Introducing the Phylum Porifera

The Phylum Porifera includes the sponges, a group of peculiar sedentary animals so different from other types of animals that they were long thought to be plants. Sponges are among the most primitive multicellular animals. They have a simple type of body organization, with a porous body permeated by a system of water canals through which water is pumped by the action of special flagellated cells, choanocytes (collar cells). The body of a sponge consists of a network of epithelial cells, canals, and chambers embedded in a loose connective tissue. The only distinct tissues are the epithelial (lining) layers made up of pinacocytes and choanocytes.

Between the inner and outer layers lies the mesohyl, a loose gelatinous matrix with several types of amoeboid cells, fibrils, and skeletal elements (spicules and/or spongin fibers). The mesohyl resembles very loose connective tissue. An inner layer of flagellated choanocytes generates water currents through the internal canal systems. These water currents are essential in the life of the sponge, for they carry food particles and oxygenated water in to the sponge and waste products out of the sponge. Sponges are sessile filter feeders, able to capture tiny food particles measuring from about 0.1 μm to 50 μm from the seawater. The capture of food, which consists chiefly of fine, suspended organic particles and tiny planktonic organisms, is accomplished mainly by the choanocytes and internal amoebocytes. All digestion is intracellular (within individual cells). Sponges lack organized multicellular organs including nerves and muscles. In one sense, the water canal system of sponges is like an externalized circulatory system, but all the life processes of sponges take place in individual cells or groups of cells. Because of their lack of differentiated organs and because of their various other morphological and developmental peculiarities, sponges are generally believed to represent an early offshoot from the main line of animal evolution and not to be closely related to any more advanced animal types.

Of the more than 5,000 described species of sponges most are marine, except for approximately 150 species found in freshwater streams, ponds, and lakes. Formerly, certain types of marine sponges were of considerable economic importance, and sponge fishing industries flourished in several areas, such as the Gulf of Mexico, the Caribbean Sea, and the Mediterranean Sea, where the warm, shallow waters and rocky bottoms were favorable for the growth of bath sponges. Overfishing and sponge diseases have taken their toll, however, and increasing competition from synthetic sponges has further diminished the commercial importance of natural sponges.

Skeleton

The skeleton of sponges is relatively complex in comparison to the general organization of the body of sponges. The skeleton is internal and consists of individual mineralized elements, called spicules, made up of calcium carbonate, silicon dioxide, and/or a network of organic fibers composed of fibrillar collagen and/or spongin fibers. Spicules occur in a variety of forms and are important in the classification of sponges. Sponggin is a tough, fibrous protein chemically similar to collagen, but unique to the sponges.
Classification
The division of the phylum into classes is based largely on the nature of the skeleton. Three classes of living sponges are currently recognized, the Demospongiae, the Calcarea, and the Hexactinellida. A new group of deep-water sponges called the coralline sponges was discovered in recent years off the coast of Jamaica. These sponges have an unusual, coral-like skeleton with a calcareous matrix with siliceous spicules and spongin fibers, and are considered by some scientists to represent a fourth class, the Sclerospongiae. Other sponge biologists, however, now include the sclerosponges in the Class Demospongiae.

Class Demospongiae
Members of this class possess a skeleton made up of a network of spongin fibers (a structural protein secreted by certain sponge cells), siliceous spicules both or neither. Most members of this class are marine, but two families are found in freshwater streams, ponds, and lakes. All commercial sponges belong to this class. Examples: *Spongia, Halicciona, Microciona*, and the deep-sea sclerosponges (all marine); *Spongilla* (freshwater).

Class Calcarea (Calcispongiae)
*Calcarea Sponges*. Sponges with a skeleton consisting of many small spicules made of calcium carbonate embedded in a loose jelly-like matrix. All species are marine. Examples: *Scypha, Leucosolenia*.

Class Hexactinellida (Hyalospongiae)
*Glass Sponges*. Sponges with a skeleton composed of siliceous spicules, usually with six rays, as the class name implies. The spicules are often fused together into a continuous network. The tissues of glass sponges are a continuous network of fused amoeboid cells. All glass sponges are marine, and most species are found in deep areas of the world oceans. Little is known about their biology. Examples: *Euplectella* (Venus’s flower basket) and *Hyalonema*.

Body Organization
Morphologically, the bodies of sponges exhibit three distinct types based on the organization of their internal canal systems. These three morphological types are designated as the ascon, sycon, and leucon types. It is important to recognize that these three body forms represent morphological types and are not directly related to the three classes of sponges. In fact, only a few species of sponges exhibit the ascon and sycon body types. The majority of sponges are of the leucon type.

Ascon-type Sponge
*Leucosolenia* is a small colonial sponge of the ascon type. This and other
sponges of this type exhibit similar features.
1. A system of horizontal tubes that bear numerous upright branches.
2. The upright branches represent individual sponges of the colony
3. Buds form on the sides of the individual sponges.
4. The terminal opening, or osculum, at the upper end of each sponge. Water passes out of the sponge through this opening.
5. The spongocoel is a large central cavity within the sponge. This cavity is lined by the specialized, flagellated collar cells (choanocytes) which create water currents within the sponge.
6. Water enters the sponge through many tiny pores that penetrate the body wall.

