Estuaries in the Balance:

Oyster Biology and Ecology Curriculum Guide

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PRIMER

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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 begin 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 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

RELATED VOCABULARY

Bivalves—mollusks that have two shells.

Crassostrea Virginica—the scientific name for the eastern oyster.

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

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

Habitat—the place where a plant or animal lives.

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

Keystone species—a species whose presence and role within an ecosystem has a large effect on other organisms within the system.

Mantle—an outgrowth of the body wall that lines the inner surface of the valves of the shell in mollusks.

Metamorphosis—a change in form from one stage to the next in the life history of an organism.

Mollusca—the phylum of animals containing animals that characteristically have a soft body protected by a hard shell. This group includes oysters, clams, mussels, scallops, snails, squid, octopus, and slugs.

Mollusk—common name for animals in the Phylum Mollusca.

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.

Trochophore—a free-swimming larva common to several groups of invertebrates such as mollusks.

Univalves—mollusks that have one shell.

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 can filter 50 gallons a day. The removal of large quantities of plankton from the water column promotes water quality, and 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.

EXTENSIONS

For more oyster-related activities, see the Texas State Aquarium's Marine Science Activities: "Treasures of the Deep," The Fantastic Filter," Old Age Oysters," Oysters by the Pound," and and "Pale, Poetic Pearls", and more, at: http://oysterrecycling.org/sammys-corner/)

ACTIVITY

2.1

BEACH-IN-A-BOX: EXPLORING SHELL COLLECTIONS

Grade Level
3–5
Subject Areas
Science
Duration
One 30 to 40-minute class session
Setting
Classroom
Skills
Sorting, grouping, describing
Vocabulary
Invertebrate, mollusk, bivalve, gastropod, univalve, taxonomy
Correlation with TEKS (Texas Educational Knowledge and Skills)
3.2C, 3.3A, 3.4A, 3.10A, 4.2B, 4.4A, 4.10A, 5.2C, 5.4A, 5.9A, 5.10A

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 80,000 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 burrowing.

A reference list of common seashells will typically include **gastropods** and **bivalves**. Gastropods, or 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 which are affixed to the shells and control the 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.

MATERIALS

- Plastic boxes containing sand and a variety of seashells collected from coastal areas of Texas.
- Reference guide or books for common seashells (Peterson Field Guides *Shells of the Atlantic and Gulf Coasts and the West Indies*, by R. Tucker Abbott & Percy A. Morris is an excellent guide; alternatively, laminated folding guides can easily be obtained at book stores and tourist shops in the coastal area.)

PROCEDURE

Warm Up

Have a class discussion about visiting the seashore. Lead into discussion of seashell collection. Ask: 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 to 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 to see how many different types of shells they can 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*.

ACTIVITY 2.2

CHA, CHA, CHANGES: A LOOK AT THE OYSTER'S LIFE CYCLE

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 TEKS
3.3C, 3.10A,C, 4.3C, 4.10A,C, 5.3C, 5.9A, 5.10A

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 after seasonal water temperatures reach about 75°F. Eggs that come into contact with sperm will become fertilized and begin 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 (**sessile**) 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.

