Chapter 32

An Introduction to Animal Diversity

PowerPoint® Lecture Presentations for

Biology

Eighth Edition

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Animals Overview

- 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.
- 1.3 million living species of animals have been identified.

Which of these organisms are animals?

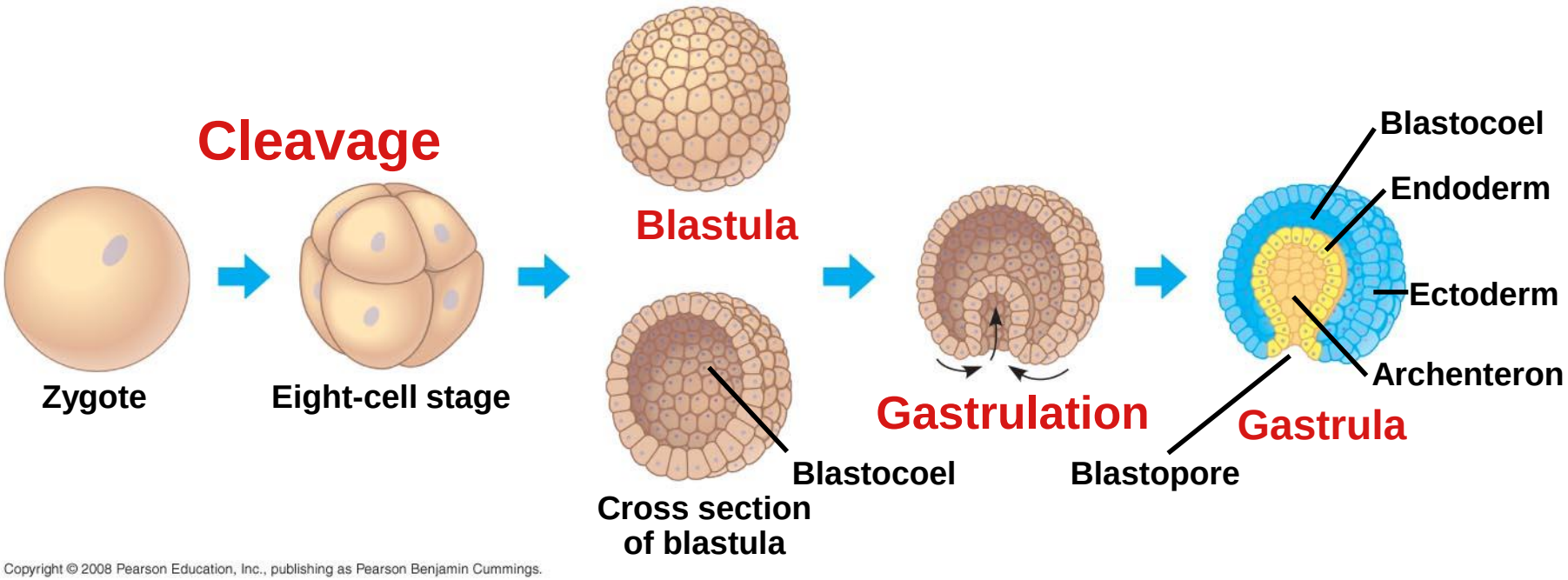
Animal Structure and Specialization

- *Nutritional Mode*: Animals are *heterotrophs* that *ingest* their food.
- Animals are *multicellular* eukaryotes.
- Their cells *lack cell walls*.
- Their bodies are held together by *structural proteins* such as *collagen*.
- *Nervous tissue* and *muscle tissue* are unique to animals.

