



Introduction to Native Freshwater Mussels Lesson and Activity *Show Us Your Mussels Challenge*

Grade: 6-12

Audience: Science, Art, and Language Arts

Activity overview:

After an introductory conversation, students will engage in one or more activities. These can be done one at a time as a large group, in rotating stations, or in small groups that then share back. For ease of instruction, the activities have been sorted as either “Introductory level” or “Advanced level.” You as the instructor can mix and match according to your classes’ academic needs.

This lesson includes learning about mussel anatomy and function, detailing a mussel’s life cycle and reproduction, and identifying and distinguishing between Minnesota mussels. If you do not need all three content areas, each activity can be stand-alone.

Objectives:

1. Students will explore what is a mussel and what its role in the environment.
2. Students will understand mussel anatomy.
3. Students will be able to re-create the lifecycle of a freshwater mussel.
4. Students will brainstorm a list of the human impacts that might influence freshwater mussel populations based on their life cycle and feeding habits.
5. Students will research host fish and substrate relationships for a specific mussel species.
6. Students will practice identifying native and non-native mussels.

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Standard connections

Minnesota 2019 State Science Standards

- 9L.3.1.1.1 Develop and use a model to illustrate the levels of organization of interacting systems and how that translates into specific functions in multicellular organisms.
- 9L.4.1.1.1 Evaluate evidence for the role of group behavior on an individual's and species' chances to survive and reproduce.

NGSS

- MS-LS1-4 Use arguments based on empirical evidence and scientific reasoning to support an explanation for how characteristic animal behaviors and specialized plant structures affect the probability of successful reproduction of animals and plants, respectively.
- HS-LS1-2 Develop and use a model to illustrate the hierarchical organization of interacting systems that provide specific functions within multicellular organisms.

Cross Cutting Concepts

1. Cause and Effect
2. Systems and System Models
3. Structure and Function

Disciplinary Core Ideas in Life Science

1. Structures and Processes
2. Ecosystems
3. Heredity
4. Biological evolution

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Key Vocabulary

Beginner	Advanced
Mussel	Glochidia (for simpler terms, say eggs)
Host	Siphon
Life Cycle	Mantle
Reproduction	Invertebrate
Species	Adductor Muscles
Filter Feeder	Gonads
	Palps

Time

Flexible. This lesson consists of 5 activities that may be done together or separately. Each activity may take 15-30 minutes.

- Life cycle diagram- *optional*
https://images.dnr.state.mn.us/education_safety/education/minnaqua/leaders_guide/lg_cd_art/mussel_life_cycle.jpg
- List of Mussel species (provided at end of the lesson)
- Specimen or pictures of various native and invasive mussel species
- Computer with internet, ability to project preferred.

Background

What is a mussel exactly? It is an animal; an invertebrate that is part of the Mollusca phylum, the second largest invertebrate phyla. It is a *bivalve* (*two shells*) like a clam, but its relatives are also snails, octopuses, squid, and much more. Common characteristics include soft, unsegmented body covered by the *mantle* and the presence of a shell, or remnant of one.

There are two types of mussels, marine and freshwater, with some differences such as their mobility. All clams and mussels feed by siphoning water into their shells, filtering out small organisms, organic particles, and toxins before releasing that water back out to its environment. Freshwater mussels are most like clams. They both have a large muscle called a *foot* that can extend beyond their shell and is used for movement

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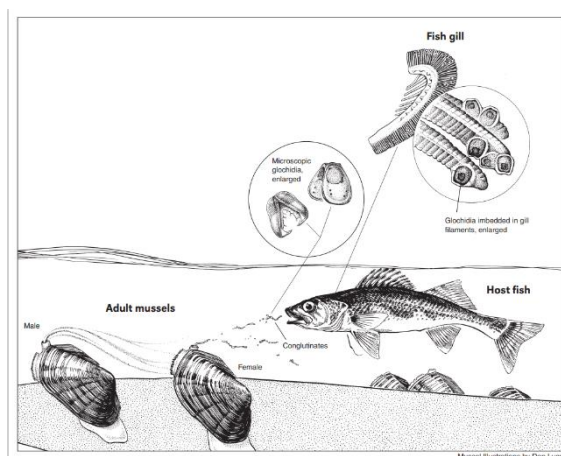


through the sand, either horizontally or vertically. Where clams and freshwater mussels differ is the shell shape and their reproductive cycle. Freshwater mussels have a sophisticated method of ensuring their brood survives. Clams release their larva into the water in hopes it survives to develop into an adult. Freshwater mussels lure a host, using a modified mantle, to care for their larva ensuring they have a higher chance of survival.

