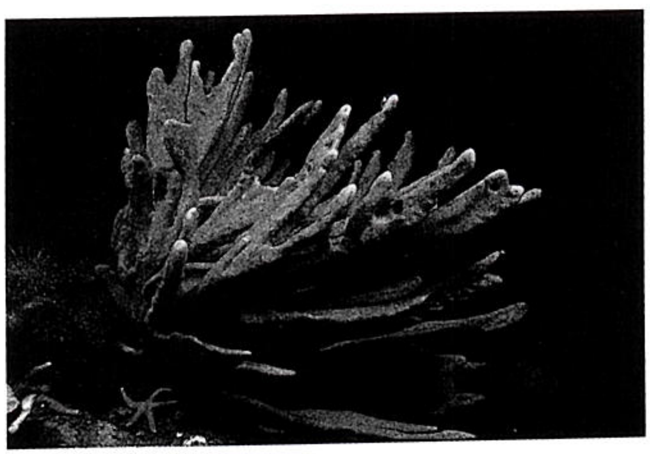
27.2 Phylum Porifera (Sponges)

Sponges 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 (Fig. 27.2).

Figure 27.2 Diversity of sponges.
(*a*) Sponges in class Calcarea have spicules of calcium carbonate. (*b*) Sponges in class Hexactinellida have glassy spicules. (*c*) In class Demospongiae, the skeleton is varied. Some members have a skeleton of spongin, some have glassy spicules, and some have a combination skeleton.

a. Class Calcarea: calcareous sponge, *Leucosolenia canariensis*

b. Class Hexactinellida: glass sponge, *Aphrocallistes vastus*



c. Class Demospongiae: bath sponge, *Haliclona oculata*

Observation: Diversity of Sponges

Examine preserved, representative sponges. Sponges are classified according to the type of **spicule** (little spike). Some have no spicules, and their skeleton is composed of a fibrous protein called spongin. These are the type of sponges that are sometimes still sold as *bath sponges*. Sponges that have sharp spicules made of calcium carbonate are called calcareous (chalk) sponges, and those whose spicules are made of silica are called glass sponges.

Examine the sponges on display in the laboratory, and complete Table 27.2.

Table 27.2 Diversity of Sponges

Common Name of Specimen	Skeleton Made Of
1	
2	
3	
4	

CLASSIFICATION: THE ANIMALS

KINGDOM ANIMALIA

Multicellular organisms usually with well-developed tissues; motile; heterotrophic by ingestion, generally in a digestive cavity; usually diplontic life cycle.

Invertebrates*

Phylum Porifera: sponges

Phylum Cnidaria: jellyfishes, sea anemones, corals, *Hydra, Obelia*

Phylum Nematoda: roundworms (e.g., *Ascaris*)

Phylum Platyhelminthes: planarians, flukes, tapeworms

Phylum Rotifera: rotifers

Phylum Mollusca: chitons, snails, slugs, clams, mussels, squids, octopuses

Phylum Annelida: segmented worms (e.g., clamworms, earthworms, leeches)

Phylum Arthropoda: spiders, scorpions, horseshoe crabs, lobsters, crayfish, shrimps, crabs, millipedes, centipedes, insects

Phylum Echinodermata: sea lilies, brittle stars, sea urchins, sand dollars, sea cucumbers

Phylum Chordata

Subphylum Urochordata: tunicates

Subphylum Cephalochordata: lancelets

Vertebrates*

Subphylum Vertebrata

Class Agnatha: jawless fishes (e.g., lampreys, hagfishes)

Class Chondrichthyes: cartilaginous fishes (e.g., sharks, rays)

Class Osteichthyes: bony fishes (e.g., trouts, cods)

Class Amphibia: frogs, toads, salamanders

Class Reptilia: snakes, lizards, turtles

Class Aves: birds (e.g., robins, herons)

Class Mammalia: mammals (e.g., cats, dogs, horses, rats, humans)

*The categories Invertebrates and Vertebrates are not in the classification of organisms, but are added here for clarity.

Anatomy of Sponges

Sponges consist of loosely organized cells and have no well-defined tissues. They are asymmetrical or radially symmetrical and **sessile** (immotile). Sponges do contain specialized cells and therefore are considered to be a colony. They can reproduce asexually by budding or fragmentation, but they also reproduce sexually by producing eggs and sperm. Most sponges have the following three types of cells, as shown in Figure 27.3:

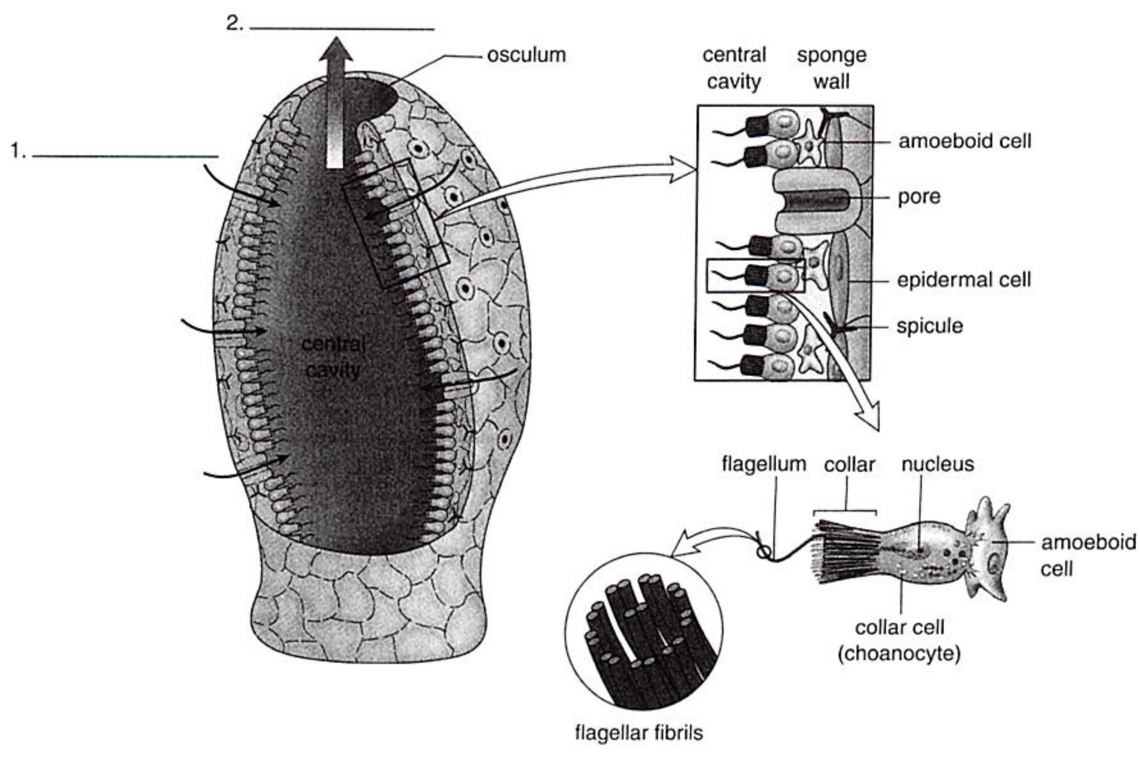
1. **Epidermal cells:** Flat cells that cover the outer surface and contain contractile fibers. Some surround pores that allow water to enter the sponge interior.
2. **Collar cells (choanocytes):** Flagellated cells lining the interior. Collar cells create water currents and filter suspended food particles from the water.
3. **Amoeboid cells:** Cells embedded in a noncellular matrix. Amoeboid cells digest and distribute food from collar cells, secrete spongin or spicules, and can form all other cells (totipotent).

Observation: Anatomy of Sponges

Preserved Sponge

1. Examine a preserved sponge. 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 27.3 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 27.3 Anatomy of a sponge.
The wall of a sponge has three types of cells: epidermal cells, amoeboid cells, and collar cells.



Prepared Slides

1. Examine a prepared slide of *Grantia*.

   a. Find the collar cells that line the interior. 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. Amoeboid cells pass some of the nutrient molecules to epidermal cells. Explain the expression *sessile filter feeder*. ______________________________

   ____

   b. Find the epidermal cells. What is the shape of these cells? ______________________________

   ____

   c. Are any amoeboid cells visible? ________ Where are they located? ______________________________

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

   ____

   Draw a sketch of a spicule.

Conclusions

- Among other functions, all animals have to acquire food, distribute nutrient molecules, carry on gas exchange, and excrete wastes. How do sponges, which have a cellular level of organization, carry on these functions? ______________________________

  ____

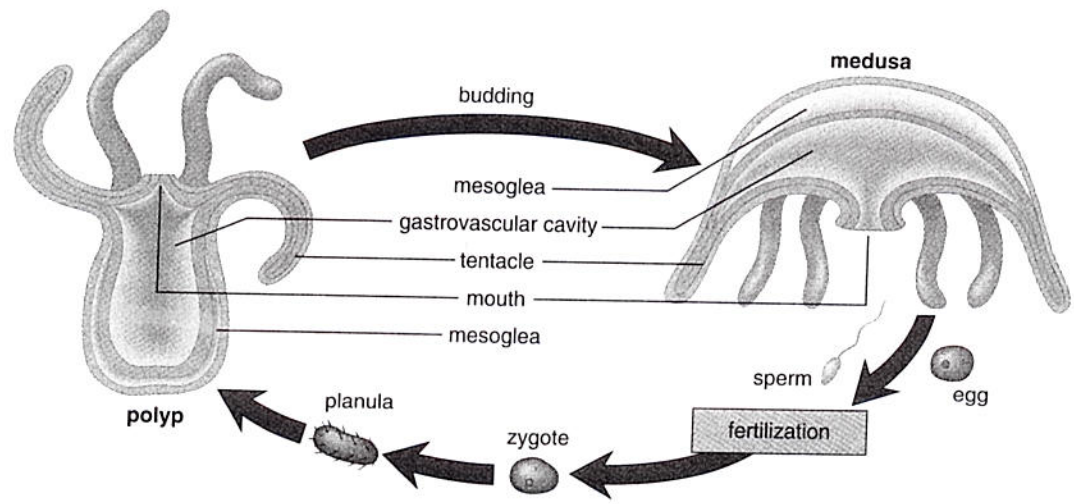
- Sponges are the "have nots" of the animal kingdom. Explain this designation by referring to Table 27.1. Sponges do not have ______________________________

  ____

27.3 Phylum Cnidaria (Cnidarians)

Cnidarians consist of a large number of mainly marine animals, including, for example, corals, sea anemones, and jellyfishes (Fig. 27.4). Stony corals have a calcium carbonate exoskeleton that contributes greatly to the building of coral reefs, areas of biological abundance in shallow tropical seas. Sea anemones, the "flowers" of the ocean, are also found around coral reefs. Jellyfishes are a part of the **zooplankton,** suspended animals that serve as food for larger animals in the ocean. The small and almost translucent hydras are one of the few freshwater species of cnidarians. They are found attached to underwater plants or rocks in most lakes and ponds.

