

project PORTS

Promoting Oyster Restoration Through Schools



An Oyster-focused Outreach Initiative of the Haskin Shellfish Research Laboratory, Rutgers University

Curriculum & Activity Guide for Grades 3 through 8

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Seeding the future: Inspiring youth to care for the environment



How to use the guide.

The Curriculum Guide is divided into three main volumes, each presenting lessons on one of three themes: the Delaware Estuary, the history of the Delaware Bay oyster fishery, and oyster biology and ecology. Each volume contains a Primer, which presents in depth background information for the educator, and a series of classroom activities and lessons. Most activities included within are written in a class-ready form; however, some activities may require specialized materials. Please contact the Project PORTS coordinator for assistance with material acquisition and technical support.

The eastern oyster *Crassostrea virginica* is one of, if not the most important species of the Delaware Estuary. Dating back thousands of years the oyster has served as a keystone organism in the estuary, promoting water quality and providing food, habitat, and refuge to countless organisms. The oyster has also served as a principle Delaware Bay fishery holding both social and cultural significance to Bayshore communities.

Project PORTS: Promoting Oyster Restoration Through Schools is a community-based oyster restoration and educational program focusing on the importance of oyster populations in the Delaware Bay ecosystem. The goal of the program is to: increase an awareness and understanding of the oyster as a critical species and an important natural resource of the Bay; to promote an understanding of basic scientific concepts and stewardship values; and to contribute to the revitalization of Delaware Bay oyster populations.

Project PORTS presents the oyster resource of Delaware Bay as an ideal vehicle for problem-based, experiential learning in the K-12 educational setting. The oyster serves as a focal point for the integration of interdisciplinary scientific topics, the local environment, and local history. The strategy of Project PORTS is to promote hands-on activities and to emphasize the local significance of the issue. The Project has three main components. (1) Workshops offer educators an opportunity to learn about the Delaware Bay and its oyster resource directly from scientists and resource managers. (2) "Oyster-focused" classroom curriculum materials enable teachers to extend these lessons to their students. (3) A community-based oyster restoration project gives school communities the opportunity to contribute to the revitalization of Delaware Bay oyster populations. The restoration component is central to Project PORTS as it offers educators, students, and their families an opportunity to experience the Delaware Estuary, oyster ecology, and environmental stewardship first hand, while at the same time enhancing critical oyster habitat in the Delaware Bay. Project PORTS educational resources are designed to supplement current school curricula and to address NJDOE Core Curriculum Content Standards.



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Primer 3. Oyster Biology and Ecology

Oysters are invertebrate animals belonging to the phylum known as Mollusca. Animals within this phylum are commonly called mollusks. There are about 100,000 species of mollusks. The phylum includes snails, clams, mussels, squids and octopuses. Among the distinguishing features of animals in this phylum are an exoskeleton in the form of a calcareous shell and a fold of the body wall known as a mantle that secretes the shell.

Oysters are commonly found in brackish and salt water. Their bodies are enclosed in an exoskeleton or shell composed of two halves or valves. Hence they are commonly called bivalves. Other well-known bivalves include clams, scallops, and mussels. Bivalves may be contrasted with snails, whelks, and conchs, which have only one shell or valve and are called univalves. The species of oyster most commonly found along the eastern coast of the United States is the eastern oyster, *Crassostrea virginica*.



Oysters begin their life as free-floating microscopic plankton known as larvae. The larvae arise from the external fertilization of sperm and eggs, which are released into the water column by mature male and female oysters. Mature oysters release gametes, spawn, after seasonal water temperatures reach about 75°F. Eggs that come into contact with sperm will become fertilized and initiate cell division. The

first larval stage is known as a trochophore. The larvae drift and swim in the water column for a period of about 2 to 3 weeks. In order to develop further, a larva must settle or attach itself to a clean hard surface. The larvae undergo a dramatic metamorphosis, changing from free-swimming larvae to a form that becomes permanently attached to a substrate. For the rest of the oyster's life it will remain sessile, not moving from its original place of settlement. The ideal settlement surface is the shell of another oyster. Once the oyster has attached to a clean hard surface, it is referred to as spat. Over time oysters settle on top of one another. This layering of oysters forms reefs that grow bigger and bigger over time. The oyster reefs provide shelter and food to many animals. Oyster shells in themselves provide a surface for many other plant and animal species to live upon. Often the shell of a living oyster will contain algae, barnacles, worms, and sponges. The shape, size, and thickness of oyster shells can vary greatly often in response to the environmental conditions to which the oyster is exposed. The reef structure provides an ideal habitat for oysters, keeping them well above the sediments of the estuary floor and placing them up in the water column where they can filter food from the water. Oysters feed on microscopic plants known as plankton through a process known as filter feeding. Oysters are known for their great capacity to filter food from the water. It has been estimated that an average sized adult oyster they can filter 50 gallons a day. The removal of large quantities of plankton from the water column improves water quality. The ability to gain their energy needs from these tiny plants makes the oyster a dominant primary consumer in estuarine systems. They in turn become a food source for other animals thereby serving as an important link in the food chain. Oysters are considered keystone species being essential to the ecological health of the waters they inhabit.

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Related Vocabulary

Invertebrates—animals without backbones. This group includes mollusks, worms, insects, spiders, and crustaceans.

Mollusca—the phylum of animals containing animals that characteristically have a soft body protected by a hard shell.

Mollusk—common name for animals in the Phylum Mollusca.

Exoskeleton—a hard structure developed on the outside of the body, such as the shell of a crab or an oyster.

Bivalves—mollusks that have two shells.

Sessile—permanently attached or fixed, not free-moving.

Spat—a post-larval oyster that is attached to a surface and less than a year old.

Crassostrea virginica—the scientific name for the eastern oyster.

Filter feeder—an animal that eats small particles (eg. Phytoplankton and zooplankton), which it filters, or collects from water.