What about this cool freshwater mussel reproductive cycle? Freshwater mussels reproduce sexually. The male release their sperm into the water. The female receives it when she takes in water filtering for food. After her eggs are fertilized, they develop into larvae, called *glochidia*. When she is ready to release them, she transforms part of her mantle into the shape of a food lure for nearby fish. Once the fish gets within shooting range, she unloads her glochidia into the gills of the fish host. The glochidia then attach themselves to the gills of the fish host feeding off its oxygenated blood until they finish growing and developing. Several months later, they release themselves, land in the substrate below, and start their life cycle. Each mussel's survival is dependent on their specific requirements to fish host, substrate, and water chemistry.

There are fifty-one species of freshwater mussels in Minnesota and twenty-eight of them are endangered. Some of the ways to tell mussels apart are size, shape of shell, color, and texture. Mussels are important indicators of a healthy environment and are essential for a balanced ecosystem, especially since some freshwater mussels can live 60-70 years.

The MN DNR page provides additional information and great videos on how mussels live and reproduce. <https://www.dnr.state.mn.us/mussels/howlive.html>.



Graphic courtesy of MN DNR

https://files.dnr.state.mn.us/natural_resources/animals/mussels/mussel_life_cycle_don_luce.pdf

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Procedure

Students can complete as many activities as you have time and need. These can be set up for the whole class, in rotating stations, or in small groups that then share back.

1. It may be useful to start this lesson with a KWL chart.

What I Know (K)	What I Wonder (W)	What I Learned (L)

2. Before students break off into any activities, make a large diagram with 3 columns.
 - The first (K) is what they know about mussels.
 - The second, (W), is what they might wonder, what questions do they have.
 - The third (L) is what they've learned. In between activities, or after regrouping from stations, check in with students to add to the W column and/or fill out this 3rd section and see if they've answered anything from the K column.

Introduction and Background Conversation

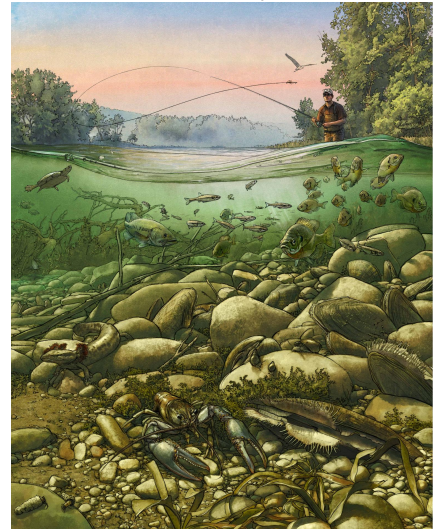
(Introductory, can be supplemented for Advanced students)

You may need to establish background knowledge about mussels first. This can be done with pictures, videos, lectures, etc. Multiple sources are supplied here and on the Minnesota Zoo's website to tailor this section to your class.



1. Show students the picture of this river ecosystem
(This picture is displayed outside the Mussel Lab at the Minnesota Zoo and located at the end of this lesson plan.)
2. Instruct the students to list what they see *(either individually or as a class)*. After a few minutes ask prompting questions, such as
 - What living things do they see? What non-living things do they see?
 - How are these living things interacting with one another? Which ones are important?
 - Did they notice the mussels? What might their role be?
3. Show the students a live mussel, shell, video, or picture. Then ask the students to answer, either as a group or in pairs, these 3 questions:
 - What do you notice? *(Clarify that they are making observations based on senses, not inferences or past knowledge. Example: "It's brown and rough")*
 - Do you have new questions about mussels or what do you still wonder about? *(Add to the W column in the KWL chart)*
 - Do mussels remind you of something? *(Examples might be a clam, or a rock, or when they saw one at the lake with their mom).*
 - Ask if they've seen one before? *(Students are more likely to know the term 'clam'.)* If so, where? What were they *(the students)* doing?
4. Expand the lesson either with a traditional lecture or ask them questions to see what students think and have them provide facts to back up their claim. Example questions could be as follows:
 - Do they think a mussel is alive? *(Yes, it grows, has cells, reproduces, etc.)*
 - Is it an animal? *(Consumes others for food, doesn't have a cell wall, sexual reproduction, mobile for part of its life, etc.)*
 - Do mussels move? Show the video Freshwater Mussel Moving, uploaded from a private party, as proof.
<https://www.youtube.com/watch?v=uQDf4JBG2DI>
 - What kind of animal is it? What characteristics does it possess?

