Chapter 32

An Introduction to Animal Diversity

PowerPoint® Lecture Presentations for

Biology

Eighth Edition

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Lectures by Chris Romero, updated by Erin Barley with contributions from Joan Sharp

Overview: Welcome to Your Kingdom

- The animal kingdom extends far beyond humans and other animals we may encounter
- 1.3 million living species of animals have been identified

PLAY Video: Coral Reef

Fig. 32-1

Concept 32.1: Animal 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 group

Nutritional Mode

- Animals are heterotrophs that ingest their food

Cell Structure and Specialization

- 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 a sperm fertilizes an egg, 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

PLAY Video: Sea Urchin Embryonic Development

Fig. 32-2-1

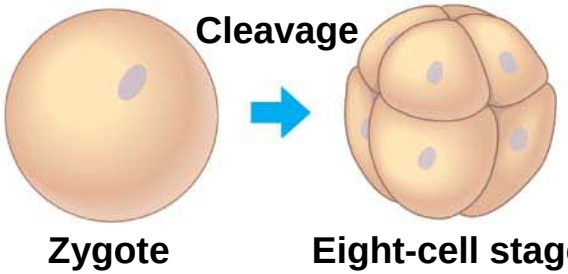


Fig. 32-2-2

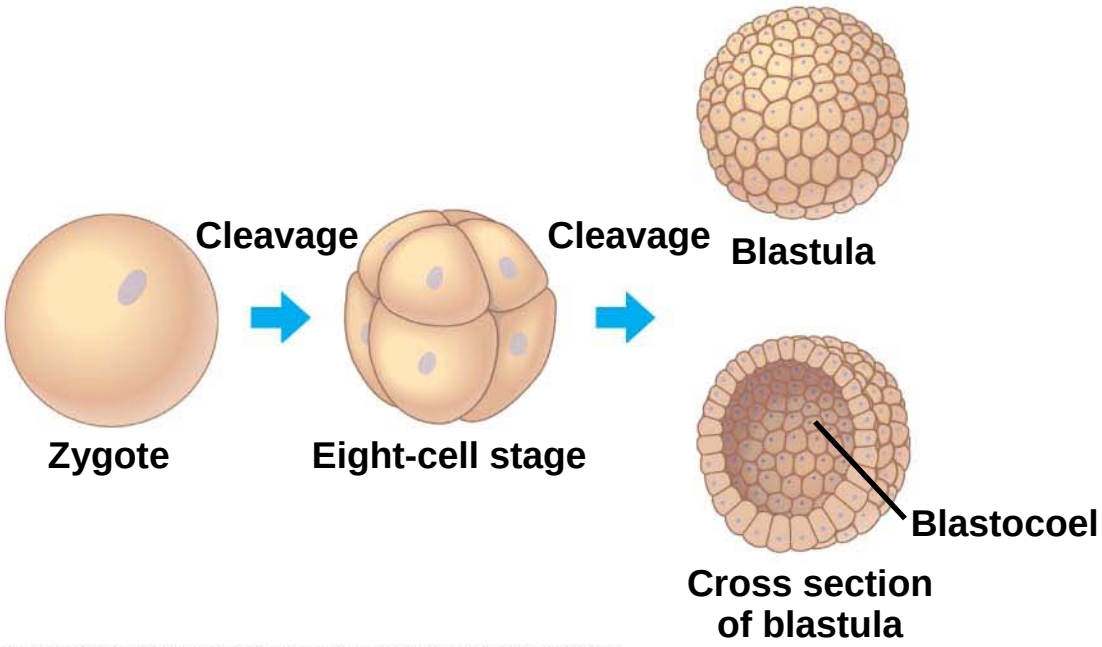
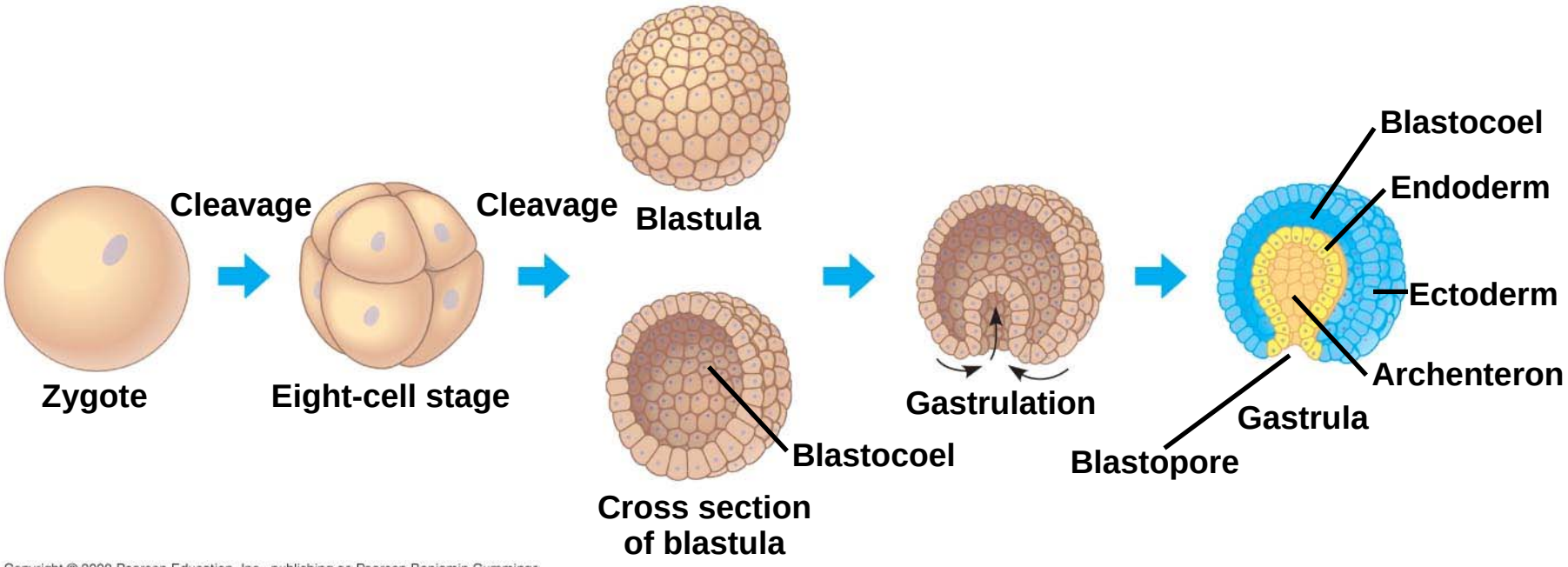


Fig. 32-2-3



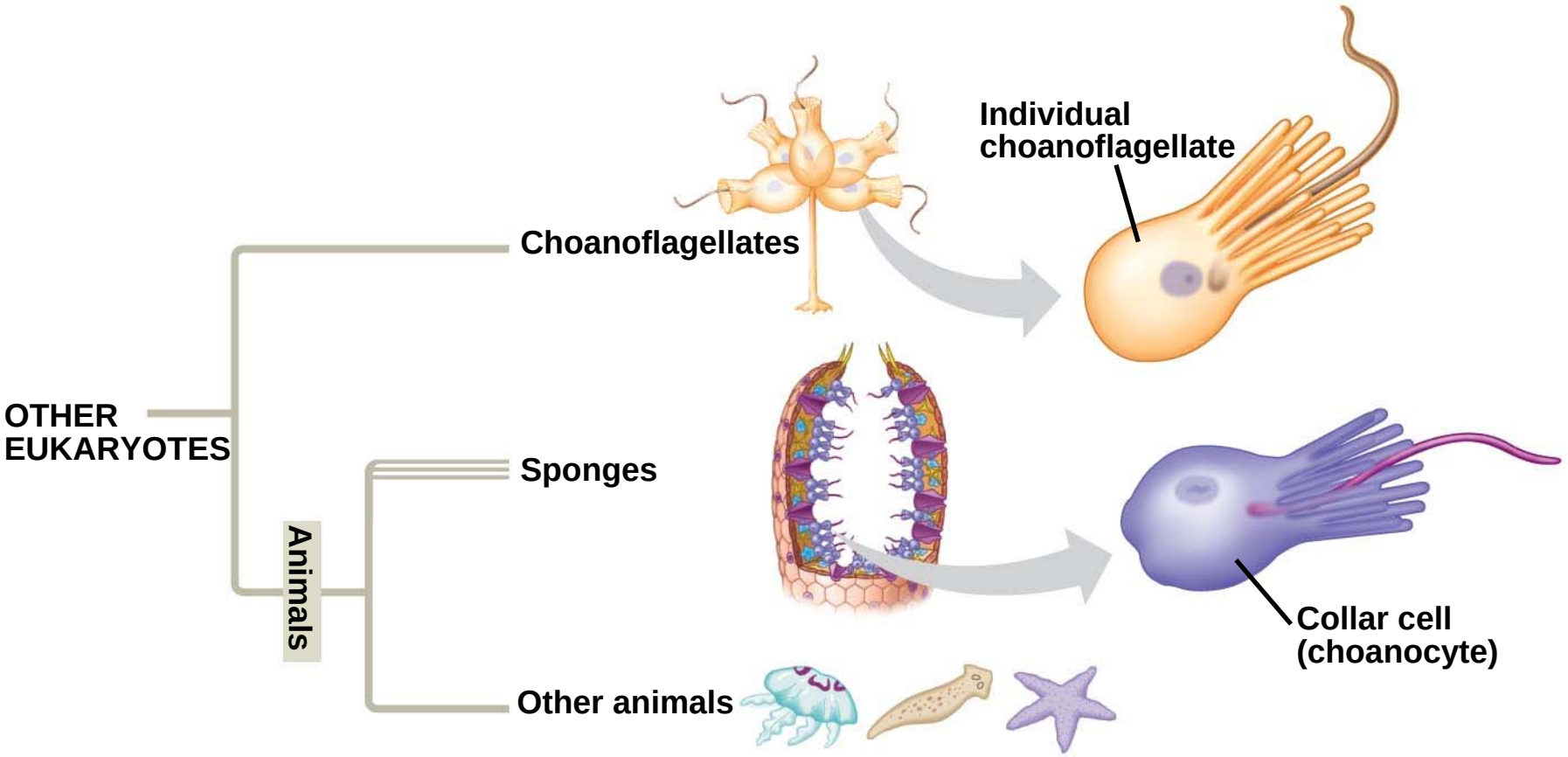
- Many animals have at least one larval stage
- A **larva** is sexually immature and morphologically distinct from the adult; it eventually undergoes **metamorphosis**

