Grade Level:
Grade 4

Teaching Time:
3-4 45 minute sessions

Materials:

- Oyster shells (at least one per student) or photos of oysters (included in lesson)
- 2-3 Live oysters if possible
- Aquarium or other large container
- An open oyster with both shells for every pair of students
- Paper or plastic to cover student desks
- Hand lens for each student
- Paper towels
- Hand sanitizer
- 1 whole oyster for every 2 students
- Gloves (latex or nitrile)
- Safety Goggles
- Wax paper or dissection trays
- Student Resource Sheets 1 and 2
- Problem statement sheet for each student
- Student science journals
- Resources to support Extension section

What's Inside?
A Simple Oyster Dissection

Activity Summary

Students will learn about the internal and external structure of oysters as an example to help them understand that all organisms have parts that help them survive and grow. They will also learn how the functions of the oyster help the ecosystem in which it lives and the benefits to humans.

Learning Objectives

Student will be able to:

- Explain how an oyster eats.
- Explain how and why the functions of oysters are critical to the Chesapeake Bay ecosystem.

Essential Question

Why is the Eastern oyster important to the Chesapeake Bay ecosystem and to the people of Maryland and Virginia?

Teacher Note:
For this activity, you will need to purchase either preserved oysters from a biological supply house, such as Wards, or fresh oysters from a supermarket fish department. You may be able to find live oysters at an Asian market. 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. Preservatives can be dangerous chemicals. For example, formaldehyde is a proven carcinogen. Special safety procedures are needed 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 and oyster shells. It is important for you to know if anyone in your classes has a shellfish allergy. For some students, this allergy can be life threatening. Even touching the shell could pose problems. Opening oysters may be hazardous for your students. You may choose to open one oyster as a demonstration so that students see how the adductor holds the oyster's two valves together.
(Taken from: http://estuaries.noaa.gov/teachers/pdf/06_oysters_tg.pdf)

Background Information
Oysters, like other bivalves, have two shells, or valves, that are hinged at one end. The shape of the shell and its thickness vary according to the oyster's habitat. For instance, oysters that live in subtidal areas tend to have regular, heavy shells. They do not form groups called clusters. Oysters that live in intertidal areas have shells that are typically thin, elongated, and irregularly shaped. Those oysters do form clusters. These oysters use their left valve to attach to the substrate or to one another. The left valve tends to be thicker and more deeply curved than the right valve. Inside an oyster's shell, a thick fold of tissue called the mantle covers the internal organs. The mantle's primary function is to secrete the oyster's shell. Unattached parts of the mantle enclose a space known as the mantle cavity, which, in a living oyster, is always full of seawater. This water keeps the oyster's internal organs constantly wet even when the oyster is exposed to air at low tide. (Taken from Estuaries 101:
http://estuaries.noaa.gov/teachers/pdf/06_Oysters_TG.pdf

Besides being excellent and tasty sources of food, oysters and oyster reefs serve vital roles in estuarine ecosystems. For example, oysters filter the water and reduce turbidity by extracting phytoplankton and organic and inorganic particles from the water column. Good water clarity, in turn, promotes the growth of submerged aquatic vegetation (SAV), which provides habitat for juvenile crabs, fish, and other organisms. In addition, the reefs may provide some protection from waves and currents.

Oyster reefs in the United States are not only unique ecosystems that support multitudes of other organisms, but they are a valuable food source and constitute important commercial fisheries. The loss of oyster reefs in the United States during the past 200 years has not only significantly decreased the amount of food harvested from them, but has also removed habitat for other estuarine animals and plants, decreased water quality, and reduced income and jobs

for workers in the oyster industry. Once the nation's crown jewel of oyster production, oyster harvests in Chesapeake Bay have reached an all-time low, and the once massive reefs have been reduced to 1 percent or less of their former mass. Similar scenarios have occurred in other locations as well, due to disease, water pollution, overharvesting, cumulative loss of clutch base, and mining of shell resources.

Key Words

Bivalve - An aquatic mollusk that has a compressed body enclosed within a hinged shell.

Density – The amount of something in an area.

