



Spawning & Rearing Bivalve Mollusks:



Part 1: Spawning

Grade Level:
5-12

Subject Area:
Biology, Aquaculture

Time:

Preparation: Spawning—
indeterminant; Daily exchange 10
minutes

Activity: Spawning—indeterminant;
Daily exchange 20 minutes

Clean-up: 10 minutes

Student Performance Standards (Sunshine State Standards):

06.03 Illustrate correct terminologies for animal species and conditions (e.g. sex, age, etc.) within those species (LA.910.1.6.1, 2, 3, 4, 5; SC.912.L.14. 19, 31, 33).

11.01 List and explain the meaning of morphology, anatomy, and physiology (LA.910.1.6.1, 2, 3, 4, 5; LA.910.2.2.2; SC.912.L.14.7).

11.02 List and describe the physiology of aquatic animals (LA.910.1.6.1, 2, 3, 4, 5; LA.910.2.2.2; SC.912.L.14.11, 12, 13, 14, 15, 16, 17, 18, 19, 21, 22, 28, 29, 31, 32, 33, 34, 36, 40, 41, 42, 43, 45, 46, 47,48, 51SC.912.L. 18. 7, 8, 9).

11.10 List and describe the major factors in the growth of aquatic fauna and flora (LA.910.1.6.1, 2, 3, 4, 5; LA.910.2.2.2; SC.7.L.17.1, 2, 3).

12.01 Recognize and observe safety practices necessary in carrying out aquaculture activities (LA.910.1.6.1, 2, 3, 4, 5; LA.910.4.2.2, 5).

13.02 Explain how changes in water affect aquatic life (LA.910.1.6.1, 2, 3, 4, 5; LA.910.2.2.2; SC.912.L.17.2, 3, 7, 10).

13.03 Explain, monitor, and maintain freshwater/saltwater quality standards for the production of desirable species (LA.910.1.6.1, 2, 3, 4, 5; LA.910.2.2.2).

14.01 Identify factors to consider in determining whether to grow an aquaculture species

(LA.910.1.6.1, 2, 3, 4, 5; LA.910.2.2.2; SC.7.L.17.3).

14.02 Identify/describe facilities used in a grow-out operation (LA.910.1.6.1, 2, 3, 4, 5; LA.910.2.2.2).

14.04 Determine the purpose and functions of a hatchery (LA.910.1.6.1, 2, 3, 4, 5; LA.910.2.2.2).

14.05 Identify and describe the sexual reproductive process and methods of reproducing aquaculture organisms (LA.910.1.6.1, 2, 3, 4, 5; LA.910.2.2.2; SC.7.L.16.3).

14.06 Identify and describe the spawning facilities used in aquaculture LA.910.1.6.1, 2, 3, 4, 5; (LA.910.2.2.2).

15.01 Identify the types of growing systems and important factors in their selection, design, and use (LA.910.1.6.1, 2, 3, 4, 5; LA.910.2.2.2).

Objectives:

1. Students will be able to describe reproductive biology and spawning of bivalve mollusks.
2. Students will be able to explain how bivalve mollusk larvae develop.
3. Students will be able to describe the conditions used in hatcheries for commercial production of bivalve mollusks.
4. Students will be able to apply techniques used for small-scale, experimental mollusk larviculture.

Abstract:

In this lesson, students will learn methods for spawning bivalve mollusks (e.g. clams or oysters) using thermal induction. Students will acquire skills in using an ocular micrometer to measure the diameter of bivalve eggs and the length of bivalve larvae. The following lesson plan will have students monitoring the density of larvae in their culture system and understanding production protocols used in bivalve hatcheries.

Interest Approach:

Ask students if they know where oysters and clams come from (after using the module example to explain the mode of reproduction — synchronous broadcast spawners). Describe to them that most of the shellfish we consume in the United States are actually farmed in the open, public waters along our coasts. Shellfish culture utilizes the natural food in our coastal waters, and as such, requires that the water is clean, free to toxins and harmful pathogenic bacteria. Therefore, shellfish farmers are at the forefront of environmental stewardship of our coastal

waters because their livelihoods depend upon it. Polluted waters become closed to shellfish farming. This lesson is to let students understand the equipment and techniques associated with spawning and rearing bivalve mollusks up to the point that they are transferred to their “pastureland” in our coastal waters.