- 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

Concept 32.2: 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

Fig. 32-3

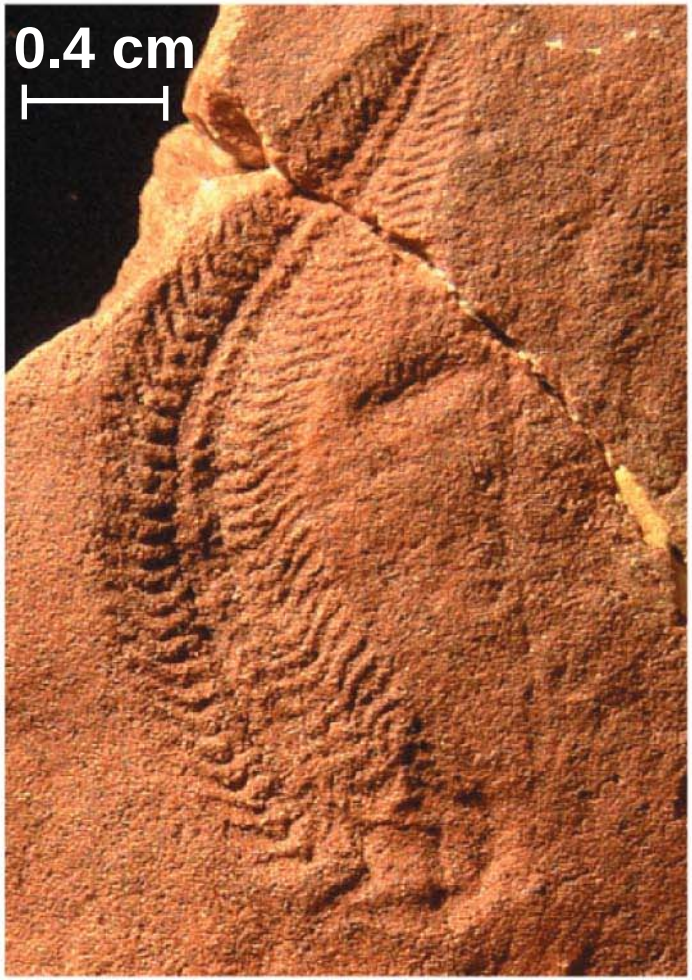


Neoproterozoic Era (1 Billion–524 Million Years Ago)