Leucon-type Sponge
Leuconoid sponges are structurally the most complex and also the most common body type among the living sponges. All freshwater sponges and most marine sponges are leuconoid. Attached to the radial canals are numerous small, spherical, flagellated chambers.

Collar cells are found lining only these tiny flagellated chambers in leuconoid sponges. Study a dried specimen of a bath sponge and note how its texture
differs from that of the preserved specimen. Only the network of spongin fibers remains in the dried sponge.

**Freshwater Sponges**

Although most sponges are marine, a few species live in freshwater streams, ponds, and lakes. Freshwater sponges are much less prominent than their ubiquitous marine relatives. The freshwater sponges grow as tufts or small irregular masses encrusting sticks, stones or submerged plants. Most species are yellow or brown in color, but a few species are green because of symbiotic algae that live within the sponge.

**Lab Exercises**

**Specimen Examination**

Before continuing the lab, examine each of the sponge preparations in the front of the room. Using your field guide attempt a tentative identification for each specimen. We will now use skeletal structure to confirm the identifications.

**Sponge Skeletons**

Some sponge skeletons, such as those of the commercial bath sponge consist of a flexible proteinaceous material known as spongin. Others have a mixture of spongin and spicules. The spicules of sponges are composed of calcium carbonate (CaCO₃) or silicon dioxide (SiO₂). Spicules are often difficult to see in a live sponge preparation, but they can easily be isolated for better observation.

1. Obtain a small piece (the size of a pencil lead is plenty) of several of the sponge specimens in the front of the room. Place the sponge to be examined on a microscope slide with a few drops of hot 5% sodium hypochlorite (household bleach). Sodium hypochlorite will remove the organic material of the sponge without damaging the spicules. But it will damage your clothing, so be careful with it.
2. After cooling, place a coverslip over the spicule suspension and observe under a compound microscope.
3. Identify each sponge and its representative spicules. Draw several spicules labeling each type.

Possibly the most complex and spectacular sponge skeleton is produced by the deep-sea glass sponge *Euplectella*. Frequently, a pair of small crustaceans invades the spongocoel and become imprisoned by the complex spicule arrangement. The sponge, with its permanent inhabitants, is traditionally presented to newlyweds in Japan as a symbol of a long and enduring marriage. Observe the cleaned sponge skeletons which are displayed. Note the reduced spongocoel and very complex canals in the walls of the cleaned commercial sponge skeleton. What advantage might the sponge gain from this complex arrangement?

**Reassociation of Sponge Cells**

Most sponges are capable of regenerating a completely new body when broken into small pieces. In fact, some sponges normally accomplish a type of asexual reproduction by budding or fragmenting into several parts, each of which develops into a new sponge. Several types of sponges can survive extremely severe fragmentation and cellular disassociation. The remarkable regeneration and reassociation abilities of *Leucosolenia* or a similar sponge can be demonstrated with the following procedure.

1. Disassociate the cells of *Leucosolenia* by gently squeezing one live sponge tube through a piece of silk bolting cloth or plankton net (no.20 mesh, 6 m) and into a 400-ml beaker of cool (15°C) seawater. One disassociated sponge provides sufficient material for the entire class.
2. Place a few drops of the cell suspension on a depression slide, cover, and observe for a few minutes with a compound microscope. Can you identity separate cell types? Do you observe any tendency for the cells to aggregate? Describe.

4. The instructor will maintain the original cell suspension at 15° C for periodic observations. Observe a fresh sample of the cell suspension after 2, 4, and 6 days. Only a few minutes are necessary for each observation period. Note in the accompanying table the degree of cell reassociation, size of cellular aggregations, and any other observations.

| Name ___________________________ | Section _______ | Date ________ |
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**Table 8.1  Sponge Reassociation**

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*Material for this lab was taken from: Lytle, C.F., and Woodsedalek, J.E. General Zoology WM. C. Brown Publishers 1991  
Sumich, J.L., and Dudley, G. Laboratory and field investigations in Marine Life. McGraw Hill 1998*
Review Questions

1. Of the three body types discussed in the laboratory exercise, which is the most common?

2. Briefly, describe why sponges are considered the most primitive of the multicellular animals?

3. What features does the Bath sponge possess and lack that gives it a soft sponge feel?

4. What is the function of choanocytes in the sponge anatomy?
Porifera Laboratory Objectives

Sponge identification
1. Observe both preserved and live sponges
2. Using your field guide attempt to identify each species

Spicule identification
1. Dissolve a small piece of each sponge species in hot bleach
2. Identify the various spicule types sketching and labeling each
3. Examine the prepared slides of spicules and sponge larvae sketching and identifying each

Sponge Reassociation
1. Obtain a sponge sample and disassociate using a sieve
2. Observe the specimen in Ms. Jenkins incubator on 2, 4, and 6 day intervals
3. Complete the reassociation table included in this lab