Activity 3.1

- Grade Level
3-5
- Subject Areas
Science
- Duration
One 30-minute class sessions
- Setting
Classroom
- Skills
Sorting, grouping, describing
- Vocabulary
Invertebrate, mollusk, bivalve, gastropod, univalve, taxonomy
- Correlation with NJ Core Curriculum Content Standards
2.4, 5.6.2A, 5.5.2B

Materials:

- Plastic boxes containing sand and a variety of seashells collected from coastal areas of New Jersey.
- Reference guide or books for common seashells.
- Student Handout-Activity 3.1

Beach-in-a-Box—Exploring Shell Collections

Charting the Course

Students will examine shell collections and reference sheets. They will learn that shells are made by animals and provide protection to the soft-bodied animals within. A sorting activity introduces students to how scientists classify animals.

Background

Shells can be found in almost any habitat, but most often we associate them with the seashore. A careful treasure hunt on the beach will reveal a host of shells, some empty and some still with an animal attached. Shells are the hard outer-coverings that offer protection to soft-bodied invertebrate animals. The shells not only protect animals from hungry predators, but also protect them from changes in the environment, such as severe weather events. Many different types of animals have shells including turtles, crabs, lobsters, snails, clams, and oysters.

Common seashells belong to the group of animals known as mollusks, which are classified in the phylum Mollusca. The phylum Mollusca is comprised of more than 100,000 species. There are seven classes of animals within this phylum. Four classes are common in the marine environment—Gastropoda (single shelled mollusks), Bivalvia (two-shelled mollusks), Cephalopoda (squid and octopi), and Polyplacophora (chitons). Most mollusks are aquatic and can be found in marine or fresh water environments, but there are also land species, which includes the slug. Scientists classify organisms into various groups using a system based on relationship (eg. similar body structure). This classification is called taxonomy.

The body of a mollusk is comprised of a soft visceral mass, containing the organs, and a surrounding outer tissue layer, the mantle. The mantle of shell forming mollusks contains glands that secrete the material that forms the shell. Some mollusks have a muscular foot that is used for crawling and borrowing.

A reference list of common seashells will typically include gastropods and bivalves. Gastropods, snails, have only one shell, which usually coils in a spiral and has a wide opening at one end. Gastropods are also called univalves. Bivalves, which include but are not limited to clams, oysters, mussels, and scallops, have two shells, which are joined together at one side by a hinge. The living bivalve animal has strong muscles that are affixed to the shells and control opening and closing of the valves.

Objectives / Students will be able to:

1. Identify common shells.
2. Sort shells according to like-characteristics.
3. Describe the function of a seashell.
4. Become acquainted to the group of animals known as mollusks.
5. Become acquainted with the concept of classification.

Procedure / Warm Up

Have a class discussion about visiting the seashore. Lead into discussion of seashell collection. Query, where do shells come from? Discuss mollusks and their key features. After describing the soft-bodied invertebrate animals that live within the shells ask students state the function of the shell. Explain that there are more than 100,000 species of mollusks, each differing from one another.

The Activity

1. Divide students into teams and provide each team with a beach box and reference materials.
2. Have students sort the shells into groups having similar characteristics.
3. Have students utilize the reference guides to identify the seashells.
4. Have students prepare a survey list and illustrations of the different types of shells that they've identified.

Extensions / Take the class on a scavenger hunt to the beach, how many different types of shells can they find. Have them construct their own shell collections. Visit the Education Program at the website of the New Jersey Marine Science Consortium (njmsc.org) for more activities such as Seashell Homes and Holey Clamshells.

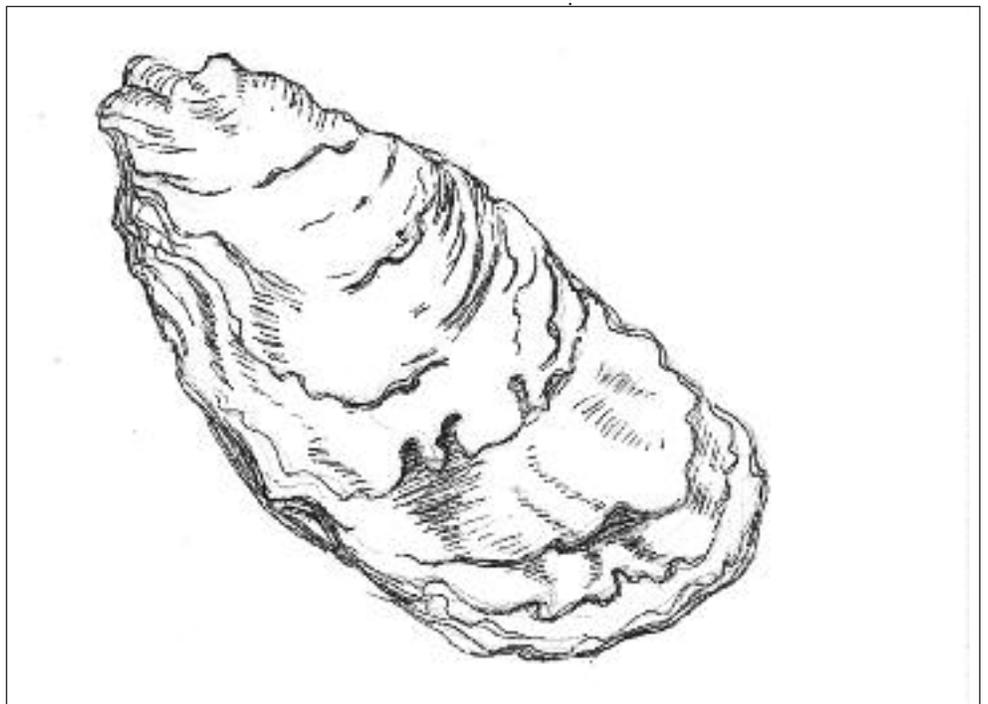


Figure 1: The Eastern oyster. Original drawing by Diane Driessen.

