LABORATORY

# 23

# Introduction to Invertebrates

## Learning Outcomes

**Introduction**

- Distinguish between invertebrate and vertebrate animals. 287

**23.1 Evolution of Animals**

- Discuss the evolution of animals in terms of type of symmetry, number of germ layers, and pattern of development. 288–89

**23.2 Sponges**

- Identify a sponge and describe the anatomy of a sponge. 289–91
- Show that the anatomy and behavior of sponges aid its survival and ability to reproduce. 289–91

**23.3 Cnidarians**

- Identify various types of cnidarians and describe the anatomy of *Hydra* in particular. 292–94
- Show that the anatomy and behavior of *Hydra* aid its survival and ability to reproduce. 293

**23.4 Flatworms**

- Identify various flatworms, both free-living and parasitic forms. Contrast their lifestyles. 296–301
- Contrast the structure of a planarian with that of a hydra and show that each is adapted to a particular way of life. 296–98

**23.5 Roundworms**

- Identify a roundworm and contrast the anatomy of a roundworm with that of a planarian. 301–4
- Show that roundworms have successfully exploited various ways of life including the parasitic way of life. 301–4

**23.6 Rotifers**

- Identify rotifers and describe their anatomy and behavior. 304–5

## Introduction

In our survey of the animal kingdom, we will see that animals are very diverse in structure. Even so, all animals are multicellular and **heterotrophic,** which means their food consists of organic molecules made by other organisms. Consistent with the need to acquire food, animals have some means of locomotion by use of muscle fibers. Animals are always diploid, and during sexual reproduction, the embryo undergoes specific developmental stages.

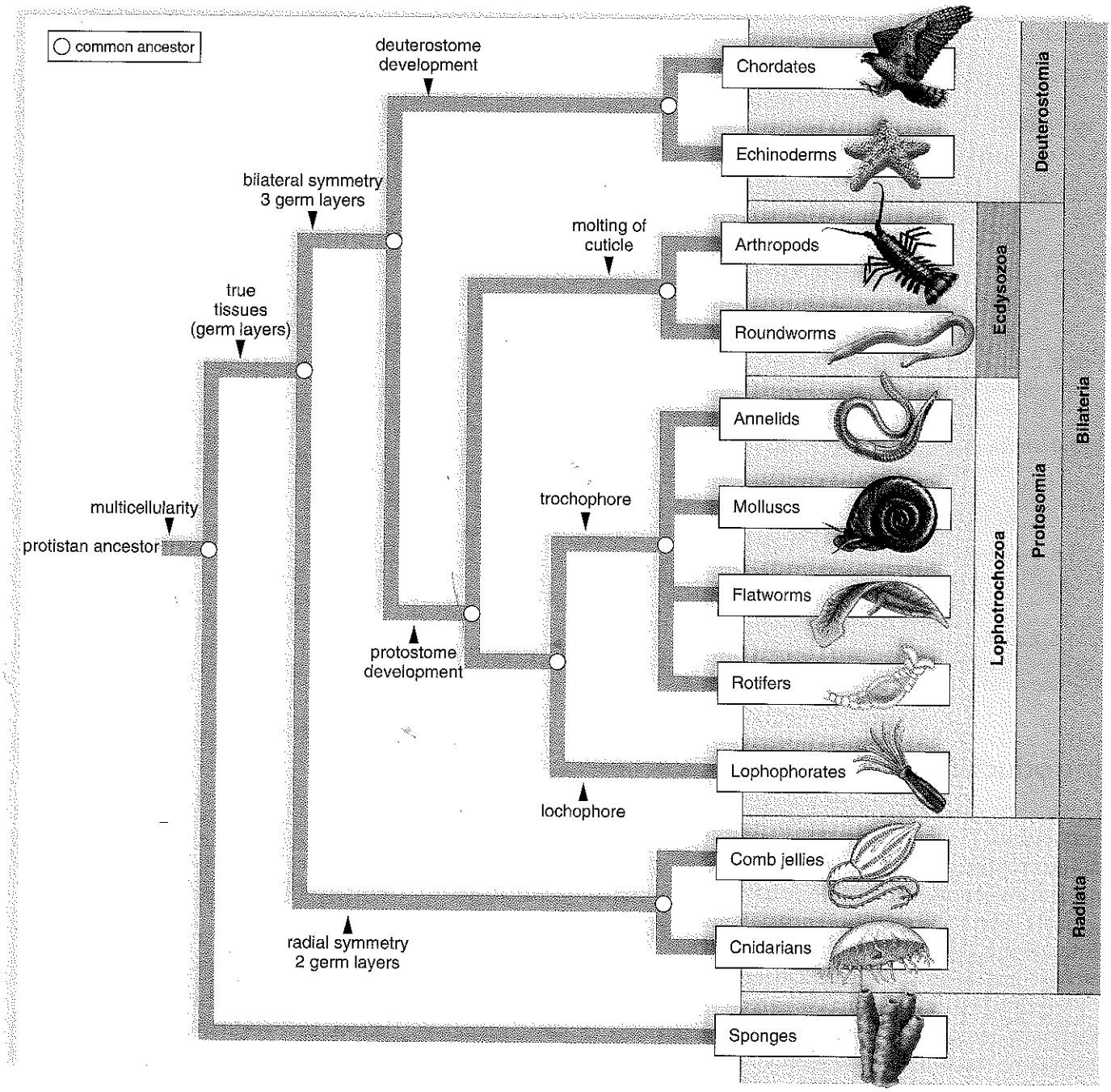
**Planning Ahead** To see hydra and planarians feed, have students observe the animals at the start of lab, add food, and then check frequently until food engulfment occurs.

