

*Freshwater Mussel  
Activity Book and  
Learning Resource*

North Carolina  
Freshwater Mussel  
Conservation Partnership



# **Freshwater Mussels**

## **Activity Book & Learning Resource**

**By Jay F. Levine, and Shane D. Hanlon.**

**Illustrations by Emma Skurnik**

NC Freshwater Mussel Conservation Partnership  
Department of Farm Animal Health and Resource Management  
College of Veterinary Medicine  
North Carolina State University

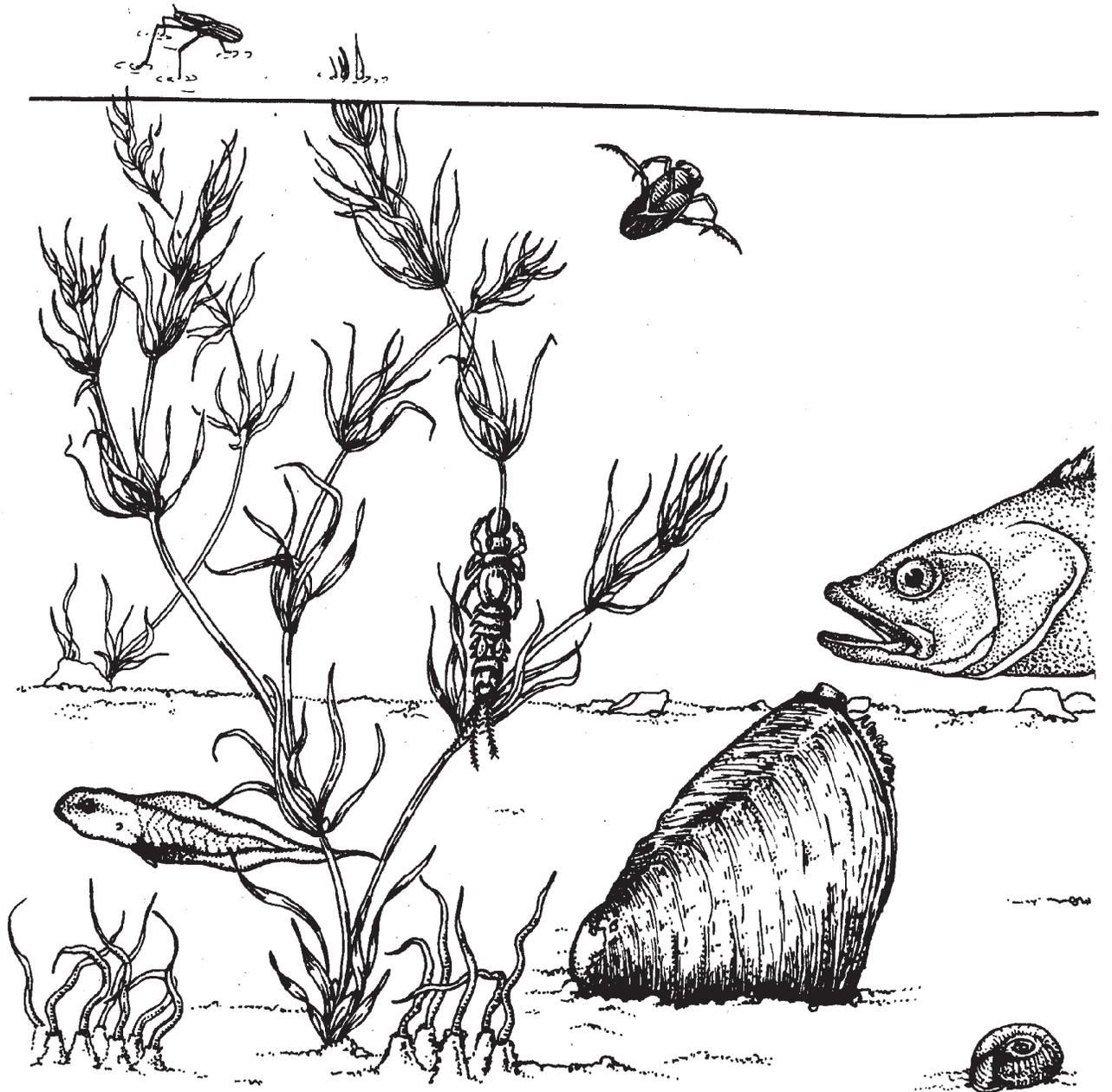
This activity book was developed by the North Carolina Freshwater Mussel Conservation Partnership to help raise our children's awareness about freshwater mussels, and aquatic ecosystems. Additional information about freshwater mussels can be found at the partnership's web site: [www.cvm.ncsu.edu/mussels/](http://www.cvm.ncsu.edu/mussels/)

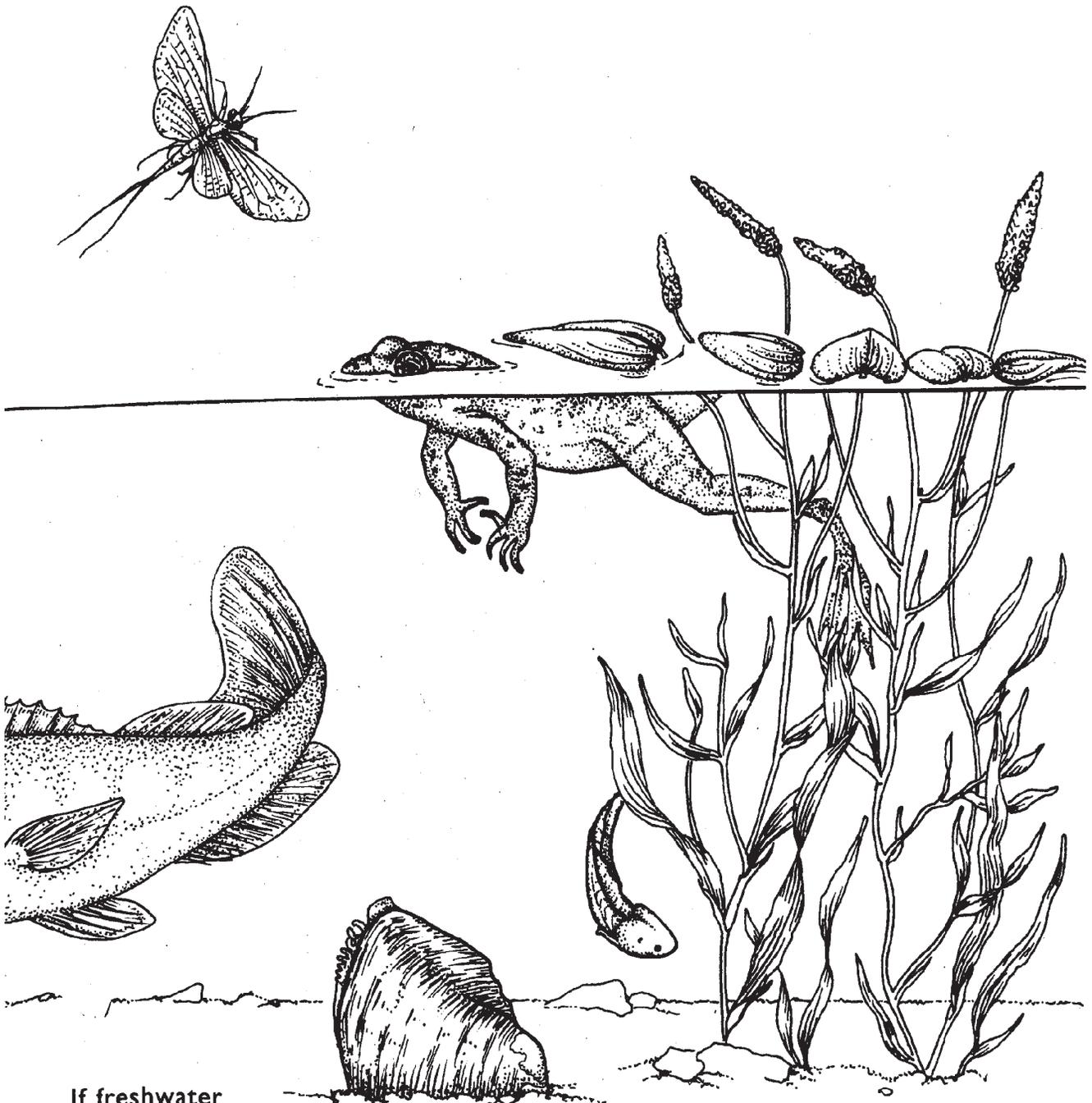
The North Carolina Freshwater Mussel Conservation Partnership was established to support research and outreach activities focused on preserving North America's remaining freshwater mussel species. The partnership is supported by the collective expertise and efforts of researchers and biologists at NC State University, the NC State Museum of Natural Sciences, The NC Department of Environment and Natural Resources Wildlife Resources Commission, The NC Department of Transportation, The US Army Corps of Engineers, and the US Fish and Wildlife Service.