Activity 3.2

- Grade Level
3-5
- Subject Areas
**Science, Language arts,
Visual Arts**
- Duration
**One to two 40-minute class
session**
- Setting
Classroom
- Skills
**Describing, constructing,
creating, interpreting**
- Vocabulary
**Food-web, predator, prey,
adaptation**
- Correlation with NJ Core
Curriculum Content Standards
**5.18A, 5.3.4C, 5.6.2D, 5.8.4D,
5.8.6D**

Materials:

- Paper and drawing tools.
- Assorted materials for 3-d models.

Crunchy on the Outside, Soft and Squishy on the Inside— Designing and Constructing the Perfect Oyster Predator

Charting the Course

Students will generate examples of an oyster predator. They will describe the structural and behavioral adaptations that allow their fictional oyster predator to survive.

Background

Oyster predators can easily locate oyster prey and since oysters are not mobile once found there is no means for escape. However, the oysters thick shell presents a significant deterrent to oyster predators as they must first penetrate the shell before consuming the tissue. Successful oyster predators possess specialized adaptations that help them crush, drill, or open the shell exposing the meat within. Common oyster predators include snails, crabs, starfish, flatworms, and fish. (such as, cownose rays, oyster toadfish, flounder, drumfish).

Objectives / Students will be able to:

1. Demonstrate an understanding of the oyster's role in the food web.
2. Describe common predators of oysters.
3. Understand that organisms have adaptations that promote their survival as predators and prey.
4. Describe the structural and behavioral adaptations that allow organisms to survive.
5. Generate a model of an oyster parasite.

Procedure / Warm Up

Have a class discussion about food webs and the variety of ways that organisms interact in an ecosystem. Discuss the role of oysters as the first consumer of primary production and how energy is transferred through the food web. Engage students describing how an oyster protects itself from predators and how predators might be specially adapted to prey on oysters.

The Activity

Have students construct 2-D or 3-D models of fictional oyster parasites. Students must note (label or discuss) the structural and behavioral adaptations of the organism, which promote its survival.

Extensions / Have students report on oyster predators.

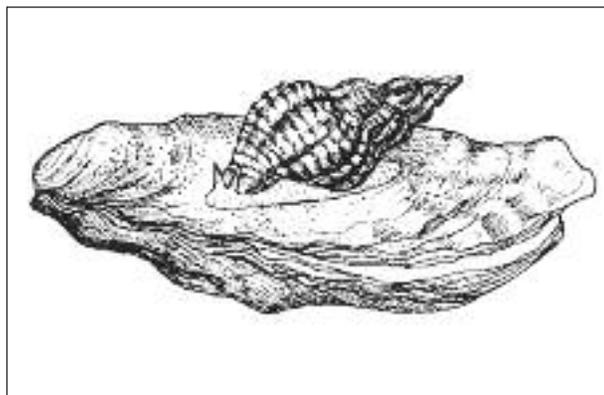


Figure 1: An oyster drill, a significant predator of the oyster. Original drawing by Karin Grosz, courtesy of the Estate of Karin Grosz.

That's Gross Anatomy, or What's Under that Shell?

Charting the Course

Students will examine the morphology and anatomy of an oyster through a dissection exercise.

Objectives / Students will be able to:

1. Examine and describe external features of an oyster.
2. Identify and record other organisms living on or in an oyster's shells.
3. Measure and record shell height and length using a metric ruler.
4. Dissect an oyster and identify main body parts.
5. Identify key features of a bivalve mollusk.

Procedure / Warm Up

Discuss the significance of the oyster to the health of the bay. Introduce the oyster in terms of important taxonomic concepts (ie. Invertebrate (soft-bodied animal lacking an endoskeleton), mollusk, bivalve vs. univalve). Explain that the focus of the lesson will be oyster anatomy (the structural make-up of the animal, examination of its parts).

The Activity

1. Divide the class into groups of 2-3 students. Provide each group with a live oyster on a tray.
2. Have the students examine and describe the oyster.
3. Identify the two shells or valves and compare them (one is more cupped and rough, the other smooth and flat; note—in nature the deeper valve is the one that is cemented down, the flatter valve acts as a lid). Are the two shells the same size? Is one thicker than the other?
4. What is the shape of the oyster? Identify the hinge, or umbo area, the narrow point where the two shells come together. This is the oldest part of the shell, as the oyster grows, shell is laid down at the opposite end. It is also the point at which the shells are attached to one another. The other end (the ventral margin) is free to open.
5. Look for other organisms on the outside of the shell, or the “scars” of organisms that were once there (sponges leave many holes on the shell surface, barnacles and oyster spat, leave an oval to round mark, oyster drills leave a single hole, worms may leave networks of tubes).
6. Measure the shell height (the longest line from umbo to ventral margin) and the shell length (the longest point across in the other, perpendicular dimension).
7. Record the measurements.
8. Draw the exoskeleton, or shell of the oyster and label the umbo.
9. Have students discuss the function of the shell, what does it do for the oyster?.
10. Have students try to open the oyster by pulling the shells apart. Ask them how the shells are held together so tightly.

Activity 3.3

- Grade Level
3-8
- Subject Areas
Science, Math, Language Arts
- Duration
One or two class periods
- Setting
Classroom
- Skills
Measuring, identifying, describing
- Vocabulary
Mollusca, bivalve, invertebrate, species, tissue, filter feeder, plankton, larvae, sessile, keystone, taxonomy
- Correlation with NJ Core Curriculum Content Standards
5.4A, 5.1.8A, 5.3.4B, 5.3.8B, 5.4.2B, 5.5.2A

Materials:

- Dissection trays (plastic plates will work)
- Oysters (can be purchased from local seafood purveyor, 1 per every 2-3 students)
- Oyster shucking knife
- Thick glove for shucking
- Oyster anatomy diagram (Student handout-Activity 3.3)

