EXERCISE 7

The Sponges
Phylum Porifera

Members of phylum Porifera are considered the simplest metazoans—little more than loose aggregations of cells, with little or no tissue organization. They are said to belong to the **cellular level of organization.** There is division of labor among their cells, but there are no organs, no systems, no mouth or digestive tract, and only very rudimentary nervous integration. Because adult sponges have no germ layers, sponges are neither diploblastic nor triploblastic. Adult sponges are all sessile in form. Some have no regular form or symmetry; others have a characteristic shape and radial symmetry. They may be either solitary or colonial.

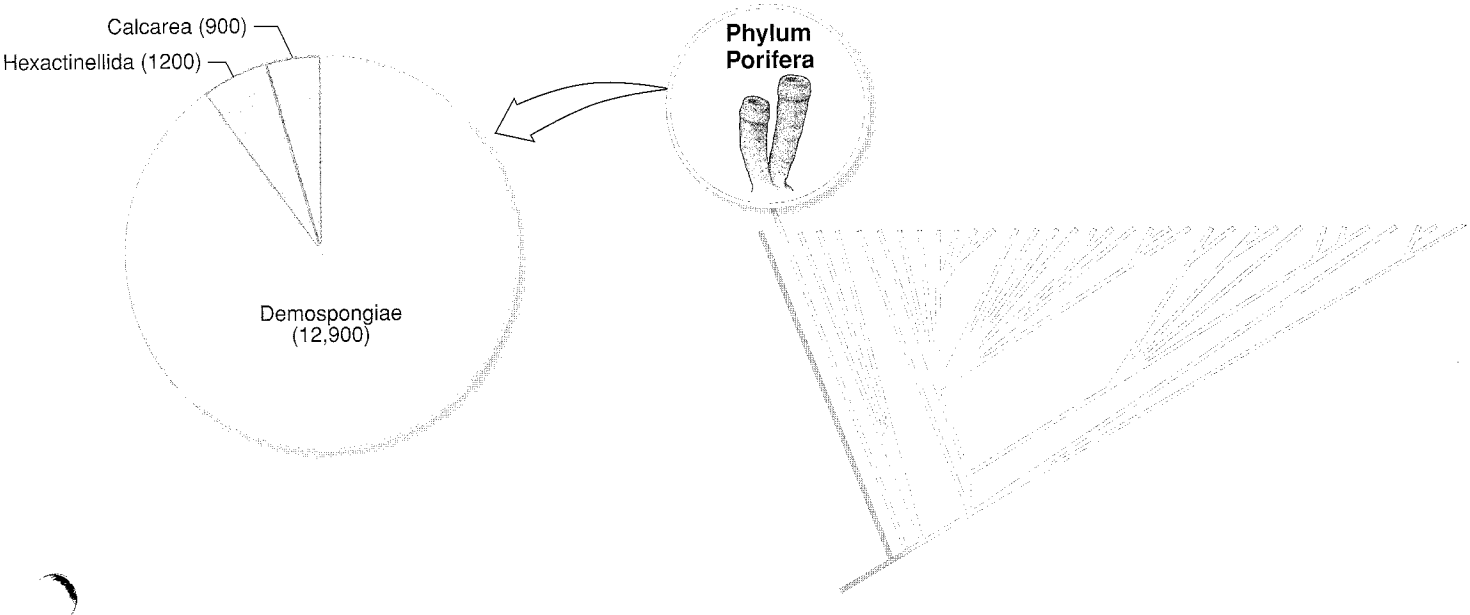
Chief characteristics of sponges are their **pores** and **canal systems;** the flagellated sponge feeding cells, called **choanocytes,** which line their cavities and create currents of water; and their peculiar internal skeletons of **spicules** or organic fibers **(spongin).** They also have some form of internal cavity **(spongocoel)** that opens to the outside by an **osculum.** Most sponges are marine, but there are a few freshwater species. Freshwater forms are found in small, slimy masses attached to sticks, leaves, or other objects in quiet ponds and streams.