Reproduction and Development

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

Animal Early Embryonic Development

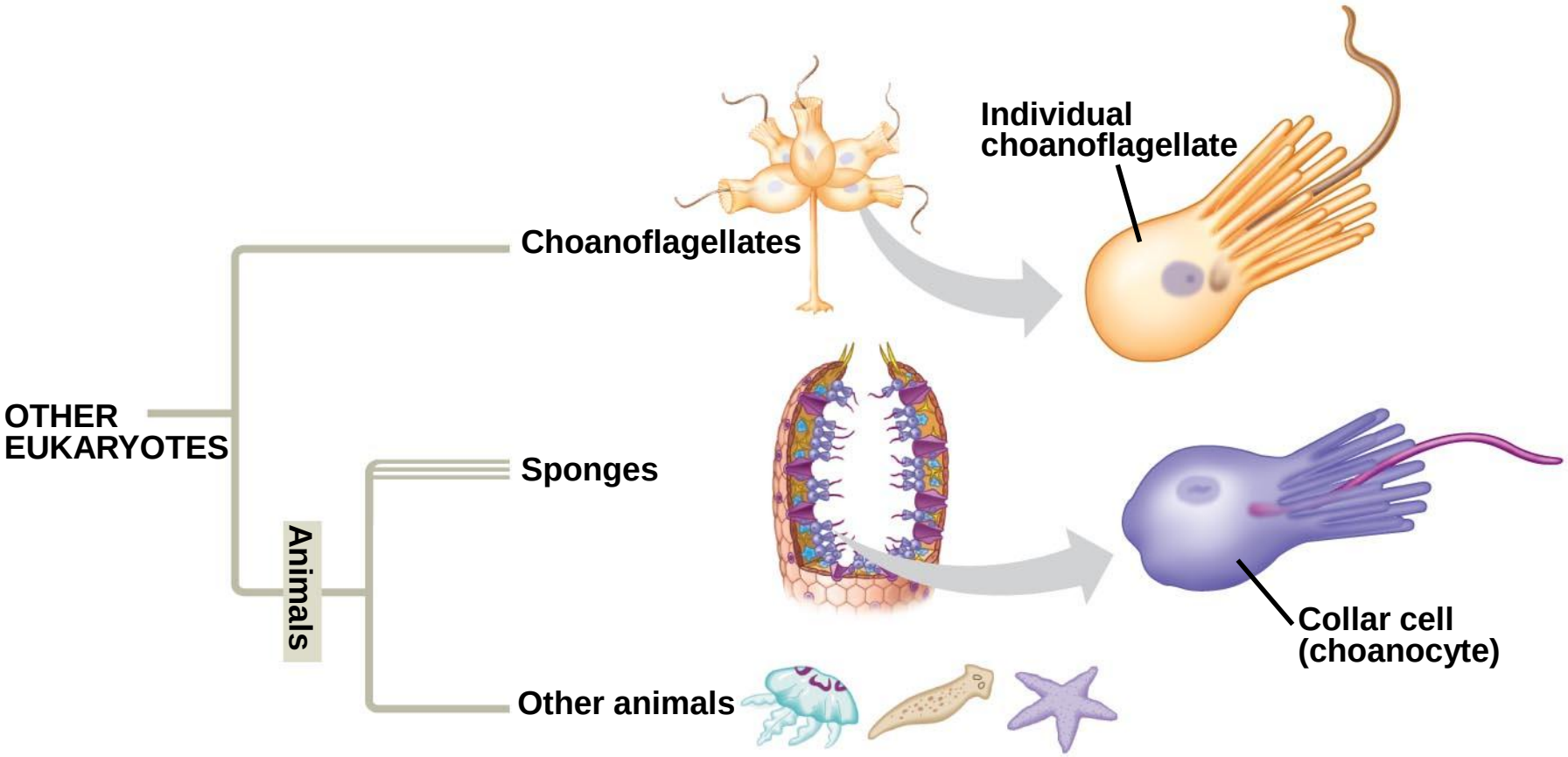


- Many animals have at least one larval stage.
- A *larva* is sexually immature and morphologically distinct from the adult; it eventually undergoes *metamorphosis*.
- *All animals*, and only animals, have ***Hox* genes** that *regulate* the development of *body form*.
- Although the *Hox* family of genes has been highly conserved, it can produce a wide diversity of *animal morphology*.

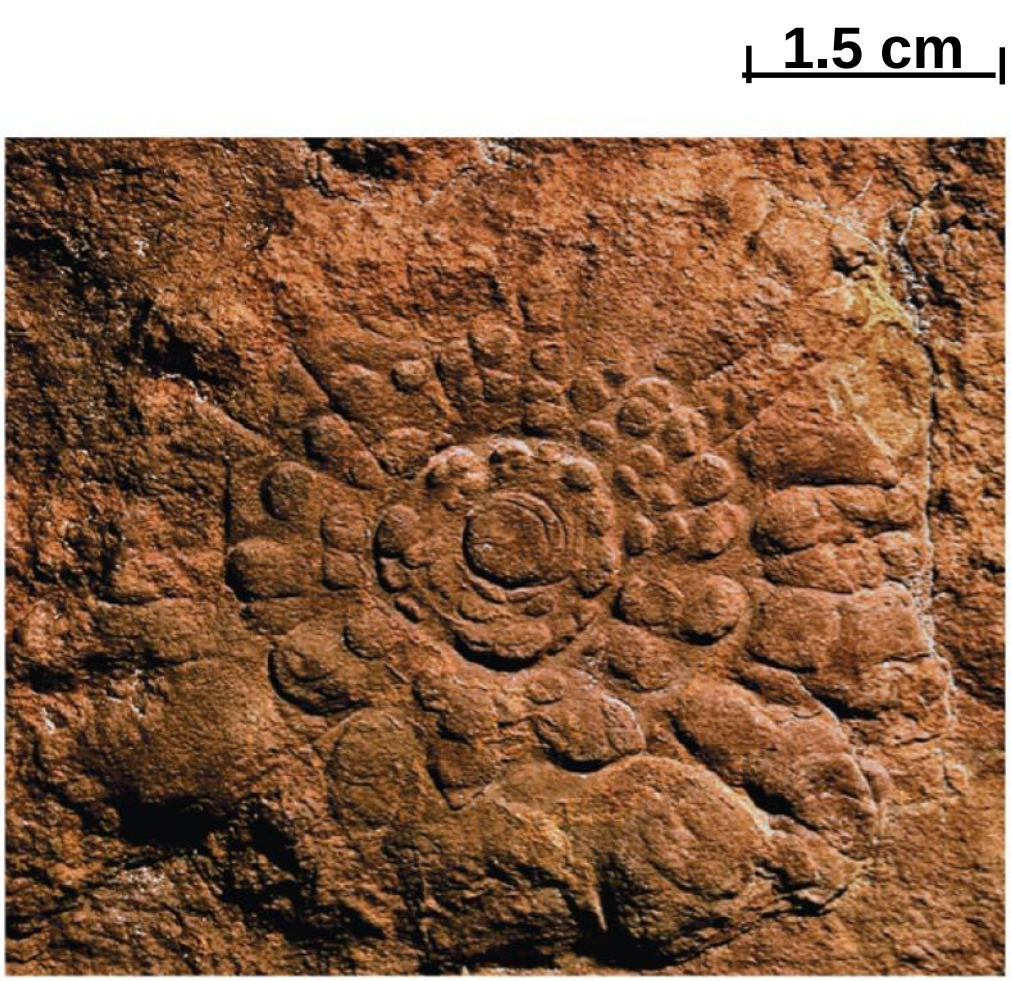
The history of animals spans more than half a billion years

- The animal kingdom includes a great diversity of living species and an even greater diversity of extinct ones.
- The *common ancestor* of living animals may have lived between 675 and 875 million years ago.
- This ancestor may have resembled modern *choanoflagellates, protists* that are the closest living relatives of animals.