A River Ecosystem





- What is a mollusk? (*Invertebrate with a soft body, lives near water, and has an organ called a mantle that can or used to secrete a shell, like squids, snails, and clams*)
 - What does it mean to be a filter feeder? (*An animal that strains small food particles out of water. They can help process nutrients, clear the water, etc.*)
5. Once you've established an appropriate understanding for your age group, move onto the other activities.

Mussel Anatomy (*Option for Intermediate or Advanced*)

1. Students will learn about mussel anatomy.
 - A dissection is a great hands-on, engaging activity. Please be mindful of your source of mussels. Native freshwater mussels should not be used for this purpose. Marine clams give the same experience and possess the same anatomy. Marine clams (and/or marine mussels) can be purchased preserved from science companies such as Carolina Biological (www.carolina.com) or fresh sustainable seafood grocery stores or supply stores. (*Additional supplies are needed for dissections such as trays and scalpels*)
 - If a dissection is not an option, these coloring projects work well too. For beginner students, have them color the worksheet in their packet as they watch one of the videos, coloring in each part as the scientist shows them.
 - a. For more basic vocabulary and explanations: one of these videos from private parties work well
<https://www.youtube.com/watch?v=XYyhCEK7qKo>
<https://www.youtube.com/watch?v=O-IxHCPif9c>
 - b. For advanced terminology this video from a private party explains anatomy quite well.
<https://www.youtube.com/watch?v=C-3GqyLswc8&t=13s>
 - c. OR use the included resources and do their own research according to their goals and abilities. Note: Some of the vocabulary words may need to be discussed as a class, reworded, or removed based on your students' needs. Some higher-tier vocabulary includes **palps**, **mantle**, **adductor muscles**, and **gonads**. The videos talk about



what these are, but you may need to rephrase or more clearly define them for your class.

- d. For advanced students, have them cut, color, and assemble the mussel anatomy from the Xerces Society. Have them take their own notes on the underside of the organs describing the function of each.

<https://xerces.org/sites/default/files/publications/Make%20a%20paper%20mussel.pdf>

2. Students can see more of how mussel organs function via the listed resources, independent research, or one of these videos as time allows:

- a. The University of Liège produced a 3D video of how filter feeding works.

NOTE: this shows a marine mussel, but the process is similar.

<https://www.youtube.com/watch?v=7KekxV78gns>

- b. A Private party uploaded a video on his mussel moving.

<https://www.youtube.com/watch?v=dUwiVNJIYUA>

Mussel Life Cycle

(Introductory with options for Advanced)

Introductory:

1. Have the students watch this video, from a private party, showcasing a natural fish lure <https://youtu.be/IoYTBjOWHkU> or utilize any of the resources listed at the end of this lesson.
2. Have them create their own diagram or representation of the mussel life cycle. If you need a shorter lesson, you may use the template included in the materials at the end of this document.
 - a. For advanced learners, have them make their own and encourage digital and multimedia use.

Advanced:

1. After watching the video, give students a list of native Minnesota mussels (found at the end of the lesson), or have them search on the DNR website.

<https://www.dnr.state.mn.us/mussels/index.html>

https://www.dnr.state.mn.us/rsg/filter_search.html?mussel=Y&allstatus=Y&action=doFilterSearch

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2. Instruct them to write a paragraph or create a visual about the mussel, specific fish host, habitat needs, and other life characteristics of that species. The DNR website provides links to each species' webpage.