While we tend to think of animals in terms of **vertebrates** (e.g., dogs, fishes, squirrels), which have a backbone, most animal species are those that lack a backbone, commonly known as **invertebrates.** In this laboratory, we will examine those invertebrates that lack a true body cavity, called a **coelom.** A survey of the rest of the animal kingdom follows in Laboratory 24 and Laboratory 25.

## 23.1 Evolution of Animals

Today, molecular data is used to trace the evolutionary history of animals. These data tell us, as shown in the phylogenetic (evolutionary) tree (Fig. 23.1), that all animals share a common ancestor. This common ancestor was most likely a colonial protist consisting of flagellated cells. All but one of the phyla depicted in the tree consists of only invertebrates—phylum Chordata contains the chordates include a few invertebrates and also the vertebrates.

**Figure 23.1 Evolutionary tree of animals.**



Certain anatomical features of animals can be used to substantiate the tree. The first feature of interest is **symmetry. Asymmetry** means the animal has no particular symmetry. The Radiata have **radial symmetry**—the animal is organized circularly and, just as with a wheel, two identical halves are obtained no matter how the animal is longitudinally sliced. Which of the phyla in the tree are the Radiata? _____

The other phyla are the Bilateria with **bilateral symmetry,** which means the adult animal has a definite right and left half.

One of the main events during the development of animals is the formation of tissue layers called **germ layers** because all other structures are derived from them. The outer germ layer of an animal is the **ectoderm** (a tissue layer that becomes the skin and nervous system) and the inner germ layer is the **endoderm** (a tissue layer that becomes the gut). The middle germ layer is the mesoderm (a tissue layer that becomes the muscles of an animal). Which of the phyla in the tree have only two germ layers (i.e., ectoderm and endoderm)? _____

_____

Finally, complex animals are either Protostomia or Deuterostomia. Protostomia have the **protostome** pattern of development in which the first opening of the embryo is the mouth. Deuterostomia have the **deuterostome** pattern of development in which the second opening of the embryo is the mouth. Which pattern of development do the flatworms, rotifers, and roundworms (animals included in this laboratory) have? _____

## 23.2 Sponges

**Sponges** (phylum Porifera) live in water, mostly marine, attached to rocks, shells, and other solid objects. An individual sponge is typically shaped like a tube, cup, or barrel. Sponges grow singly or in colonies whose overall appearances vary widely. A single sponge can become a colony by asexual budding.

### Anatomy of Sponges

Sponges consist of loosely organized cells and have no well-defined tissues. They are asymmetrical or radially symmetrical and **sessile** (immotile). They can reproduce asexually by budding or fragmentation, but they also reproduce sexually by producing eggs and sperm.

