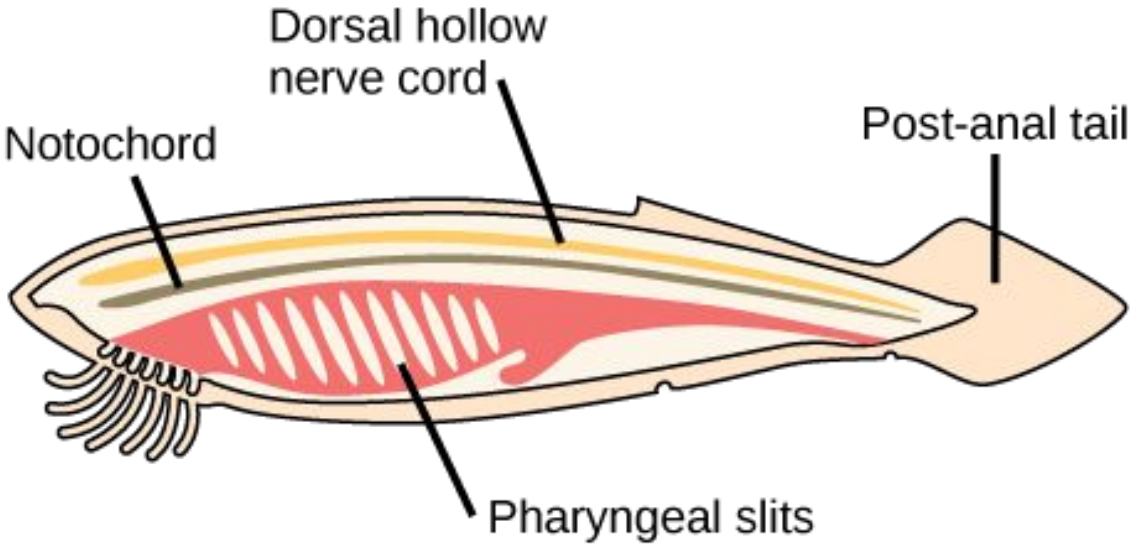
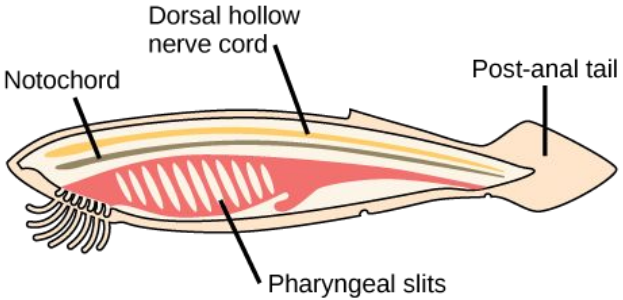
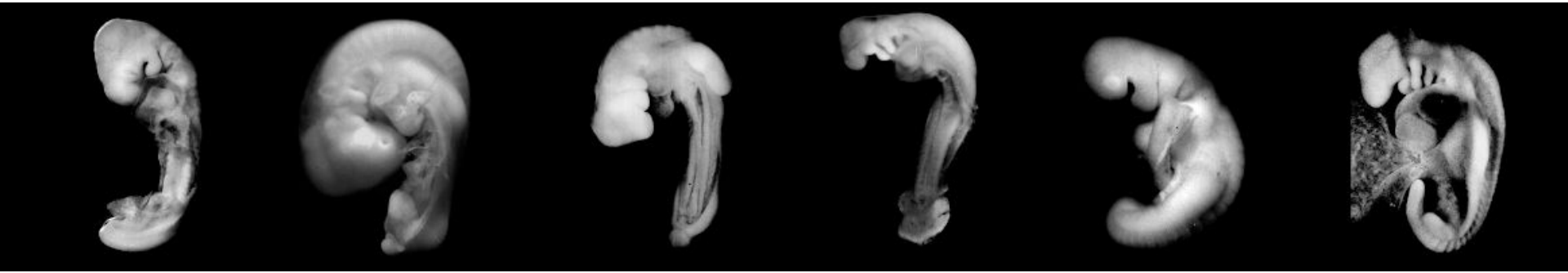
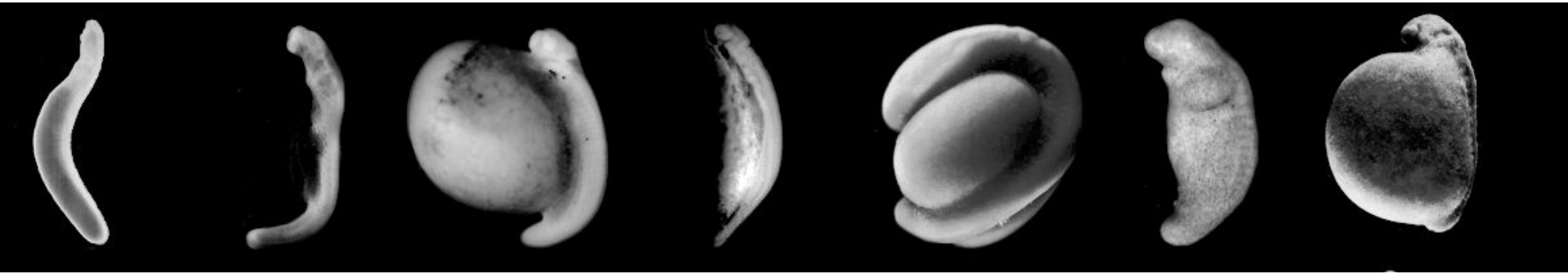
4. Post anal tail

All DEUTEROSTOMES



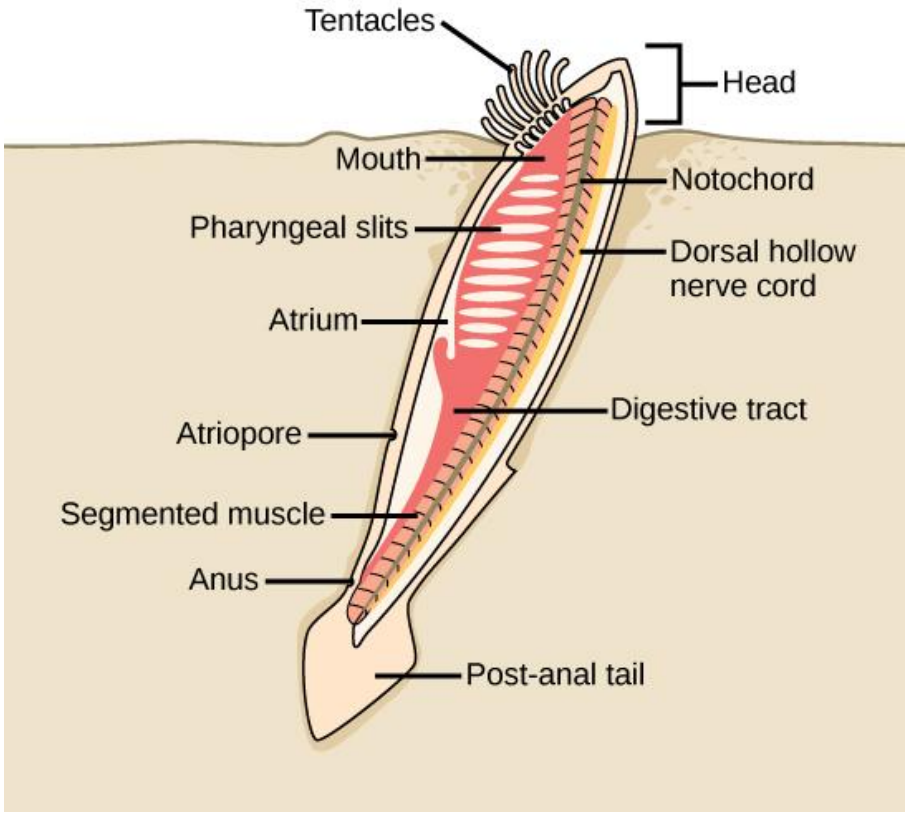

Dorsal hollow
nerve cord
Notochord
Post-anal tail
Pharyngeal slits





Function

- **The notochord** provides skeletal support, and develops **into vertebral column in vertebrates**.



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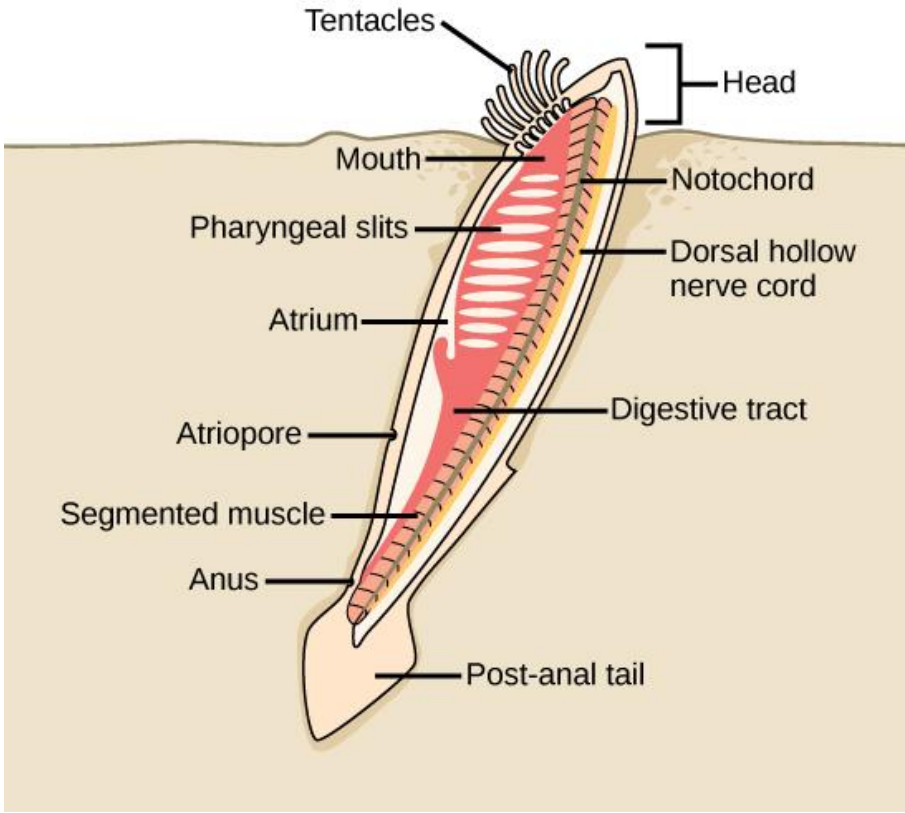
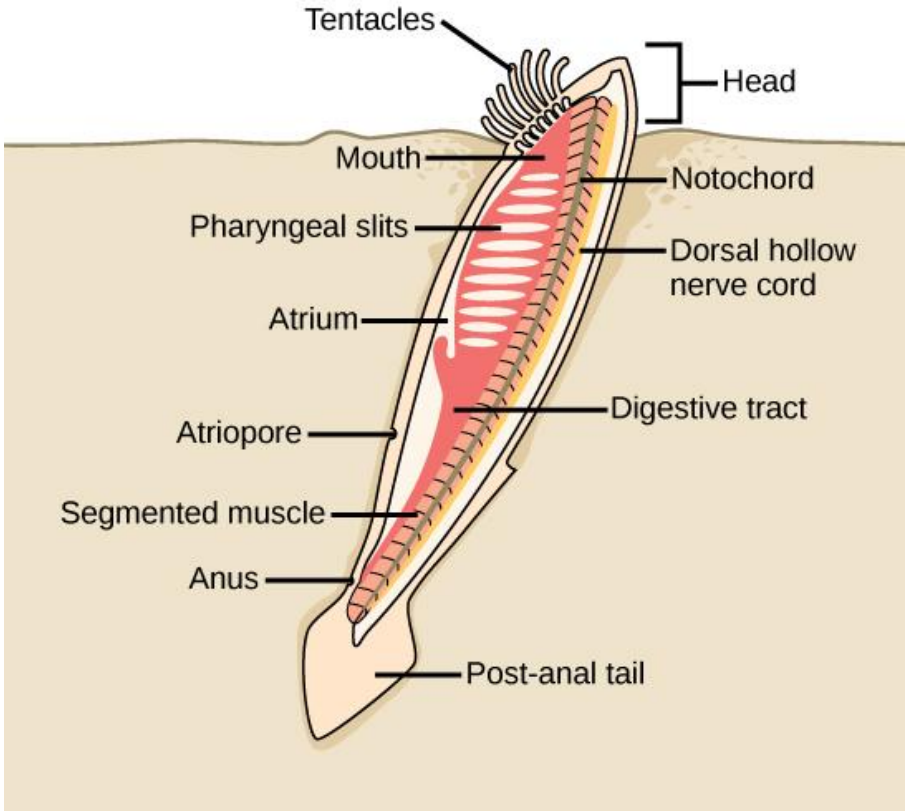


Function

- **The notochord** provides skeletal support, and develops **into vertebral column in vertebrates**.
- The **dorsal hollow nerve cord** develops into the **central nervous system: the brain and spine.**



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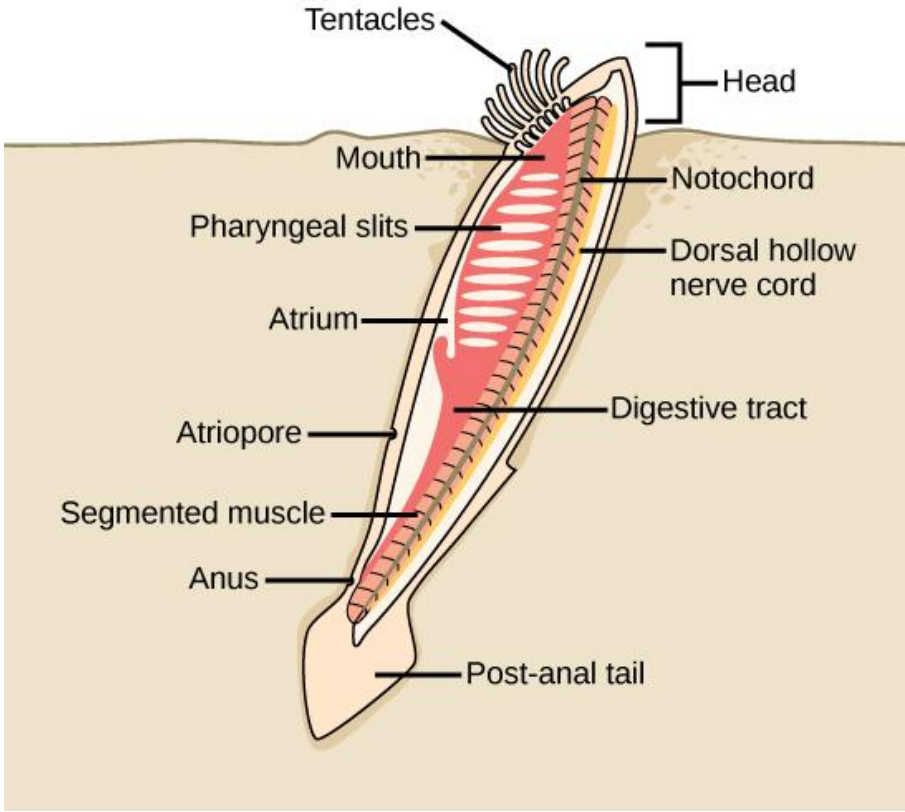
- The **dorsal hollow nerve cord** develops into the **central nervous system: the brain and spine.**
- **Pharyngeal slits** are openings in the pharynx that develop **into gill arches in bony fish and into the jaw and inner ear** in terrestrial animals.



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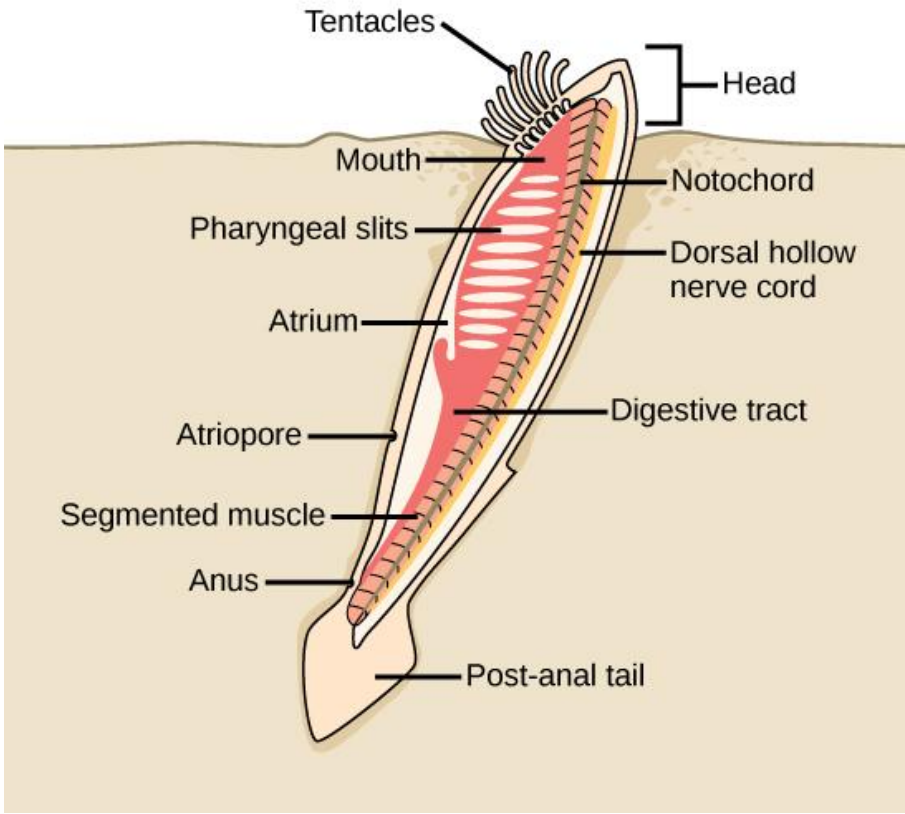
- The **dorsal hollow nerve cord** develops into the **central nervous system: the brain and spine.**
- **Pharyngeal slits** are openings in the pharynx that develop **into gill arches in bony fish and into the jaw and inner ear** in terrestrial animals.
- **The post-anal tai**l is a skeletal extension of the posterior end of the body, absent in humans and apes, but **present during embryonic development**.