Classification

Phylum Porifera

Class Calcarea Cal-ca′re-a (Gr. *calcis,* limy). Sponges with spicules of calcium carbonate, needle-shaped or three-rayed or four-rayed; canal systems asconoid, syconoid, or leuconoid; all marine. Examples: *Sycon, Leucosolenia.*

Class Hexactinellida (hex-ak-tin-el′i-da) (Gr. *hex,* six, + *aktis,* ray). Sponges with three-dimensional, six-rayed siliceous spicules; spicules often united to form network; body often cylindrical or funnel-shaped; canal systems syconoid or leuconoid; all marine, mostly deep water. Examples: *Euplectella* (Venus' flower basket), *Hyalonema.*



Class Demospongiae (de-mo-spun'je-e) (Gr. *demos,* people, + *spongos,* sponge). Sponges with siliceous spicules (not six-rayed), spongin, or both; canal systems leuconoid; one family freshwater, all others marine. Examples: *Spongilla* (freshwater sponge), *Spongia* (commercial bath sponge), *Cliona* (a boring sponge). Most sponges belong to this class.

EXERCISE 7A

Class Calcarea—*Sycon*

Sycon, a Syconoid Sponge

Phylum Porifera
Class Calcarea
Order Heterocoela
Genus *Sycon (=Scypha, Grantia)*

Where Found

Sycon is strictly a marine form, living in clusters in shallow water, usually attached to rocks, pilings, or shells. *Sycon* is chiefly a North Atlantic form. *Rhabdodermella* is a somewhat similar Pacific intertidal form, also belonging to class Calcarea.

Gross Structure

Place a preserved specimen in a watch glass and cover with water. Examine with a hand lens or dissecting microscope.

Sycon (Gr., like a fig) is a **syconoid** type of sponge (Figure 7-1). What is the shape of the sponge? _____ The body wall is made up of a system of tiny, interconnected, dead-end canals whose flagellated cells draw in water from the outside through minute pores, take from it the necessary food particles and oxygen, and then empty it into a large central cavity for exit to the outside. What is the name of this central cavity? _____ All sponges have some variation of this general theme of canals and pores on which they depend for a constant flow of water.

External Structure. Is the base of the sponge open or closed? _____ The opening at the other end is the **osculum** (L., a little mouth), surrounded by a fringe of stiff, rodlike **spicules.** The external surface appears bristly when examined under magnification. Why? _____

Note that the body wall seems to be made up of innumerable, fingerlike processes pointing outward (Figure 7-1). Inside each of these processes is a **radial canal,** which is closed at the outer end but which opens into a central cavity, the **spongocoel** (Gr. *spongos,* sponge, +*koilos,* hollow). External spaces between these enclosed canals are **incurrent canals,** which open to the outside but end blindly at the inner end. What is the name of the openings, or pores, to the outside of the sponge? _____

Water enters the incurrent canals and passes through minute openings called **prosopyles** (Gr. *prosō,* forward, + *pylē,* gate) into radial canals and then to the spongocoel and out through the osculum. There is no mouth, anus, or digestive system. What kind of symmetry does this sponge have? _____

Spongocoel. To study the spongocoel, do the following:

Make a longitudinal cut through the midline of the body from osculum to base with a sharp razor blade. Place the two halves in a watch glass and cover with water.

Find the small pores, called **apopyles** (Gr. *apo,* away from, + *pylē,* gate), that open from the radial canals into the spongocoel (Figures 7-1 and 7-2). Can you distinguish the tiny canals in the cut edge of the sponge wall? _____ Which direction does the water move through these canals? _____

Study of Prepared Slide

Transverse sections of sponge are difficult to prepare for slides because the spicules prevent cutting sections thin enough for studying the cells. Therefore, the spicules have been dissolved away for slide preparation.

On a prepared slide of a cross section of *Sycon,* examine the entire section with low power to get an idea of its general relations.

Note the **spongocoel** in the middle of the section (Figure 7-2). Study the canal system. Find the **radial canals,** which open into the spongocoel by way of the **apopyles.** Are apopyle openings smaller or larger in diameter than the radial canals? _____ Some apopyle openings will be lacking in this section, and some of the radial canals will appear closed at the inner end. Follow the radial canals outward. Do they open to the outside or end blindly? _____ The radial canals may contain young larvae, called **amphiblastula larvae.** Identify the **incurrent canals,** which open to the exterior by the **dermal ostia.** Follow these canals inward and note that they also end blindly. Water passes from incurrent canals into radial canals through a number of tiny pores, or **prosopyles,** which will not be evident on the slides.