—continued on page 6

Activity 3.3

—continued from page 5

11. The oysters should be carefully shucked open by the teacher. Methods for shucking oysters can be found on the World Wide Web by searching the keywords *how to shuck an oyster*. Warning—This is somewhat of an art and should be practiced before lesson. Teachers may want to have a separate class session for the internal anatomy, and if possible have the oysters shucked before students arrive in class. Tissues should be carefully dissected from one shell and remain attached to the second valve. Set the removed shell on top of the exposed body.
12. Have students remove the loose shell and describe the oyster's body. Can they see or feel bones, is the tissue hard or soft, wet or dry? Is there a head? Do they see blood?
13. Have students refer to the oyster anatomy diagram in Student Handout-Activity 3.3. Using the diagram have them locate the:
 - a. Muscle—this is a notably different type of tissue, generally shaped like an oval. The muscle controls the opening and closing of the shells. The muscle leaves a scar on the shell at the point where it is attached. Have students find the muscle scar.
 - b. Mantle—this is the loose outer tissue that covers the entire body.
 - c. Gills—pull back the edge of the mantle to view the gills. There are four layers of gills, you will be able to see tiny lines crossing the gill surface. The gills are covered by tiny hairs, known as cilia, that move water across the oyster's body and move food and remove oxygen from the water.
 - d. Palps and mouth—follow the gills up toward the umbo area. There will be a slit followed by two thicker layers of tissue these are the palps and this is the area where the mouth can be found. Food enters the oyster through the mouth.
 - e. Stomach and digestive glands—locate the area where the stomach can be found. The stomach lies under the mantle layer and will often be dark brown. It connects to the intestines and the digestive glands. This is where food is broken down into usable nutrients.
 - f. Rectum—the rectum can be found along the edge of the muscle. It is a tube through which wastes are eliminated.
 - g. Heart—the heart lies just above the muscle. Sometimes you can see it beating. It is located in a clear sac and looks like a tiny sponge connected to a tube. Oysters have blood, but it is not pigmented red like human blood. The heart pumps the blood through the oyster's body. Note mollusks have an open circulatory system, there are no definite veins, blood instead drains through open sinuses within the body.
 - h. Tentacles on mantle edge— Oysters sense the surrounding world through tentacles that are present on the edge of the mantle. They can sense changes in light, chemicals in the water, sediments, and temperature. Oysters don't have a brain, but they do have simple nervous systems containing nerves and organs called ganglia. These will not be visible in the dissection.
 - i. Inner shell surface—have students describe the inner surface of the shell.

Wrap Up / Without referring to the diagram, have students point out the main features of the oyster to one another and discuss the functions of the various structures. Discuss with students how the oyster's anatomy allows them to live in the environment that they inhabit. Have students describe and draw a real or fictional predator of the oyster.

Assessment / Have students draw and label their own oyster anatomy diagrams. Have students compare and contrast oyster anatomy with that of a human.

Extensions / Set up an aquarium containing oysters and allow the students to observe feeding and resting living oysters. Have students compare and contrast common bivalve mollusks, including mussels and clams. Discuss how they are similar and how they are different. Take the students to the beach for a mollusc scavenger hunt and use a field guide to identify the shells that they find. Have students trace oyster shells, and construct 3-d models of oyster anatomy (include valves, mantle and muscle, and internal organs).

Have students calculate the average and graphically represent shell height and length measurements. Have students report on other common bivalve mollusks such as the hard clam, *Mercenaria mercenaria*, the blue mussel, *Mytilus edulis*, the soft shell clam *Mya arenaria*, the surf clam *Spisula solidissima*, and the ocean quahog, *Arctica islandica*. Students should identify the species habitat and size range. Using illustrations or real shells students can construct mobiles of common bivalves.

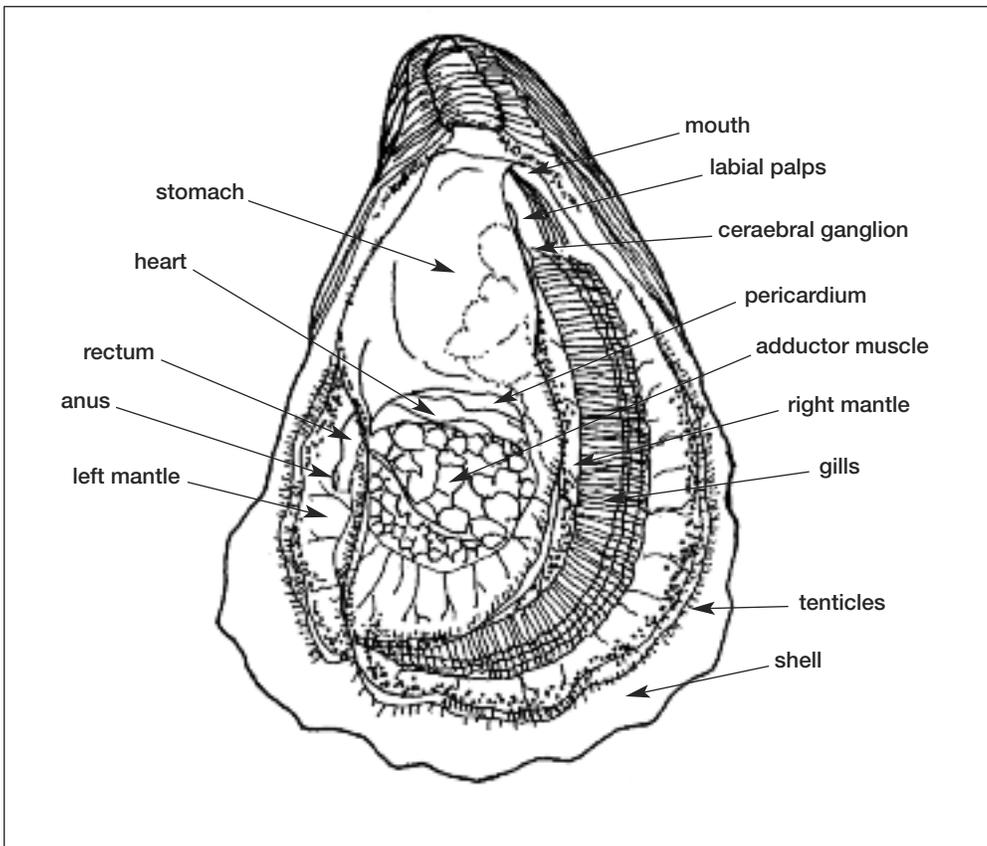


Figure 1.