Phylum **Chordata**
Subphylum **Urochordata**
Subphylum **Cephalochordata**
Subphylum **Craniata**
Hagfishes

First Block;
3 non-vertebrate chordates

1) Urochordata
2) Cephalochordata
3) Craniata
    a) Hagfish

First Block;
3 non-vertebrate chordates

Phylum **Chordata**
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First Block;
3 non-vertebrate chordates

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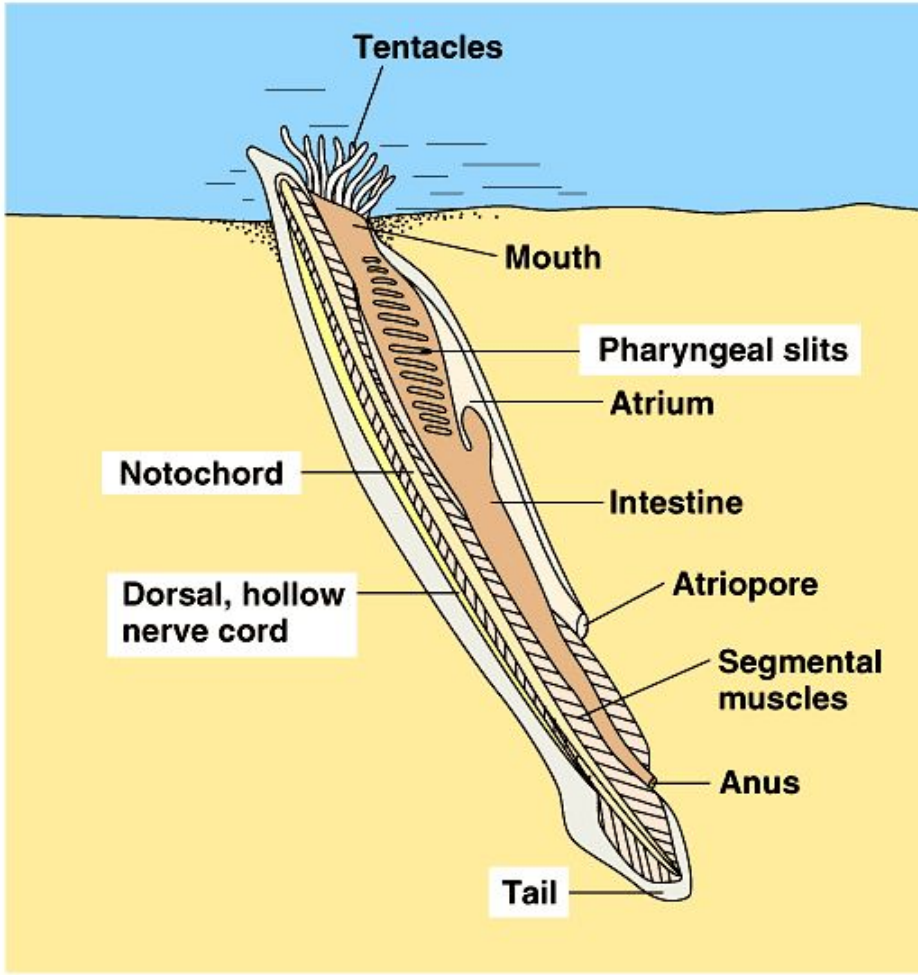
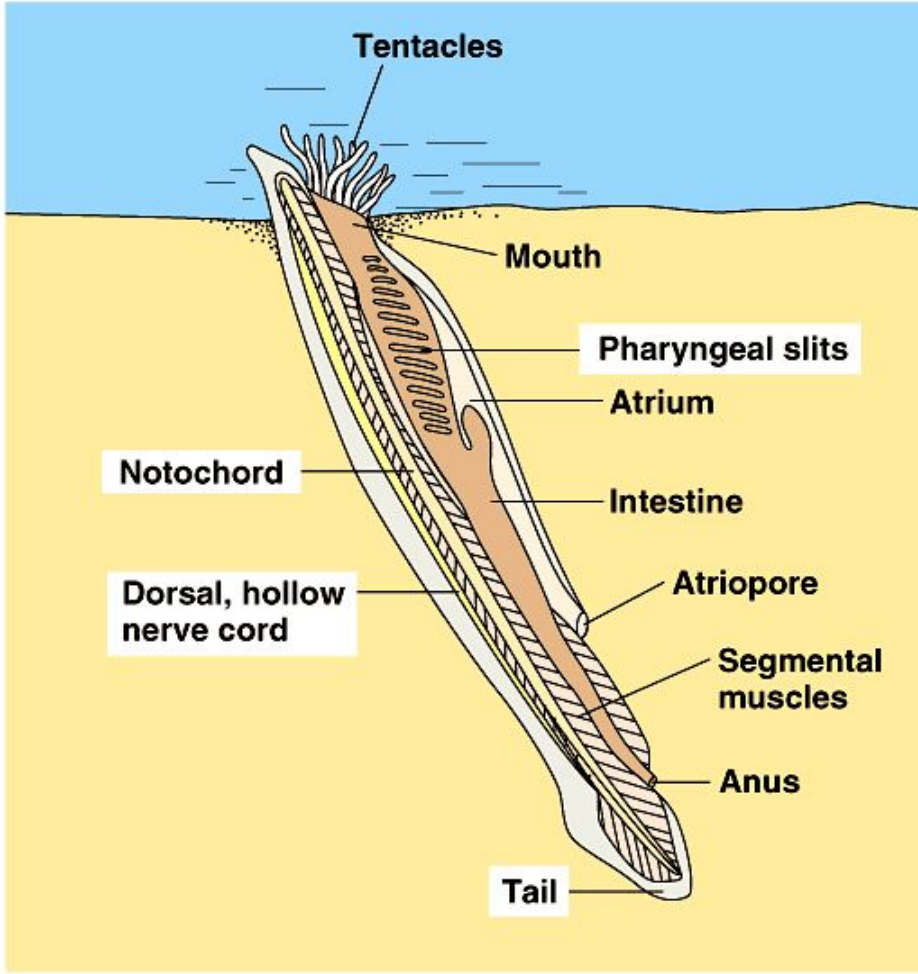
Lancelets- Cephalochordata

- Live on sea bottoms buried in sediment

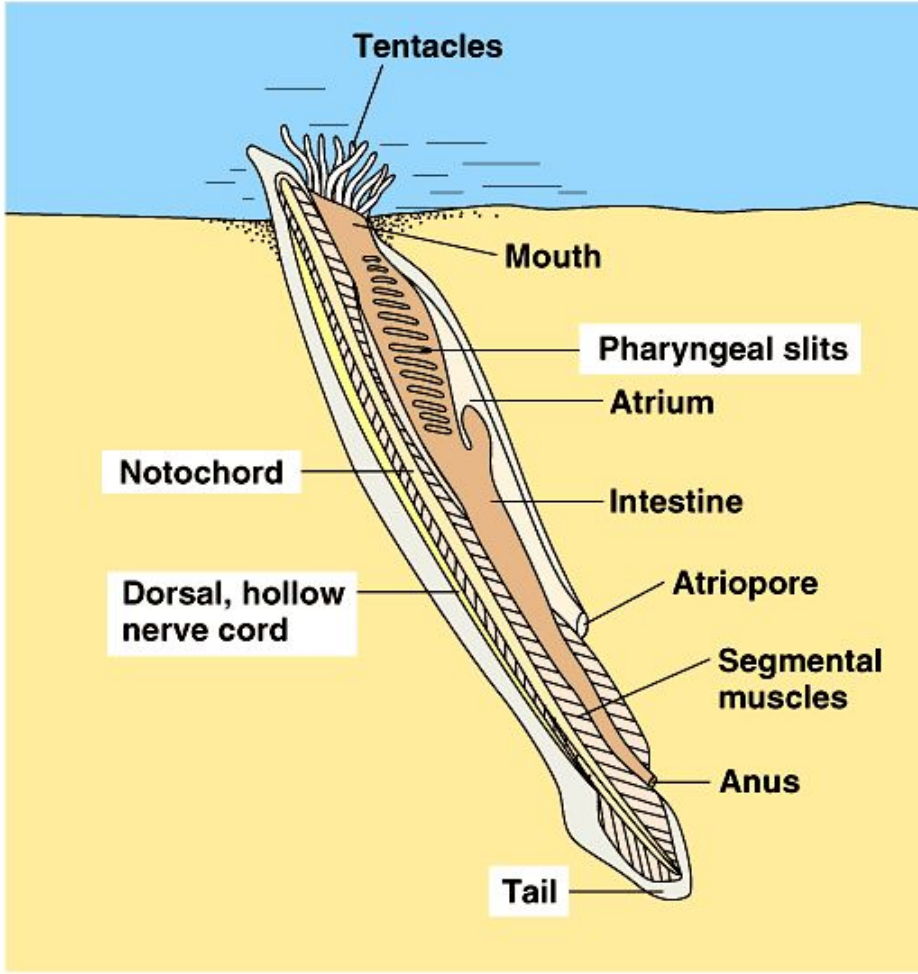


Lancelets- Cephalochordata

- Live on sea bottoms buried in sediment
- Filter feeders through pharynx- inherited from tunicates
- Find the tail and segmental muscles in lab slide!

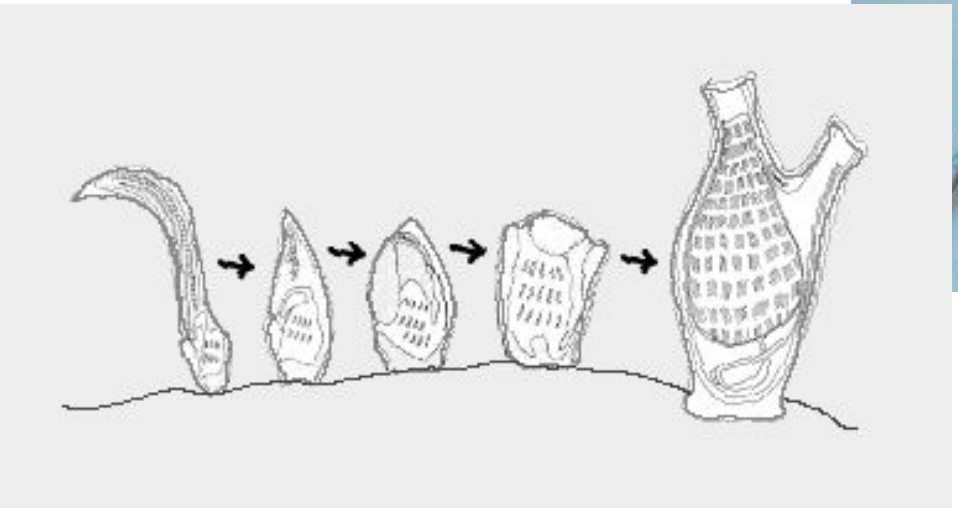


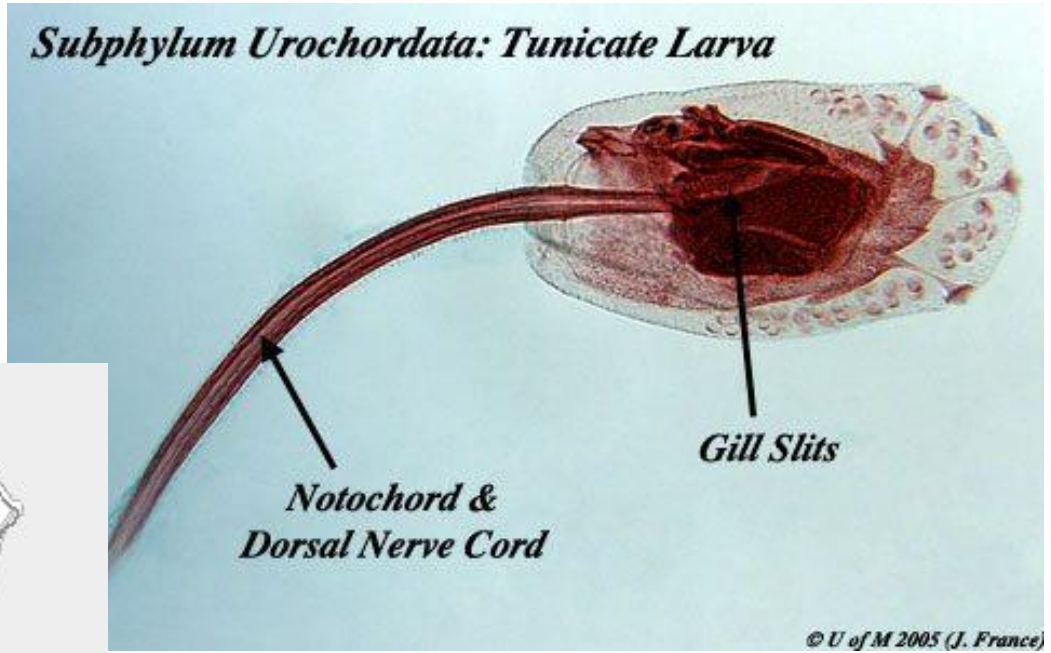
Lancelets- Cephalochordata



Tunicates & Larvaceans: Subphylum Urochordata

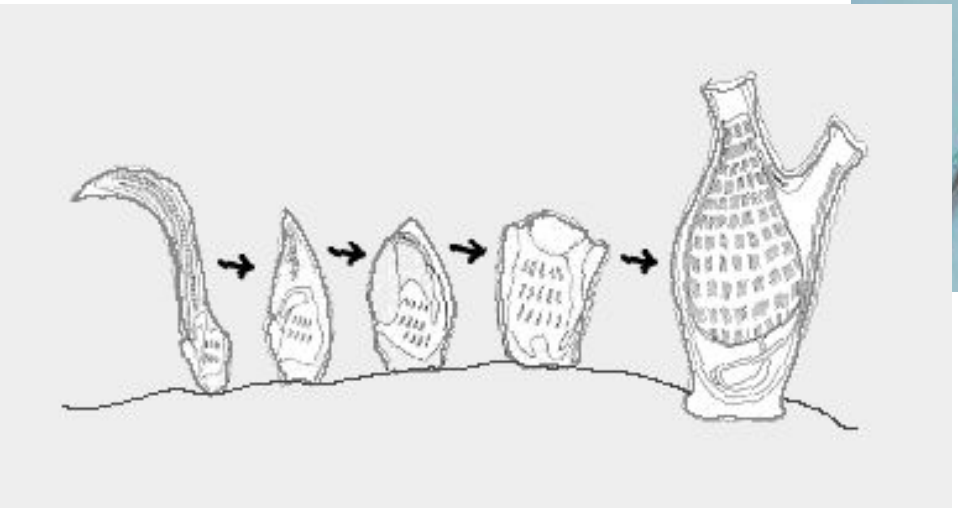
- Sessile filter feeders with mobile “tadpole” larval stage

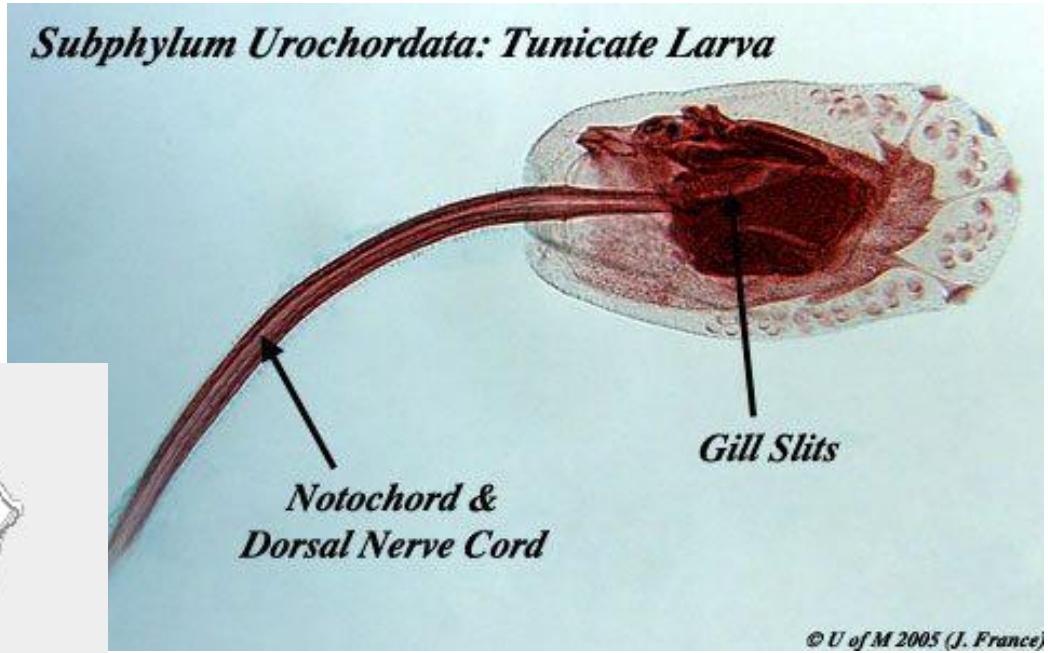




Tunicates & Larvaceans: Subphylum Urochordata

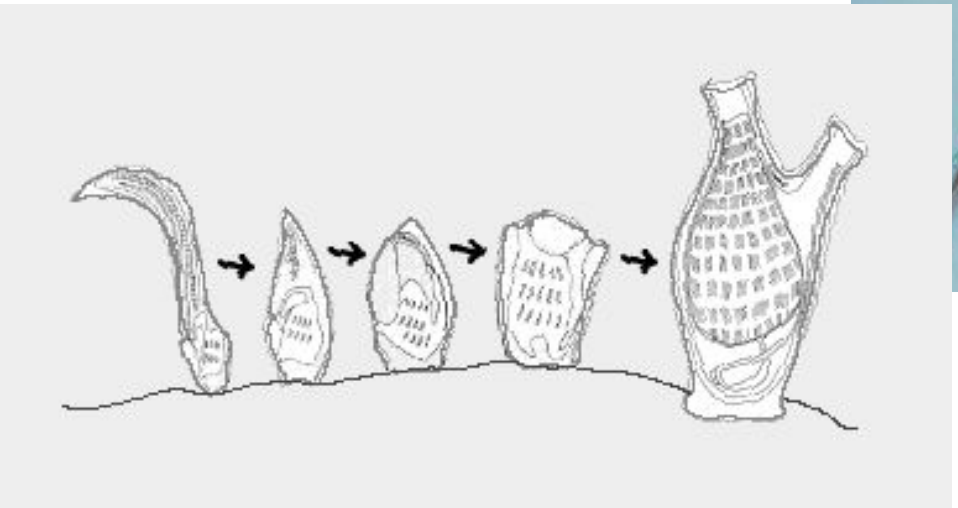
- Sessile filter feeders with mobile “tadpole” larval stage
- Expanded pharynx and gill slits