Cellular Structure

Sponge cells are loosely arranged in a gelatinous matrix called **mesohyl** (also called mesenchyme). The mesohyl (Gr. *mesos,* middle, + *hyle,* wood) is the "connective tissue" of sponges, holding together the various types of ameboid cells, skeletal elements, and fibrils that make up the sponge body.

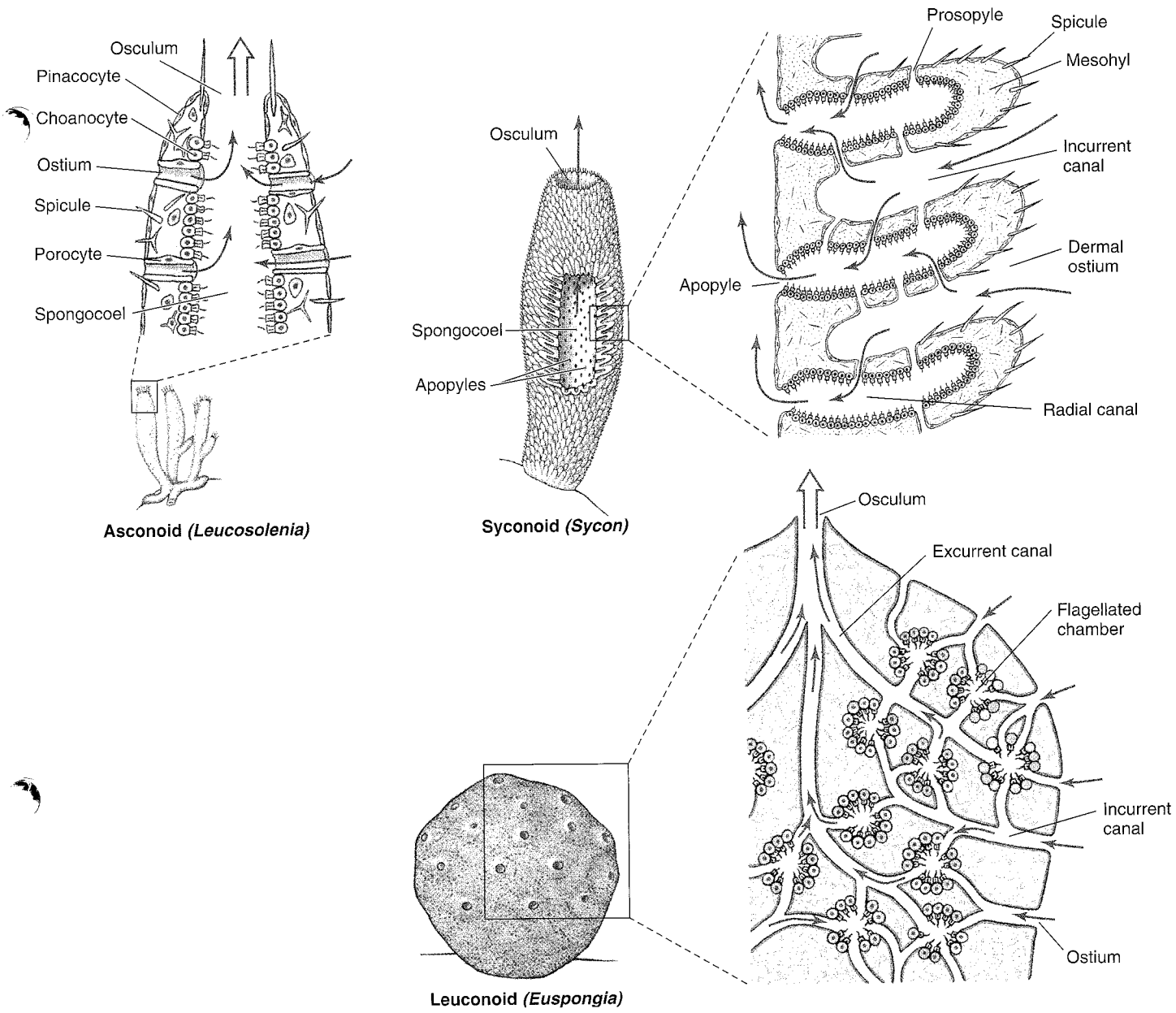


Figure 7-1

Three types of sponge structures. The degree of complexity from asconoid to complex leuconoid type involves mainly the water canal and skeletal systems, accompanied by outfolding and branching of the collar cell layer. The leuconoid type is considered the major body plan for sponges because it permits greater size and more efficient water circulation.