Sorting Mussels (Introductory)

1. Supply students with either picture (The MN DNR mussel poster is available at https://files.dnr.state.mn.us/natural_resources/animals/mussels/mussels-poster.pdf or individually pick from the A List of Common Minnesota Freshwater Mussels, included in this lesson packet. Be sure to include both native and zebra or quagga mussels for comparison. **NOTE:** The Minnesota Zoo can meet with your students with several mussel examples. Contact them for more details.
2. Spend a few minutes with students making observations about the different mussels- their size, shape, color, texture. etc. The following activity can be facilitated in multiple ways:
3. Ask students to sort the mussels into different groups. Have them discuss why they grouped specimens together.
Challenge question: Are there other ways to regroup the mussels? Have the students brainstorm other factors that would recategorize the mussels?
4. Have students practice descriptive writing skills by picking one mussel and writing a story, an ad, or a poem using as much detail as they can about their shell. Then swap stories and see if their classmates can identify the mussel based on the description.

Why do Mussels Matter?

(Option for all levels)

1. Reference the A River Ecosystem picture from the resources section of this lesson plan. The picture was referenced in the introduction but can be used with this activity as a standalone even if you haven't used it previously.
 - What do the students think the mussels are doing for their ecosystem, fellow living beings, or the environment?
 - You can discuss the different animals that eat mussels (muskrats, otters, raccoons, geese, ducks, flatworms (on juvenile mussels), fish, and humans).
 - Talk about what a filter feeder is and why that might be an important role.
(They draw in water, filter out small particles, and release the water.)

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This means they can help keep water clear, get rid of toxins, and help process nutrients.)

- What do students think would happen with no mussels? What would that picture look like?
 - Watch this video: “Mussels at Work: A Time Lapse Demonstration”
<https://www.youtube.com/watch?v=vrEyHo3SuZI>
 - Discuss about what other organisms and/or living things would be impacted by losing native mussels. What chain events or domino effect would this have? (*Aquatic plants can't grow, mussel predators lose food, toxins aren't filtered and poison other animals, etc.*)
2. As a class, have a brief discussion about human activities and which ones might impact the life cycle of a freshwater mussel.

This will go more into depth in later lessons. (Things like boating and fishing, pet waste, fertilizer, and yard maintenance. See more at the Zoo website: <http://mnzoo.org/conservation/minnesota/freshwater-mussels/>)

Conclusion

Students who complete all these activities should be able to answer the following questions:

1. What is a mussel?
2. How does a mussel eat?
3. How does a mussel's body work?
4. How does a freshwater mussel reproduce?
5. How can I recognize and distinguish between different mussels I might see in my area?
6. What are some things mussels need to survive?

Extensions:

1. Keokuk Dam impact on mussel reproduction:
<https://www.molluskconservation.org/MUSSELS/Youdo.html>
2. Use other activities from the Mussel Mania lesson from the DNR to reinforce the concepts from this lesson:
https://files.dnr.state.mn.us/education_safety/education/minnaqua/leadersguide/chapter_3/3_7_mussel_mania.pdf

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3. This Educator's guide to pair with the MN DNR's Ask an Expert video, has bullet points of a suggested power point with an overview of a range of information on mussels that could be presented to your class, started on the document page 34: https://mrbdc.mnsu.edu/sites/mrbdc.mnsu.edu/files/public/pdf/askexpert/Mussel%20Educator%27s%20Guide_rev.pdf

Assessment:

Students will be able to answer questions in student packets and participate in class discussion. They will complete a life cycle diagram, mussel anatomy, and specimen observation and identification activity, and/or share with each other the results of one activity station they completed.

Lesson Resources:

- MN DNR mussel information:
https://www.dnr.state.mn.us/minnaqua/speciesprofile/freshwater_mussels.html
<https://www.dnr.state.mn.us/mussels/howlive.html>
- Mussel Bound in Minnesota - July-August 2000 Young Naturalist Article
https://webapps8.dnr.state.mn.us/volunteer_index/past_issues/article_pdf?id=907
- Glossary of Terms related to freshwater mussels - by the Minnesota DNR
<https://www.dnr.state.mn.us/mussels/glossary.html>
- Mussel Cabin Video
<https://tpt.pbslearningmedia.org/resource/nat16.sci.lisci.mussel/selection-deception-and-reproduction-mimicry-in-freshwater-mussels/#.WoT421VKjIU>
- Mussel Lure in Natural Habitat Video
https://www.youtube.com/watch?v=_3m1YAqM76M
- Mussels Filtering Video
<https://www.sciencelearn.org.nz/videos/732-mussels-filtering-water>
- Xerces: About Native Freshwater Mussels: <https://xerces.org/endangered-species/freshwater-mussels/about>