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

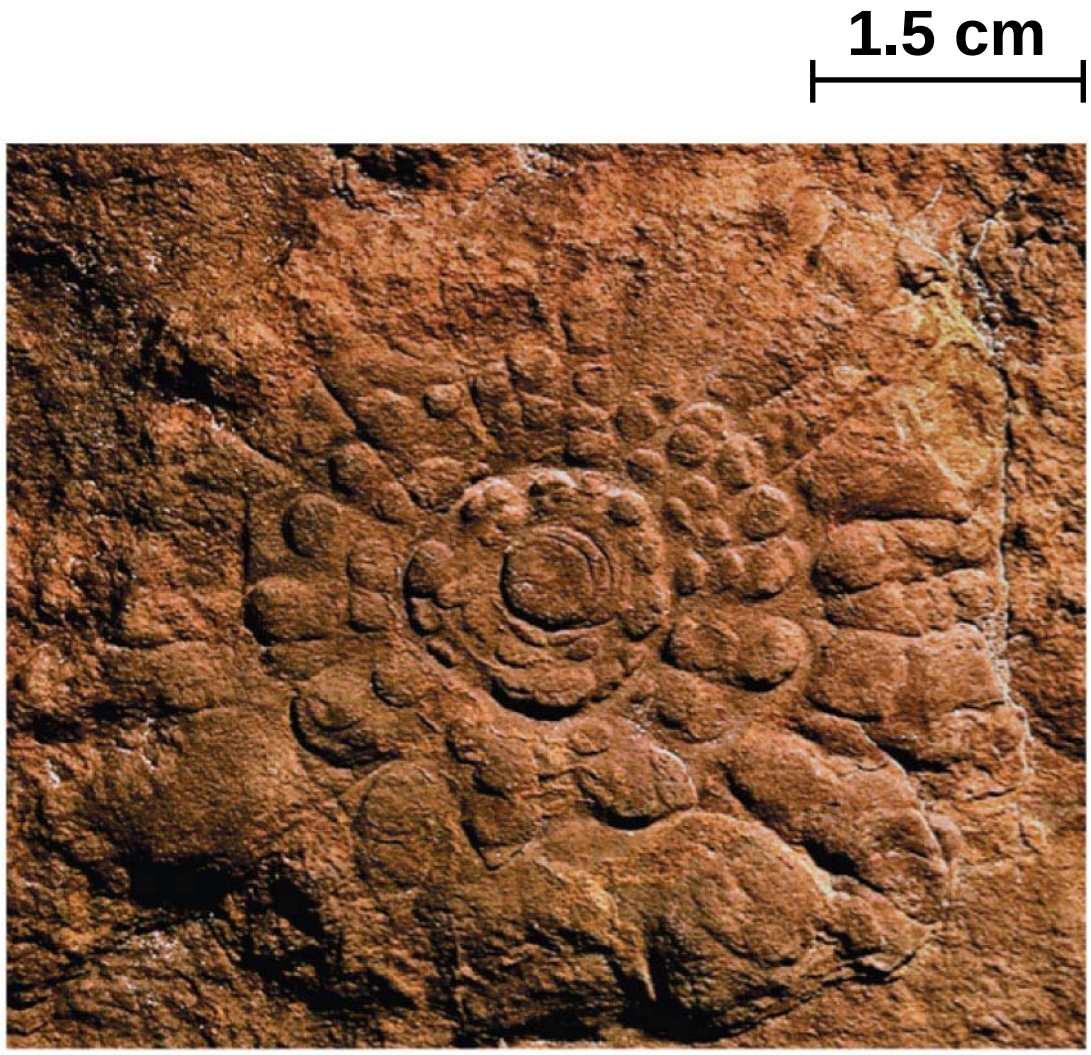
Fig. 32-4

(a) *Mawsonites spriggi*



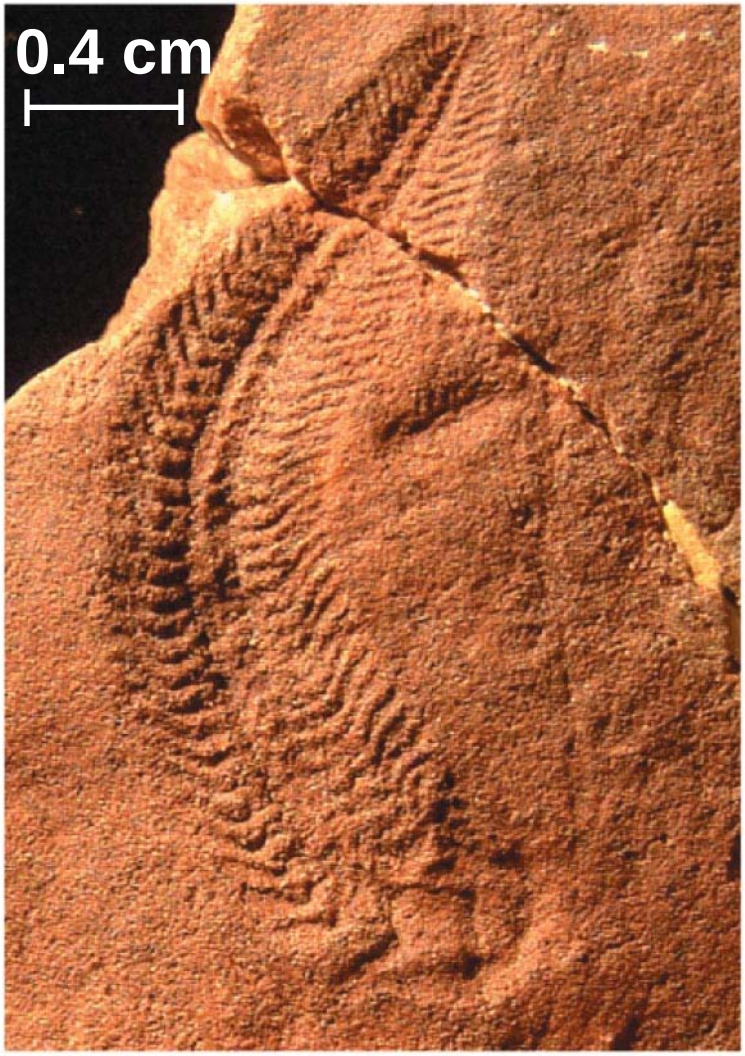
(b) *Spriggina floundersi*

Fig. 32-4a



(a) *Mawsonites spriggi*

Fig. 32-4b

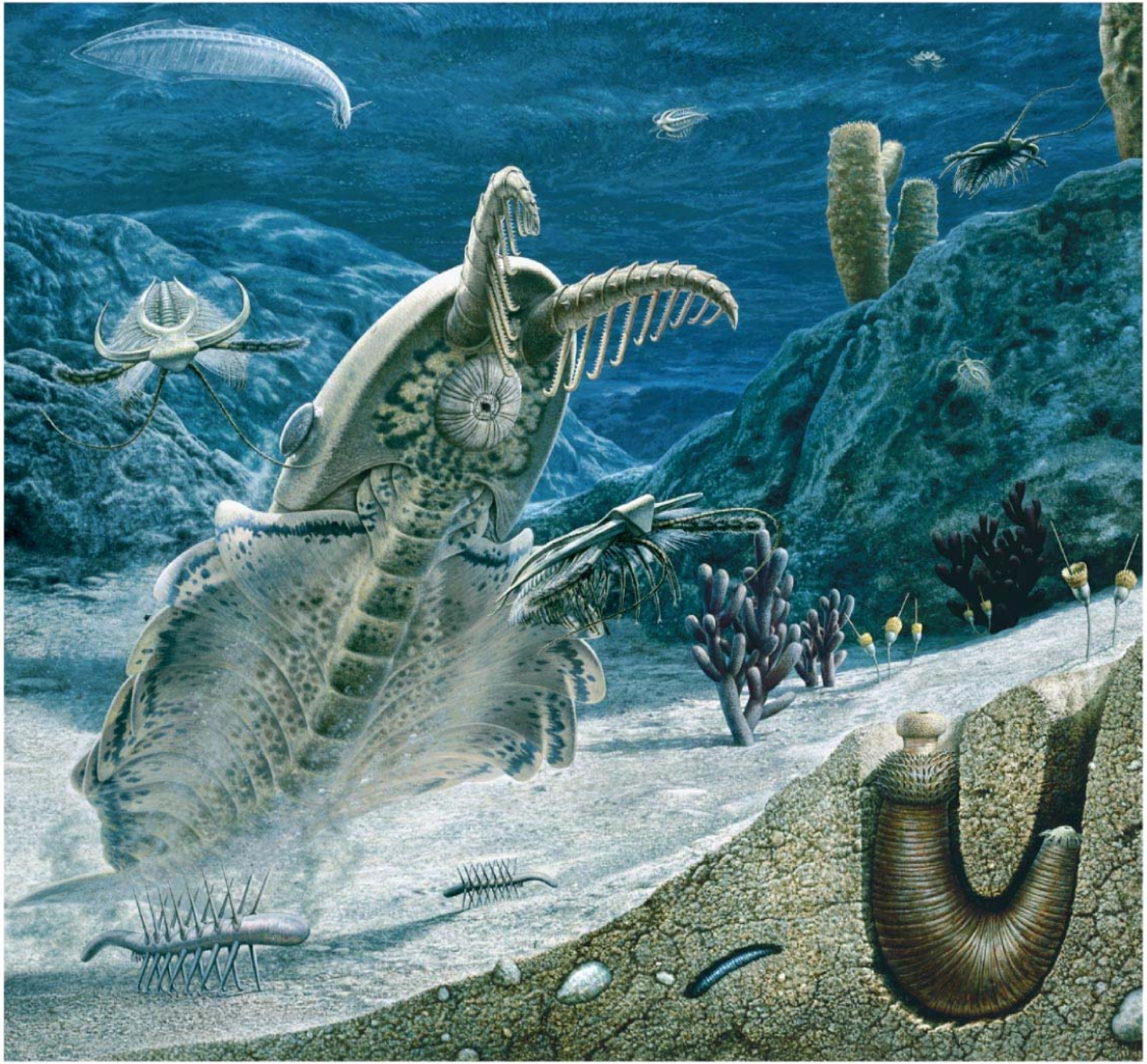


(b) *Spriggina floundersi*

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

Fig. 32-5



- 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

Mesozoic Era (251–65.5 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

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
- A *grade* is a group whose members share key biological features
- A grade is not necessarily a *clade*, or monophyletic group

