

CHAPTER 6 STUDY GUIDE PHYLUM PORIFERA

6.1 Advent of Multicellularity

A. Advantages

1. Nature's experiments with larger organisms without cellular differentiation are limited.
2. Increasing the size of a cell causes problems of exchange; multicellularity avoids surface-to-mass problems.
3. Molecular evidence suggests sponges form a clade with other metazoa.
4. Porifera are multicellular but lack germ layers of Eumetazoa.
 - a. They have a cellular level of organization.
 - b. Sponges are organized into incipient tissues with low integration.
 - c. Bodies are masses of cells imbedded in a gelatinous matrix stiffened by **spicules**

B. Characteristics of Porifera

1. Porifera means "pore-bearing;" their sac-like bodies are perforated by many pores.
2. They are sessile and depend on water currents to bring in food and oxygen and carry away wastes.
3. Their body is a mass of cells embedded in gelatinous matrix and stiffened by spicules of calcium carbonate or silica and collagen.
4. They have no organs or tissues; cells are somewhat independent.
5. Being sessile, they have no nervous or sense organs and have simplest of contractile elements.
6. Sponges are commonly called Parazoa.
7. Sponges vary from a few millimeters to 2 meters across; they vary greatly in shape and color (Figure 6.1).
8. Sponges are ancient; fossils extend to Cambrian or earlier.
9. Sponges are assigned to three classes: Calcarea, Hexactinellida, and Demospongiae.

6.2

Ecological Relationships

1. Most of the 5000 species are marine; about 150 are freshwater.
2. Embryos are free swimming, adults are attached to submerged objects.
3. Morphology changes with substratum, calmness of water, etc. (Figure 6.2).
4. Many animals live as commensals or parasites on sponges.
5. Sponges may grow on mollusks, barnacles, brachiopods, or corals.
6. Some crabs use sponges as camouflage.
7. Sponges are generally distasteful, may emit noxious odors, and have few enemies.
8. Position in Animal Kingdom: Metazoa are divided into 3 grades:
 - a. Mesozoa (a single phylum)
 - b. Parazoa (phylum Porifera, sponges; and phylum Placozoa)
 - c. Eumetazoa (all other phyla).
 - d. Cell layers possessed by Mesozoa and Parazoa are not homologous to the germ layers of Metazoa.
9. Biological Contributions:
 - a. Compose a higher level of morphological and physiological integration than Protozoa.
 - b. Poriferans have several types of cells which form **incipient tissues**.
 - c. Embryonic layers are not homologous to germ layers of Eumetazoa.
 - d. Sponges have a unique **water current system**.

6.3

Form and Function

A. Characteristics

1. Body openings consist of small incurrent pores or **ostia** and a few excurrent **oscula**.
 2. Openings are connected by a system of canals; water passes from ostia to osculum.
 3. **Choanocytes** or flagellated collar cells line some of the canals.
 - a. They keep the current flowing by beating of flagella.
 - b. They trap and phagocytize food particles passing by.
 4. The framework of the sponge is composed of needle-like calcareous or siliceous spicules or organic spongin fibers.
 5. There are three types of canal systems (Figure 6.3).
 - a. **Asconoids**: Flagellated Spongocoels
 - 1) Asconoids are simplest; they are small and tube-shaped.
 - 2) Water enters a large cavity, the spongocoel, lined with choanocytes.
 - 3) Choanocyte flagella pull water through.
 - 4) All Calcarea are asconoids: *Leucosolenia* and *Clathrina* are examples (Figure 6.4).