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- Knowable: the Hidden Strengths of Freshwater Mussels:
<https://knowablemagazine.org/article/living-world/2019/hidden-strengths-freshwater-mussels>
- Freshwater Mussel Moving:
<https://www.youtube.com/watch?v=uQDf4JBG2DI>

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List of Common Minnesota Freshwater Mussels

The Minnesota Department of Natural Resources has information on common Minnesota Mussels. For the complete list, visit: https://www.dnr.state.mn.us/rsg/filter_search.html?mussel=Y&allstatus=Y&action=doFilterSearch or the direct webpage for any of the mussels listed below.

<u>Common name</u>	<u>Scientific name</u>
Black Sandshell	<u>Ligumia recta</u>
<u>http://dnr.state.mn.us/rsg/profile.html?action=elementDetail&selectedElement=IMBIV26020</u>	
Butterfly	<u>Ellipsaria lineolata</u>
<u>http://dnr.state.mn.us/rsg/profile.html?action=elementDetail&selectedElement=IMBIV13010</u>	
Creek Heelsplitter	<u>Lasmigona compressa</u>
<u>http://dnr.state.mn.us/rsg/profile.html?action=elementDetail&selectedElement=IMBIV22020</u>	
Ebonyshell	<u>Fusconaia ebena</u>
<u>http://dnr.state.mn.us/rsg/profile.html?action=elementDetail&selectedElement=IMBIV17060</u>	
Elephant-ear	<u>Elliptio crassidens</u>
<u>http://dnr.state.mn.us/rsg/profile.html?action=elementDetail&selectedElement=IMBIV14080</u>	

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<u>Common name</u>	<u>Scientific name</u>
Elktoe	<u><i>Alasmidonta marginata</i></u>
http://dnr.state.mn.us/rsg/profile.html?action=elementDetail&selectedElement=IMBIV02040	
Ellipse	<u><i>Venustaconcha ellipsiformis</i></u>
http://dnr.state.mn.us/rsg/profile.html?action=elementDetail&selectedElement=IMBIVA4010	
Fluted-shell	<u><i>Lasmigona costata</i></u>
http://dnr.state.mn.us/rsg/profile.html?action=elementDetail&selectedElement=IMBIV22030	
Hickorynut	<u><i>Obovaria olivaria</i></u>
http://dnr.state.mn.us/rsg/profile.html?action=elementDetail&selectedElement=IMBIV31020	
Higgins Eye	<u><i>Lampsilis higginsii</i></u>
http://dnr.state.mn.us/rsg/profile.html?action=elementDetail&selectedElement=IMBIV21100	

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<u>Common name</u>	<u>Scientific name</u>
Monkeyface	<u><i>Quadrula metanevra</i></u>
http://dnr.state.mn.us/rsg/profile.html?action=elementDetail&selectedElement=IMBIV39080	
Mucket	<u><i>Actinonaias ligamentina</i></u>
http://dnr.state.mn.us/rsg/profile.html?action=elementDetail&selectedElement=IMBIV01020	
Pistolgrip	<u><i>Tritogonia verrucosa</i></u>
http://dnr.state.mn.us/rsg/profile.html?action=elementDetail&selectedElement=IMBIV44010	
Purple Wartyback	<u><i>Cyclonaias tuberculata</i></u>
http://dnr.state.mn.us/rsg/profile.html?action=elementDetail&selectedElement=IMBIV09010	
Rock Pocketbook	<u><i>Arcidens confragosus</i></u>
http://dnr.state.mn.us/rsg/profile.html?action=elementDetail&selectedElement=IMBIV06010	

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<u>Common name</u>	<u>Scientific name</u>
Round Pigtoe	<u><i>Pleurobema sintoxia</i></u>
http://dnr.state.mn.us/rsg/profile.html?action=elementDetail&selectedElement=IMBIV35070	
Salamander Mussel	<u><i>Simpsonaias ambigua</i></u>
http://dnr.state.mn.us/rsg/profile.html?action=elementDetail&selectedElement=IMBIV41010	
Sheepnose	<u><i>Plethobasus cyphus</i></u>
http://dnr.state.mn.us/rsg/profile.html?action=elementDetail&selectedElement=IMBIV34030	
Snuffbox	<u><i>Epioblasma triquetra</i></u>
http://dnr.state.mn.us/rsg/profile.html?action=elementDetail&selectedElement=IMBIV16190	
Spectaclecase	<u><i>Cumberlandia monodonta</i></u>
http://dnr.state.mn.us/rsg/profile.html?action=elementDetail&selectedElement=IMBIV08010	

