BIOL 01112
General Biology II Lecture

CHAPTER 32
An Overview of Animal Diversity
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CH 32 Learning Objectives

1. Describe key characteristics of animals and their life cycles.
2. Identify key milestones in the evolutionary history of animals.
3. Differentiate between different types of animal "body plans."
4. Describe current views of the animal phylogenetic tree.

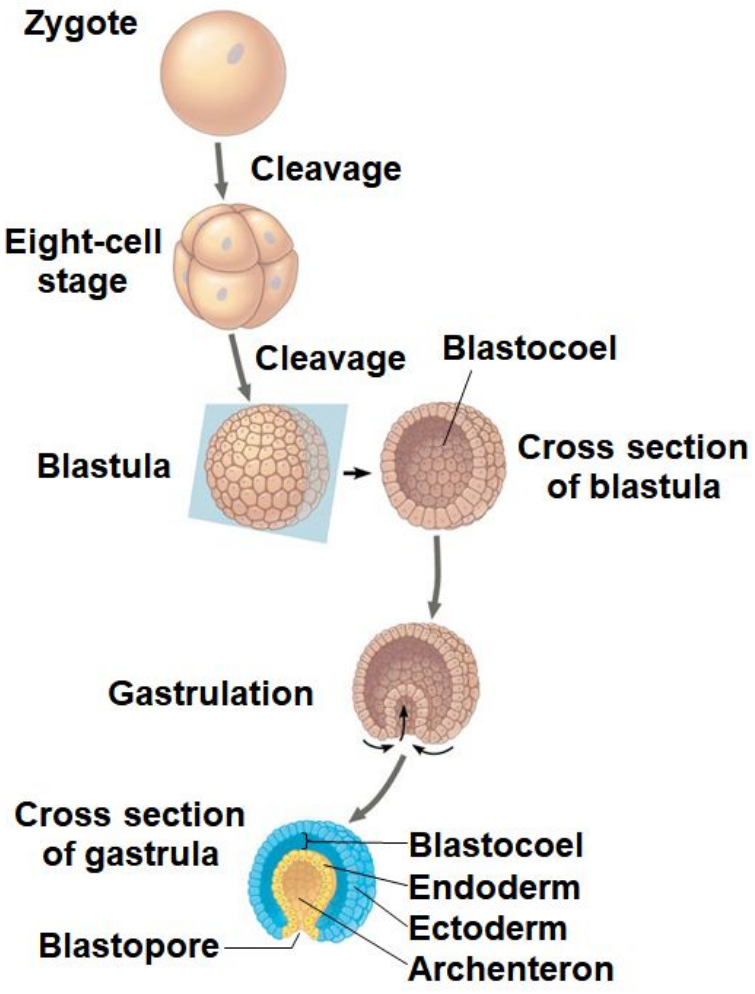
I would suggest completing the crossword puzzle to help you understand the terminology and correlate how the terms relate to topics covered in this chapter.

Concept 32.1: Animals are multicellular, heterotrophic eukaryotes with tissues that develop from embryonic layers

- There are exceptions to nearly every criterion for distinguishing animals from other life-forms
- Several characteristics, taken together, sufficiently define the animal kingdom
- Animals are heterotrophs that ingest their food
- Animals are multicellular eukaryotes
- Cells are supported by structural proteins such as collagen, rather than cell walls
- Nervous tissue and muscle tissue are unique, defining characteristics of animals

Reproduction and Development

- Most animals reproduce sexually, the diploid stage usually dominating the life cycle
- After a sperm fertilizes an egg, the zygote undergoes rapid cell division called **cleavage**
- Cleavage leads to formation of a multicellular, hollow **blastula**
- The blastula undergoes **gastrulation**, forming a **gastrula** with different layers of embryonic tissues



- Most animals have at least one larval stage
- A **larva** is sexually immature and morphologically distinct from the adult; it eventually undergoes **metamorphosis** to become a juvenile
- A juvenile resembles an adult, but is not yet sexually mature
- All animals have developmental genes that regulate the expression of other genes
- Most animals share a unique family of developmental genes called *Hox* genes
- *Hox* genes regulate the development of body form
- The *Hox* family of genes can produce a wide diversity of animal morphology

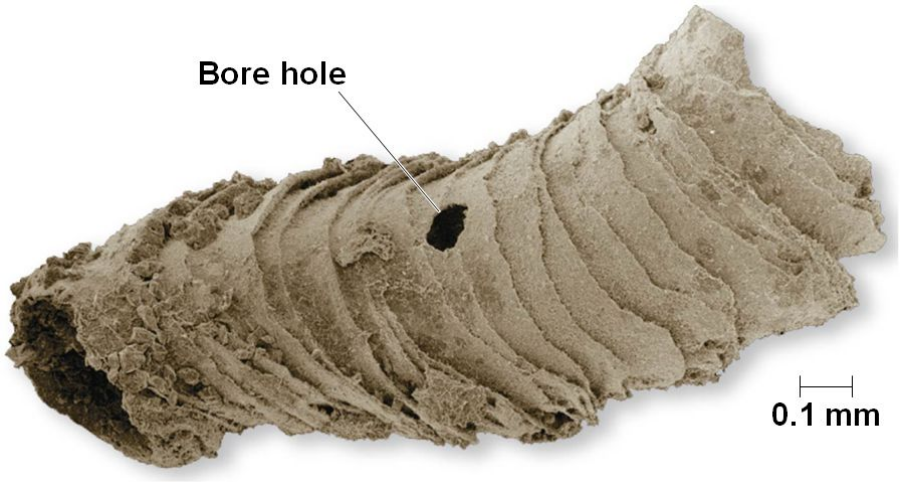
Concept 32.2: The history of animals spans more than half a billion years

- Biologists have identified 1.3 million living animal species to date; far more (8.7M) are estimated to exist
- The common ancestor of all living animals likely lived about 770 MYA
- The common ancestor may have resembled modern choanoflagellates
- The origin of multicellularity requires the evolution of new ways for cells to adhere (attach) and signal (communicate) to each other
- Choanoflagellates and animals have sequence similarities in the genes involved in adherence and attachment