- 5) Tubular individuals grow in groups attached by a stolon.
 - b. **Syconoids: Flagellated Canals** (Figure 6.5).
 - 1) They resemble asconoids but are bigger with a thicker body wall.
 - 2) The wall contains choanocyte-lined radial canals that empty into the spongocoel.
 - 3) Water entering filters through tiny openings called **prosopyles**.
 - 4) The spongocoel is lined with epithelial cells rather than choanocytes.
 - 5) Flagella force the water from radial canals through internal pores called apopyles into the spongocoel and out the osculum.
 - c. **Leuconoids: Flagellated Chambers**
 - 1) These are most complex and are larger with many oscula.
 - 2) Clusters of flagellated chambers are filled from incurrent canals, discharge to excurrent canals.
 - 3) Most sponges are leuconoid; it is seen in most Calcarea and in all other classes.
 - 4) The leuconoid system has evolved independently many times in sponges.
 - 5) This system increases flagellated surfaces compared to volume; more collar cells can meet food demands.
6. **Types of Cells** (Figure 6.6)
- a. Sponge cells are arranged in a gelatinous matrix called **mesohyl**, a type of “connective tissue”.
 - b. **Pinacocytes**
 - 1) These cells form the external epithelium; they are flat epithelial-like cells.
 - 2) Pinacocytes are somewhat contractile, some are myocytes that help regulate flow of water.
 - c. **Porocytes: tubular cells piercing the walls of asconoid sponges.**
 - d. **Choanocytes**
 - 1) These are oval cells with one end embedded in mesohyl.
 - 2) The exposed end has a flagellum surrounded by a collar.
 - 3) A collar is made of adjacent microvilli forming a fine filtering device to strain food (Figure 6.7).
 - 4) Particles too large to enter the collar are trapped in mucus and moved to the choanocyte where they are phagocytized.
 - 5) Food engulfed by choanocytes is passed to neighboring archaeocytes for digestion.
 - e. **Archaeocytes**
 - 1) These cells move about in the mesohyl.
 - 2) They phagocytize particles in the external epithelium.
 - 3) They can differentiate into any other type of cell.
 - 4) Those called sclerocytes secrete spicules.
 - 5) Spongocytes secrete spongin.
 - 6) Collencytes secrete fibrillar collagen.
7. **Types of Skeletons**
- a. Collagen fibrils are found throughout intercellular matrix of sponges.
 - b. Various Demospongiae secrete a form of collagen called **spongin**.
 - c. Demospongiae also secrete siliceous spicules.
 - d. Calcareous sponges secrete spicules of crystalline calcium carbonate.
 - e. Glass sponges have siliceous spicules with six rays.
 - f. Spicule patterns are important taxonomic features (Figure 6.8).
8. **Sponge Physiology**
- a. Sponges feed primarily on suspended particles from 50 μm to 0.1 μm
 - b. Detritus, plankton, and bacteria are consumed.
 - c. Pinacocytes phagocytize surface particles.
 - d. Archaeocytes consume large particles.
 - e. Choanocytes phagocytize the smallest particles (accounts for 80% of the particulate organic matter).
 - f. Some large sponges can filter 1,500 liters of water a day.
 - c. Digestion is completely intracellular, primarily by archaeocytes.
 - d. There are no excretory or respiratory organs; diffusion suffices.
 - e. Sponges consume dissolved organic matter by pinocytosis.
 - f. Some sponges crawl 4 mm per day.

B. Reproduction and Development

1. Sexual Reproduction
 - a. Most are monoecious with both male and female sex cells in one individual.
 - b. Sperm arise from transformed choanocytes.
 - c. In some Demospongiae and Calcarea, oocytes develop from choanocytes; others derive them from archaeocytes.
 - e. In some, when one sponge releases sperm, they enter the canals of another sponge..
 - f. Choanocytes phagocytize the sperm and transfer them to carrier cells that carry sperm through mesohyl to oocytes.
 - g. Some release both sperm and oocytes into water.
 - h. The free-swimming larva of sponges is a solid **parenchymula** (Figure 6.9).
2. Asexual Reproduction
 - a. Sponges reproduce by fragmentation or by producing external buds.
 - b. Internal buds or gemmules are formed by archaeocytes that survive drought, freezing, etc. (Figure 6.10).
 - c. Sponges can regenerate wounded portions.

C. Brief Survey of Sponges:

1. **Class Calcarea (Calcispongiae)**
 - a. These are calcareous sponges with spicules of calcium carbonate.
 - b. The spicules are straight or have three or four rays.
 - c. Most are small sponges with tubular or vase shapes.
 - d. Asconoid, syconoid and leuconoid forms all occur.
2. **Class Hexactinellida (Hyalospongiae)**
 - a. These are glass sponges with six-rayed spicules of silica.
 - b. Nearly all are deep-sea forms; most are radially symmetrical.
 - c. Their living tissue forms a spicular network; a trabecular net of bilayered tissue made of archaeocytes, sclerocytes, and choanoblasts.
 - d. Chambers appear to correspond to both syconoid and leuconoid types (Figure 6.11).
 - e. They are adapted to a deep-water habitat with a large and easy flow of water.
 - f. The reticulum has primary and secondary layers.
 - g. Collar cells are attached to choanoblasts.
 - h. Water passes through prosophyles, collar cells, and finally into flagellated chambers.
3. **Class Demospongiae (Figure 6.12)**
 - a. This class contains 80% of living sponge species.
 - b. Spicules are siliceous but not six-rayed; they may be absent or bound together by spongin.
 - c. All are leuconoid and all are marine except for Spongillidae, the freshwater sponges.
 - d. Freshwater sponges flourish in summer and die in late autumn, leaving gemmules.
 - e. Marine demosponges are highly varied in color and shape.
 - f. Bath sponges belong to a group that lacks siliceous spicules but have spongin skeletons.

D. Phylogeny and Adaptive Radiation

1. Sponges appeared before the Cambrian.
2. Glass sponges rapidly expanded in the Devonian.
3. One theory is that sponges arose from choanoflagellates; however, some corals and echinoderms also have collar cells, and sponges acquire them late in development.
4. Molecular rRNA evidence suggests a common ancestor for choanoflagellates and metazoans and that sponges and Eumetazoa are sister groups with Porifera splitting off before radiates and placozoans.

E. Classification

- Class Calcarea
- Class Hexactinellida
- Class Demospongiae

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