The authors thank Jan Burger for creating the cartoon story line and Sharon Levine for evaluating the puzzles included in this activity book to ensure that they were kid-friendly. We also thank the teachers and environmental science educators that have reviewed the text and puzzles to ensure that they can be used to support curricular activities in the classroom. In addition, we thank Art Bogan NC State Museum of Natural Sciences for his editorial comments and suggestions and John Alderman and Judith Johnson, NC Wildlife Resources Commission, Tim Savidge, NC Department of Transportation, Greg Cope, NCSU Department of Toxicology, Tom Augsperger, and John Fridell, US Fish and Wildlife Service and the entire freshwater mussel team at the College of Veterinary Medicine for their continued support as members of the NC Freshwater Mussel Conservation Partnership. Funds supporting the development of this activity book were provided by the NC State University Extension Grant Program.

**Freshwater mussels live in streams, rivers and lakes.**

That small stream in your neighborhood is probably full of life. It may be the home of one or more species of freshwater mussels. Although more than 290 species of freshwater mussels live in North America, many are endangered or threatened.

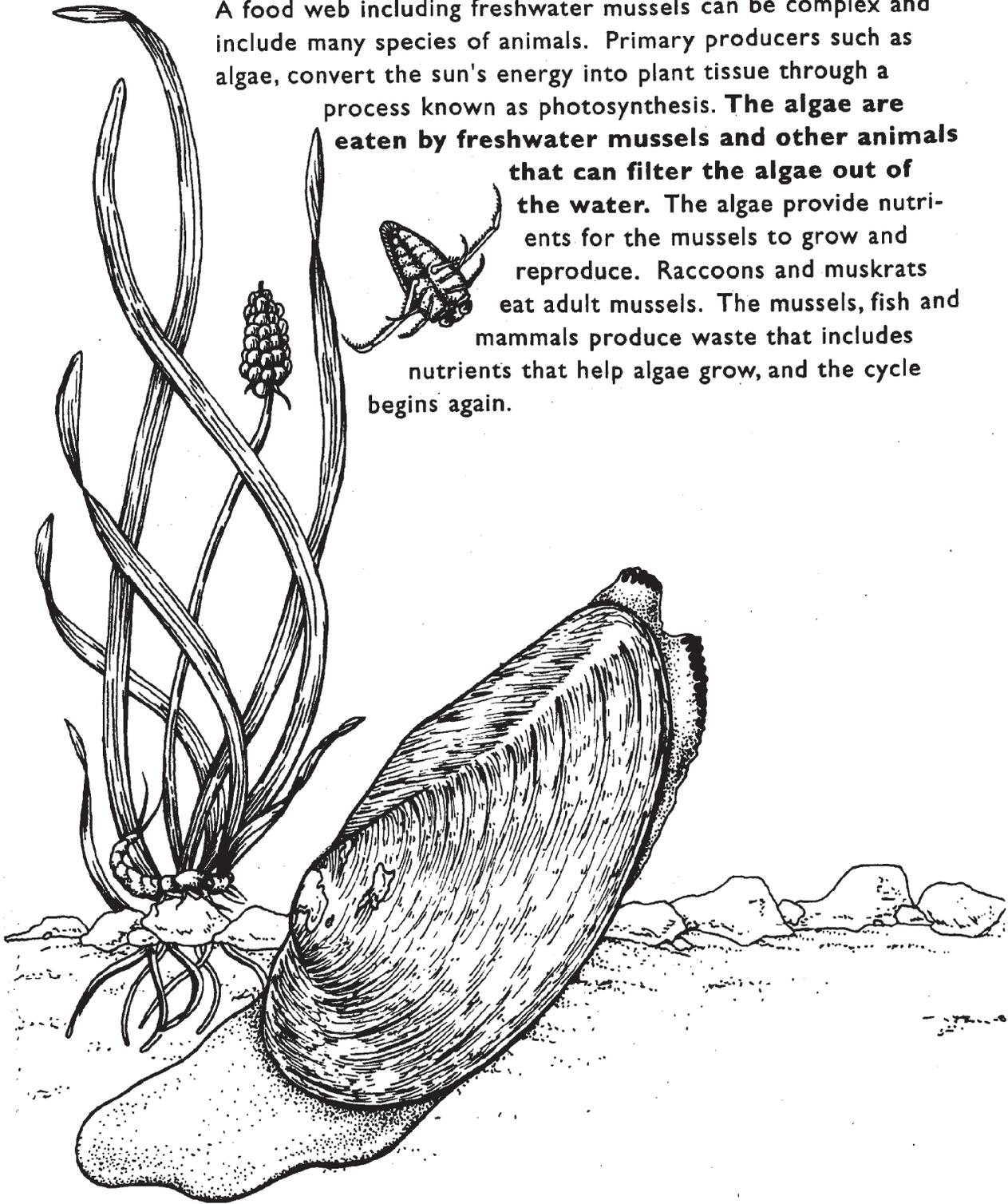




If freshwater mussels are present, you will usually find fish, which play an important role in the life cycle of freshwater mussels. **Both the mussels and fish, like all animals in an ecosystem, are part of the food web that supports the cycle of life.**



A food web including freshwater mussels can be complex and include many species of animals. Primary producers such as algae, convert the sun's energy into plant tissue through a process known as photosynthesis. **The algae are eaten by freshwater mussels and other animals that can filter the algae out of the water.** The algae provide nutrients for the mussels to grow and reproduce. Raccoons and muskrats eat adult mussels. The mussels, fish and mammals produce waste that includes nutrients that help algae grow, and the cycle begins again.



A O Q X O G F Z O F Y U F R C  
 E E P S P E C I E S S R P F G  
 C W Y G T F M U S S E L S E R  
 O N U T R I E N T S W P E I V  
 S O F Y I E U T H D R D D U E  
 Y P I F O O D W E B H I I P N  
 S E S T E Y A S T R E A M S D  
 T P H H J T O E A H E U E W A  
 E E C O E Y A H E L U D N R N  
 M L U R U G P O C W G E T T G  
 P A G U L I J Y E A R A E O E  
 T W T A K W C U W S D Y E K R  
 M A T W E U R S T R I O T Y E  
 U R S R I T H R E A T E N E D  
 B P H O T O S Y N T H E S I S

