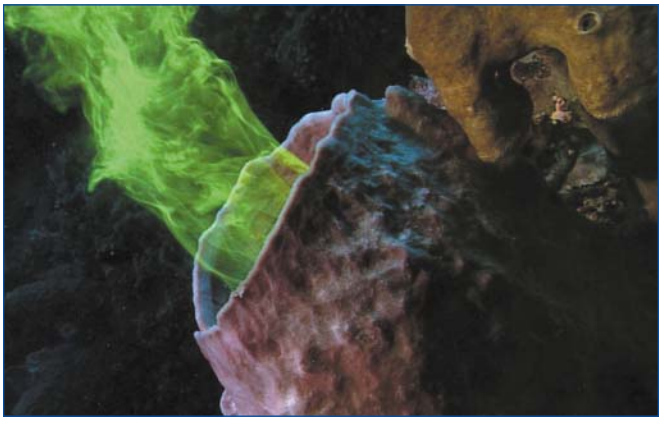
EPISODE 1

SPONGES:
ANIMAL ORIGINS



Background

Episode One of *The Shape of Life: The Story of the Animal Kingdom,* entitled "Sponges: Animal Origins," features the rather unassuming phylum Porifera [pronounced por-IF-er-uh] commonly known as the sponges. Sponges are considered the oldest of the animal phyla. The name Porifera means "pore bearer" in Latin. Like all animals, sponges are multicellular, but their specialized cells are not organized into tissues or organs. Their cells more or less independently carry out all the necessary tasks to stay alive and reproduce. A skin, one cell thick, covers the surface of a sponge's body. Numerous small pores and a few large openings penetrate this skin. These pores function as both entrances and exits for a complex system of canals and chambers through which the sponge pumps a current of water. This current of water brings food to the sponge. Within this system of canals, the body of the sponge is a loose assemblage of specialized cells. Some secrete a skeleton of collagen fibers and mineral spicules (glass or calcium carbonate) while other cells carry out the processes of growth, repair, nourishment, and reproduction.

As the sponge pumps in water, some of its cells capture tiny food items—usually bacteria as small as a single micron in diameter. Specialized funnel-shaped collar cells, called choanocytes, pump water through the sponge's body at an amazing rate: many sponges can filter their entire body volume in less than one minute. That's an important attribute, considering that some sponges must pump more than a ton of water to secure just a single ounce of food!

Vocabulary

autotroph	flagellum
calcium carbonate	heterotroph
canal	reaggregation
choanocyte	sessile
collagen	spicule
collar cell	spongin

Before the Video

You may want to discuss the characteristics that define an animal and how animals are classified. This should be an open-ended discussion to get the students to think about concepts rather than just define terms. You may have to start the discussion by determining which organisms are animals. At this point, it doesn't matter if your list is complete or entirely correct. Discussion after the video will clear up any confusion. The following questions might help the discussion.

- What are some of the characteristics found in all animals? Do all animals move? Do all animals breathe? Do all animals have a head?

- What are the similarities and the differences among plants and animals and fungi? The answers to this question should lead the discussion into the next question.

- What are the criteria biologists use to classify life into kingdoms?

- Scientists who specialize in classification systems for organisms are called taxonomists or systematists. Their research areas are called taxonomy or systematics.

- Outline, define, and discuss the five kingdoms of organisms and the taxonomic hierarchy of animals (kingdom, phylum, class, order, family, genus, species). You may want to use this popular mnemonic to help students memorize the hierarchy: **K**ings **P**lay **C**hess **O**n **F**ine-**G**rained **S**and. You may also want to point out that the hierarchy for plants has one difference—instead of phyla, the plant kingdom is subdivided into divisions.

- Discuss the differences between the polynomial and the binomial systems for classifying organisms.

During the Video

Students will see two on-screen questions during this episode, and one immediately after. You may want to pause the video at this time for class discussion of the concepts.

