Module 2

Grade Level: Middle School

Teaching Time: 3-4 class periods

Materials:
Live oysters and oyster clumps
5-10 gal aquarium
Small plastic cups
Rubber bins
Dip nets
Bucket
Magnifying glasses
Hand sanitizer
Paper towels
Organism identification key

If available:
Compound microscope
Plastic culture dish
Dissecting microscopes
Life in the Chesapeake Bay 3rd edition, Alice Jane Lippson and Robert L. Lippson

Build a Better Filter Activity
List may vary:

- Rubber bands
- Cotton balls
- Sand
- Coffee filter
- Sponges
- Straws
- Tape
- Paper towel strips
- Clips
- Toilet paper

I. Oysters: Inside and Out

Summary

This activity explores the physical characteristics that make oysters efficient filter feeders through an investigation into oyster external and internal anatomy. They will design a water filter and test its function with dirty water, then investigate the ecosystem services that oyster reefs provide to organisms that depend on oyster reefs.

Learning Objectives

Students will be able to:

- Identify the form and function of oyster anatomy that make oysters efficient filter feeders.
- Compare oyster filter feeding anatomy with student-created filters.

- Explain the importance of oysters and oyster reef habitats to the Chesapeake Bay
- Examine and identify organisms living in the oyster reef community

Background Information

Oysters have remained relatively unchanged for 190 million years. This mollusk is found throughout much of the Bay in water depths up to 100 feet, although today they are rarely found below 30 feet. The adaptive nature of the oyster in a changing estuarine environment has allowed it to become extremely successful. This success is also due to its simple anatomy and it ecological niche.

Oysters alter the sediments below them through their biodeposits, which add organic matter to the sediments below. Biodeposits consist of feces (partially digested food) and pseudofeces (undigested food that has not passed through their gut). The biodeposits are then subject to decomposition by aerobic bacteria. The resulting dissolved nutrients are recycled back into the water.

Aquatic reefs are complex, diverse communities made of densely packed oysters. Healthy reefs form when oyster larvae attach to adult oysters, and layers of oysters grow upward and outward. Hundreds of aquatic animals find food and shelter in oyster reefs. With their many nooks and crannies, reefs provide a safe haven for small fish and invertebrates to hide from predators. Larger species, including white perch, striped bass and blue crabs visit reefs to breed and find food. Reefs are the largest source of hard surface on the Bay's bottom, which is otherwise mostly covered with soft sediment. Oyster larvae, sponges, and barnacles are just a few of the many invertebrates that live attached to hard surfaces. Piers, rocks, jetties, wrecks, and pilings are similar to aquatic reefs. They provide hard surfaces for invertebrates and attract larger predators in search of food.
(http://www.chesapeakebay.net/fieldguide/categories/category/aquatic_reefs_pilings)

Oyster reefs are important in stabilizing exposed marsh edges. The presence of an oyster reef helps prevent bank erosion and the loss of marsh grasses. The energy of natural and man-made waves (e.g., the wake from boats) is dissipated as the waves are refracted off of the complex structure of the oyster reef. In many areas along the east coast of the United States, oyster habitats have declined dramatically in recent years. Overharvesting, habitat destruction, and oyster diseases are only some of the causes. Non-point source pollutants and suspended sediment negatively affect oysters. Oyster reefs also suffer over time if oysters are removed, but no shells returned to the reef areas on which new oysters can set and grow.

Key Words

Abiotic - All non-living factors within an environment, including physical, chemical, and time (e.g., seasonal, daylight, etc.) components.
Bacteria - Diverse group of single cell organisms important in decomposition, nitrogen fixation, and disease.
Biotic - All living factors within an environment
Bivalve - Marine or freshwater mollusk that has two shells.
Cilia - Hair-like structures used for the movement of particles or fluids in certain cells of more advanced organisms.
Commensal organism - Organisms that rely on a host for a benefit, but does not harm or benefit the host (i.e., an oyster bar provides protection for crabs and a hard substrate for barnacle settlement).
Digestive gland - The gland responsible for the production of digestive enzymes.
Esophagus - Tube that connects the mouth with the stomach
Gills - The gills are the largest organ in the oyster's body, and consists of four folds of tissue. Along with the mantle, it is the chief organ of respiration. They create water currents, collect food particles, and move food particles to the labial palps for further sorting.
Hemocyte - Blood cell found in the circulatory fluid of the oyster. There are different types that perform a wide variety of functions from defense to nutrient transport.
Hermaphroditic - Possessing functioning male and female reproductive organs.
Mantle - Two fleshy folds of tissue that cover the internal organs of the oyster and are always in contact with the shells, but not attached to them. Its principal role is the formation of the shell.
Mollusk - Animals with soft unsegmented bodies usually enclosed in a calcareous shell.
Omnivorous - Organisms that consume a variety of plant and animal materials.
Parasitic organisms - Organisms that rely on a host for resources, and as a result are harmful.
Pericardial cavity - Cavity containing the heart.
Phytoplankton - Diverse group of minute plants that drift freely within the water column.
Pseudofeces - Undigested food that has not passed through an oyster's gut.
Sessile – An organism that is permanently attached to a hard surface and not freely moving.
Shucking - Opening an oyster.
Stomach - A large sac-like organ that is divided into two chambers used in the digestion and sorting of food particles.
Tentacles - Small sensory organs attached to the edge of the mantle used for the detection of environmental stimuli.
Umbo - The pointed and oldest part of the oyster.
Valves - The two shells of the oyster.
Watermen - Individuals who earn an income from harvesting aquatic resources.
Zooplankton - Diverse group of minute animals that drift freely in the water.