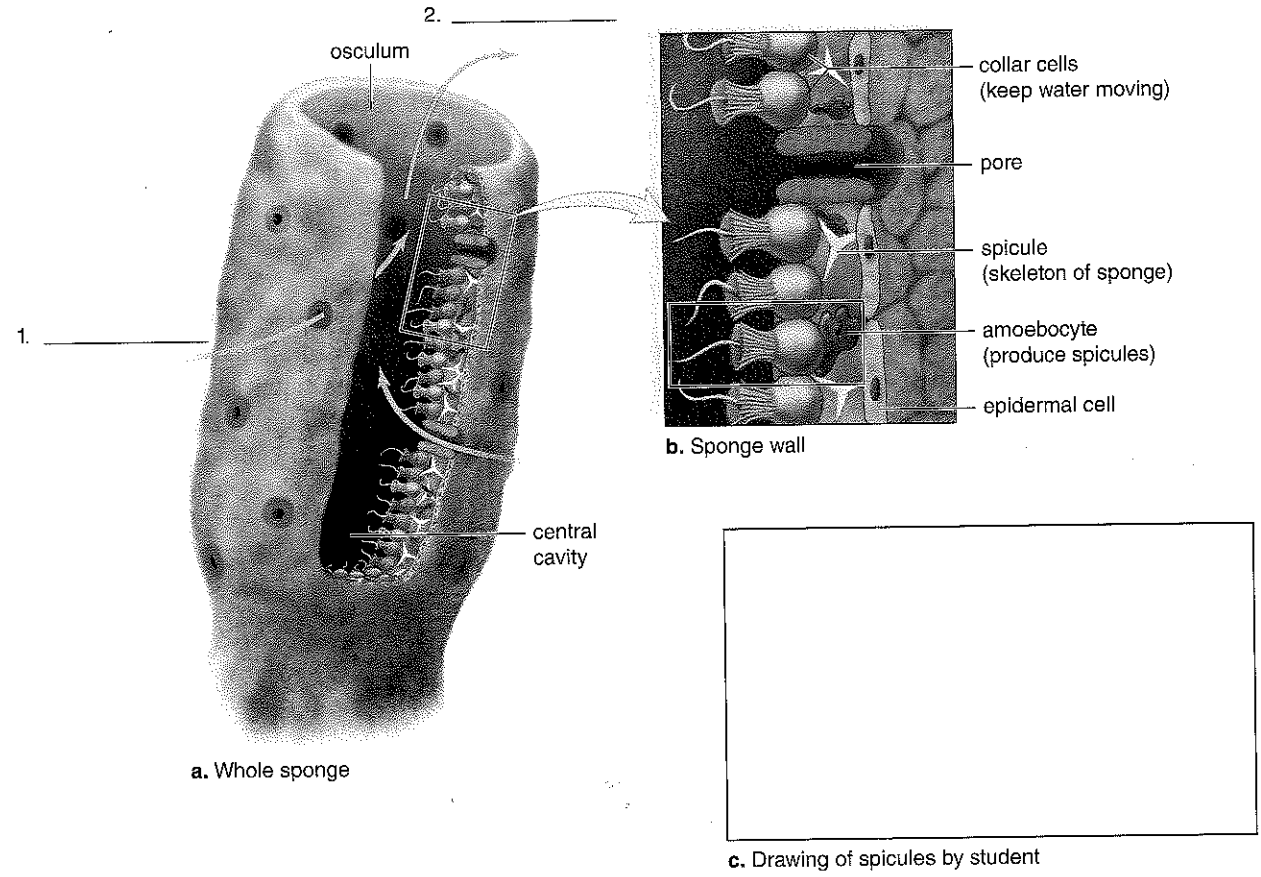
Sponges have a few types of specialized cells. Most notably they have flagellated **collar cells (choanocytes).** The movement of their flagella keep water moving through the pores into the central cavity and out the osculum of a sponge (Fig. 23.2). Collar cells also take in suspended food particles from the water and digest them for the benefit of all the other cells in a sponge.

#### *Observation: Anatomy of Sponges*

##### *Preserved Sponge*

1. Examine a preserved sponge (Fig. 23.2*a*). Note the main excurrent opening (**osculum**) and the multiple incurrent pores. Water is constantly flowing in through the pores and out the osculum. *Label the arrows in the left-hand drawing of Figure 23.2a to indicate the flow of water.* Use the labels *water out* and *water in* through pores.
2. Examine a sponge specimen cut in half. Note the central cavity and the sponge wall. The wall is convoluted in some sponges, and the pores line small canals. Does this particular sponge have pore-lined canals? _____
3. You may be able to see **spicules,** fine projections over the body and especially encircling the osculum. Does this sponge have spicules? _____

**Figure 23.2 Sponge anatomy.**
**a.** Movement of water through pores into the central cavity and out the osculum is noted. *Label the water flow.* **b.** Collar cells line the central cavity of a sponge and the movement of their flagella keeps the water moving through a sponge.
**c.** Draw an enlargement of spicules here.