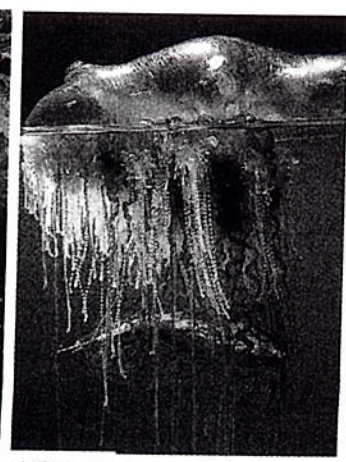
Figure 27.4 Cnidarian life cycle and diversity.
(*a*) The cnidarian life cycle can include two phases: polyp and medusa. When both forms are part of the life cycle, the medusa is the sexual phase, and the polyp is the asexual phase. In many cnidarians, the life cycle includes only one or the other of the two forms. Class Anthozoa contains (*b*) the sea anemones, which are solitary polyps, and (*c*) the corals, which are often colonial polyps. (*d*) Class Hydrozoa contains colonies of polyps with free-swimming medusae such as *Obelia* and the Portuguese man-of-war, which is a colony of modified polyps and medusae. *Hydra*, a solitary polyp without a medusa stage, is also in this class. (*e*) Class Scyphozoa contains the true jellyfishes in which the medusae are large and the polyps are inconspicuous.



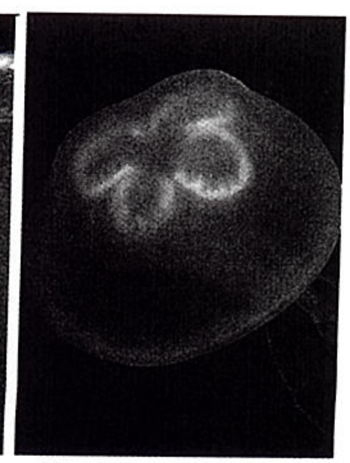
a. The life cycle of a cnidarian

b. Class Anthozoa: sea anemone, *Apitasia*

c. Class Anthozoa: corals, *Tubastrea*



d. Class Hydrozoa: Portuguese man-of-war, *Physalia*



e. Class Scyphozoa: Jellyfish, *Aurelia*

Observation: Diversity of Cnidarians

Examine preserved, representative cnidarians, and with the help of Figure 27.4, complete Table 27.3.

Table 27.3 Cnidarian Diversity

Common Name of Specimen	Form (Polyp and/or Medusa)
1	
2	
3	
4	
5	

Anatomy of Cnidarians

Cnidarians have the following anatomical features.

1. **Tissue level of organization:** Animals can have a total of three developmental or germ layers (see Table 27.1); cnidarians have two. The germ layers have become an outer epidermis and an inner gastrodermis, cell layers separated by the jellylike mesoglea.
2. **Radial symmetry:** Any longitudinal cut gives two equal halves. Tentacles for capturing prey ring the mouth. Radial symmetry allows a relatively sessile animal to reach out in all directions to seek food.
3. **Sac body plan:** The mouth serves both as an incurrent and an excurrent opening.
4. **Gastrovascular cavity:** This plays an important role in digestion. Inner cells depend on the water within the cavity for gas exchange and excretion. The fluid also acts as a hydrostatic skeleton, offering resistance to contractile fibers.
5. **Nerve net:** Nerve cells interconnect to form a nerve net below the epidermis (Fig. 27.5*b*).
6. **Stinging cells (cnidocytes):** These contain capsules **(nematocysts)** with a barbed or poisonous thread. When discharged, they help the animal capture prey or defend itself (Fig. 27.5).

