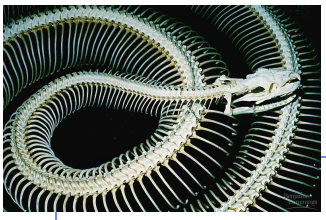
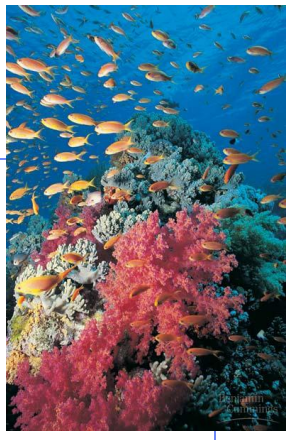
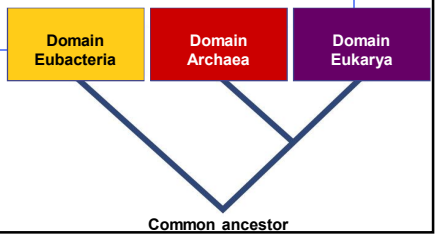




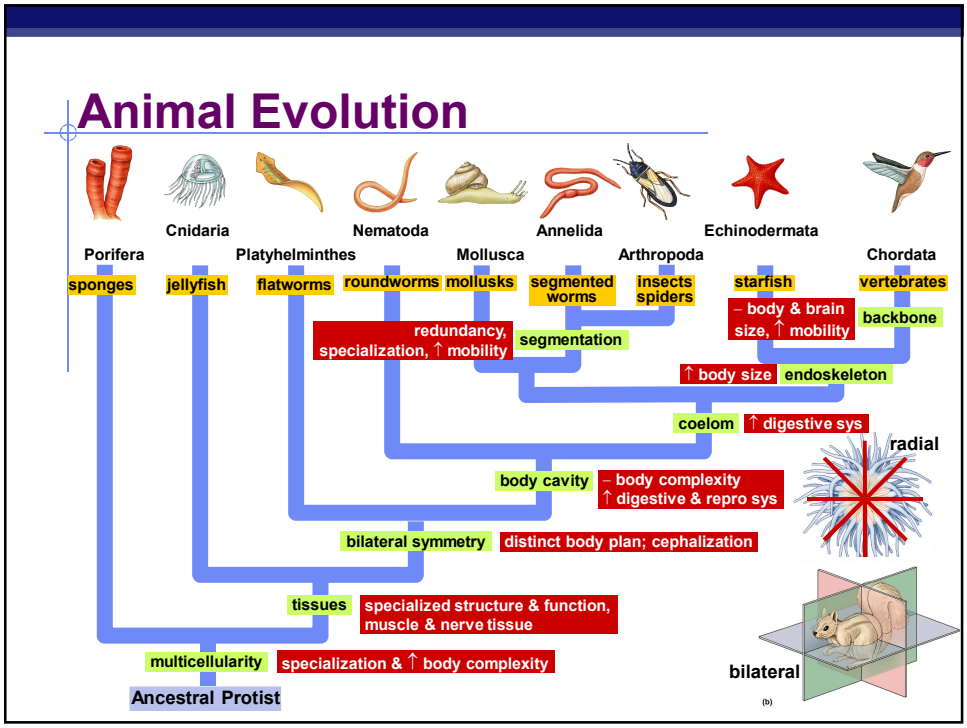
## Kingdom: Animals

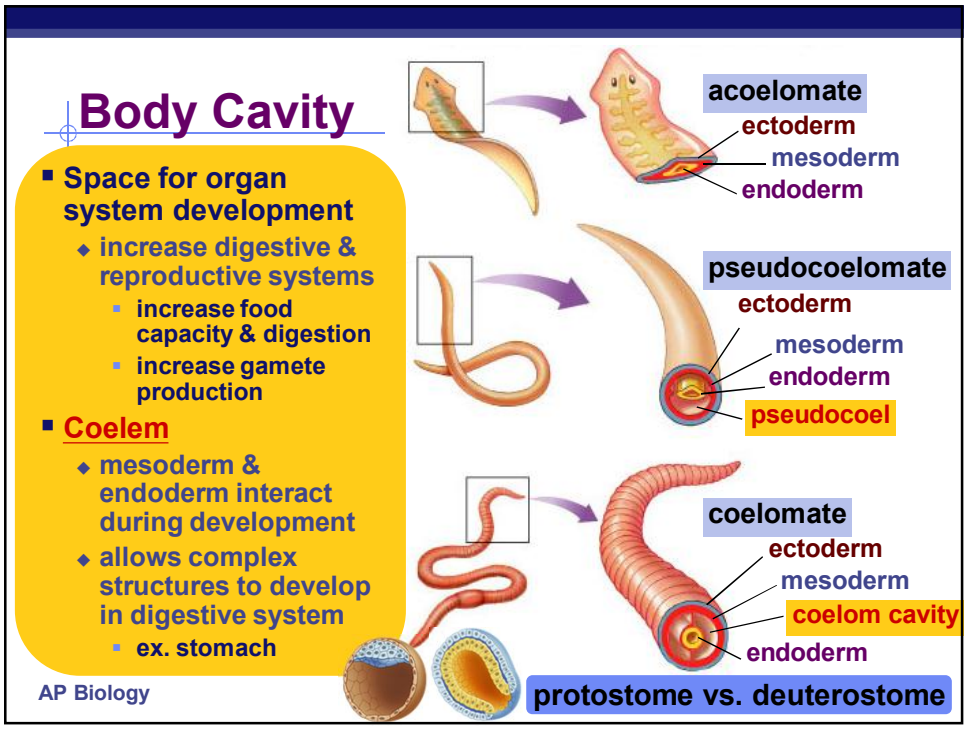
### Domain Eukarya




## Animal Characteristics

- **Heterotrophs**
  - must ingest others for nutrients
- **Multicellular**
  - complex bodies
- **No cell walls**
  - allows active movement
- **Sexual reproduction**
  - no alternation of generations
  - no haploid gametophyte

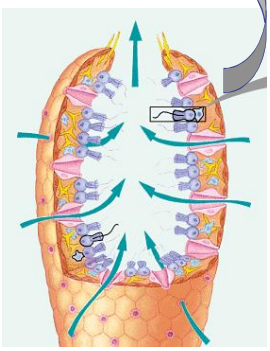

Animal Evolution
Cnidaria
Nematoda
Annelida
Echinodermata
Porifera
Platyhelminthes
Mollusca
Arthropoda
Chordata
sponges
jellyfish
flatworms
roundworms
mollusks
segmented worms
insects spiders
starfish
vertebrates
– body & brain size, ↑ mobility
backbone
redundancy, specialization, ↑ mobility
segmentation
↑ body size
endoskeleton
coelom
↑ digestive sys
radial
body cavity
– body complexity ↑ digestive & repro sys
bilateral symmetry
distinct body plan; cephalization
tissues
specialized structure & function, muscle & nerve tissue
multicellularity
specialization & ↑ body complexity
Ancestral Protist
bilateral
(b)


Body Cavity
Space for organ system development
increase digestive & reproductive systems
increase food capacity & digestion
increase gamete production
Coelem
mesoderm & endoderm interact during development
allows complex structures to develop in digestive system
ex. stomach
acoelomate
ectoderm
mesoderm
endoderm
pseudocoelomate
ectoderm
mesoderm
endoderm
pseudocoel
coelomate
ectoderm
mesoderm
coelom cavity
endoderm
protostome vs. deuterostome
AP Biology

## Invertebrate: Porifera

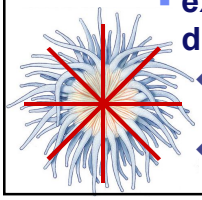
- Sponges
  - no distinct tissues or organs
    - do have specialized cells
  - no symmetry
  - sessile (as adults)