Neoproterozoic Era (1 BYA–541 MYA)

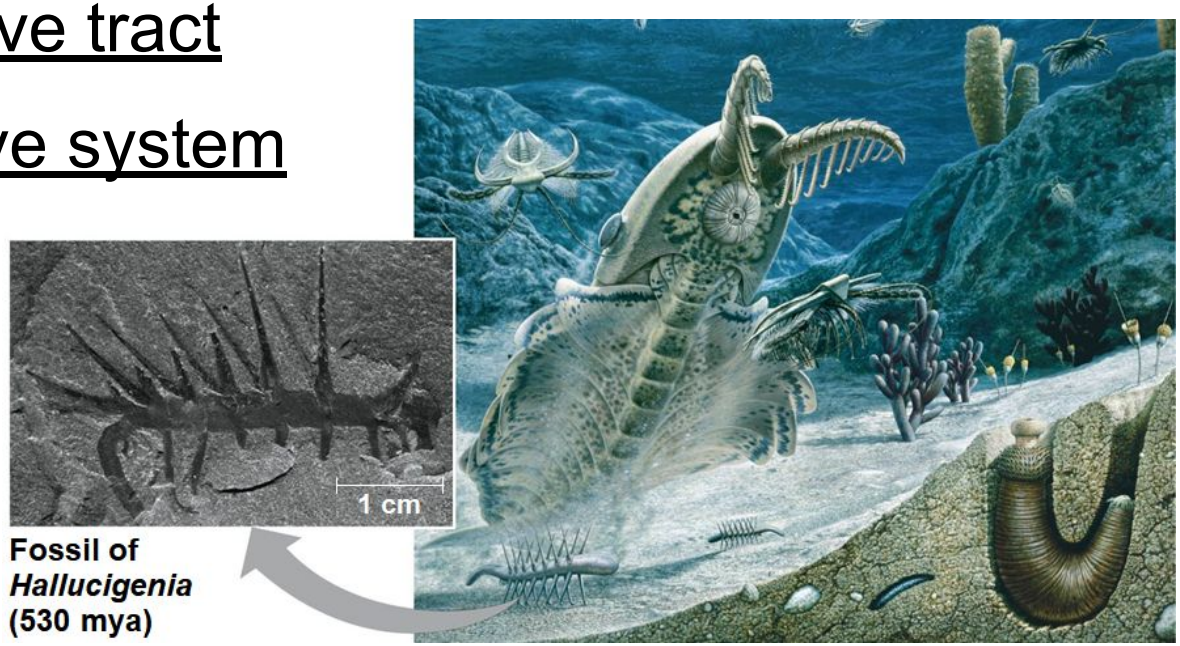
- Early members of the animal fossil record include the **Ediacaran biota**, which dates back to about 560 MYA
- Microscopic fossils of animal embryos have been found in Neoproterozoic rocks
- Evidence of predation has also been found in fossils of the Ediacaran period (635-541 MYA)

(a) *Dickinsonia costata* 2.5 cm



Paleozoic Era (541–252 MYA)

- The **Cambrian explosion** (535–525 MYA) marks the earliest fossil appearance of many major groups of living animals
- Most of the fossils from the Cambrian explosion are of **bilaterians**, organisms with the following traits:
  - Bilaterally symmetric form
  - Complete digestive tract
  - One-way digestive system



- There are several hypotheses regarding the cause of the Cambrian explosion and Ediacaran biota decline
  1. New predator-prey relationships
  2. A rise in atmospheric oxygen
  3. The evolution of the *Hox* gene complex and addition of new microRNAs
- Animal diversity continued to increase through the Paleozoic era, but was punctuated by mass extinctions
- Animals began to make an impact on land by 450 MYA
- Vertebrates made the transition to land around 365 MYA

Mesozoic Era (252–66 MYA)

- Coral reefs emerged, becoming important marine ecological niches for other organisms
- The ancestors of plesiosaurs were reptiles that returned to the water
- During the Mesozoic era, dinosaurs were the dominant terrestrial vertebrates
- The first mammals emerged
- Flowering plants and insects diversified

Cenozoic Era (66 MYA to the Present)

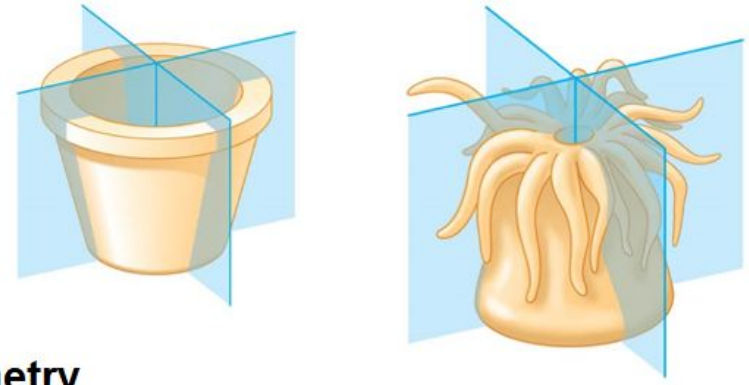
- The beginning of the Cenozoic era followed mass extinctions of both terrestrial and marine animals
- These extinctions included the large, nonflying dinosaurs and the marine reptiles
- Mammals increased in size and exploited vacated ecological niches
- The global climate cooled

Concept 32.3: Animals can be characterized by "body plans"

- Zoologists sometimes categorize animals according to a **body plan**, a set of morphological and developmental traits
- Some body plans have been conserved, while others have changed multiple times over the course of evolution