MATERIALS

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

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

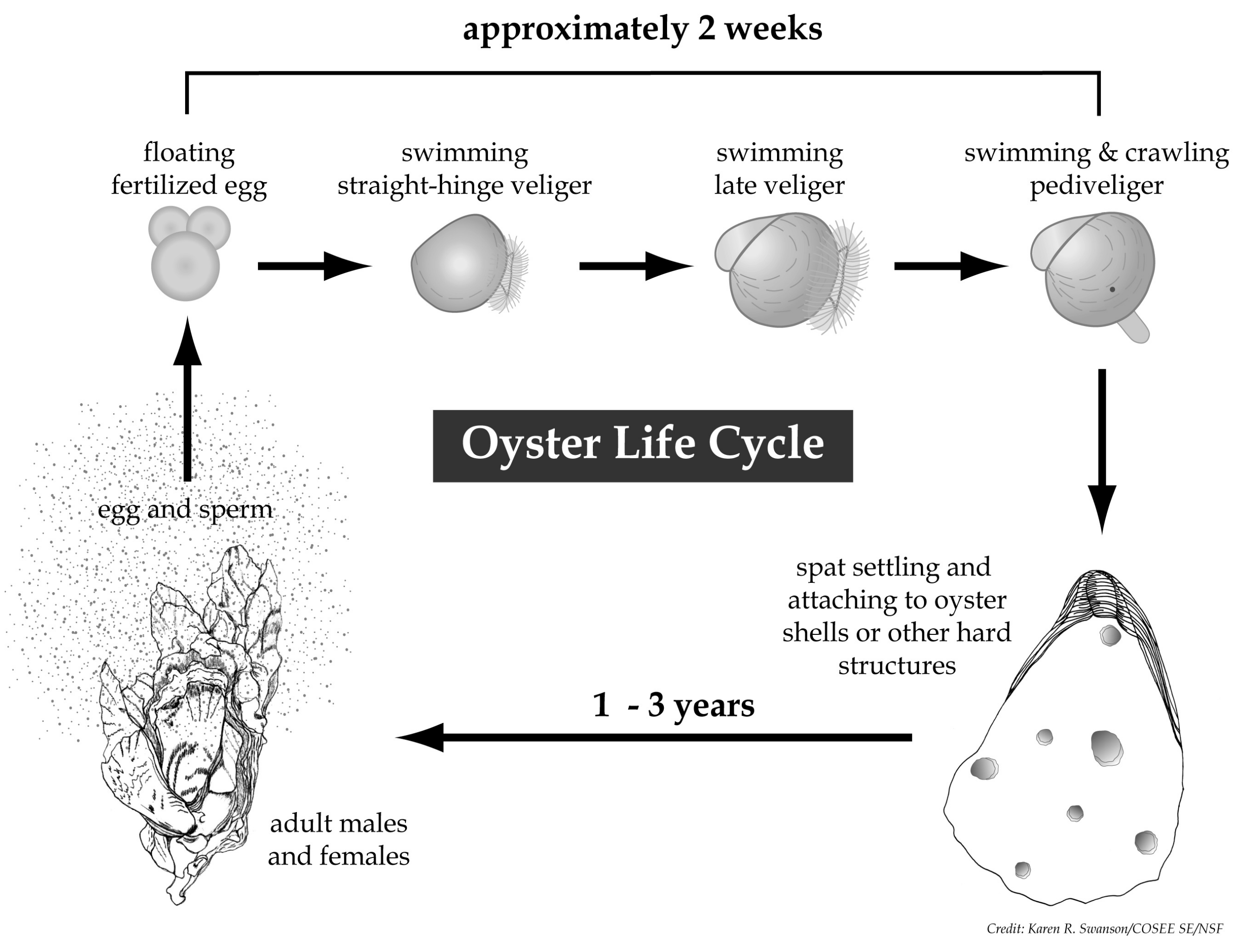
Obtain oyster or clam larvae from a hatchery (late spring, best time). Observe larvae under a microscope.

For a more elaborate design, follow larvae through time.

Compare the life cycle of the oyster to other marine animals (i.e. redfish, blue crabs, or brown shrimp).

Participate in "Sink Your Shucks" oyster restoration project. Students fill shell bags, which are deployed in Copano Bay, supplying a clean hard surface for oyster larvae to settle upon.

Oyster Life Cycle



ACTIVITY 2.3

THAT'S GROSS ANATOMY, OR WHAT'S UNDER THAT SHELL

Grade Level
3–8
Subject Areas
Science
Duration
One or two class periods
Setting
The classroom
Skills
Measuring, identifying, describing
Vocabulary
Mollusca, bivalve, invertebrate, species, tissue, filter feeder, plankton, larvae, sessile, keystone, taxonomy
Correlation with TEKS
Science 3.1A,B, 3.2A, 3.4A,B, 3.9A, 3.10A, 4.1A,B, 4.2A, 4.4A,B, 4.10A, 5.1A,B, 5.2C, 5.4A,B, 5.9A,C, 5.10A, 6.1A,B, 6.4A,B, 6.12D,E,F, 7.1A,B, 7.4A,B, 7.10A,B, 7.11A,B, 7.12A, 7.13A, 8.1A,B, 8.4A,B, 8.11A-D

CHARTING THE COURSE

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

OBJECTIVES

Students will:

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.