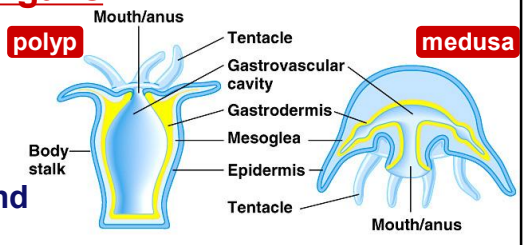
food taken into each cell by endocytosis



## Invertebrate: Cnidaria

- Jellyfish, hydra, sea anemone, coral
  - tissues, but no organs
  - two cell layers
  - radial symmetry
  - predators
    - tentacles surround gut opening
    - extracellular digestion
      - release enzymes into gut cavity
      - absorption by cells lining gut

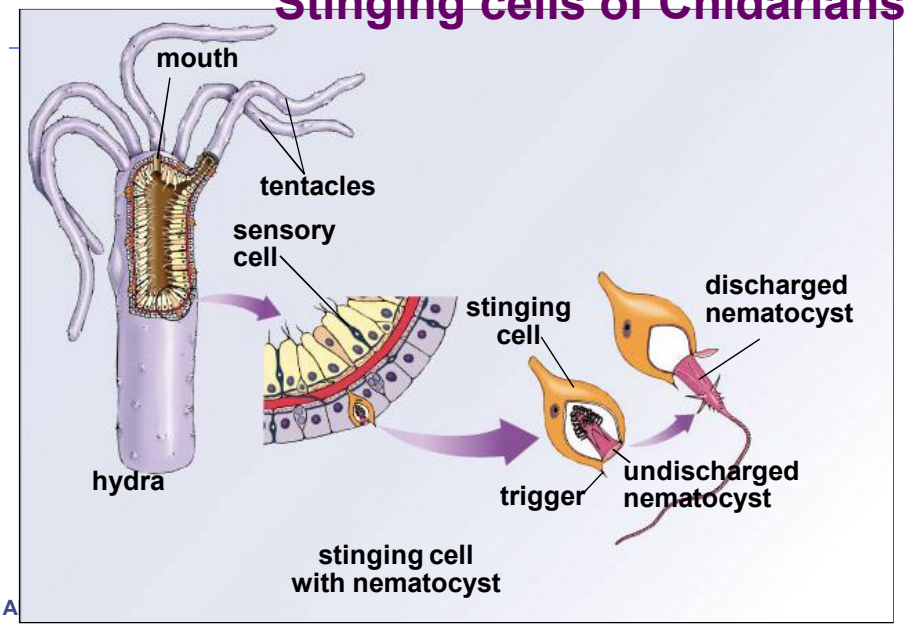




(a) Sea anemone: a polyp

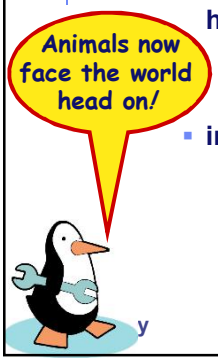
(b) Jelly: a medusa

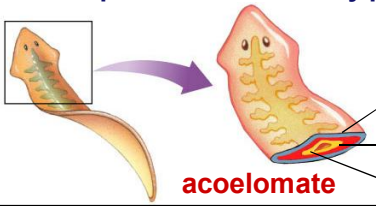
## Stinging cells of Cnidarians



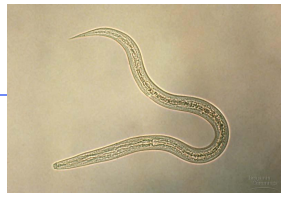

## Invertebrate: Platyhelminthes

- Flatworms
  - tapeworm, planaria
  - mostly parasitic
  - bilaterally symmetrical
    - have right & left & then have head (anterior) end & posterior end
      - cephalization = development of brain
      - concentration of sense organs in head
    - increase specialization in body plan