Symmetry

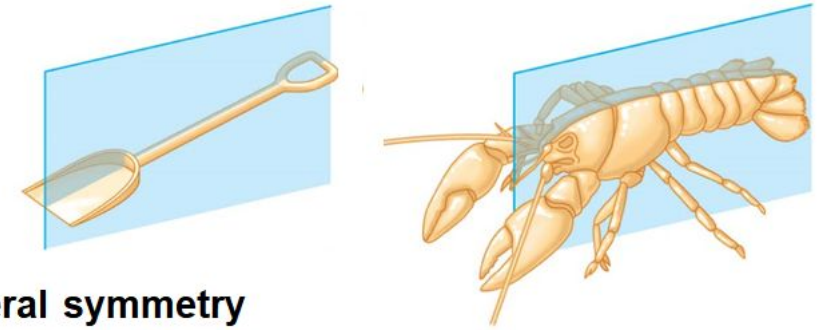
- Animals can be categorized according to the symmetry of their bodies, or lack of it
- Some animals have **radial symmetry**, the type of symmetry found in a flowerpot
- Radially symmetrical animals have a top and a bottom, but no front and back, or left and right
- Radial animals are often sessile or planktonic (drifting or weakly swimming)



(a) Radial symmetry

- The two-sided symmetry of a shovel is an example of **bilateral symmetry**
- Bilaterally symmetrical animals have
  - A **dorsal** (top) side and a **ventral** (bottom) side
  - A right and left side
  - **Anterior** (front) and **posterior** (back) ends
- Many also have sensory equipment, such as a brain, concentrated in the anterior end
- Bilateral animals typically move actively and have a central nervous system

digress on PTC taste test

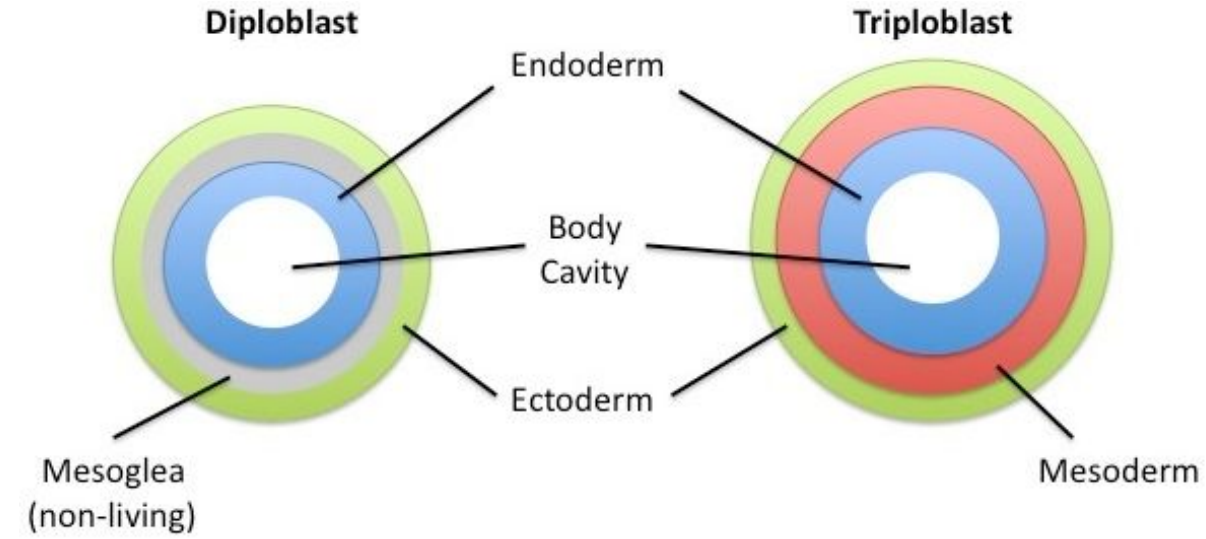


(b) Bilateral symmetry

Tissues

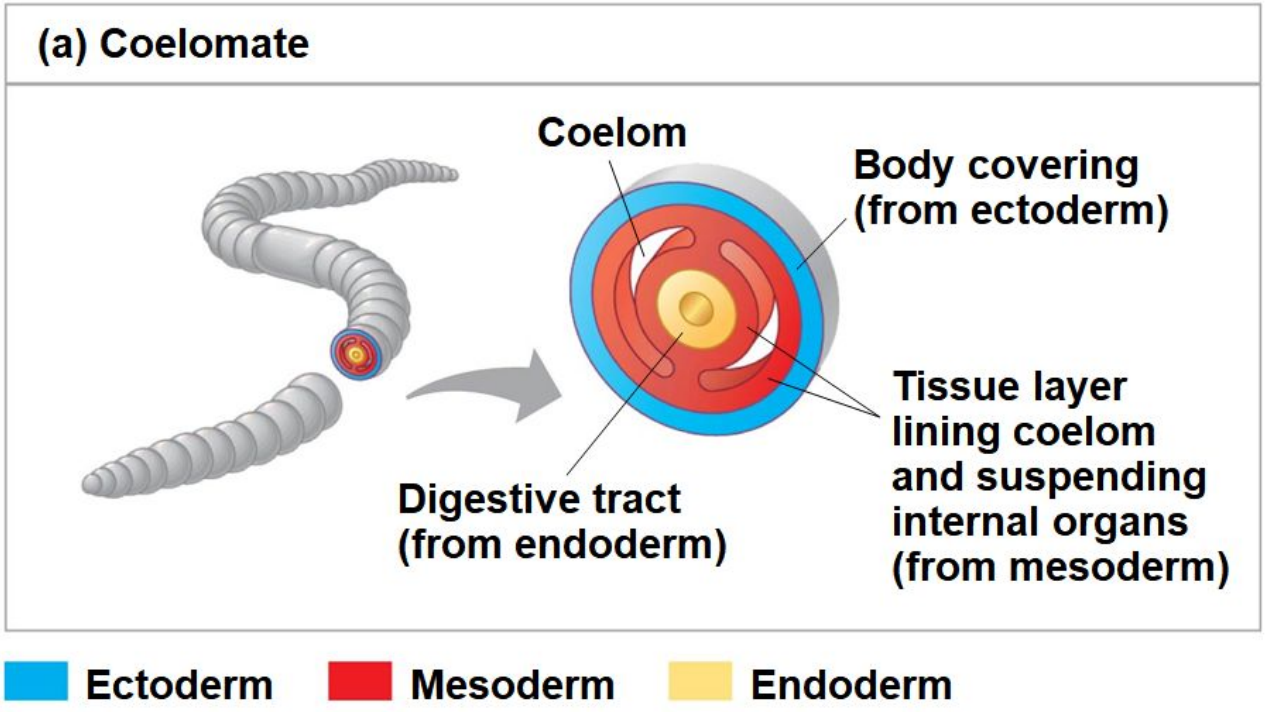
- Animal body plans also vary according to the organization of the animal's tissues
- Tissues are collections of specialized cells isolated from other tissues by membranous layers
- During development, three germ layers give rise to the tissues and organs of the animal embryo
- **Ectoderm** is the germ layer covering the embyro's surface
- **Endoderm** is the innermost germ layer and lines the developing digestive tube, called the archenteron