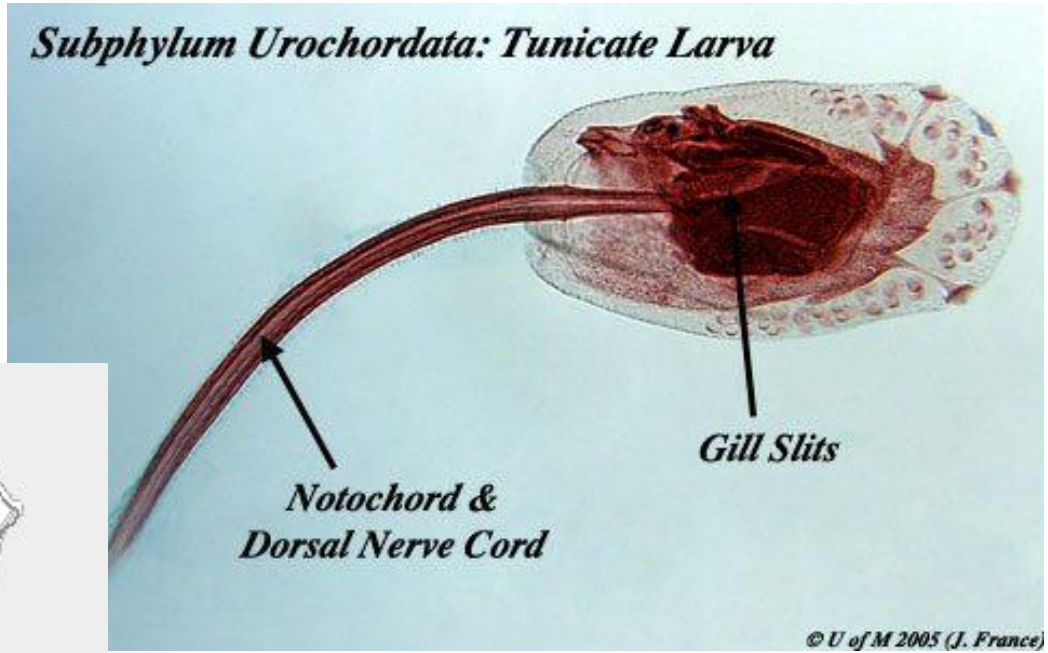




Tunicates & Larvaceans: Subphylum Urochordata

- Sessile filter feeders with mobile “tadpole” larval stage
- Expanded pharynx and gill slits
- Thought to be ancestral to all chordates





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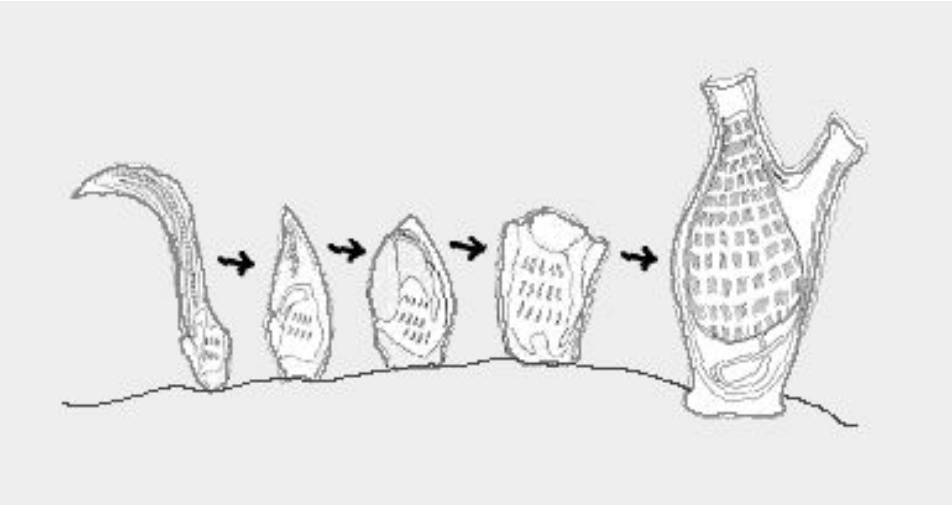

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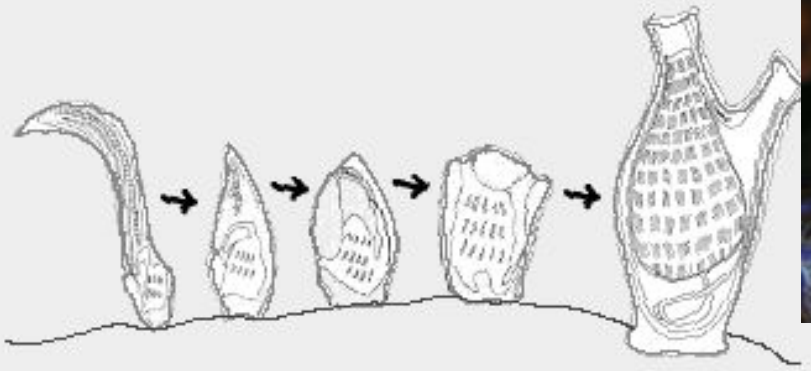
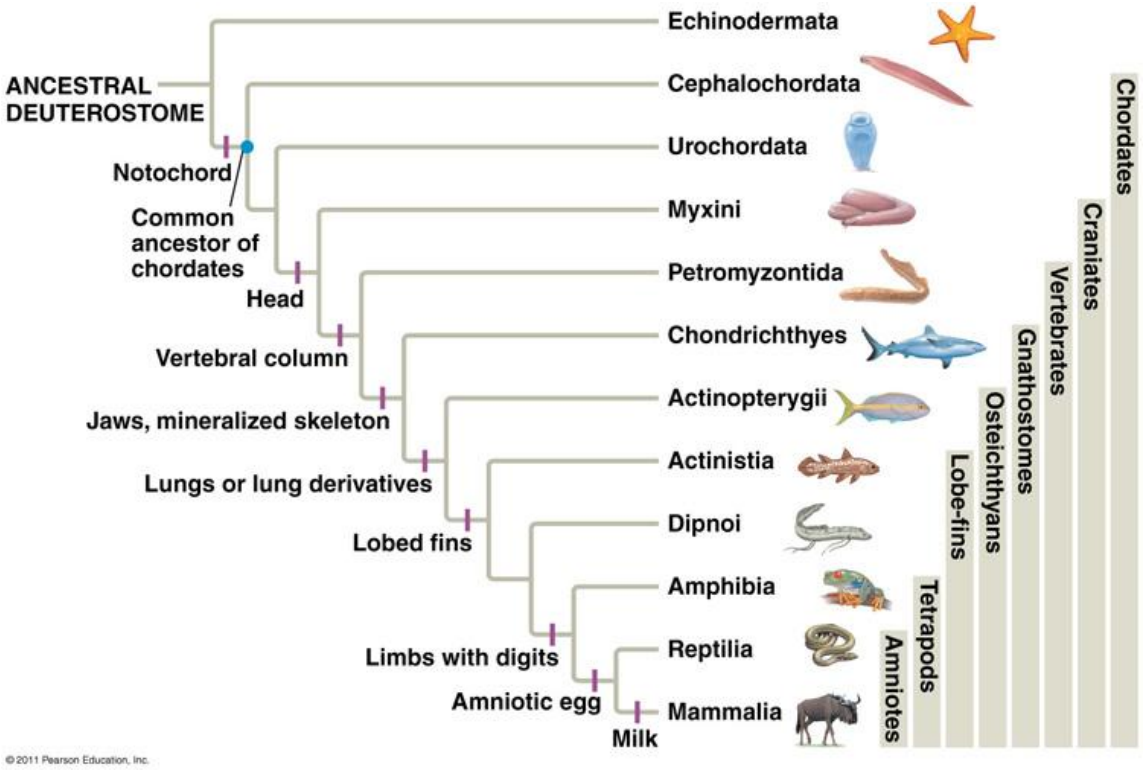


Hagfish: Subphylum Craniata- the familiar chordates

Include: fish, amphibians, reptiles birds, and mammals



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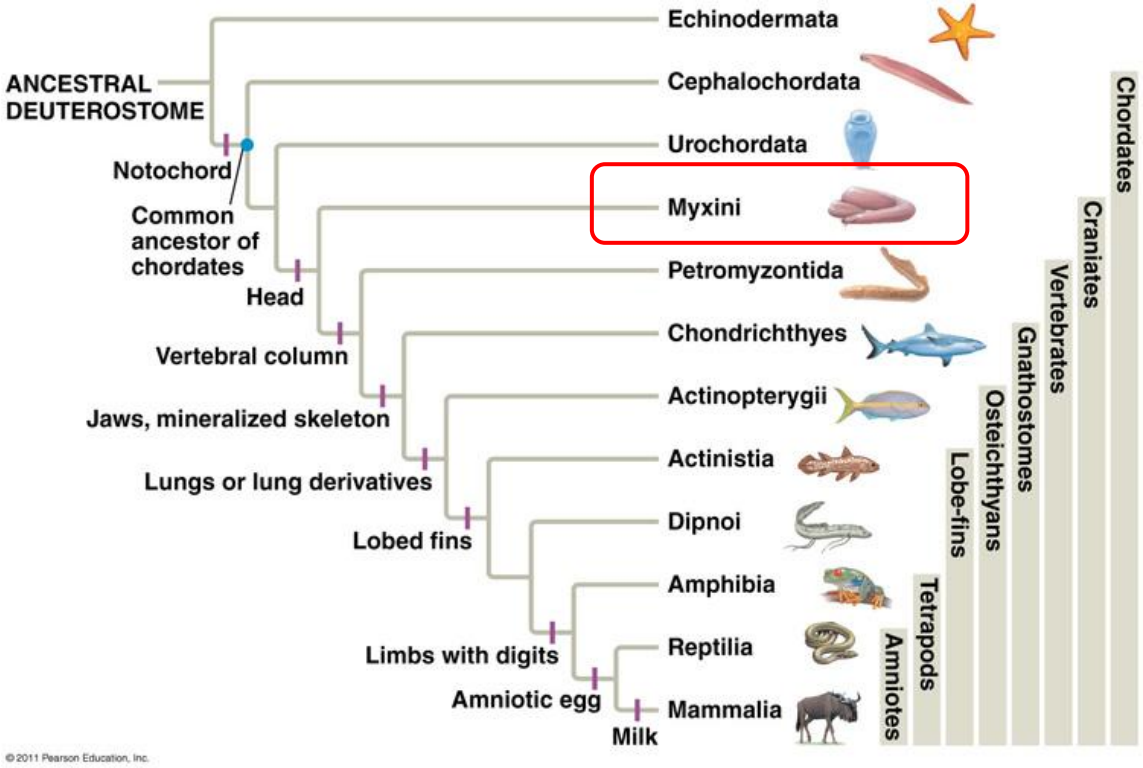
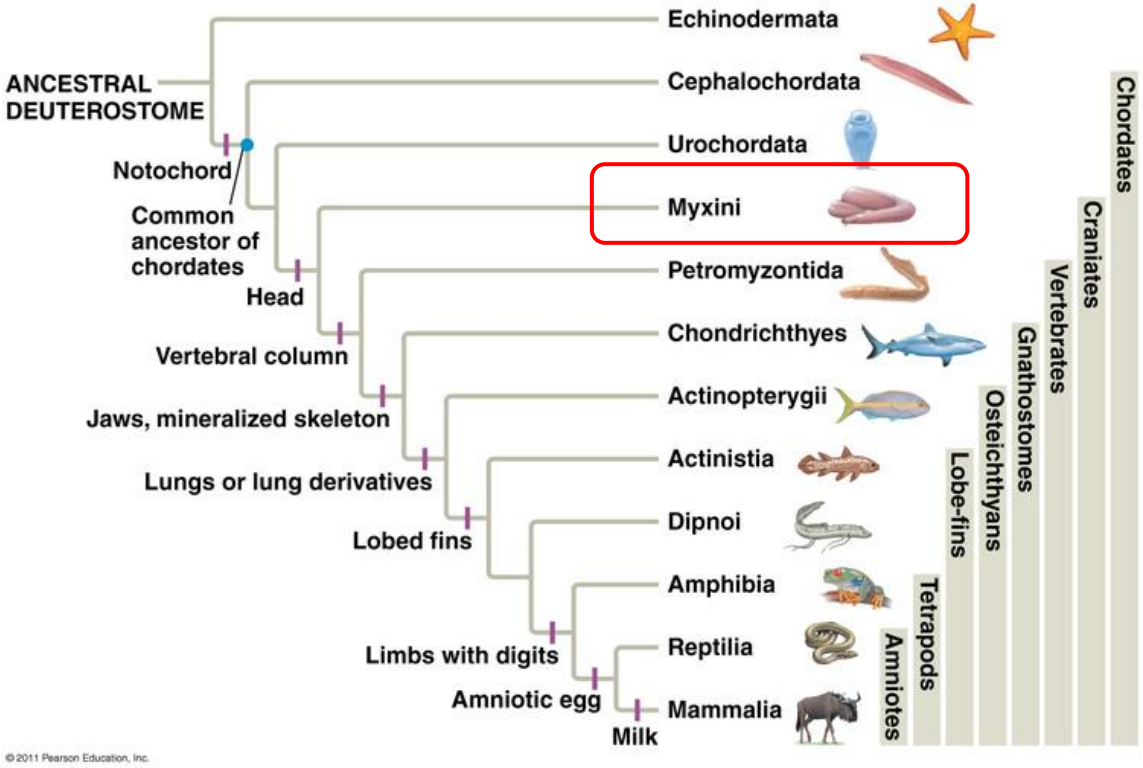


Hagfish: Subphylum Craniata- the familiar chordates

Include: fish, amphibians, reptiles birds, and mammals

Myxini (**Hagfish**) Lack jaws and paired fins BUT they do have a skull



Subphylum Craniata- the familiar chordates

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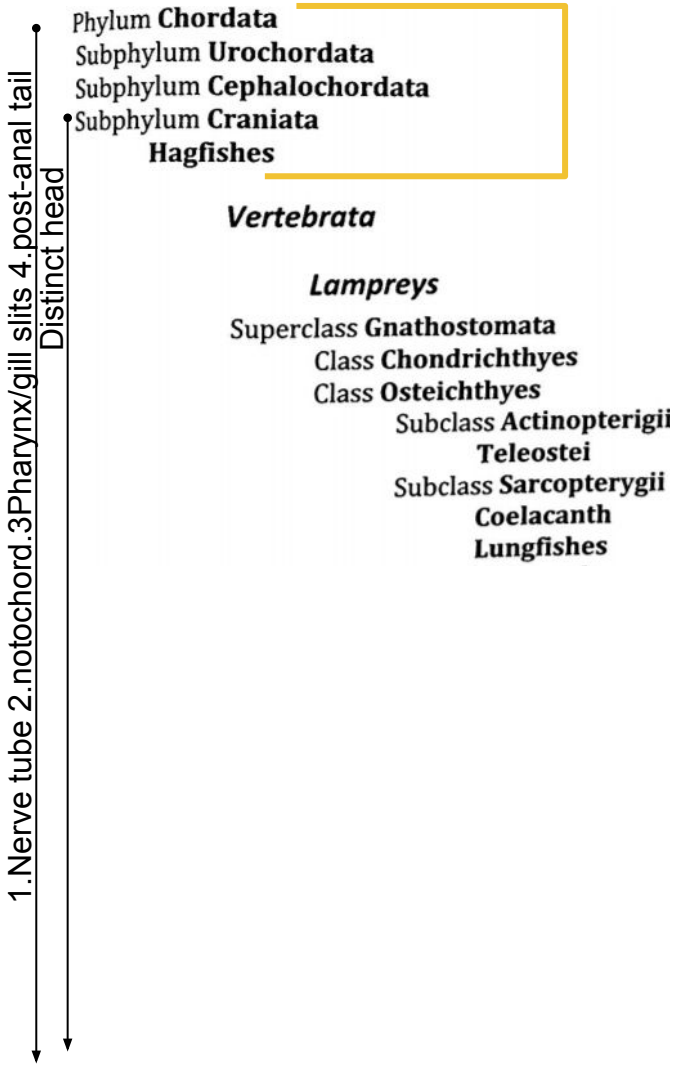
Subphylum Craniata- the familiar chordates

Second Block;
5 non-tetrapod vertebrates

1) Lampreys
2) Chondrichthyes
3) Osteichthyes
    a) Actinopterygii
        i) Teleostei
    b) Sarcopterygii
        i) Coelacanth
        ii) Lungfish



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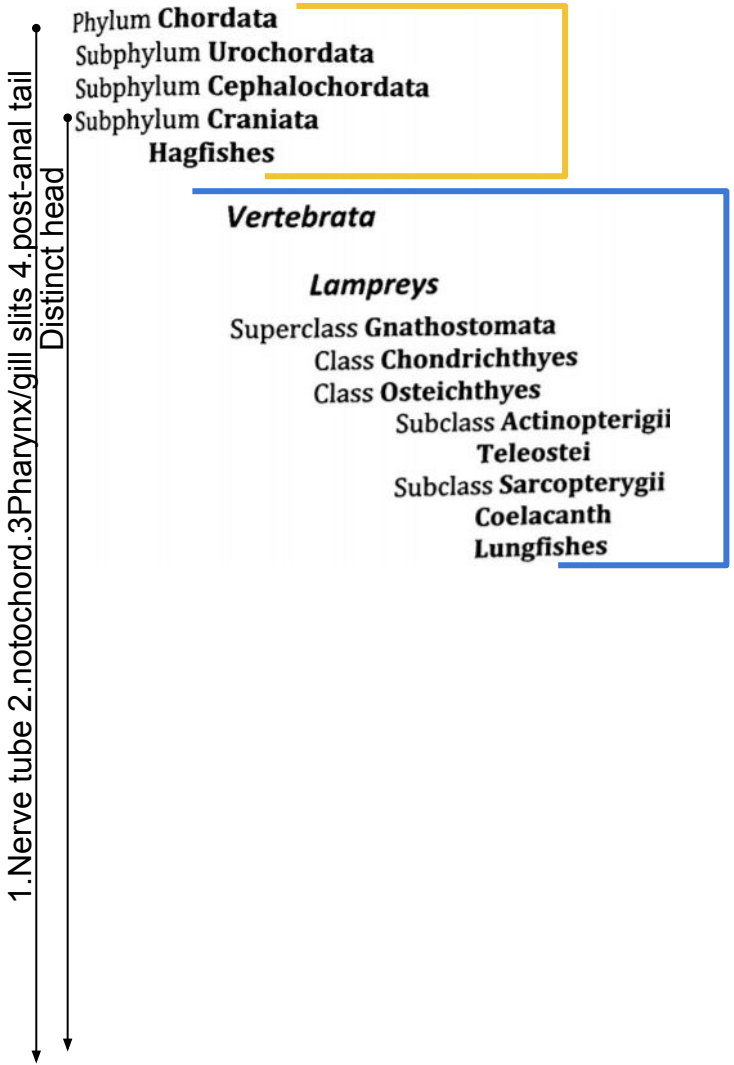