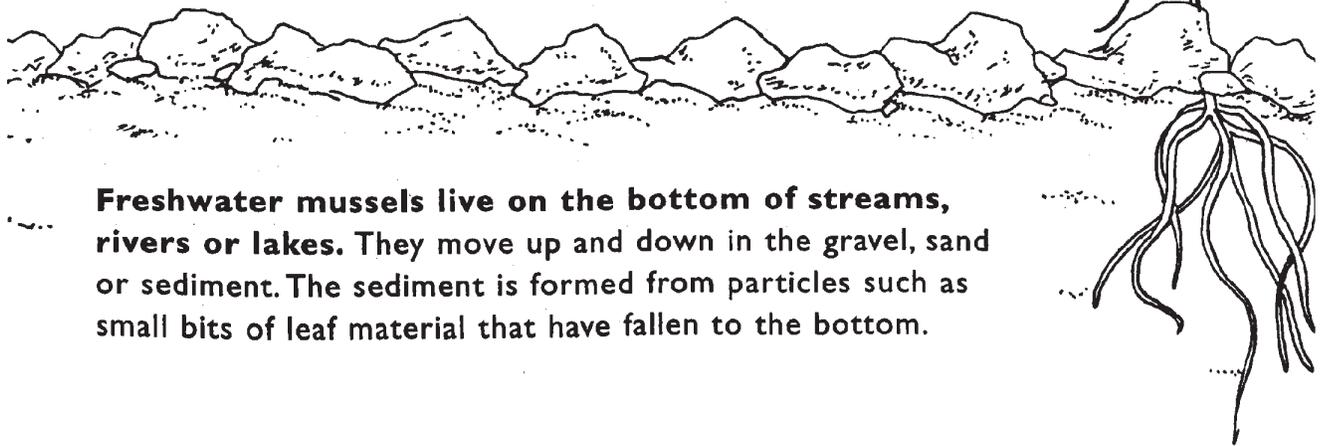
**Find the following words in the word search above:**

FRESHWATER  
 SEDIMENT  
 PHOTOSYNTHESIS  
 ECOSYSTEM

MUSSELS  
 NUTRIENTS  
 ALGAE  
 FOOD WEB

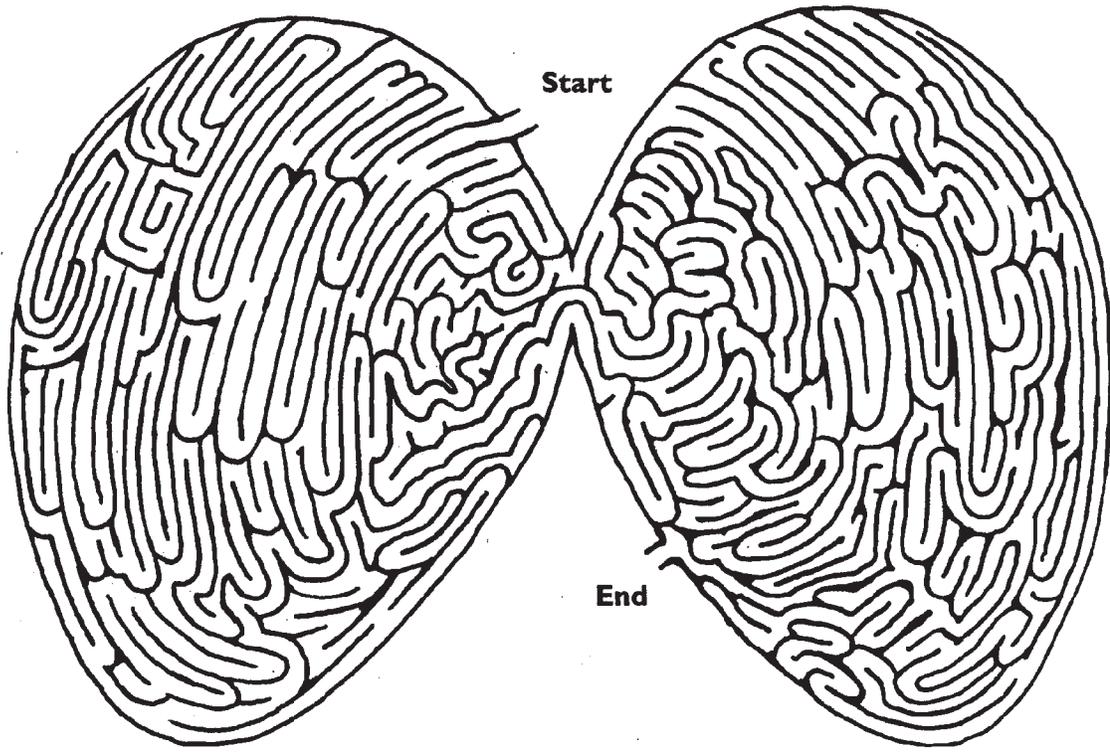
SPECIES  
 THREATENED  
 FISH

STREAMS  
 ENDANGERED  
 CYCLE



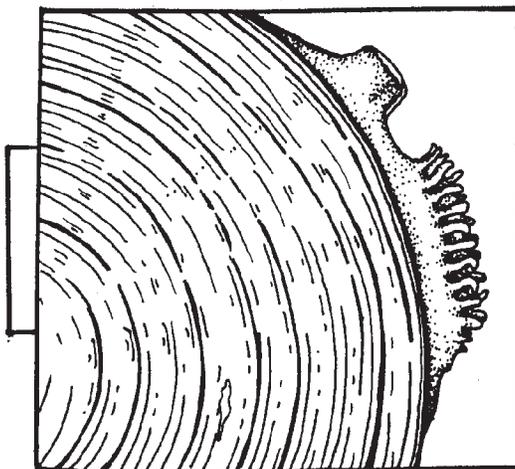
**Freshwater mussels live on the bottom of streams, rivers or lakes. They move up and down in the gravel, sand or sediment. The sediment is formed from particles such as small bits of leaf material that have fallen to the bottom.**

Find your way through the freshwater mussel maze!