Figure 1. Anatomy of the oyster, *Crassostrea virginica* and proper methods for measuring shell height, length, and width. Figure modified from Galtsof (1964)

Activity 3.4

- Grade Level
3-5
- Subject Areas
Science
- Duration
One 30 to 40-minute class session
- Setting
Classroom
- Skills
Sequencing, describing
- Vocabulary
Larvae, trochophore, veliger, pediveliger, spat, plankton
- Correlation with NJ Core Curriculum Content Standards
PK3.3, 5.5.4C, 5.5.6C

Materials:

- Diagram of oyster life stages.
- Materials to make flip-books, construction paper, scissors, crayons, staplers, and glue sticks.

Cha, Cha, Changes—A Look at the Oysters Life Cycle

Charting the Course

Students will prepare flip-books depicting the life cycle of the oyster.

Background

Oysters begin their life as free-floating microscopic plankton known as larvae. The larvae arise from the external fertilization of sperm and eggs, which are released into the water column by mature male and female oysters. Mature oysters spawn, release gametes after seasonal water temperatures reach about 75°F. Eggs that come into contact with sperm will become fertilized and initiate cell division. The dividing cells develop into larvae, which swim in the water column for a period of about 2 to 3 weeks. During this time the larvae increase in size and undergo metamorphosis through three main larval forms—trochophore to veliger to pediveliger. The trochophore stage exists during the first 24 to 48 hours and does not feed. The trochophore possesses cilia that help it spin about in the water. The veliger stage is characterized by the presence of an organ known as a velum that helps the larva swim and feed. The pediveliger is characterized by the presence of a foot that enables the larvae to crawl. The pediveliger seeks a suitable habitat and undergoes a dramatic metamorphosis, changing from the free-swimming larvae stage to a form that becomes permanently attached to a hard surface. For the rest of the oyster's life it will remain sessile, not moving from its original place of settlement. Once the oyster has attached to a surface, it is referred to as spat. The spat develops into juvenile and adult forms, which undergo mass spawning in summer, beginning the cycle again.

Objectives / Students will be able to:

1. Demonstrate an understanding of how the oyster changes as it grows.
2. Identify various stages in the life cycle of the oyster.
3. Describe the life cycle of the oyster.

Procedure / Warm Up

Have a class discussion about how living things change as they grow. Describe the oyster's life cycle.

The Activity

1. Distribute life cycle diagrams and materials to students.
2. Have students cut out, color, and sequence oyster life stages.
3. Paste sequenced images into flip-book, and label.
4. Write a descriptive sentence for each stage.
5. Have students hypothesize why each stage of the oyster is different.

Extensions / Obtain oyster or clam larvae from a hatchery (late spring, best time). Observe larvae under a microscope. For a more elaborate design follow larvae through time. Compare the life cycle of the oyster to other marine animals (ie blue fish, blue crabs, eels, whelks, horseshoe crabs).

Participate in Project PORTS oyster restoration project. Students construct shell bags, which are deployed in the bay, supplying a clean hard surface for oyster larvae to settle upon.

Figure 1.