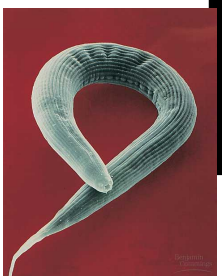



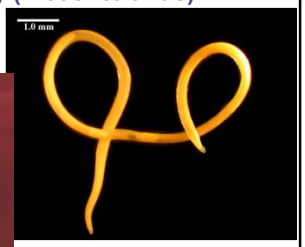
## Invertebrate: Nematoda



*C. elegans*

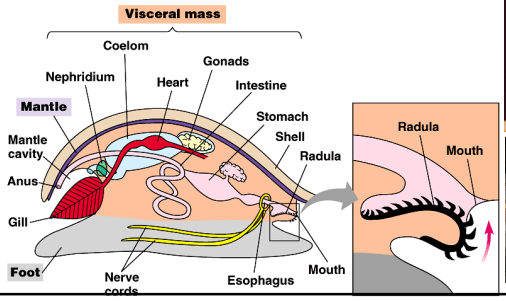
- Roundworms
  - bilaterally symmetrical
  - body cavity
    - pseudocoelom = simple body cavity
    - digestive system
      - tube running through length of body (mouth to anus)
  - many are parasitic
    - hookworm






## Invertebrate: Mollusca

- Mollusks
  - slugs, snails, clams, squid
  - bilaterally symmetrical (with exceptions)
  - soft bodies, mostly protected by hard shells
  - true coelem
    - increases complexity & specialization of internal organs



## Invertebrate: Annelida

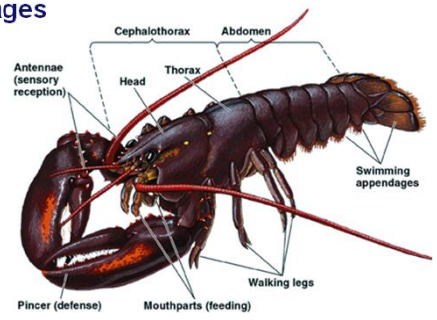
- Segmented worms
  - earthworms, leeches
  - segments
    - increase mobility
    - redundancy in body sections
  - bilaterally symmetrical
  - true coelem

fan worm

leech

## Invertebrate: Arthropoda

- Spiders, insects, crustaceans
  - most successful animal phylum
  - bilaterally symmetrical
  - segmented
    - specialized segments
    - allows jointed appendages
  - exoskeleton
    - chitin (carbohydrate) + protein



## Arthropod groups

**arachnids**
8 legs, 2 body parts
spiders, ticks, scorpions

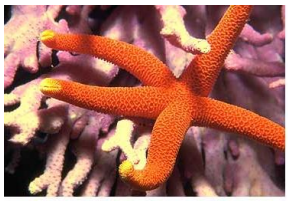
**crustaceans**
gills, 2 pairs antennae
crab, lobster, barnacles, shrimp

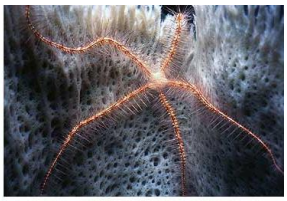
**insects**
6 legs, 3 body parts

## Invertebrate: Echinodermata

- Starfish, sea urchins, sea cucumber
  - radially symmetrical as adults
  - spiny endoskeleton
  - deuterostome

loss of bilateral symmetry?





## Invertebrate quick check…

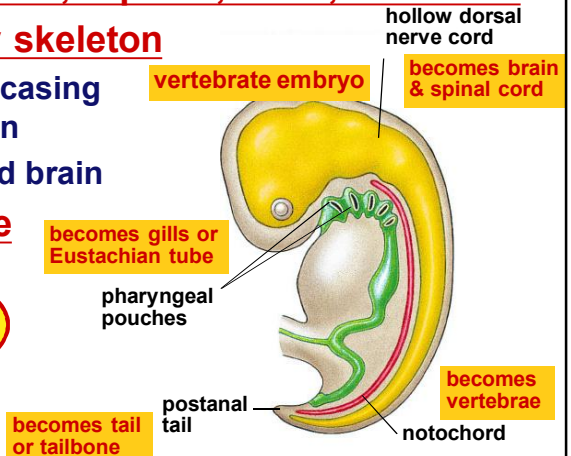
**Invertebrates:** Porifera, Cnidaria, Platyhelminthes, Nematoda, Annelida, Mollusca, Arthropoda, Echinodermata

