

BCH1200 Discovery in Biology

Biodiversity

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Lecture Outline

- Biodiversity & Species
- Classification & Naming of a Species
- Plant & Animal Diversity
- Ecosystem Diversity
- Significance of Biodiversity
- Major Threats to Biodiversity

Intended Learning Outcomes

1. Discover facts related to biodiversity & species
2. Relate biodiversity with evolution
3. Explain importance of biodiversity and consequences of its loss

Biodiversity & Species

- Biodiversity = Biological diversity
- Describes whole variety of life on Earth
 - 1. Diversity of all living things [**Species diversity**]
 - 2. Diversity of genetic makeups in individuals within a species or among species [**Genetic diversity**]
 - 3. Diversity of all habitats [**Ecosystem diversity**]

Definition of a Species

- “Species” is from the Latin for “kind” or “appearance”
- Species = distinct life-forms/living things
- How similar are members of the same species?
- What keeps one species distinct from others?

Four concepts to define a species

1. Biological species concept
2. Morphological species concept
3. Ecological species concept
4. Phylogenetic species concept

1. Biological species concept

- Defines a species as
 - a group of populations
 - whose members have the potential to interbreed in nature
 - produce **fertile** offspring



♂



♀

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Male donkey, 62 chromosomes



Female horse, 64 chromosomes



Mule, 63 chromosomes, sterile

Biological species concept

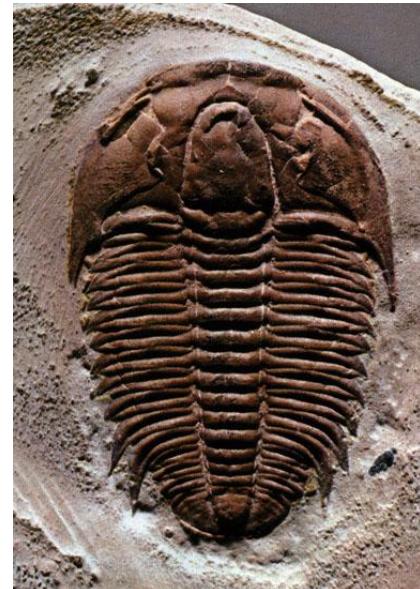
- Members of a species are **similar** because they reproduce with each other
- Since **reproductive isolation**
 - prevents members of different species from mating with each other
 - prevents gene flow between species
- Therefore, maintains **separate** species

Reproductive isolation

- Cannot usually be determined for extinct organisms known only from fossils



Trilobite fossil 1

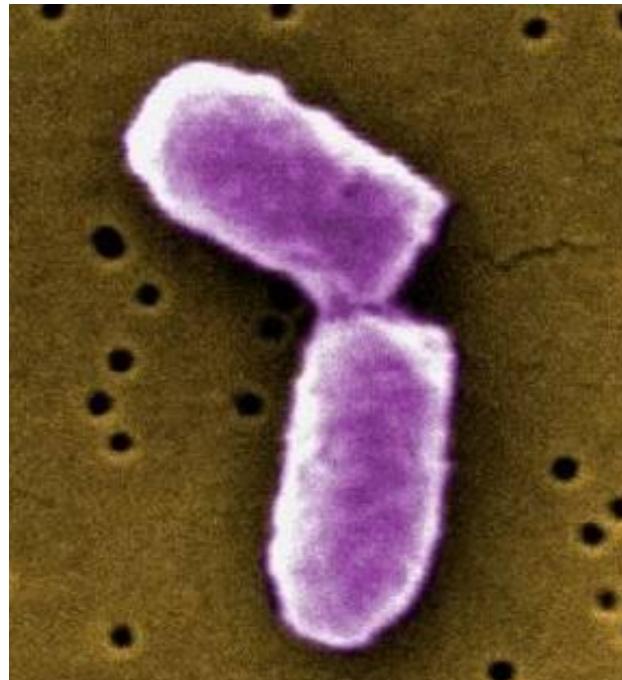


Trilobite fossil 2

Same or different species?

Reproductive isolation

- Does not apply to prokaryotes or other organisms that reproduce only **asexually**



Bacterium



Hydra

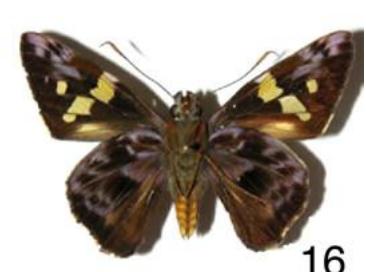
2. Morphological species concept

- Classifies organisms based on observable **physical traits** (morphological characters)
- Can be applied to
 - asexual organisms
 - fossils
- There is some subjectivity in deciding which traits to use



Cockspur thorn (cockspur hawthorn) (*Crataegus crusgalli*).

<https://nature.mdc.mo.gov/discover-nature/field-guide/hawthorns>



Males (columns one and three) and females (columns two and four) of four cryptic species of butterfly in dorsal (left) and ventral (right) view.

(1–4) *P. adela*

(5–8) *P. poaceaphaga*

(9–12) *P. geonomaphaga*

(13–16) *P. prestoeaphaga*

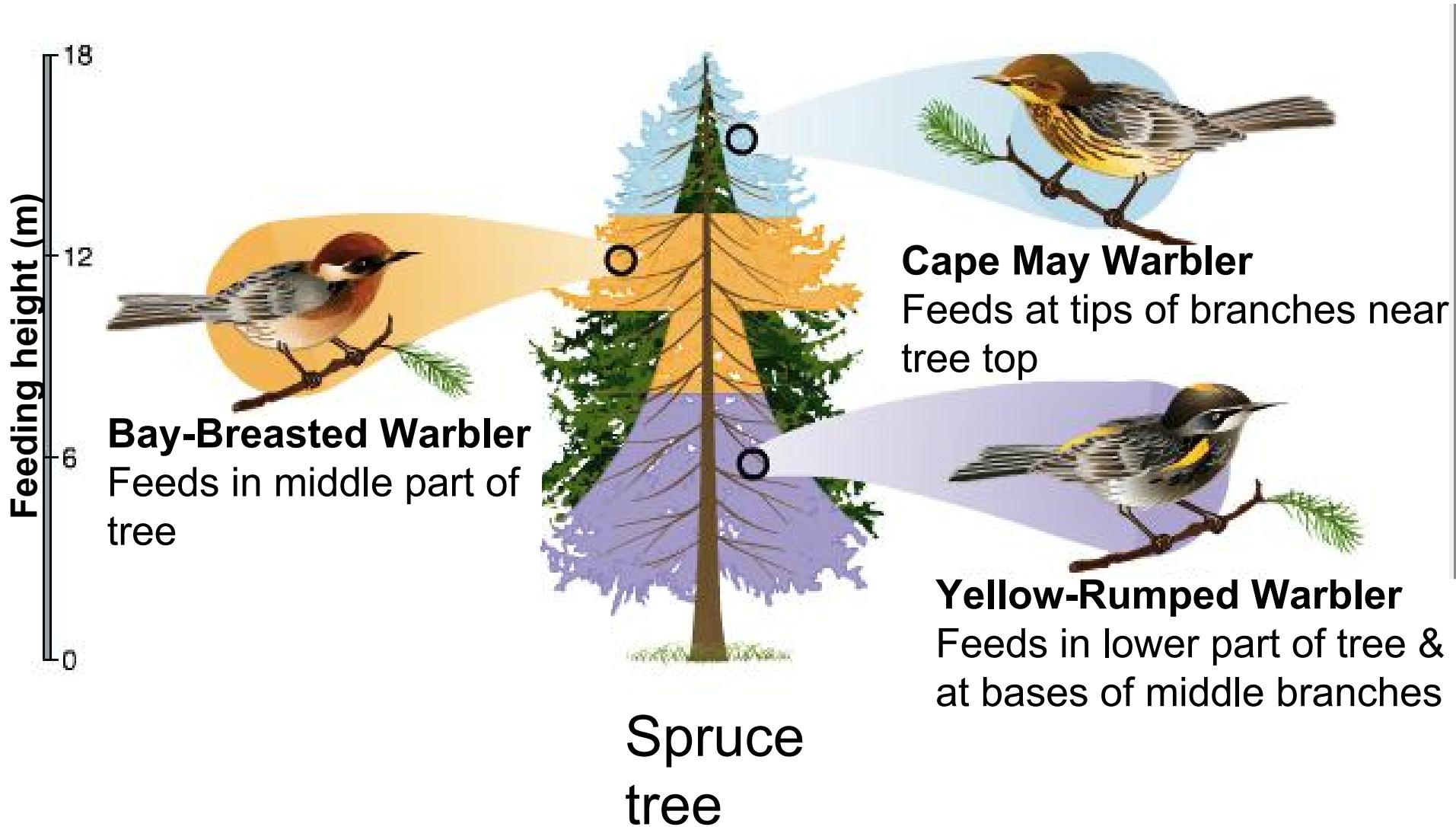


<http://www.animalabs.com/genetic-tests-for-dogs/>

3. Ecological species concept

- Defines a species by its ecological role or niche
- Focuses on unique adaptations to particular roles in a biological community
- For example, two species may be similar in appearance but distinguishable based on:
 - what they eat
 - where they live

Niche differentiation

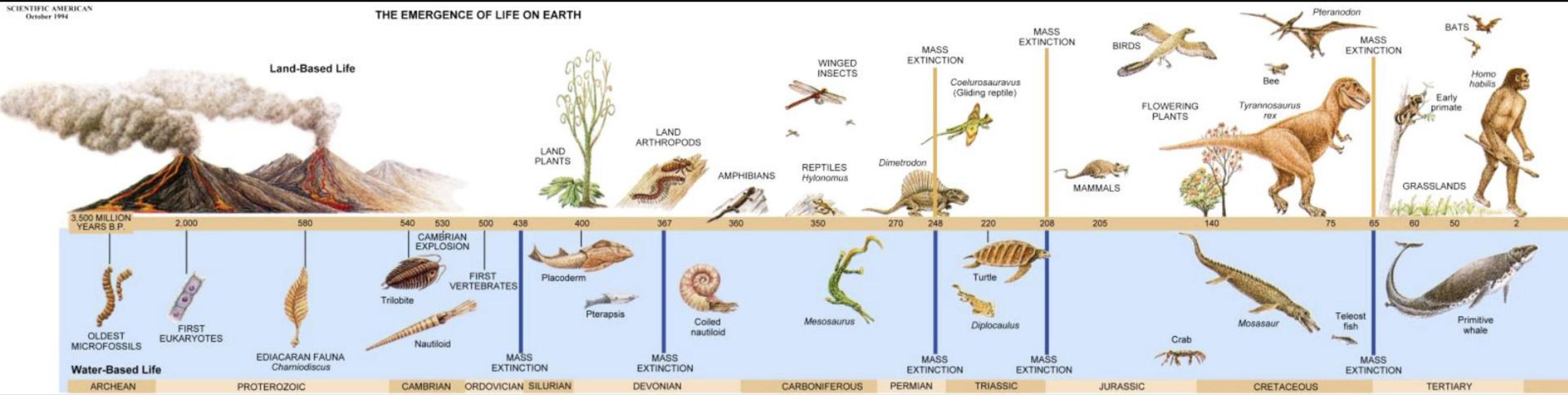


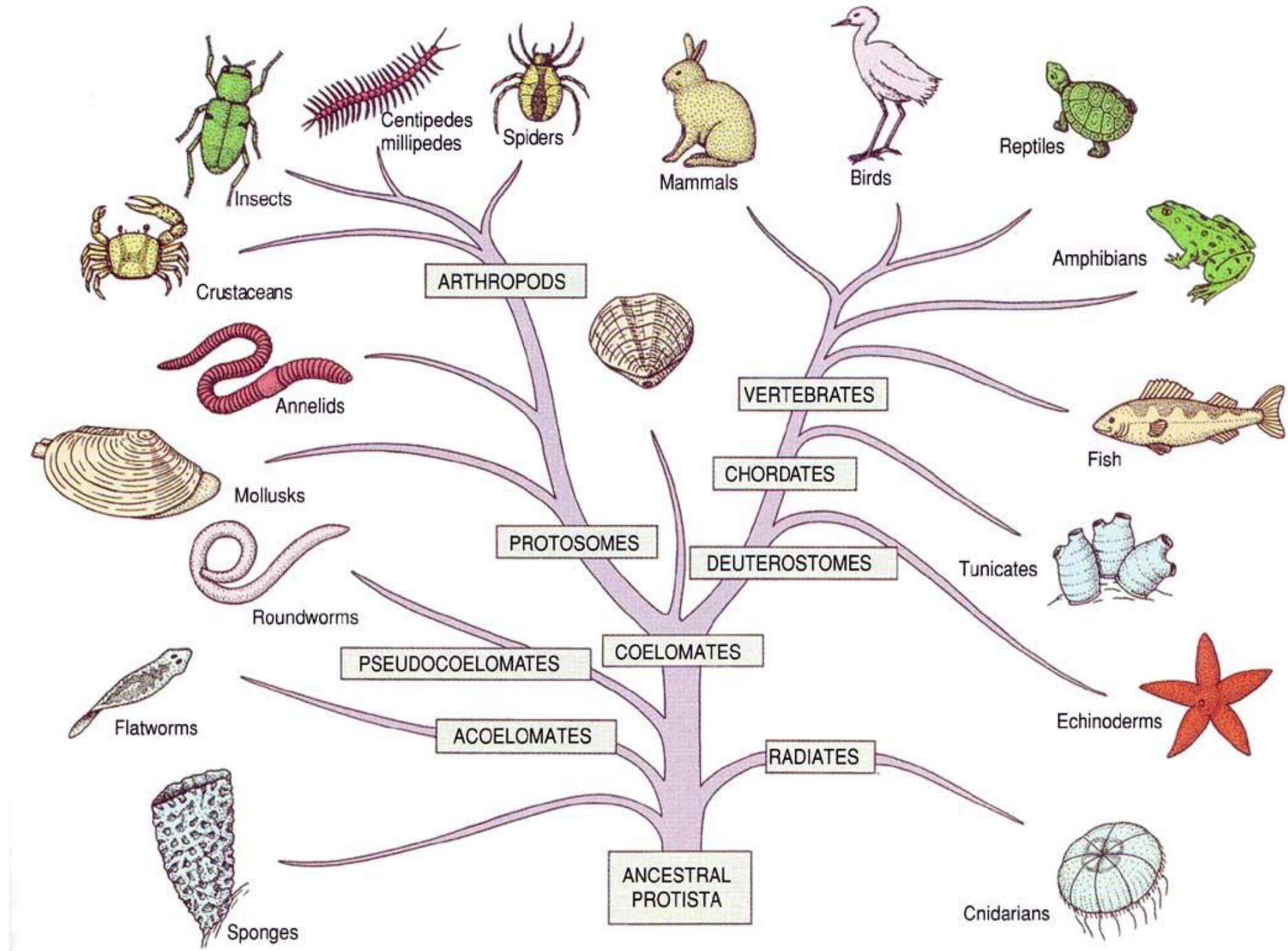
4. Phylogenetic species concept

- Defines a species as the smallest group of individuals that shares a **common** ancestor, to form one branch of the “**tree of life**”
- Trace the phylogenetic history of a species by comparing its
 - morphology
 - DNA (Deoxyribonucleic Acid)
- To define the amount of difference required to distinguish separate species can be a problem

Biological Tree of Life

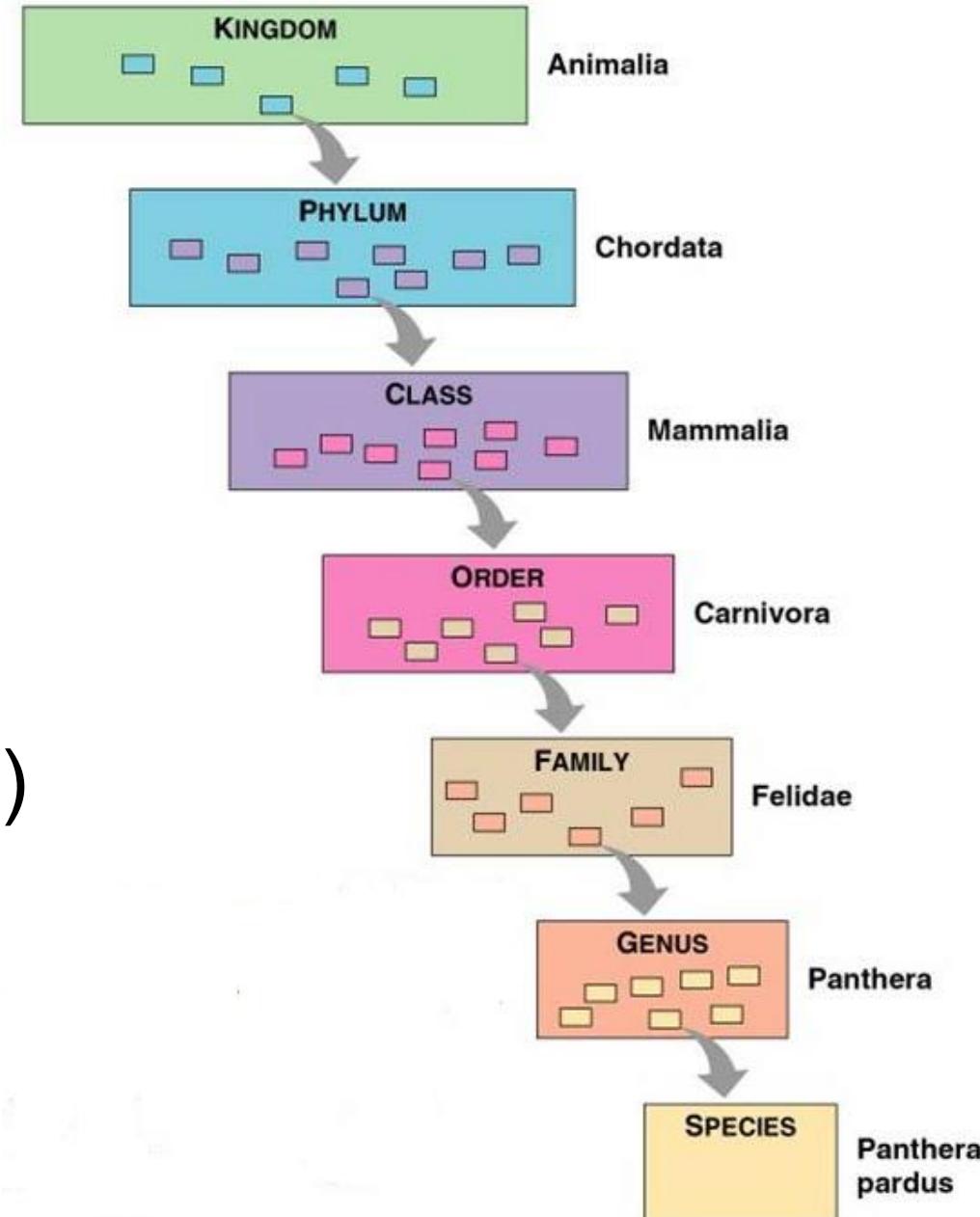
- A classification of living things based on **phylogenetic relationship & morphological differences**
- Related to concept of **evolution** – *On the Origin of Species* (Charles Darwin)
- Linkages resemble tree-like, from a common origin (**ancestor**)
- Some members were already extinct; evidence as **fossils**