Fig. 32-6

RESULTS

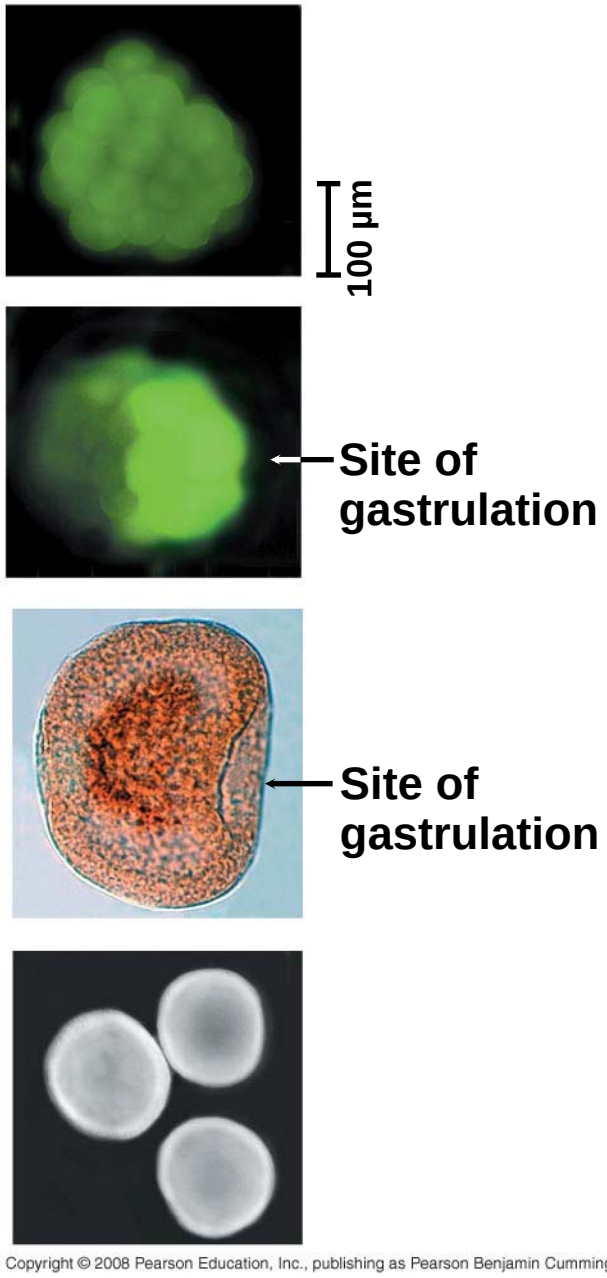


Fig. 32-6a

RESULTS

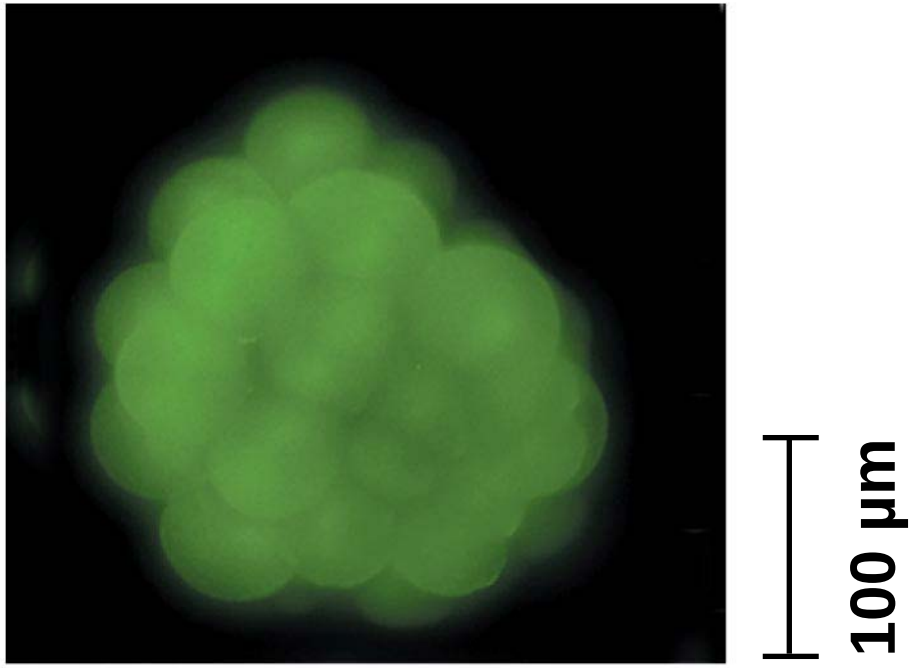


Fig. 32-6b

RESULTS

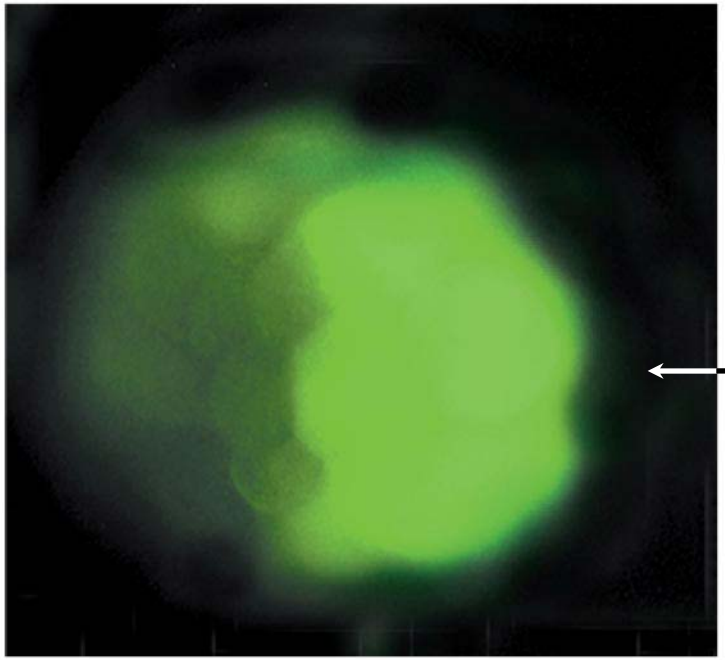
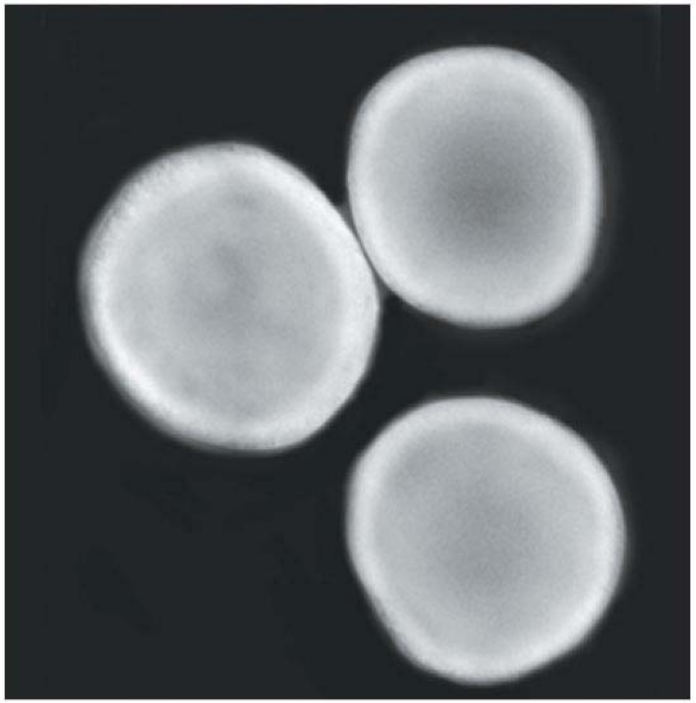


Fig. 32-6c

RESULTS

Fig. 32-6d

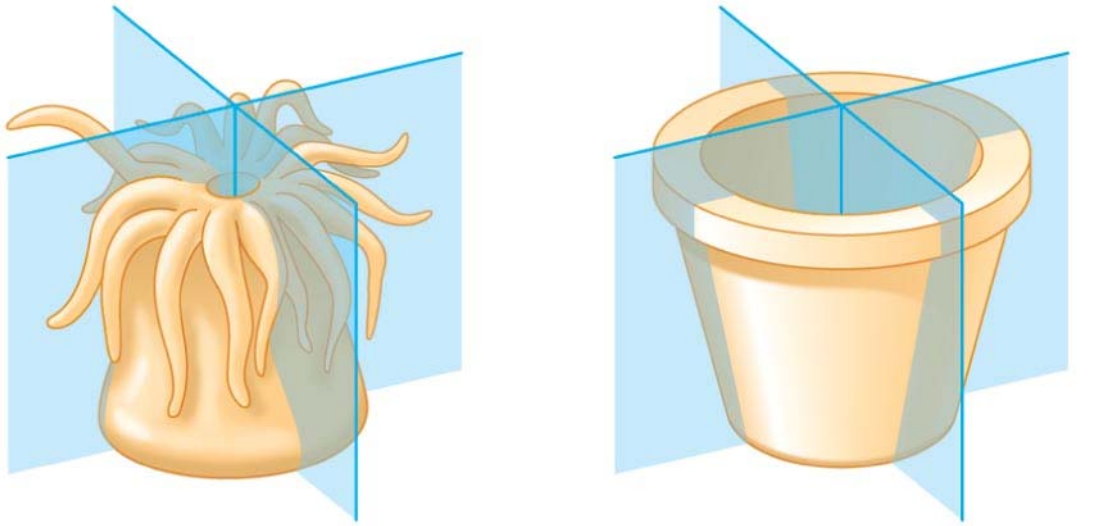
RESULTS



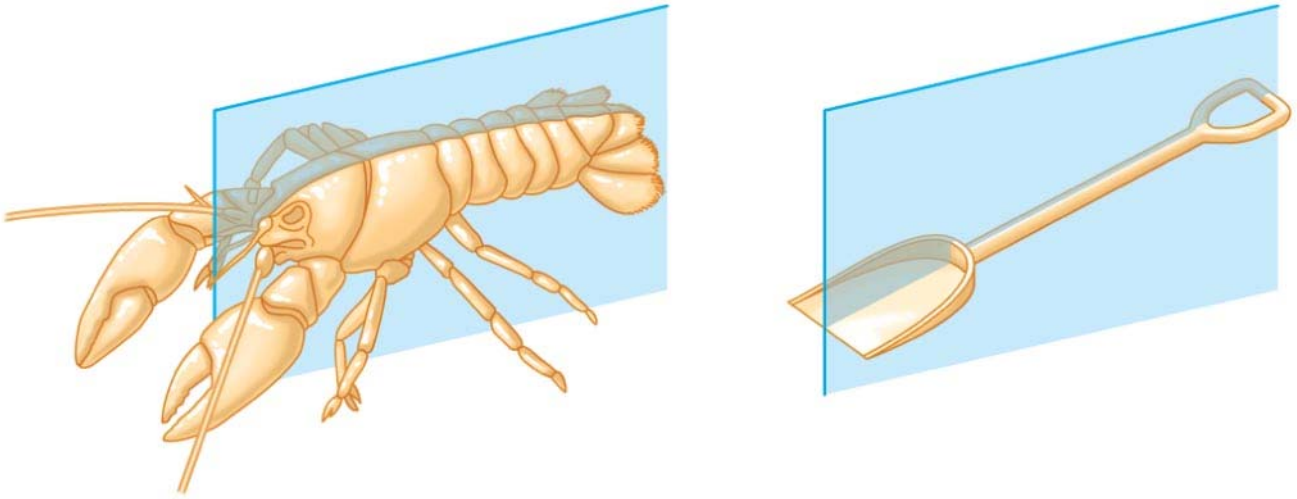
Symmetry

- Animals can be categorized according to the symmetry of their bodies, or lack of it
- Some animals have **radial symmetry**

Fig. 32-7



(a) Radial symmetry



(b) Bilateral symmetry

- Two-sided symmetry is called **bilateral symmetry**
- Bilaterally symmetrical animals 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

Tissues

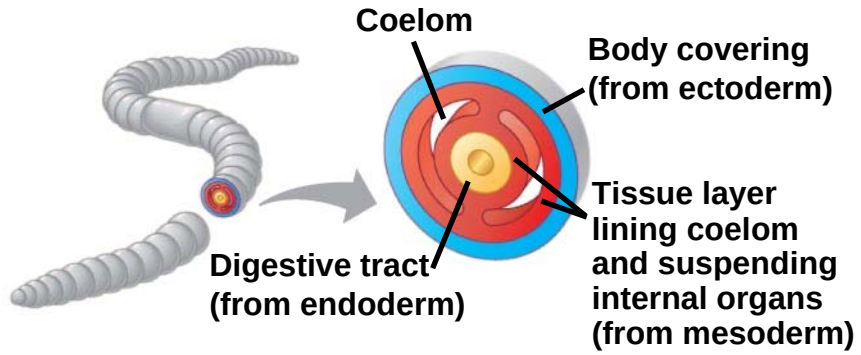
- Animal body plans also vary according to the organization of the animal's tissues
- Tissues are collections of specialized cells isolated from other tissues by membranous layers
- During development, three *germ layers* give rise to the tissues and organs of the animal embryo

- **Ectoderm** is the germ layer covering the 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 an intervening **mesoderm** layer; these include all bilaterians

