**Protostomes** (mollusks, annelids, arthropods)

- **Eight-cell stage**
  - Spiral and determinate

**Deuterostomes** (echinoderms, chordates)

- **Eight-cell stage**
  - Radial and indeterminate

---

**A**

**CLEAVAGE**

- Protostomes: spiral and determinate
- Deuterostomes: radial and indeterminate

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**B**

**COELOM FORMATION**

- Protostomes: schizocoelous, solid masses of mesoderm split to form coelom
- Deuterostomes: enterocoelous, folds of archenteron form coelom

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**C**

**FATE OF BLASTOPORE**

- Protostomes: mouth develops from blastopore
- Deuterostomes: anus develops from blastopore

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Phylogenetic tree of the chordates

- Cephalochordata (lancelets)
- Urochordata (tunicates)
- Agnatha (jawless fishes)
- Chondrichthyes (cartilaginous fishes)
- Osteichthyes (bony fishes)
- Amphibia (amphibians)
- Reptilia (reptiles)
- Aves (birds)
- Mammalia (mammals)

- Ancestral chordates

- Feathers
- Mammary glands, hair
- Amnion
- Limbs
- Lungs
- Jaws
- Vertebrae
Muscle segments

Notochord

Dorsal, hollow nerve cord

Brain

Postanal tail

Anus

Pharyngeal slits

Mouth
Tunicates
Lancelets

- Tentacle
- Mouth
- Pharyngeal slits
- Atrium
- Digestive tract
- Notochord
- Dorsal, hollow nerve cord
- Atriopore
- Segmental muscles
- Anus
- Tail
Haikuichthys
Hagfish
Lamprey
Gnathostomes
Evolution of Vertebrate Jaws
Chondrichthyes
Bony Fishes

- Brook trout
- Trout
- John dory
- Pacific salmon
- Atlantic salmon
Tetrapods
Amphibians

salamander

tree frog

common toad

newt
Reptiles

- Have scales, not fur.
- Have dry skin.
- Usually lay eggs, sometimes live young.
- Ear holes instead of ears.
- 4 legs or no legs.
- Cold-blooded.
Amniotes

- Shell
- Amnion
- Embryo
- Allantois (waste)
- Yolk sac
Birds