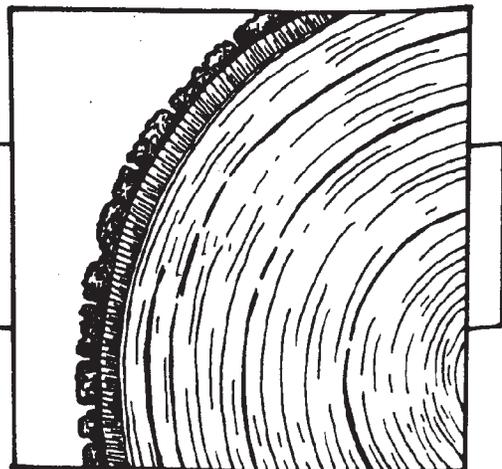


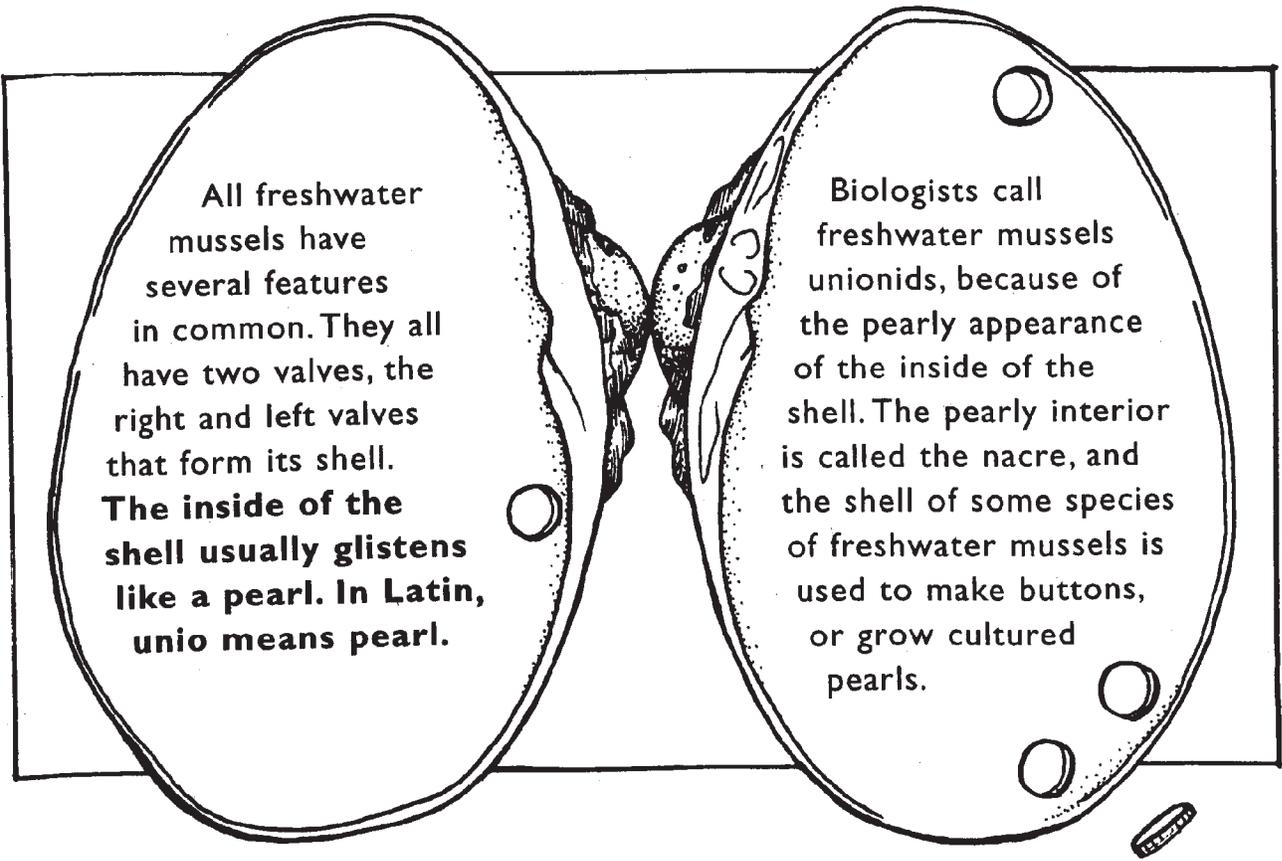
Although it's hard to believe, some **freshwater mussels** can live for more than 150 years. They continue to grow throughout life, and as they grow their shell forms rings. The rings are similar to those on the inside of a tree trunk that can be used to guess the age of the tree. In a similar manner, the rings on a freshwater mussel shell can be used to estimate the age of a freshwater mussel.

**Growth rings of a freshwater mussel**



**Tree Trunk Rings**





All freshwater mussels have several features in common. They all have two valves, the right and left valves that form its shell. **The inside of the shell usually glistens like a pearl. In Latin, unio means pearl.**

Biologists call freshwater mussels unionids, because of the pearly appearance of the inside of the shell. The pearly interior is called the nacre, and the shell of some species of freshwater mussels is used to make buttons, or grow cultured pearls.

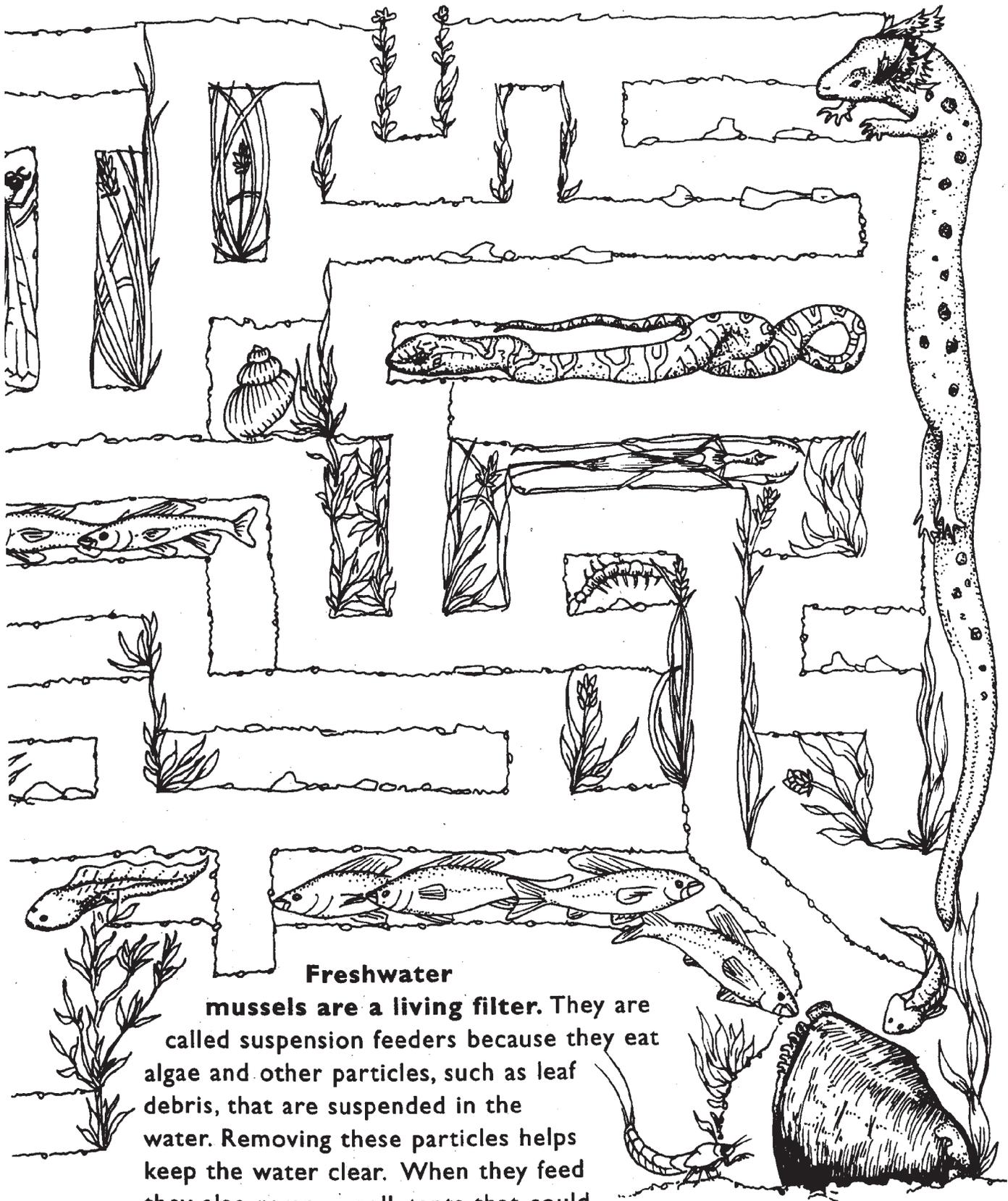
K P S Q E K U G L S U B D H P  
 V Y H W M S C V M T M T F O J  
 U A E D U L J B R P E A L Y E  
 H K L N S M R U F N J L O X S  
 Q J L V S C S T X G U W S N T  
 U N I O E R Q T I T A E H E I  
 W S H V L S F O A W Q N A U M  
 O N F L S A U N I O N I D S A  
 Z M I A E J T S H E K T R V T  
 R A L R G S R E D B Y L Y K E  
 U V C O A B I O L O G I S T V  
 G A F J B W N E N A F U C O G  
 N D W E M D G S V L N A D O S  
 R Y A G E Y S P T U O C T F R  
 K B T W M G R O W T H G R L M

**FIND THE FOLLOWING WORDS IN THE WORD SEARCH:**

- MUSSELS
- UNIO
- UNIONIDS
- VALVES
- FOOT
- SHELL
- NACRE
- RINGS
- ESTIMATE
- BUTTONS
- BIOLOGIST
- POLLUTANTS







**Freshwater mussels are a living filter.** They are called suspension feeders because they eat algae and other particles, such as leaf debris, that are suspended in the water. Removing these particles helps keep the water clear. When they feed they also remove pollutants that could potentially harm aquatic animals, birds, land dwelling animals, and people that may drink the water.