Activity Procedure

Engagement

Class Demonstration: Place 6-8 live oysters in a 5-10 gallon fish tank, and fill with no more than 5 gallons of Bay water. Take a picture of the water when the oysters are placed into the tank, and let the oysters sit in the tank for the rest of the lesson time and compare the water at the end. Alternatively, you can show the following demonstration video from the Chesapeake Bay Foundation.
http://www.cbf.org/about-the-bay/more-than-just-the-bay/creatures-of-the-chesapeake/eastern-oyster

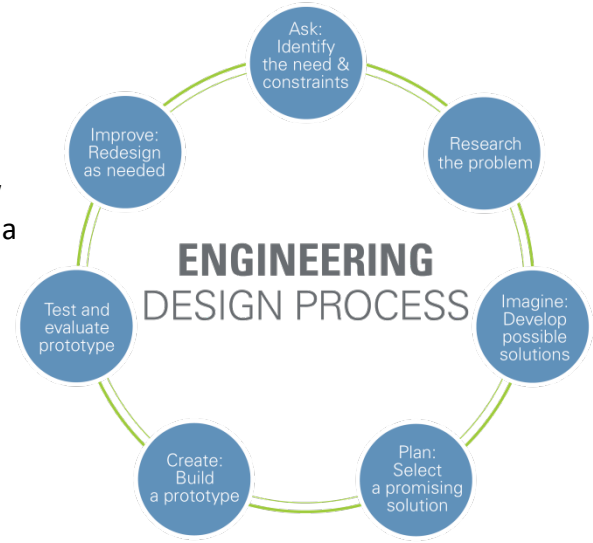
Discussion questions:

- What effect did the oyster have on the water?
- What did the oyster do to the sediment in the water?
- What is the impact of many oysters on a larger body of water?

Note: Under optimal temperature and salinity conditions, a single oyster may filter as much as 15 liters of water per hour, up to 1500 times its body volume. Spread over an entire reef, for an entire day, the potential for oysters to improve water clarity is immense.

Exploration

Students work in teams to design and build their own water filtering system, collect data, and compare their results with other teams. Take a few minutes to review the engineering design process with your students. It is a series of steps that engineering teams use to guide them as they solve problems. The design process is cyclical, meaning that engineers repeat the steps as many times as needed, making improvements along the way. Two key themes of the engineering design process are **teamwork** and **design**.



Information and this diagram are from
https://www.teachengineering.org/k12engineering/designprocess#Improve

Consider using one of these activities from NASA for your water filtration design activity.
https://www.nasa.gov/pdf/146846main_Cleaning_Water_Educator.pdf

Student page is here: https://www.nasa.gov/pdf/146847main_Cleaning_Water_Student.pdf

You might also consider this activity using empty 2 liter bottles.
http://www.jpl.nasa.gov/edu/teach/activity/water-filtration-challenge/

Build a better filter

- Teams of students plan and present a blueprint for a simple filter that will best clean dirty water. Once the blueprint has been approved by the instructor, teams collect the appropriate materials and build their filter.
- They will test their filter with 2 cups of "polluted water" after construction.
- The teams can let their filter work for 5 minutes.
- After 5 minutes, the amount of clean water is measured and a sample poured into a clear specimen cut for comparison to other teams.
- Students should complete the Student Data Sheet 1.