- Which group includes snails, clams, and squid?
- Which group is the sponges?
- Which are the flatworms?
  - …segmented worms?
  - …roundworms?
- Which group has jointed appendages & an exoskeleton?
- Which two groups have radial symmetry?
- What is the adaptive advantage of bilateral symmetry?
- Which group has no symmetry?



## Chordata

- Vertebrates
  - fish, amphibians, reptiles, birds, mammals
  - internal bony skeleton
    - backbone encasing spinal column
    - skull-encased brain
  - deuterostome

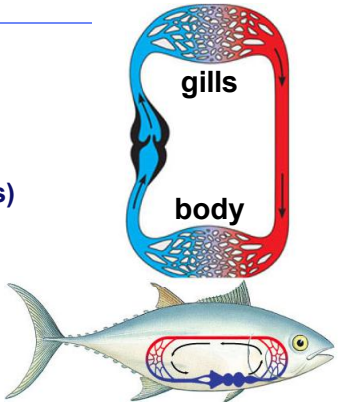


450 mya

salmon, trout, sharks

# Vertebrates: Fish

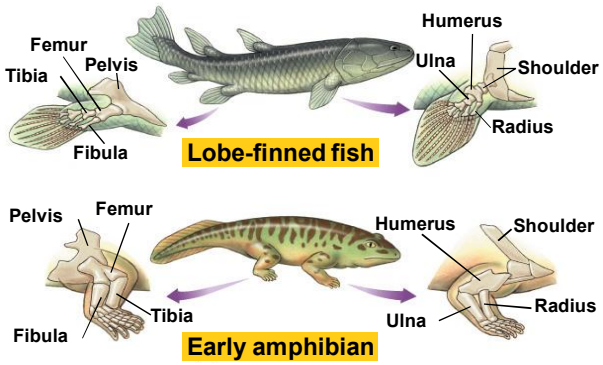
- Characteristics
  - body structure
    - bony & cartilaginous skeleton
    - jaws & paired appendages (fins)
    - scales
  - body function
    - gills for gas exchange
    - two-chambered heart; single loop blood circulation
    - ectotherms
  - reproduction
    - external fertilization
    - external development in aquatic egg



# Transition to Land

## Evolution of tetrapods

Tiktaalik

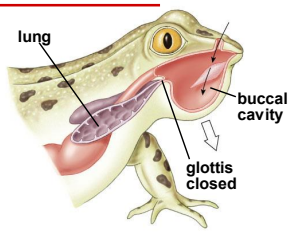


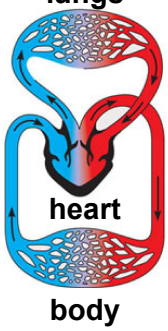
350 mya

## Vertebrates: Amphibian

frogs
salamanders
toads

- Characteristics
  - body structure
    - legs (tetrapods)
    - moist skin
      - gas exchange
  - body function
    - lungs (positive pressure) & diffusion through skin for gas exchange
    - three-chambered heart; veins from lungs back to heart
    - ectotherms
  - reproduction
    - external fertilization
    - external development in aquatic egg
    - metamorphosis (tadpole to adult)