Disease - A condition that impairs the proper function of the body or of one of its parts.

Ecosystem - All the living organisms that occur together in a particular area.

Filter - To separate or remove matter.

Habitat - Place where an organism or a community of organisms lives; includes all living and nonliving factors or conditions of the surrounding environment.

Harvest – Process of gathering as in a crop.

Hatchery – Place where oyster larvae and young oysters are grown.

Larvae – Early form of an animal that is unlike its parent; Changes to look like/act like parent.

Mollusk - Invertebrate that has a soft unsegmented body and lives in aquatic habitats and often has a shell.

Oyster - Bivalve mollusk with rough irregular shell sometimes eaten as a delicacy and may be farmed for food or pearls.

Oystermen – Women and men who harvest oysters to sell to restaurants or to eat themselves

Phytoplankton – Free swimming algae.

Pollution – Contamination of air, water or soil with harmful substances. **Pollutants** can be artificial substances, such as pesticides and PCBs, or naturally occurring substances, such as oil or carbon dioxide, that occur in harmful concentrations in a given environment.

Reef – Group of oysters rising close to the surface of the water.

Restore – Bring back into existence.

Sediment – Small particles of soil, sand, or silt, which will sink to the bottom of the water.
Seed – Plant or lay down young oysters so they will grow.

Spat – Name for oyster larvae after they attach to a surface.

Substrate – Base on which an organism lives.

Turbidity - Cloudiness or haziness of a fluid caused by large numbers of individual particles that are generally invisible to the naked eye, similar to smoke in air. The measurement of turbidity is a key test of water quality.

Water current - Part of a fluid body (as air or water) moving continuously in a certain direction.

Activity Procedure

Day 1

Engagement

Show the opening minutes (0:13-3:00) of the Maryland Public Television video, *Chesapeake by Air*, (http://www.chesapeakebaybyair.org/). Afterward, ask students what they know about the Chesapeake Bay and to describe any experiences they have had there.

Exploration

1. Pose the following problem to the students:

   Many years ago, people started noticing that the Chesapeake Bay did not have as many animals as it once had, and the water was not as clean as it once was. They knew many animals were harvested for food, but they did not understand why the animals did not replenish quickly. Something had changed. The water was tested and found to have pollutants and sediment in it making it hard for animals to survive. People knew how to limit pollution going into the Bay, but what kept the water clean before the pollution?

2. Ask students to glue the problem statement into the science journals and then brainstorm and record possible solutions with a partner. Chart their responses during class discussions.

3. Have each student choose one of the suggestions, and list in their science journals what they think it will take to implement each solution. Share their thoughts with a partner and then discuss with the class. If none of the students have mentioned an animal that cleans as a solution, ask them if they think an animal could help. Why or why not?

4. Show the students pictures of the Eastern oyster explaining that people thought this animal may be able to help the Bay. Separate students into small groups and have them investigate empty separated oyster shells for a couple minutes and have them try to

match two shells to make the cover of the animal. Discuss their observations and if the animal could actually help the Bay.

5. Show the students 2-3 live oysters and ask them to tell you the differences between what you are holding and what is on their desks (empty shell halves). Tell the class they will learn more about the animals tomorrow. If you do not have access to live oysters, show images of live oysters with both shells intact and closed.

Place 2-3 oysters in a glass aquarium or other large container filled with murky salt water. (Use de-chlorinated tap water and "Instant Ocean" or similar salt; 14-21 grams per liter of water.) Cover the aquarium or container so students cannot see the change occurring. Leave the oysters in the container overnight.

Day 2

You will need the following materials for Day 2:

- Paper towels
- Hand sanitizer
- 1 whole oyster for every 2 students
- Gloves (latex or nitrile)
- Wax paper or dissection trays

Engagement

Show the students the oyster tank. Ask them what happened and why they think it happened. If the students have not already identified the animals as an oyster, have them do so now.

Exploration

1. Have students read the Student Resource 1, Oysters in the Chesapeake Bay, and answer the following question in their science journals: What services do oysters provide for the Chesapeake Bay?