- Sponges and a few other groups lack true tissues
- **Diploblastic** animals have only ectoderm and endoderm
  - These include cnidarians and a few other groups
- **Triploblastic** animals also have an intermediate tissue layer called mesoderm
  - All bilaterally symmatric animals are triploblastic

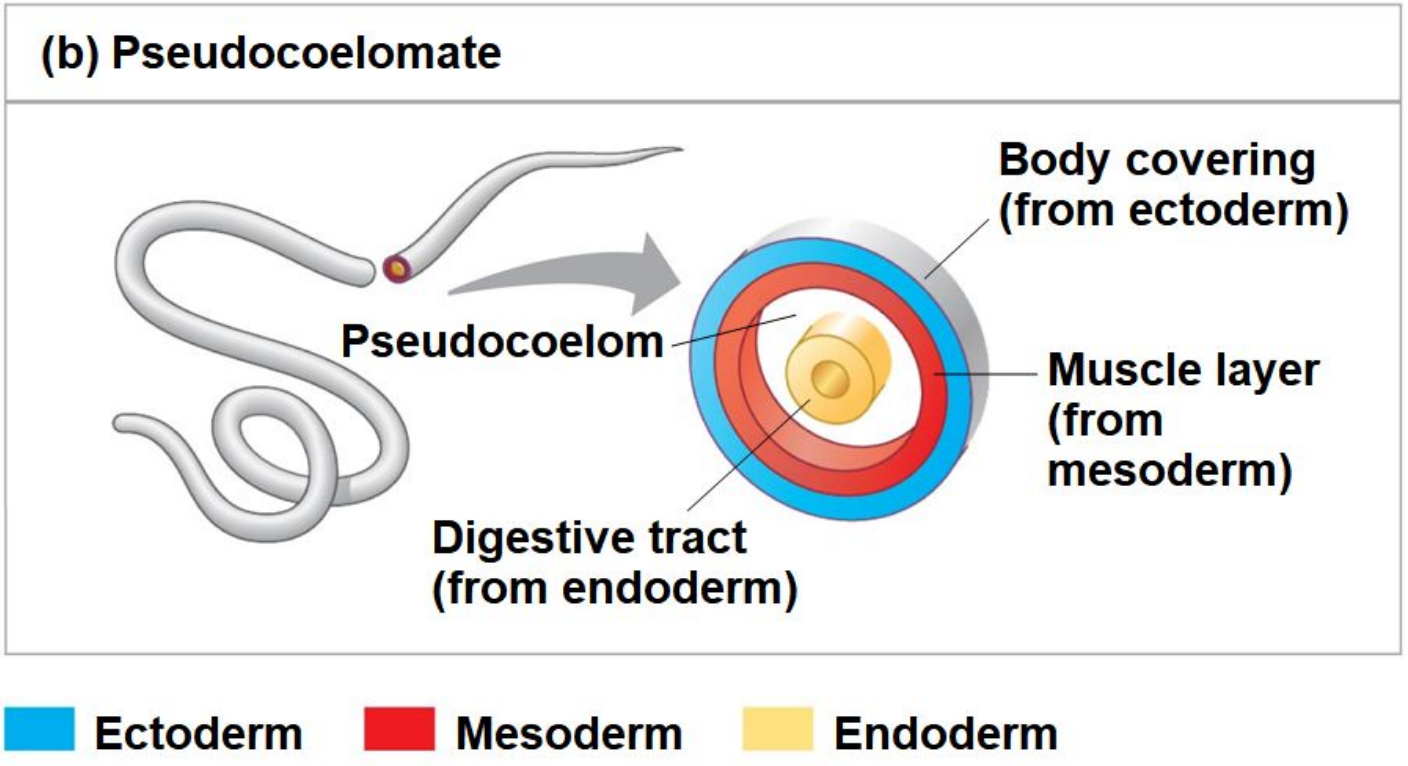


Body Cavities

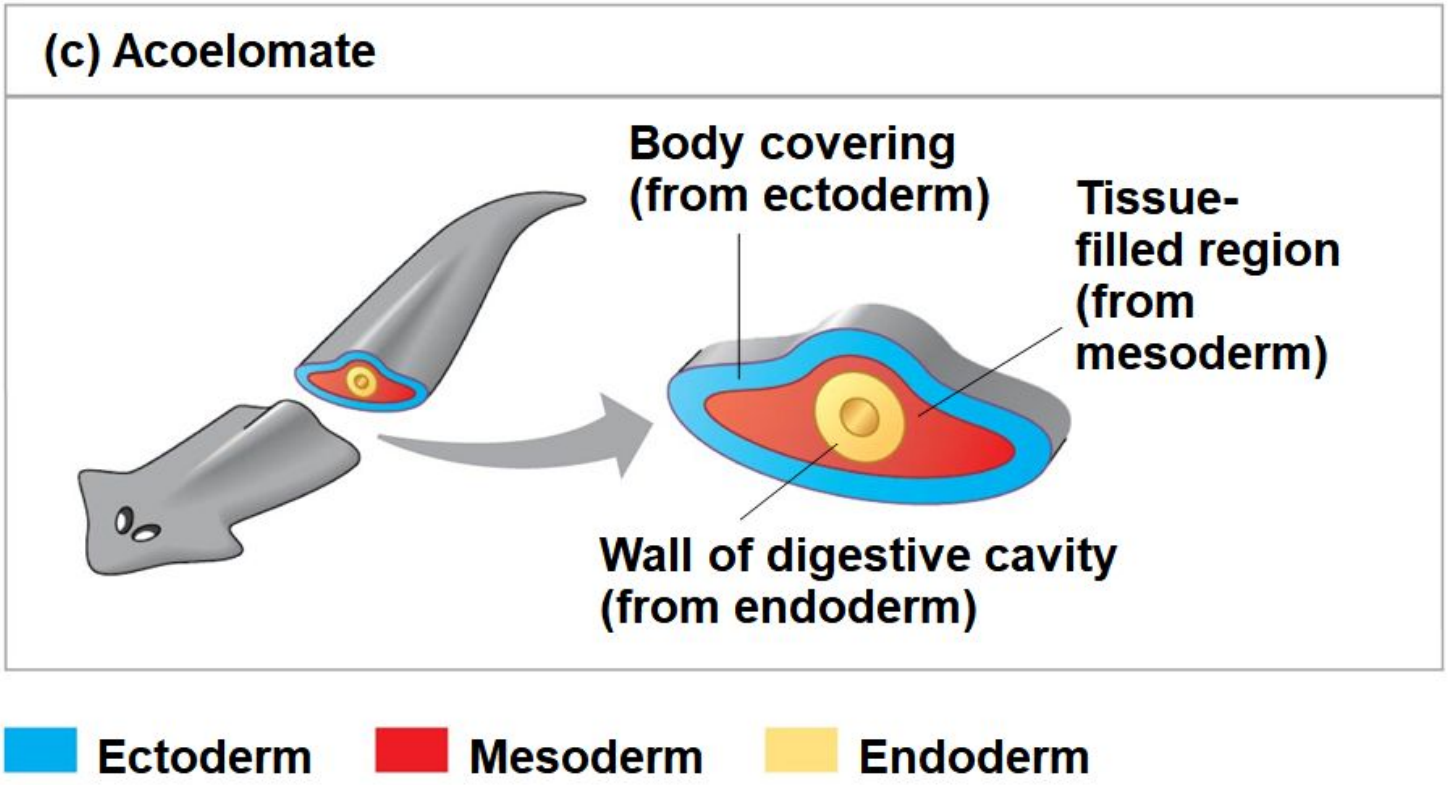
- Most triploblastic animals possess a **body cavity**