Life Cycle of an Oyster

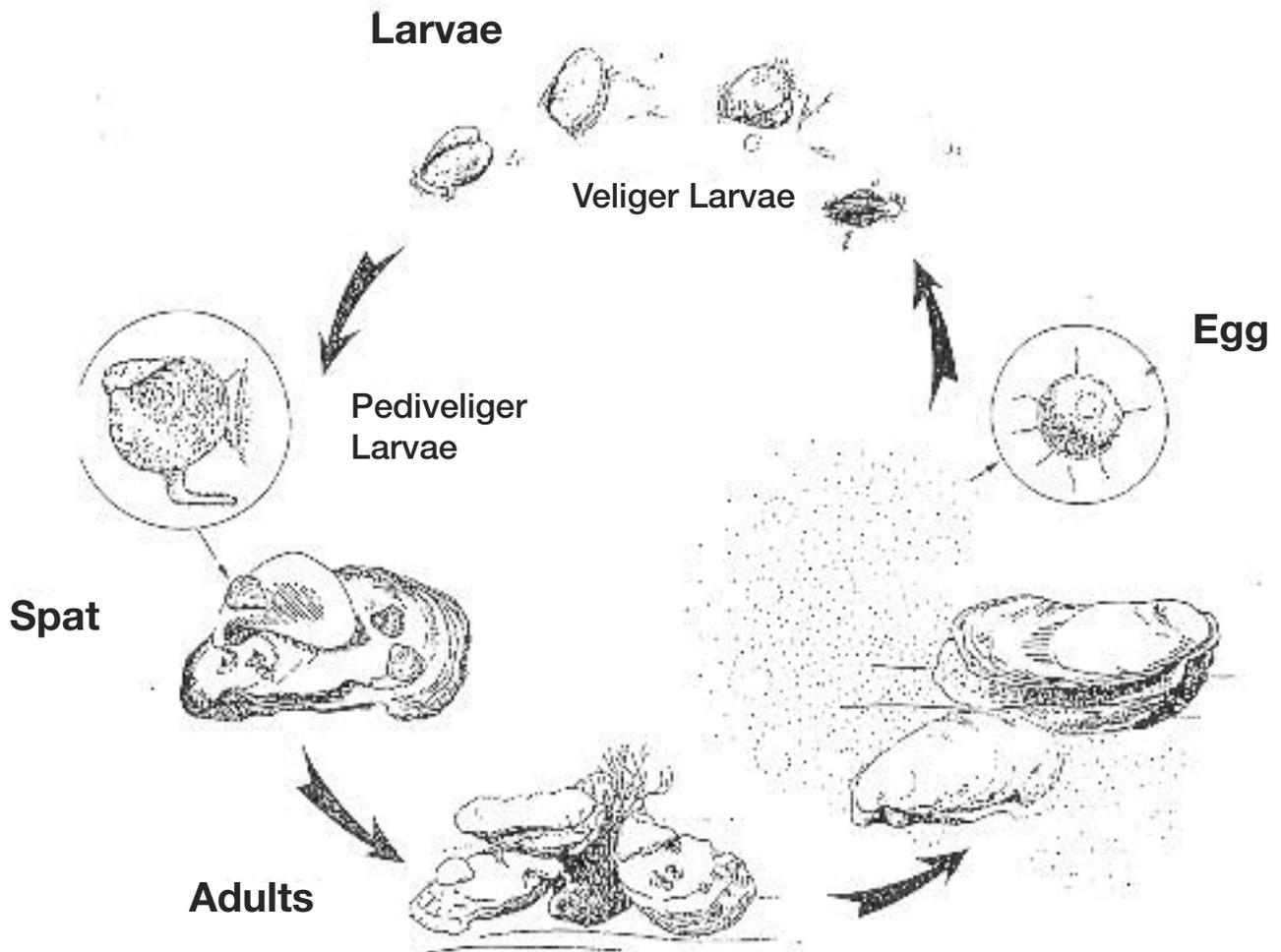


Figure 1. Life Cycle of the oyster. Modified drawing, courtesy of the Virginia Institute of Marine Sciences.

Activity 3.5

- Grade Level
5-8
- Subject Areas
Science
- Duration
One 40-minute class session
- Setting
Classroom
- Skills
Interpreting, hypothesizing, correlating, graphing
- Vocabulary
Protistan, Haplosporidium nelsoni, Perkinsus marinus, prevalence, epizootic
- Correlation with NJ Core Curriculum Content Standards
5.5.4A, 5.5.6A, 5.10.2A, 5.10.6A

Materials:

- Student worksheet-Activity 3.5.
- Data set.
- Computer graphing program (optional).

Parasites on the Half Shell

Charting the Course

In the following Data Activity, students become shellfish biologists and examine *P. marinus* disease dynamics at three Delaware Bay oyster bars. Students will correlate their disease data observations with environmental conditions at the site.

Background

During the past four decades Delaware Bay oyster populations have been plagued by two disease-causing protistan oyster parasites. Though quite harmful to oysters, the diseases do not affect humans. The first parasite *Haplosporidium nelsoni*, or MSX first appeared in 1957 and caused severe mortalities of oysters in the higher salinity areas of the bay. Over the following 2 to 3 years the parasite spread and killed 90-95% of the oysters on the lower bay planted grounds and 50% of the oysters in the upper bay seed-beds. Since that time oysters in the bay have developed natural resistance to the disease and at the present time though still present in the Bay MSX does not cause significant oyster mortalities. The second oyster parasite, *Perkinsus marinus* (also called Dermo disease) emerged in the early 1990s and caused severe oyster mortalities in the lower seed-bed area. *Perkinsus marinus* was not new to the Bay as it was first documented in Delaware Bay oysters in the 1950s and since that time had occasionally been found; however, it was not associated with significant oyster mortalities until the 1990s. The intensification of *P. marinus* in the Delaware Bay was coincidental with a northward expansion of the parasite from the Chesapeake Bay to the Damariscotta River in Maine. This expansion was associated with atypically dry and warm weather conditions. Today *P. marinus* remains a significant threat to Delaware Bay oyster populations and causes severe mortalities of oysters in the moderate to high salinity areas of the Bay.

In order to gain a better understanding of the disease and to better manage Delaware Bay oysters, scientists carefully monitor the levels of the disease throughout the Bay. You can't tell if an oyster is infected with the disease just by looking at it, a tissue sample must be analyzed using a special diagnostic assay for an accurate diagnosis to be made. Typically 20 to 30 oysters from a particular site are examined. The percentage of infected oysters in the sample is termed the disease prevalence. Epizootic is the term for an outbreak of a disease in a particular animal population. Epizootiology refers to the sum of factors controlling a particular disease in an animal population. *Perkinsus marinus* prevalence varies seasonally and annually in response to varying environmental conditions. *Perkinsus marinus* prevalence increases during the summer and Fall in response to warm water temperatures and then declines in the winter and spring in response to cooling temperatures. The distribution of the parasite within a particular estuary or tributary varies with salinity—*P. marinus* prevalence is generally higher down bay where higher salinities prevail than upbay where lower salinities are dominant. The disease tends to be more prevalent in drought years when river flows are reduced and salinities increase bay wide than in wet years.

Objectives / Students will be able to:

1. Identify two common oyster diseases.
2. Correlate environmental conditions with disease prevalence.
3. Compare and contrast oyster disease levels between years.

Procedure / Warm Up

Set the stage by posing the question “ what might cause the oysters of Delaware Bay to decline?” Introduce the concept of an epizootic. Introduce *Perkinsus marinus* as a protistan disease of oysters, which has severely impacted Delaware Bay oyster populations. If you were trying to manage the oyster resource of Delaware Bay, what might you want to know about the disease?

The Activity [Class Period 1]

1. Divide the class into teams of shellfish biologists charged with studying the *P. marinus* disease in oysters.
2. Each team will receive a data set containing the results of disease, temperature, and salinity samples that were recorded for most months in 2004.
3. The samples were collected at three oyster bars Arnolds, Shell Rock, and New Beds.
3. Students should graph the data (either by hand or using excel if proficient in it).
4. Using their graphs students should:
5. Compare temperature at the three sites.
6. Determine the maximum and minimum temperature for the year and indicate the month in which they occurred.
7. Compare salinity at the three sites, which site had the lowest salinities, which had the highest salinities?
8. Determine the range of salinity at each site.
9. Compare *P. marinus* prevalence at the three sites, which site had the highest and which had the lowest.
10. Determine at what time of the year disease was the highest.