Classification & Naming of a Species

- Linnaean taxonomy: from Kingdom to Species
- Binomial scientific name - genus, species, e.g.,
- *Panthera pardus* (leopard)
- *Panthera leo* (lion)
- *Panthera tigris* (tiger)
- *Panthera onca* (jaguar)





Lion



Tiger



Leopard



Jaguar

Species diversity

- Microbes, fungi, plants, animals
- About 1.75 million species of organisms have been named on Earth
- Yet, an estimated 10 to 100 million more species that scientists still have not described

Genetic diversity

- Essential to process of evolution by natural selection
- Evolution – a very slow process
- Once genetic diversity is depleted, it may take millions of years for a group (species, population) to recover, if at all



Ecosystem diversity

- An ecosystem is comprised of a geographical location, its physical features and the organisms that survive and interact there
- Our biosphere is formed by a variety of ecosystems



Biosphere: part of the earth's air water and soil where life is found

Ecosystem: a community of different species interacting with one another and with their non-living environment of matter and energy



Community: populations of **different** species living in a particular place, and potentially interacting with each other

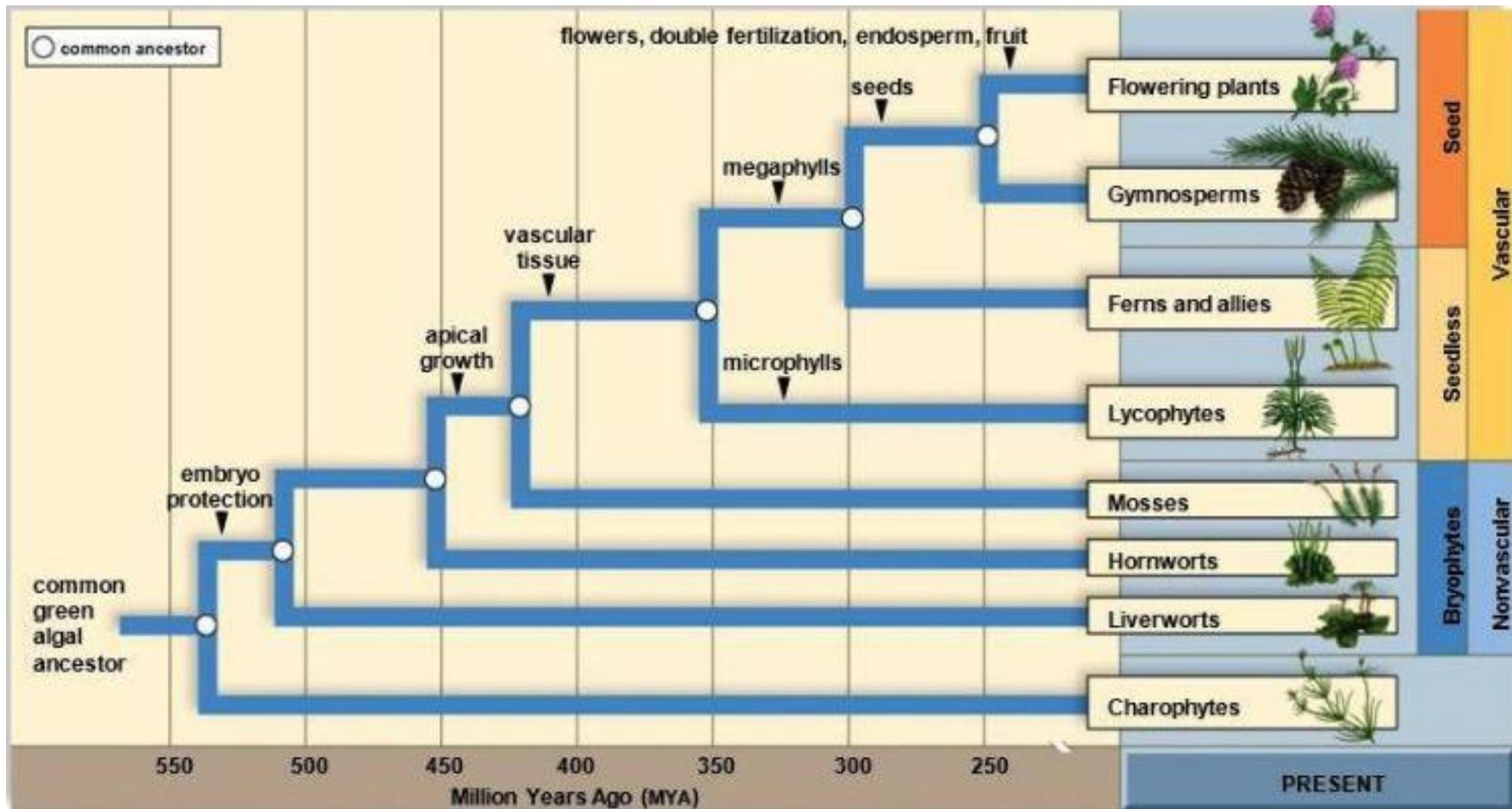


Population: a group of individuals of the **same** species living in a particular place (**habitat**)



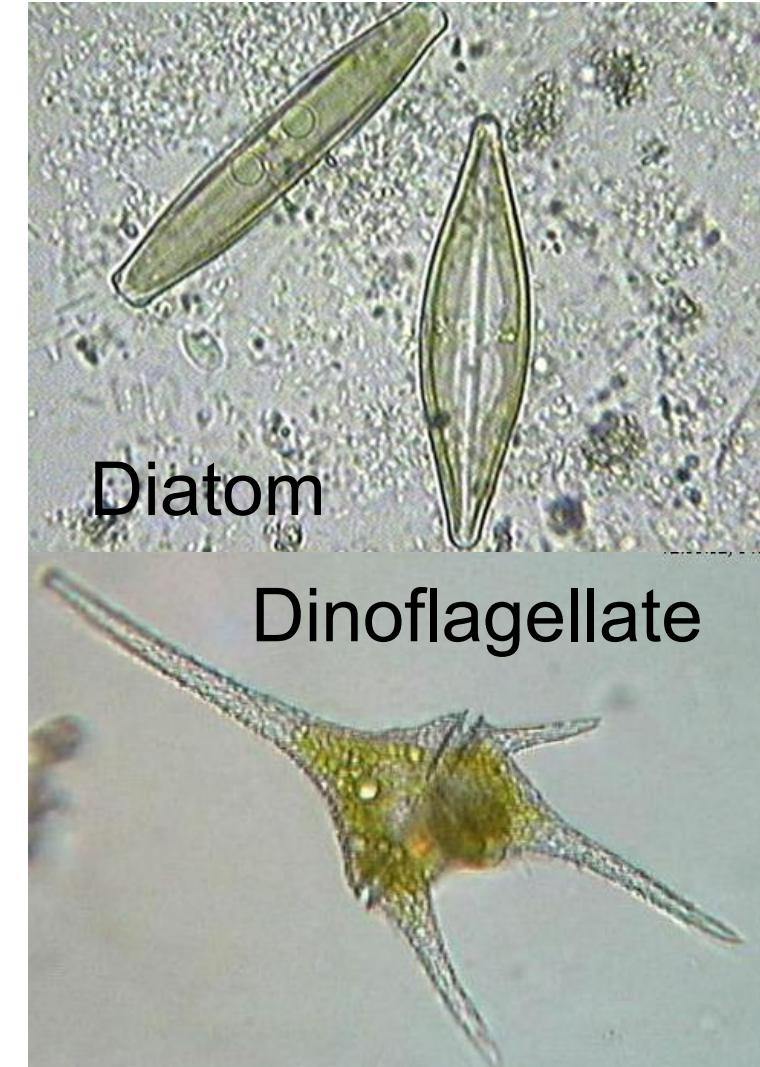
Organism: an individual living being

The Evolution of Plants



Plant diversity: Diatoms & Dinoflagellates

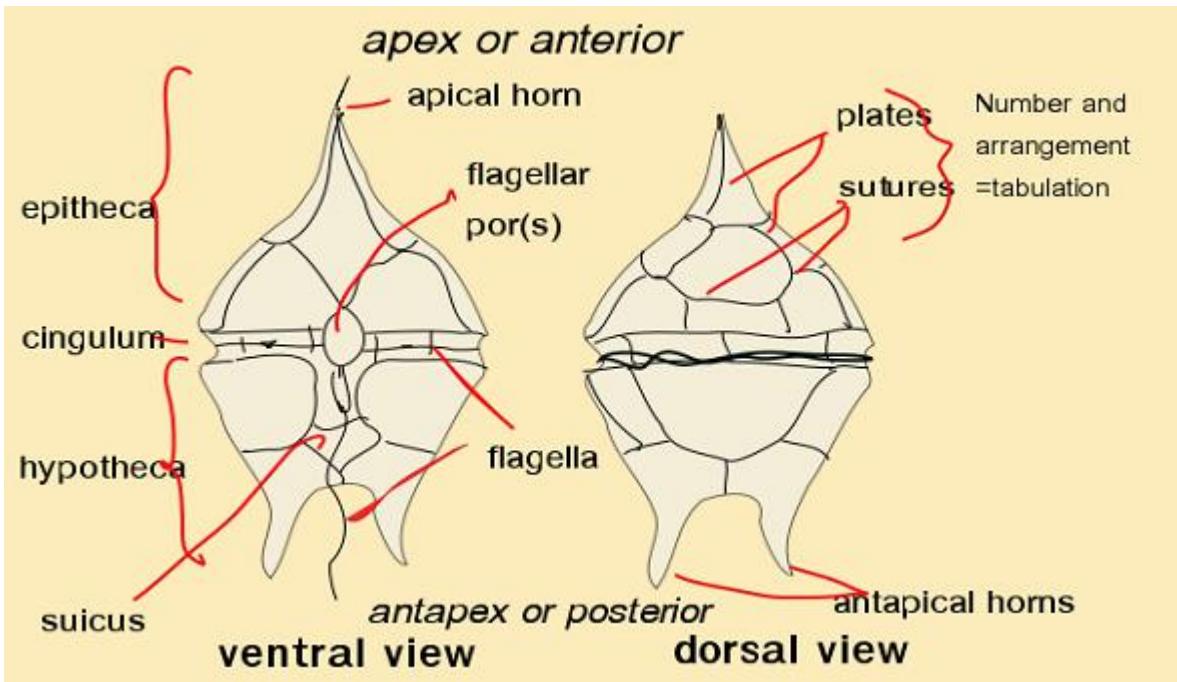
- Plant-like protists (Eukaryotes)
- Diatoms – outside “cell” wall (frustule) made of silica; single or form chain
- Dinoflagellates – two flagella for swimming; mostly single





Species diversity of diatoms

Bioluminescence in dinoflagellates



<http://serious-science.org/bioluminescent-algae-6827>

Plant diversity: Green algae

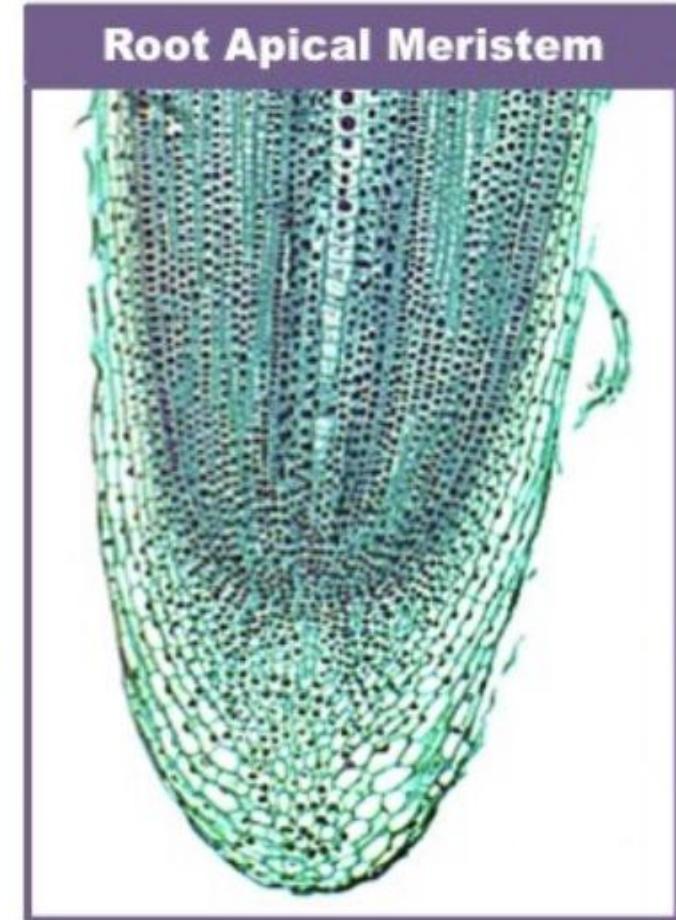
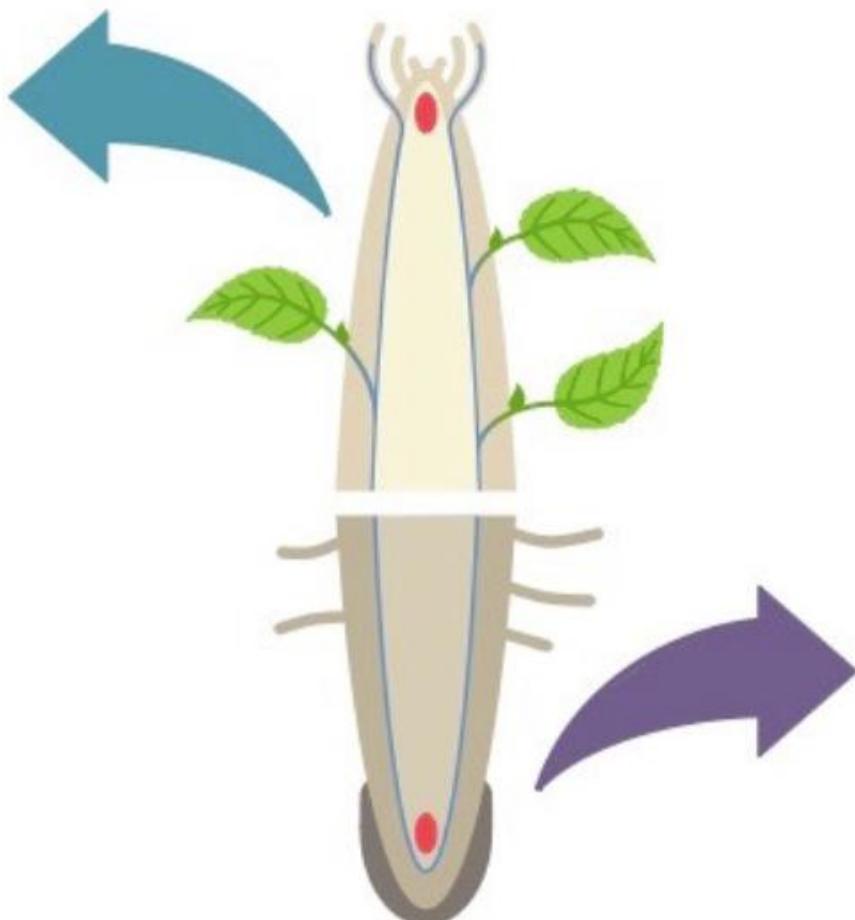
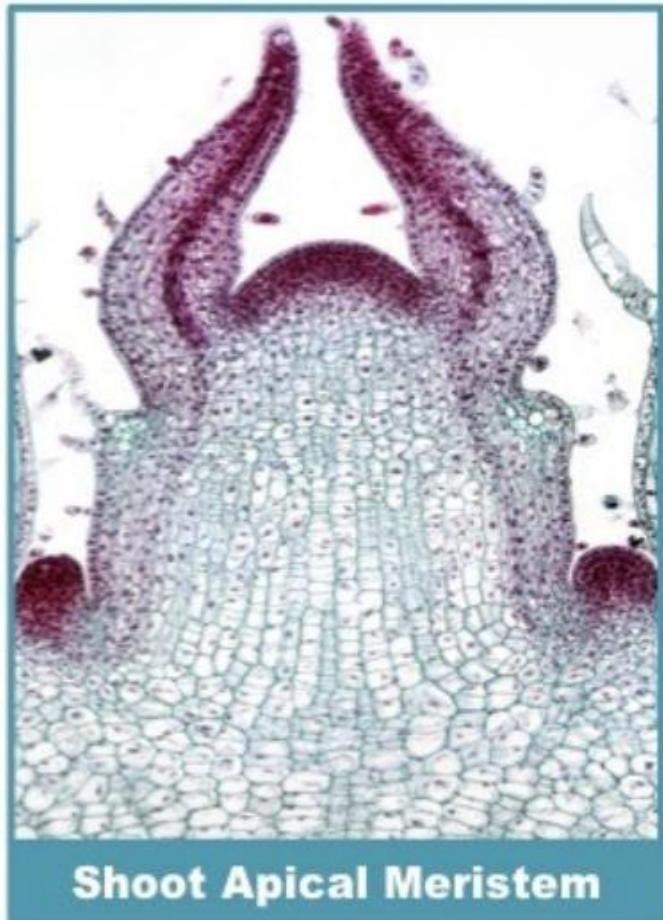
- Green algae – autotrophs that carry out photosynthesis using same pigments as plants
- Single celled, colonial or multicellular species
- Microscopic to large size, e.g., seaweeds



Plant diversity: Bryophytes

- Seedless, non-vascular plants: liverwort, hornwort, moss (with **apical growth**)
- Lack true roots & leaves
- No lignified cell wall
- Different fruiting body (sporophytes) as compared to gametophytes