Three lines of evidence that choanoflagellates protists are closely related to animals



Early members of the animal fossil record include the Ediacaran biota, which dates from 565 to 550 million years ago



(a) *Mawsonites spriggi*

(b) *Spriggina floundersi*

Paleozoic Era (542–251 Million Years Ago)

- The ***Cambrian explosion*** (535 to 525 million years ago) marks the earliest fossil appearance of *many major groups of living animals.*
- There are several hypotheses regarding the cause of the Cambrian explosion
  - *New predator-prey relationships*
  - A *rise in atmospheric oxygen*
  - The evolution of the *Hox* gene complex.

A Cambrian seascape

Mesozoic Era (251–65.5 Million Years Ago)

- Animal diversity continued to increase through the Paleozoic, but was punctuated by mass extinctions.
- *Animals* began to make an *impact on land* by 460 million years ago.
- Vertebrates made the transition to land around 360 million years ago.
- *Coral reefs* emerged, becoming important marine ecological niches for other organisms.
- *During the Mesozoic era, dinosaurs were the dominant terrestrial vertebrates*.
- The *first mammals* emerged.

Cenozoic Era (65.5 Million Years Ago 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.
- *Modern mammal orders and insects diversified during the Cenozoic*.

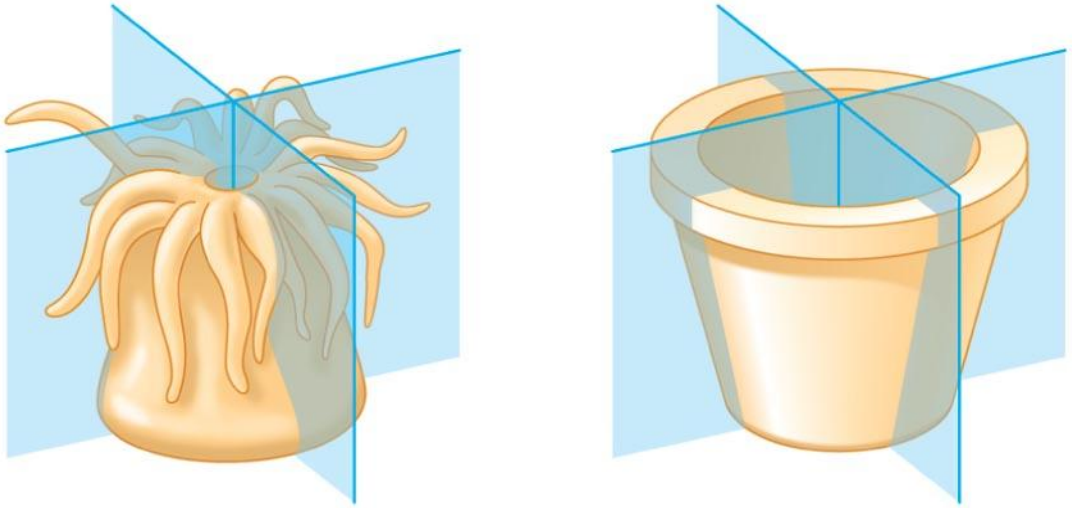
Animals can be characterized by "body plans"

- Zoologists sometimes categorize animals according to a ***body plan***, a set of morphological and developmental traits.
- *A **grade** is a group whose members share key biological features*.
- A grade is not necessarily a *clade*, or monophyletic group.

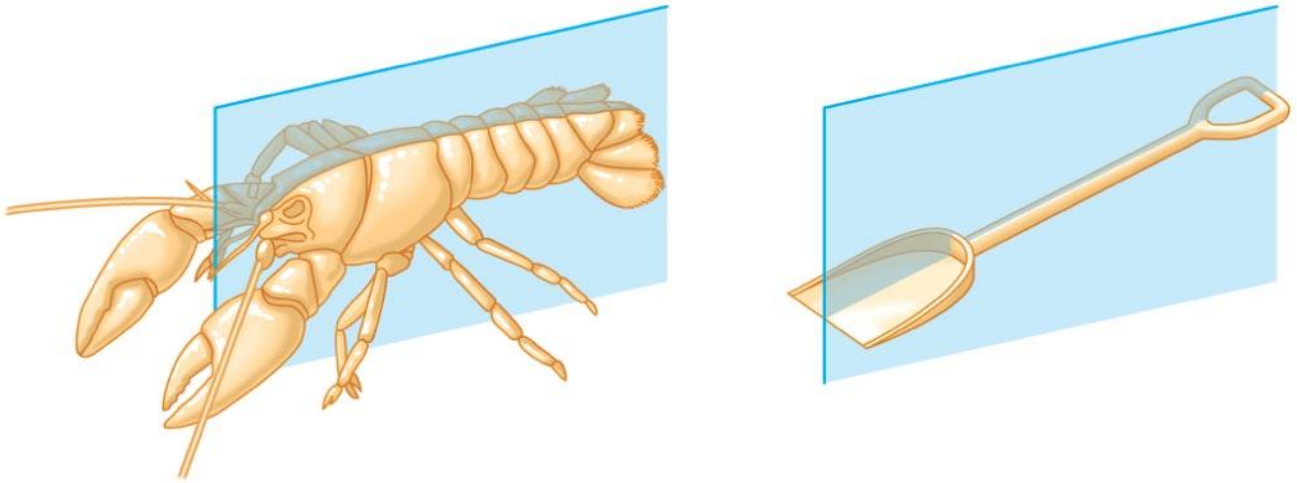
Body Plan -- Symmetry

- Animals can be categorized according to the symmetry of their bodies, or lack of it.
- Some animals have ***radial symmetry*****.**
- Two-sided symmetry is called bilateral symmetry**.**
- Animals with ***bilateral symmetry*** have:
  - A **dorsal** (top) side and a **ventral** (bottom) side
  - A right and left side
  - **Anterior** (head) and **posterior** (tail) ends
  - ***Cephalization***, the development of a head. (*Brain*…)

Animal Body Symmetry



(a) **Radial** symmetry



(b) **Bilateral** symmetry

Body Plan -- 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*.