**a.** Whole sponge

**b.** Sponge wall

**c.** Drawing of spicules by student

***Prepared Slides***

1. Examine a prepared slide of *Grantia*.

   **a.** Find the collar cells that line the interior (Fig. 23.2*b*). A sponge is a **sessile filter feeder.** Collar cells phagocytize (engulf) tiny bits of food that come through the pores along with the water flowing through the sponge. They then digest the food in food vacuoles. Explain the expression *sessile filter feeder.* _____

   _____

   _____

   **b.** Do you see any spicules? _____ Do they project from the wall of a sponge? _____

   **c.** Depending on the sponge, spicules are made of either calcium carbonate, silica (glass), or protein. Calcium carbonate and silica produce hard sharp spicules. Name two possible advantages of spicules to a sponge.

   _____

   _____

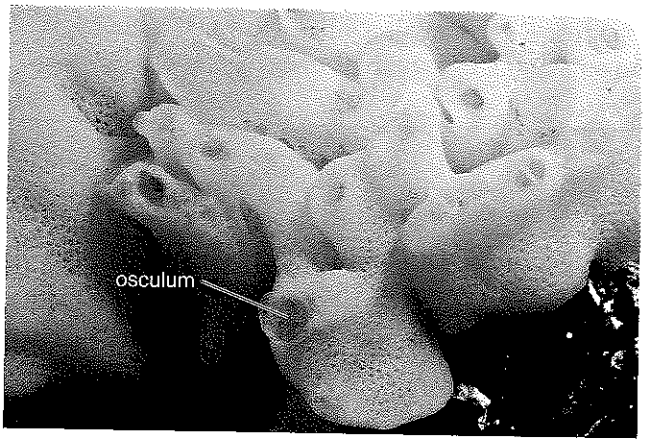
2. Examine a prepared slide of sponge spicules. What do you see? _____

   _____

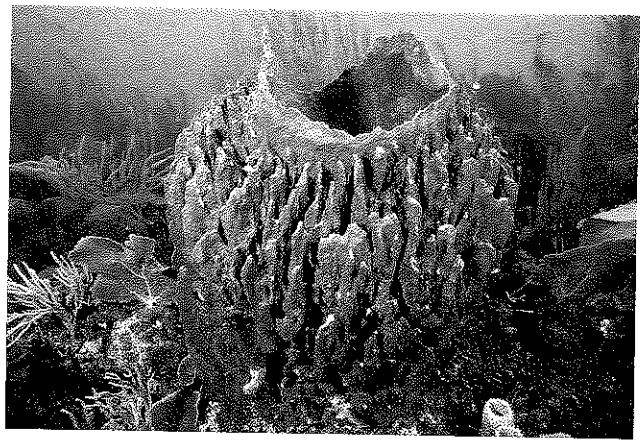
   *Draw a sketch of four spicules, each having a different appearance in the space provided in Figure 23.2c.*

### *Diversity of Sponges*

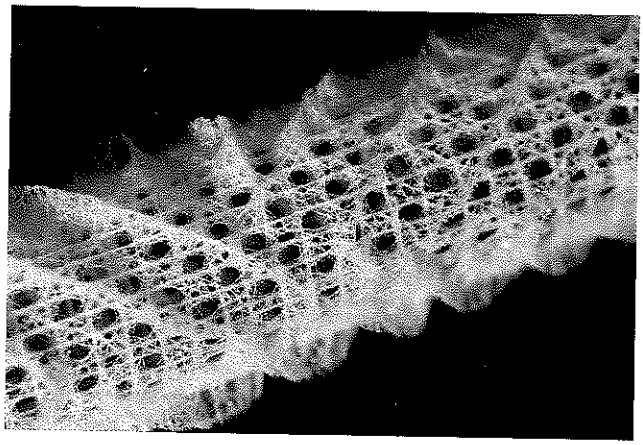
Sponges are very diverse and come in many shapes and sizes. Some sponges live in fresh water although most live in the sea and are a prominent part of coral reefs, areas of abundant sea life discussed in the next section. Zoologists have described over 5,000 species of sponges, which are grouped according to the type spicule (Fig. 23.3).