- A true body cavity is called a **coelom** and is derived from mesoderm
- **Coelomates** are animals that possess a true coelom



- Triploblastic animals that possess a pseudocoelom are called **pseudocoelomates**
- A pseudocoelom is a body cavity derived from the mesoderm and endoderm



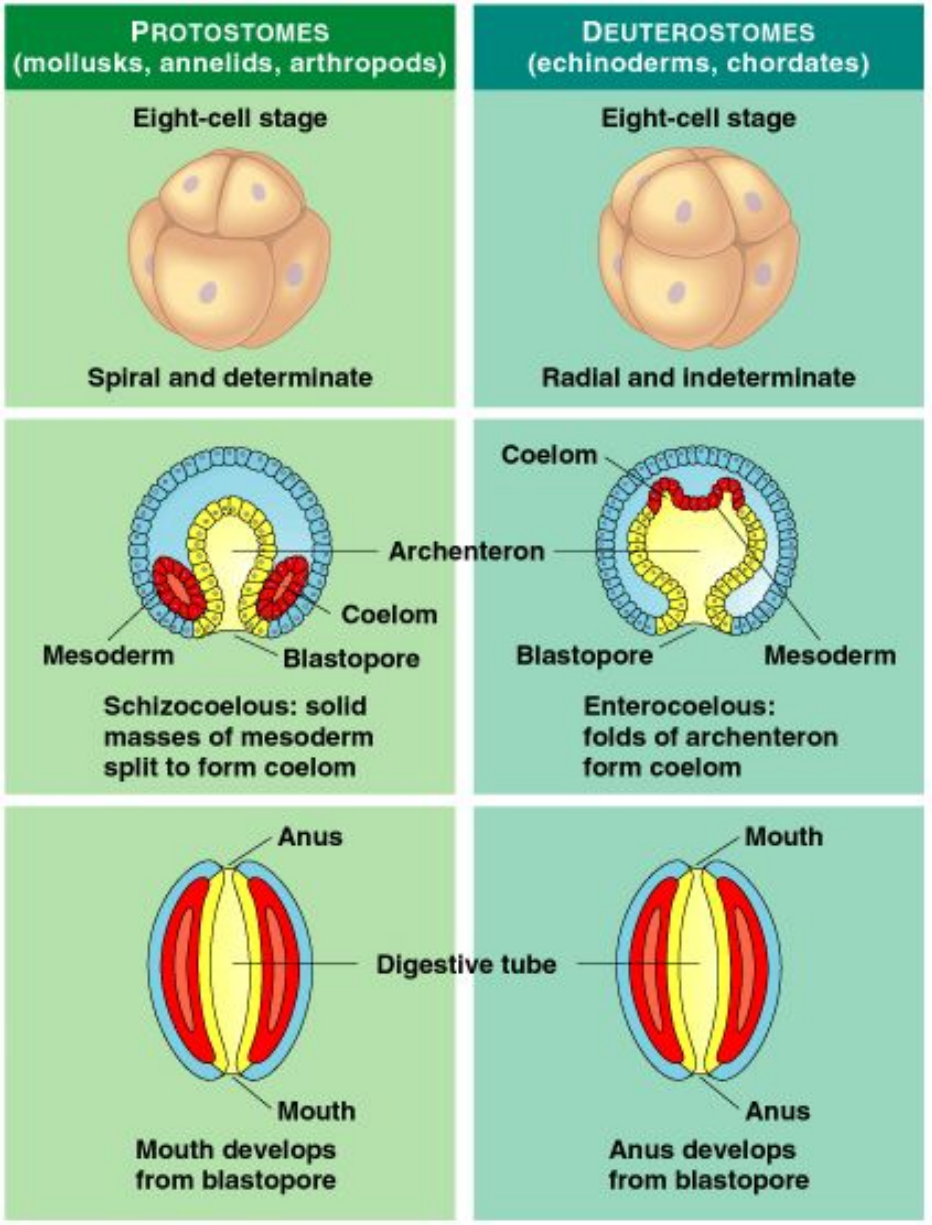
- Triploblastic animals that lack a body cavity are called **acoelomates**