Choanocytes.

With high power, observe the "collar cells," or choanocytes (Gr. *choanē,* funnel, + *kytos,* hollow vessel), that line the radial canals (Figure 7-3).

Although they are flagellated, you probably will not see the flagella. What is the function of the choanocytes?

_____

Pinacocytes. Dermal pinacocytes (Gr. *pinax,* tablet, + *kytos,* hollow vessel) may be seen as extremely thin (squamous) cells lining the incurrent canals and spongocoel and covering the outer surface (Figure 7-3). What is their function? _____

Amebocytes. In the jellylike **mesohyl** that lies in the wall between the pinacocytes and choanocytes, look for large, wandering amebocytes of various functions (Figure 7-3). Some may differentiate into spicule-forming cells, some form sex cells, and some secrete spongin or spicules, serve as contractile cells, or aid in digestion.

If living sponges are available, tease a bit of tissue on a slide with a drop of seawater and look for the various types of cells.

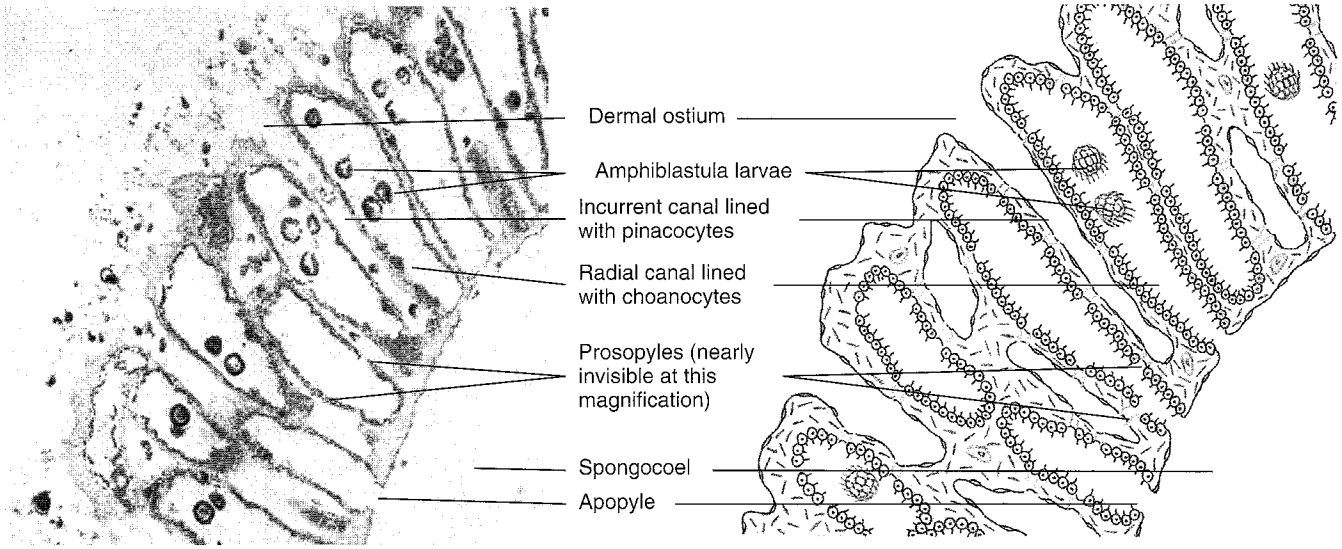


Figure 7-2
Section through wall of *Sycon.*

Reproduction

Sexual. *Sycon* sponges are monoecious, having both male and female sex cells in the same individual. Eggs and sperm are produced in the mesohyl. Fertilized eggs, after undergoing early cleavage in the mesohyl, develop into little blastula-like embryos, called **amphiblastula larvae.** These break through into the radial canals (Figure 7-2) and finally leave the parent by way of the osculum. They soon settle down on a substratum and grow into sessile adults.