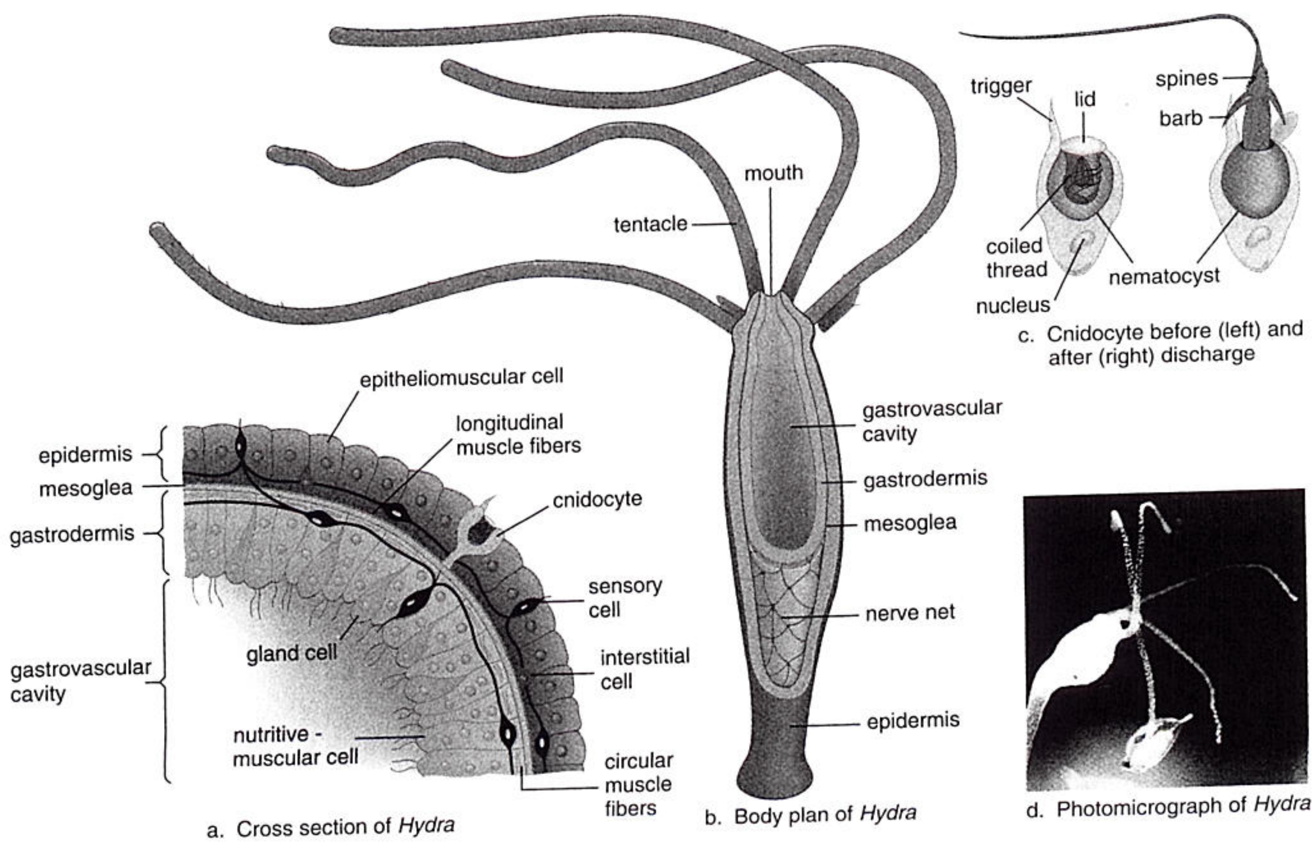
Observation: Anatomy of Cnidarians

Hydra: *Living Specimen*

1. Examine a live specimen of *Hydra* with a binocular dissecting microscope or hand lens. Refer to Figure 27.5 for help in identifying the foot, tentacles, and mouth.
2. Touch one of the tentacles very gently with a dissecting needle. What happens? ______
3. Mount a living *Hydra* on a glass slide with a coverslip, and examine a tentacle. Note the stinging cells that appear as swellings on the tentacles.
4. Tap the coverslip, or add a drop of vinegar (5% acetic acid), if available, and note what happens to the cnidocytes (stinging cells). ______
5. Describe the structure and function of the cnidocytes and nematocysts. ______

   ______
6. With the aid of a hand lens, examine preserved specimens of *Hydra*. Note that some of these contain outgrowths or swellings along the trunk. *Hydra* reproduces both asexually and sexually. During asexual reproduction, buds form that develop directly into small hydras. During sexual reproduction, *Hydra* develops testes, which produce sperm, and ovaries, which produce eggs. The testes are generally located near the attachment of the tentacles; the ovaries appear farther down on the trunk, near the foot.

Figure 27.5 Anatomy of *Hydra*.
Hydra typifies the anatomy of a cnidarian as described on page 385.



a. Cross section of *Hydra*   b. Body plan of *Hydra*   d. Photomicrograph of *Hydra*

Hydra: *Prepared Slide*

1. Examine prepared slides of cross and longitudinal sections of *Hydra*. With the help of Figure 27.5*a*, note the epidermis, gastrodermis, mesoglea, and gastrovascular cavity. Describe them. ______

2. Examine the epidermis and gastrodermis with high power. Do you find any cells? ______ Describe them. ______

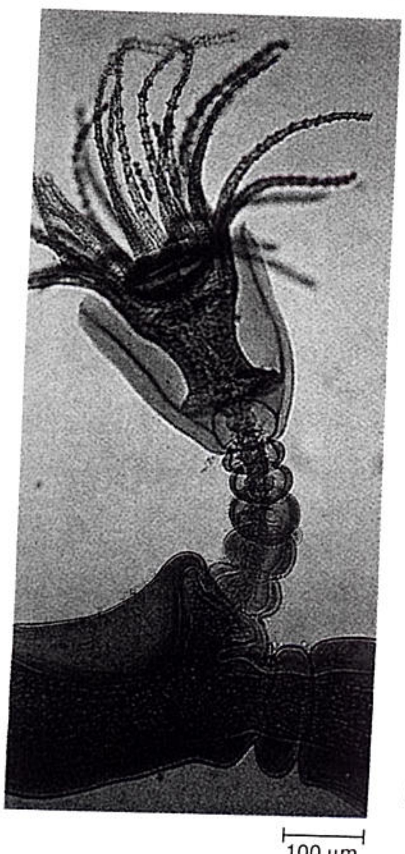
Obelia: *Prepared Slides*

Obelia's life cycle includes both a polyp phase and a medusa phase (Fig. 27.6).