Embryonic Germ Layers

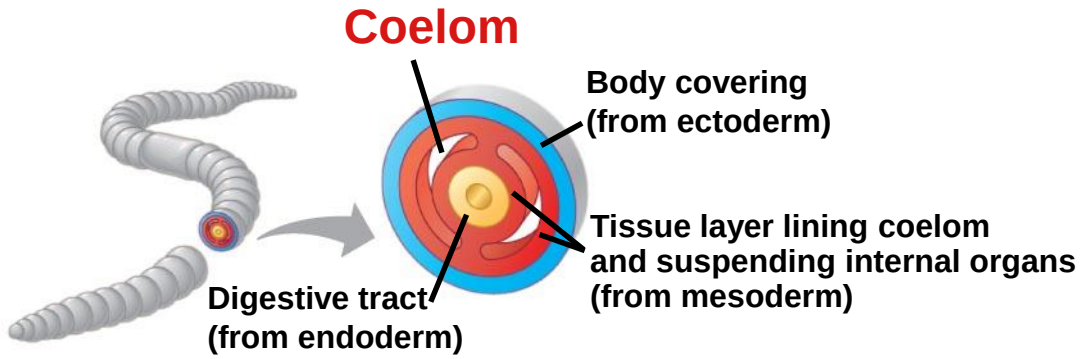
- ***Ectoderm*** is the germ layer *covering* the embryo's surface.
- ***Endoderm*** is the *innermost* germ layer and lines the *developing digestive tube*, called the ***archenteron*****.**
- **Diploblastic** animals have ectoderm and endoderm.
- **Triploblastic** animals also have a *middle* ***mesoderm*** layer; these include all bilaterians.

Body Cavities

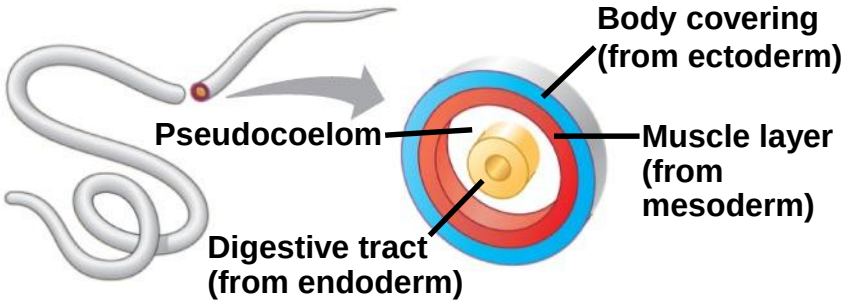
Most triploblastic animals possess a body cavity.

- *A true body cavity is called a* ***coelom*** *and is derived from mesoderm*. **Coelomates** are animals that possess a true coelom.
- A pseudocoelom is *a body cavity derived from the mesoderm and endoderm*. Triploblastic animals that possess a pseudocoelom are called ***pseudocoelomates***.
- Triploblastic animals that *lack a body cavity* are called ***acoelomates***.