Look for the embryos in the radial canals of the cross-section slide.

What is the advantage to a sessile animal of producing free-swimming larvae? _____

Most sponges do not have amphiblastula larvae. In most Demospongiae and some calcareous sponges, the zygote develops into a **parenchymula** (pair-en-ki'mu-la) **larva** in which the flagellated cells invaginate to form a solid internal mass.

Asexual. Many sponges, including those of genus *Sycon,* also reproduce asexually by budding off new individuals from their base, thus forming sessile clusters. What would be the disadvantage if this were the sole means of reproduction?_____
Is there a bud on your specimen?_____

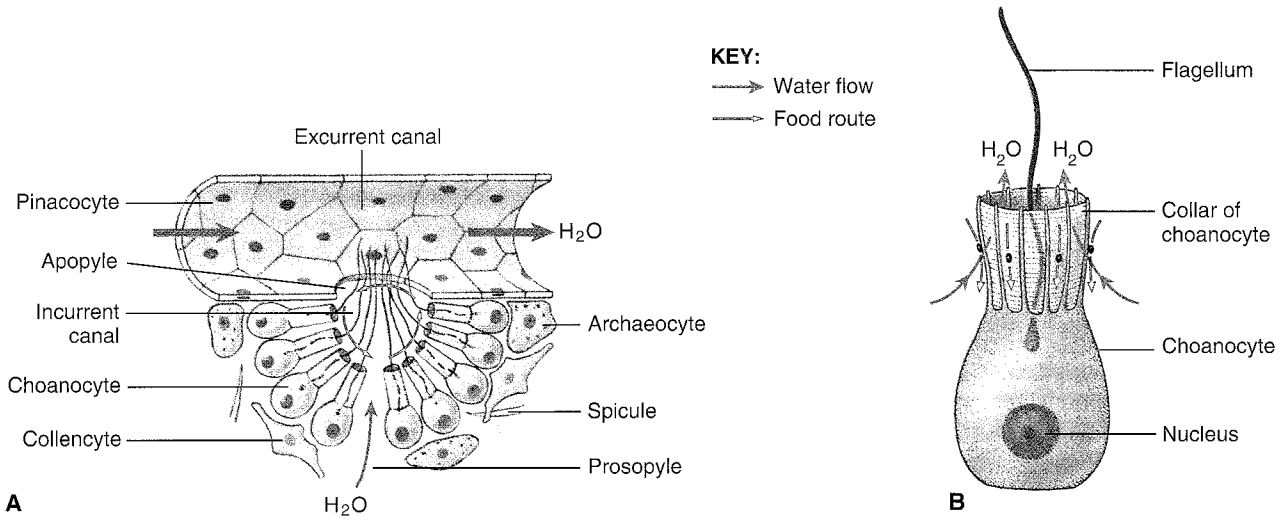


Figure 7-3
A, Small section through sponge wall, showing types of sponge cells and the water current created by choanocytes in flagellated chambers. **B,** Choanocyte as a food-catching cell. The "collar" is a series of cytoplasmic extensions that screen out larger food particles, letting them fall to the side of the cell for ameboid ingestion. Smaller particles flow through and are carried away in the current.

Freshwater sponges and some marine Demospongiae reproduce asexually by means of **gemmules,** made up of clusters of amebocytes. Gemmules (L. *gemma,* bud, + *ula,* dim.) of freshwater sponges are enclosed in hard shells (Figure 7-4) and can withstand adverse conditions that would kill an adult sponge. In spring, cells in gemmules escape through the micropyle and develop into young sponges. Marine gemmules give rise to flagellated larvae.

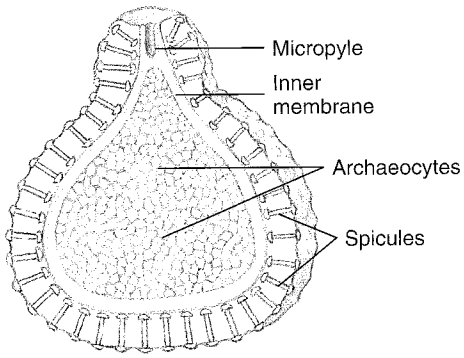


Figure 7-4
Gemmule of freshwater sponge.