- A body cavity has many functions
  1. fluid cushions the suspended organs
  2. Fluid acts like a skeleton against which muscles can work
  3. The cavity enables internal organs to grow and move independently of the outer body wall
- Terms such as coelomates and pseudocoelomates refer to organisms that have a similar body plan and belong to the same grade
- A **grade** is a group whose members share key biological features
- A grade is not necessarily a clade, an ancestor and all of its descendants

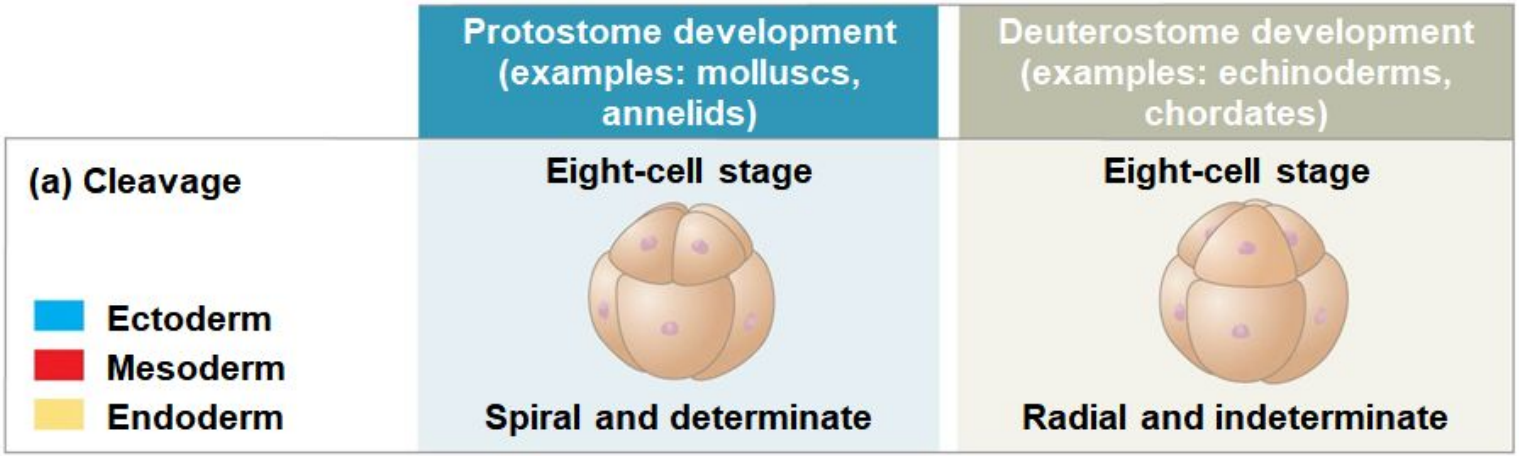
Protostome and Deuterostome Development

- Based on early development, many animals can be categorized as having **protostome development** or **deuterostome development**
- These developmental modes differ in cleavage, coelom formation, and fate of the blastopore