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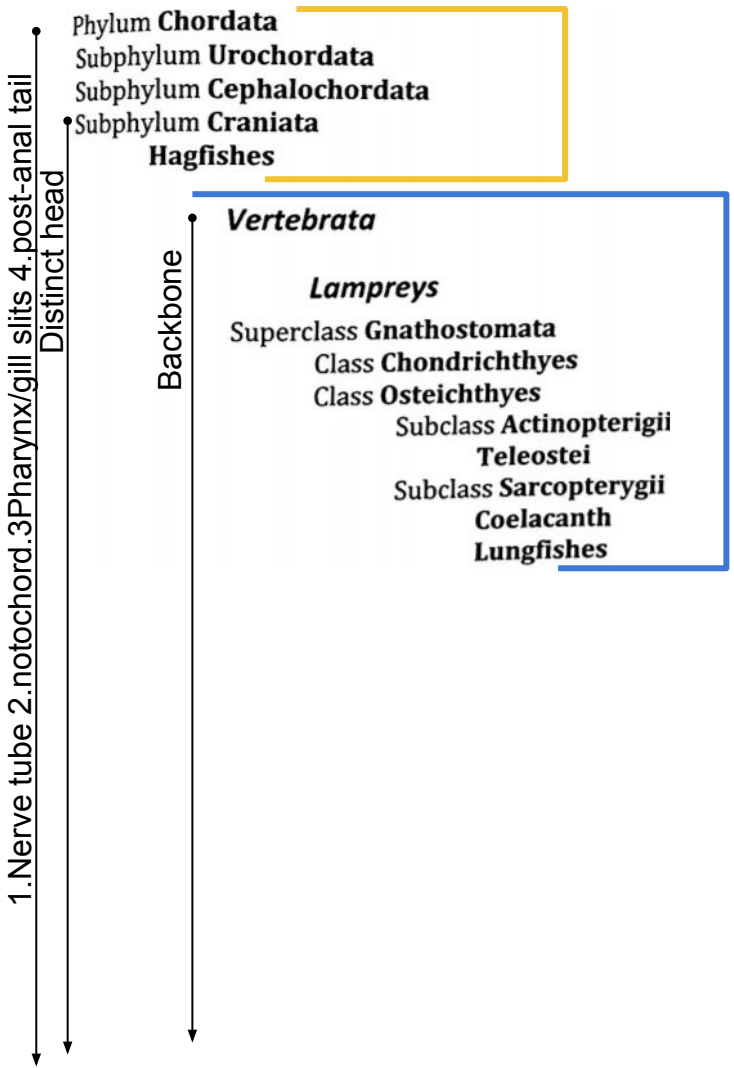

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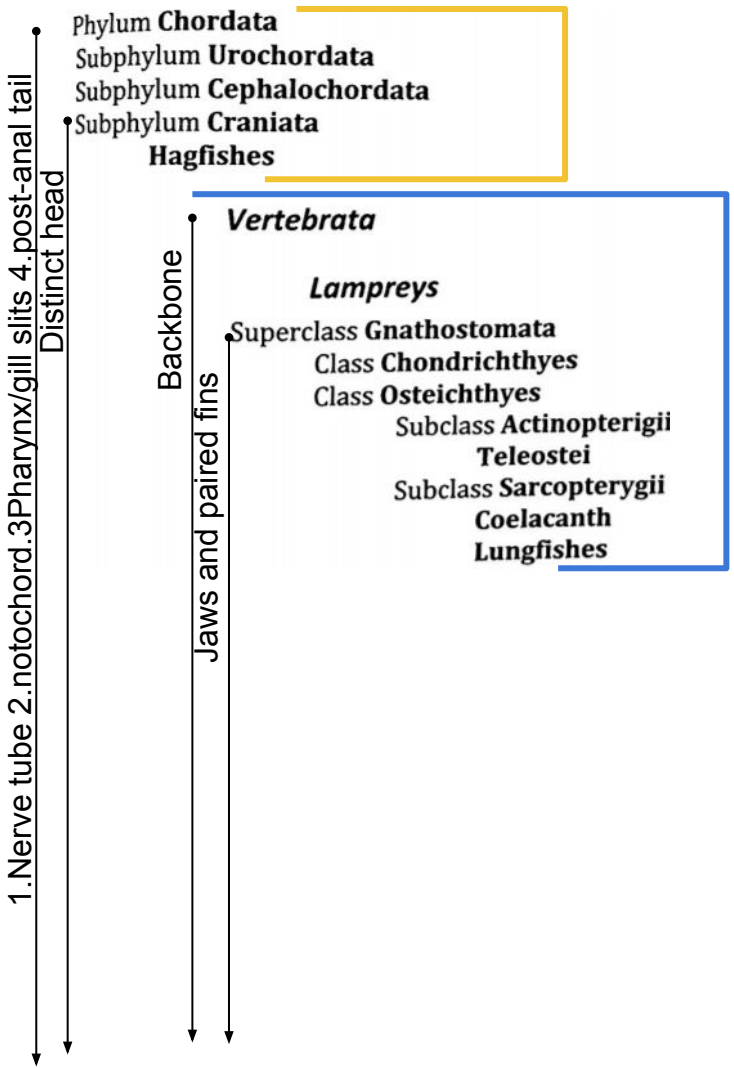

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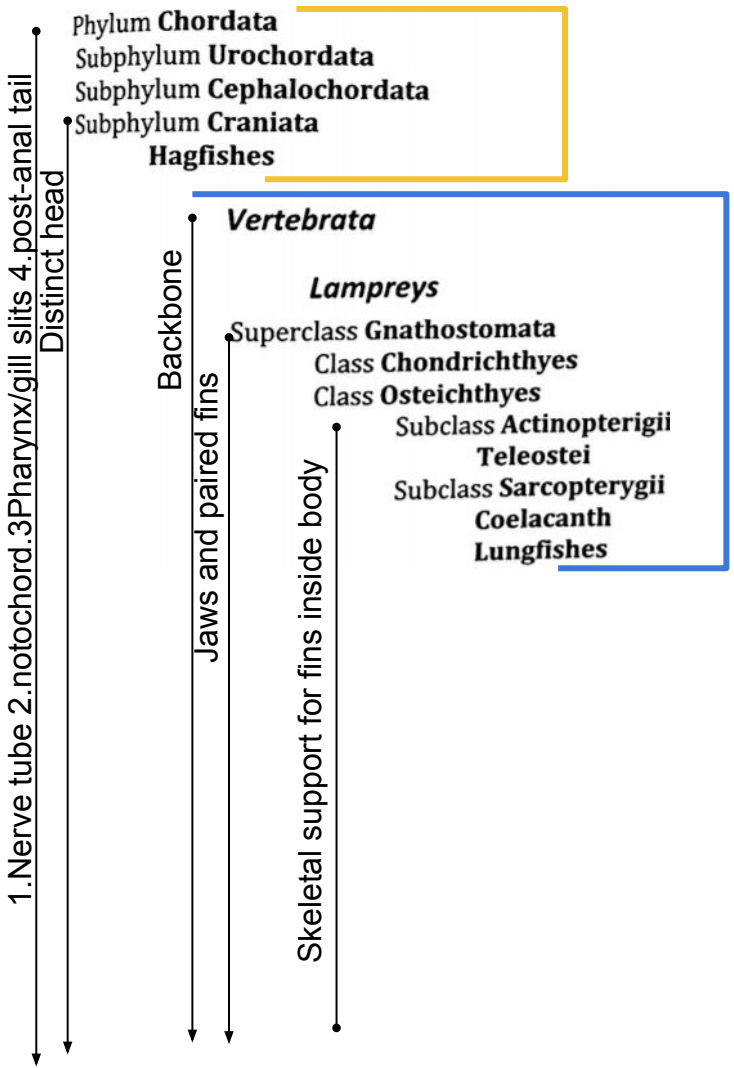

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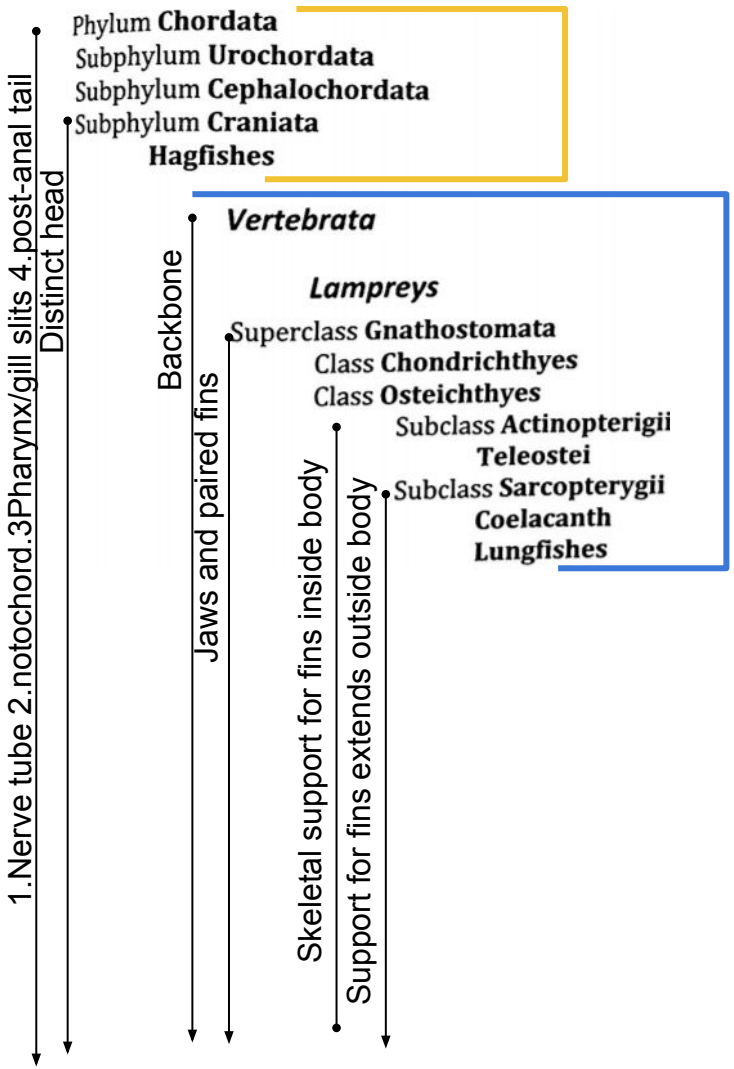
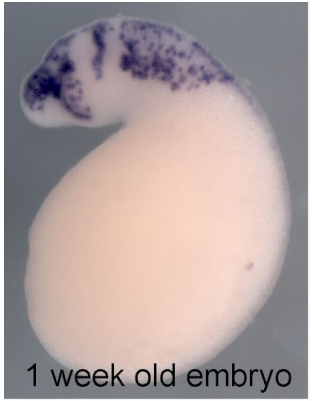
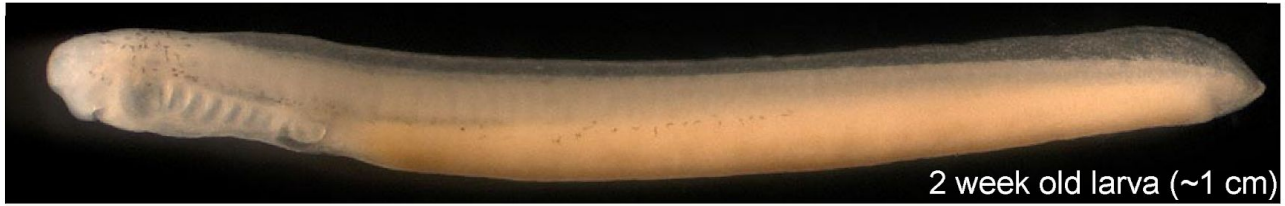


Vertebrata- all groups have a backbone

Lampreys- lack jaws and paired fins like the hagfish but ARE vertebrates

Vertebrata- all groups have a backbone





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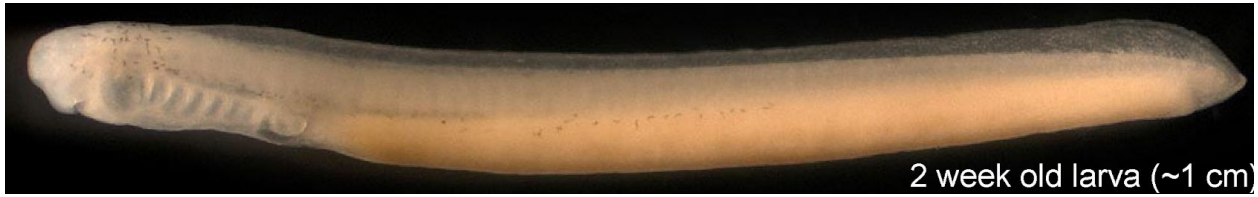
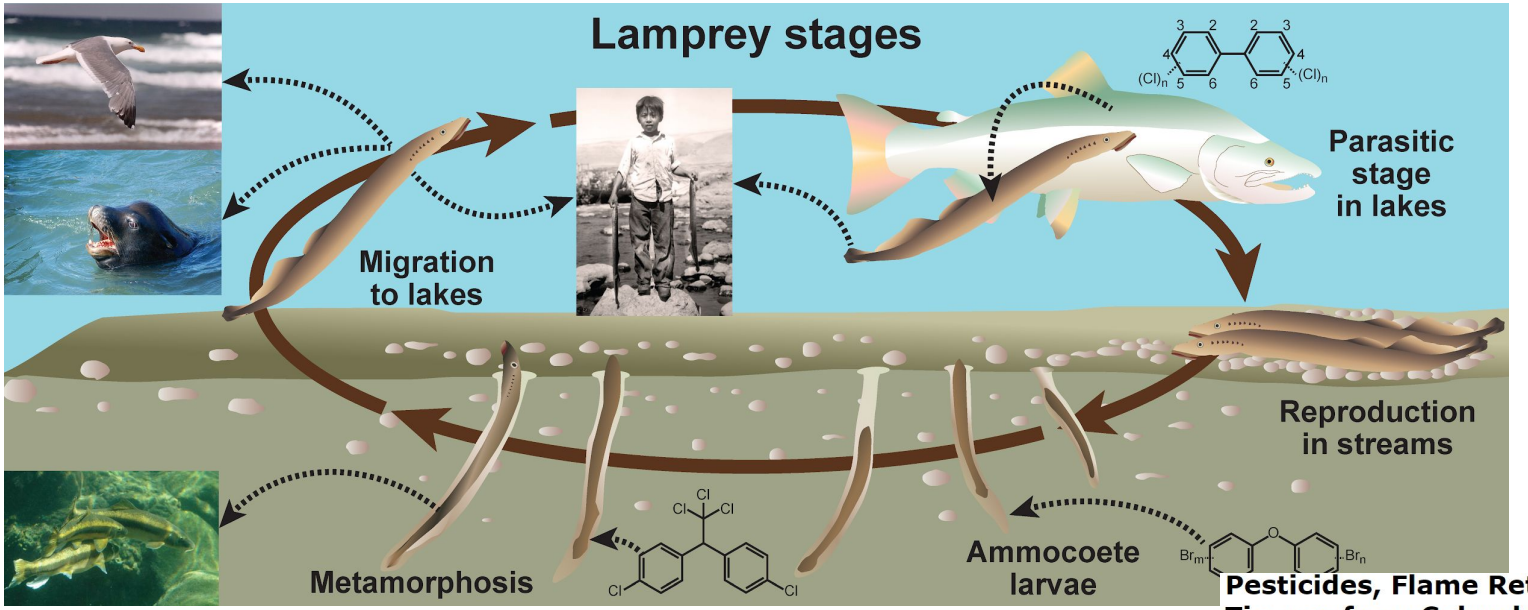


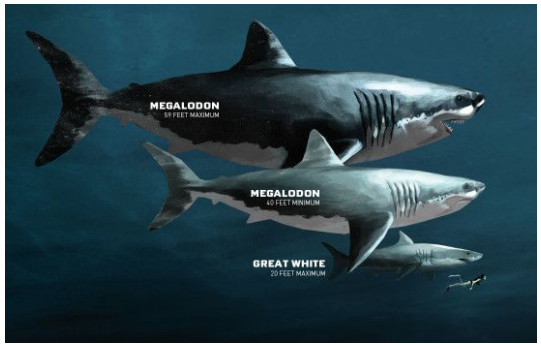
c.f.