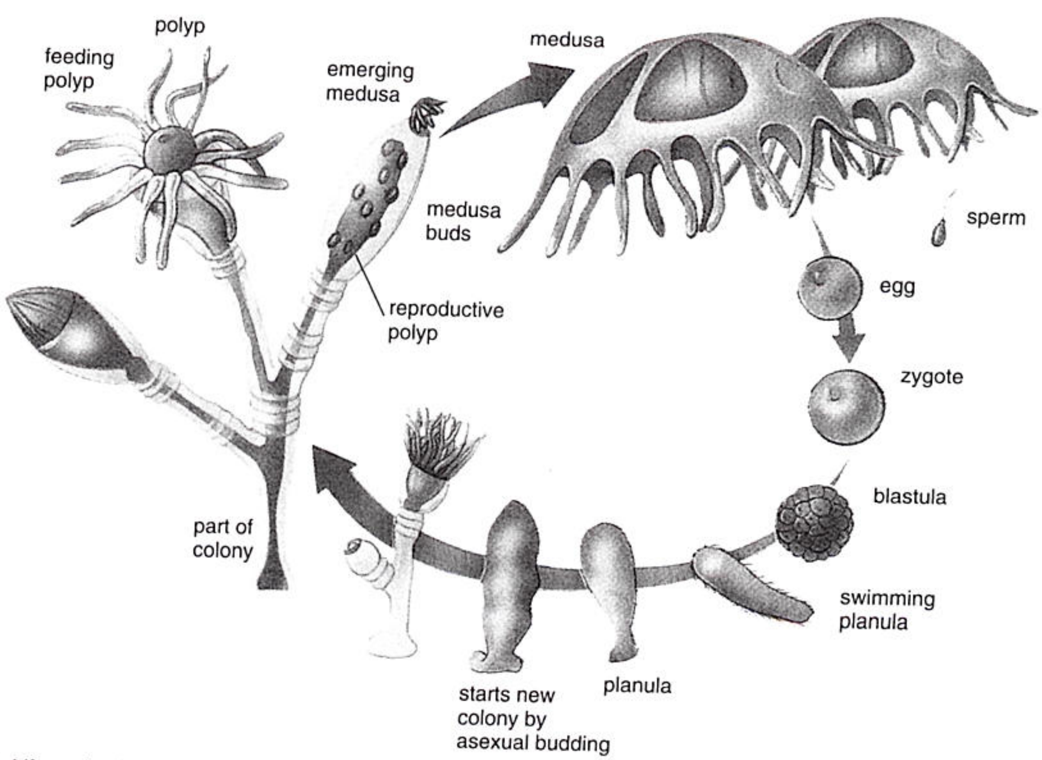
1. Study a prepared slide showing a polyp colony of *Obelia*. The colony grows by budding; full-grown buds usually remain attached to the colony. Note the bell-shaped **feeding polyps** with a mouth and a ring of stinging cell-bearing tentacles. The other polyps, called **reproductive polyps,** develop small, bell-shaped medusae in their interior that, when mature, escape from the polyp and assume a free-swimming existence as sexually active individuals. Given that the polyp stage of *Obelia* is sessile, what function does the free-swimming medusa serve for the species? ______

2. Examine a prepared slide showing a medusa of *Obelia*. Note the tentacled bell and the central mouth. (Preparation of the slide unavoidably distorts the medusa—the umbrella is turned inside out.)

Figure 27.6 ***Obelia.***
An *Obelia* colony contains feeding polyps and reproductive polyps. (*a*) A feeding polyp. (*b*) The reproductive polyps asexually produce medusae, which carry out the sexual part of the life cycle.