Explanation

Oyster Internal and External Anatomy:
(from Estuaries 101 Curriculum, Activity 6, http://estuaries.noaa.gov/teachers/pdf/06_oysters_tg.pdf)

For this activity, you will need to purchase either preserved oysters from a biological supply house or fresh oysters from a supermarket fish department. If you live near an estuary or marine site, perhaps you can collect the oysters yourself. If you buy preserved oyster specimens, you should review and follow safety rules for class dissection of prepared specimens. Special safety procedures are always taken when using preserved specimens in class.

You will need to clean up properly afterward as all materials exposed to preservatives must be considered contaminated. In addition, students will be handling oysters, oyster shells, and oyster knives in this activity. It is important for you to know if anyone in your class (or classes) has a shellfish allergy. For some students, this allergy can be life threatening. Opening oysters may be hazardous for your students. You may want to open the oysters yourself ahead of time. This can help decrease the need for your students to use a scalpel or knife.

You may choose to open one oyster as a demonstration so that students see how the adductor holds the oyster's two valves together.

Have students examine the anatomy of the oyster and take notes on the shape, color, and texture of the oyster's shell and the oyster's interior organs on Student Data Sheet 2

Procedure

1. Distribute copies of Student Data Sheet 2: Oyster Dissection. Discuss the importance of lab safety, particularly having to do with using the scalpel or knife and with the possible exposure to chemical preservatives.
2. Students assemble in small groups and put on their gloves, goggles, and lab aprons. Each student group will be given an oyster to dissect.
3. Have students use the scalpel or knife to gently slice along the adductor (hinge) of the oyster. Again, you may prefer to do this yourself ahead of time so that students do not need to open the oysters themselves. At minimum, demonstrate the proper way of separating the valves.
4. Students have a simple diagram of oyster anatomy on Student Data Sheet 2 and are asked to identify and describe the oyster body parts shown.
5. Properly dispose of all specimens and contaminated materials when the exercise is finished.
6. Discuss with the students why the anatomy of an oyster makes the oyster well-suited to live in an oyster reef. Oyster anatomy is typical of any bivalve. Discuss the function of the different oyster body parts.

Alternatively, the following online activities allow students to observe and investigate the anatomy of the oysters.

Resource: http://ww2.mdsg.umd.edu/interactive_lessons/oysters/anatlab/index.htm

External Anatomy - http://ww2.mdsg.umd.edu/interactive_lessons/oysters/anatlab/lab_e.htm

Internal Anatomy - http://ww2.mdsg.umd.edu/interactive_lessons/oysters/anatlab/lab_i.htm

Short on time? These videos may be useful.

Dissecting the Eastern Oyster - http://www.bing.com/videos/search?q=oyster+anatomy+videos&qpvt=oyster+anatomy+videos&view=detail&mid=F684D64842EB7123159EF684D64842EB7123159E&FORM=VRDGAR

Behind the Shell - http://www.bing.com/videos/search?q=oyster+anatomy+videos&qpvt=oyster+anatomy+videos&view=detail&mid=2CE3A373772B247991DA2CE3A373772B247991DA&FORM=VRDGAR

Extension

Investigate an oyster reef

(Compiled in 2012 by education staff at the Chesapeake Bay National Estuarine Research Reserve in Virginia for use in the B-WET *Chesapeake Studies in the Classroom* program)

Oyster reefs are built primarily by the eastern oyster, *Crassostrea virginica*, through successive reproduction and settlement of larvae onto existing reef structure. Oyster reefs are formed in the intertidal zone when oysters grow on a hard foundation or substrate, such as dead shells. This process forms clusters of oysters which join together creating an elaborate three-dimensional group. The structure of an oyster reef provides a place for many estuarine species to seek refuge from predators and provides a habitat for organisms that thrive in brackish water. Students will examine different species found on an oyster reef in the Chesapeake Bay; use a microscope and a dichotomous key to help them determine the different organisms being viewed, and; draw conclusions based on the observed adaptations of the organisms about how the organism utilizes the oyster reef. They will also practice scientific sketching and become familiar with how to use a field guide and dichotomous key. http://www.chesapeakebay.net/fieldguide/categories/category/aquatic_reefs_pilings

Oyster reefs perform important functions, such as:

- Provide habitats for plants, fish and invertebrates
- Provide breeding, feeding, and nursery grounds for fish, crustaceans, other invertebrates, and birds species
- Create a hard structure that is used as a place of refuge against larger predators
- Provide a place for sessile organisms to attach to
- Assist in cycling nutrients for marine organisms to utilize
- Maintain water quality and stabilizing sediments
- Protect coastal areas from erosion