Apical Growth in Shoots and Roots



Liverwort



Moss

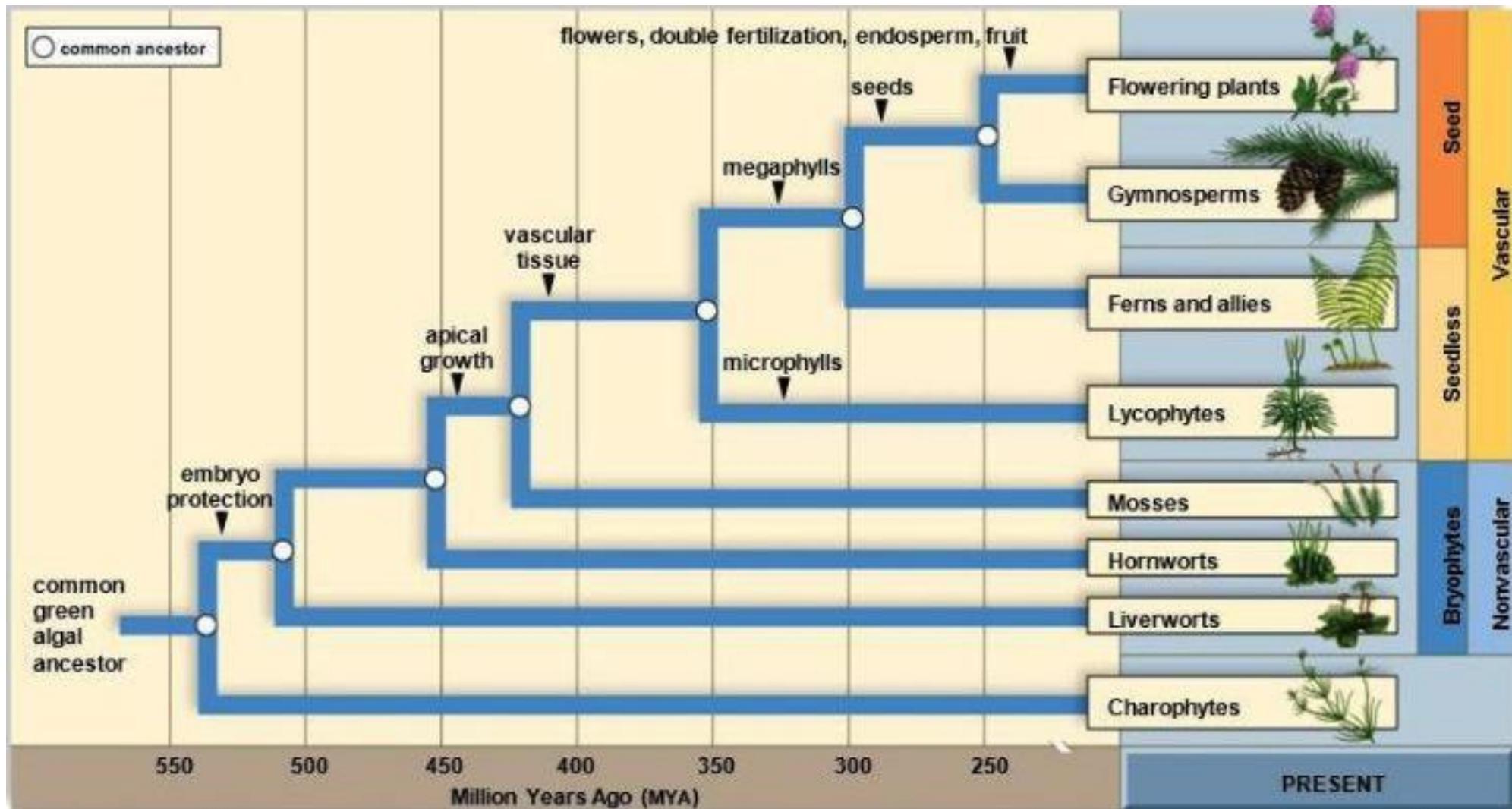


Hornwort

Carpets of Bryophytes

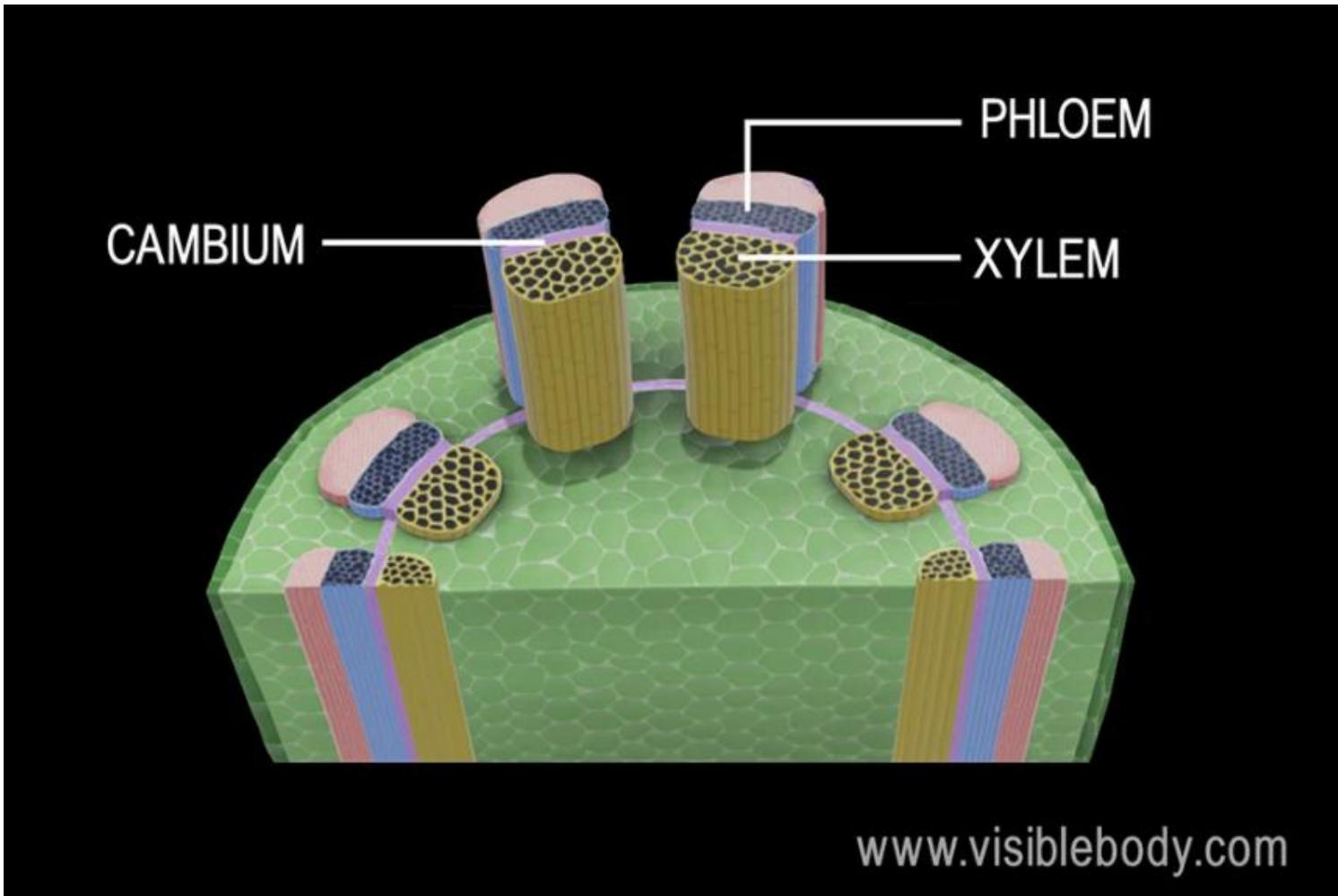


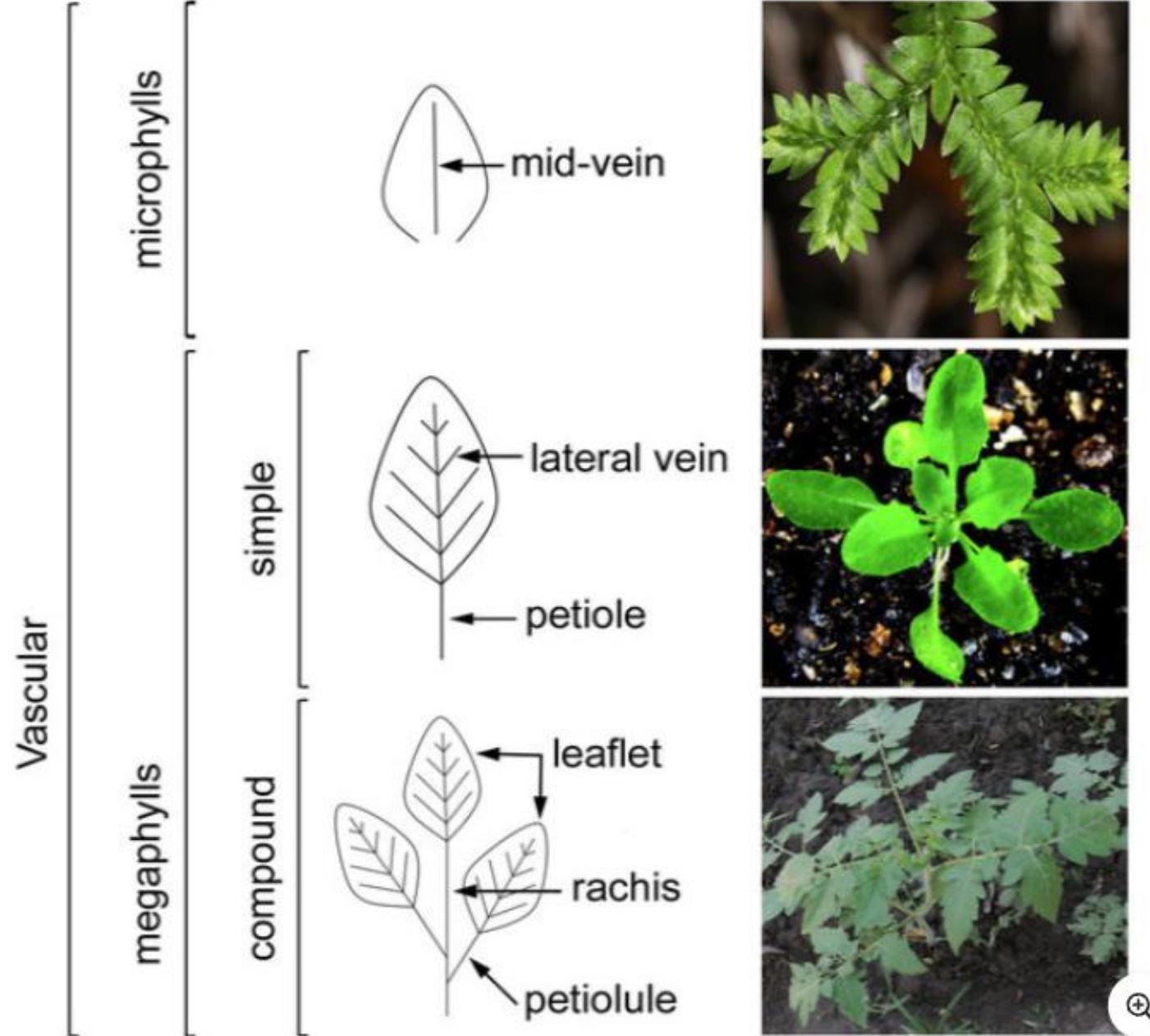
The Evolution of Plants



Vascular tissue

- consisting of xylem and phloem
- xylem transports water and dissolved minerals from the roots to the stem and leaves
- phloem transports dissolved sugars and organic compounds from the leaves to the stem and roots
- cambium gives rise to secondary xylem and phloem





Plant diversity: Pteridophytes

- Ferns
- Seedless, **vascular plants**
- Fern leaves = fronds
- Stems of most ferns are underground rhizomes
- Need air to carry spores for fertilization





Hardy Tree Fern

Dicksonia antarctica

*(one of the oldest vascular plants
in the world)*

<https://www.primrose.co.uk/6ft-hardy-tree-fern-dicksonia-antarctica-p-115150.html>

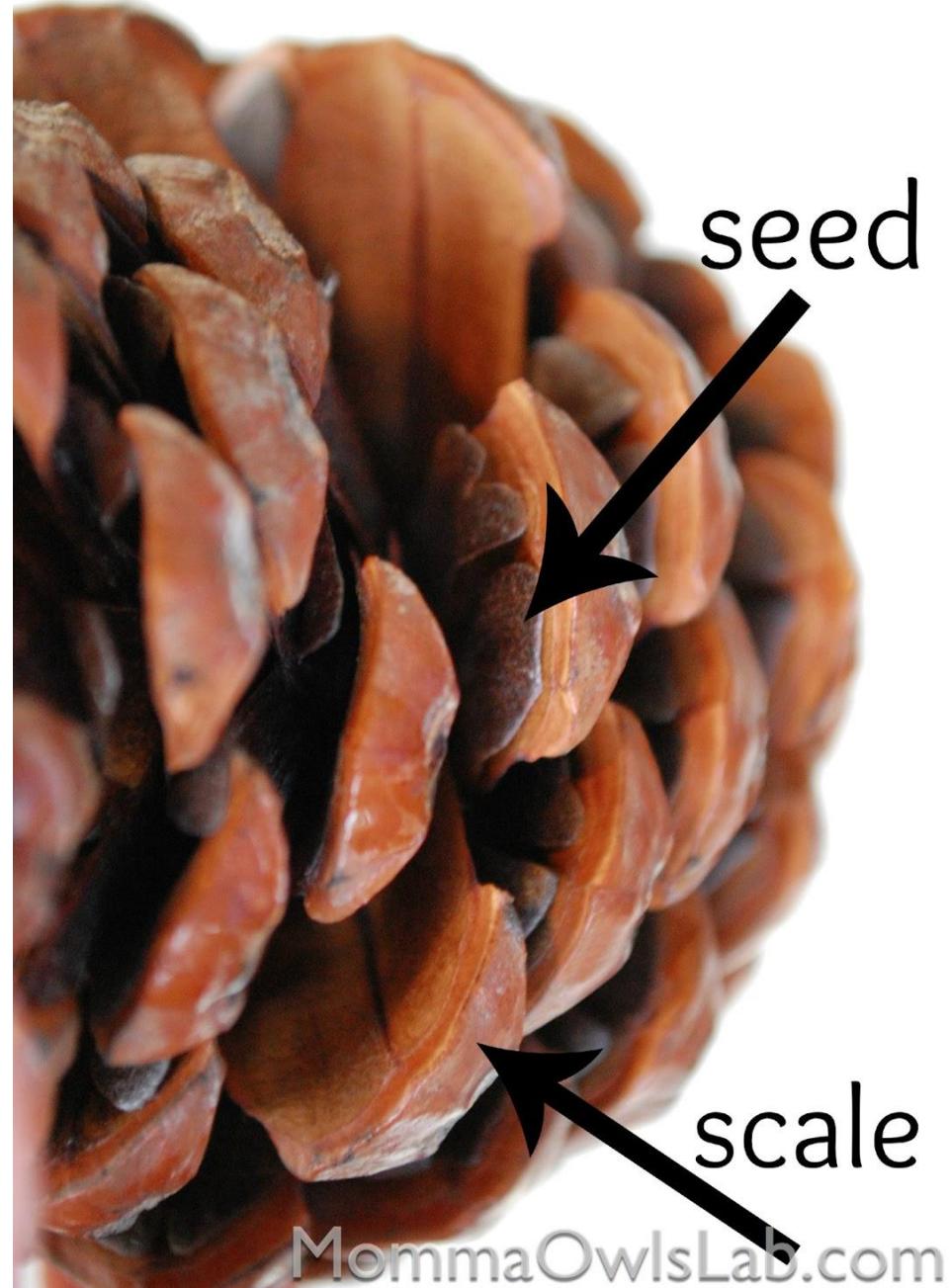
Plant diversity: Gymnosperms

- Seed-producing plants
- Gymnosperms = “**naked seed**” plants
- Conifers – with male and female cones
- Ginkgo – living fossil from 270 MYA



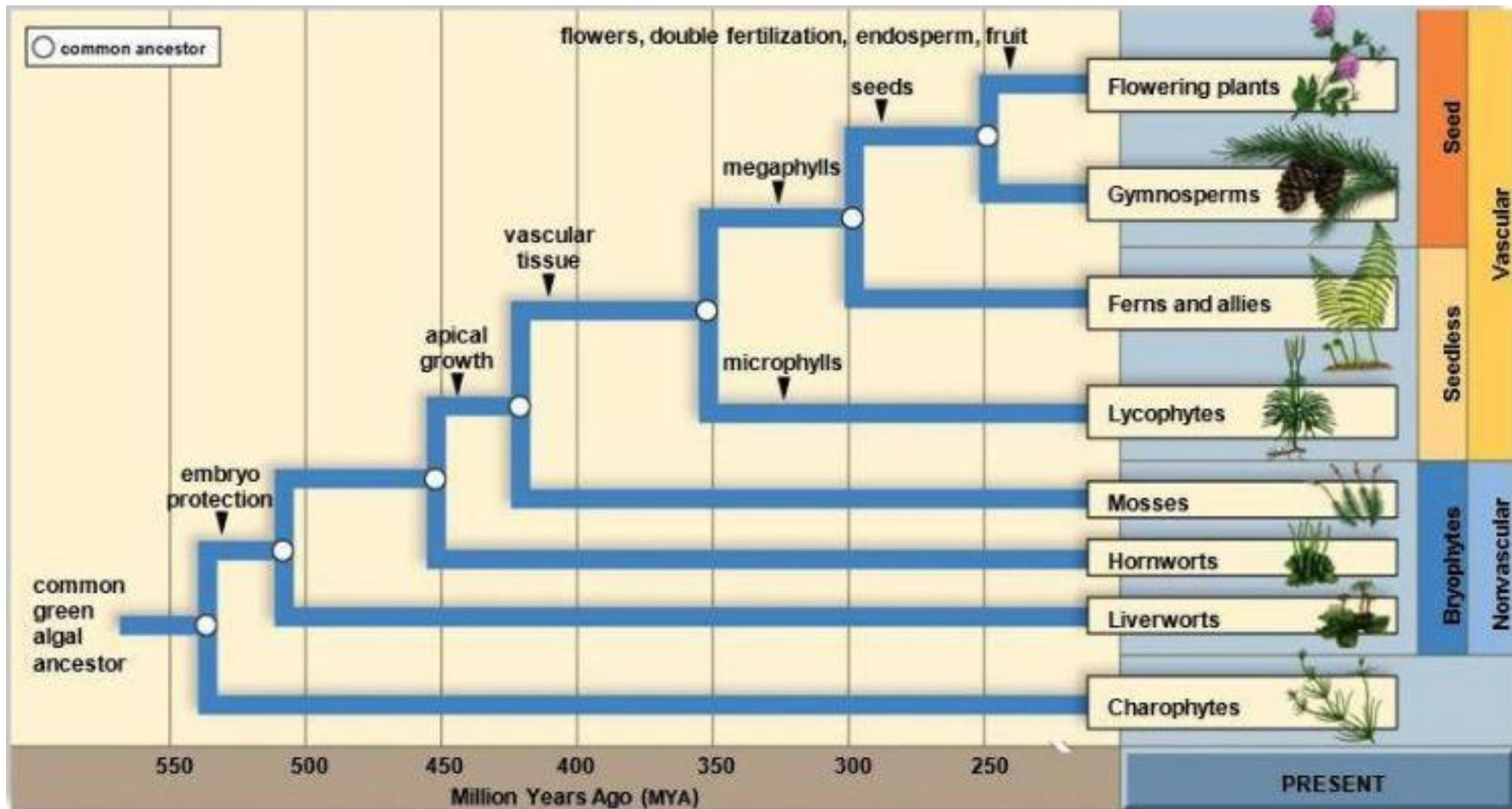


<https://homeguides.sfgate.com/name-group-plants-seeds-not-surrounded-fruit-58100.html>