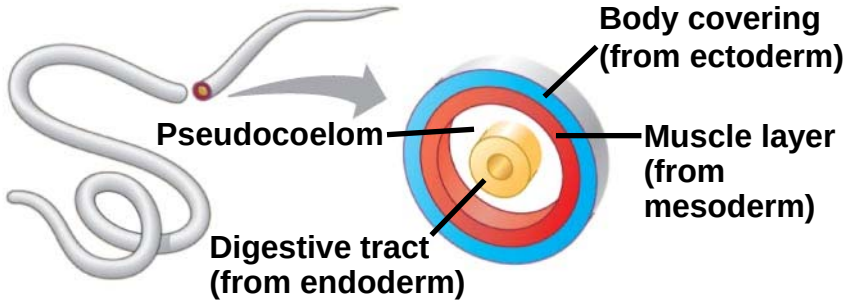
Body Cavities

- 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

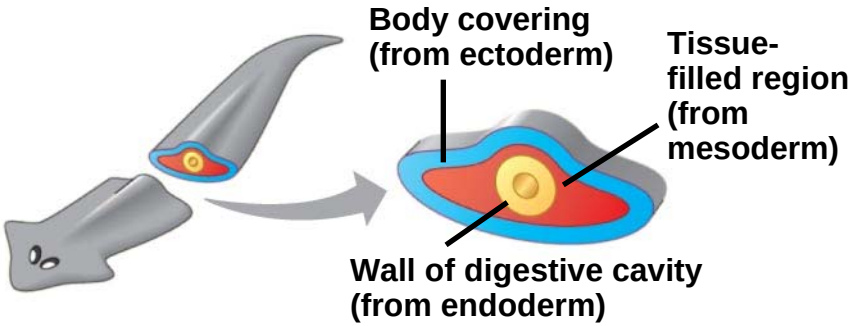
Fig. 32-8



(a) Coelomate

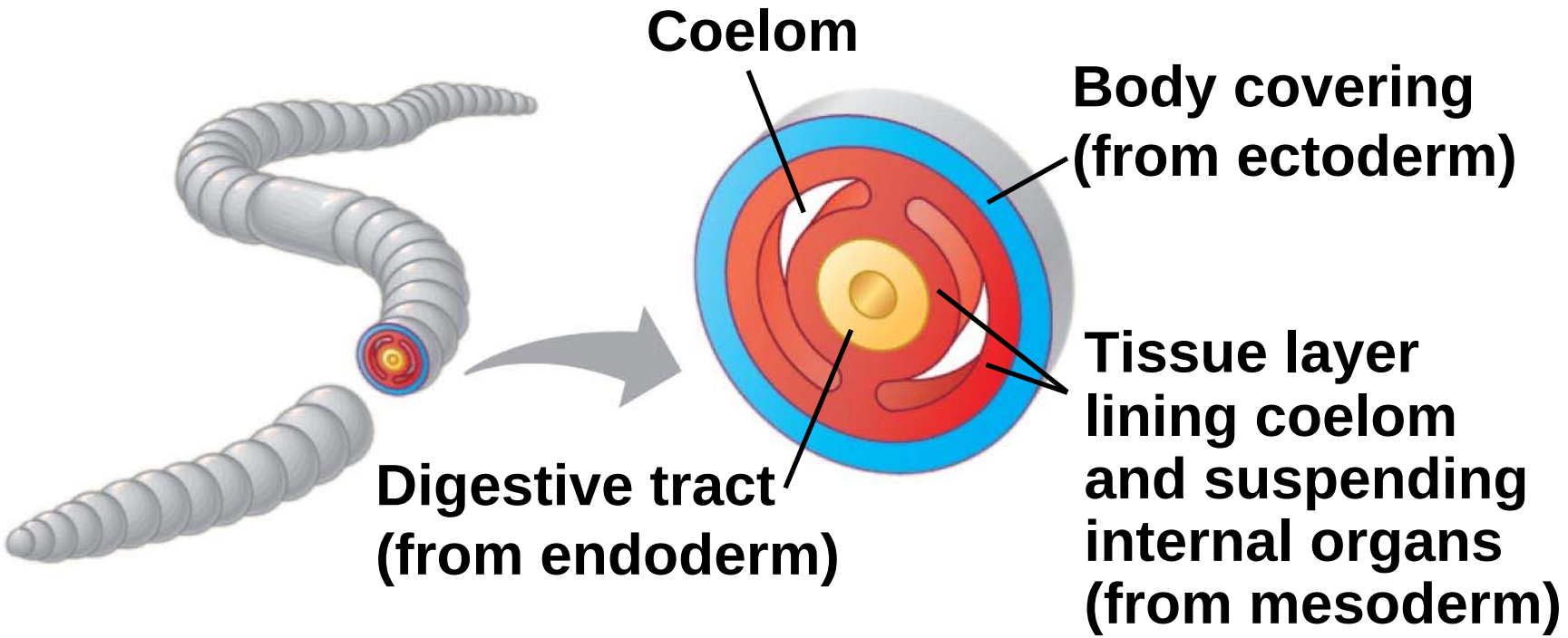


(b) Pseudocoelomate



(c) Acoelomate

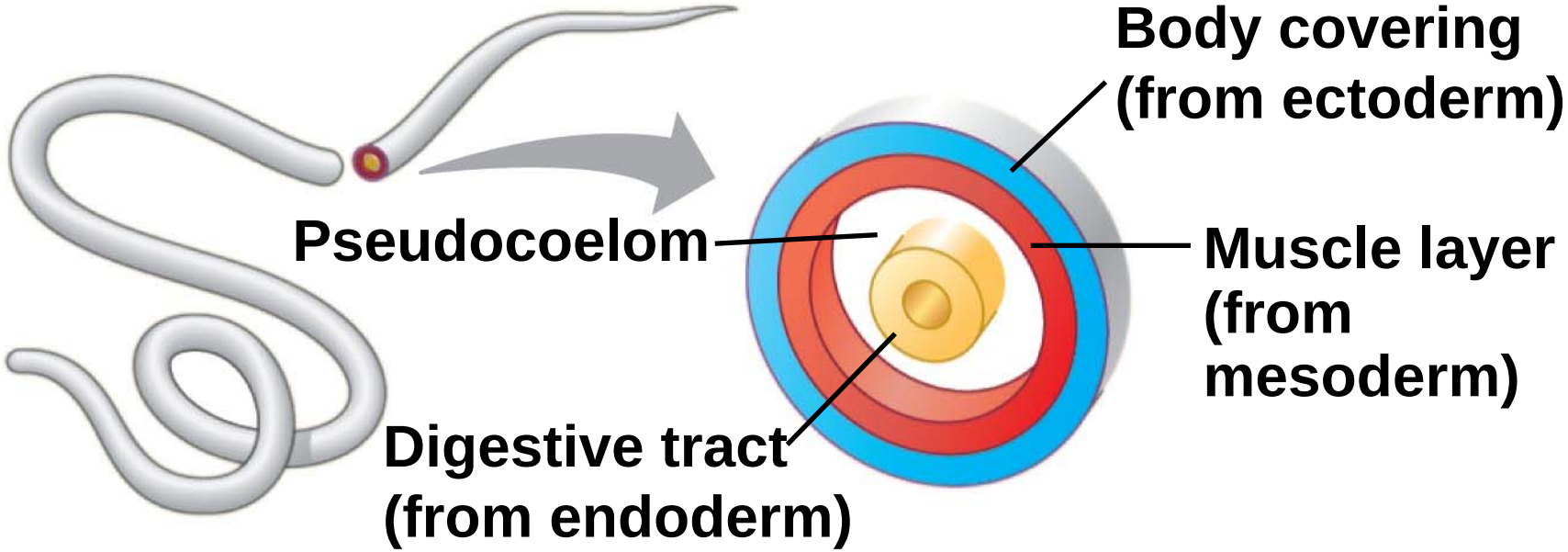
Fig. 32-8a



(a) Coelomate

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

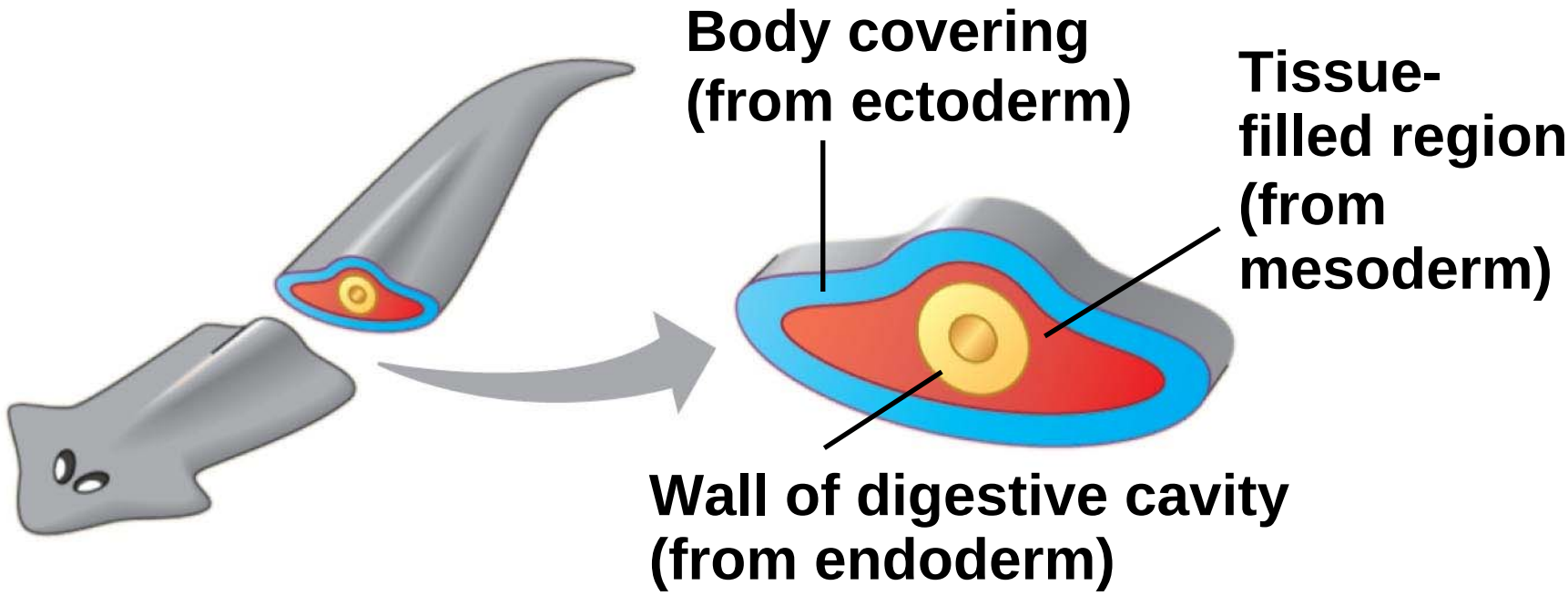
Fig. 32-8b



(b) Pseudocoelomate

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

Fig. 32-8c



(c) Acoelomate

Protostome and Deuterostome Development

- Based on early development, many animals can be categorized as having **protostome development** or **deuterostome development**