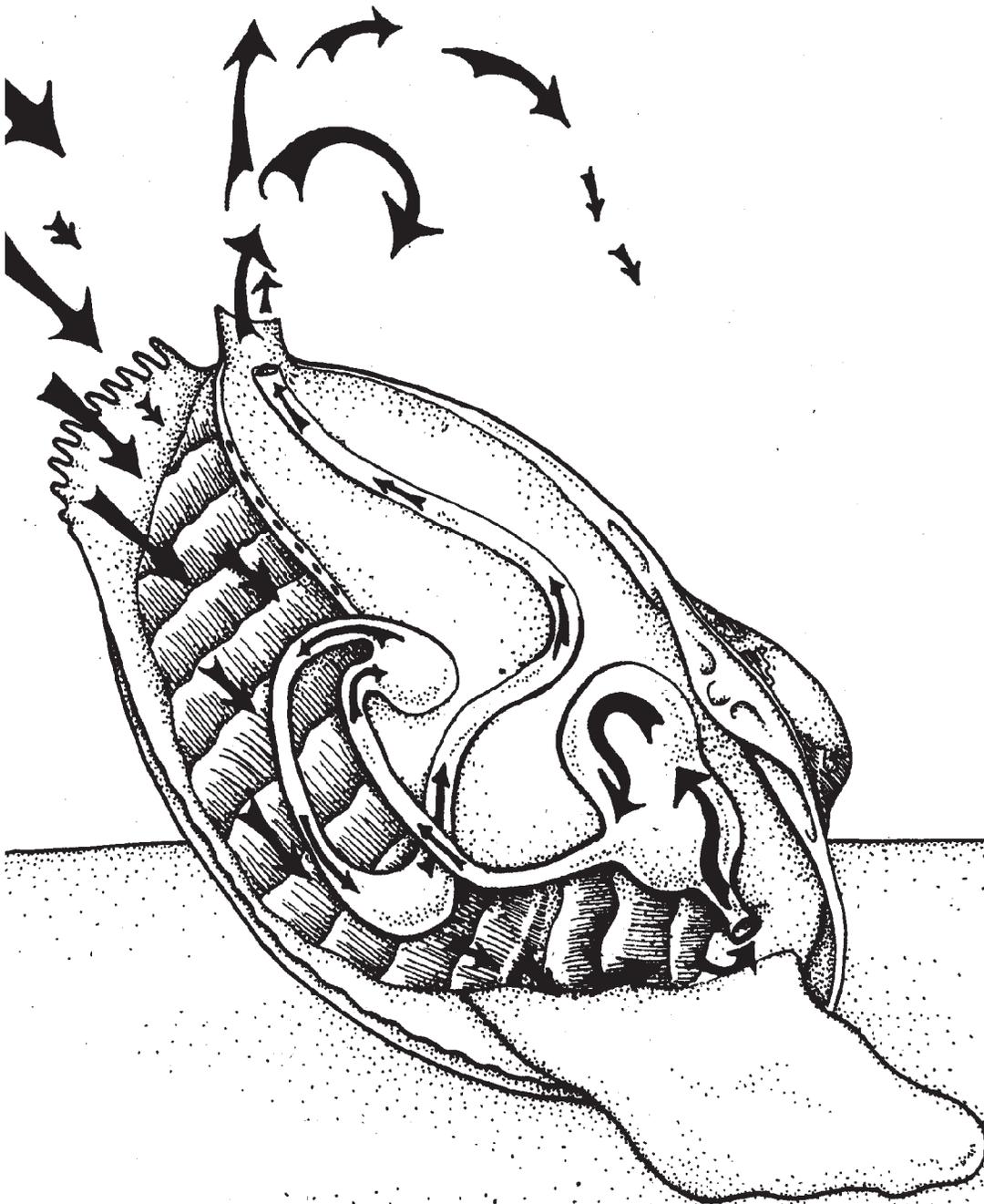
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**Match the words in each column. Draw a line to the matching word.**

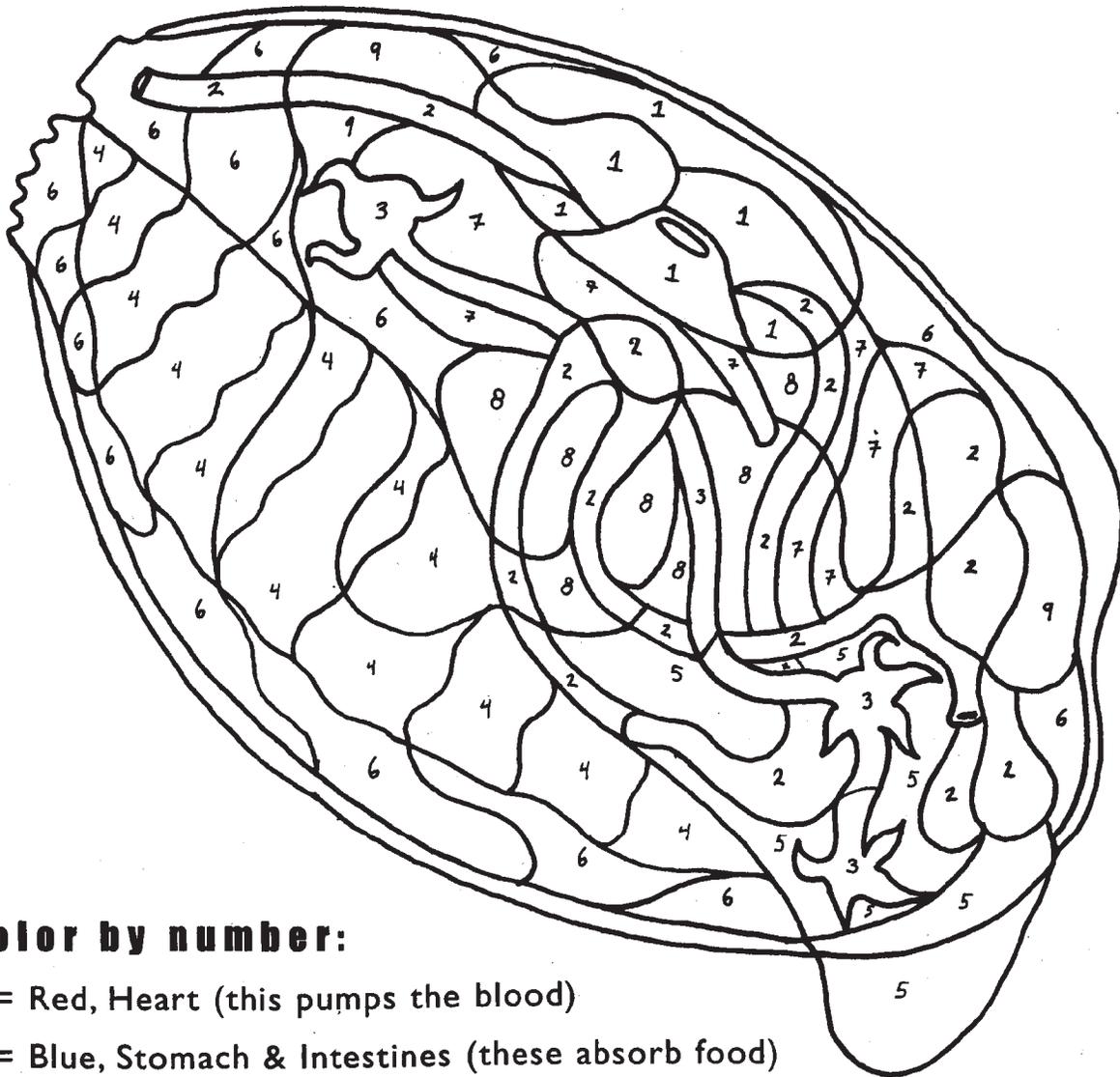
|   |   |
|---|---|
| <p><b>MUSSEL FOOD</b></p> <p><b>MUSSEL SHELL</b></p> <p><b>APERTURE</b></p> <p><b>FRESHWATER MUSSEL</b></p> <p><b>PEARL</b></p> <p><b>BLOOD</b></p> | <p><b>HEMOLYMPH</b></p> <p><b>UNIO</b></p> <p><b>UNIONID</b></p> <p><b>SIPHON</b></p> <p><b>ALGAE</b></p> <p><b>VALVE</b></p> |
|---|---|

**Freshwater mussels siphon water through an inhalant aperture (opening) to filter the water and feed. Water is expelled through an exhalant aperture. The siphoned water moves over the mussel's gills. Just like fish, they use their gills to breathe. However, the gills also contain small hairs called cilia that help filter out particles. Particles that are too large are coated with mucous and released back into the water, particles that are the preferred size move from the gills into the mouth.**

You use your teeth to grind food before you swallow the food. **Freshwater mussels have a small crystal-like structure called the crystalline style, which some researchers believe helps grind food particles.** It may work a little like the gizzard of a bird. As the food is digested, it moves through the intestine. The material that can't be digested is excreted through the exhalant aperture as feces.