MommaOwlsLab.com

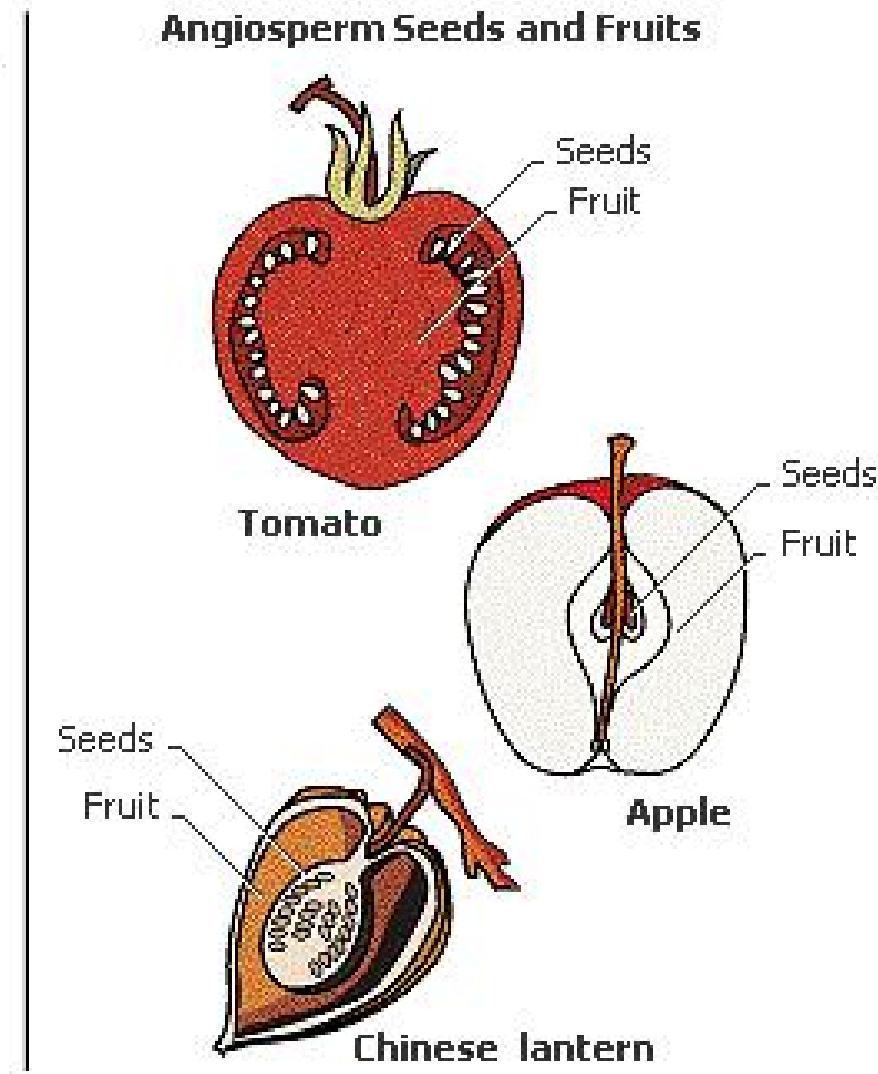
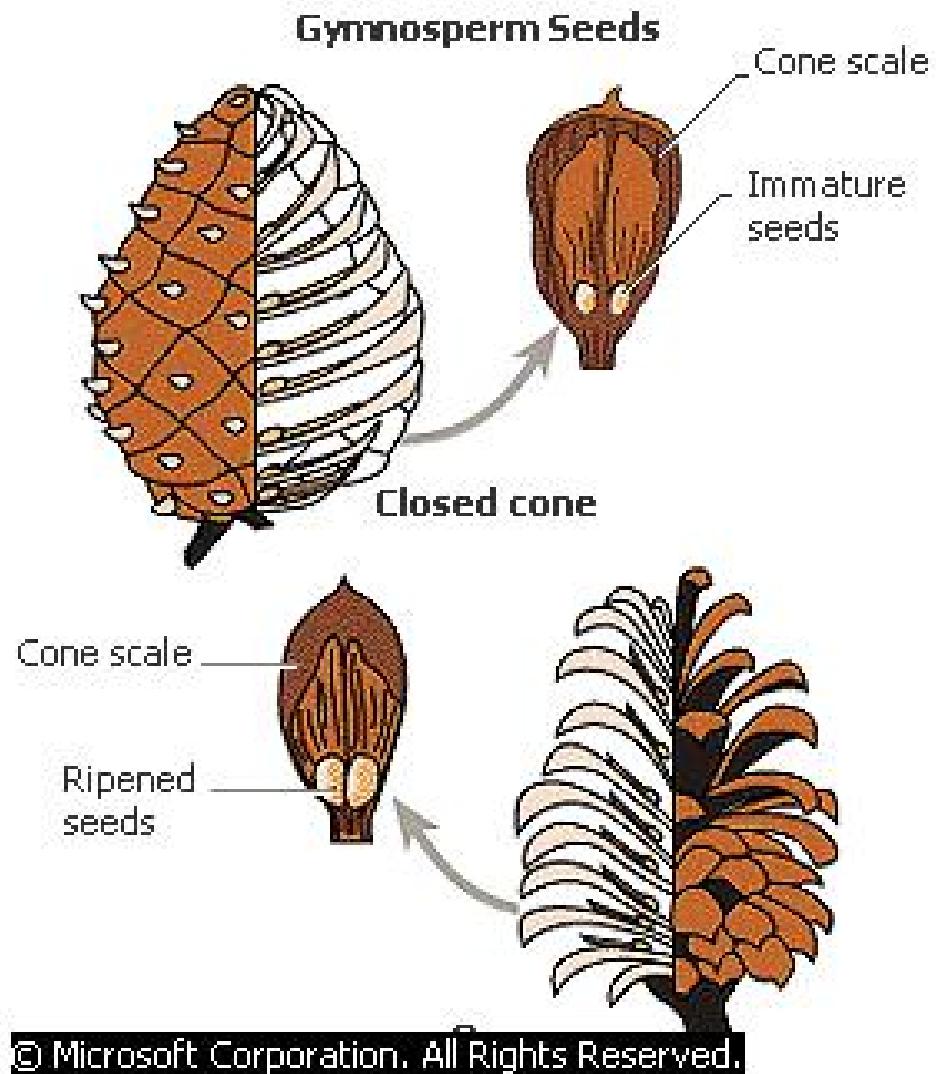
The Evolution of Plants



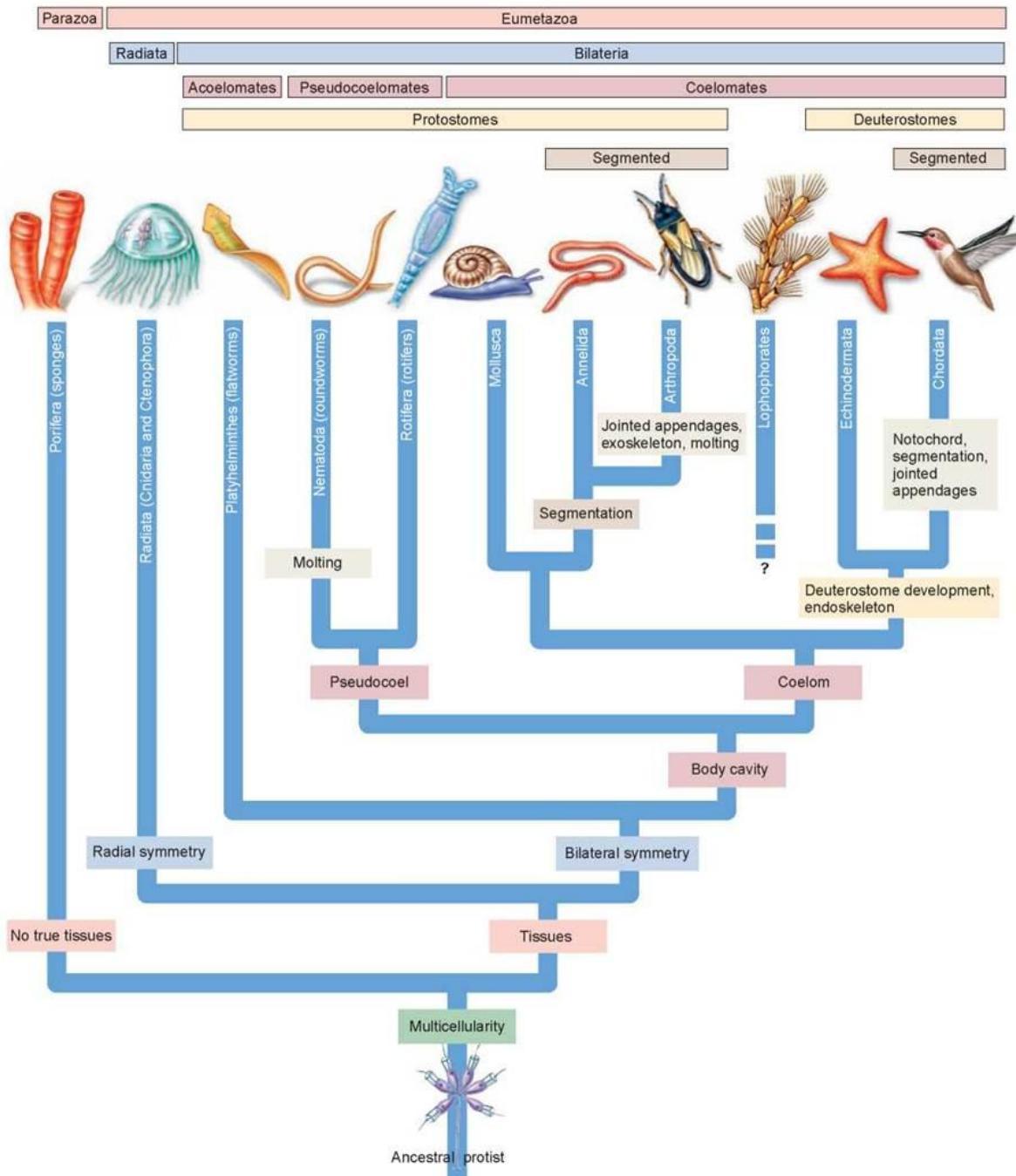
Plant diversity: Angiosperms

- Flowering, seed plants
- Monocots – embryos have a single seed leaf (cotyledon)
- Eudicots (true dicots) – embryos have two cotyledons
- Colonize terrestrial (land) and aquatic (water) habitats





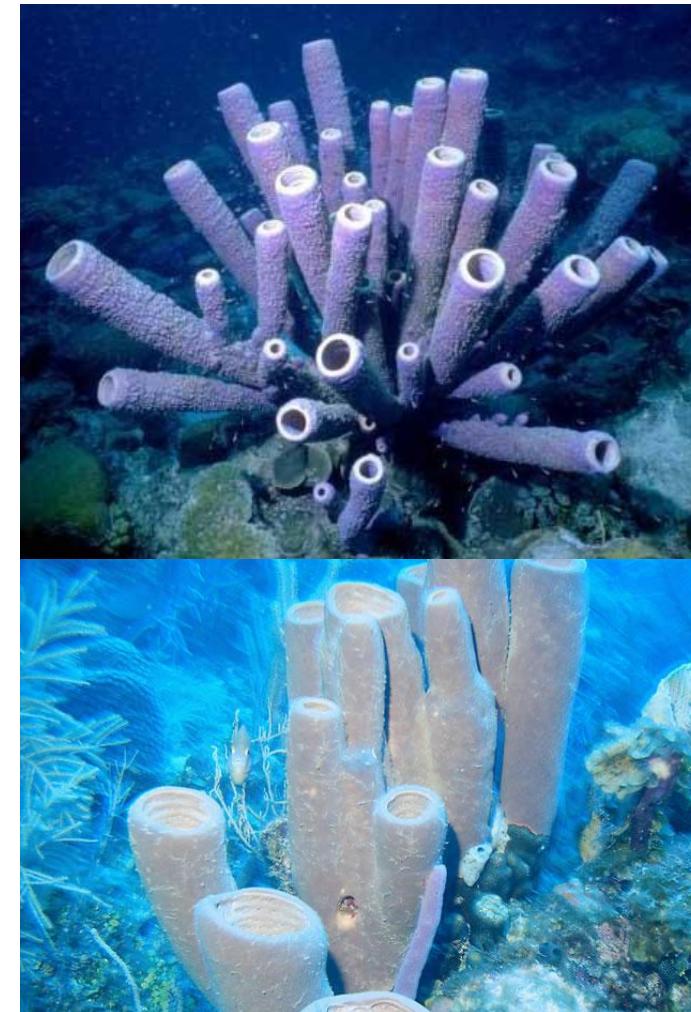
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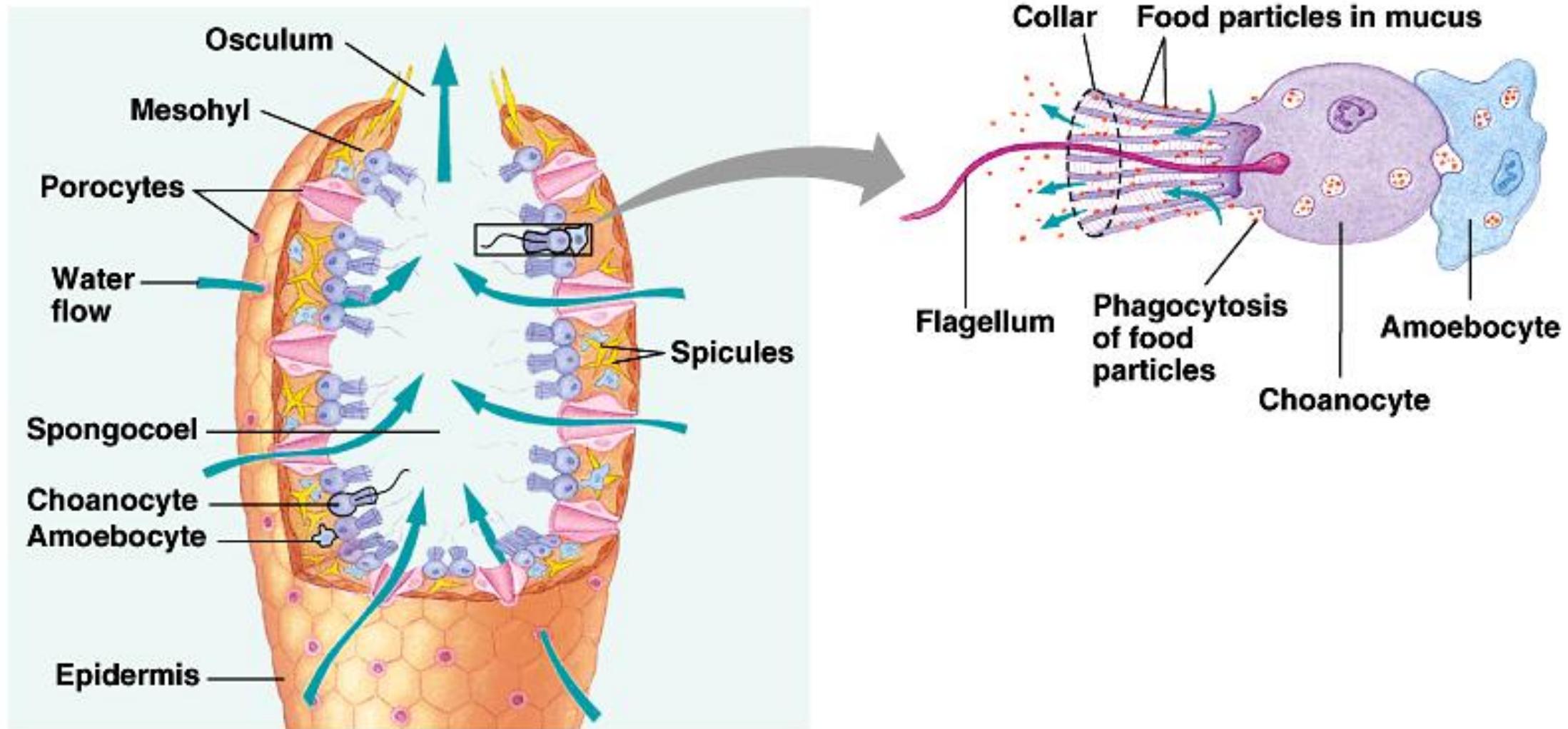


The Evolution of Animals

Animal diversity: Porifera

- Sponges
- Lack true tissues
- Simple body plan
- Hermaphroditic (individual produces eggs & sperms)
- Mature sponges are sessile