Cleavage

- 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

Fig. 32-9

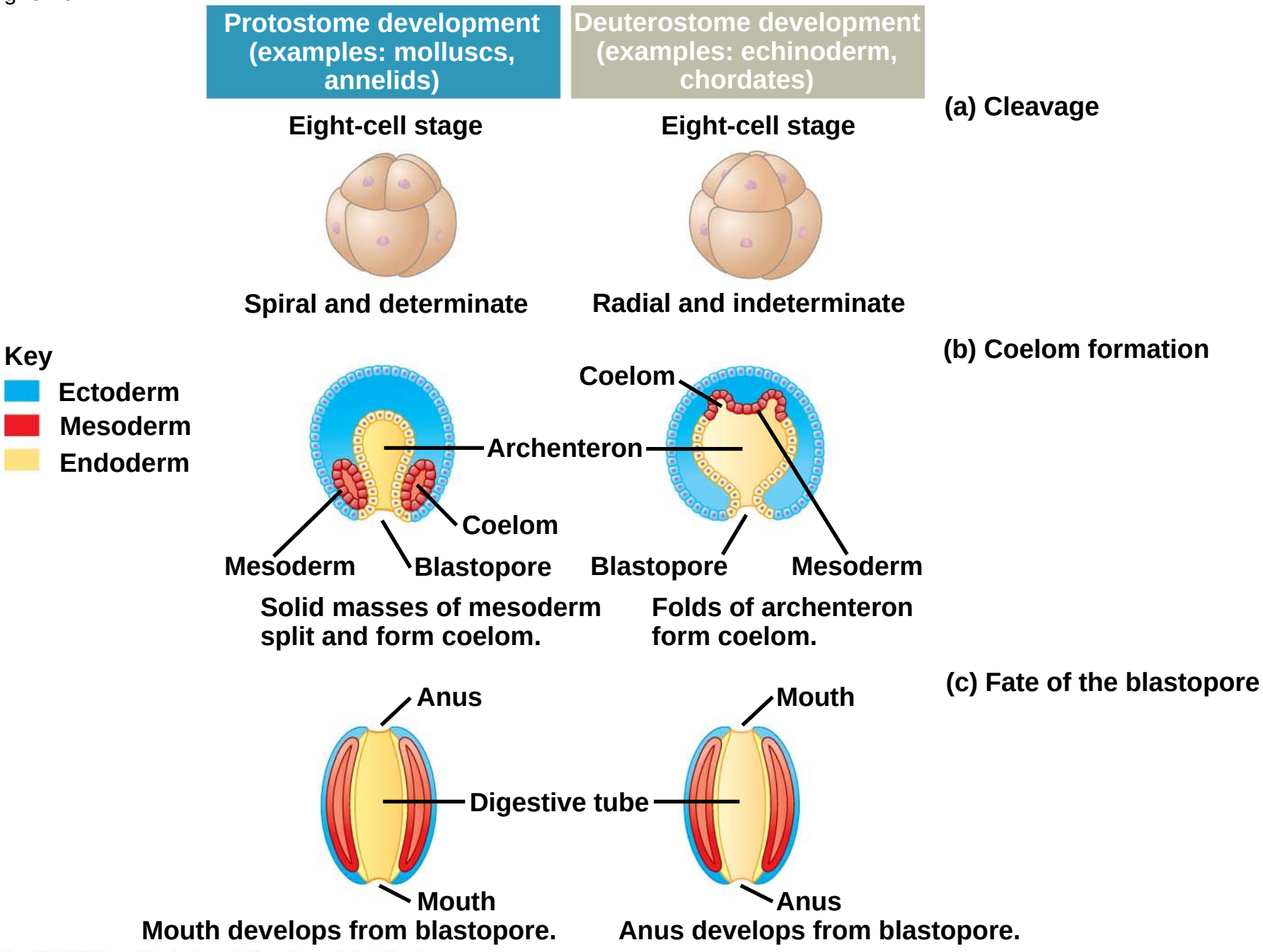
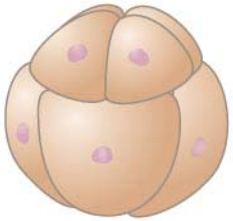


Fig. 32-9a

Protostome development (examples: molluscs, annelids)

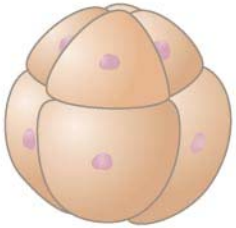
Eight-cell stage



Spiral and determinate

Deuterostome development (examples: echinoderms, chordates)