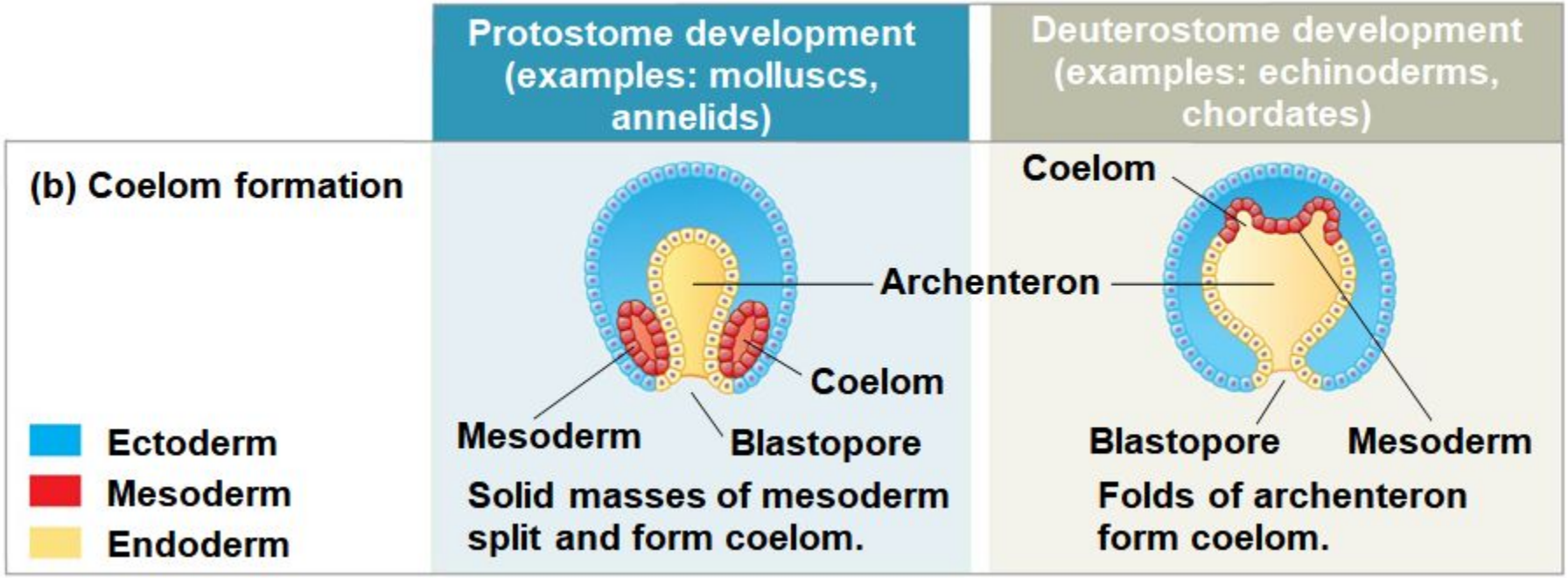
Cleavage

- In protostomes, cleavage is **spiral & determinate**
  - Developmental fate of embryonic cells is determined early in development
- In deuterostomes, cleavage is **radial & indeterminate**
  - Each cell in the early stages of cleavage retains the capacity to develop into a complete embryo
- Indeterminate cleavage makes possible identical twins and embryonic stem cells



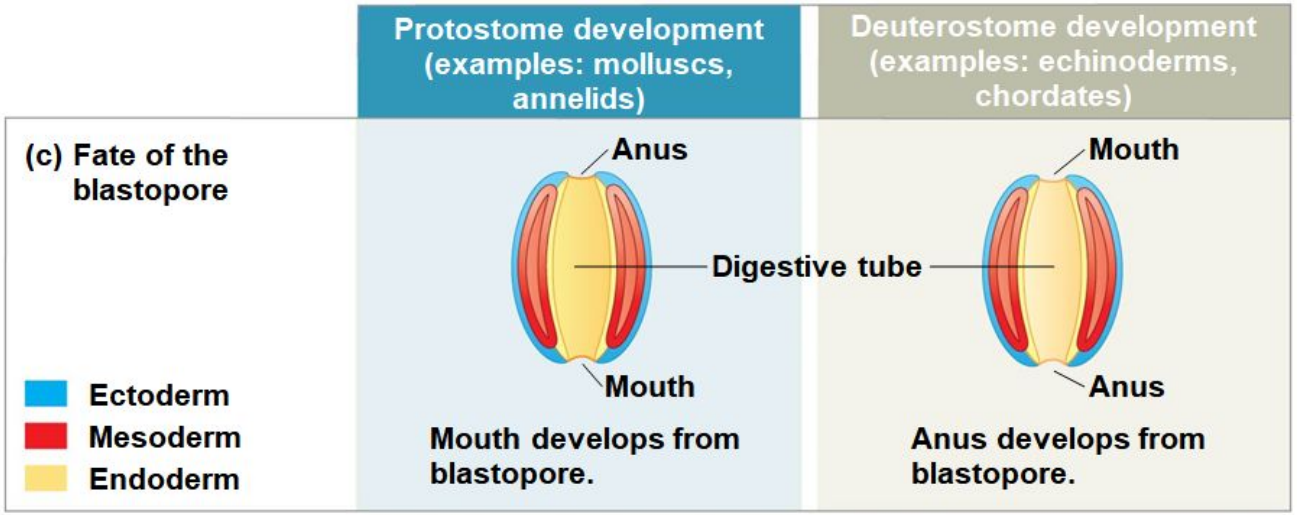
Coelom Formation

- In protostome development, the splitting of solid masses of mesoderm forms the coelom
- In deuterostome development, the mesoderm buds from the wall of the **archenteron** to form the coelom



Fate of the Blastopore

- The **blastopore** forms during gastrulation and connects the archenteron to the exterior of the gastrula
- In protostome development, the blastopore becomes the **mouth**
- In deuterostome development, the blastopore becomes the **anus**



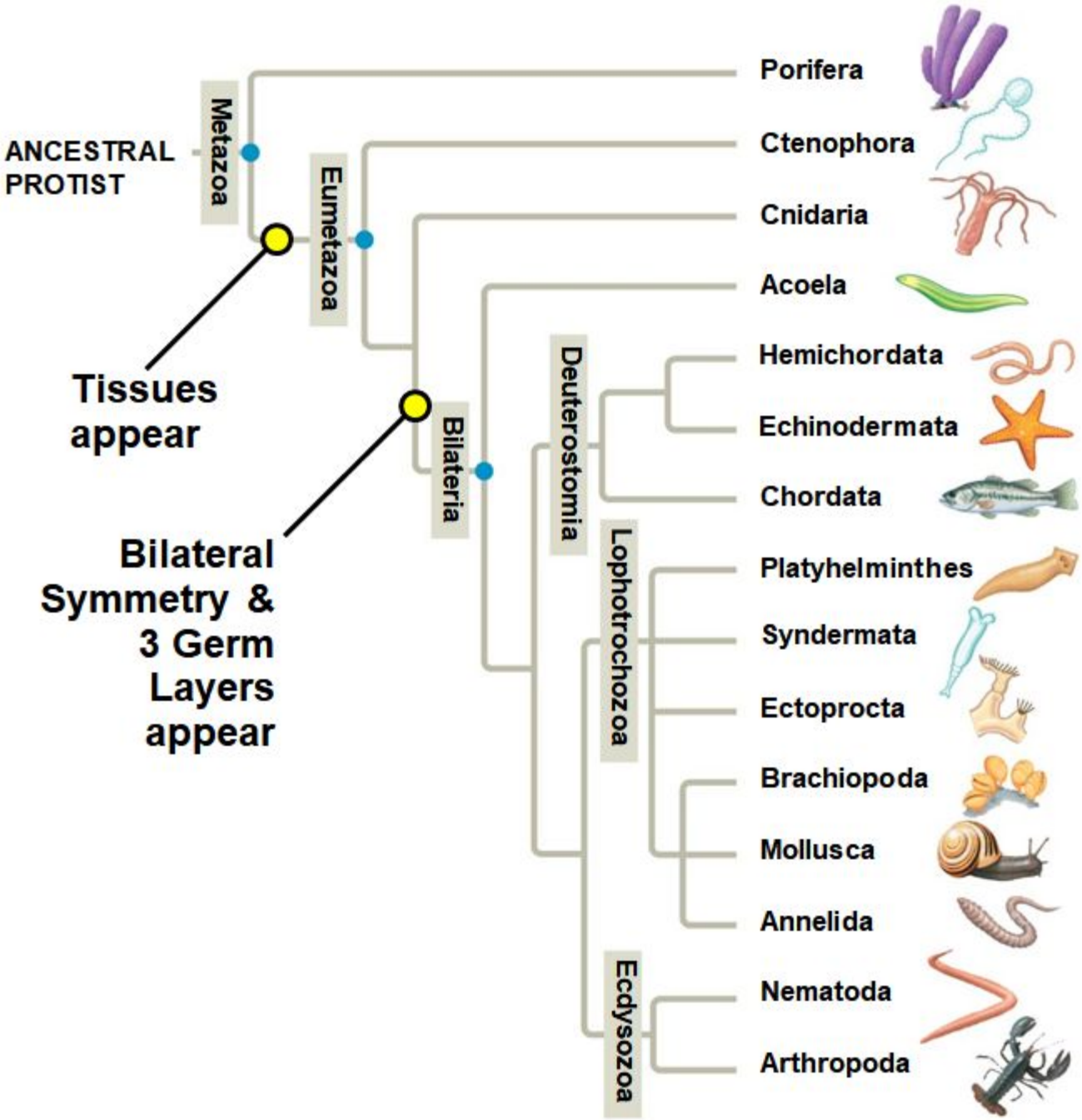
Concept 32.4: Views of animal phylogeny continue to be shaped by new molecular and morphological data