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
- Forceps or other small tools for exploration
- Hand lenses or dissecting microscopes for observing organisms
- Oyster anatomy diagram
- Carmine Alum Lake dye (0.1 g of carmine dye dissolved in 5 ml of seawater)

PROCEDURE

Warm Up

Discuss the significance of the oyster to the health of the bay.
Introduce the oyster in terms of important taxonomic concepts (i.e. 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 cluster of live oysters on a tray. There should be other small organisms living on or around the oysters, such as small crabs, shrimp, barnacles, and worms.

2. Have the students examine and describe the oyster community. Use forceps to extract small animals and observe them with hand lenses or dissecting microscopes. Students can list and/or draw animals.

3. Examine an oyster. 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.

11. The oysters should be carefully shucked open by the teacher. Instructions for shucking can be found in appendix I. **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. Using the diagram, have them locate the following parts:

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, which move water across the oyster's body and move food and remove oxygen from the water.

d. With a pipette or eyedropper, gently add two drops of carmine solution to the posterior end of the gills and observe the movement of the water by cilia under a stereomicroscope. You will see the filtering action of the gill cilia and mucus as it transports particles of dye toward the mouth.

e. 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.

f. 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. In connects to the intestines and the digestive glands. This is where food is broken down into usable nutrients.

g. Rectum—the rectum can be found along the edge of the muscle. It is a tube through which wastes are eliminated.

h. 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.

i. 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.

j. 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.
Use Activity sheet 2.3 for an alternate assessment.

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 mollusk 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, muscle, and internal organs).

REFERENCES

Arlington Echo Outdoor Education Center's "Out of the Ordinary Oysters" (http://www.arlingtonecho.org/activities-and-lessons/activities-a-lessons.html)

Texas A&M Galveston's "Guess Who's Coming to Dinner" (http://www.tamug.edu/seacamp)

Maryland SeaGrant's "Oyster Anatomy Laboratory" and "Particulate Matters" (http://www.mdsg.umd.edu/issues/chesapeake/oysters/education/)

Lessons on oyster anatomy and other activities: "Sammy's Corner:" http://oysterrecycling.org/sammys-corner/

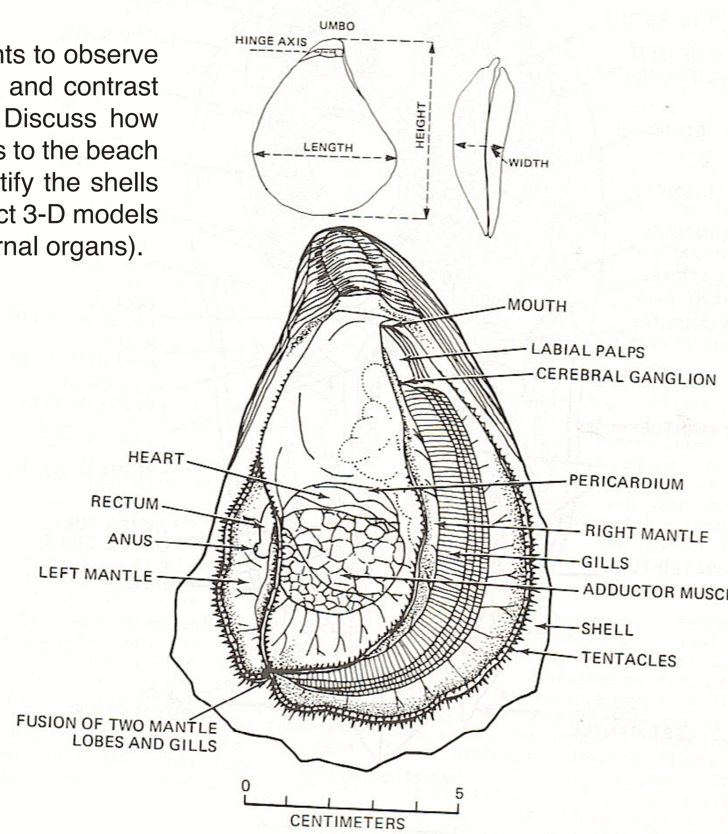


Figure 1. Anatomy of the oyster, Crassostrea virginica and proper methods for measuring shell height, length, and width. Figure credited to Galtsolf (1964)

Name: Date:

ACTIVITY 2.3

THAT'S GROSS ANATOMY, OR WHAT'S UNDER THAT SHELL

1. What kind of a creature is an oyster? (Describe it.)

2. What is a baby oyster called?

3. What does an oyster eat?

4. How does an oyster eat?

5. Name two animals that live on an oyster reef:

6. Even if you don't want to eat an oyster, why are they helpful to have in an estuary? Give 3 reasons:

7. Describe one reason why an area might temporarily be closed to oyster harvesting.

8. Describe one other interesting fact that you learned about Eastern oysters.

ACTIVITY
2.4

CRUNCHY ON THE OUTSIDE, SOFT AND SQUISHY ON THE INSIDE: DESIGNING AND CONSTRUCTING THE PERFECT OYSER PREDATOR

Grade Level
3–5
Subject Areas
Science, Language arts, visual arts
Duration
One 40-minute class sessions
Setting
Classroom
Skills
Describing, constructing, creating, interpreting
Vocabulary
Food-web, predator, prey, adaptation
Correlation with TEKS
Science 3.9A,B, 3.10A, 4.9A,B, 4.10A, 5.9A,B, 5.10A
Language Arts 3.17A-E, 3.20A, 4.15A-E, 4.18A, 4.20, 5.15A-E, 5.18A, 5.20

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 oyster's 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 cow nose rays, oyster toadfish, flounder, and black drum).

Predatory snails (gastropods) such as oyster drills and moon snails are common in marine environments and represent significant oyster predators. They move slowly but have voracious appetites. Using mechanical and chemical action they bore holes through the shell of the oyster and insert a large proboscis that extracts the flesh of the oyster. For their small size, less than 1 inch, oyster drills can cause a surprising amount of oyster mortality. Crabs such as the blue crab, mud crab, rock crab, and green crab are particularly harmful to oyster spat and juvenile oysters. Crabs have specialized claws that enable them to crush oyster shells. Flatworms of the genus Stylochus are commonly found on oyster beds. These small flat worms prefer to attack small oysters, which they enter through the oyster's gaping shells. Starfish are highly destructive oyster predators. They employ two different methods to open oysters. First they use force with their appendages gripping and pulling apart the oysters shells and then they secrete an anesthetic substance from their stomachs to numb the oyster and cause them to gape. When the valves gape 1 mm the starfish extends its stomach into the shell and begins to digest the oyster flesh. Fish use both visual and chemical clues to locate oyster prey. Most expose the oyster's tissue by crushing the shell. Cow nose rays, summer flounder, skates, and black drum have been noted to cause significant oyster mortalities. Of course one of the most cunning predators of oysters is man.

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.

MATERIALS
- Paper and drawing tools.
- Assorted materials for 3-D models.

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.

ACTIVITY
2.5

I CAN SEE CLEARLY NOW: A DEMONSTRATION OF FILTER-FEEDING

Grade Level
5–8
Subject Areas
Science
Duration
Two 40-minute class sessions
Setting
Classroom
Skills
Hypothesizing, designing, comparing, interpreting
Vocabulary
Filter-feeding, phytoplankton, algae, control, treatment, hypothesis
Correlation with TEKS
Science 5.1A,B, 5.2A-G, 5.4A,B, 5.9A, 5.10A, 6.1A,B, 6.2A-E, 6.4A,B, 6.12E, 7.1A,B, 7.2A-E, 7.4A,B, 7.10A, 7.12A, 7.13A, 8.1A,B, 8.2A-E, 8.4A,B, 8.11B,C,D

CHARTING THE COURSE

Students demonstrate via an experiment how oysters can filter and clear water as they feed.

BACKGROUND

Oysters feed on microscopic plants known as phytoplankton 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. As oysters filter food from the water they also remove sediments, nutrients (nitrogen and phosphorus), and even pollutants from the water. The removal of these substances from the water column helps increase water clarity and can have a positive effect on water quality. The oyster's ability to obtain energy needs from these tiny plants makes the oyster a dominant primary consumer in estuarine systems.