By performing these functions, reefs are able to support important local and commercial fisheries, as well as maintain species of plants and animals' diversity and abundance. If the health of the reef is degraded in any way, it can affect the functioning of this habitat, such as its' ability to filter sediments, and cycle nutrients for reef organisms, or provide a healthy nursery and breeding grounds for organisms. (http://www.oyster-restoration.org/wp-content/uploads/2012/07/CoenLuckRestMonitoring.pdf)

1. Have the students share what information they already know about the Bay. Be sure to explain that the Chesapeake Bay is an estuary, a semi-enclosed body of water where the rivers meet the sea. Because the Chesapeake Bay is an estuary, it has brackish water, a mixture of

salt and fresh water. Animals that live in the Chesapeake Bay must be able to thrive in brackish water.

2. There are many unique habitats found along the Chesapeake Bay. Have the students list a few (e.g., oyster reef, salt marsh, mud flat, sea grass bed, etc.). Explain that they will be closely examining an oyster reef community by using microscopes, a dichotomous key, and a field guide. Be sure students understand that community is a group of organisms living and interacting with one another in a particular environment. By the end of the lab, students should be able to describe how the organisms living in the oyster reef function as a community, and why oysters and oyster reefs are important to the Chesapeake Bay. Explain how to use the dichotomous key:
http://www.vims.edu/cbnerr/_docs/education_docs/habitatcageactivity.pdf
Choose an organism that most students are familiar with, for example an oyster, and work through the dichotomous key step by step as a class. Be sure everyone practices how to use the key. Review microscope and lab safety. Remind students that they are handling glass, shells, which could be sharp, and live animals that need to be handled carefully.

3. Students will use their dichotomous key to identify what organism they are looking at through the microscope. Students will write the name and sketch a picture of the organism in Student Data Sheet #3. Students will research their organism in the field guide and write down several adaptations or characteristics it has, to share with the class.

4. Students will identify and repeat the above steps for at least three organisms living in the oyster reef (or as time permits).

5. As students identify an organism, have them write the name of the organism on the board. Additional students should add to the list, but only with organisms not already listed on the board. This will create a comprehensive list of what the entire class was able to identify.

Students should complete the following questions:

1. Was it easy or hard to find the organisms living on the oyster shell? (Students should be able to explain that some organisms were easier to see then others, but by using a microscope they could see the organisms more clearly.)

2. What external characteristics did a lot of the organisms share? (Same color, relatively small, blend in with the oyster shell, etc.)

3. What is the difference between sessile and motile organisms? Name an example of each. How does this affect their survival in an estuary? (A sessile organism is one which is not free to move about; it is attached to the substrate, for example a barnacle or an anemone. A motile organism is able to freely move, for example, a polychaete worm or mud crab. Because sessile

organisms cannot freely move about, they must have the ability to find food another way. Sessile organisms have adapted to this obstacle by finding food through processes such as suspension feeding or filter feeding. While motile organisms are able to freely move about the oyster reef, at times they may appear to be more exposed to predators than sessile organisms. Successful motile organisms in an oyster reef typically have excellent camouflage that allows them to blend in with the habitat.)

4. What does the oyster reef provide for these organisms? (Habitat, protection, food, place to reproduce, etc.)

5. Why are oysters important to the Chesapeake Bay? (Help to filter water, provide food for humans and other organism, provide a habitat for many organisms, help the economy, etc.)

Page 31 references a large poster of an oyster reef. You can go to the link provided and discuss the organisms on the poster, or use it as a reference for this activity. Alternatively, you can print a large poster-sized copy for classroom use.

Possible animals that might be found on an oyster reef:

Mud Crab: A small dark brown or black crab about the size of a quarter that lives in the nooks and crevices of the oyster shells.
Blenny: A small fish that has a feathery dorsal ridge (top fin). It is brown and black in color.
Naked Goby: A small fish that has big eyes, the body is scales and it is greenish in coloration with narrow pale cross bars along its sides.
Grass Shrimp: A small translucent shrimp that lives among the oysters
Oyster Toad Fish: Slightly larger than the blenny with large bulging eyes, pale yellow in coloration with brown spots on the body. Its mouth is large with sharp teeth, and whiskers.
Amphipods: A small crustacean related to a pill bug on land. An amphipod lies and moves on its side (flattened laterally) with jointed appendages; less than half an inch in size.
Barnacle: There are three different species of barnacles that grow in the Bay. It's an animal that lives inside a three-sided shell. To feed, the barnacle will stick out its feathery like appendage (arm) and wave it about to capture small particles floating in the water.