Explanation

1. Discuss the reading (Student Resource 1) with the students, highlighting that oysters help clean the Bay and how they do it.
2. Show students an image of the inside of an oyster and tell them they are going to dissect an oyster.
3. Give each pair of students a shucked oyster and show a diagram of external parts of the oyster.
4. Identify the two shells or valves and compare them. One is more cupped and rough, the other smooth and flat. In nature the oyster stands vertically. The deeper valve is the one that is cemented down, the flatter valve acts as a lid. Demonstrate the action for the students. Are the two shells the same size? Is one thicker than the other is?
5. 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, and it is a point

at which the shells are attached to one another. The other end, referred to as the bill (the ventral margin), is free to open.

6. Have students draw the exoskeleton in their science journals, or shell of the oyster and label the umbo and bill. Discuss the function of the shell with students.

Day 3

You will need the following materials for Day 3:

- Paper towels
- Hand sanitizer
- Student Response sheet 2: Oyster Dissection
- 1 whole oyster for every 2 students
- Gloves (latex or nitrile)
- Safety goggles
- Lab aprons
- Wax paper or dissection trays
- Plastic garbage bags or zip lock bags

Engagement

Give each pair of students a shucked oyster and have them identify the sides and part of the shells.

Exploration

1. Have the students open their oysters and, using the hand lens, explore the inside of the oyster by carefully lifting tissue from various areas. Take care to not pull or rip any tissue.
2. Give the students a blank copy of the Student Response Sheet 1 (Oyster Dissection) and have them attempt to label the parts of the oyster.

Explanation

1. Show the students a diagram of the inside of an oyster, pointing to each part of the oyster and explaining its function.
    a. **Adductor muscle** – Muscle tissue shaped like an oval that controls the opening and closing of the shells. The adductor muscle leaves a scar on the shell at the point where it is attached. Have students find the muscle scar.
    b. **Cilia** – Small hair-like whips attached to gills that draw food (phytoplankton) and other particles (sand, pollution, etc.) into the oyster; Move food parts captured by gills to the mouth
    c. **Mantle** – Loose outer tissue that covers the entire body of the oyster. The mantle is always in contact with the shell but is not attached to it. The primary function of the mantle is to produce the oyster shell.
    d. **Gills** – Oyster's largest organ consisting of four folds of tissue that are located under the mantle edge. Gills are the main respiratory organ, but they also play a role in feeding. By beating tiny hairs called cilia, the gills are able to create a current by

pumping water over the gills. By this method, the gills are able to collect particles and move them onto the palps for further sorting.

e. **Palps and mouth** – Specialized organs that control the total amount of food that is passed along to the mouth. Follow the gills toward the umbo area. There will be a slit followed by two thicker layers of tissue these are the palps. The mouth is the U-shaped slit that is located between the palps.
f. **Stomach** – The stomach lies under the mantle layer and is brown in color. The stomach connects to the intestines and digestive glands, and is where food is broken down into usable nutrients.
g. **Rectum** – Found along the edge of the adductor muscle. It is a tube through which waste is eliminated.
h. **Heart** – Lies above the adductor 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. Oysters have an open circulatory system, there are no definite veins and arteries through which the blood can flow instead blood drains through open sinuses within the body.

3. Have students adjust their answers on the Oyster Dissection sheet and reexamine their oysters to find each part.
4. Using the Student Resource 2, "How do Oysters Eat?" and the diagram, ask students how they think oysters eat. Discuss the process and then walk the students through the process of an oyster eating. Students should identify the parts on their oyster at each stage of the process.
5. Discuss how the process an oyster uses to eat also cleans the water in their ecosystem.
6. Revisit the problem statement and explain that a mature oyster can filter up to four gallons (four big milk jugs) of water a day. Ask them if that is the case, then why is the Bay dirty? (not enough oysters) What should people do about it?

Extension

1. Students can research other filter feeders to learn how they feed and any positive effects they may have on the environment.
2. The students should develop a visual presentation to share the information on the filter feeder they research. This can be a poster board display, a Power Point presentation, a video, etc.