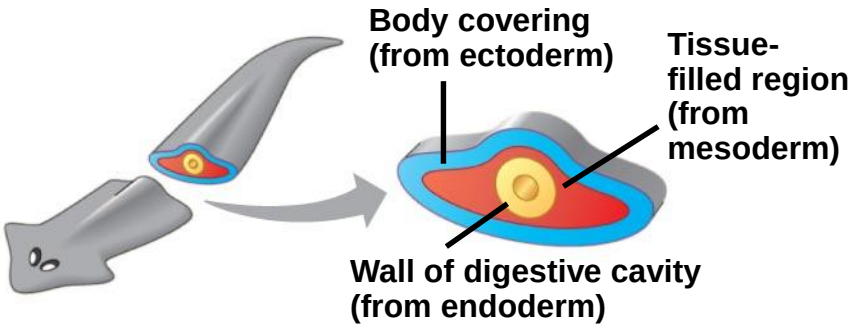
Triploblastic Animals Body Cavities



(a) Coelomate - true body cavity



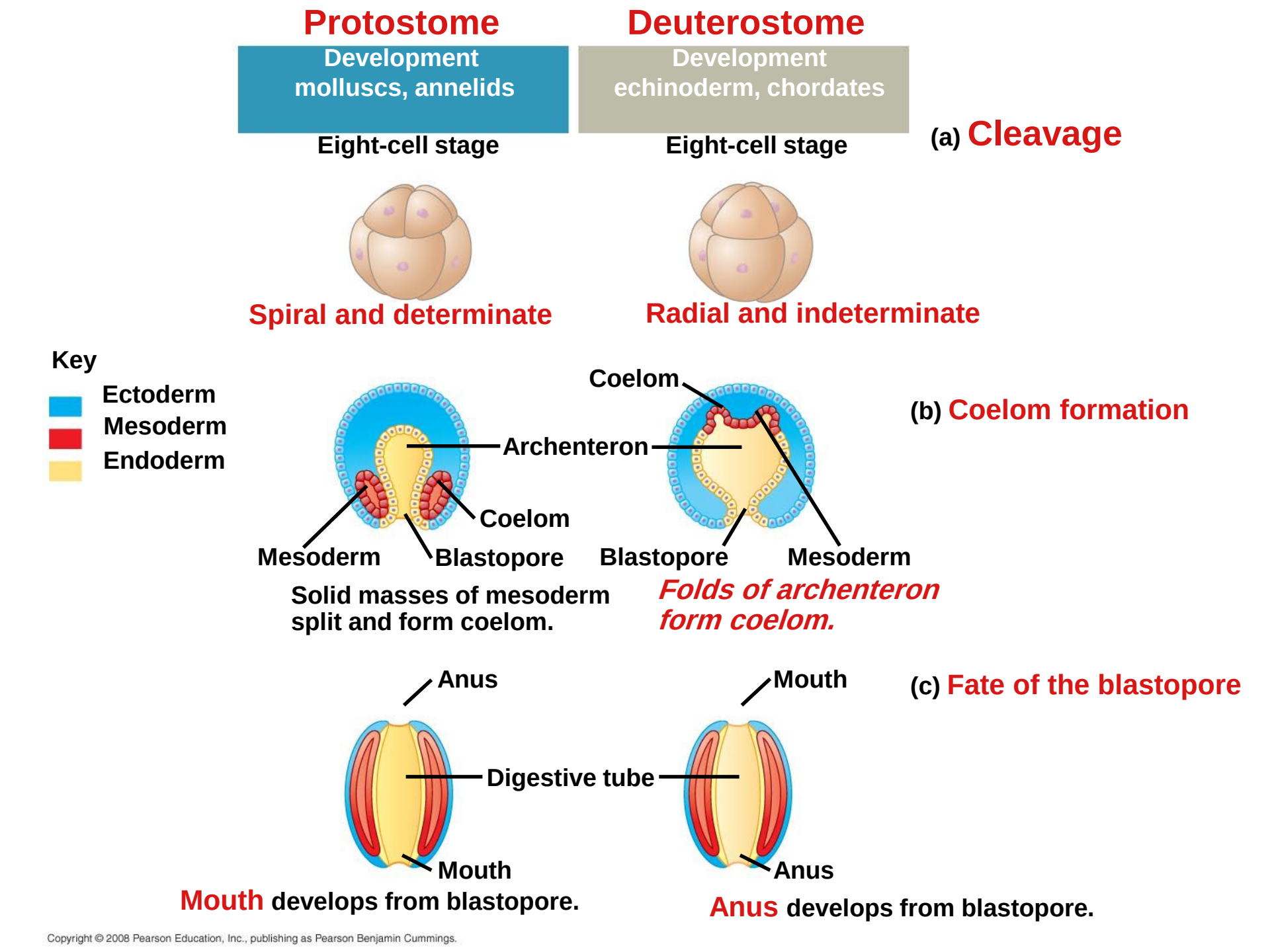
(b) Pseudocoelomate



(c) Acoelomate - lack a body cavity

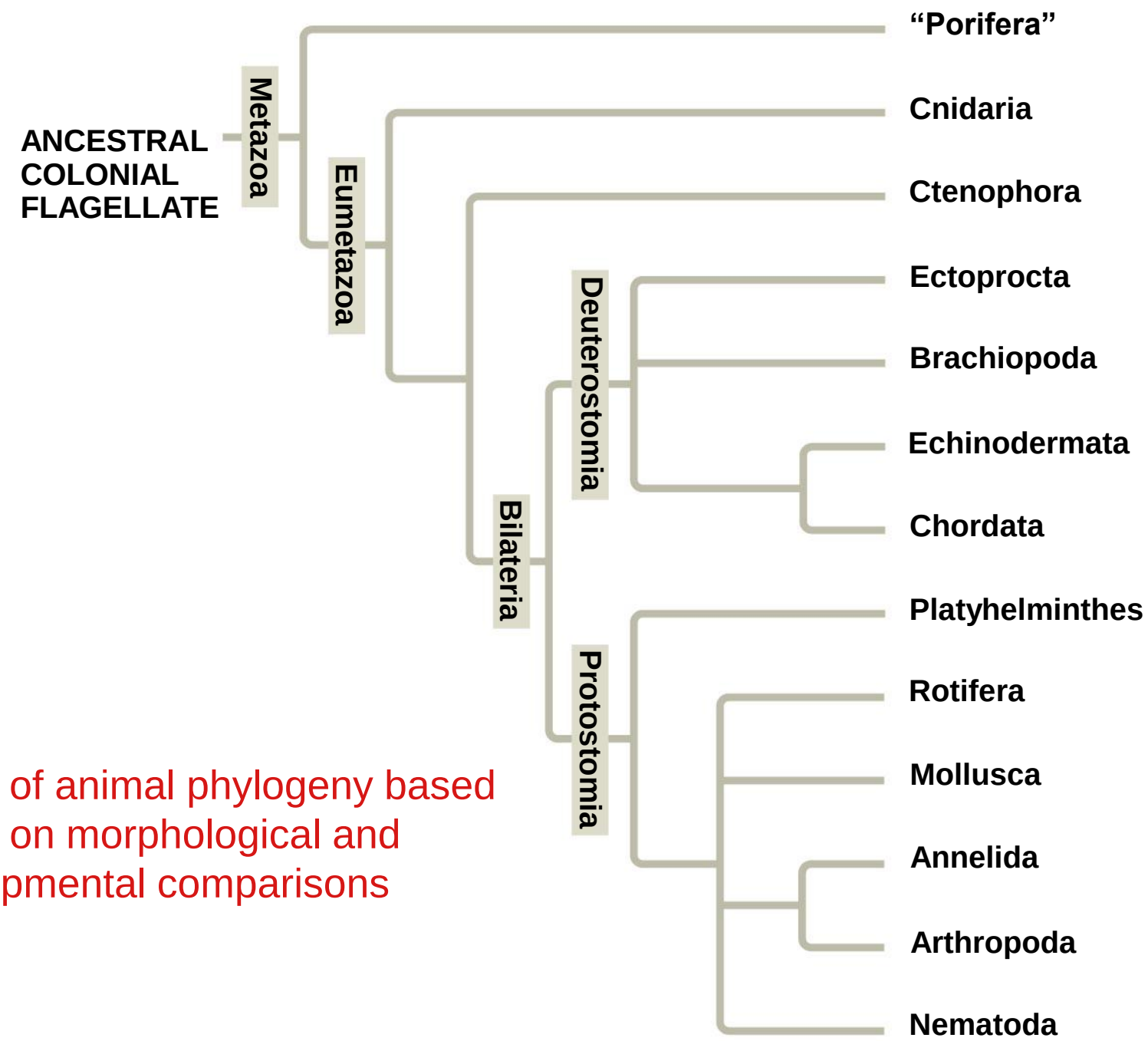
Cleavage: protostome or deuterostome development