**a.** Calcareous sponge, *Clathrina canariensis*



**b.** Bath sponge, *Xestospongia testudinaria*



**c.** Glass sponge, *Euplectella aspergillum*

**Figure 23.3 Diversity of sponges.**
**a.** Calcareous (chalk) sponges have spicules of calcium carbonate. **b.** Bath sponges have a skeleton of spongin. **c.** Glass sponges have glassy spicules.

### *Conclusions: Anatomy of Sponges*

- The anatomy and behavior of a sponge aid its survival and its ability to reproduce. How does a sponge:
  - **a.** Protect itself from predators? _____
  - **b.** Acquire and digest food? _____
  - **c.** Reproduce asexually and sexually? _____

## 23.3 Cnidarians

Cnidarians (phylum Cnidaria) are tubular or bell-shaped animals that live in shallow coastal waters, except for the oceanic jellyfishes. Two basic body forms are seen among cnidarians. The mouth of a **polyp** is directed upward, while the mouth of a jellyfish, or **medusa,** is directed downward. At one time, both body forms may have been a part of the life cycle of all cnidarians. When both are present, as in *Obelia*, the sessile polyp stage produces medusae, and this motile stage produces egg and sperm (Fig. 23.4). Today in some cnidarians, one stage is dominant and the other is reduced; in other species, one form is absent altogether. How can a life cycle that involves two forms, called polymorphism, be of benefit to an animal, especially if one stage is sessile (stationary)? _____

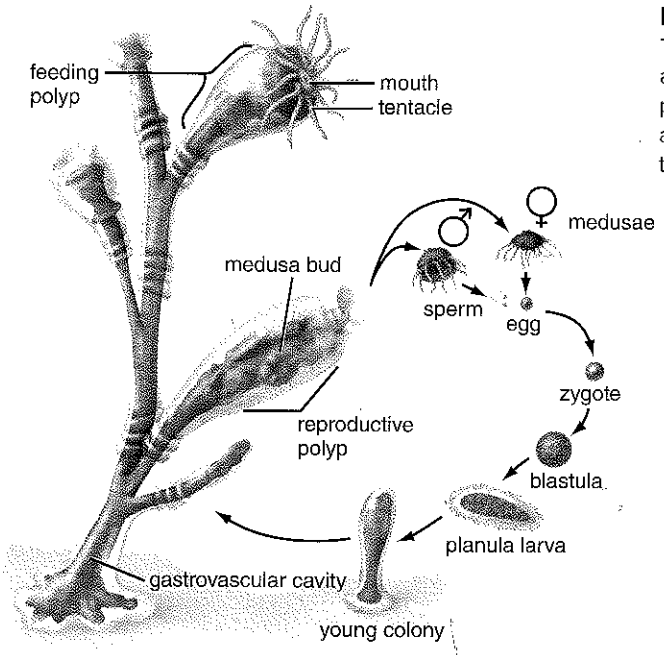



**Figure 23.4 Life cycle of *Obelia*.**
The stationary *Obelia* colony has both feeding polyps and reproductive polyps. The reproductive polyps produce motile bell-shaped medusae that make eggs and sperm. Each zygote becomes a ciliated planula larva that develops into the polyp stage.

Consult Figure 23.1 and note again that cnidarians are radially symmetrical and have two germ layers. How can radial symmetry benefit an animal? _____