Evaluation

Formative:

1. Class discussions and participation
2. Dissection participation
3. Journal entries

Summative:
Students will write an opinion piece persuading the reader that oyster restoration is needed to clean the water of the Chesapeake Bay. They should use the facts they learned about oysters in general and their anatomy as reasons and elaborate for emphasis.

Education Standards

Three Dimensional Learning		
Disciplinary Core Idea(s)	**LS1.A: Structure and Function** Plants and animals have both internal and external structures that serve various functions in growth, survival, behavior, and reproduction. (4-LS1-1)	**How Standard is Addressed** Students investigate the internal and external structures of an oyster and the functions.
Science/Engineering Practice	**Engaging in Argument from Evidence** Engaging in argument from evidence in 3–5 builds on K–2 experiences and progresses to critiquing the scientific explanations or solutions proposed by peers by citing relevant evidence about the natural and designed world(s). • Construct an argument with evidence, data, and/or a model. (4-LS1-1)	After learning about oyster anatomy and functions, students construct an argument with evidence to persuade a reader that more oysters are needed in the Chesapeake Bay.
Cross – Cutting Concepts	**Systems and System Models** A system can be described in terms of its components and their interactions. (4-LS1-1 and 2)	Students dissect an oyster, learn the functions on the parts of the internal structure, and then model how oysters clean water by the process of gathering food.
Common Core Standards		
Ties to Common Core	**W.4.1** Write opinion pieces on topics or text, supporting a point of view with reasons and information.	Students write an opinion piece as described above.
Maryland Environmental Literacy Standards		
Ties to MD Environmental Literacy Standards	**C. COMMUNITY AND ECOSYSTEM DYNAMICS** **Indicator 1:** Explain how the interrelationships and interdependencies of organisms and populations contribute to the dynamics of communities and ecosystems.	Students study the internal and external structure and function of an oyster to understand why the oyster is important to its ecosystem and how it contributes to the dynamics of the Chesapeake Bay.

Additional Resources

Web Resources

YouTube Videos:

- Chesapeake by Air http://www.chesapeakebaybyair.org/

- Oyster Filtration: A one minute time-lapsed video of oyster filtration in action. https://www.youtube.com/watch?v=saAy7GfLq4w

- OYSTERFILTER: A one minute and 20 second time-lapsed video of six oysters filtering a gallon of water. https://www.youtube.com/watch?v=LOp3V_QpAyA

- Restoring Oyster Reefs in Chesapeake Bay: Sea Grant Documentary https://www.youtube.com/watch?v=v4pKoDPdmzM

TeacherTube Videos:

- Oyster Filtering: Excerpt from The Chesapeake Bay Foundation's documentary "Common Ground." (42 seconds) http://www.teachertube.com/viewVideo.php?video_id=211324

- Oyster Rap: An oyster restoration scientist raps about Eastern oysters in the Chesapeake Bay http://www.teachertube.com/viewVideo.php?video_id=93158

Book Resources

Allen, Elaine Ann. Olly the Oyster Cleans the Bay. Tidewater Publishers, May 1, 2008. ISBN-10: 0870336037.

Tate, Suzanne. Pearlie Oyster: A Tale of an Amazing Oyster. Nags Head Art, Inc., June 1, 1989. ISBN 10: 0961634472.

The Eastern Oyster in the Chesapeake Bay

Two halves of a single Eastern Oyster.

What are Eastern oysters, Crassostrea virginica?

Eastern oysters are **bivalve mollusks**. That means they have two shells. You will see one shell on the left side and one shell on the right side when you open an Eastern oyster.

Where do Eastern oysters live?

Eastern oysters live on the East Coast of North America from Canada to Venezuela.

Very young oysters float in water currents looking for a place to stick to and grow into adults. As they float, they grow a foot. They use the foot to find a hard surface to attach to. Then they make a cement-like glue to stick the foot to the hard surface. They cannot attach to mud and sand or to a place with too much sunlight. They need to be in flowing water where their food (**phytoplankton**) is. Other oyster shells are the best place for oyster **larvae** to attach. Once attached, the larvae are called **spat**. Over time, the spat grow and make shells, and other oyster **larvae** attaches to them. As more and more oysters attach to older oysters, oyster reefs grow.