a. *Obelia* feeding polyp

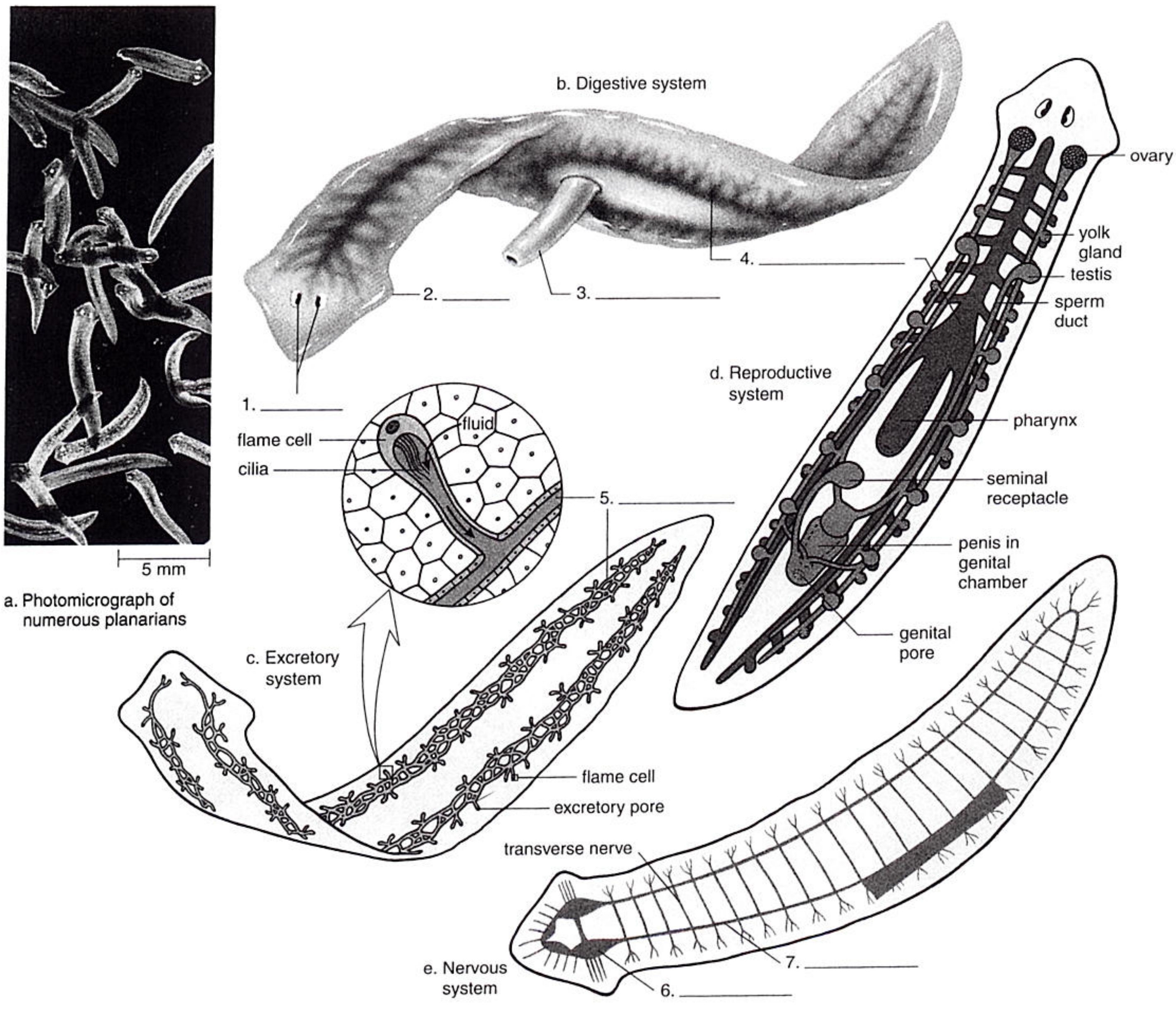


b. Life cycle of *Obelia*

27.4 Phylum Platyhelminthes (Flatworms)

Flatworms (phylum Platyhelminthes) include three classes. Class Turbellaria contains planarians—black, gray, or brightly colored worms that are literally flat. Planarians live in fresh water or seawater, where they feed on protozoans, small crustaceans, snails, or other worms. Class Trematoda contains the flukes, which are internal parasites, and class Cestoda are the tapeworms, which live in digestive tracts. This laboratory focuses only on planarian flatworms.

Figure 27.7 Planarian anatomy.
(*a*) Planarians as they appear under the microscope. (*b*) Label the structures indicated, and notice whether they can be seen externally and whether they are involved in (*c*) excretion, (*d*) reproduction and digestion, or (*e*) nerve conduction.



Observation: Diversity of Flatworms

Examine the preserved flatworm specimens on display in the laboratory, and then complete Table 27.4.

Table 27.4 Flatworms

Sample	Common Name of Specimen	Description	Class
1			
2			
3			
4			
5			

Anatomy of Planarians

Planarians have the following anatomical features.

1. **Organ system level of organization:** Planarians have organs for digestion, excretion, reproduction, and nerve conduction.
2. **Acoelomates:** Planarians do not have a coelom.
3. **Bilateral symmetry:** Only one longitudinal cut produces two equal halves of the body. Bilateral symmetry is seen in active animals with a definite head and a posterior end.
4. **Sac body plan:** The mouth serves as both a mouth and an anus.
5. **Three germ layers:** The middle layer—the mesoderm—gives rise to parenchyma and muscles. Parenchyma completely fills the space between the epidermis and the intestine. There is no coelom.
6. **Nervous organization:** The brain and nerves are connected by longitudinal and lateral branches.
7. **Cephalization:** Planarians have a definite head with sense organs.

Observation: Anatomy of Planarians

Living Specimen

1. Examine a living specimen of a planarian (Fig. 27.7*a*) in water in a watch glass. Note the definite head region (cephalization). In Figure 27.7*b*, label the following structures.
   a. **Eyespots:** Areas sensitive to light that do not form images.
   b. **Auricle:** A lateral projection that contains nerve endings sensitive to touch and to chemicals.
   c. **Pharynx:** An extension from the midventral surface of the body when the animal is feeding. The mouth is at the free end of the pharynx.
   d. **Gastrovascular cavity:** Digestion is both extracellular and intracellular in a three-branched blind cavity.
2. Place a small piece of meat, such as hamburger or liver, in the watch glass, and carefully watch the planarian's reaction. Describe how a planarian feeds. ______________________

____

3. Prepare a wet mount of a planarian, using a concave depression slide, and cover with a coverslip. Examine with a microscope, and note the planarian's mode of locomotion. Planarians have cilia on the ventral surface, and numerous gland cells secrete a mucous material that assists movement. Describe what you see. ____