OBJECTIVES

Students will be able to:

1. Demonstrate an understanding of how bivalve animals obtain their food via the process of filter-feeding.
2. Demonstrate an understanding of the oyster's role in the food chain.
3. Establish a hypothesis.
4. Conduct investigations incorporating the use of a control
5. Communicate experimental findings to others

MATERIALS

- 3–5 live oysters
- 2 5-gallon aquaria
- 6 to 10 gallons of Bay water, or dechlorinated tap water mixed with sea salt* salinity 20–30 ppt
- Aquarium air pump, air tubing and air stones (use two pumps, one for each aquarium or obtain adaptor to divide air supply between two pieces of tubing)
- oyster feed (available from aquaculture sources such as Reed Mariculture at www.reed-mariculture.com; Phyto-Feed or Instant algae species Thalassiosira weissflogii recommended)
- microscopes
- depression microscope slides
- 1 ml pipette and pipette bulb
- small graduated cylinder
- data sheets

*artificial sea salt can be purchased from pet stores, to adjust water to approximately 20 ppt add 20 mg salt per liter of water (approximately 80 mg per gallon)

PROCEDURE

Warm Up

Have a class discussion about how bivalve mollusks feed by filtering phytoplankton from the water. Explain how this process can improve water quality. Explain that this will be tested via a laboratory experiment. Have the class establish a hypothesis for this experiment. Engage them in designing the experiment, defining the need for a control and treatment tank.

THE ACTIVITY

Class period 1

1. Open the class with pre-laboratory warm-up lesson.
2. Divide students into teams and have them design an experiment to test the hypothesis relating to filter-feeding and the improvement of water clarity.
3. Have groups present their experimental designs.
4. Explain the design that will be used for the class—(1) establish a control tank (no oysters) and a treatment tank (oysters), (2) add equal amounts of algae to each tank, (3) assess change in water clarity through time by quantifying the change of the abundance of algal cells in the water.

   Set up two 5-gallon aquaria tanks, each containing 4 gallons of water. Aerate aquaria using air pump, tubing and air stones. Place 3–5 oysters in one tank (the treatment tank) and no oysters in the other tank (the control tank). Allow oysters to acclimate overnight.

Class period 2

5. At the beginning of class have students add 25 ml of oyster feed to each tank (this should color the water, if it doesn't add an additional measured amount to each tank—note both tanks must receive the same amount of algae). Record the temperature and if possible salinity of the tank water.
6. Gently stir the water to mix.
7. Immediately remove a 0.5 ml sample of water from each tank, place on 2 separate microscope slides, and cover with cover slip. Count the number of algae cells in 5 fields of view. This is the initial or time 0 sample. Each team can collect samples. They should carefully record the counts for each sample. The counts from the five fields represent replicates. Because of the error associated with sampling and counting it is important to include replication when you run an experiment. The mean value of the replicates will provide a more accurate estimate of the algae abundance than any individual count.

   Repeat sampling through time as permitted. The oysters should clear the water in about 2 hours. Try to have at least three time points (such as 0, 30 minutes, 2 or 24 hours).
8. Have students, interpret and discuss results (written or orally).

EXTENSIONS

Design other methods to assess the change in water quality through time. Compare oysters to clams, or small oysters to large oysters, or oysters maintained at different temperatures. Have students write up formal scientific papers on the topic. Relate to lessons on the scientific method.

ACTIVITY
2.6

PARASITES ON THE HALF SHELL

Grade Level
6–8
Subject Areas
Science
Duration
One 40-minute class sessions
Setting
Classroom
Skills
Interpreting, hypothesizing, correlating, graphing
Vocabulary
Protistan, *Perkinsus marinus*, prevalence, epizootic
Correlation with TEKS
6.2D,E, 6.3A, 6.12D,E, 7.2D,E, 7.3A, 7.13A, 8.2D,E, 8.3A, 8.11A-D

CHARTING THE COURSE

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

BACKGROUND

During the past eight decades, oyster populations have been plagued by a disease-causing protistan oyster parasite. Though quite harmful to oysters, the disease does not affect humans. The oyster parasite, Perkinsus marinus (also called Dermo disease) was first documented in the Gulf of Mexico in the 1940s and caused severe oyster mortalities. Today P. marinus remains a significant threat to Gulf coast oyster populations and causes severe mortalities of oysters in moderate to high salinity areas of the coast.

In order to gain a better understanding of the disease and to better manage oysters in Texas, scientists carefully monitor the levels of the disease throughout the coast. 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 up bay 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.

MATERIALS

- Student handouts.
- Data set.
- Computer graphing program (optional).