If you were to look inside a freshwater mussel, you would also see a beating heart that pumps hemolymph, which is mussel blood. The hemolymph bathes all the internal organs and provides oxygen and nutrients.



**Color by number:**

- 1 = Red, Heart (this pumps the blood)
- 2 = Blue, Stomach & Intestines (these absorb food)
- 3 = Green, "Ganglion" (this controls the mussel's actions)
- 4 = Purple, Gills (this is how the mussel breathes)
- 5 = Yellow, Foot (this is how the mussel moves)
- 6 = Orange, Mantle (this makes the shell)
- 7 = Light Blue, Kidney & Liver (these help process waste)
- 8 = Pink, Genital Gland (this helps the mussel reproduce)
- 9 = Light Green, Adductor Muscles (these hold the shell closed)

A D M A K D A V H K M J H U X  
 T O R G A N S M F W K C E R O  
 W M A D F J T E W G P U M P S  
 L A U S N I W P T R O L O V G  
 X X Y S I P H O N I E T L D I  
 M J C N S H N A X N O R Y Q Z  
 S V F D M E F U I D A K M D Z  
 L Y R E G C L L D E P E P L A  
 N S U Y S Q L E B R F O H F R  
 H K X Z O A V T D O B U W P D  
 E O R H T J H R G I L L S Y S  
 N V R S T Y L E O Y C A O N J  
 C D Y O H E A R T U P H L O P  
 E R V K C B A T H E S D F U D  
 C H A L K M J D Y T K M Z S W