____

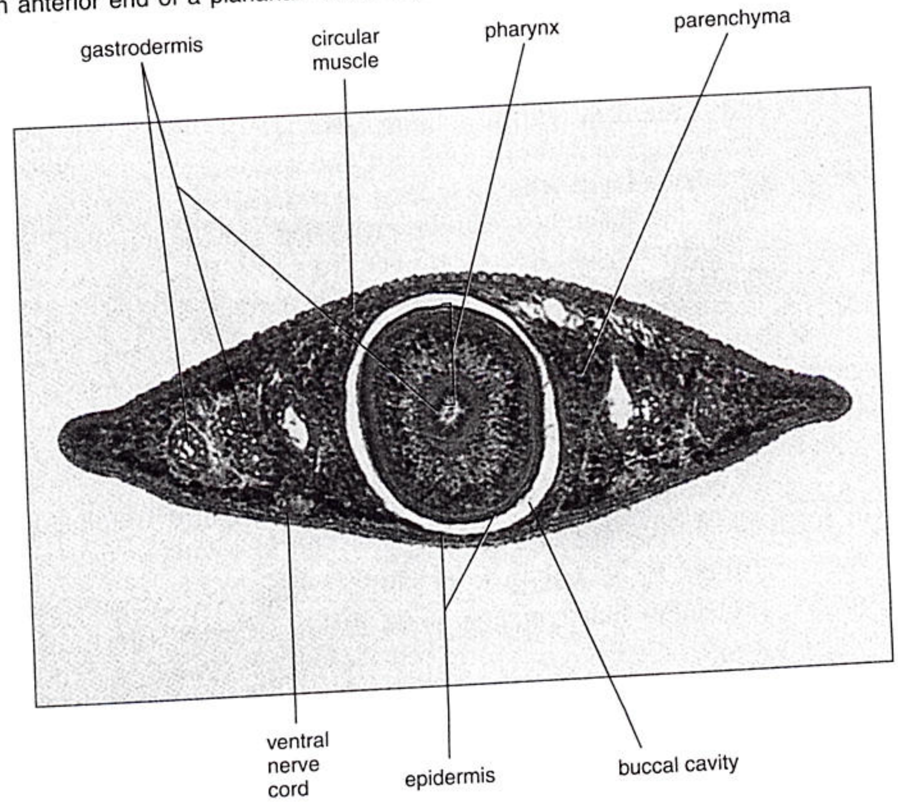
Prepared Slides

1. Examine a whole mount of a planarian that shows the branching gastrovascular cavity. Why is it sometimes called a tripartite organ? (Figure 27.7*d* may be helpful.) ____

____

2. Examine a cross section of a planarian under the microscope (Fig. 27.8). Do you see evidence of organs? ____
3. In Figure 27.7*c*, label an excretory canal, which ends in a **flame cell.** Flame cells collect water and wastes, which exit by way of excretory pores.
4. Note the reproductive system in Figure 27.7*d*. **Hermaphroditic animals** have both male and female sex organs.
5. Label the nerve cord and the brain in Figure 27.7*e*. Why are planarians said to have a ladderlike nervous system? ____

Figure 27.8 Planarian cross section.
Cross section through anterior end of a planarian at the region of the pharynx, as it would appear under the microscope.



27–14

Conclusions

- Planarians, with three tissue layers, are more complex than cnidarians. Contrast a hydra with a planarian by stating in Table 27.5 any significant differences between them.
- Planarians have no respiratory or circulatory system. As with cnidarians, each individual ________ takes care of its own needs for these two life functions.

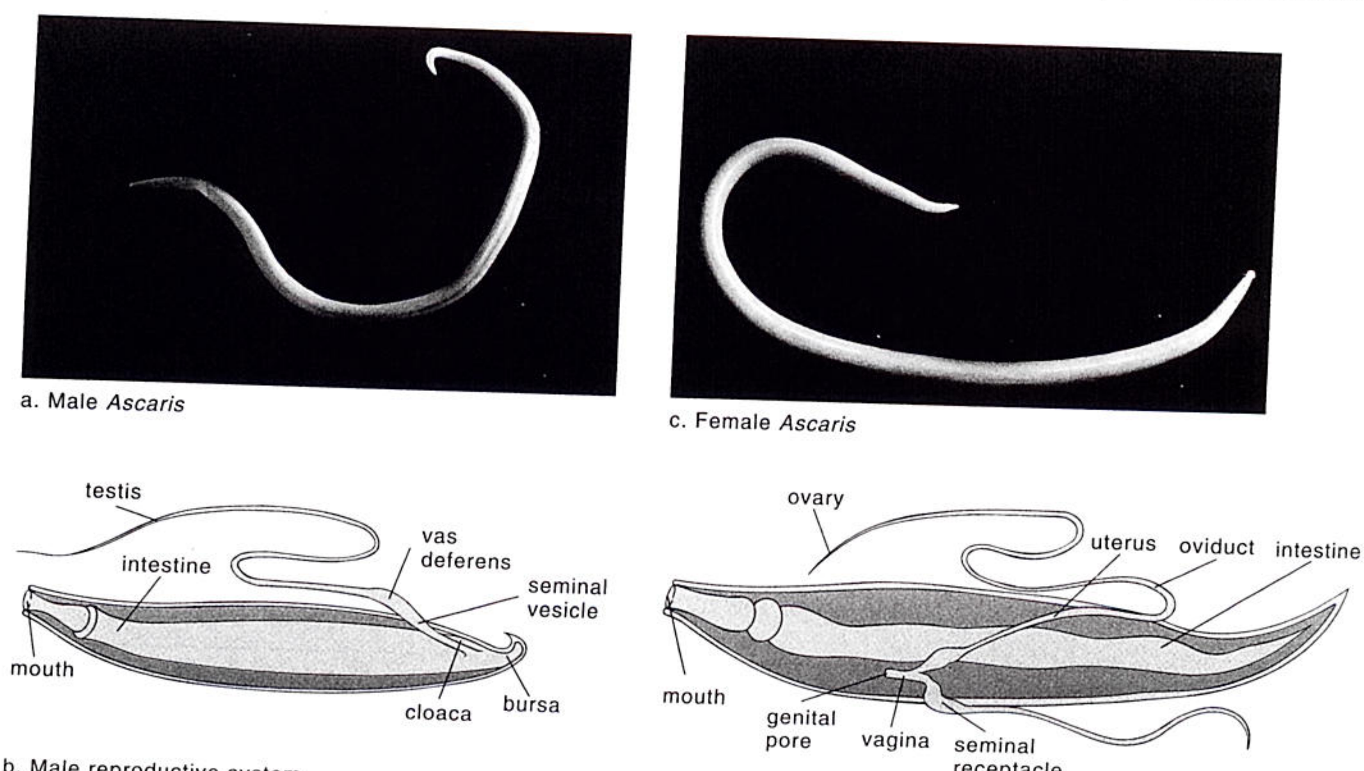
Table 27.5 Contrasts Between a Hydra and a Planarian

	Digestive System	Excretory System	Nervous Organization
Hydra			
Planarian			

27.5 Phylum Nematoda (Roundworms)

Roundworms are found in all aquatic habitats and in damp soil. Some even survive in hot springs, deserts, and cider vinegar. They parasitize (take nourishment from) both plants and animals. They are significant crop pests and also cause disease in humans. Both pinworms and hookworms are roundworms that cause intestinal difficulties; trichinosis and elephantiasis are also caused by roundworms. *Ascaris*, a large, primarily tropical intestinal parasite, is often studied as an example of this phylum (Fig. 27.9).