Oyster spat attached to oyster shell (left), restored oyster beds.
Photo: NOAA

What do Eastern oysters look like?

Adult Eastern oysters have a grey and white bumpy shell. They are shaped like giant kidney beans with one skinny end. They can grow to eight inches long. There were once oysters as big as dinner plates! Those oysters had grown for many years because Native Americans could only **harvest** small numbers of oysters.

Why are Eastern oysters important to the Chesapeake Bay?

For thousands of years, people have eaten Eastern oysters, and Native Americans used oyster shells for jewelry and money in the past. Starting about 400 years ago, people also made money by harvesting and selling oysters.

Eastern oysters filter the water in the Bay. Oysters suck in water and filter out phytoplankton for food. They also filter **sediment** and **pollution** out of the water. Then they spit clean and clear water back into the Chesapeake Bay. Without oysters, the water in the Bay would become cloudy and polluted; not a good place for other animals to live.

Oyster reefs also provide habitat to other animals such as small crabs and fish. The young animals live in the oyster reefs for protection from predators and for food.

What happened to the Eastern oysters?

For hundreds of years, Eastern oysters were known as the best tasting oysters in the United States. Oystermen harvested oysters faster than the oysters could

reproduce. Oysters live close together in reefs, and their young like to stick to other oyster shells to grow. There were not enough oysters to reproduce or provide shells for oyster larvae to attach to, so fewer oyster reefs were made. People also used oyster habitat as places for building docks and houses.

Also, in the 1940s and 1950s, scientists found two diseases in Eastern oysters called MSX and Dermo. Both of these kill oysters and make it harder for more reefs to grow in the Chesapeake Bay.

What are people doing to help the Eastern oyster?

People are doing many things to help the Eastern oyster. Scientists are learning more and more about oysters and their habitat, and water currents in the Chesapeake Bay. They use this information to find the right places to place piles of empty oyster shells to give oyster larvae sticking places. The new reefs are often built on old oyster shells from restaurants.

People are also growing oysters from boat docks in bags that look like mesh socks and give the oysters to oyster **restoration** groups to put onto reefs when the young oysters are large enough. Businesses are growing oysters on floating rafts. They sell the oysters for food and use the shells to help new oysters grow.

What can you do to help the Eastern oyster?

Learning about the Eastern oyster is the first step toward helping more oysters grow in the Chesapeake Bay. You can share the story of the Eastern oyster and its importance to the Chesapeake Bay and to Maryland with others. You can also collect oyster shells from restaurants and take them to groups around the Chesapeake Bay who are working to **restore** oyster beds. If you live on the Bay, you can grow oysters from your dock in oyster socks and then take the sock to a group that will plant them on an oyster bed. If you are boating in the Chesapeake, watch for oyster beds. Putting down your anchor on a bed can hurt the living oysters and destroy the bed. Anything you do to bring oysters back to the Chesapeake Bay benefits all Marylanders and Virginians.

Tiny oysters at a **hatchery**.

How do oysters eat?

The oyster feeds by filtering food particles from the surrounding water. Opening and closing of the valves (shells) are controlled by an adductor muscle attached to each shell. Food and other particles, suspended in the water, are drawn into the oyster by the motion of small, hair-like whips called cilia located on the gills. A large, healthy oyster may pump almost four gallons of water per hour. Food particles captured by the gills are moved by the cilia to the mouth and then to the stomach of the oyster. Matter brought into the shell, but not passed through the mouth, is trapped by sticky mucus on the gills and then discarded. The oyster then spits the filtered water into the ecosystem. This ability to separate food from other material apparently allows oysters to survive in waters of high turbidity which occurs in many estuaries. The filtering action of oysters can play an important role in removing not only suspended sediments from the water column, but can cleanse the water of various pollutants.