Pesticides, Flame Retardants, and Mercury in Tissues from Columbia Basin Pacific Lamprey

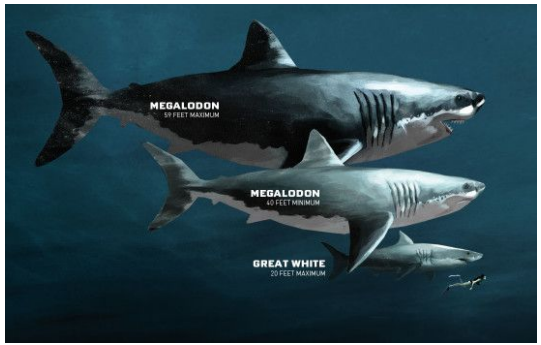
Gnathostomata-JAWED Vertebrates
Class Chondrichthyes

- Vertebrates with jaws and paired fins



Gnathostomata-JAWED Vertebrates
Class Chondrichthyes

- Vertebrates with jaws and paired fins
- cartilaginous skeleton



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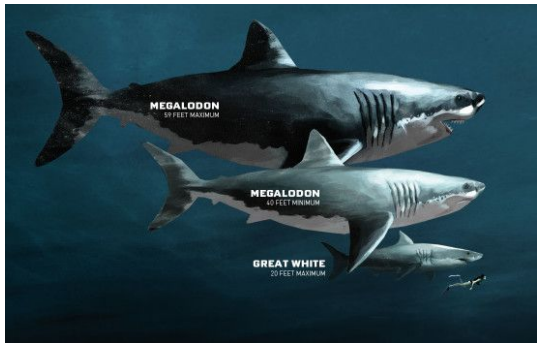
- Have separate gill slits, no lungs or swim bladder



Gnathostomata-JAWED Vertebrates
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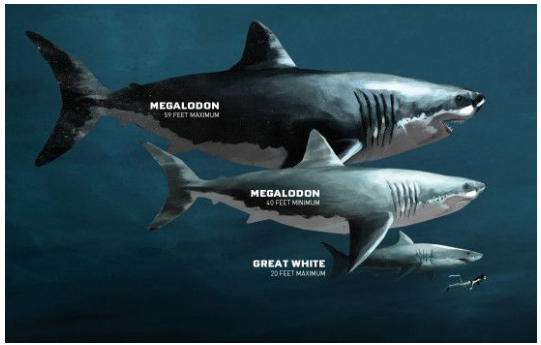
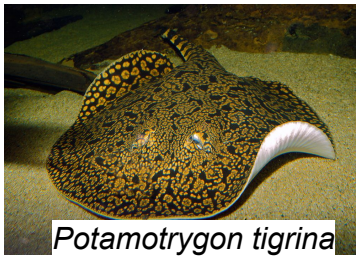
- Have separate gill slits, no lungs or swim bladder
- E.g. include Sharks, rays, and chimaeras



Gnathostomata-JAWED Vertebrates
Class Chondrichthyes

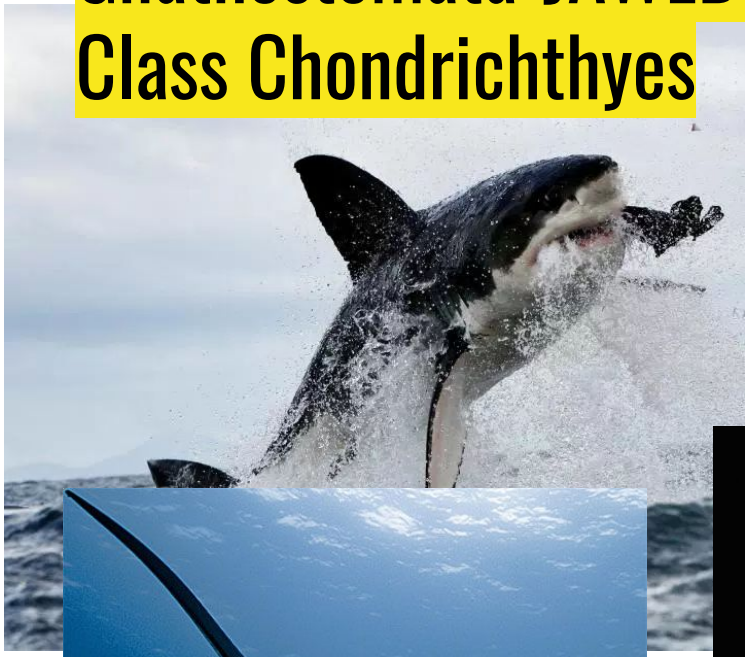
Himantura polylepis

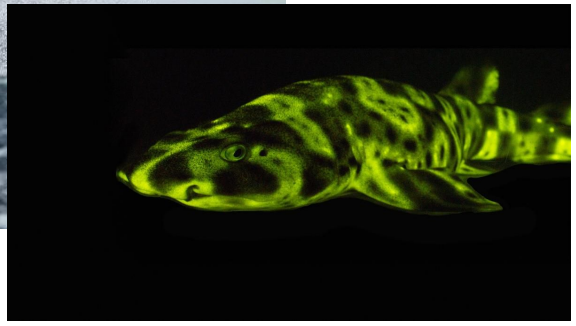

Potamotrygon tigrina

Dasyatis brevicaudata

Torpedo californica

Gnathostomata-JAWED Vertebrates
Class Chondrichthyes





Countershading

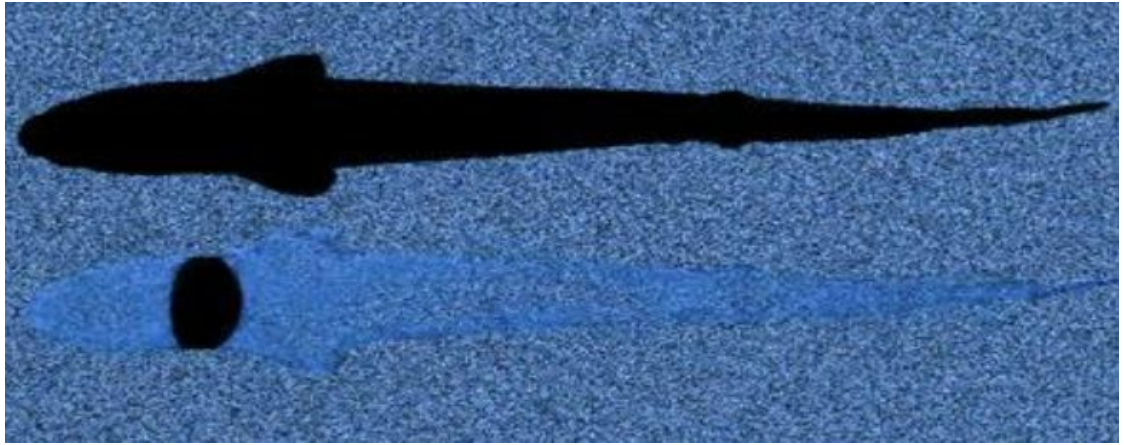
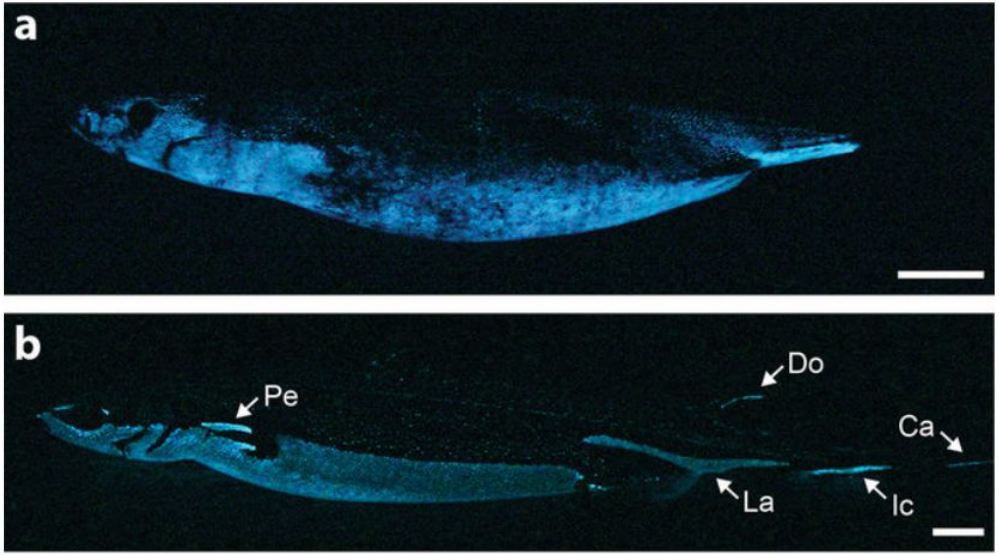
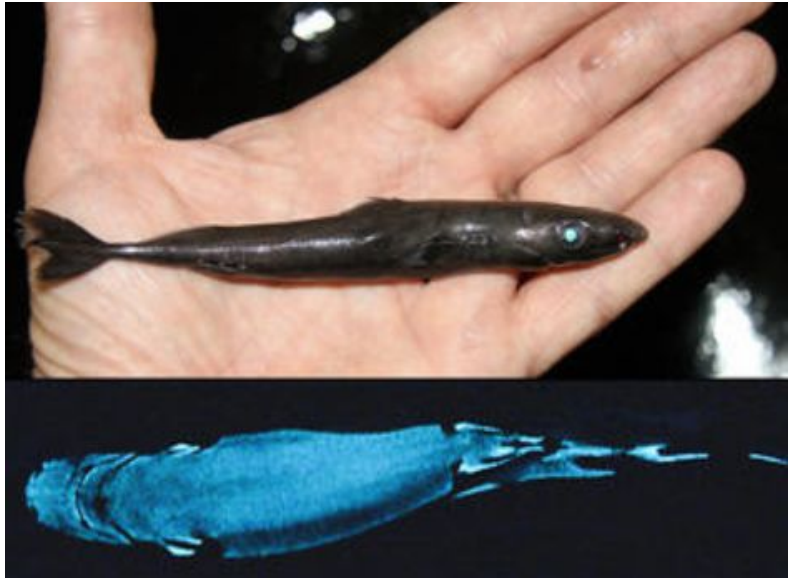


Figure 1: Shark photophore patterns.





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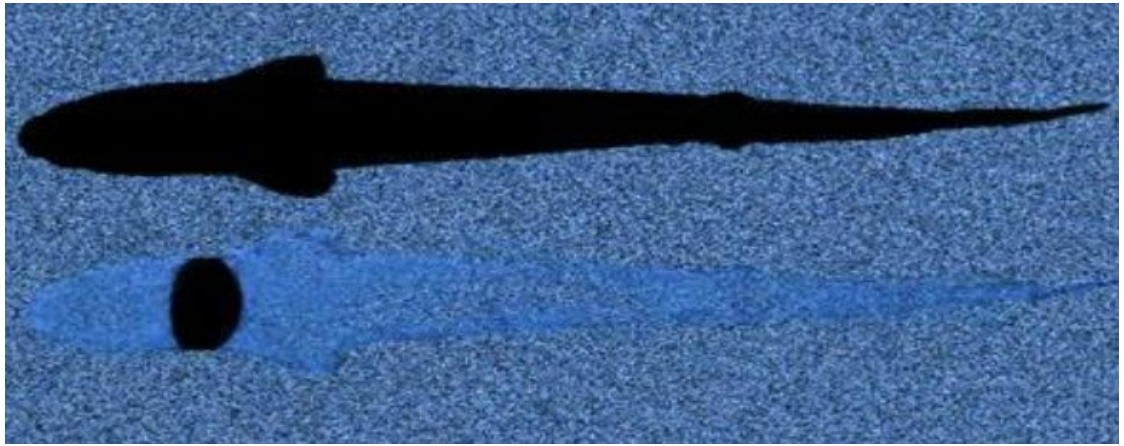
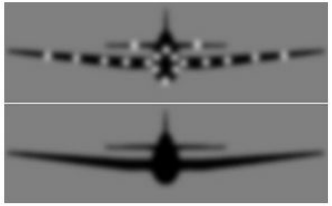
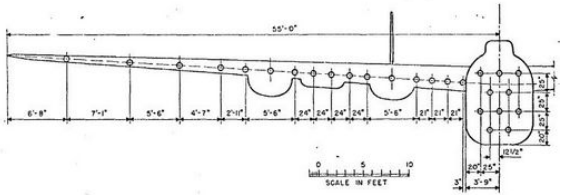
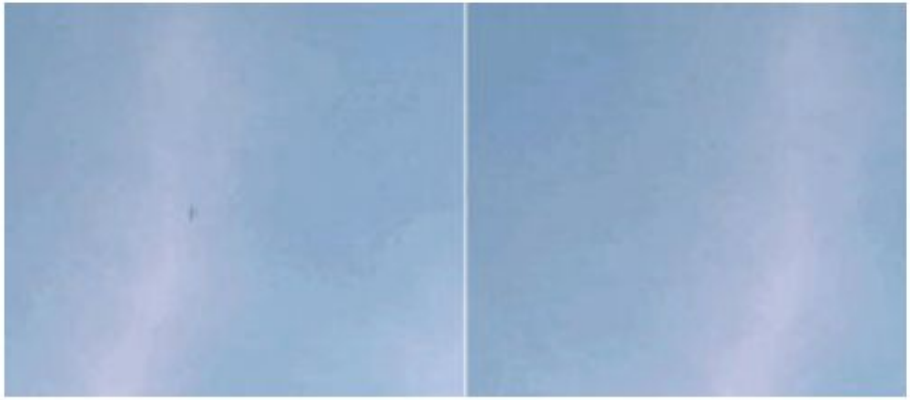




Yehudi Lights raise the average brightness of a Grumman Avenger from a dark shape to the same as the sky.



Yehudi Lights plan for counter-illumination camouflage of a B-24 Liberator, showing lights spaced along leading edges and front of fuselage



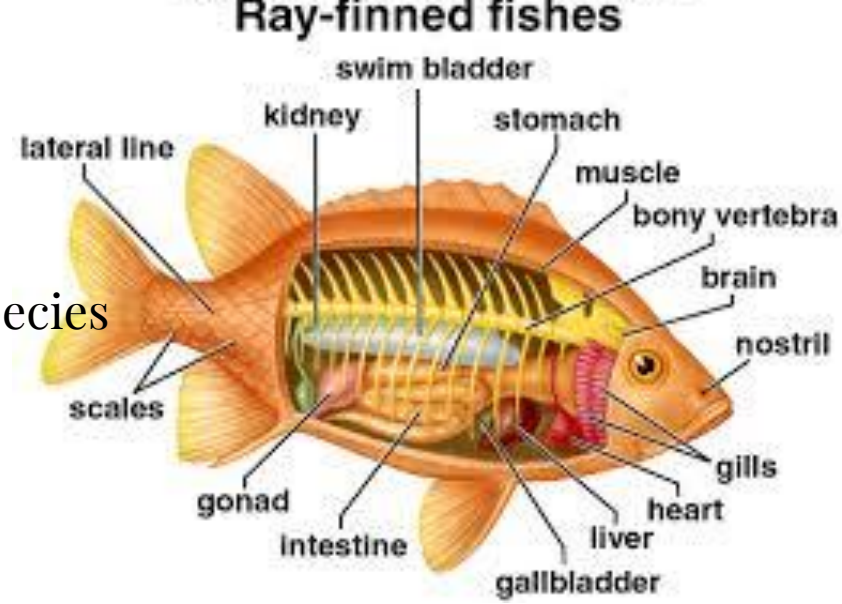
Gnathostomata-JAWED Vertebrates
Class Chondrichthyes

Class Osteichthyes
Subclass: Actinopterygii

- Ray-fin fishes- represent 95% of extant species

Usually have:

- Bony skeletons, lungs or a swimbladder
- Form a lineage from shark and rays
- Include all of the bony fishes (ray finned fishes)



Class Osteichthyes
Subclass: Actinopterygii

Class Osteichthyes
Subclass: Sarcopterygii

- Fleshy fin fishes includes lungfishes and one extant coelacanth

Usually have:

- Fin support continues outside of body

Class Osteichthyes
Subclass: Sarcopterygii

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Subclass: Sarcopterygii

Class Osteichthyes
Subclass: Sarcopterygii

1938

A FISH OUT OF PRE-HISTORY

Why Science is Excited Over E. London Find

THE OUTDOOR WORLD

A LIVING FOSSIL CAUGHT IN THE SEA

DAILY DISPATCH EXCLUSIVE STORY

SENSATIONAL SCIENTIFIC DISCOVERY

SCIENCE SERVICE
MAR. 27—APRIL 2, 1939

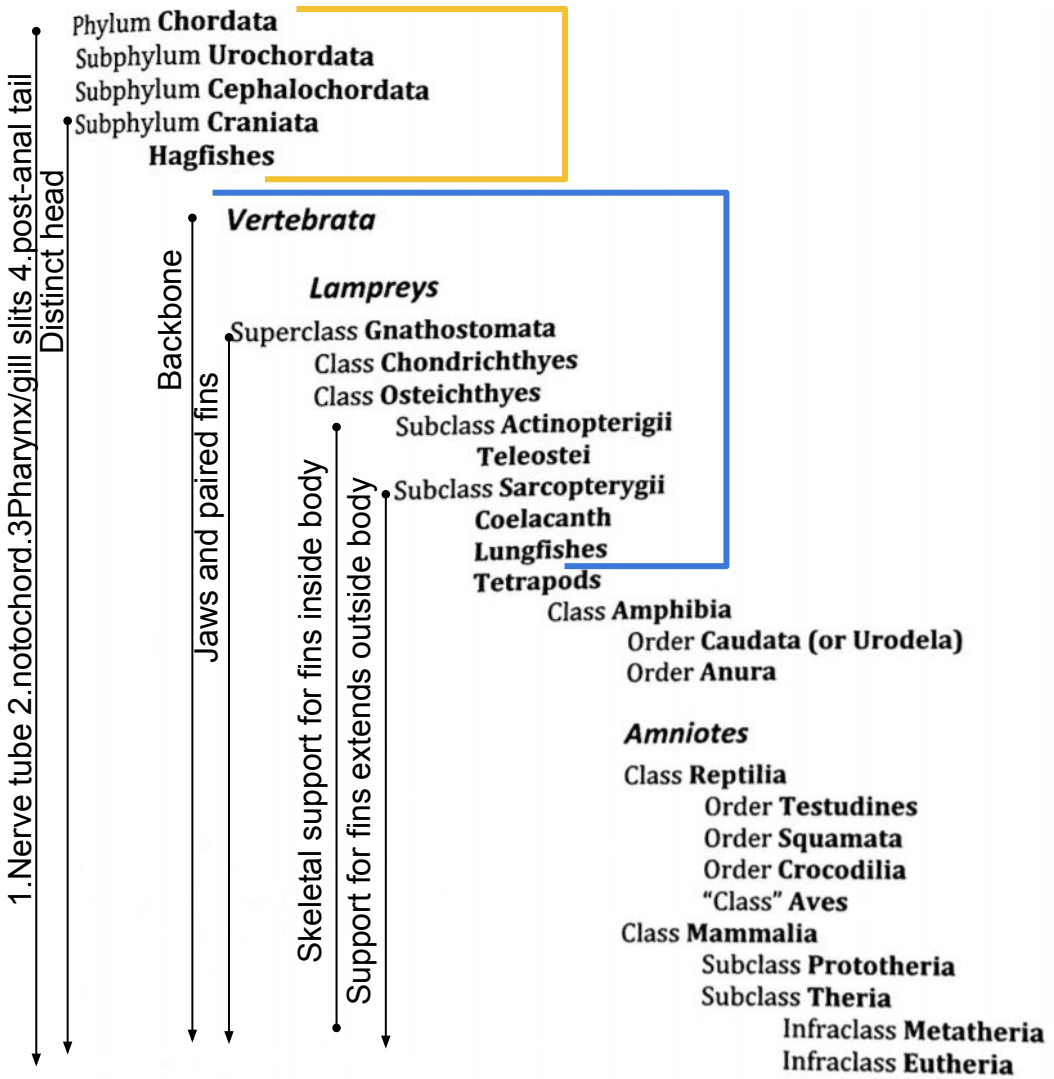
Find Live Fish 'Extinct' Since

Fish Believed Extinct 50,000,000 Years

More closely related to tetrapods and lungfish than ray finned.