1 **Why do scientists need to classify or organize all the species of life?**

ANSWER: There are three reasons: The first is our natural inclination to group organisms. We classify as a means of making connections. Similar organisms may have similar benefits or dangers. Grouping unfamiliar organisms with

familiar ones gives us a foothold in the unknown. The second has to do with communication. Millions of different kinds of organisms exist. In order for scientists to study them, talk to each other about them, and report their findings to the world, it is necessary that each kind of organism have a unique name. If every scientist created a different set of names, considerable confusion would arise. For example, think about the creatures some people call "roly-poly bugs." Other people may think of them as "pill bugs" or "sow bugs." Inconsistencies like this led scientists to create a universally accepted binomial naming system. (Using this system, we find that the correct scientific name for one species of the roly-poly bug is *Armadillium vulgare*. It's actually not a bug at all, and is more closely related to a shrimp or crab.) The third reason has to do with scientific understanding. We classify in order to understand the relationships among organisms and their ancestry.

The development of the field of taxonomy or systematics has made a major impact on the study of animal life.

2 **If a sponge has no mouth, how does it feed?**

ANSWER: Sponges draw water into their bodies and use specialized cells to capture and eat microscopic organisms like plankton and bacteria and other particulate organic matter from the current. Cells in the walls of the canals capture food as it passes by and both choanocytes and amebocytes capture food in the

choanocyte chambers. A sponge doesn't have organs; the cells perform all body functions. Digestion takes place inside cells.

3 What do scientists mean when they say that the sponge is "basal" to all animals?

ANSWER: The sponge is considered to be the common ancestor of every animal species alive on the planet today. In that regard, it can be found at the "base" of the animal family tree, meaning that all body forms descend from it.

(Note: This final on-screen question can be used as a springboard to a more extensive discussion using the following questions.)

After the Video

Use the following questions to evaluate your students' understanding of the key concepts and facts from this episode.

1 What evidence supports the theory that the sponge was the first animal?

ANSWER: Scientists draw from a variety of evidence including morphological, biochemical, and genetic data. Morphologically, sponges are organized on the simplest level of body organization—the cellular level. They have no tissues or organs but possess the basic complement of animal proteins. Genetically they lie at the base of the family tree. Scientists can take a particular gene common to all organisms, compare subtle differences in that gene between animal groups, and based on those differences assemble a tree of relatedness.

2 What fields of biology began to combine forces, or share knowledge, to help solve the mysteries of animal origins in the past two or three decades? What breakthroughs made this collaboration possible?

ANSWER: Paleontology and the study of fossils, morphology and the study of body plans (in fields such as anatomy and embryology), and genetics have combined forces to study animal origins. Due to breakthroughs in genetics, gene sequencing techniques, and computer technology, scientists are now able to study specific gene sequences in the DNA of different species.

3 What distinguishes animal life from plant life?

ANSWER: Animals are all heterotrophs, meaning they get their energy from organic substances produced by other organisms. Plants are autotrophs; they make their own food, most often through photosynthesis. Most animals also move for at least part of their lives. (In sponges the larval form is free-swimming, and a very few sponges even move as adults but not like other animals.) Plants are immobile. Plant cell walls are rigid and composed of cellulose. Animal cell walls are flexible and without cellulose.

4 What function do the canals and chambers inside a sponge serve toward the circulation of nutrients?

ANSWER: Since the sponge has no circulatory system to distribute food after it is digested (like humans and other complex animals), food must be delivered directly to all parts of the sponge's body. It does this by distributing water throughout its body chambers so individual cells can directly capture food. Residing in chambers are specialized choanocyte cells that provide the filtering power for the sponge. More chambers mean more filtering area and power.

5 All animals are multicellular. What does this term mean? What are specialized cells? Name a specialized cell in a sponge.