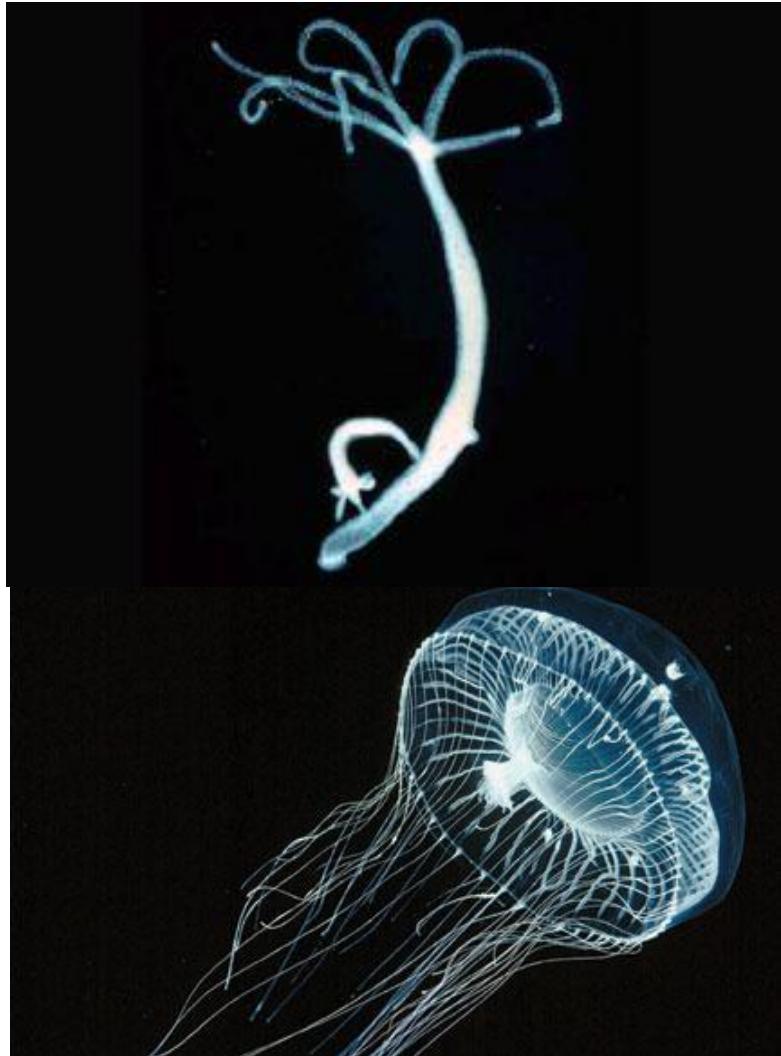




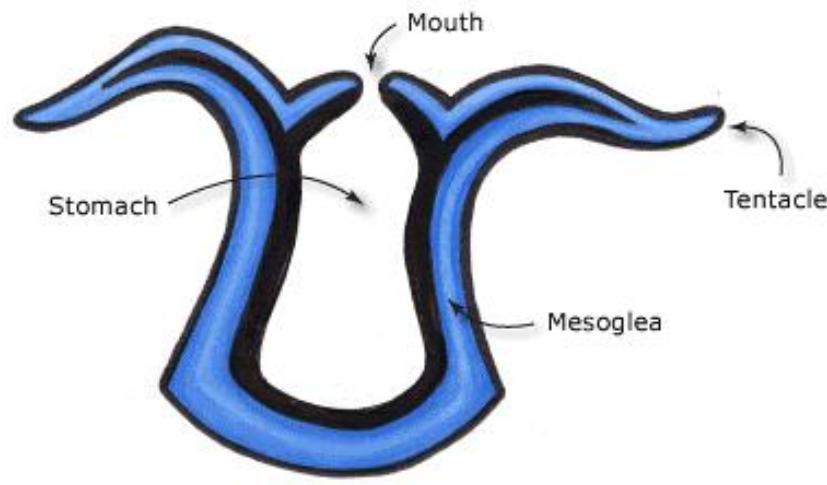
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Animal diversity - Cnidaria

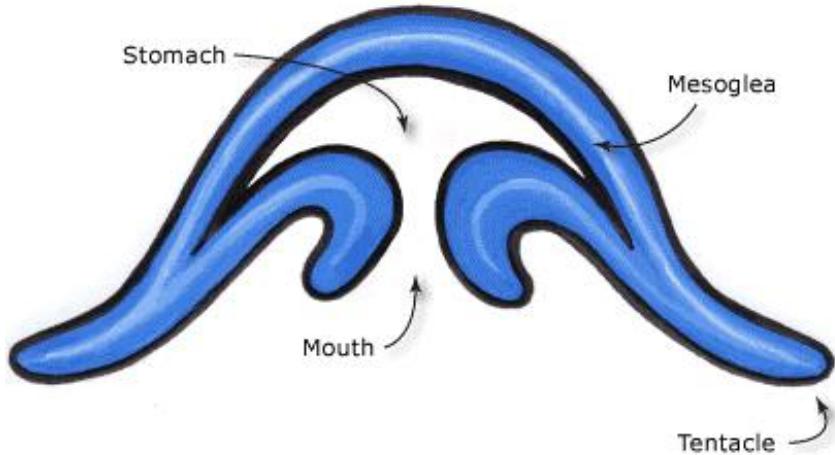
- Exist as polyp(s) or medusa(e)
[jellyfish]
- Simplest animal that show a division of labour among specialized tissues
- Have sting cells (cnidocytes), each armed with a nematocyst
- Radially symmetry



Polyp



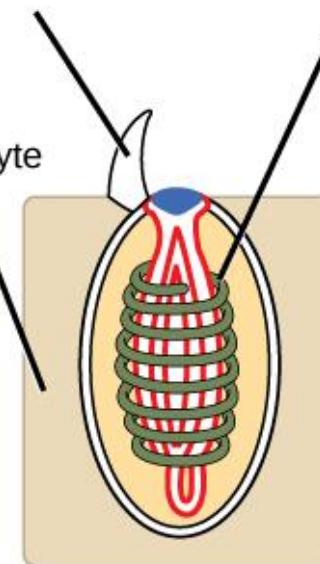
Medusa



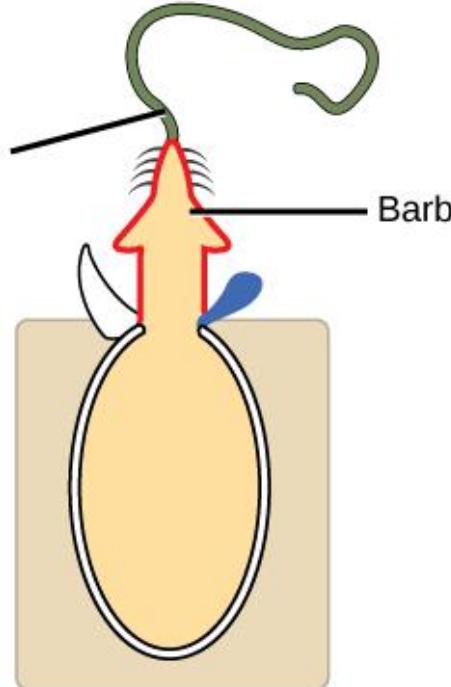
Touch-sensitive hairlike projection

Cnidocyte

(a) Nematocyst with stored thread and barb

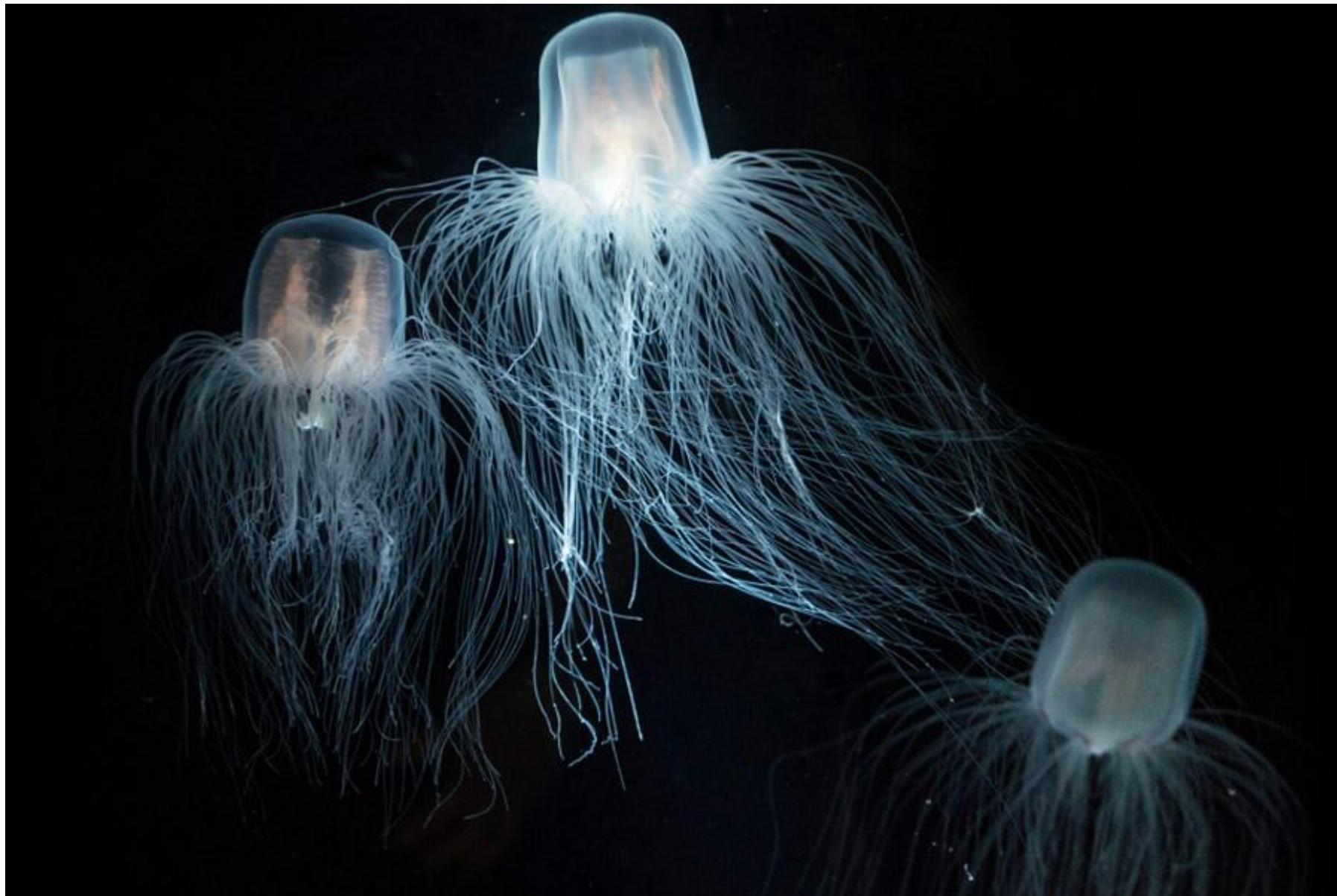


Thread



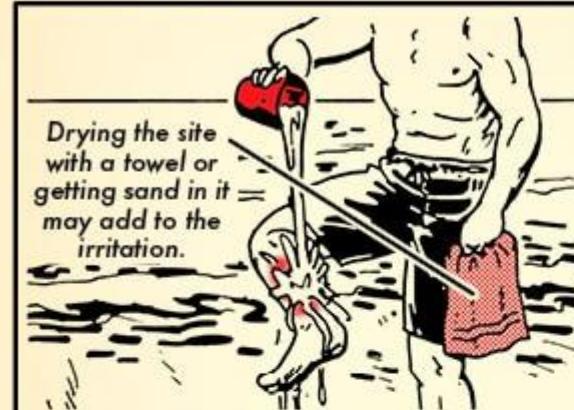
(b) Nematocyst after firing

Chironex fleckeri (Sea Wasp)

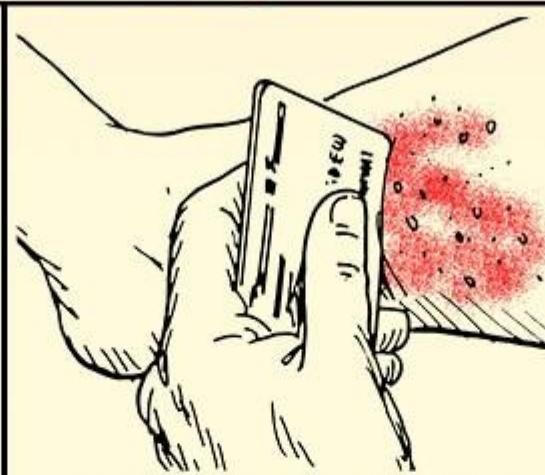


How to Treat a Jellyfish Sting

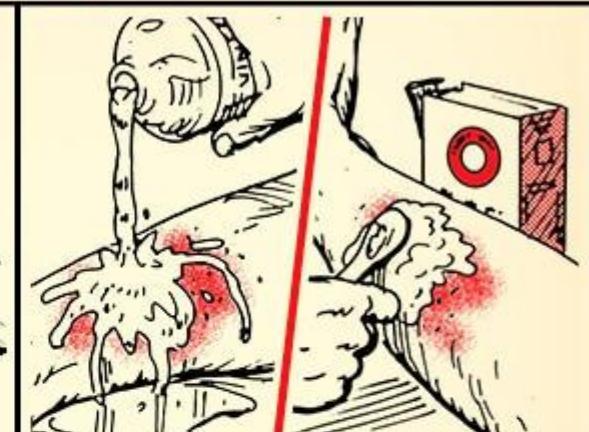
The Art of
MANLINESS
EST. 2006



1. Rinse the affected area with seawater to help get rid of loose stingers. Avoid freshwater which may irritate the wound by activating additional nematocysts.



2. Carefully scrape remaining stingers out of your skin using an ID or credit card.



3. Apply plain vinegar to the site or a paste of baking soda and seawater which may deactivate nematocysts and reduce the reaction.



4. Rinse the area under hot water not to exceed 113 degrees F or apply ice packs. Choose the method that seems to offer you the most relief.



5. Apply calamine lotion and take a pain reliever or anti-inflammatory medication to help reduce swelling and irritation.

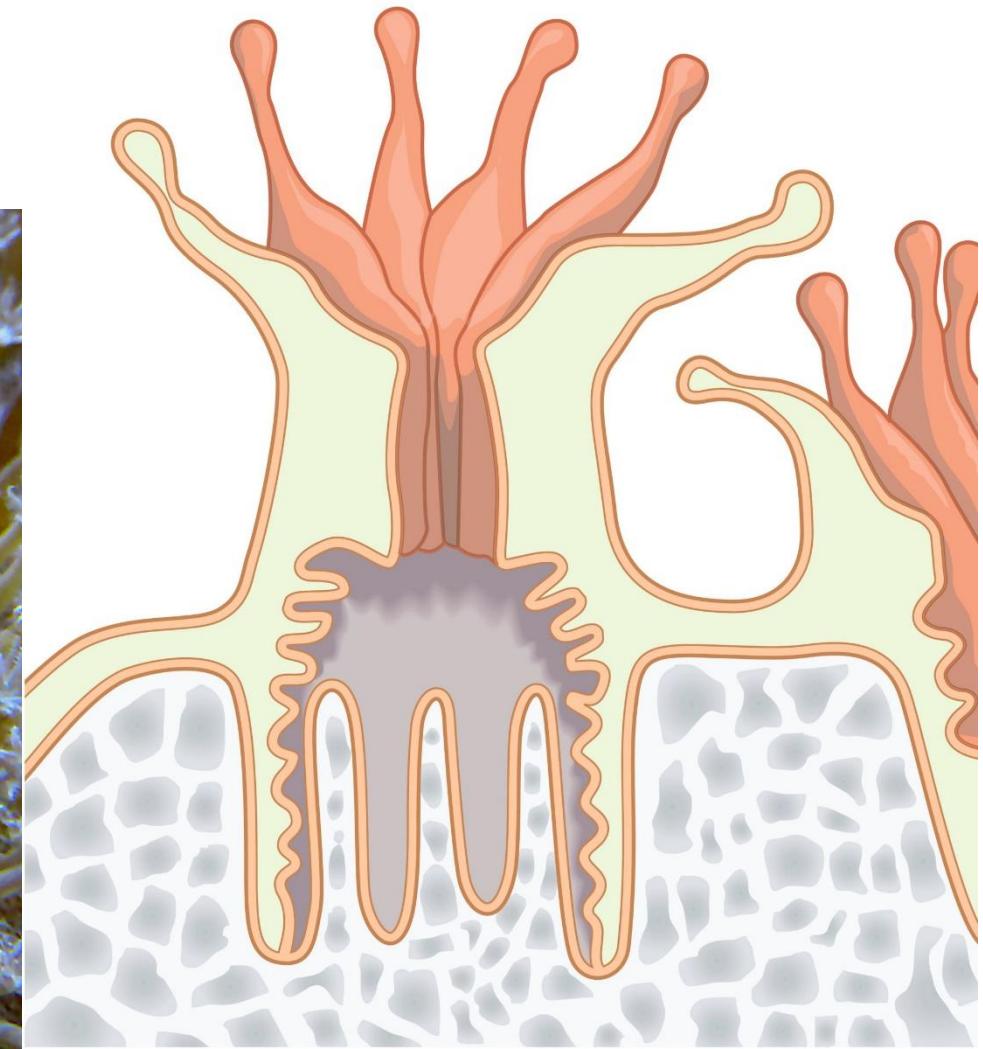


6. Rest and monitor the site. See a doctor if a rash develops or you start to have difficulty breathing.

A coral colony



A coral polyp



Animal diversity - Annelida

- Segmented worms
- All annelids except leeches have chitin-made bristles (setae)
- Three groups: oligochaetes (few setae); polychaetes (many setae); leeches (no setae)