Third Block;
Amphibians, eggs=no shell

1) Caudata
2) Anura



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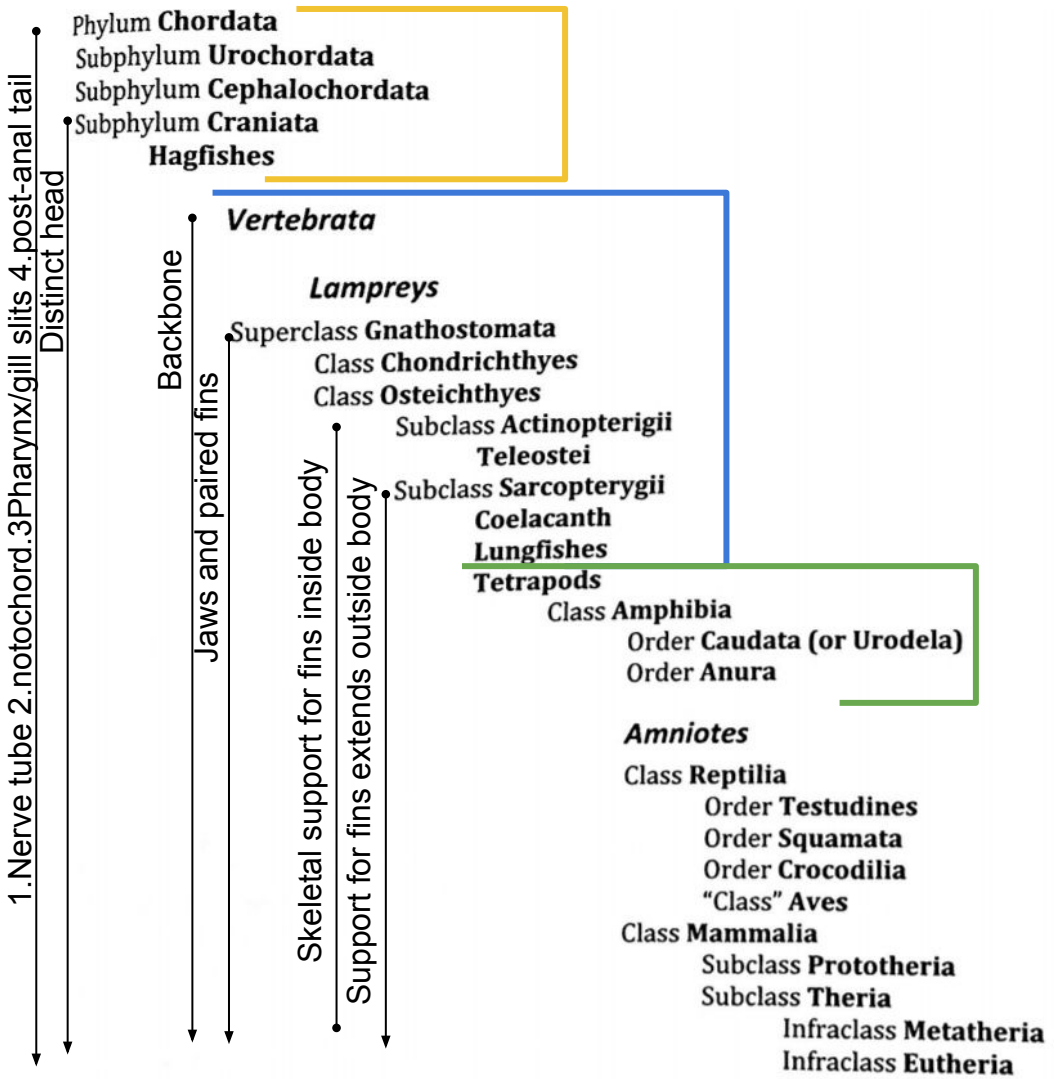

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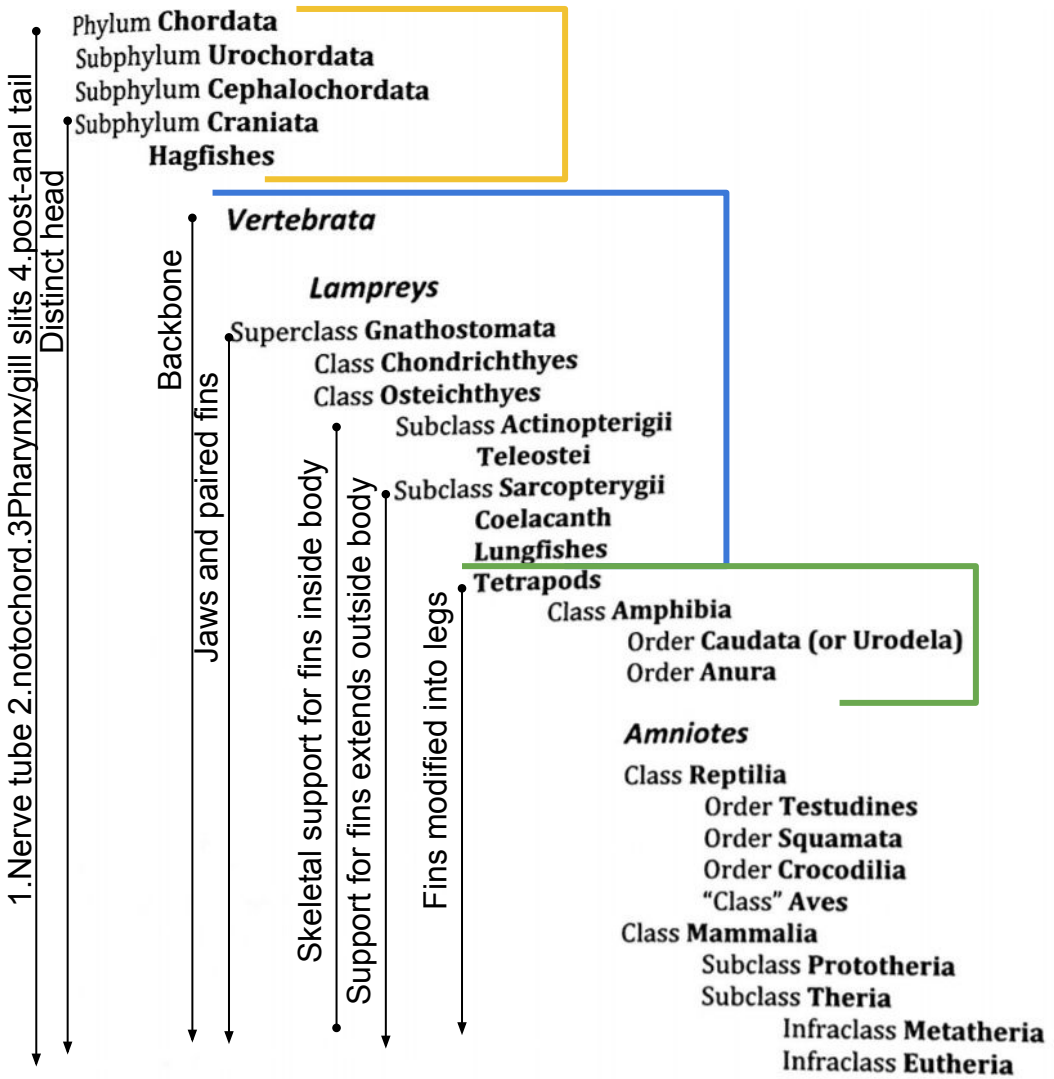

Tetrapoda

- Derived from the fleshy finned fishes related to lungfishes

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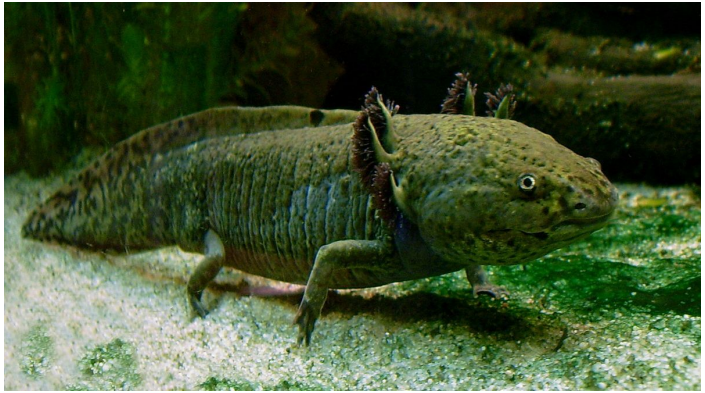
- Amphibians, reptiles and mammals make up the tetrapods but amphibians lack the amniotic egg

Tetrapoda

- Derived from the fleshy finned fishes related to lungfishes
- Amphibians, reptiles and mammals make up the tetrapods but amphibians lack the amniotic egg
- They have four limbs and have 3 chambered hearts.

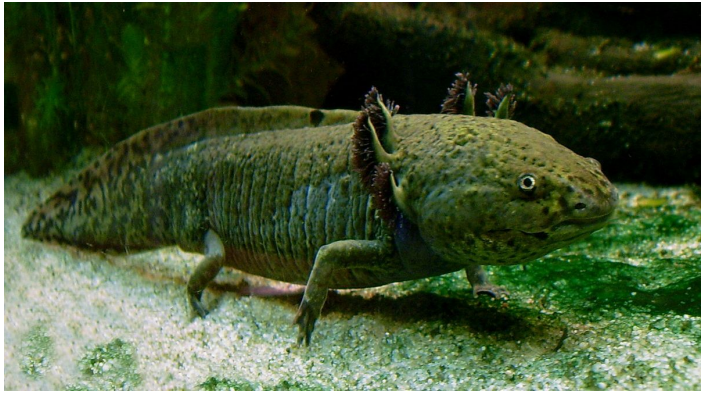
Tetrapoda:Amphibia

- Are tetrapods



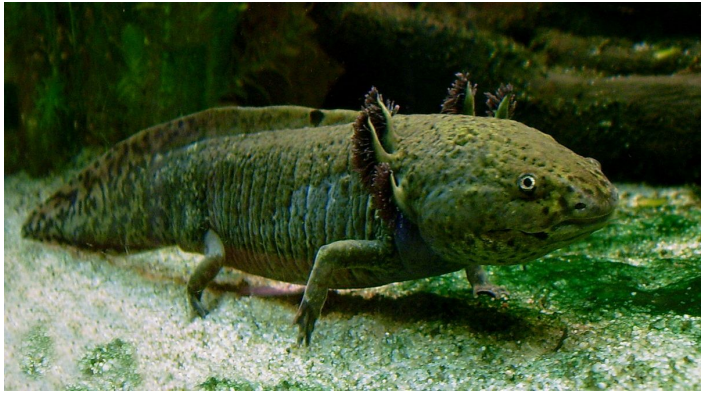
Tetrapoda:Amphibia

- Are tetrapods
- Have a 3 chambered heart

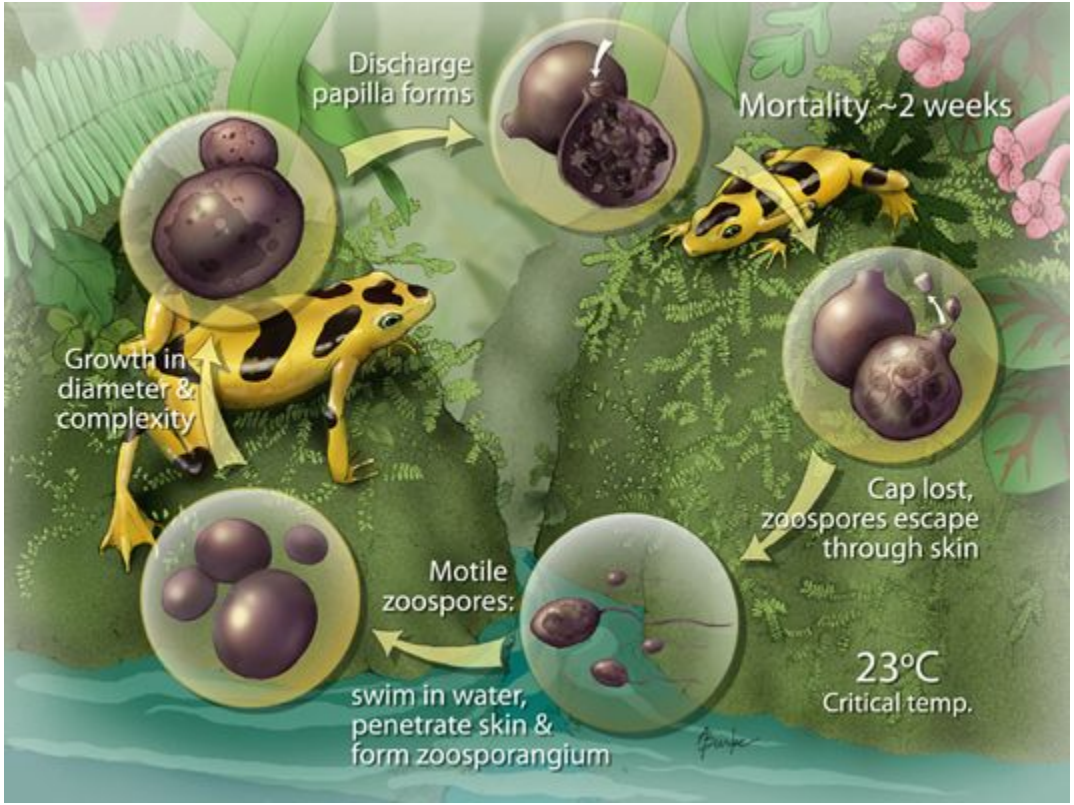


Tetrapoda:Amphibia

- Are tetrapods
- Have a 3 chambered heart
- **Lack the amniotic egg**



Tetrapoda:Class Amphibia: order Anura



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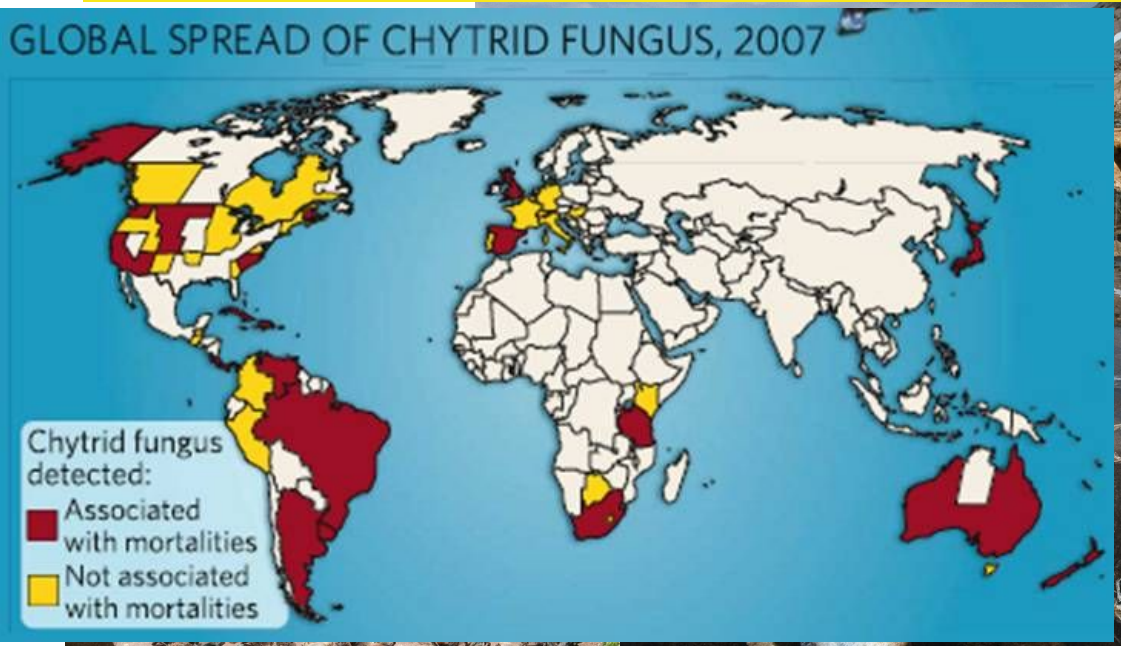
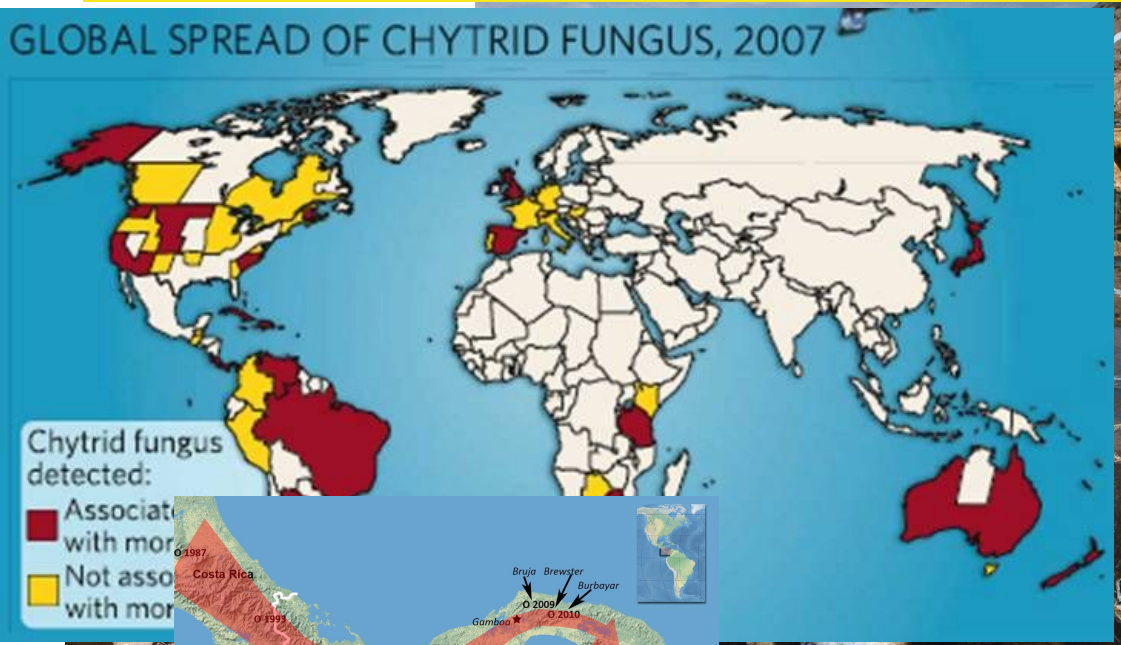
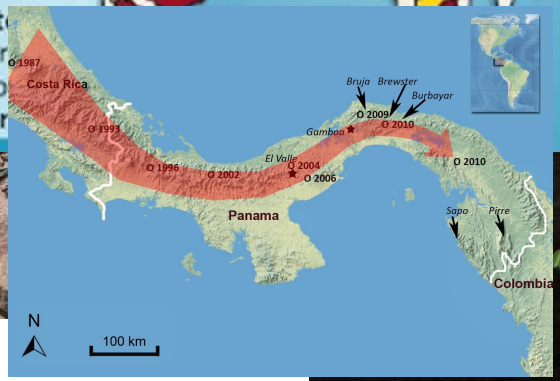
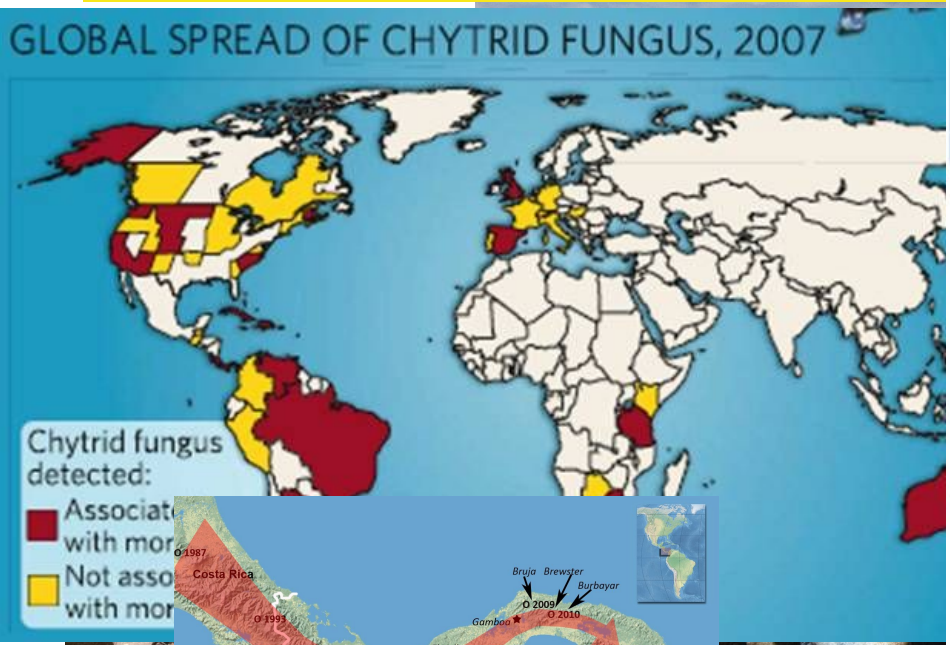