### Anatomy of *Hydra*

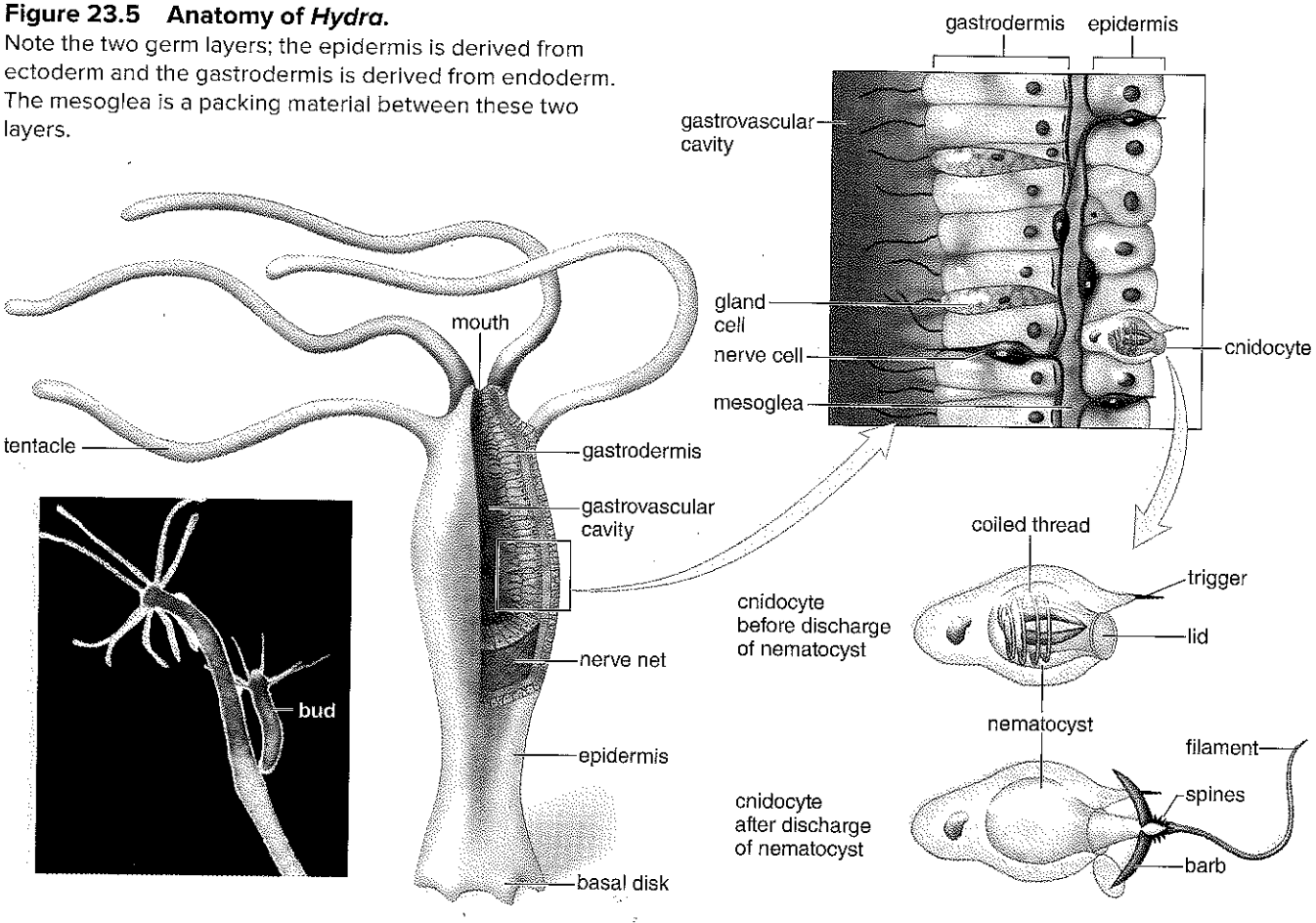
Figure 23.5 shows the anatomy of a hydra which will be studied as a typical cnidarian. Hydras exist only as sessile polyps; there is no alternate stage. Note the **tentacles** that surround the **mouth,** the large **gastrovascular cavity,** and the basal disk. A gastrovascular cavity has a single opening that is used both as an entrance for food and an exit for wastes.

#### *Observation: Cnidarians*

#### *Preserved Hydra*

With the aid of a hand lens, examine preserved specimens of *Hydra.* Hydras typically reproduce asexually by budding (Fig. 23.5, *far left*). Do you see any evidence of buds that are developing directly into small

**Figure 23.5 Anatomy of *Hydra*.**
Note the two germ layers; the epidermis is derived from ectoderm and the gastrodermis is derived from endoderm. The mesoglea is a packing material between these two layers.




hydras? _____ The body wall can also produce ovaries and testes that produce eggs and sperm. The testes are generally located near the attachment of the tentacles; the ovaries appear farther down on the trunk, toward the basal disk.