Oligochaete



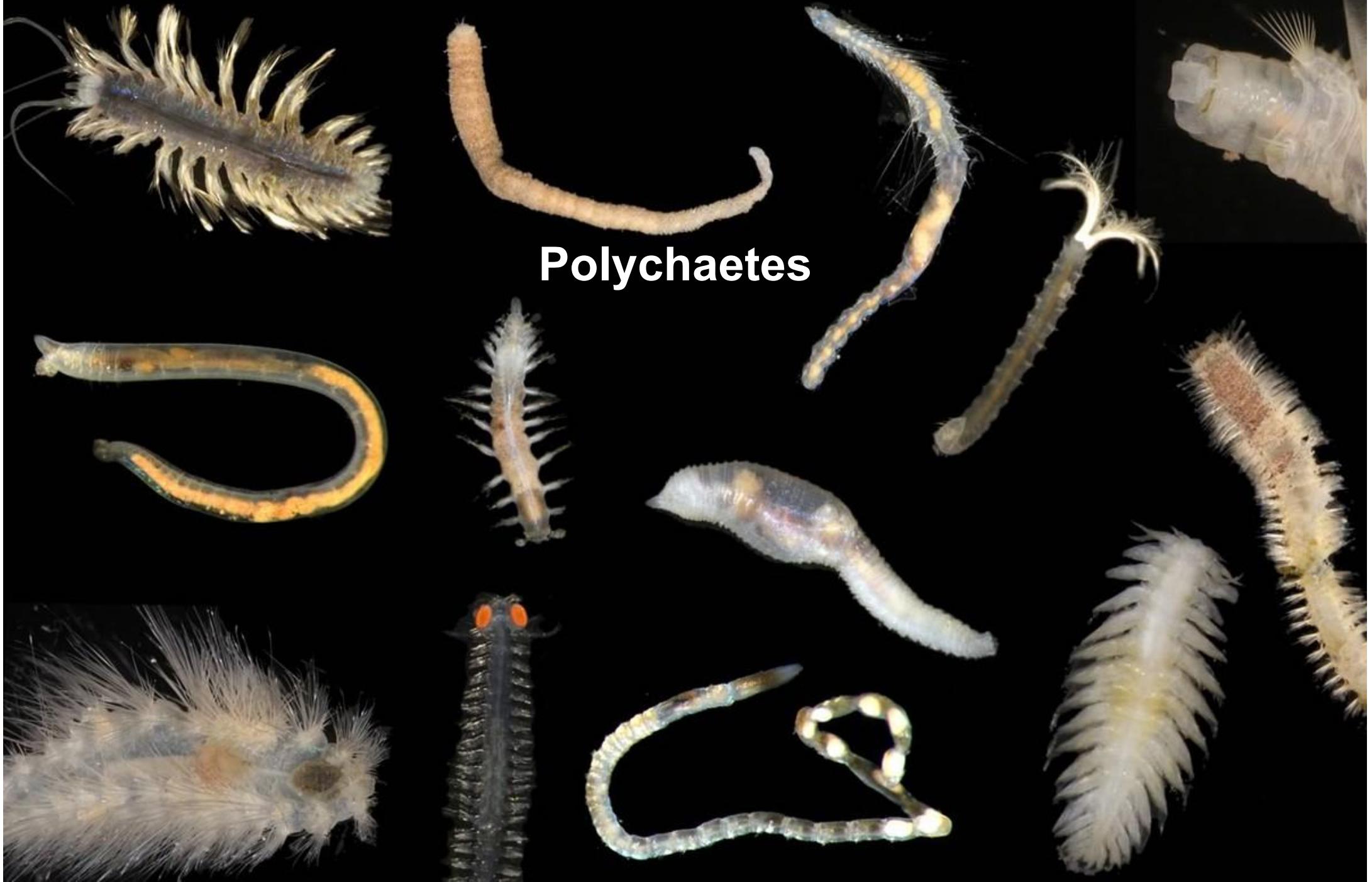


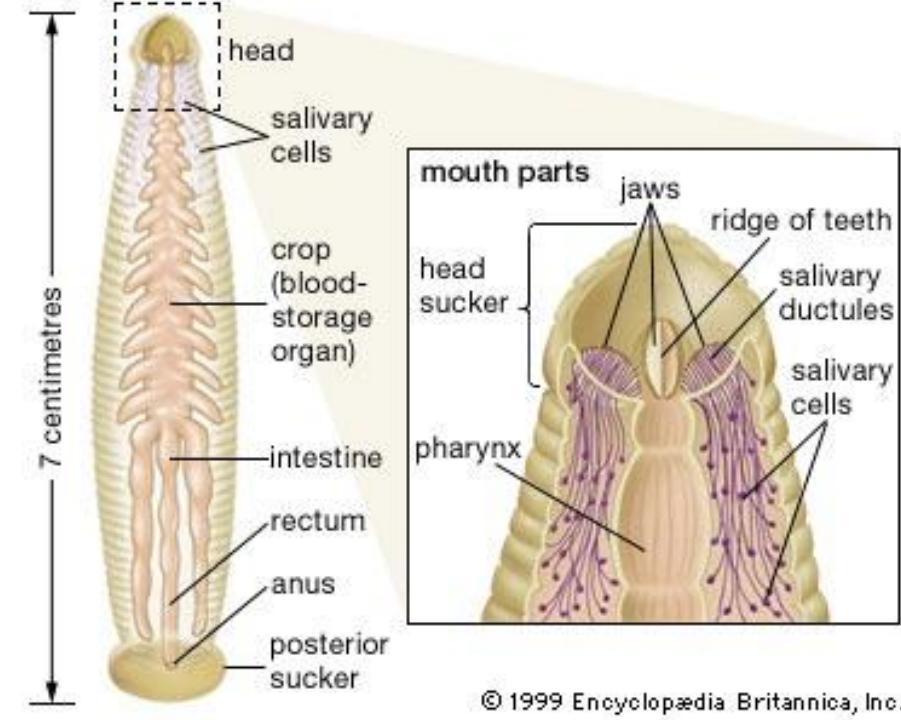
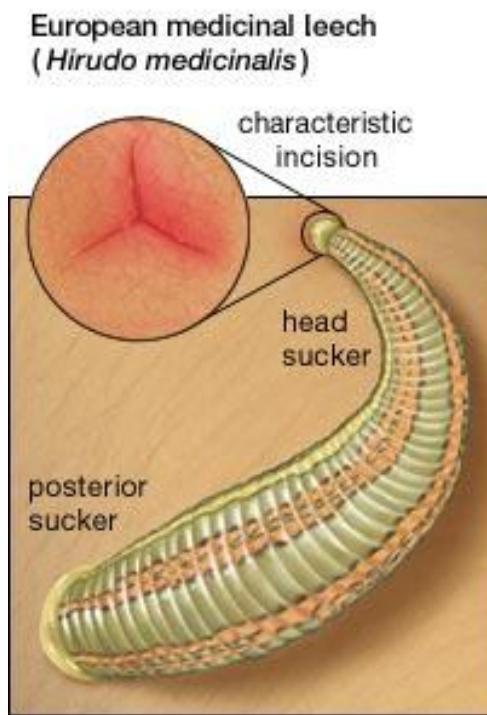
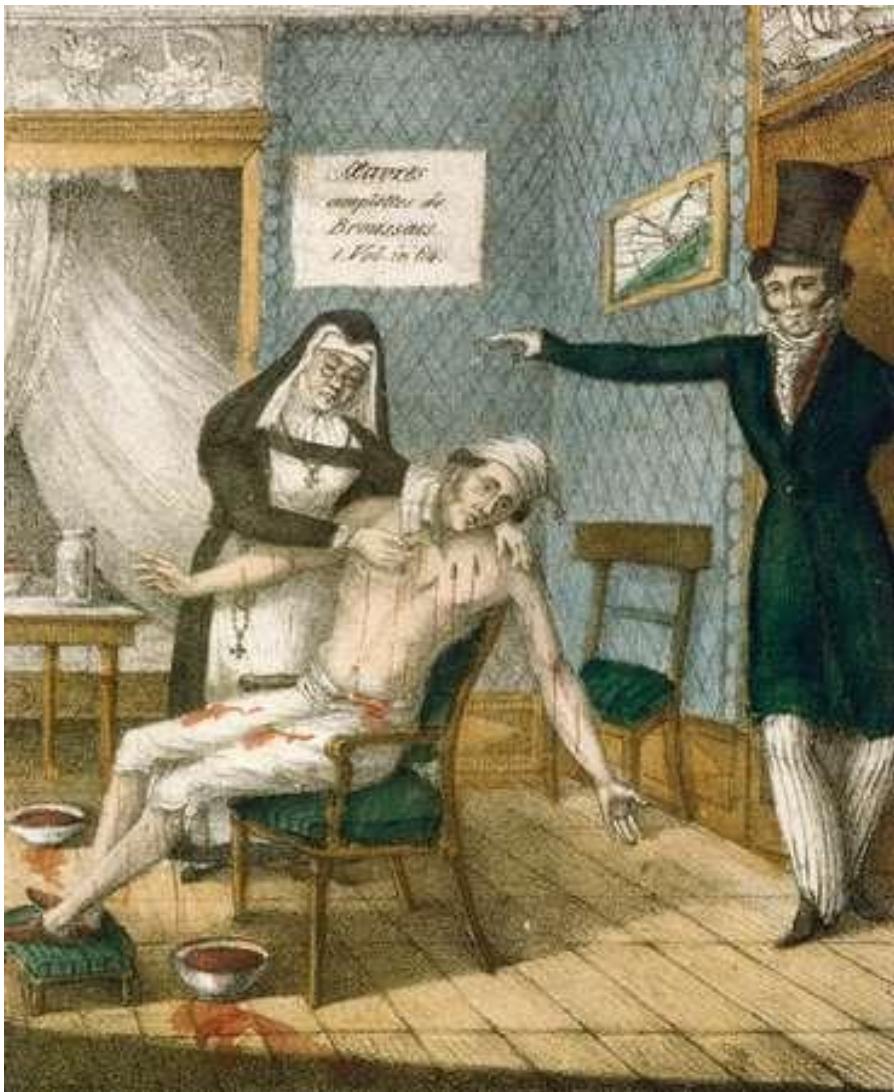
VERMICOMPOST

Vermicomposting is fun



Polychaetes



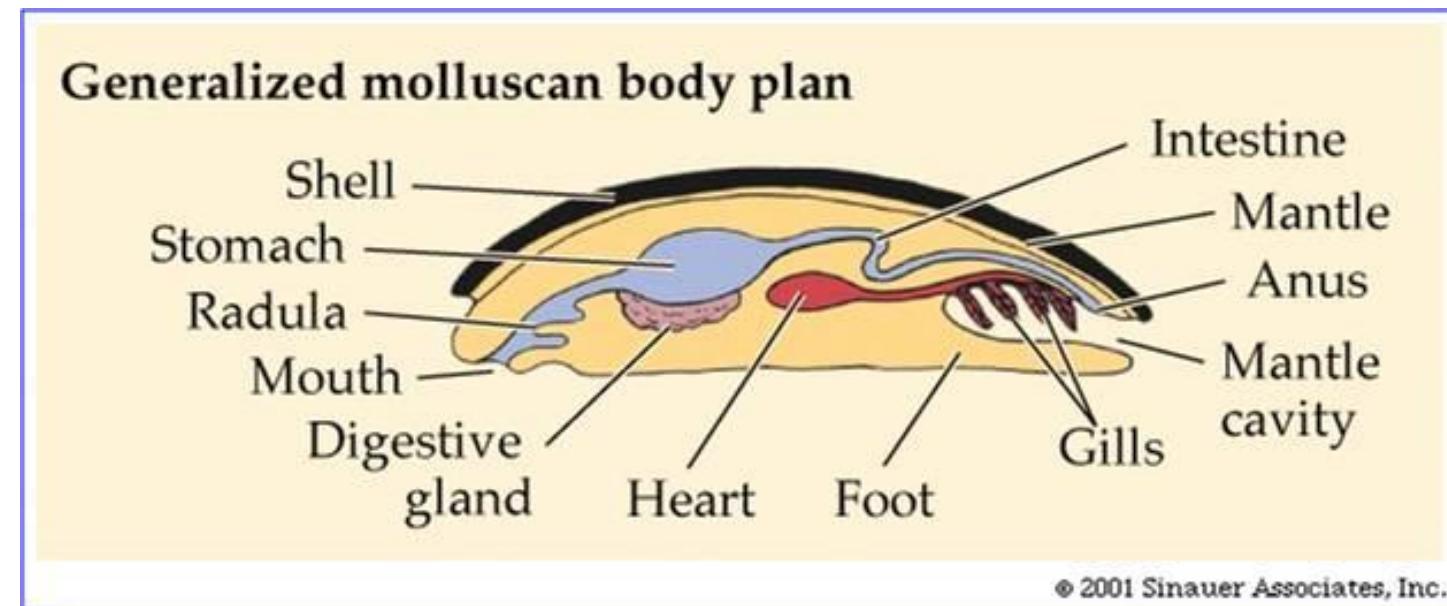


[https://www.popsci.com/so-you've-been-bitten-by-leech-whats-worst-that-could-happen/](https://www.popsci.com/so-youve-been-bitten-by-leech-whats-worst-that-could-happen/)

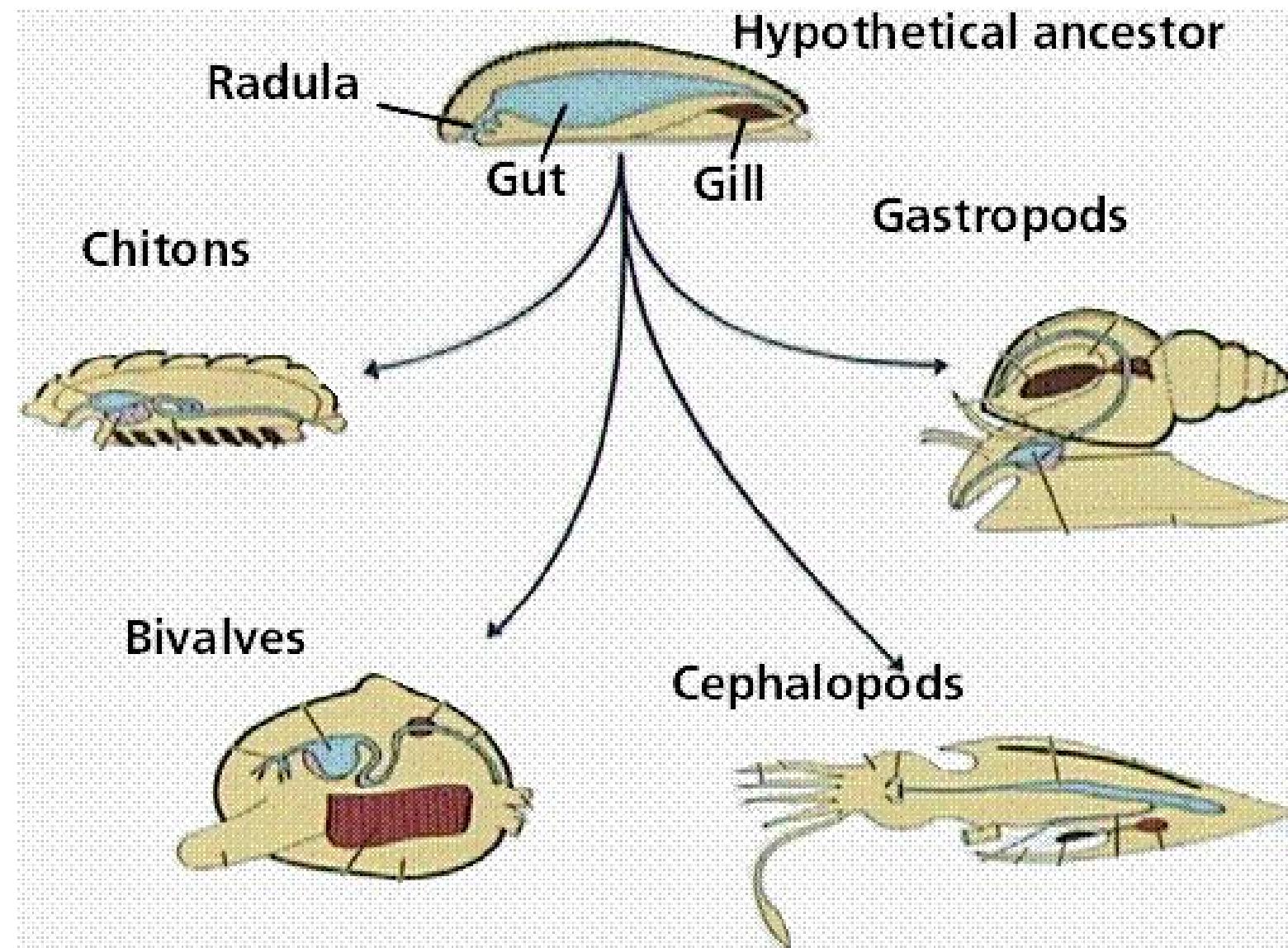
© 1999 Encyclopædia Britannica, Inc.

Animal diversity - Mollusca

- Body divided into visceral mass, foot and head
- Many molluscs are covered by a shell made of calcium carbonate



Molluscan body plan





Chiton



Snail (Gastropod)



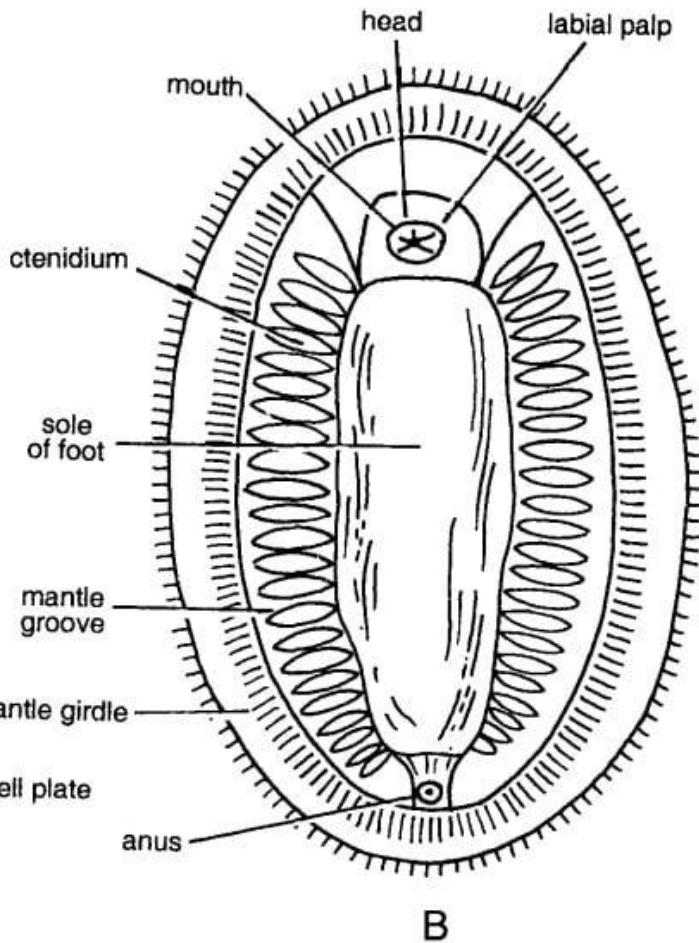
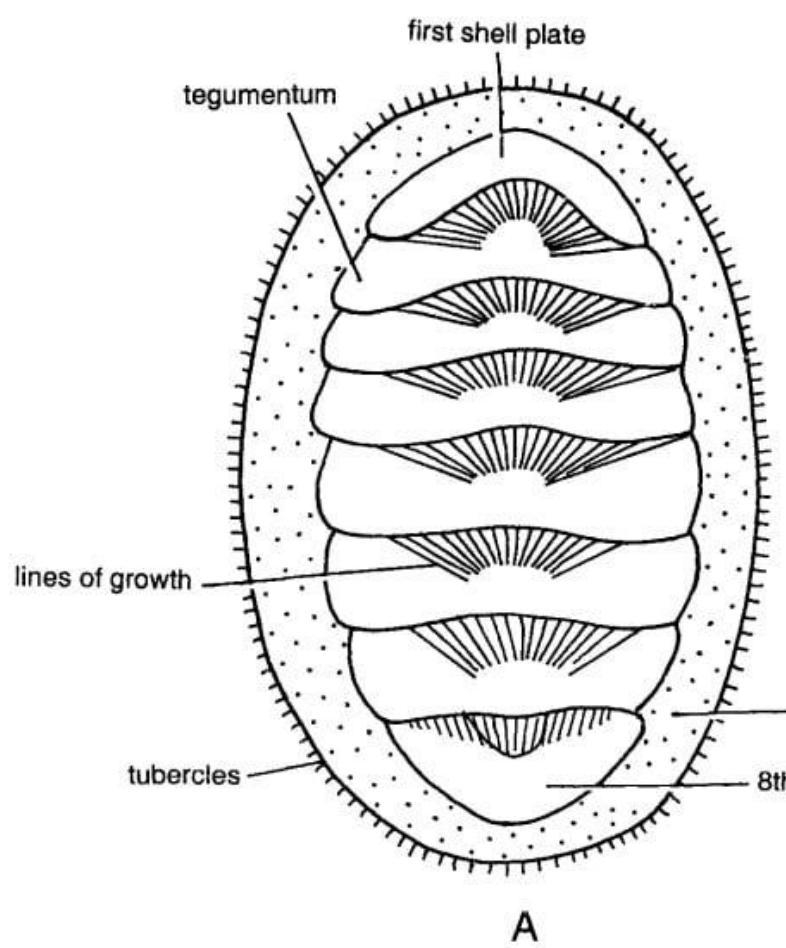
Clam (Bivalves)



Cuttlefish
(Cephalopod)



Octopus (Cephalopod)



Chiton. A. Dorsal view, B. Ventral view.