Eight-cell stage



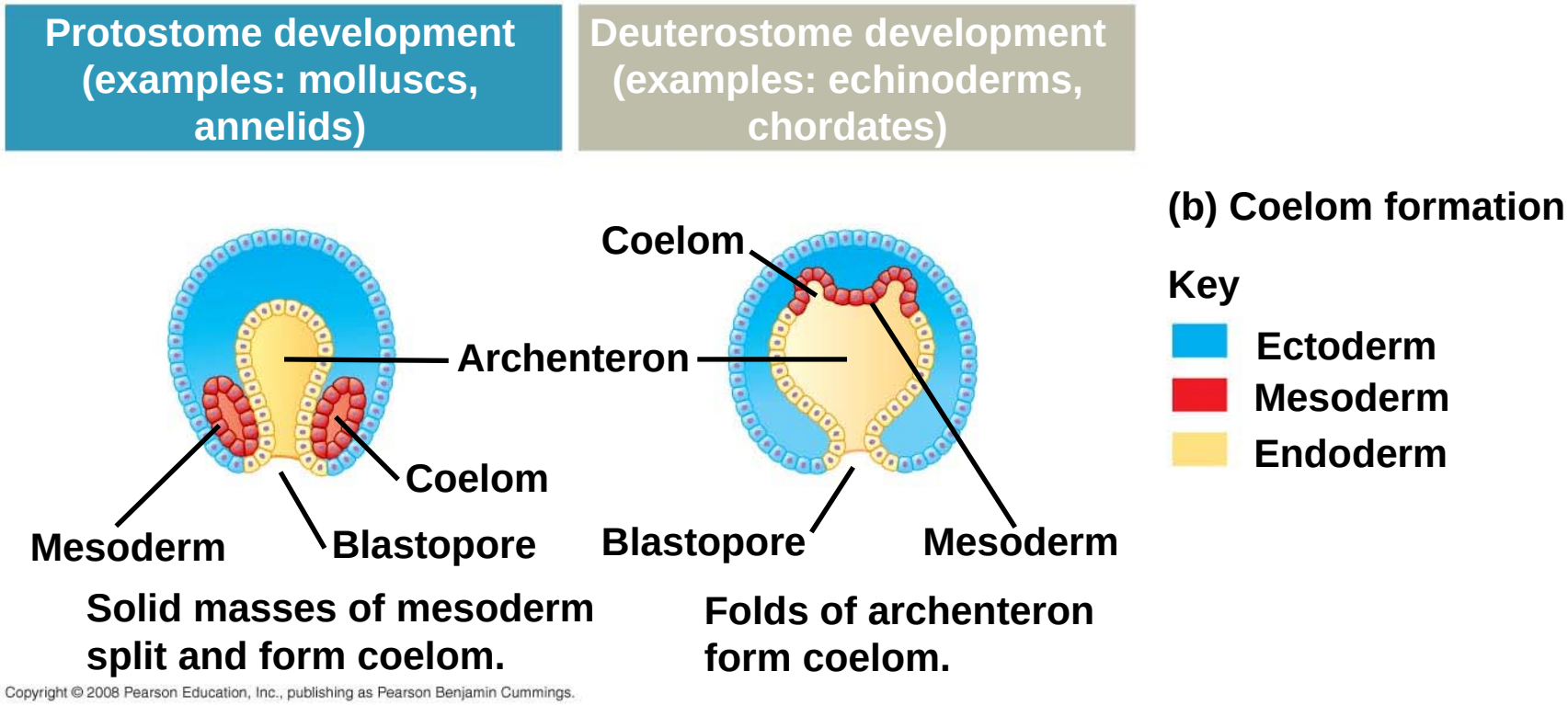
Radial and indeterminate

(a) Cleavage

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

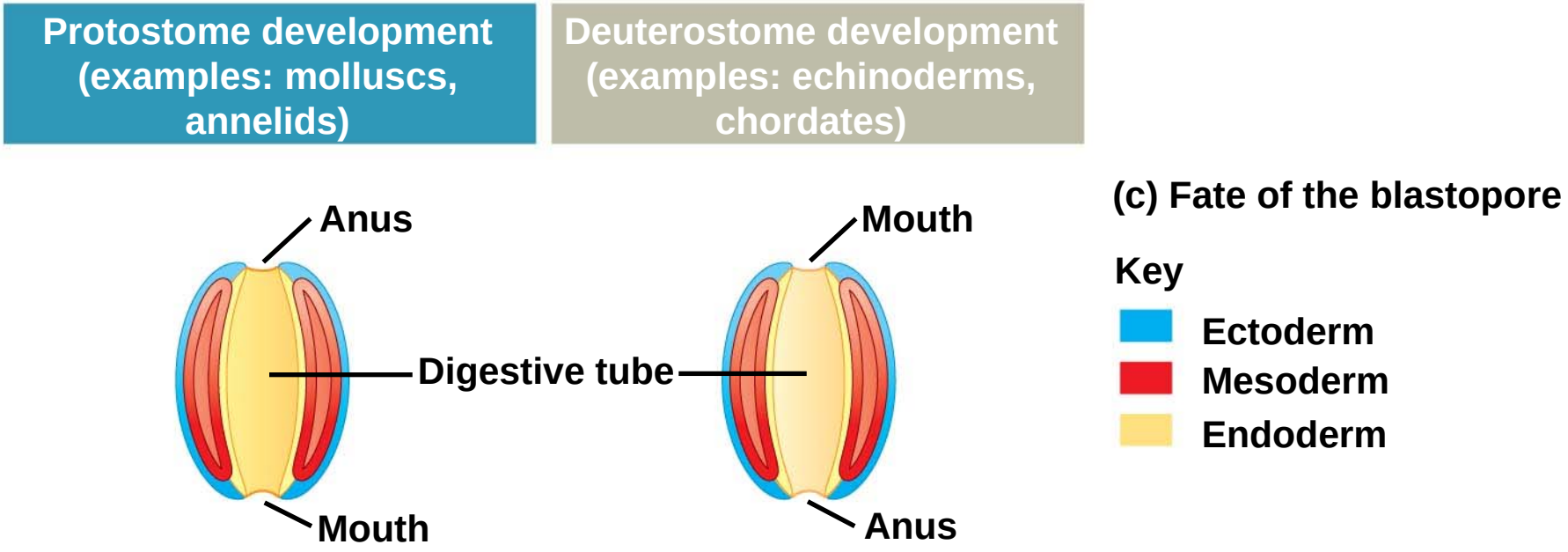
Fig. 32-9b



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

Fig. 32-9c

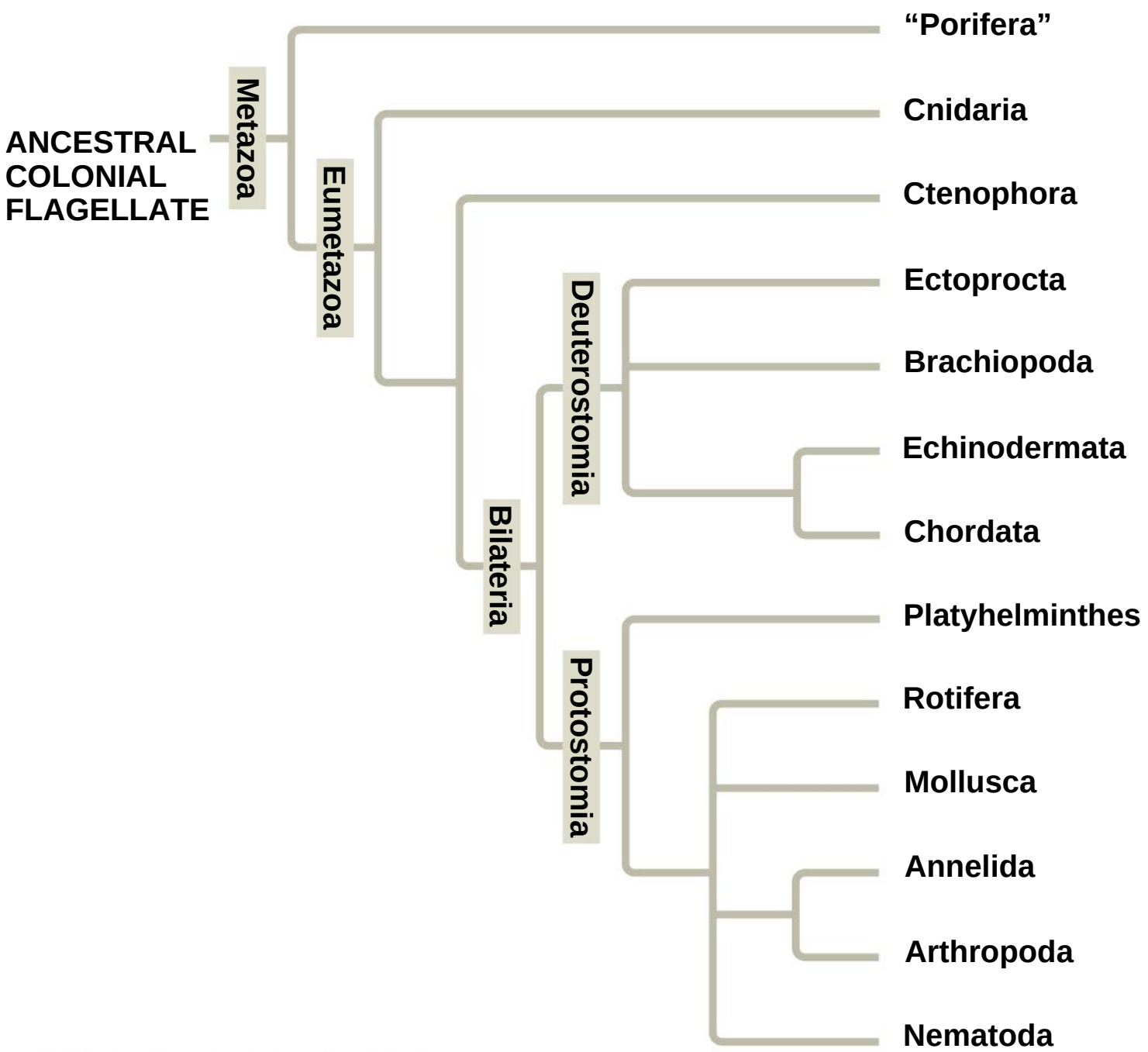


Concept 32.4: New views of animal phylogeny are emerging from molecular data

- 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

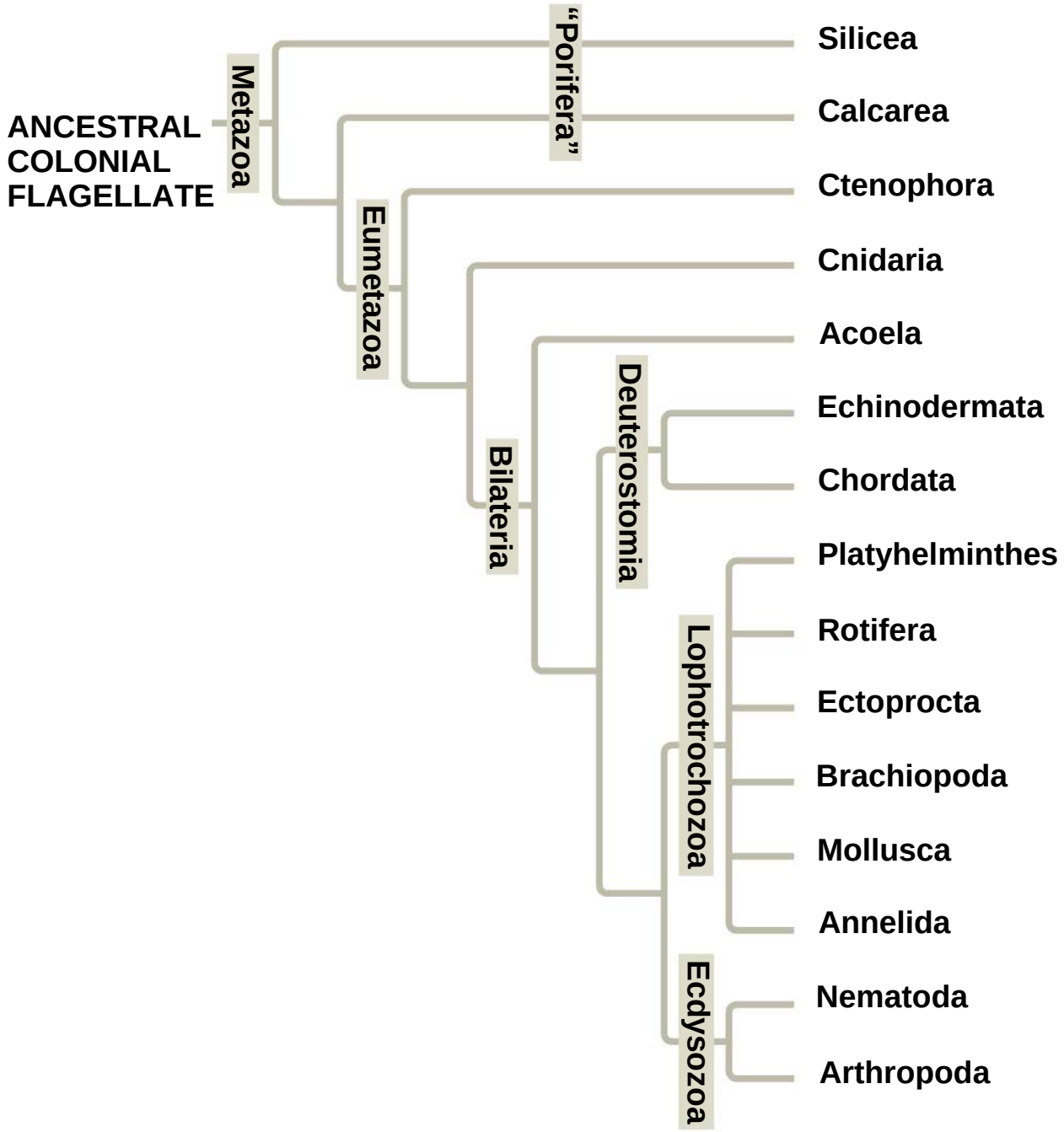
- One hypothesis of animal phylogeny is based mainly on morphological and developmental comparisons