**FIND THE FOLLOWING WORDS IN THE WORD SEARCH:**

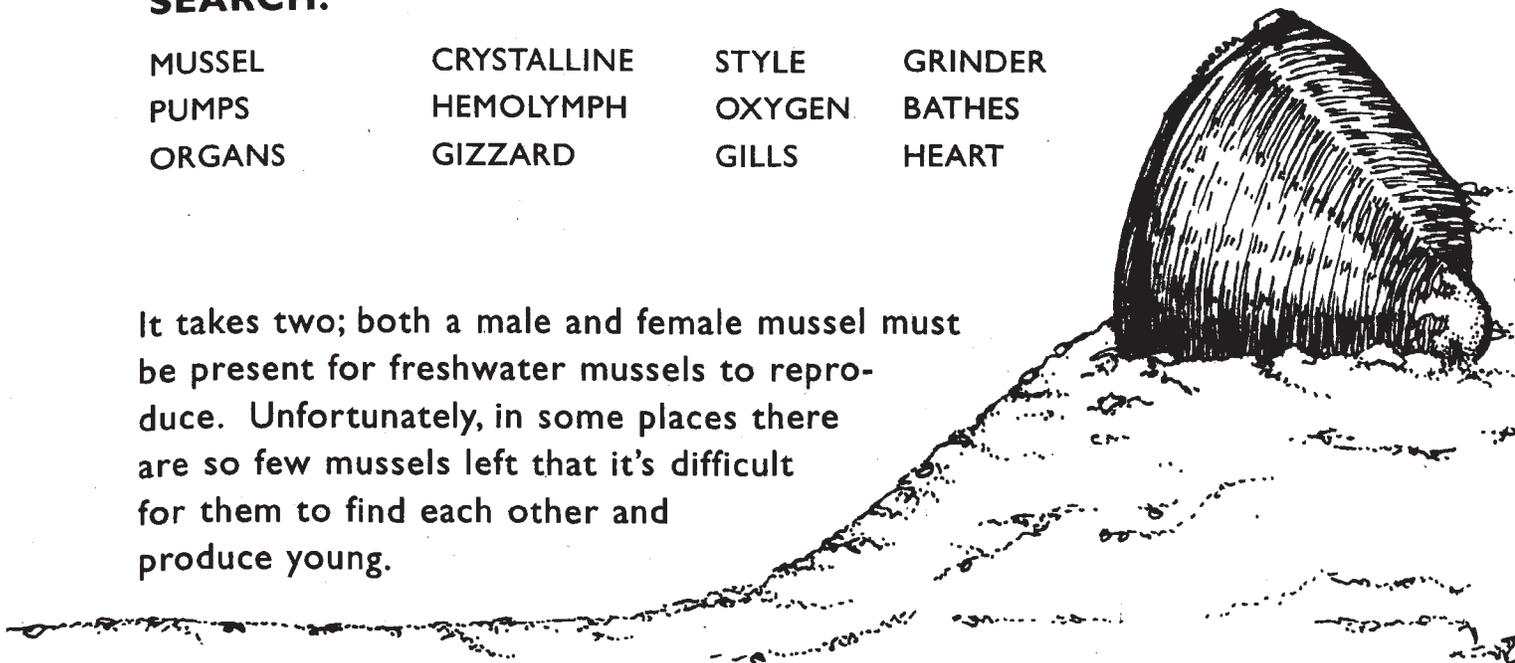
MUSSEL  
 PUMPS  
 ORGANS

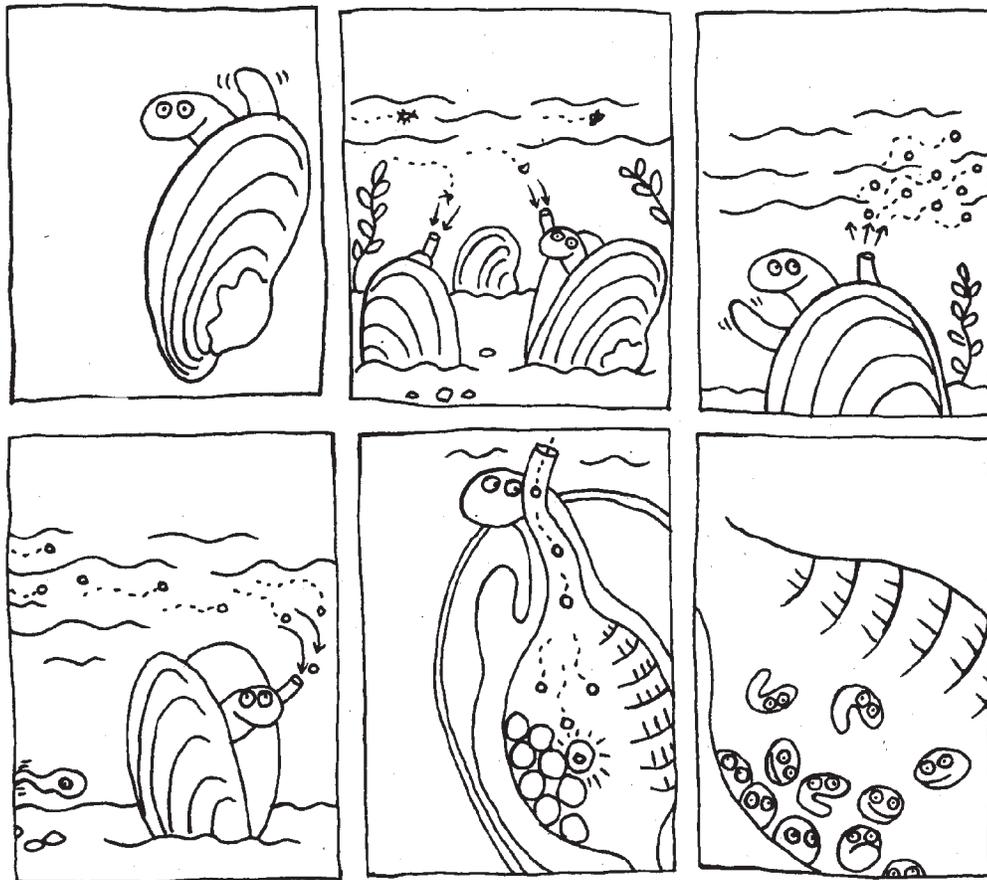
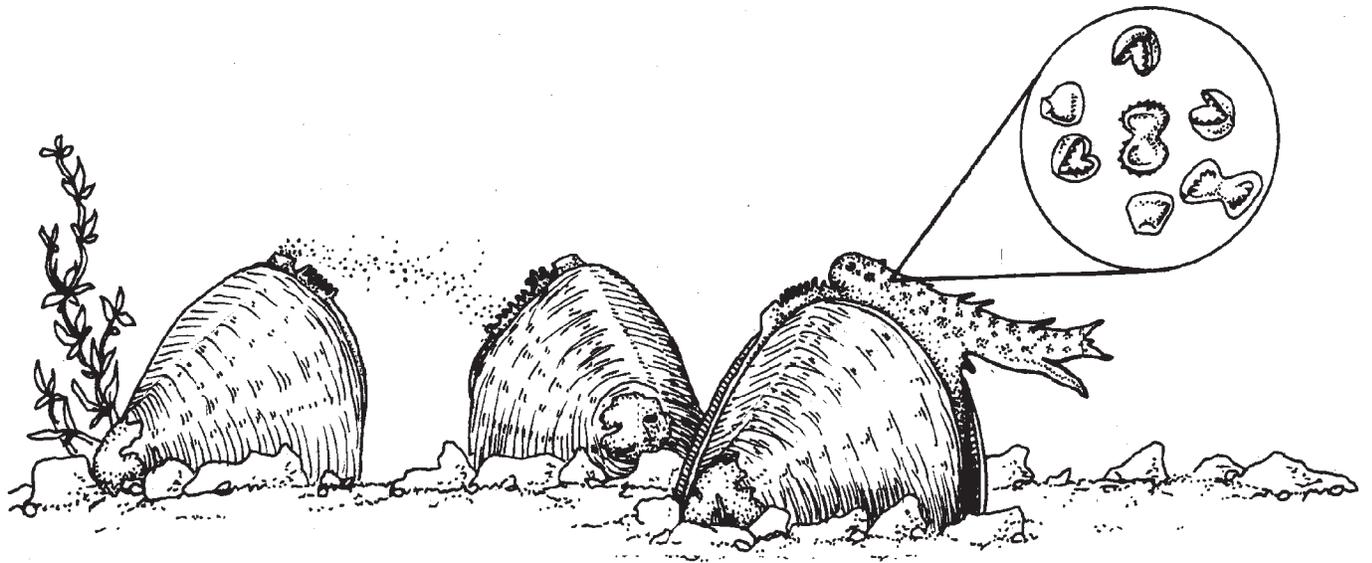
CRYSTALLINE  
 HEMOLYMPH  
 GIZZARD

STYLE  
 OXYGEN  
 GILLS

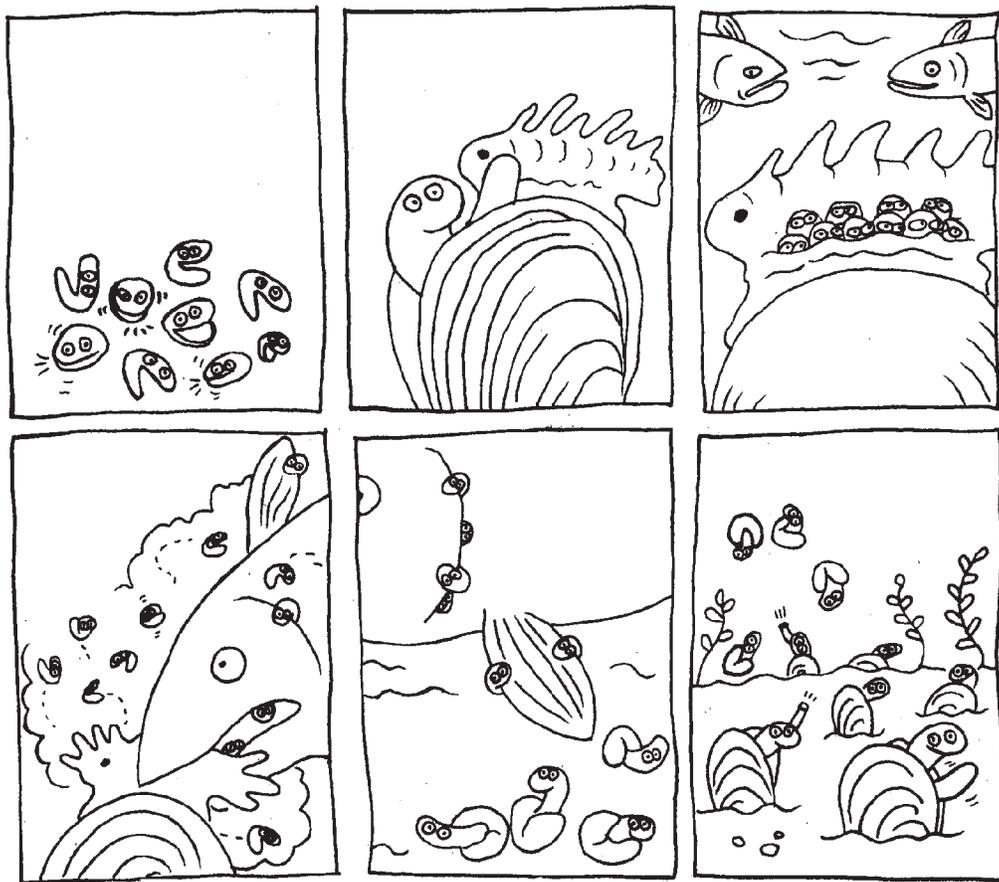
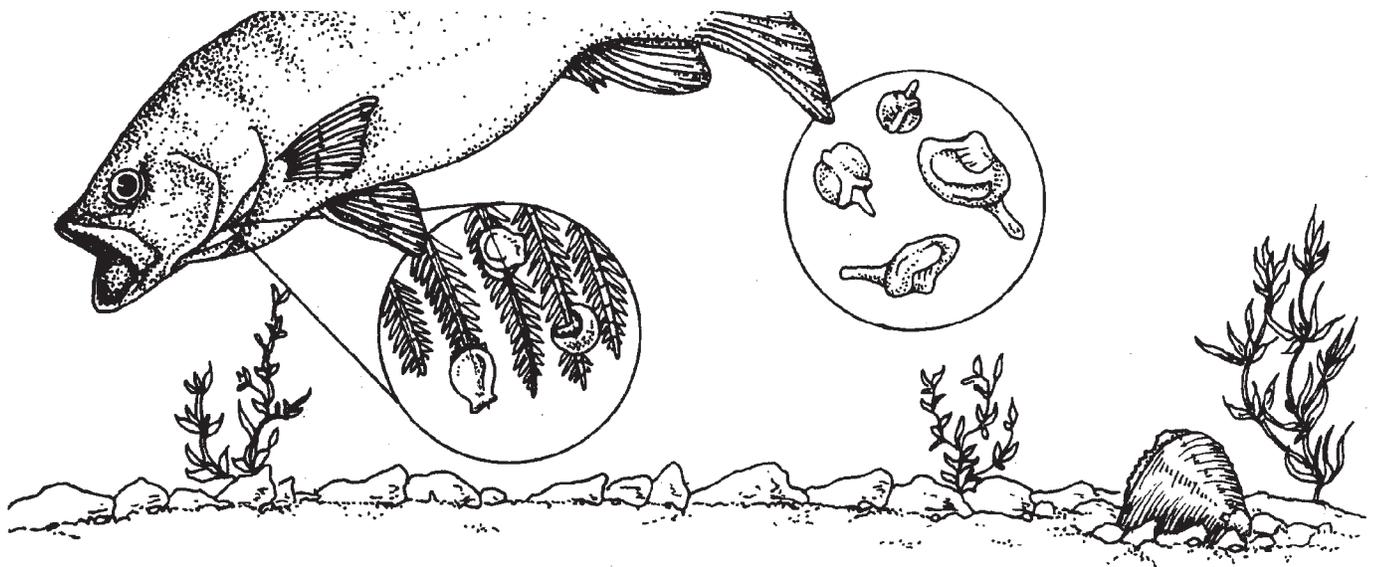
GRINDER  
 BATHES  
 HEART

It takes two; both a male and female mussel must be present for freshwater mussels to reproduce. Unfortunately, in some places there are so few mussels left that it's difficult for them to find each other and produce young.