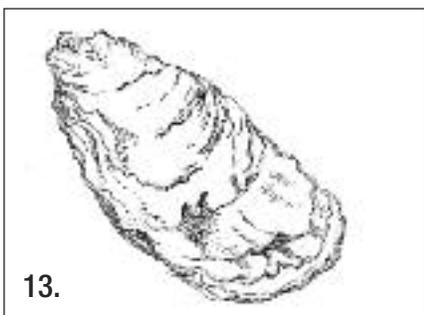
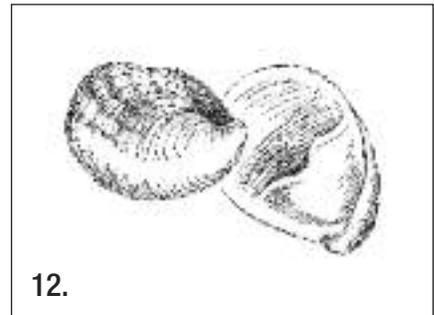
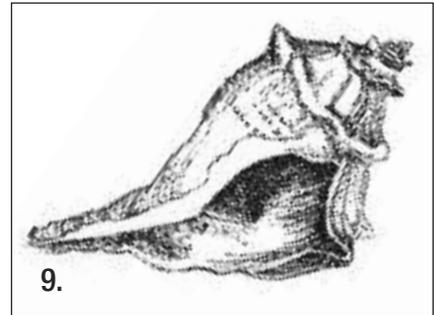
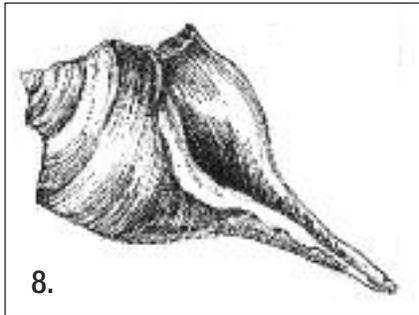
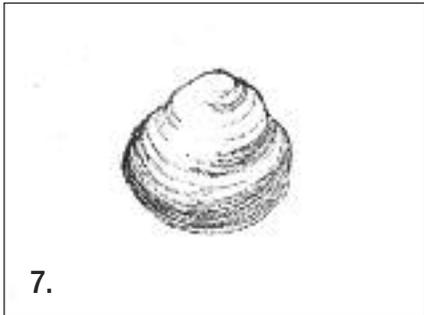
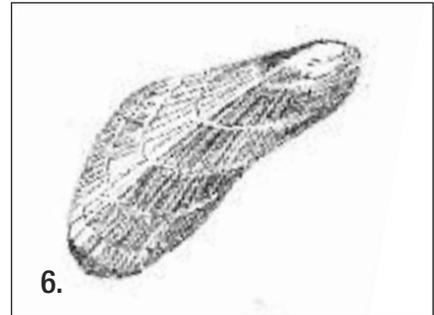
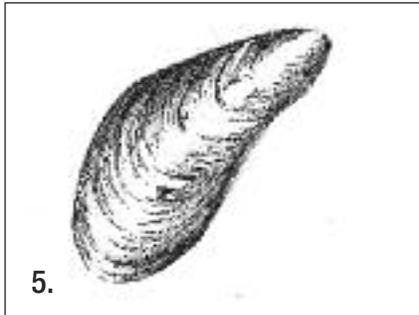
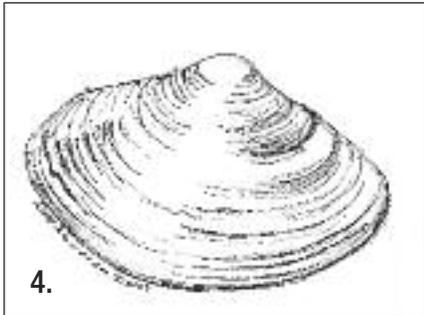
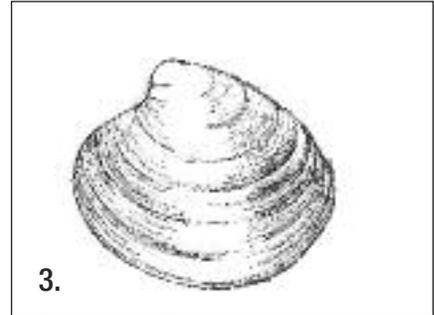
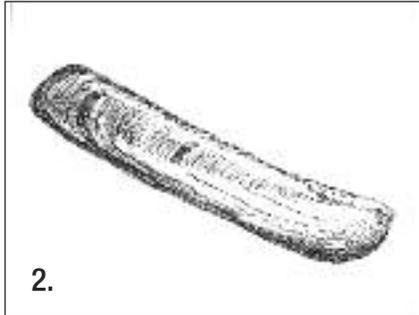
Extensions / Based on their analysis of the data students should speculate on why they saw salinity and disease differences between the sites and why temperature varied little between sites.

Discuss the relationship between temperature and disease levels.

Predict which oyster bar is going to be most impacted by disease.

As shellfish biologists what recommendations might students make to the oyster resource managers and those involved with the oyster fishery.