- In protostome development, cleavage is **spiral** and **determinate.**
- In deuterostome development, cleavage is **radial** and **indeterminate.**
- *With indeterminate cleavage, **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.

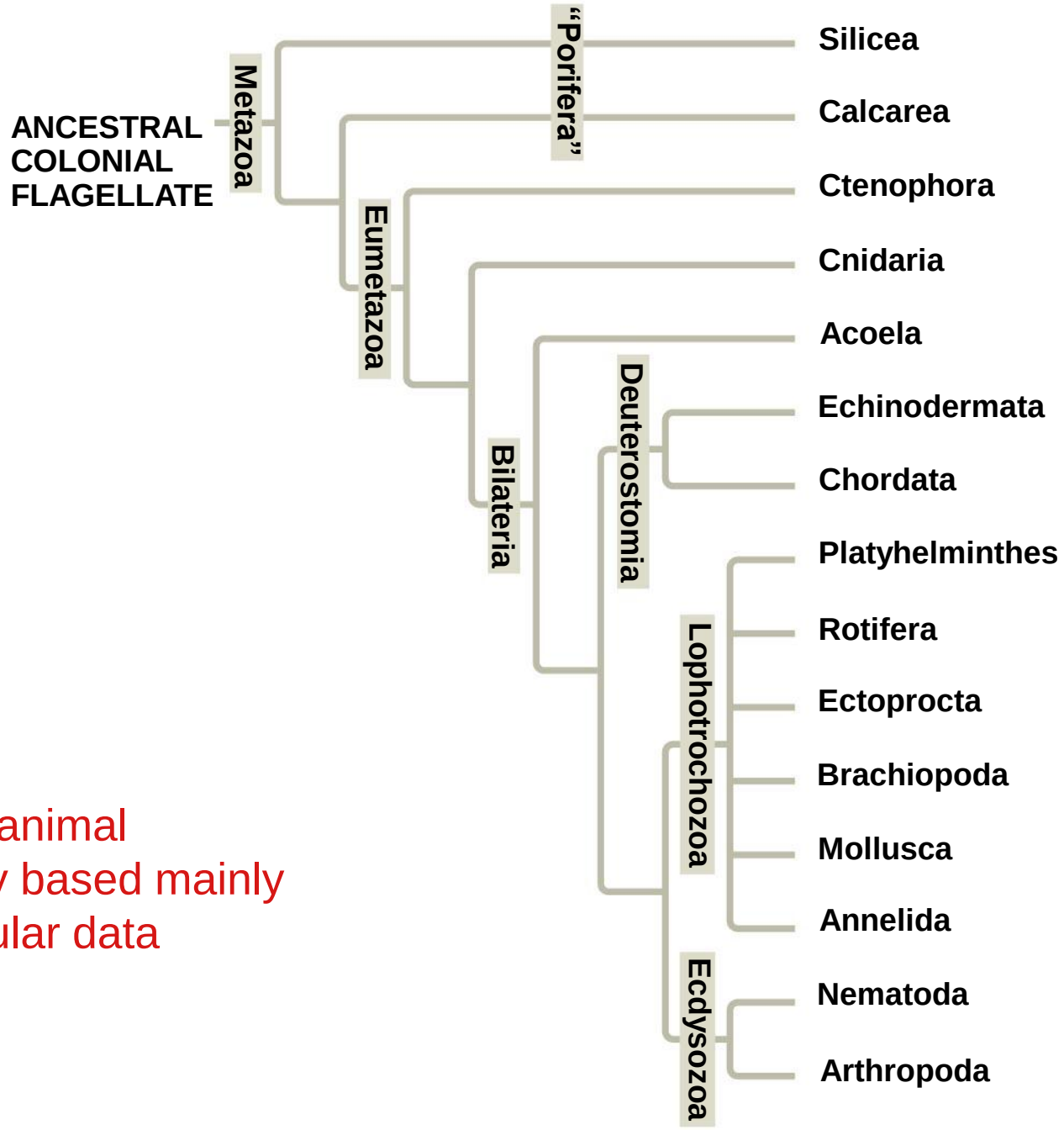


New views of animal phylogeny are emerging from molecular data

- Zoologists recognize about three dozen animal phyla.
- Current debate in animal systematics has led to the development of two phylogenetic hypotheses, but others exist as well.
- One hypothesis of animal phylogeny is based mainly on morphological and developmental comparisons.
- Another hypothesis is based mainly on molecular data.