Sample rubric for scoring summative assessment

	Below Average	Average	Above Average	Excellent
Opening statement of opinion	No statement	Writes a statement, but the opinion is not clear.	Writes a brief statement, and the opinion is clear.	Clearly writes the opinion statement and gives a simple elaboration.
Main Concepts	Does not cite any of the main concepts.	Includes one main concept.	Includes two main concepts.	Include all three main concepts to make argument for the conclusion.
Concept Elaboration	No elaboration or description.	Elaborates on one main concept or gives a general description.	Elaborates on two main concepts.	Elaborates on all three main concepts.
Conclusion from Activity Analysis	No conclusion	Only writes a conclusion statement.	Writes an overview and a conclusion.	Clearly writes a brief overview of the activities AND states the conclusion drawn in response to the activity.

*This rubric addresses the science concepts from the student readings and the classroom activities. You may wish to include other items for evaluation.

Oyster Image 1

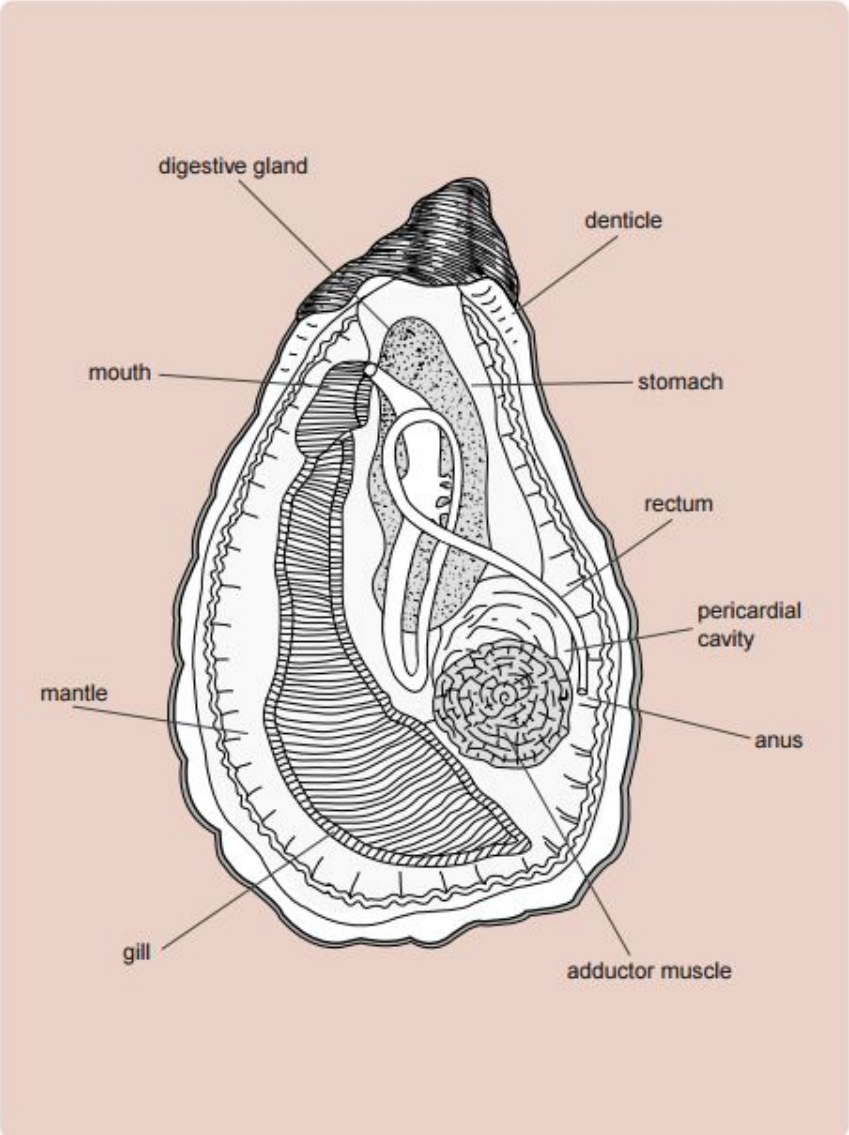
Oyster Image 2

Oyster Image 3

Oyster Image 4

Oyster Image 5

Oyster Image 6

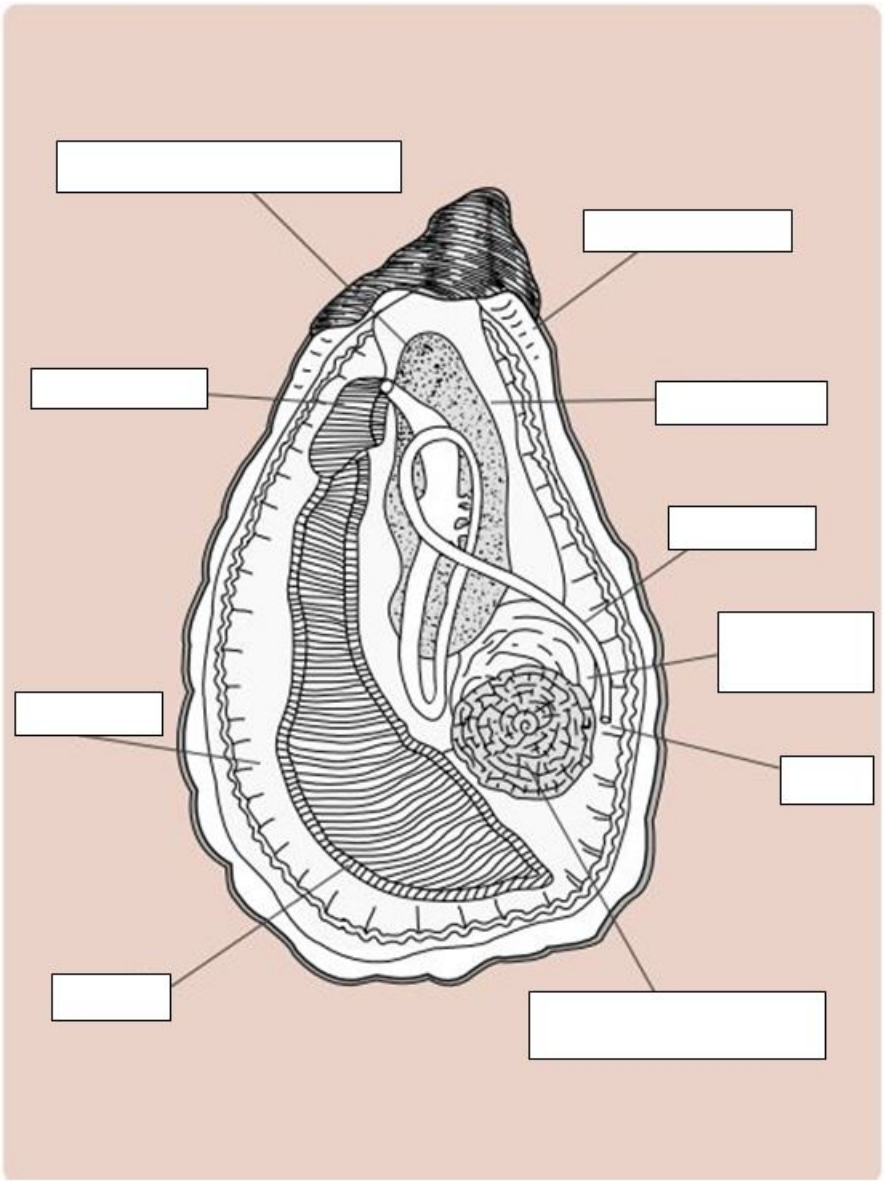


Source: FAO http://www.fao.org/home/en/

Enclosed in a thick sturdy shell, the soft body of the oyster is adapted for filtering tiny plankton and other items from the surrounding water. The gills filter and collect food that the stomach then digests. The mantle is a thin membrane that covers the body and lines the inside of the shell. The adductor muscles and the hinge between the two halves of the external shell help keep the shell closed.

Name: _____

Direction: Label each part of the oyster using terms in the word.



Word Bank

mantle	rectum	denticle
digestive gland	gill	stomach
adductor muscle	mouth	anus
pericardial cavity		