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<u>Common name</u>	<u>Scientific name</u>
Spike	<u><i>Elliptio dilatata</i></u>
http://dnr.state.mn.us/rsg/profile.html?action=elementDetail&selectedElement=IMBIV14100	
Wartyback	<u><i>Quadrula nodulata</i></u>
http://dnr.state.mn.us/rsg/profile.html?action=elementDetail&selectedElement=IMBIV39090	
Washboard	<u><i>Megalonaias nervosa</i></u>
http://dnr.state.mn.us/rsg/profile.html?action=elementDetail&selectedElement=IMBIV29020	
Winged Mapleleaf	<u><i>Quadrula fragosa</i></u>
http://dnr.state.mn.us/rsg/profile.html?action=elementDetail&selectedElement=IMBIV39050	
Yellow Sandshell	<u><i>Lampsilis teres</i></u>
http://dnr.state.mn.us/rsg/profile.html?action=elementDetail&selectedElement=IMBIV21240	

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A River Ecosystem



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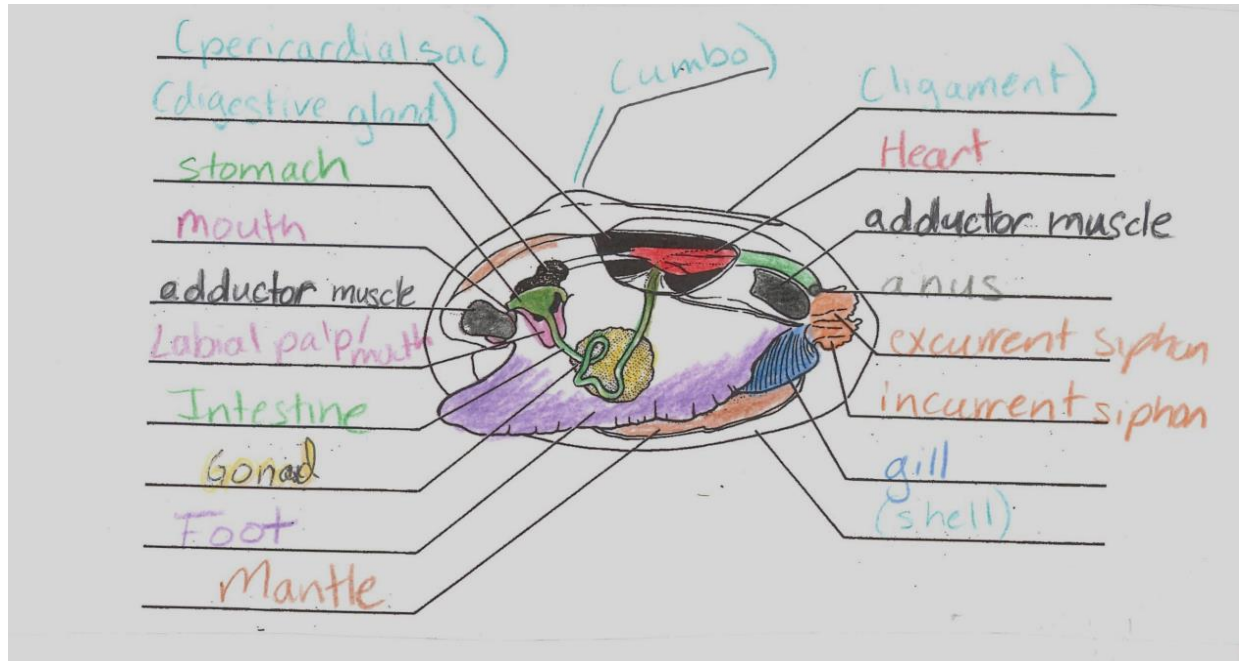




MINNESOTA ZOO

Mussel Anatomy Key

(Teal parentheses indicate optional vocabulary)



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