A view of animal phylogeny based mainly on morphological and developmental comparisons



A view of animal phylogeny based mainly on molecular data

Points of Agreement

- All animals share a *common ancestor*.
- Sponges are basal animals.
- Eumetazoa is a clade of animals - ***eumetazoans*** with *true tissues*.
- Most animal phyla belong to the clade Bilateria, and are called ***bilaterians***.
- Chordates and some other phyla belong to the clade Deuterostomia.

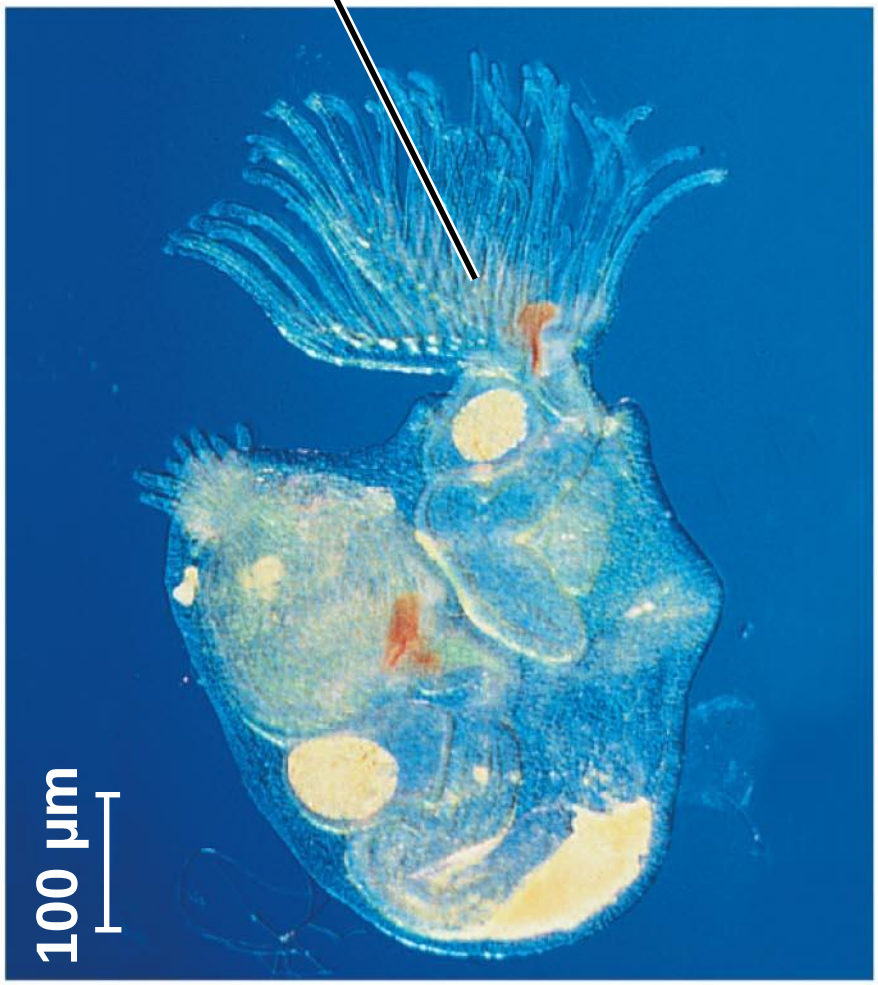
Progress in Resolving Bilaterian Relationships

- The morphology-based tree divides bilaterians into two clades: deuterostomes and protostomes.
- In contrast, recent molecular studies indicate three bilaterian clades: Deuterostomia, Ecdysozoa, and Lophotrochozoa.
- ***Ecdysozoans*** *shed their exoskeletons through a process called ecdysis.*