Figure 27.9 Roundworm anatomy.
(*a*) Photograph of male *Ascaris.* (*b*) Male reproductive system. (*c*) Photograph of female *Ascaris.* (*d*) Female reproductive system.



a. Male *Ascaris*

c. Female *Ascaris*

b. Male reproductive system

d. Female reproductive system

Observation: Diversity of Roundworms

Examine preserved, representative roundworms, and then complete Table 27.6.

Table 27.6 Roundworm Diversity

Common Name of Specimen	Description (Length, Thickness, Other)
1	
2	
3	
4	
5	

Anatomy of Roundworms

Like planarians, roundworms have an organ level of organization, three germ layers, and bilateral symmetry. In addition, roundworms have the following features.

1. **Tube-within-a-tube body plan:** The digestive tract has both a mouth and an anus.
2. **Pseudocoelom:** This body cavity, which allows space for the organs, is incompletely lined with mesoderm.
3. **Nervous organization:** Roundworms have a brain plus dorsal, ventral, and lateral nerves.
4. **Nonsegmented:** The body wall is smooth and not divided into segments.

Observation: Anatomy of Roundworms

Ascaris: *Dissection of Preserved Specimen*

1. Examine preserved specimens of *Ascaris,* both male and female (Fig. 27.9). Note the body shape and the smooth, tough cuticle that covers it. Find the mouth at the anterior end and the anus near the tip of the posterior end on the ventral surface. In roundworms, the sexes are separate. The male is smaller and has a curved posterior end. Be sure to examine specimens of each sex.
2. Place a specimen of *Ascaris* in a dissecting pan, pinning the anterior and posterior ends to the wax so that the dorsal surface is exposed.
3. Carefully slit open the worm longitudinally, cutting along the middorsal line.
4. Pin the body open to expose the internal organs.
5. Add a small amount of water to the pan to prevent drying out. Note the body cavity, or pseudocoelom, which is now evident. Note also the inner tube (consisting of the digestive tract) and the outer tube (made up of the muscular body wall). Does this explain the phrase *tube-within-a-tube body plan*? ______________________________
6. Examine the flattened digestive tract, which extends within the body cavity from the mouth to the anus. The anterior end forms a muscular pharynx, which is used to suck food materials into the mouth. The rest of the tract is a tube that passes to the anus.

7. Note the reproductive system. In the male, the reproductive structures are the **testis,** the **vas deferens,** and the **seminal vesicle** (Fig. 27.9*b*). These structures increase in size, from testes to vasa deferentia to seminal vesicles. In the female, the reproductive structures are the **ovary,** the **oviduct,** and the **uterus.** These structures increase in size, from ovaries to oviducts to uterus (Fig. 27.9*d*).

Vinegar Eels: Living Specimens

Vinegar eels are tiny, free-living nematodes that can live in unpasteurized vinegar.

1. Examine live vinegar eels, and observe their active, whiplike swimming movements. This thrashing motion may be a result of nematodes having longitudinal muscles only; they lack circular muscles.
2. Select a few larger vinegar eels for further study, and place them in a small drop of vinegar on a clean microscope slide. If the eels are too active for study, you can slow them by briefly warming them or by adding methyl cellulose.
3. Try to observe the tubular digestive tract, which begins with the mouth and ends with the anus. Also, you may be able to see some of the reproductive organs, particularly in a large female vinegar eel.

Conclusion

- Contrast roundworms (phylum Nematoda) with the other animals studied today by filling out the following table.

	Porifera	Cnidaria	Platyhelminthes	Nematoda
Example:				
Level of organization				
Germ layers				
Symmetry				
Body plan				
Nervous organization				
Coelom				
Segmentation				

Laboratory Review 27

_______________ 1. Animals without an endoskeleton of bone or cartilage are called what?

_______________ 2. Sponges are members of what phylum?

_______________ 3. Tapeworms are members of what phylum?

_______________ 4. What does an acoelomate animal lack?

_______________ 5. What type of gametes does a hermaphroditic animal produce?

_______________ 6. What do the cnidocytes (stinging cells) of cnidarians contain?

_______________ 7. A nerve net is characteristic of what group of animals?

_______________ 8. Which of the animal phyla was the first to evolve three germ layers?

_______________ 9. Which of the animal phyla studied today contains animals with radial symmetry?

_______________ 10. What type of cell lines the interior cavity of a sponge?

_______________ 11. On what basis are sponges classified?

_______________ 12. The cnidarian life cycle often includes two phases. One phase is absent in *Hydra.* Which phase is present?

_______________ 13. *Hydra* and *Obelia* use which two anatomical structures to obtain food?

_______________ 14. What two characteristics of a planarian may be associated with cephalization?

_______________ 15. What type of excretory system do planarians have?

_______________ 16. Upon examining a roundworm, how would you know it has a tube-within-a-tube body plan?

_______________ 17. What type of coelom does *Ascaris* have?

Thought Questions

18. Explain the difference between radial and bilateral symmetry, and associate these with the lifestyle of one of the animals studied.

19. Relate the number of germ layers to the level of complexity.