Student Materials:

1. *Introduction to the Biology of Mollusks* handout
2. *Spawning Bivalve Mollusks* handout

Teacher Materials:

<i>Material</i>	<i>Store</i>	<i>Estimated Cost</i>
<i>Introduction to the Biology of Mollusks</i> handout copies	NA	NA
<i>Spawning Bivalve Mollusks</i> handout copies	NA	NA
SPAWNING MATERIALS (per group)		
Assorted containers (buckets, dishes, etc.)	WalMart, Home Depot	\$3 and up
Means to heat water (microwave, aquarium heater)	NA	NA
Means to cool water (refrigerator, freeze-pacs, frozen water in soda bottles)	NA	NA
Ripe bivalve mollusks	NA	NA
Paper towels	Local grocery store	\$3 and up
Hand sanitizer	Local grocery store	\$3 and up
Dissecting microscope	Carolina Biological	\$100 and up
1 ml pipettes	Aquatic Ecosystems	\$10 and up
Algae starter culture	Aquatic Ecosystems	\$50 and up
Aerator	NA	NA
Sieves (made from 35 µm mesh screens)	Aquatic Ecosystems	\$40 and up

Student Instructions:

1. Read the handout *Spawning Bivalve Mollusks* for homework in preparation for this laboratory.
2. Once assigned to a group, prepare your table to be used to spawn bivalves.
3. Place the bivalves in spawning container with seawater (@ 22°C); add algae.
4. Gradually raise the water temperature to @ 30 °C.

5. If the bivalves do not spawn within 30 minutes, gradually lower the temperature and repeat the cycle. Very ripe bivalves may spawn on the first warming, or it could take several cycles (be prepared to perhaps spend the day).
6. If spawning does not occur after several cycles, and option is to strip sperm from a male (dissected earlier), mix with seawater, and pipette into the spawning container to induce spawning.
7. If spawning does not occur, it is most likely that the bivalves were not in reproductive condition; probably should review the time of year (is it reproductive season) or arrange to get conditioned bivalves on loan from a commercial hatchery.

Teacher Instructions:

Preparations:

1. Obtain your clam or oyster specimens. Dissect a few to determine their ripeness and save for later.
2. Divide your class into 2 or 3 groups, or complete spawning as a demonstration.
3. Ensure that all materials are available, particularly methods to change water temperature (spawning is induced through thermal shock).

Activity:

1. The teacher should coordinate with students to facilitate the spawning process described above.

Post work/Clean-up:

1. When students are finished with spawning, have them remove live bivalves for disposal. Sacrificed (dissected) bivalves should be disposed in a sealed container.
2. Have each group thoroughly rinse and sanitize spawning containers, glassware, and other materials used for spawning.

Anticipated Results:

1. Students will observe broadcast spawning of bivalves and the methods used by hatcheries to induce spawning.
2. Students will observe the fertilization and larval development of bivalve mollusks.

Support Materials:

1. *Introduction to the Biology of Mollusks* handout

2. *Spawning Bivalve Mollusks* handout
3. *Molluscan Culture Overview* presentation
4. Video: *Hard Clam Spawning Procedures*
(available at www.aquaculture-online.org)
5. Video: *Oyster Settlement* (available at www.aquaculture-online.org)
6. Clam Printables:
<http://homeschooling.about.com/od/freeprintables/ss/clamprint.htm>
7. Whetstone, J.M., L. N. Sturmer, and M. J. Oesterling. 2005. Biology and culture of the hard clam (*Mercenaria mercenaria*). SRAC Publication No. 433.
(<http://srac.tamu.edu>)

Explanation of Concepts:

Methods of external reproduction in bivalve mollusks

Microscope skills and volume/density calculations

Biology of plankton and larval development



Support Materials



Introduction to the Biology of Mollusks

Mollusks are animals belonging to the phylum **Mollusca**. There are around 93,000 recognized extant species, making it the largest marine phylum with about 23% of all named marine organisms. Representatives of the phylum live in a huge range of habitats including marine, freshwater, and terrestrial environments. Molluscs are a highly diverse group, in size, in anatomical structure, in behaviour and in habitat. The phylum is typically divided into nine or ten taxonomic classes, of which two are entirely extinct. Cephalopod molluscs such as squid, cuttlefish and octopus are among the most neurologically advanced of all invertebrates. Either the giant squid or the colossal squid is the largest known invertebrate species. The gastropods (snails and slugs) are by far the most numerous molluscs in terms of classified species, and account for 80% of the total number of classified molluscan species.