Skeleton

Place a small bit of the sponge on a clean microscope slide; add a drop of commercial chlorine bleach, such as Clorox (sodium hypochlorite); and set aside for a few minutes to allow the cellular matter to dissolve. Break up the piece with dissecting needles, if necessary. Add a coverslip and examine under the microscope.

Look for **short monaxons** (short and pointed at both ends), **long monaxons** (long and pointed) (Figure 7-5), **triradiates** (Y-shaped with three prongs), and **polyaxons** (T-shaped). These spicules of crystalline calcium carbonate ($CaCO_3$) form a sort of network in the walls of the animal (Figure 7-3). What is the advantage of spicules to a loosely constructed animal such as *Sycon?*_____

Spicule types are used in the classification of sponges, along with the types of canal system. Demospongiae have siliceous (mainly $H_2Si_3O_7$) spicules, spongin fibers (composed of an insoluble scleroprotein that is resistant to protein-digesting enzymes) (Figure 7-6A), or a combination of both. Their spicules are either straight or curved monaxons or tetraxons, but never six-rayed. The glass sponges (Sclerospongiae) have siliceous triaxon (six-rayed) spicules.

Drawings

On p. 119, draw the following:

1. External view of *Sycon,* gross structure
2. Longitudinal section showing spongocoel and internal ostia; use arrows to show direction of water flow
3. Types of spicules you have seen

On p. 120, draw a pie-shaped segment of a transverse section through *Sycon,* showing a few canals and some of the cellular details of their structure. On the same page, sketch any other sponges you have studied.

Label all drawings fully.

Other Types of Sponge Structure

Asconoid Type of Canal System

The asconoid canal system is best seen in *Leucosolenia,* another marine sponge of the class Calcarea. *Leucosolenia* grows in a cluster, or colony (Figure 7-1), of tubular individuals in varying stages of growth. Large individuals may carry one or more buds.

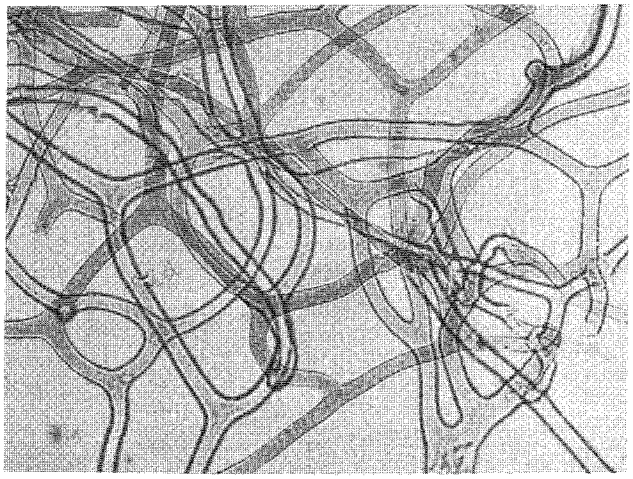
After observing the external structure of a submerged specimen, cut it in half longitudinally, place it on a slide with a little water, and cover. Study with low power or use a prepared slide.

The body wall is covered with pinacocytes on the outside and filled with mesohyl that contains amebocytes and spicules. Incurrent pores extend from the external surface directly to the spongocoel, which is lined with flagellated choanocytes. Choanocytes produce the water current and collect food. An osculum serves as an excurrent outlet of the spongocoel. On living specimens, you may be able to see some flagellar activity in the spongocoel.

Leuconoid Type of Canal System

Most sponges are of the leuconoid type and most leuconoids belong to the class Demospongiae (Figures 7-1 and 7-7). Leuconoid sponges have clusters of flagellated chambers lined with choanocytes, and water enters and

Figure 7-5
Skeletal spicules, mostly monaxons, from the cut and dehydrated surface of *Sycon,* SEM about ×480.