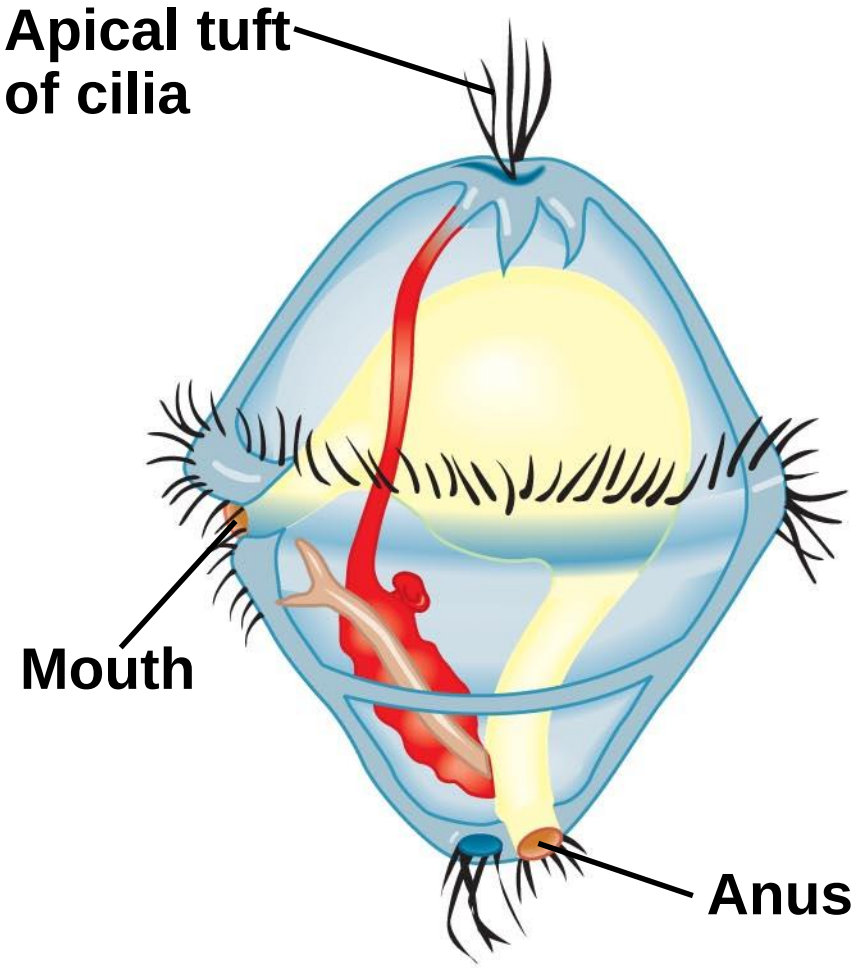
Ecdysis - Shedding of Exoskeleton

- Some **lophotrochozoans** have a feeding structure called a **lophophore.**
- Other phyla go through a distinct developmental stage called the **trochophore larva.**

Lophotrochozoans Characteristics

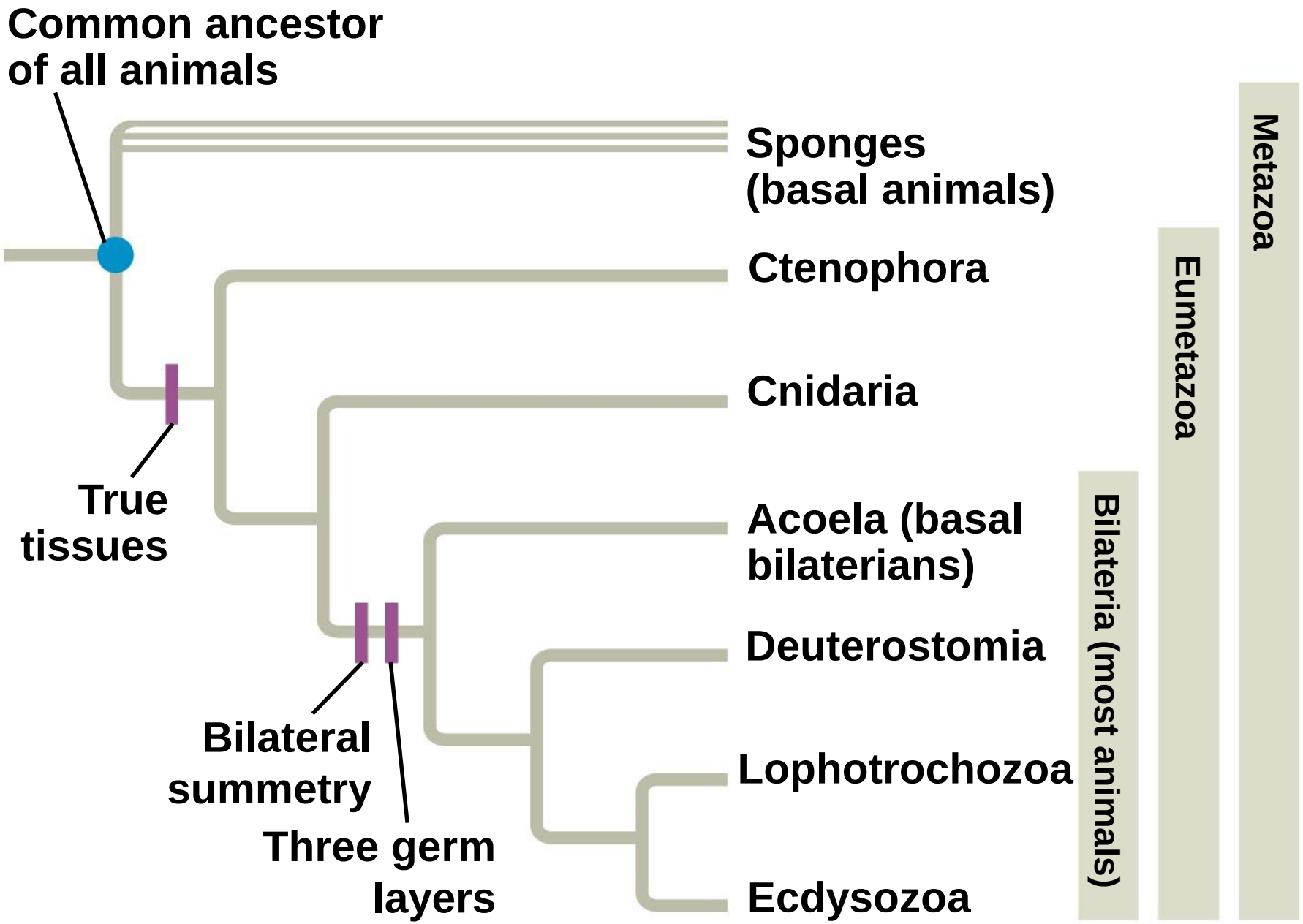


(a) An ectoproct



(b) Structure of a trochophore larva

Animal Phylogeny



You should now be able to:

1. List the characteristics that combine to define animals.

2. Summarize key events of the Paleozoic, Mesozoic, and Cenozoic eras.

3. Distinguish between the following pairs or sets of terms:
   radial and bilateral symmetry;
   diploblastic and triploblastic;
   spiral and radial cleavage;
   determinate and indeterminate cleavage;
   acoelomate, pseudocoelomate, and coelomate

4. Compare the developmental differences between protostomes and deuterostomes.