Mollusks have such a varied range of body structures that it is difficult to find defining characteristics that apply to all modern groups. The two most universal features are a mantle with a significant cavity used for breathing and excretion, and the structure of the nervous system. As a result of this wide diversity, many textbooks base their descriptions on a hypothetical "generalized mollusc". This has a single, "limpet-like" shell on top, which is made of proteins and chitin reinforced with calcium carbonate, and is secreted by a mantle that covers the whole upper surface. The underside of the animal consists of a single muscular "foot". Although mollusks are [coelomates](#), the [coelom](#) is very small, and the main body cavity is a [hemocoel](#) through which [blood](#) circulates – mollusks' circulatory systems are mainly [open](#). The "generalized" mollusc feeding system consists of a rasping "tongue" called a [radula](#) and a complex digestive system in which exuded [mucus](#) and microscopic, muscle-powered "hairs" called [cilia](#) play various important roles. The "generalized mollusc" has two paired [nerve cords](#), or three in [bivalves](#). The brain, in species that have one, encircles the [esophagus](#). Most mollusks have eyes, and all have sensors that detect chemicals, vibrations and touch. The simplest type of molluscan reproductive system relies on [external fertilization](#), but there are more complex variations. All produce eggs, from which may emerge [trochophore](#) larvae, more complex [veliger](#) larvae, or miniature adults. A striking feature of mollusks is the use of the same organ for multiple functions. For example: the heart and [nephridia](#) ("kidneys") are important parts of the reproductive system as well as

the circulatory and excretory systems; in bivalves, the [gills](#) both "breathe" and produce a water current in the mantle cavity which is important for excretion and reproduction.

The mantle secretes a shell that is mainly chitin and [conchiolin](#) (a [protein](#)) hardened with [calcium carbonate](#), except that the outermost layer is all conchiolin. The mantle cavity is a fold in the mantle that encloses a significant amount of space, and was probably at the rear in the earliest molluscs but its position now varies from group to group. The underside of the body generally consists of a muscular foot, which has been adapted for different purposes in different classes. In gastropods, it secretes [mucus](#) as a lubricant to aid movement. In forms that have only a top shell, such as [limpets](#), the foot acts a sucker attaching to the animal to a hard surface, and the vertical muscles clamp the shell down over it; in other molluscs, the vertical muscles pull the foot and other exposed soft parts into the shell. In bivalves, the foot is adapted for burrowing into the sediment; in cephalopods it is used for jet propulsion, and the tentacles and arms are derived from the foot.

Most mollusks have only one pair of gills, or even only one gill. Generally the gills are rather like feathers in shape, although some species have gills with filaments on only one side. They divide the mantle cavity so that water enters near the bottom and exits near the top. Their filaments have three kinds of cilia, one of which drives the water current through the mantle cavity, while the other two help to keep the gills clean. Each gill has an incoming blood vessel connected to the hemocoel and an outgoing one connected to the heart.

Most mollusks have muscular mouths with radulae, "tongues" bearing many rows of chitinous teeth, which are replaced from the rear as they wear out. This is primarily designed to scrape [bacteria](#) and [algae](#) off rocks. The particles are sorted by a group of cilia, which send the smaller particles, mainly minerals, to the prostyle so that eventually they are excreted, while the larger ones, mainly food, are sent to the stomach's [cecum](#) (a pouch with no other exit) to be digested. The anus is in the part of the mantle cavity that is swept by the outgoing "lane" of the current created by the gills. Carnivorous mollusks usually have simpler digestive systems.

A typical mollusk has: a pair of tentacles on the head, containing chemical and mechanical sensors; a pair of eyes on the head, a pair of [statocysts](#) in the foot which act as balance sensors; and a pair of osphra reproductive systems, two [gonads](#) sit next to the coelom that surrounds the heart and shed [ova](#) or [sperm](#) into the coelom, from which the nephridia extract them and emit them into the mantle cavity.