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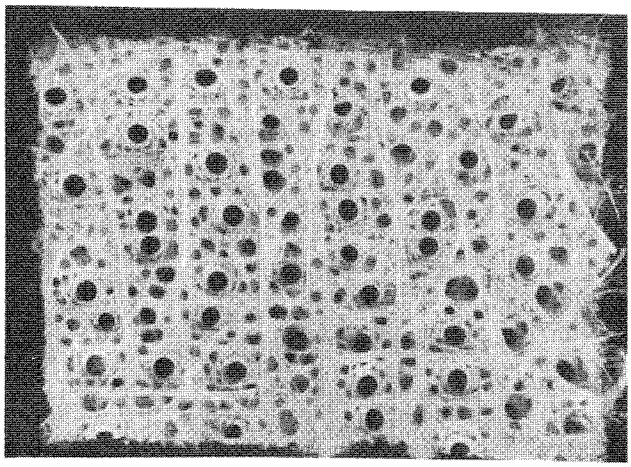


B

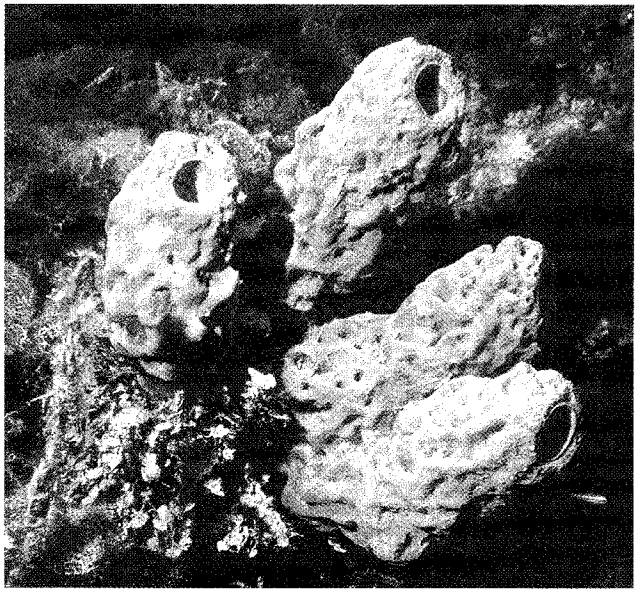
Figure 7-6

Skeletal elements. **A,** Spongin fibers found in Demospongiae (greatly enlarged). **B,** Portion of wall of sponge *Euplectella* (Hexactinellida), in which the spicules are arranged in a definite pattern (about natural size).

leaves the chambers by systems of incurrent and excurrent canals. Water from the excurrent canals is collected into spongocoels and emptied through the oscula. In large sponges, there may be many oscula. *Spongilla* and *Heteromeyenia,* which are freshwater sponges, and many marine sponges, such as *Halichondria, Microciona, Cliona,* and *Haliclona*—all belonging to Demospongiae—are of the leuconoid type.

Examine any such sponges available, in both external view and cut sections, to see this type of canal system.

See Appendix A, p. 396, for projects on the preparation of spicule samples and a study of sponge gemmules, including the preparation of permanent mounts of gemmules.



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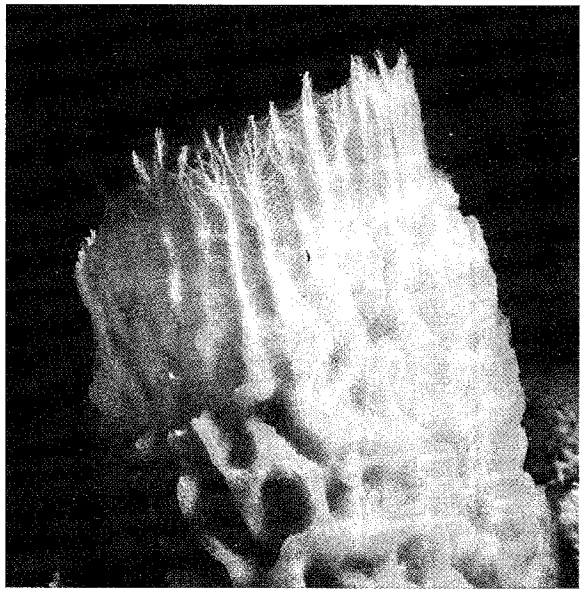

B

Figure 7-7

Two leuconoid-type sponges of the class Demospongiae from the Caribbean. **A,** *Aplusina lacunosa,* a tube sponge. **B,** *Spinosella plicifera,* a barrel sponge.