- By 500 MYA, most animal phyla with members alive today were established
- Zoologists recognize about three dozen animal phyla
- Phylogenies are now primarily based things such as:
  1. whole-genome analysis
  2. morphological traits
  3. ribosomal RNA (rRNA) genes
  4. *Hox* genes
  5. Protein-coding nuclear genes & Mitochondrial genes

- Five important points about the relationships among living animals are reflected in their phylogeny

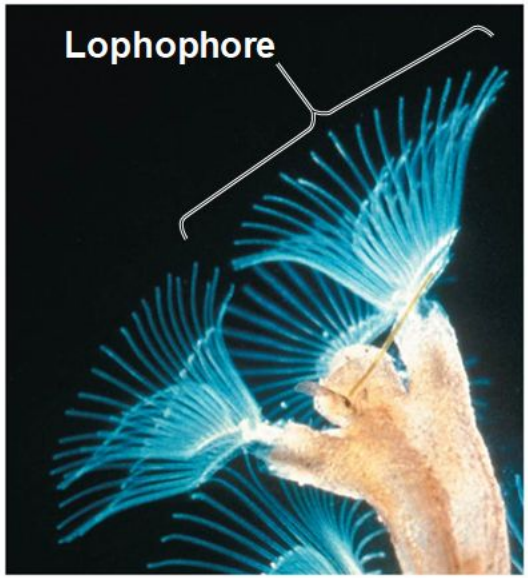
1. All animals share a common ancestor
2. Sponges are the sister group to all other animals
3. Eumetazoa ("true animals") is a clade of animals with tissues
4. Most animal phyla belong to the clade Bilateria
5. There are three major clades of bilaterian animals, all of which are **invertebrates**, animals that lack a backbone, except Chordata, which includes **vertebrates**, animals with a backbone

Figure 32.11

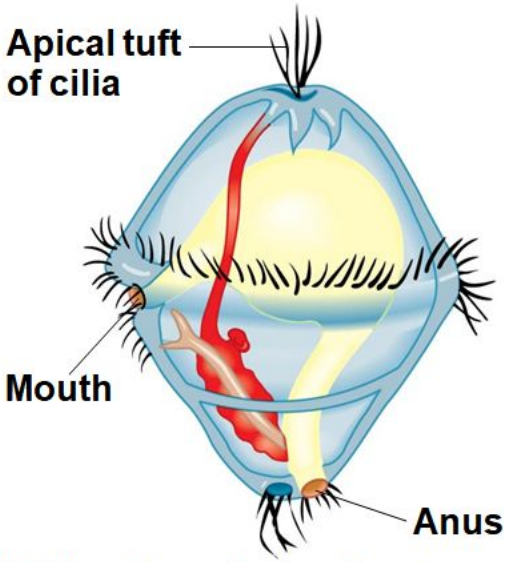

ANCESTRAL PROTIST
Metazoa
Eumetazoa
Bilateria
Deuterostomia
Lophotrochozoa
Ecdysozoa
Tissues appear
Bilateral Symmetry & 3 Germ Layers appear
Porifera
Ctenophora
Cnidaria
Acoela
Hemichordata
Echinodermata
Chordata
Platyhelminthes
Syndermata
Ectoprocta
Brachiopoda
Mollusca
Annelida
Nematoda
Arthropoda

- The bilaterians are divided into three clades:
  1. Deuterostomia
  2. Ecdysozoa
  3. Lophotrochozoa
- **Deuterostomia** includes hemichordates (acorn worms), echinoderms (sea stars and relatives), and chordates
- This clade includes both vertebrates & invertebrates
- The ecdysozoans and the lophotochozoans are composed entirely of invertebrates
- Members of **Ecdysozoa** secrete external skeletons
- As they grow, they shed their exoskeletons through a process called ecdysis

- **Lophotrochozoa** is another clade of bilaterian invertebrates
- Some lophotrochozoans have a feeding structure called a **lophophore**
- Others go through a distinct developmental stage called the **trochophore larva**



(a) Lophophore feeding structures of an ectoproct



(b) Structure of a trochophore larva