PROCEDURE

Warm Up

Set the stage by posing the question, "What might cause the oysters of Copano or Aransas Bay to decline?"

Introduce the concept of an epizootic.

Introduce Perkinsus marinus as a protistan disease of oysters, which has impacted Copano and Aransas Bay oyster populations.

If you were trying to manage the oyster resource, what might you want to know about the disease?

THE ACTIVITY

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 several months from 2009–2012.
3. The samples were collected at three oyster reefs: Shellbank, Lap, and Long Reefs in Copano and Aransas Bays.
4. Students should graph the data (either by hand or using Excel). Using their graphs, students should:
5. Compare temperature at the three sites.

- Determine the maximum and minimum temperature for the year and indicate the month in which they occurred.
- Compare salinity at the three sites: which site had the lowest salinities, and which had the highest salinities?
- Determine the range of salinity at each site.
- Compare P. marinus prevalence at the three sites, which site had the highest and which had the lowest.
- Determine at what time of the year disease was the highest.

WRAP UP

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.

Name: Date:

ACTIVITY 2.6

PARASITES ON THE HALF SHELL

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 reefs known as Shellbank, Lap, and Long Reefs in 2011–2012. 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 infestation?

6. Determine at what time of the year disease was the highest.

7. Based on your analysis of the data, speculate on why you saw salinity and disease differences between the sites, but very little temperature differences between the sites.

8. Discuss the relationship between temperature and disease levels.

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

10. As shellfish biologists, what recommendations might you make to the oyster resource managers and those involved with the oyster fishery?

TABLE
1

Monthly *Perkinsus marinus* prevalence data at three sample locations: Shellbank, Lap, and Long Reefs. The data is for the years 2009–2012.

PERKINSUS MARINUS PREVALENCE (% commercial infected)

Year	Month	Oyster Reef Shellbank	Lap	Long
2009	January	0%	30%	33%
2009	May	0%	0%	44%
2009	October	0%	0%	87.5%
2010	January	0%	0%	----
2010	August	0%	33%	100%
2010	December	0%	20%	100%
2011	April	0%	10%	90%
2011	June	0%	78%	100%
2011	September	0%	100%	100%
2011	November	0%	90%	100%
2012	May	50%	92%	100%
2012	August	75%	100%	0%
2012	November	70%	92%	92%

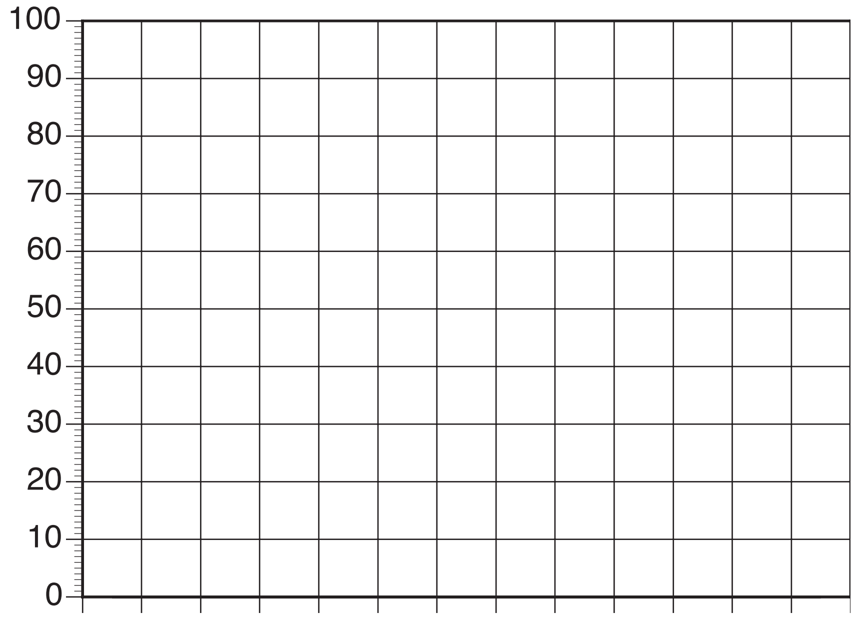
TEMPERATURE (C°)