Deadly Cone Snails

<https://www.youtube.com/watch?v=ajlRZ6TGD2Y>



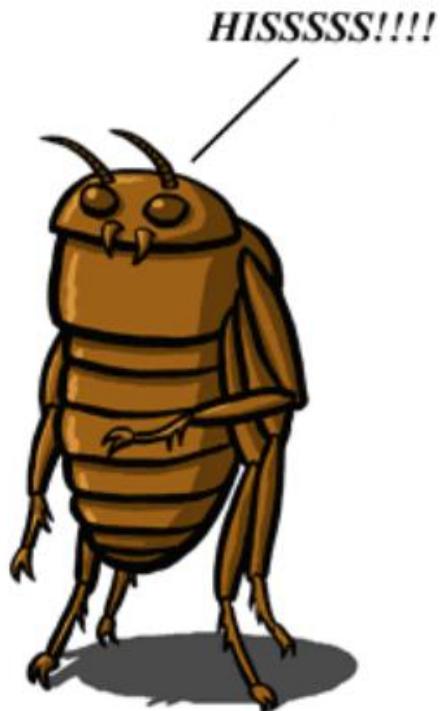
[YouTube: Octopus Opens Jar](#)

Animal diversity - Arthropods

- Segmented animals with a hard exoskeleton & jointed appendages
- Arachnids – spider, scorpion, mite, tick
- Centipedes
- Insects – ant, moth, butterfly, etc
- Crustaceans - shrimp and crab

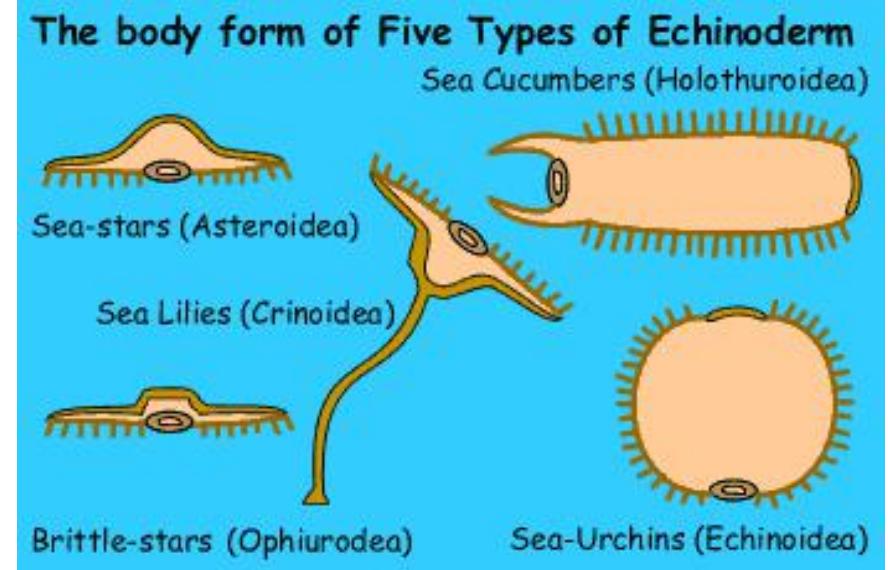
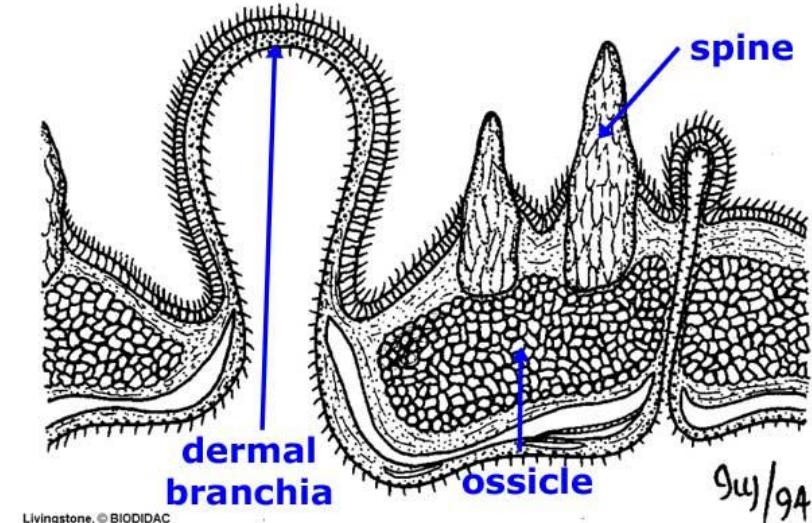


Nice armor, friend.



Animal diversity - Echinoderms

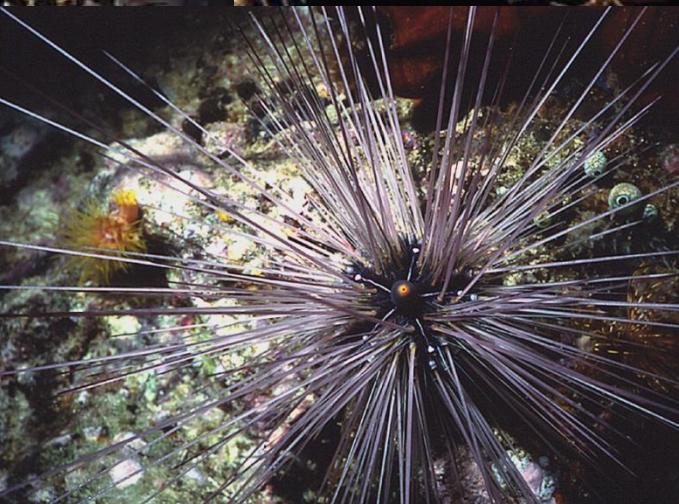
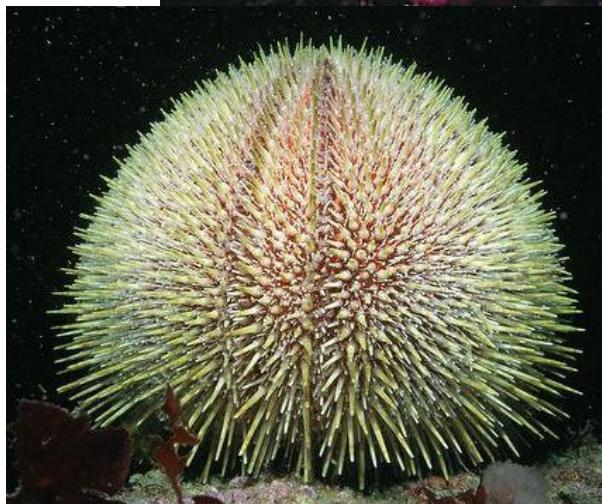
- “Spiny skin” animals
- Have internal skeleton with calcium ossicles, in which spines project from them
- Many have an oral and aboral surface
- Slow moving or sessile on sea bottom



Sea star (echinoderm, asteroid)



Brittle star (echinoderm, ophiuroid)

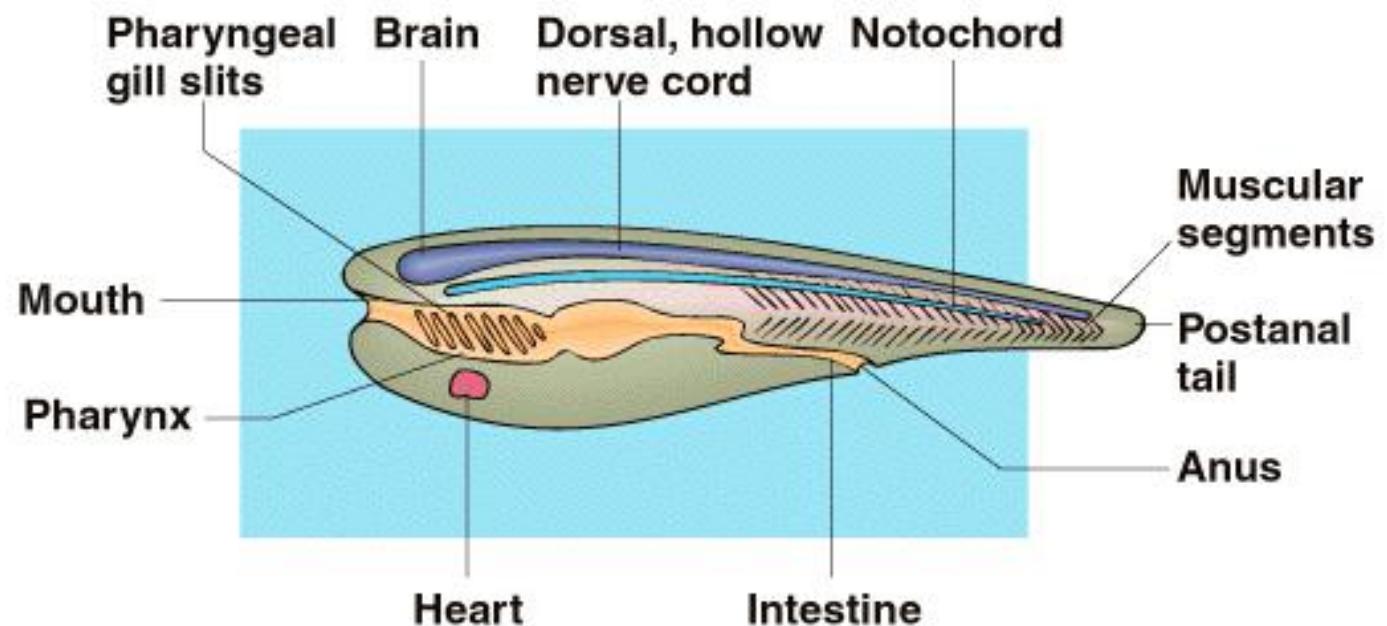


Sea urchin (echinoderm, echinoid)

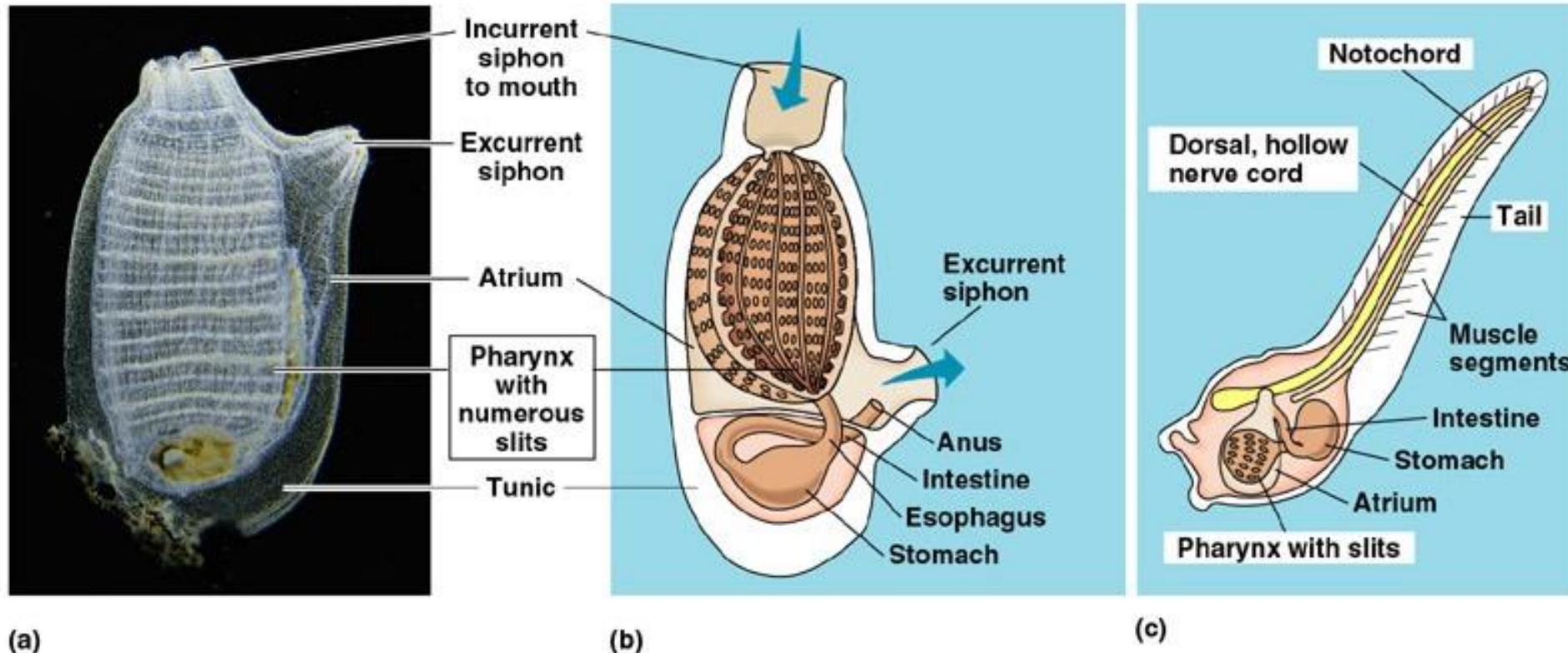
Sea cucumber
(echinoderm, holothuroid)

Animal diversity - Chordates

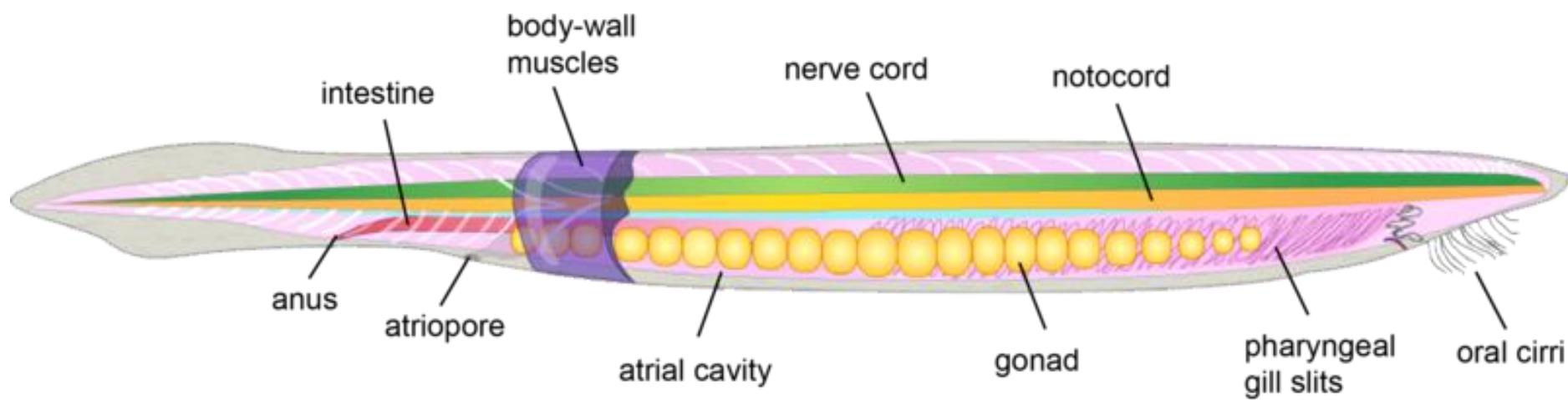
- Notochord
- Segmental body wall & tail muscles
- Dorsal hollow nerve cord
- Perforated pharynx

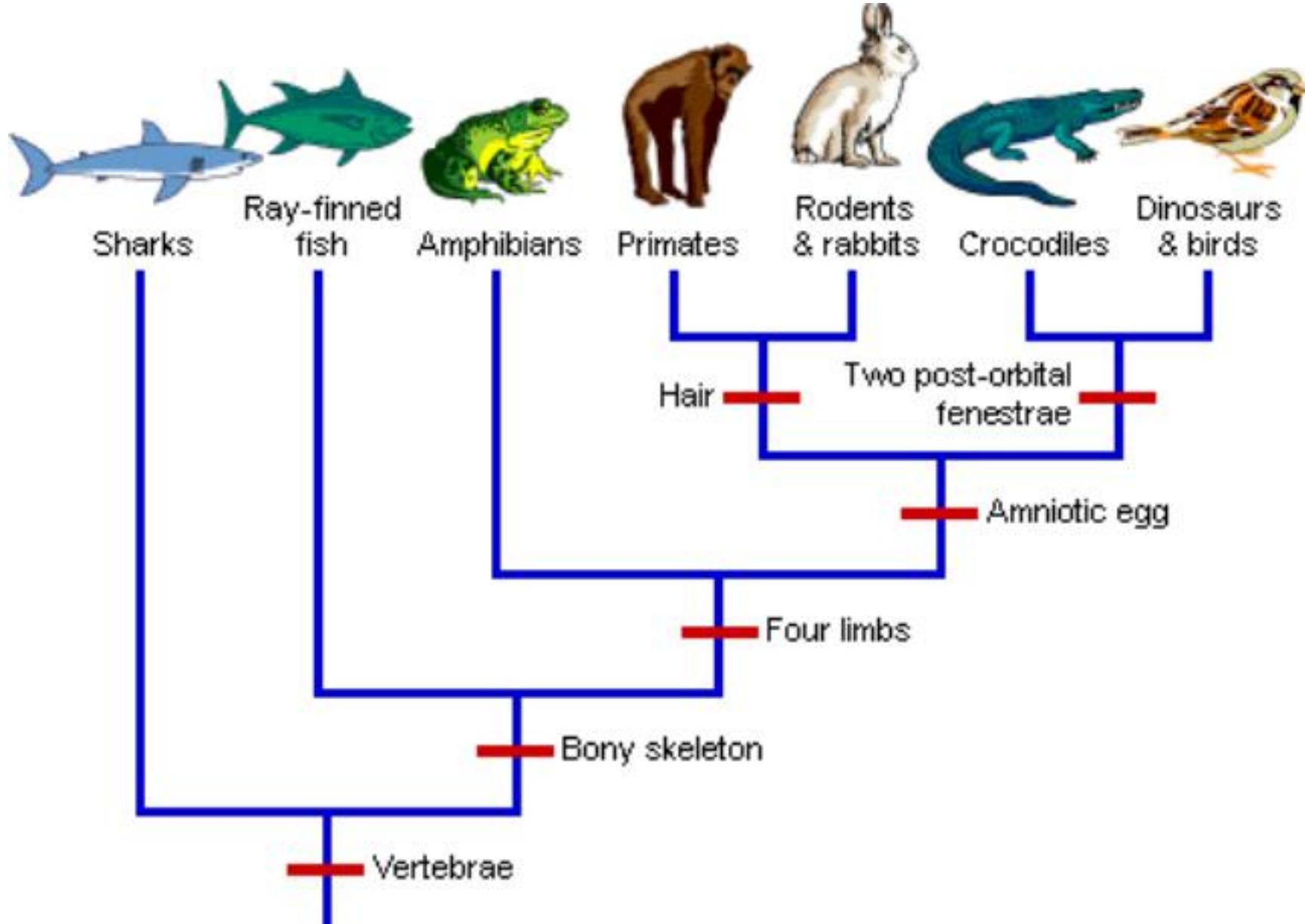


Urochordates (tunicates, water squirts)