Evaluation

- Dissection questions on Student Data Sheet 1, Oyster Internal and External Anatomy pages.
- Student designs and results for Build a Better Filter (Student Data Sheet 2).
- Student observations of organisms from an oyster reef. (Student Data Sheet 3).
- Exit/Debrief: What are oyster reefs important in the Bay?

Module References

http://www.mdsg.umd.edu/topics/k-12-lesson-plans/oysters-classroom

http://ww2.mdsg.umd.edu/interactive_lessons/oysters/anatlab/index.htm
http://ww2.mdsg.umd.edu/interactive_lessons/oysters/anatlab/lab_e.htm

http://ww2.mdsg.umd.edu/interactive_lessons/oysters/anatlab/lab_i.htm

https://e360.yale.edu/digest/a_remarkable_recovery_for_the_oysters_of_chesapeake_bay/4437/

http://chesapeakebay.noaa.gov/oysters/oyster-reefs

http://www.vims.edu/cbnerr/_docs/education_docs/habitatcageactivity.pdf

www.vims.edu/cbnerr/_docs/education_docs/habitatcageactivity.pdf

http://www.sms.si.edu/irlspec/Oyster_reef.htm

http://www.oyster-restoration.org/wp-content/uploads/2012/07/CoenLuckRestMonitoring.pdf

Maryland Environmental Literacy Standards
http://marylandpublicschools.org/programs/Documents/Environmental/MDEnvironmentalLitStandards.pdf

Additional Resources

http://estuaries.noaa.gov/teachers/pdf/06_oysters_tg.pdf

http://digg.com/video/the-best-way-to-shuck-an-oyster

http://hatchery.hpl.umces.edu/oysters/oysters-life-cycle/

Three Dimensional Learning		How the Dimensions are Addressed.
Core Disciplinary Idea(s)	**MS-LS1A. Structure and Function**. Within cells, special structures are responsible for	Students gather information about water filtration of oysters

	particular functions. In multicellular organisms the body is a system of multiple interacting sub-systems. **MS-LS2.A**. **Interdependent Relationships in Ecosystems.** Organisms and populations of organisms are dependent on their environmental interactions, both with other living things and with non-living factors. **MS-LS2.C**. **Ecosystem Dynamics.** The completeness or integrity of an ecosystem's biodiversity is often used as a measure of its health. **MS-ETS1.B. Developing possible solutions.**	through observations of live oysters, and then investigate the external and internal structures and systems that contribute to the successful water filtration of oysters as mechanism to obtain food. The students model the filtration system of oysters in a design-a-filter task, and then they look at the organisms that are dependent on oyster reefs for protection, food, breeding places, and water quality. Students will use the engineering design process to create a water filtration system.
Science/Engineering Practice(s)	**Developing and using models.** (Develop a model to describe phenomena) Construct an explanation using a model or representation. Undertake a design project to construct and/or implement a solution that meets specific design criteria and constraints. Students model complex and microscopic structures and systems and visualize how their function depends on the shapes, composition, and relationships among its parts.	Students design a solution to clean up dirty water through various filtration systems that mimic how oysters efficiently filter Chesapeake Bay water. Students investigate the structures and systems that allow an oyster to provide valuable ecosystem services such as water filtration.
Cross-cutting Concepts	**Cause and Effect** - Use cause and effect relationships to predict phenomena in natural or designed systems.	Students investigate the anatomy that allows the oyster to be an efficient filter feeder.

	Structure and Function. Complex and microscopic structures and systems can be visualized, models and used to describe how their function depends on the relationships among its parts.	They also look for typical oyster anatomy parts, which are named similarly in the animal kingdom based on function. Many organs in the oyster serve similar functions in other animals.
Ties to Common Core	**Grades 6-8 Reading Standards for Literacy in Science and Technical Subjects.** Follow precisely a multistep procedure when carrying out experiments, taking measurements, or performing technical tasks. **RST.6-8.7** Integrate quantitative or technical information with a diagram, model, graph, or table.	Students use a multistep protocol to investigate the external and internal structures of the oyster and learn to use a dichotomous key to identify organisms in an oyster reef. Students will include accurate and precise descriptions with their design diagram.
Ties to MD Environmental Literacy Standards	**Standard 4: Populations, Communities and Ecosystems**. The student will use physical, chemical, biological, and ecological concepts to analyze and explain the interdependence of humans and organisms in populations, communities, and ecosystems	Students organize data to show the variety of organisms and their relationships in an oyster reef.