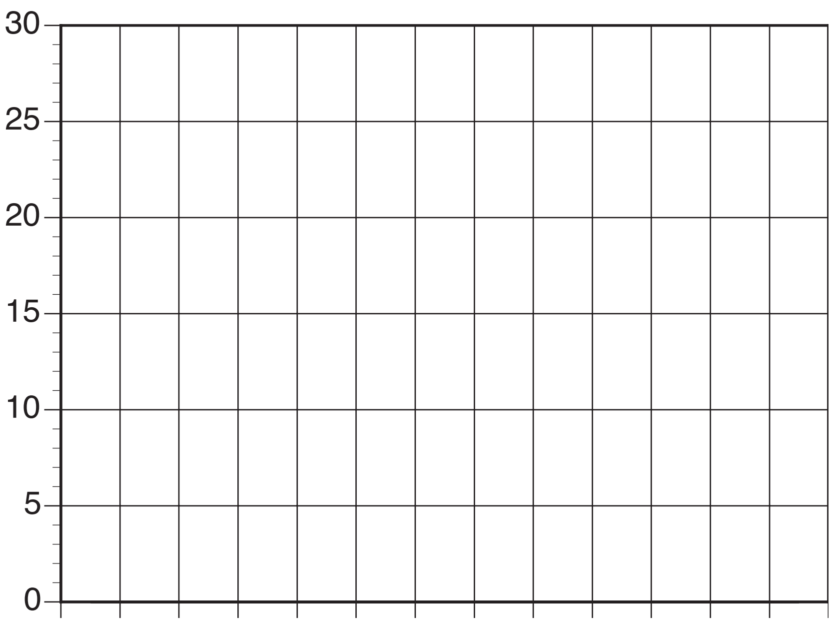
Year	Month	Oyster Reef Shellbank	Lap	Long
2009	January	15	15	14
2009	May	29	28	28
2009	October	29	29	28
2010	January	13	14	----
2010	August	31	31	31
2010	December	16	17	16
2011	April	24	24	23
2011	June	30	30	30
2011	September	29	29	29
2011	November	19	19	20
2012	May	27	27	27
2012	August	30	30	31
2012	November	18	17	18

SALINITY (PPT)

Year	Month	Oyster Reef Shellbank	Lap	Long
2009	January	29	30	29
2009	May	34	33	33
2009	October	43	43	42
2010	January	12	11	----
2010	August	11	13	26
2010	December	7	9	12
2011	April	16	19	26
2011	June	25	26	30
2011	September	34	37	40
2011	November	37	38	37
2012	May	25	27	28
2012	August	32	34	39
2012	November	35	34	31

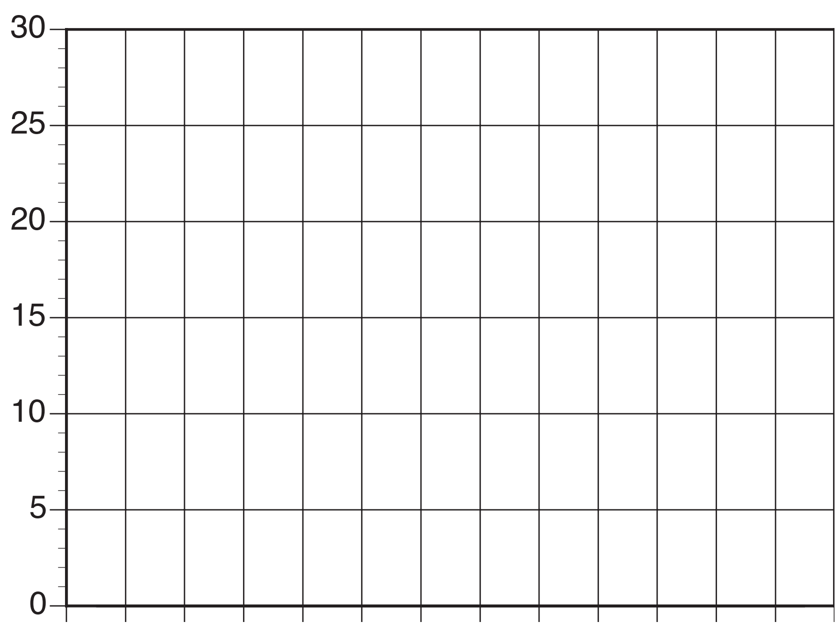
PERKINSUS MARINUS PREVALENCE





SALINITY

TEMPERATURE



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