Fig. 32-10



- One hypothesis of animal phylogeny is based mainly on molecular data

Fig. 32-11



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

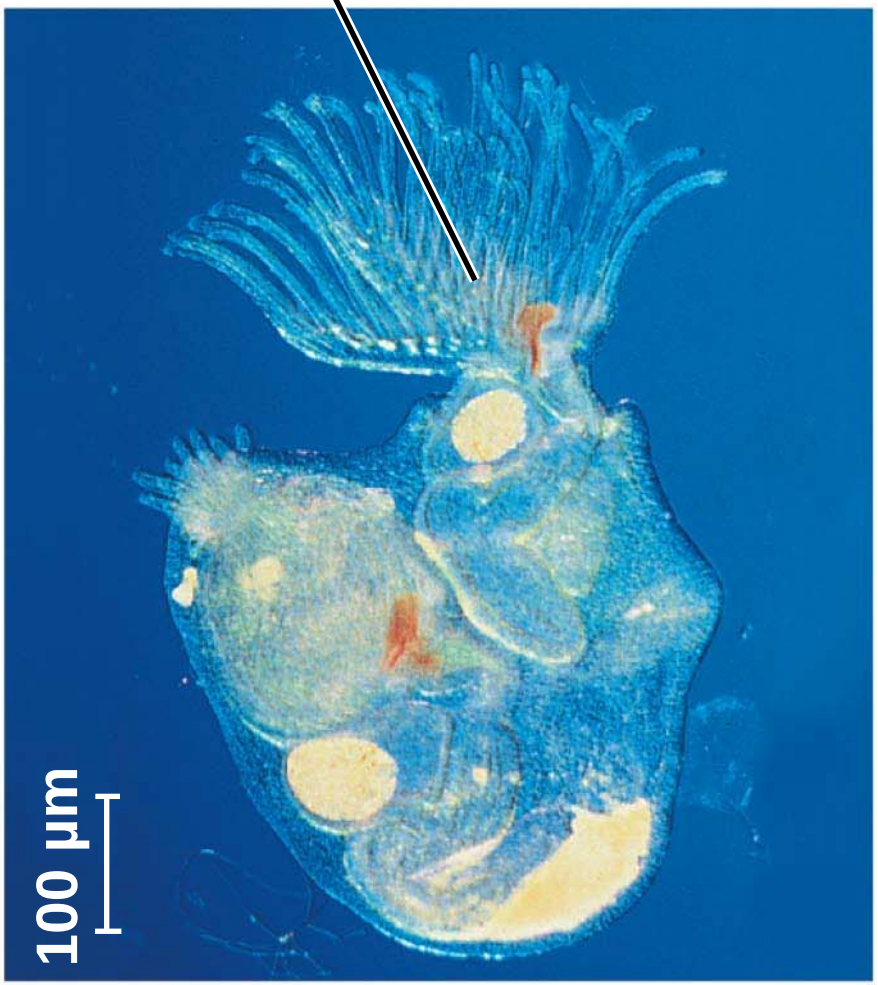
Progress in Resolving Bilaterian Relationships

- 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*

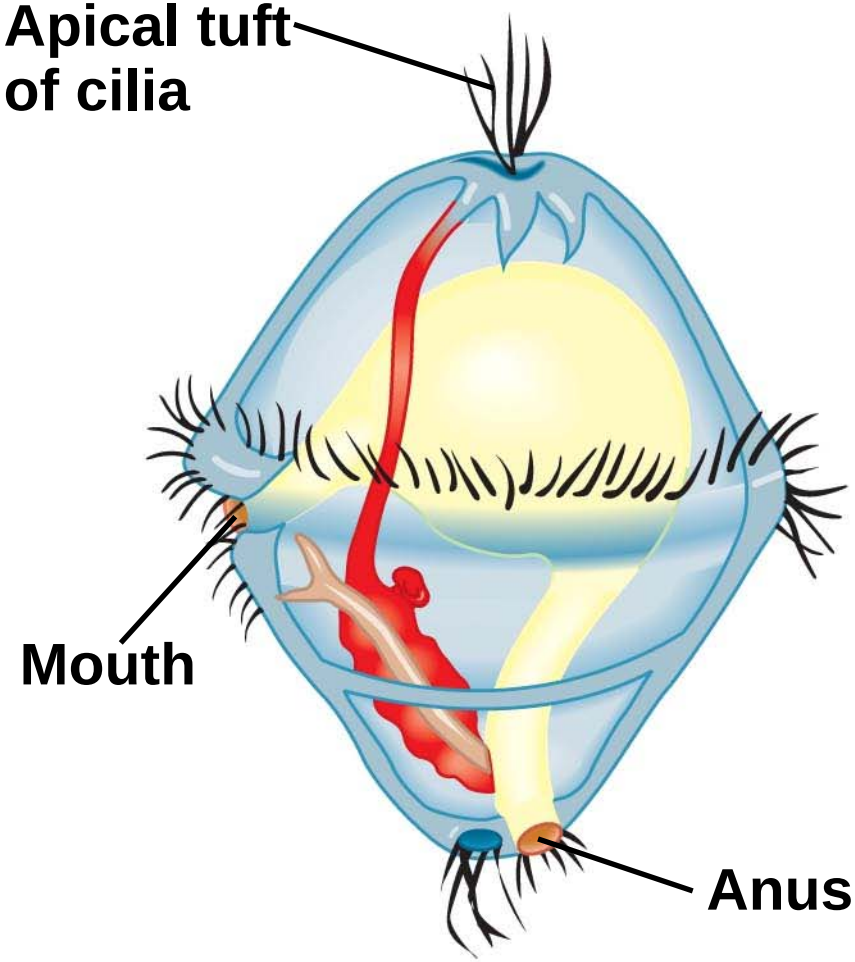
Fig. 32-12

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

Fig. 32-13



(a) An ectoproct



(b) Structure of a trochophore larva

Future Directions in Animal Systematics

- Phylogenetic studies based on larger databases will likely provide further insights into animal evolutionary history

Fig. 32-UN1

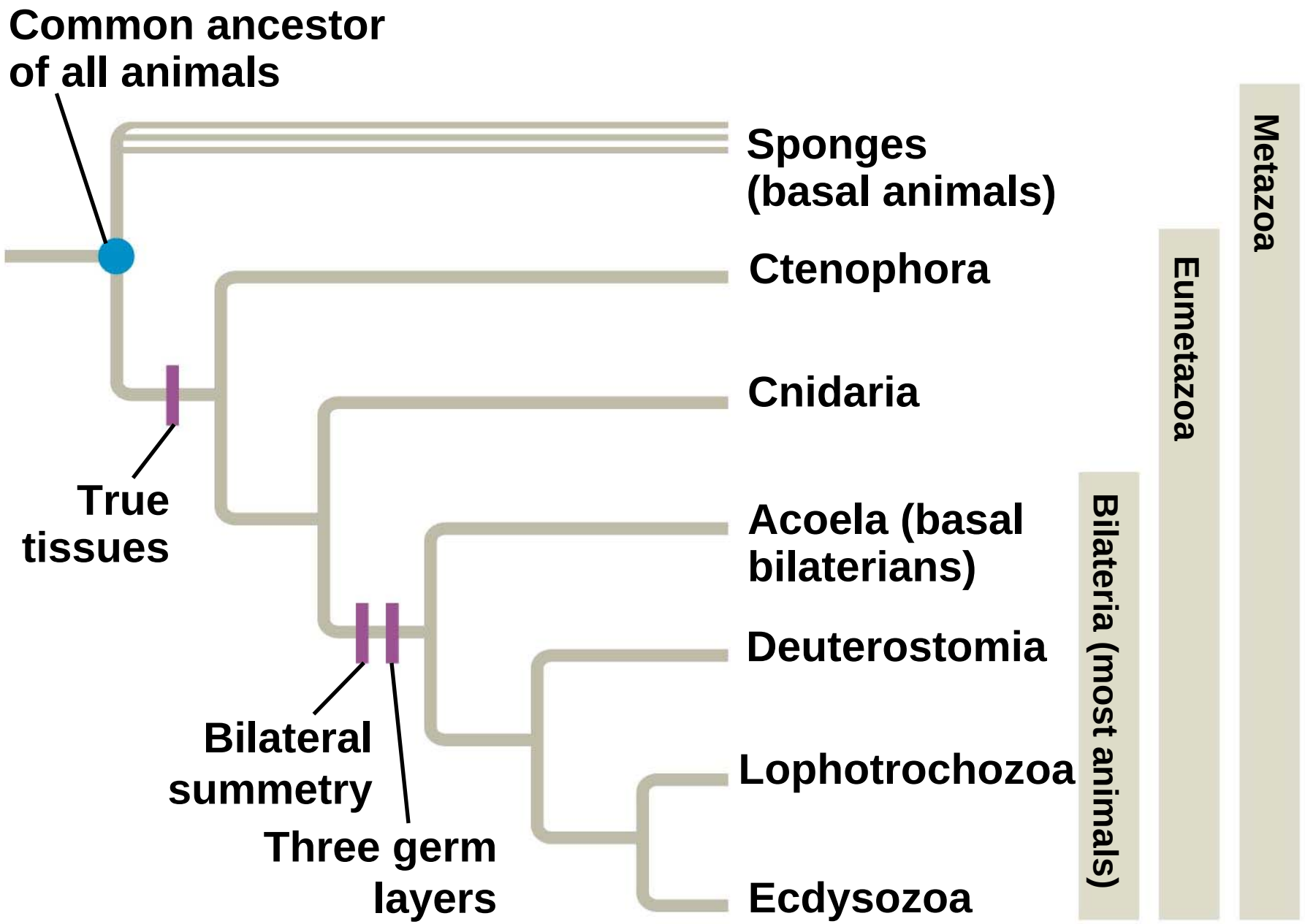


Fig. 32-T1

Cleavage Pattern	Phyla
Spiral (S)	Mollusca, Platyhelminthes, Annelida
Idiosyncratic (I)	Acoela, Arthropoda
Radial (R)	All eumetazoan phyla not listed above

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; grade and clade of animal taxa; diploblastic and triploblastic; spiral and radial cleavage; determinate and indeterminate cleavage; acoelomate, pseudocoelomate, and coelomate grades

4. Compare the developmental differences between protostomes and deuterostomes

5. Compare the alternate relationships of annelids and arthropods presented by two different proposed phylogenetic trees

6. Distinguish between ecdysozoans and lophotrochozoans