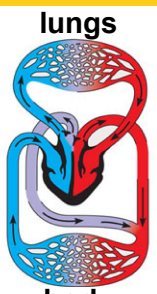



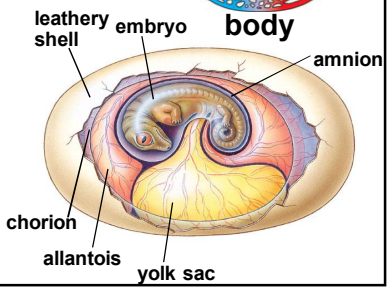
250 mya

## Vertebrates: Reptiles

dinosaurs, turtles
lizards, snakes
alligators, crocodile

- Characteristics
  - body structure
    - dry skin, scales, armor
  - body function
    - lungs for gas exchange
    - thoracic breathing; negative pressure
    - three-chambered heart
    - ectotherms
  - reproduction
    - internal fertilization
    - external development in amniotic egg



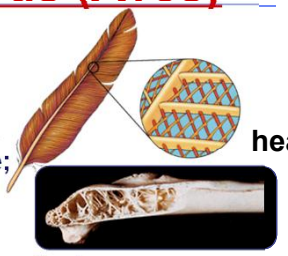


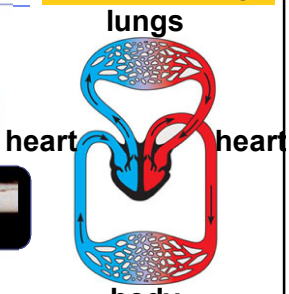
150 mya

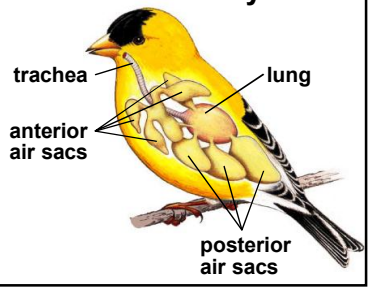
## Vertebrates: Birds (Aves)

finches, hawk
ostrich, turkey

- Characteristics
  - body structure
    - feathers & wings
    - thin, hollow bone; flight skeleton
  - body function
    - very efficient lungs & air sacs
    - four-chambered heart
    - endotherms
  - reproduction
    - internal fertilization
    - external development in amniotic egg





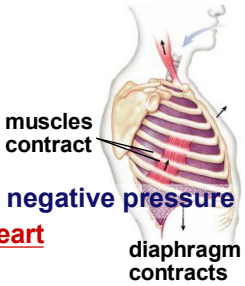
AP Biology

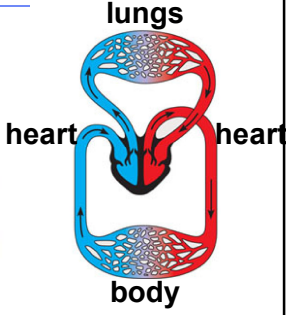
220 mya / 65 mya

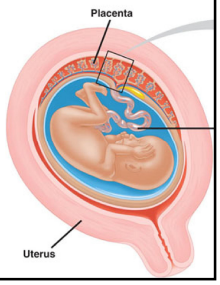
## Vertebrates: Mammals

mice, ferret
elephants, bats
whales, humans

- Characteristics
  - body structure
    - hair
    - specialized teeth
  - body function
    - lungs, diaphragm; negative pressure
    - four-chambered heart
    - endotherms
  - reproduction
    - internal fertilization
    - internal development in uterus
      - nourishment through placenta
    - birth live young
    - mammary glands make milk






AP Biology

## Vertebrates: Mammals

- Sub-groups
  - monotremes
    - egg-laying mammals
    - lack placenta & true nipples
    - duckbilled platypus, echidna
  - marsupials
    - pouched mammals
      - offspring feed from nipples in pouch
    - short-lived placenta
    - koala, kangaroo, opossum
  - placental
    - true placenta
      - nutrient & waste filter
    - shrews, bats, whales, humans

## Vertebrate quick check…

- Which vertebrates lay eggs with shells?
- Which vertebrates are covered with scales?
- What adaptations do birds have for flying?
- What kind of symmetry do all vertebrates have?
- Which vertebrates are ectothermic and which are endothermic
- Why must amphibians live near water?
- What reproductive adaptations made mammals very successful?
- What characteristics distinguish the 3 sub-groups of mammals?

That's the buzz! Any Questions?