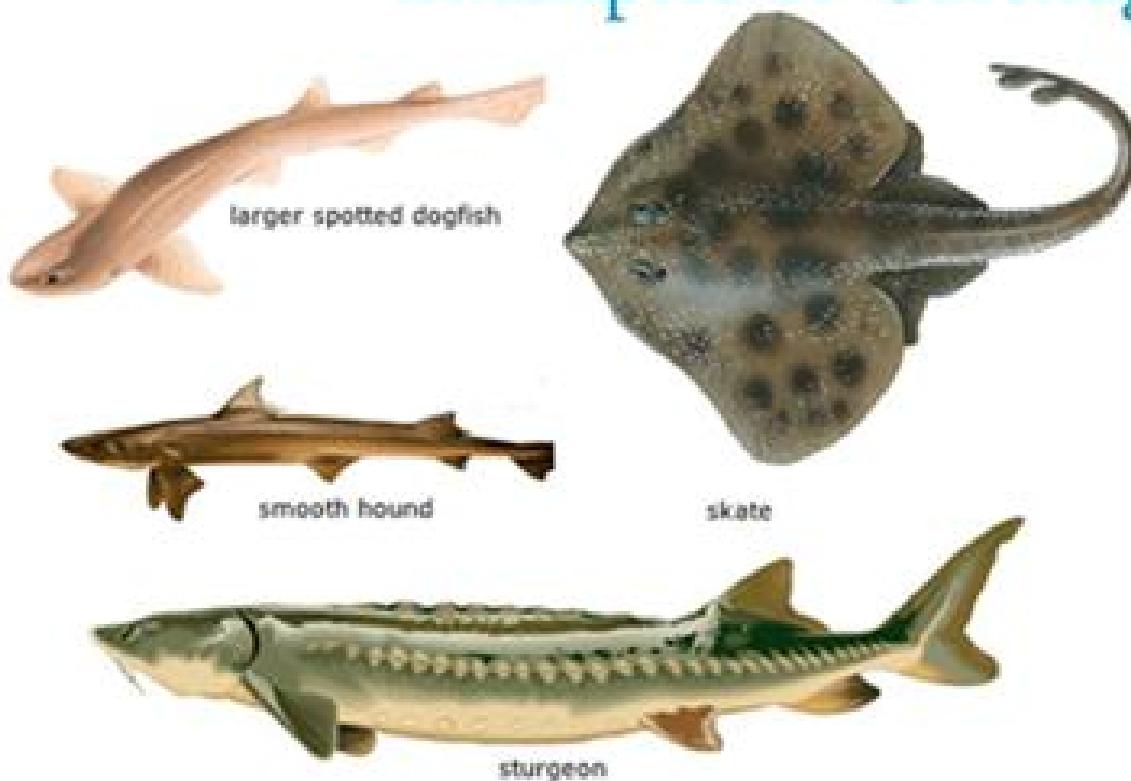
Cephalochordates (Lancelets)





Animal diversity - Fishes

Examples of Cartilaginous and Bony Fishes



Cartilaginous Fishes



Bony Fishes

Cartilaginous vs. Bony Fishes

	Cartilaginous	Bony
Scales	placoid	cycloid, ctenoid
Mouth	ventral	terminal
Tail lobes	unequal (heterocercal)	equal (homocercal)
Gills	5-7 pairs, slits	4 pairs, covers
Position in water	fins, lower density (cartilage and oily liver)	swim bladder
Osmoregulation	urea (equal solutes), rectal gland	less solutes, gill excretion
Sensory	ampullae of Lorenzini, lateral line	lateral line
Reproduction (fertilization, development, strategy)	internal, variety, fewer offspring	external, mostly ovipary more offspring

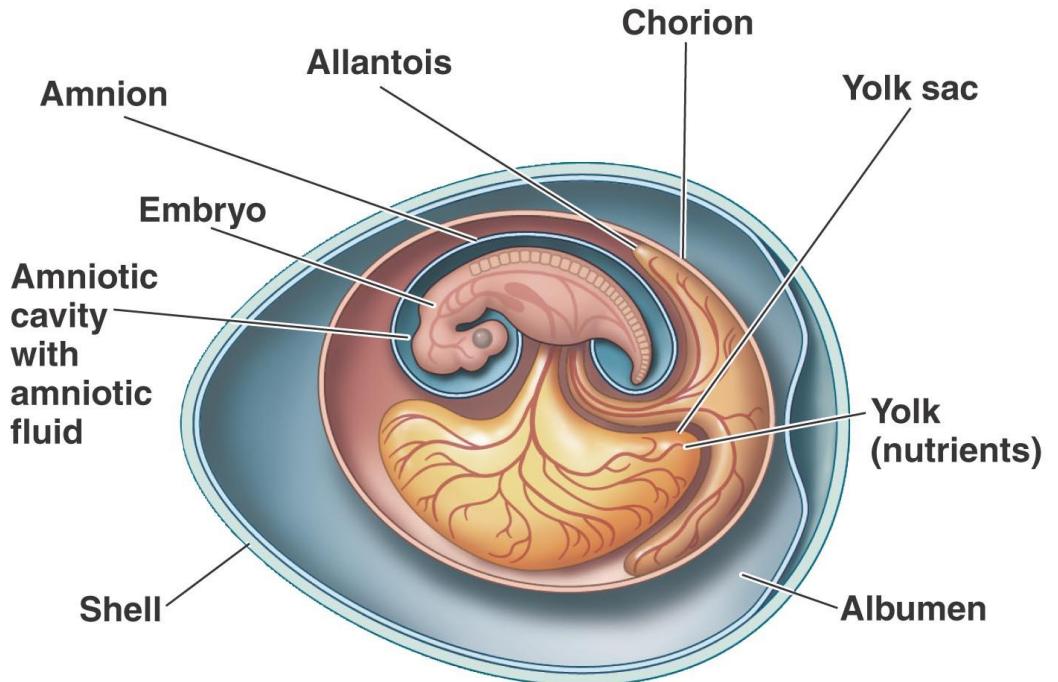
Animal diversity – Amphibians

- Vertebrates
- Transition from water to land
- With thin, scaleless skin, well supplied with blood vessels for gas exchange
- Adults of some species have saclike lungs
- Larval stage in water and adult stage in both water and land



Animal diversity – Reptiles

- Vertebrates
- Tetrapods
- Develop amniote eggs
- Have scales/scutes
- Ectothermic (cold blooded)





Sea turtle



Land tortoise



Lizard



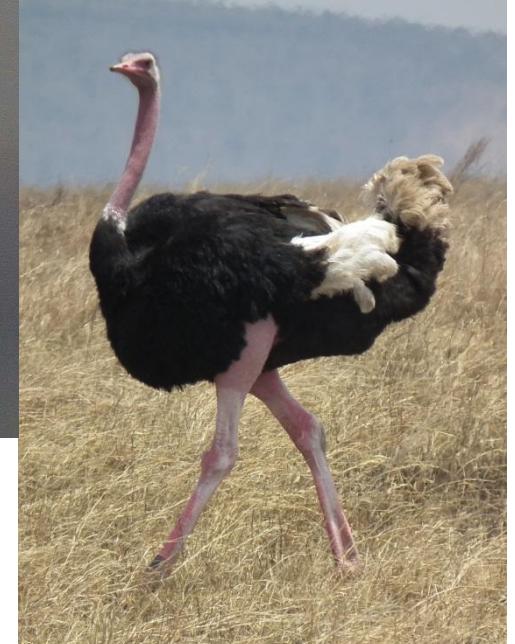
Snake



Crocodile

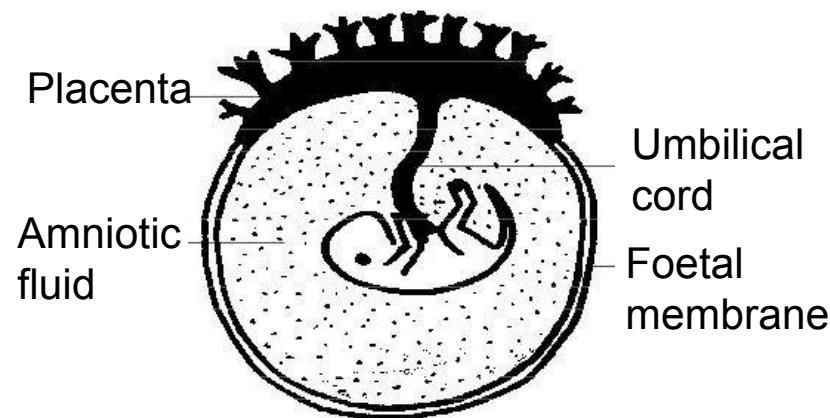
Animal diversity – Aves (Birds)

- Vertebrates
- Feathers
- Endothermic (warm blooded)
- Lay amniote eggs
- Wings; but not all birds can fly

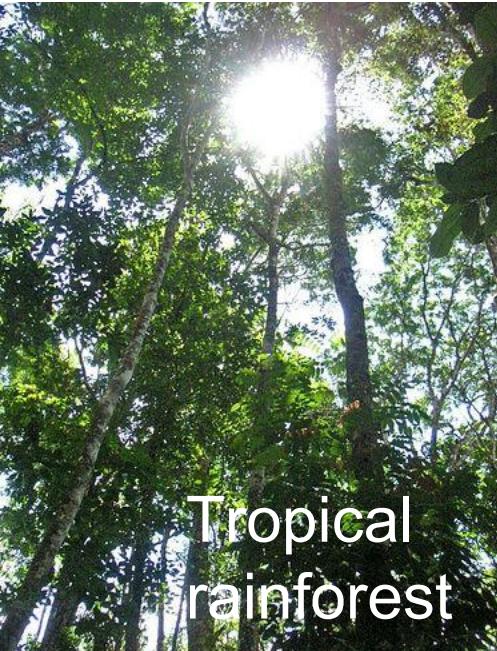


Animal diversity – Mammals

- With hair
- Produce milk
- With placenta
- With lung
- Endothermic



Ecosystem diversity: Terrestrial



Tropical
rainforest



Boreal forest



Woodland/
Shrubland



Grassland

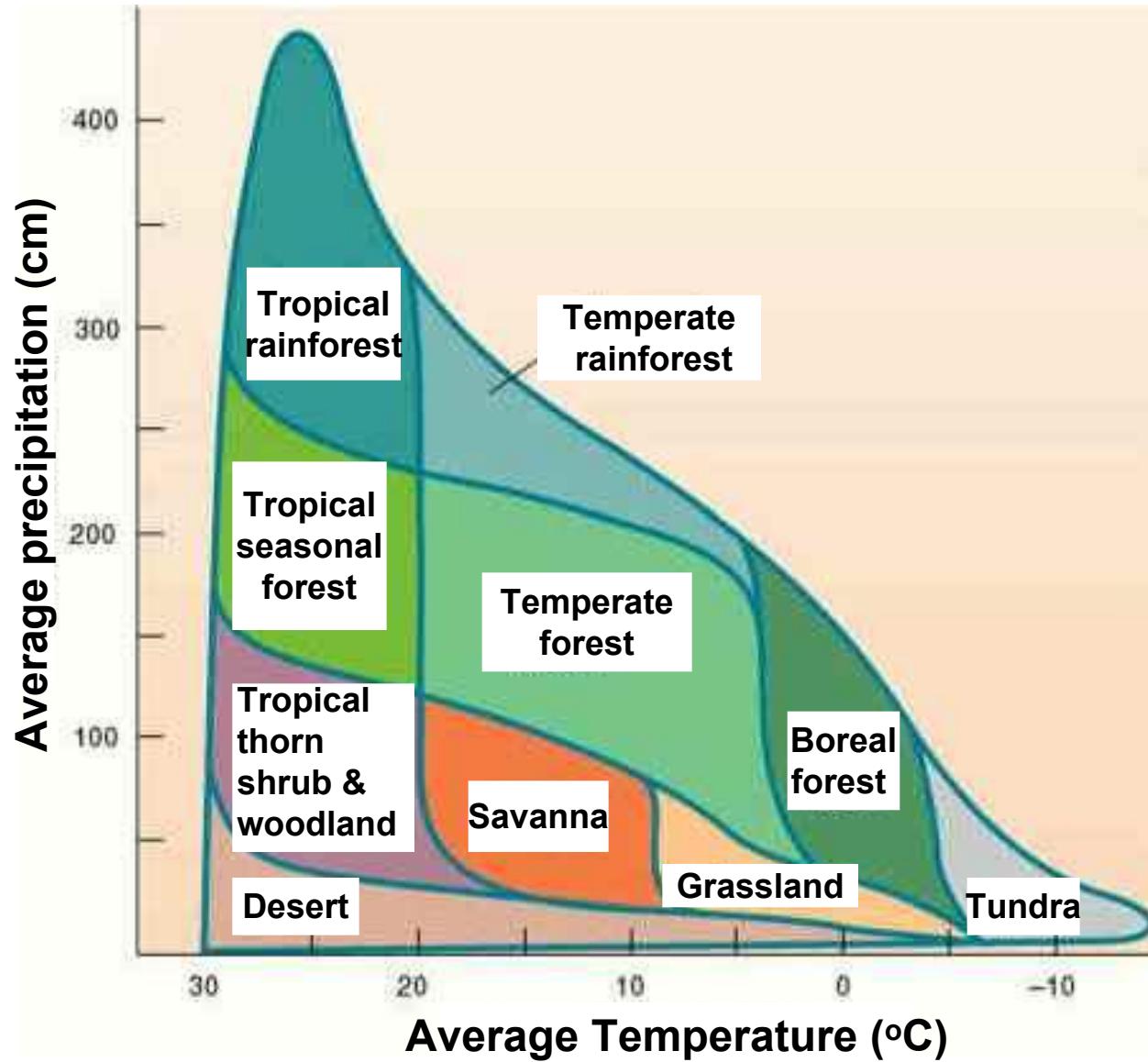


Desert



Tundra

Environmental factors controlling distribution of terrestrial ecosystems



Savanna =
thorny plants



Ecosystem diversity: Aquatic



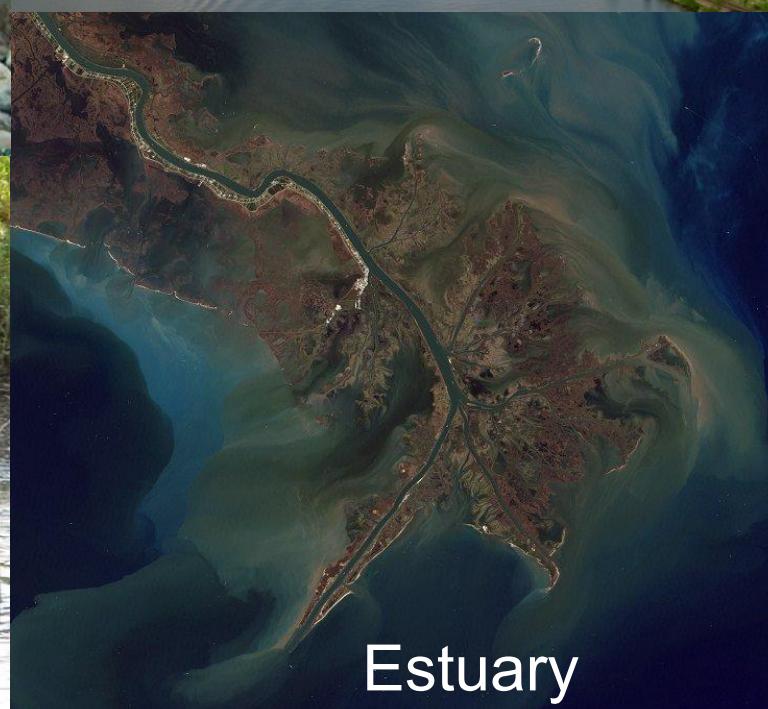
Lake



River



Wetland

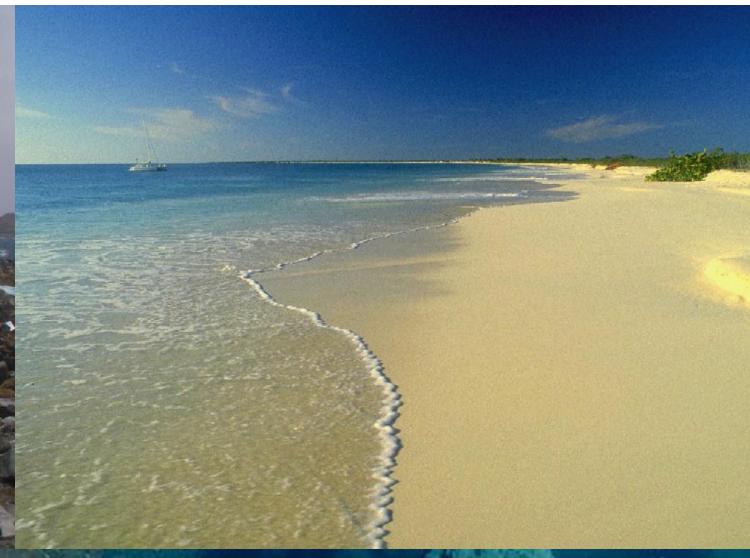


Estuary

Ocean: Intertidal
(Rocky shore)



Ocean: Intertidal
(Sandy shore)



Ocean: Coral reef



Ocean: Deep sea

Environmental factors controlling distribution of aquatic ecosystems

- Light (solar energy)
- Temperature
- Salinity
- Depth/Pressure
- Water movement (current)
- Wind, Wave, Tide



Why there is biodiversity on Earth

- A result of evolution
- Fit for survival:
 - Adapt to different habitats
 - Avoid competitions
 - Maintain reproductive successes
 - Prevent extinctions

Significance of biodiversity

- Plant diversity offers possibilities for developing new crops; vital to future food supply
- Loss of ecosystem diversity
 - loss of ecosystem functions/ services (e.g., water purification, carbon dioxide fixation)

Significance of biodiversity

- Loss of ecosystem diversity
 - loss of species diversity
 - loss of opportunities/discoveries of new, useful materials for humans (e.g., medicinal drugs, chemical compounds)

Significance of biodiversity

- Loss of ecosystem diversity
 - loss of species diversity
 - loss of genetic diversity
 - loss of potential resistance to diseases, adverse weather → affect food supply

Major threats to biodiversity

- Habitat loss
- Invasive species
- Pollution
- Population increase
- Over-harvesting



Summary

- Biodiversity = Diversity of species; exists at different scales: forms and sizes
- Biodiversity = Result of evolution and adaptations for survival of species
- Loss of biodiversity will affect ecosystem functions/services, cause extinction of species, and limit development of future (human) food supply and other uses