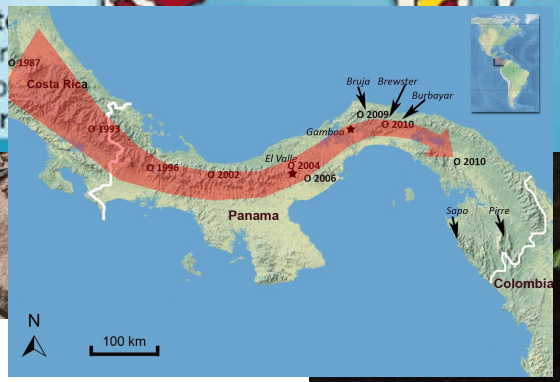
Tetrapoda:Class Amphibia: order Anura

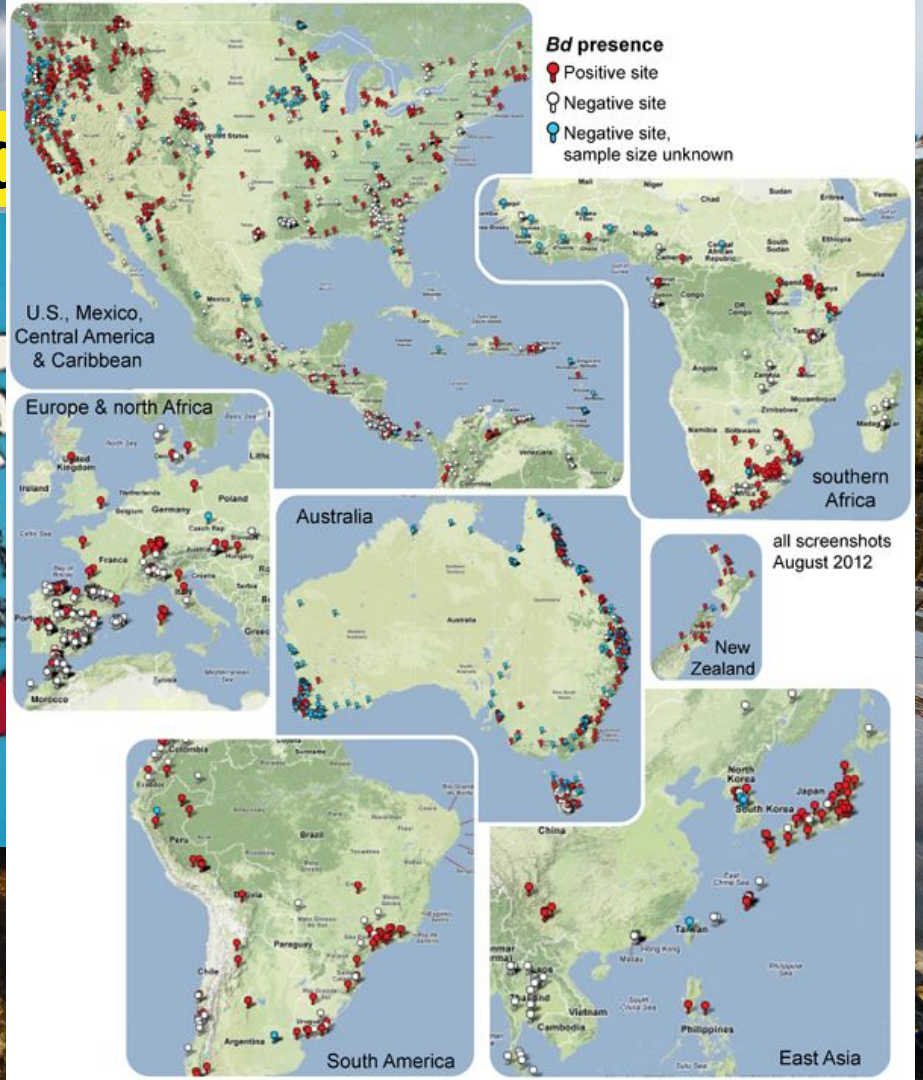




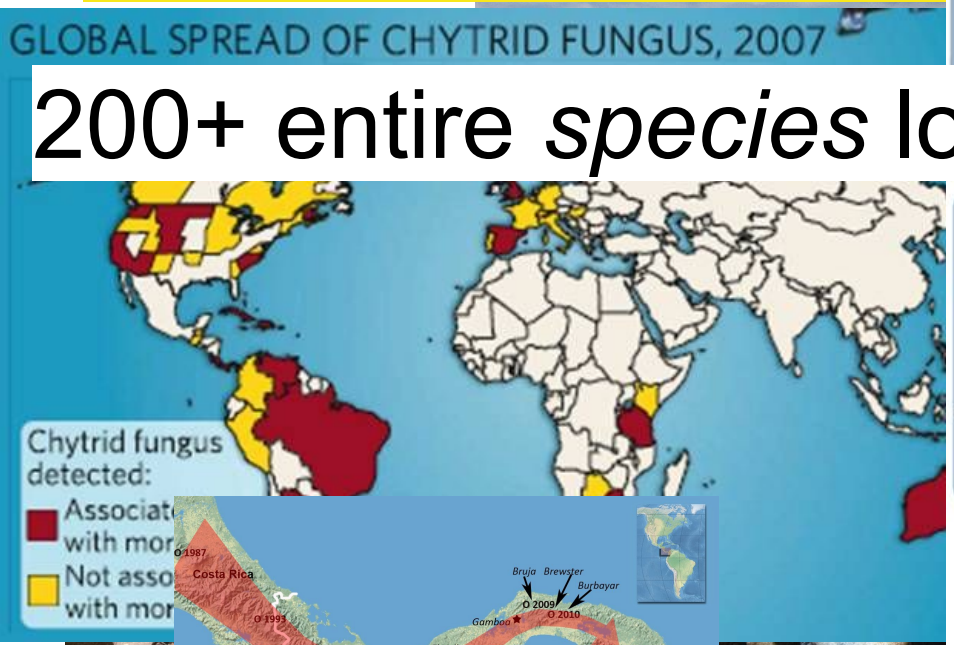
Tetrapoda:Class Amphibia: orc



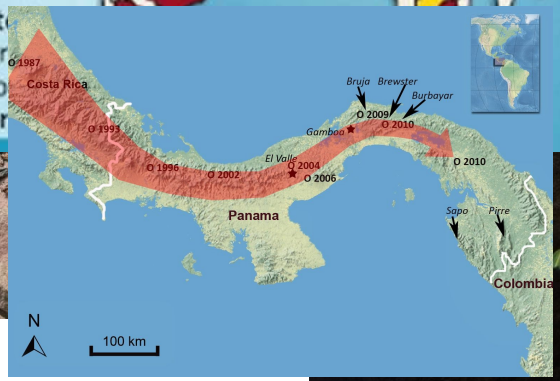


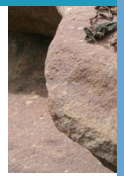


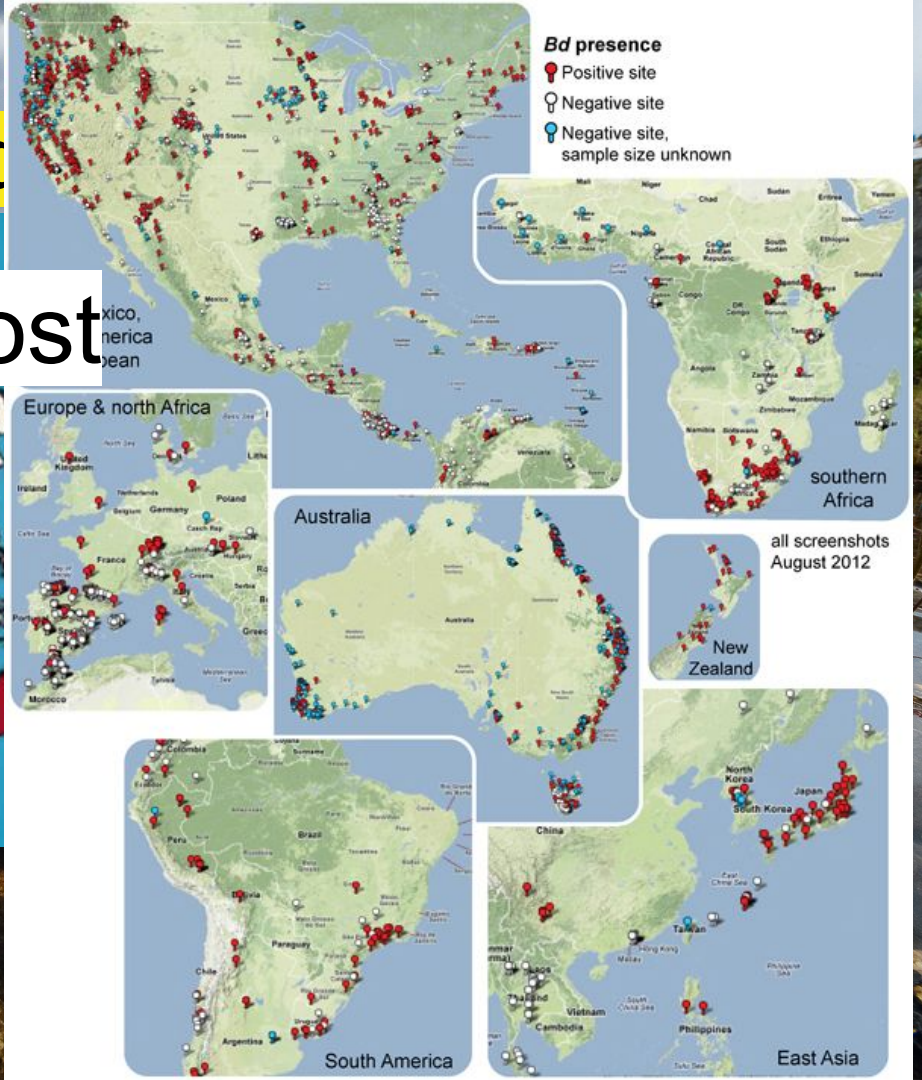
Tetrapoda:Class Amphibia: orc



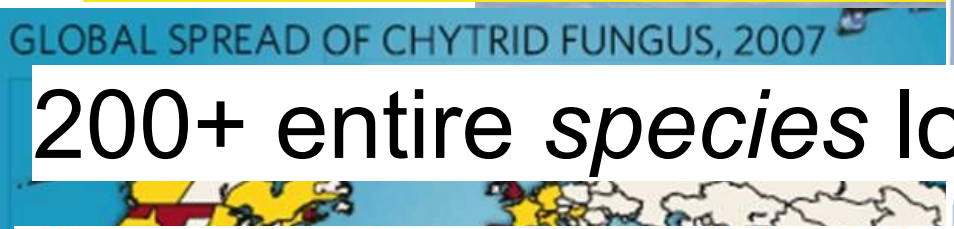
200+ entire *species* lost







Tetrapoda:Class Amphibia: orc



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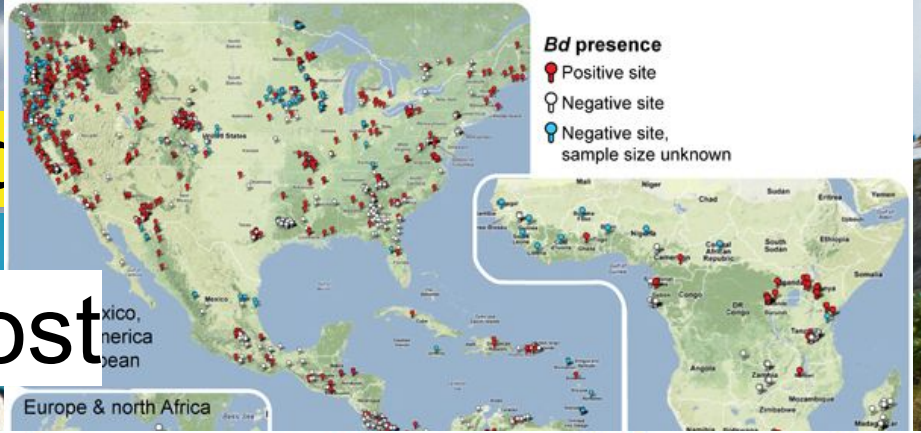
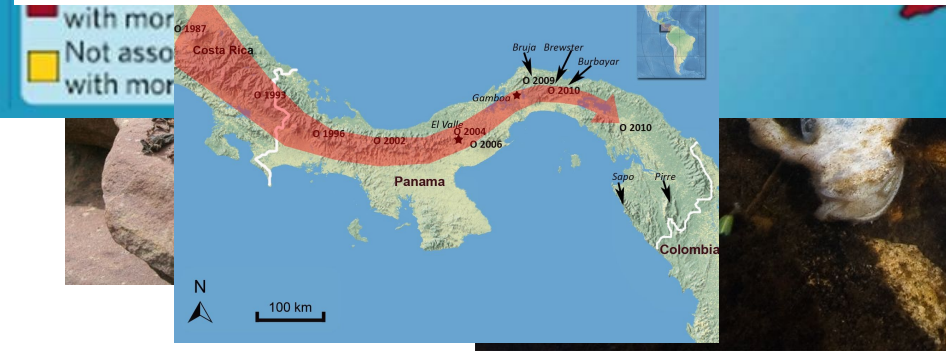
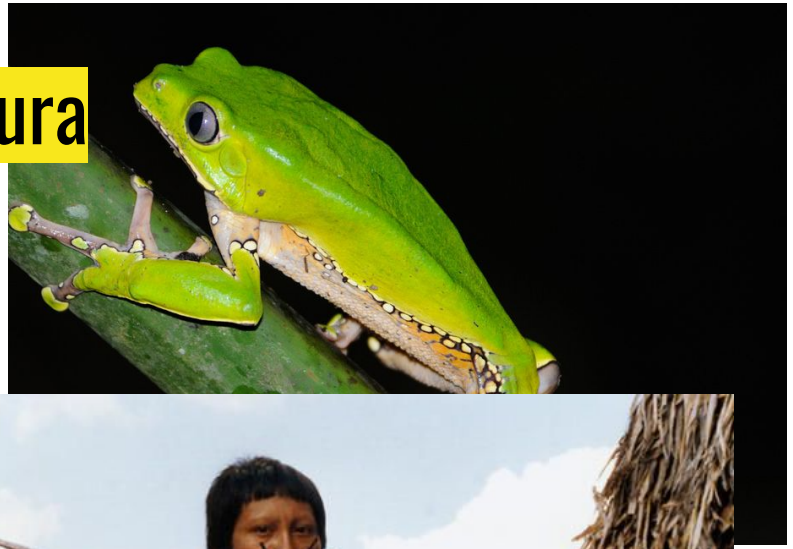


Are we in the midst of the sixth mass extinction? A view from the world of amphibians

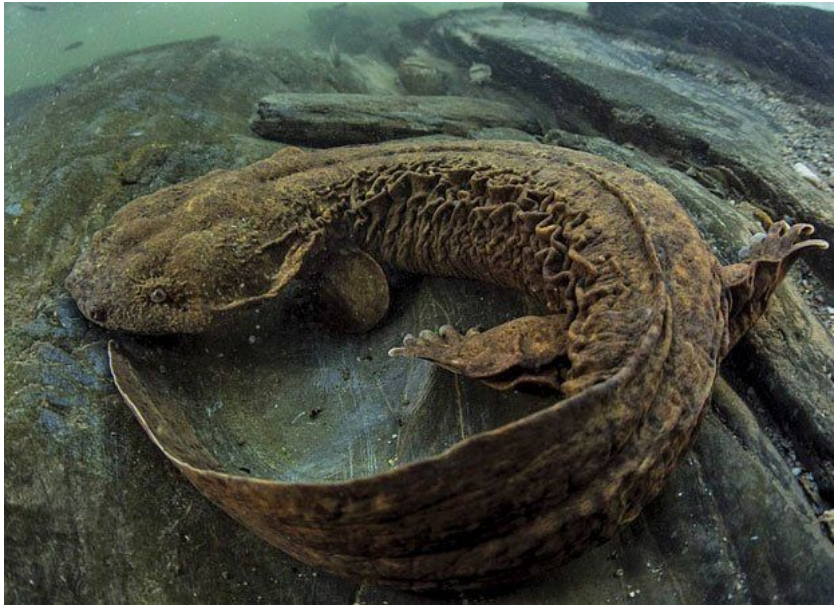
David B. Wake*,† and Vance T. Vredenburg*,‡



Tetrapoda:Class Amphibia: order Anura



Tetrapoda:Class Amphibia: order Caudata



Amniotes- from fins to feet!