ANSWER: Multicellular organisms, as the term implies, have more than one cell. Single-celled organisms such as bacteria have to carry out all the processes of life within a single cell. In multicellular organisms, tasks are shared among different types of specialized cells. Specialized cells are cells designed for a particular function. The choanocytes of sponges are spe-

cialized cells with a flagellum that beats constantly to create the current that flows through the sponge's body.

6 **How did Cristina Diaz test for the rate of water flow that moves through a sponge as it feeds? What kind of information about the feeding patterns of sponges could be gained from this type of experiment?**

ANSWER: She injected a harmless colored dye into the water around the sponge, and then timed it to see how quickly the dyed water exited from the central cavity of the sponge. From this experiment, she was able to determine the rate at which the sponge pumps water. Such visualization techniques can also help scientists identify daily feeding cycles.

The following questions are designed to promote in-depth discussions.

1 Compare and contrast protozoans and animals.

2 What evidence from the fields of paleontology, developmental biology, genetics, and animal and plant breeding has helped us understand the mechanisms of evolution?

3 What behavior does a sponge exhibit?

Extending the Lesson

Following are suggested research topics you may wish to assign to your class, for either group or individual study.

1 **Career Exploration.** In this episode, students meet evolutionary biologist Mitchell Sogin of the Marine Biological Laboratory in Woods Hole (Mass.), taxonomist Cristina Diaz of the University of California, Santa Cruz, and conservationist Mark Erdmann of the Indonesian Institute of Sciences and the University of California, Berkeley. Have each student (or group) select one of these careers and describe the education, training, and career opportunities available today. What are some areas of specialization available to people with degrees in these scientific fields?

2 **Historical Perspectives, part 1.** How have relationships between animal groups been determined in the past? Describe the contributions to taxonomy made by Aristotle, John Ray, Jean-Baptiste Lamarck, and Carolus Linnaeus, and compare how they approached the task of organizing animals. How are their theories viewed today?

3 **Historical Perspectives, part 2.** What theory of evolution did Baron Georges Cuvier favor? Compare Cuvier's conclusions with the theory of evolution presented by Alfred Russel Wallace or Charles Darwin, and discuss the evidence on which each scientist based his conclusions.

4 **Phyla Focus.** More than 9,000 species of sponges exist, and they range in size from a few millimeters to over two meters in diameter. What accounts for this range in sizes? Describe the differences between sponges with spicule skeletons and those with spongin skeletons; include their chemical composition and how the different skeletons affect the body plan and lifestyle of the sponge. Which type of skeleton is the model for a bathtub sponge?

5 **Body Plans.** Larval sponges are free-swimming, but the adults are *sessile,* in other words, anchored in place. Describe the life cycle of a sponge, from reproduction (sexual only) to larval and adult stages. Briefly describe each of the stages. How is this sexual life cycle different than the process of asexual reproduction?

6 **Geographical Connections, part 1.** The enormous number of Indonesia's islands and their location in a tropical, equatorial climate have produced an unrivalled diversity of plant and animal life. With only 1 percent of the world's land area, Indonesia is home to over 10 percent of all mammal species and 17 percent of all birds. Why does this area boast such diversity? What is the Wallace Line, and what does it signify?

7 **Geographical Connections, part 2.** Indonesia is of importance to marine biologists because it contains some of the greatest diversity of marine life on Earth. Research some pressing ecological issues in Indonesia today (such as loss of habitat, chemical or acoustic pollution, and irresponsible hunting and fishing practices) and describe the detrimental impacts on scientific research.

8 **Science and Technology.** The 1980s and 1990s saw considerable advances in the understanding of the structure of genes and how they work, thanks to the development of techniques for isolating and manipulating genes. Investigate these techniques, including recombinant DNA technology, gene sequencing, and the use of polymerase chain reactions (PCR)—and then outline some of the applications of this knowledge that could not have been foreseen before their discovery. Include brief descriptions of

these applications in vaccines, crop improvement, forensic studies, and medicine. How do these advances in genetic understanding apply to evolutionary biology? How is molecular and genetic research influencing our classification of animals into related groups?