### *Prepared Slide of Hydra*

Examine prepared slides of cross and longitudinal sections of *Hydra*. With the help of Figure 23.5, note the two tissue layers. A gelatinous material called mesoglea separates the epidermis from the gastrodermis, which lines the gastrovascular cavity. Switch to high power. Do you find any cells? _____

Describe them. _____

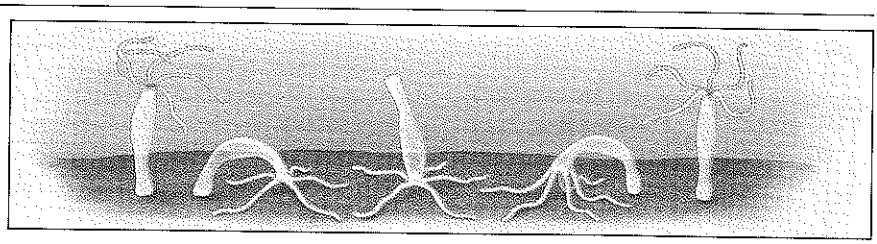
_____

### *Living Hydra*

1. Observe a living *Hydra* in a small petri dish for a few minutes. What is the current behavior of your hydra? _____

_____

Most often a hydra is attached to a hard surface by its basal disk. A hydra can move, however, by turning somersaults:



2. After a few minutes, tap the edge of the petri dish. What is the reaction of your hydra?

_____

_____

3. The tentacles of a hydra capture food, which is stuffed into the gastrovascular cavity (Fig. 23.6) where it is digested both externally in the cavity and internally in the cells that line the cavity. Place a small protozoan or crustacean near the tentacles of the hydra and observe it feeding.
4. Mount a living *Hydra* on a depression glass slide with a coverslip and examine a tentacle. Unique to cnidarians are specialized stinging cells, called **cnidocytes,** which give the phylum its name. Each cnidocyte has a fluid-filled capsule called a **nematocyst** (see Fig. 23.5, far right), which contains a long, spirally coiled hollow thread. The threads trap and/or sting prey. Note the cnidocytes as swellings on the tentacles. Add a drop of vinegar (5% acetic acid) and note what happens to the cnidocytes. Did your hydra discard any nematocysts? _____ Describe. _____

_____

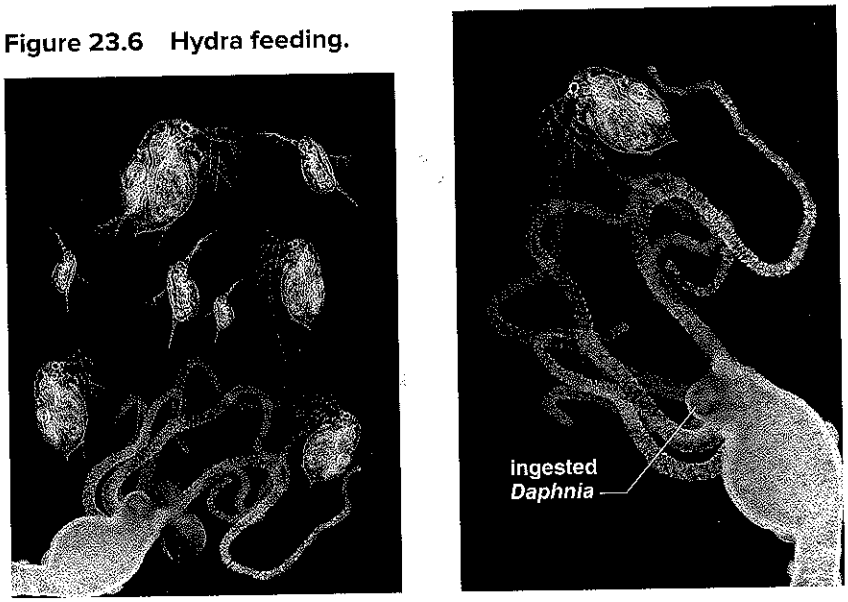
_____

Of what benefit is it to *Hydra* to have cnidocysts? _____

_____

_____

**Figure 23.6 Hydra feeding.**




### *Conclusions: Anatomy of Hydra*

- The anatomy and behavior of a hydra aid its survival and its ability to reproduce. How does a hydra:

**a.** Acquire and digest food? _____

_____

**b.** Protect itself from predators? _____

_____

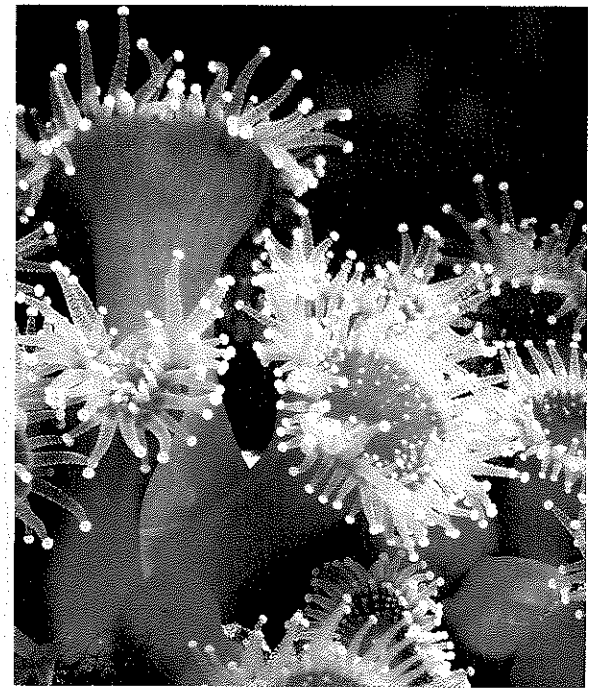
**c.** Reproduce asexually and sexually? _____

_____

## Diversity of Cnidarians

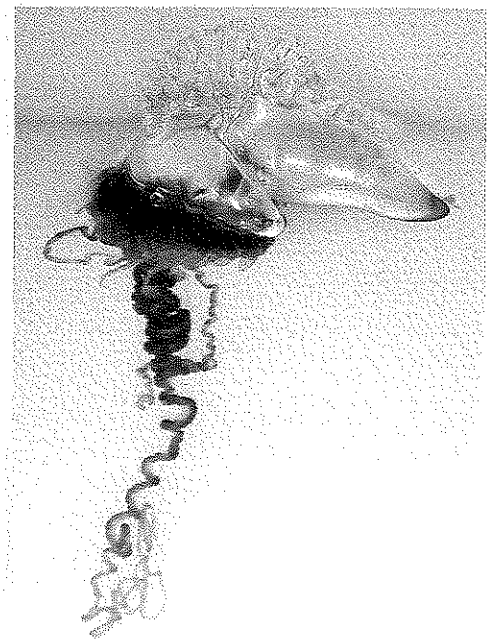
Cnidarians consist of a large number of mainly marine animals (Fig. 23.7). Sea anemones, sometimes called the flowers of the sea are solitary polyps often found in coral reefs, areas of biological abundance in shallow tropical seas. Stony corals have a calcium carbonate skeleton that contributes greatly to the building of coral reefs. Portuguese man-of-war is a colony of modified polyps and medusae. Jellyfishes are a part of the zooplankton, suspended animals that serve as food for larger animals in the ocean.

**Figure 23.7 Cnidarian diversity.**

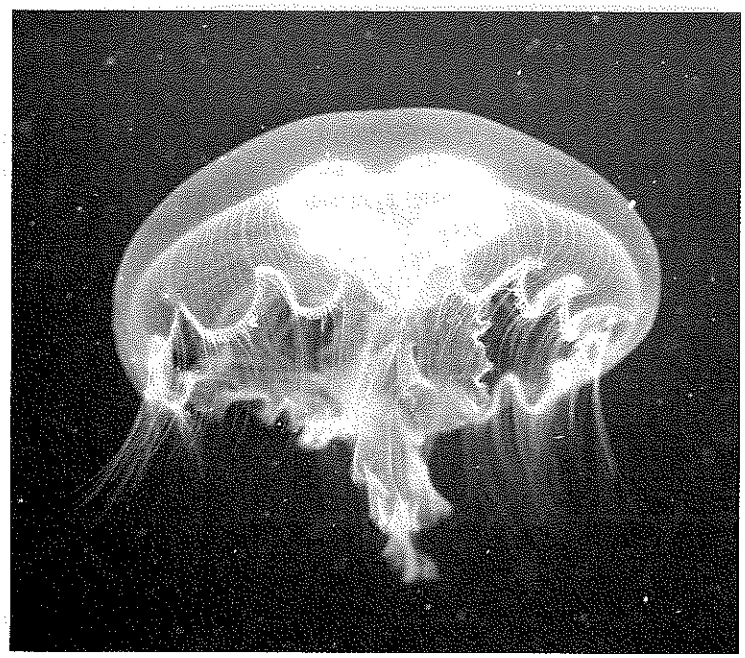


Sea anemone, *Corynactis*

Cup coral, *Tubastrea*



Portuguese man-of-war, *Physalia*



Jellyfish, *Aurelia*