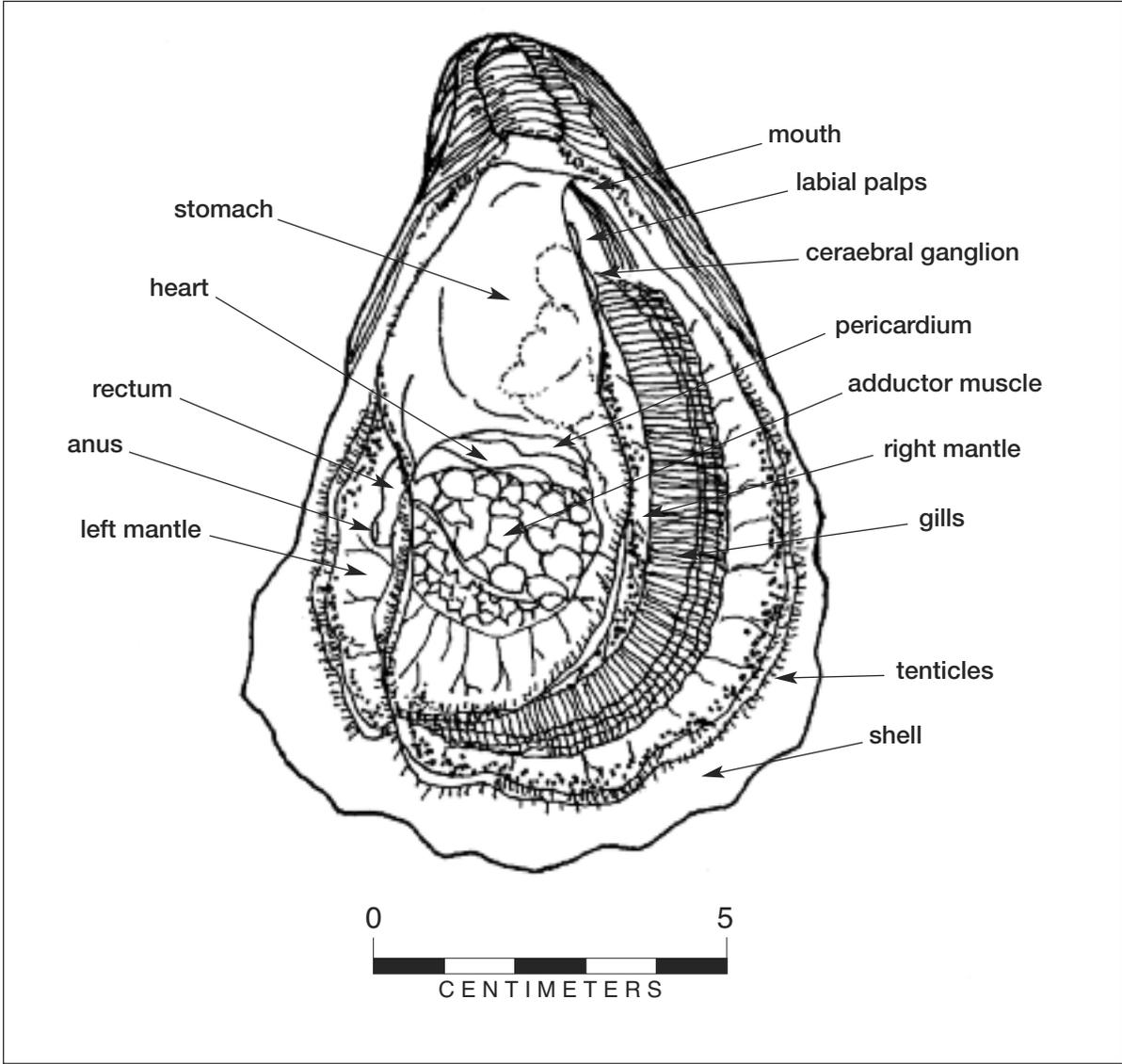
Student Handout Activity 3.1—Beach in a Box



Common Shells of the Mid-Atlantic

- | | |
|---------------------------|--------------------------|
| 1. Soft-shelled Clam | 7. Jingle Shell |
| 2. Common Razor Clam | 8. Channeled Whelk |
| 3. Hard Clam | 9. Knobbed Whelk |
| 4. Atlantic Surf Clam | 10. Atlantic Moon Snail |
| 5. Common Blue Mussel | 11. Bay Scallop |
| 6. Atlantic Ribbed Mussel | 12. Common Slipper Shell |
| | 13. Eastern Oyster |

Student Handout Activity 3.3—That's Gross! Anatomy



Student Worksheet Activity 3.5—Parasites on the Half Shell

Name _____ Date _____

A. Using the chart on the following page and the data in Table 1 draw graphs to compare the monthly prevalence of *Perkinsus marinus*, temperature, and salinity at the oyster bars known as Arnolds, Shell Rock, and New Beds for 2004. Be sure to put a title and labels on your graph.

B. After completing your graph answer the following questions.

1. Compare temperature at the three sites.
2. Determine the maximum and minimum temperature for the year and indicate the month in which they occurred.
3. Compare salinity at the three sites, which site had the lowest salinities, which had the highest salinities?
4. Determine the range of salinity at each site.
5. Compare *P. marinus* prevalence at the three sites, which site had the highest and which had the lowest.
6. Determine at what time of the year disease was the highest.
7. Based on their analysis of the data students should speculate on why they saw salinity and disease differences between the sites and why temperature varied little between sites.
8. Discuss the relationship between temperature and disease levels.
9. Predict which oyster bar is going to be most impacted by disease.
10. As shellfish biologists what recommendations might students make to the oyster resource managers and those involved with the oyster fishery.

Activity 3.5
Perkinsus marinus Prevalence (% infected) Oyster Bar

Year	Month	Arnolds	ShellRock	New Beds
2004	January			
2004	February			
2004	March	10%	25%	40%
2004	April	0%	15%	35%
2004	May	5%	0%	20%
2004	June	5%	30%	55%
2004	July	5%	30%	50%
2004	August	15%	60%	35%
2004	September	10%	50%	35%
2004	October	5%	60%	65%
2004	November	10%	60%	55%
2004	December	8%	50%	55%

Temperature (°C) Oyster Bar

Year	Month	Arnolds	ShellRock	New Beds
2004	January			
2004	February			
2004	March	7.1	6.4	6.5
2004	April	13.8	12.7	13.3
2004	May	23.2	23.5	23
2004	June	24.1	23.6	23.5
2004	July	25.5	25	25.4
2004	August	25.6	25.5	25.8
2004	September	22.1	21.8	22.2
2004	October	16.0	16.0	16.1
2004	November	9.2	9.5	9.5
2004	December			

Salinity (ppt) Oyster Bar

Year	Month	Arnolds	ShellRock	New Beds
2004	January			
2004	February			
2004	March	7.6	12.9	15.8
2004	April	7.6	12.8	14.8
2004	May	7.1	15.0	16.4
2004	June	10.6	18.3	17.6
2004	July	10.6	16.1	17.1
2004	August	5.0	17.6	12.6
2004	September	0.1	18.7	12.5
2004	October		12.8	16.9
2004	November	3.3	14.5	12.3
2004	December	7.6	14.0	15.8