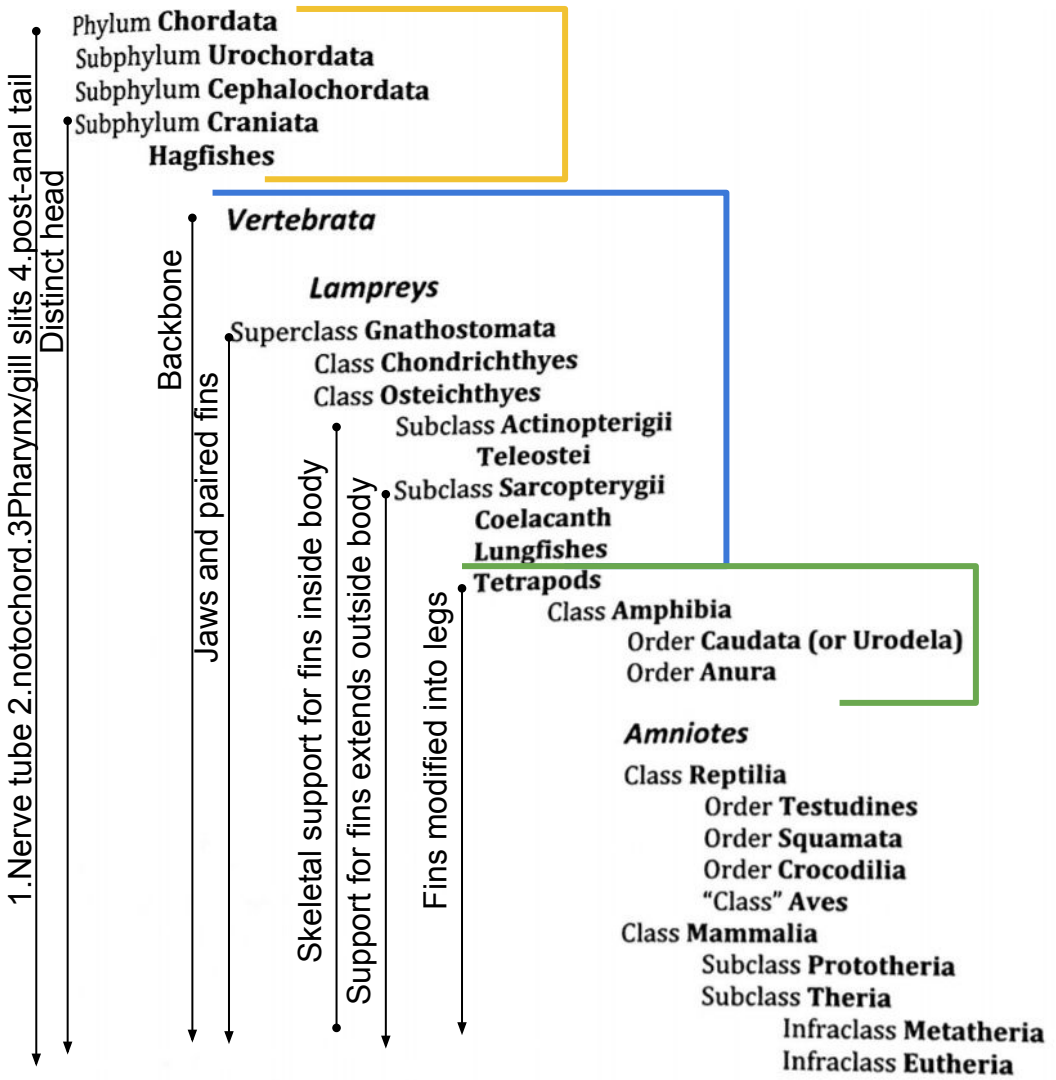
Class Reptilia

Class Mammalia

1. Monotremes
2. Marsupials
3. Placentals ↠ must know orders seen in class

Fourth Block;
Amniotes, eggs=shell

1) Reptilia
    a) Tustudines
    b) Squamata
    c) Crocodilia
    d) Aves
2) Mammalia
    a) Prototheria
    b) Theria
        i) Metatheria
        ii) Eutheria



Fourth Block;
Amniotes, eggs=shell

1) Reptilia
    a) Tustudines
    b) Squamata
    c) Crocodilia
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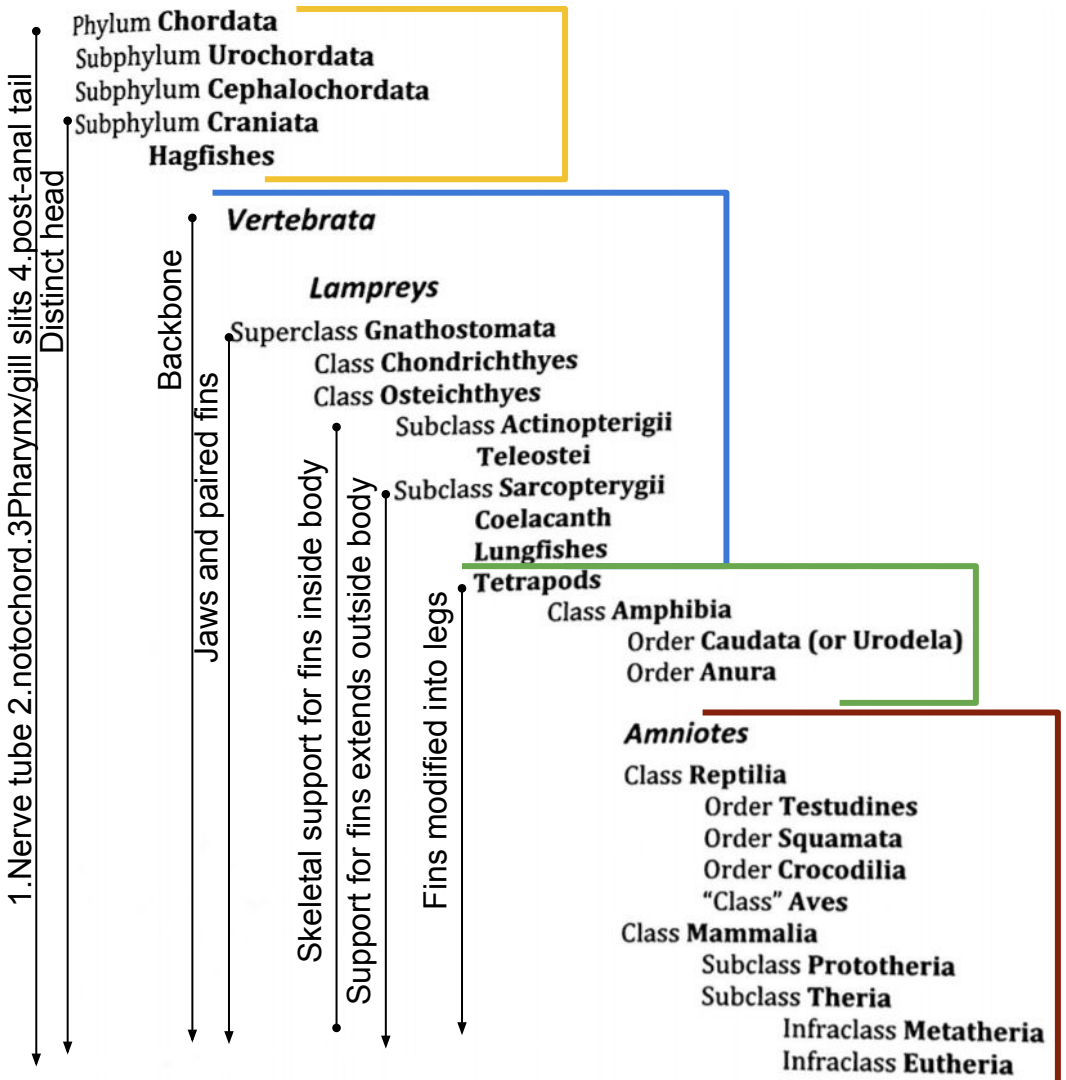
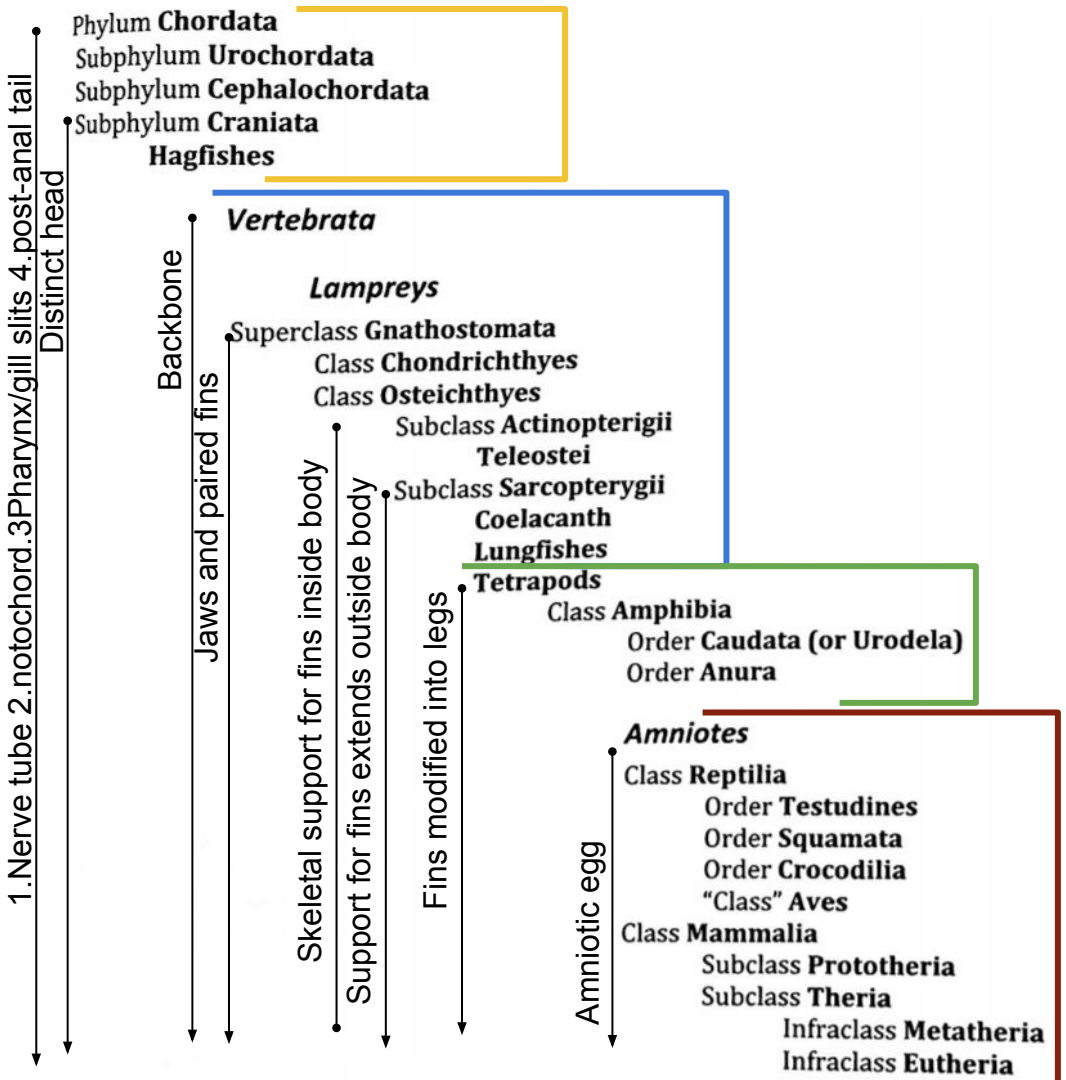


Fourth Block;
Amniotes, eggs=shell

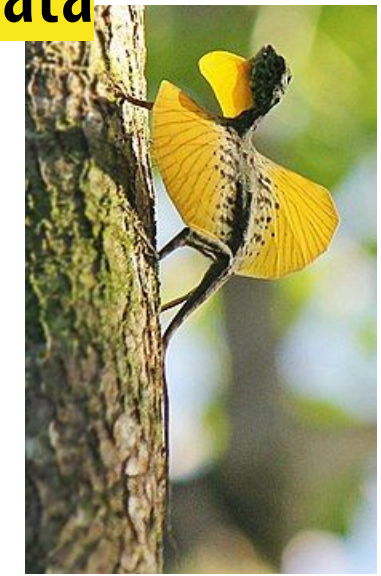
1) Reptilia
    a) Testudines
    b) Squamata
    c) Crocodilia
    d) Aves
2) Mammalia
    a) Prototheria
    b) Theria
        i) Metatheria
        ii) Eutheria



Class Reptilia

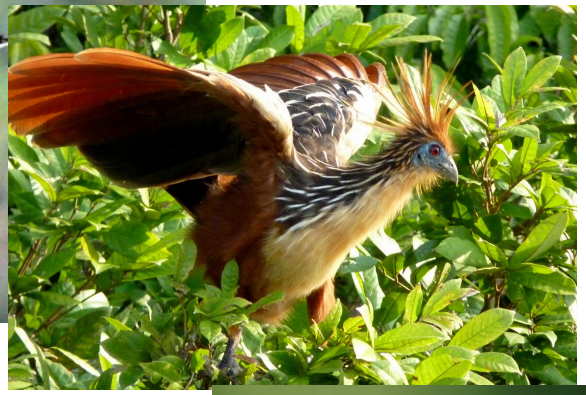
Class Reptilia: order Testudines

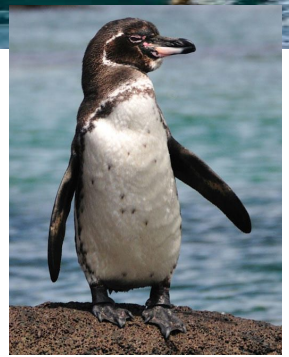
Class Reptilia: order Squamata

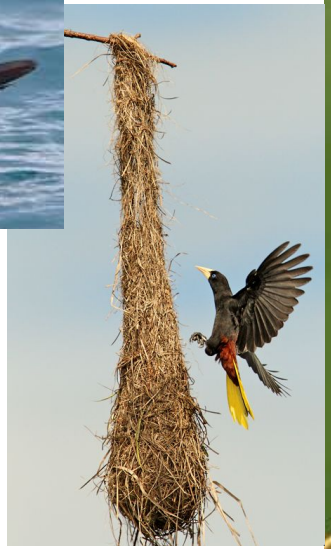


Class Reptilia: order Crocodilia

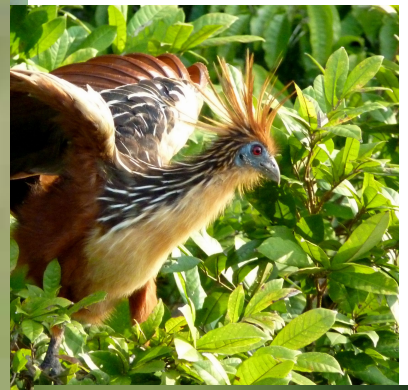
Class Reptilia: Aves

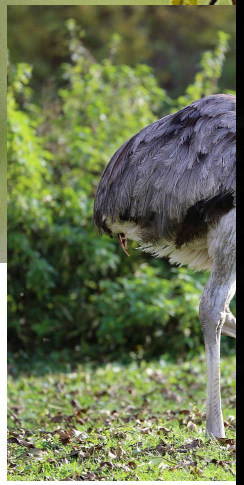






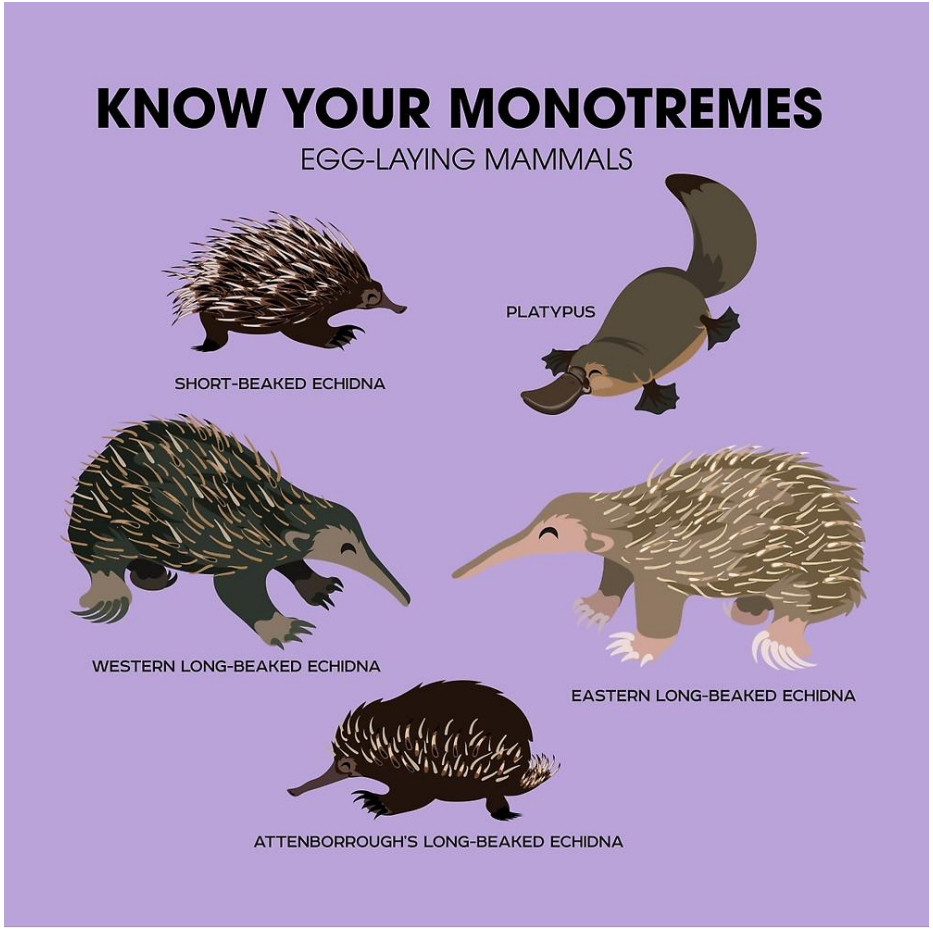
Class Reptilia: Aves





Class Mammalia- monotremes

- Monotremes lay eggs. The egg is retained for some time within the mother, which actively provides the egg with nutrients, and generally hatches soon after birth, within the span of 10 days
- Ingenious to New guinea and Australia
- Platypus one of a few venomous mammals: the male platypus has a spur on the hind foot that delivers a venom capable of causing severe pain to humans.



Class Mammalia- marsupials

- Females have a marsupial pouch where their young develop rather than a placenta

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- Dominant family group in Australia

Class Mammalia- marsupials

- Females have a marsupial pouch where their young develop rather than a placenta
- Dominant family group in Australia
- Nourished by milk, develop more after birth

Class Mammalia- Placentals

- Placenta is formed from embryonic membranes and the wall of the uterus is a food, water, and oxygen source for the embryo.
- 18-23 orders

Class Mammalia- Placentals

- Placenta is formed from embryonic membranes and the wall of the uterus is a food, water, and oxygen source for the embryo.
- 18-23 orders

Quiz