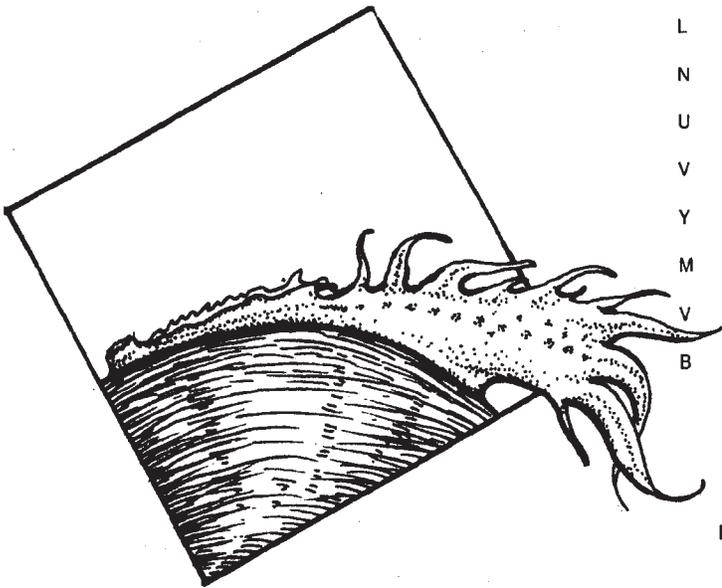
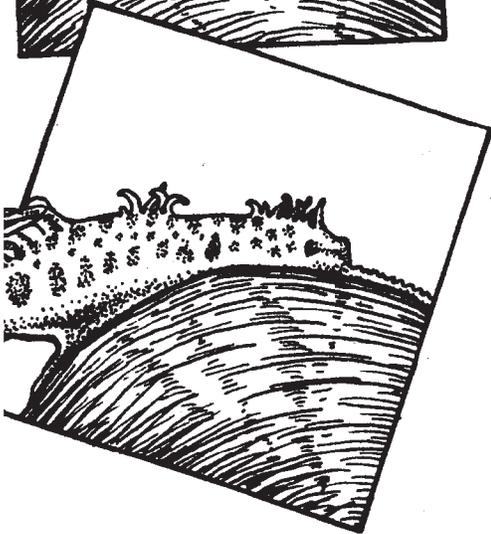
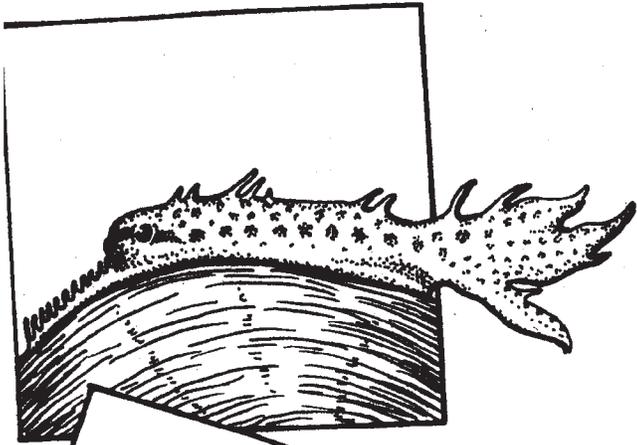




Fertilization takes place within a female mussel. A female mussel holds the fertilized eggs in brood chambers in the gills as they mature into mussel larvae called glochidia. They can't swim, but they can hitch a ride on a fish by closing down tight and snapping shut on the fish's gills or fins. **The glochidia of the majority of species of freshwater mussels must attach to a fish to metamorphose into juvenile mussels.** A metamorphosis is a change in form; similar to the change a caterpillar makes into a butterfly or moth.



When the glochidia are mature, the female mussel tries to attract a fish. But to a fish a mussel must look like a rock, and why would a fish eat a rock? So the female mussel must use something to bring the fish into her neighborhood. The females of some species of freshwater mussels use a lure to attract fish, the same way you might use a lure if you go fishing.



The lures used by freshwater mussels come in many different shapes and sizes. **Some of the lures look like worms others look like insect larvae, caterpillars, crayfish, or small fish.** These lures are formed by a flap of mantle tissue that the female pushes out of its shell. When the fish sees the lure, it's attracted to the mussel. When it approaches or tries to swallow the lure, the female releases a cloud of glochidia that attach to either the gills or the fins of the fish.

C N Z N C O P A C V T Z P S T  
 Q U O P L B U T E F I S H B G  
 W S N B P O L L U T I O N W L  
 E T Q G T S E B C U B N R L O  
 R P W I L A R V A E O S E T C  
 T I E L U U Q A M U S L Y V H  
 Y G Z L R W T U R U C N E E I  
 L Y B S E R Y I L Q S M I C D  
 N P U N S V S W N Z V S E F I  
 U A I U P H M P O A N L E Z A  
 V C R G M I N S E C T U Y L S  
 Y K M E E L P M X N I E O Q S  
 M E N T V S R S A Y N W S R C  
 V T X L M T U M E A R S T W E  
 B S Y I M P E R I L E D X O Y

FIND THE FOLLOWING WORDS IN THE WORD SEARCH ABOVE:

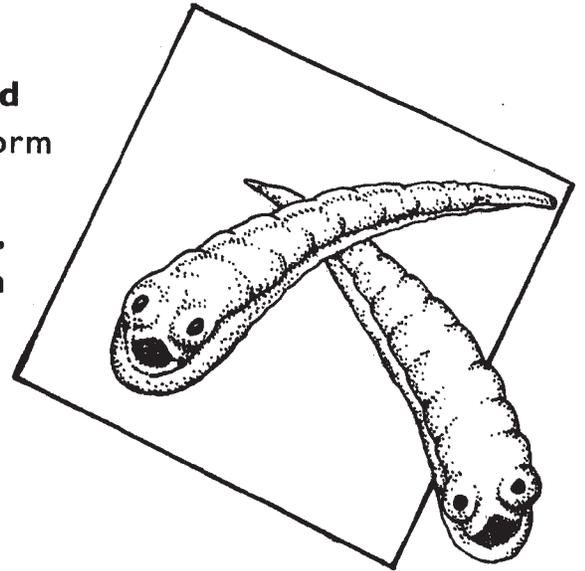
MUSSELS  
 GILLS  
 FISH

GLOCHIDIA  
 FINS  
 LURES

PACKETS  
 IMPERILED  
 INSECT

LARVAE  
 POLLUTION  
 MANTLE

Some other species of freshwater mussels form the glochidia into small packets called **conglutinates**. Conglutinates also act like a worm lure moving in the current to attract fish. Some conglutinates have dark spots that look like eyes, which makes the packet look like small fish or an insect larva. When the fish bites the conglutinate, the larvae attach to the fish's gills.



**UNSCRAMBLE THE LETTERS BELOW TO FORM WORDS THAT APPEAR IN THE ACTIVITY BOOK:**

selsum

eurl

ihodcalgi

soht hfsi

eamnlt lapf

anreddegne

hatenderte

ohremsatsmiop

ilareclprta

tahcat

otsntignuceal

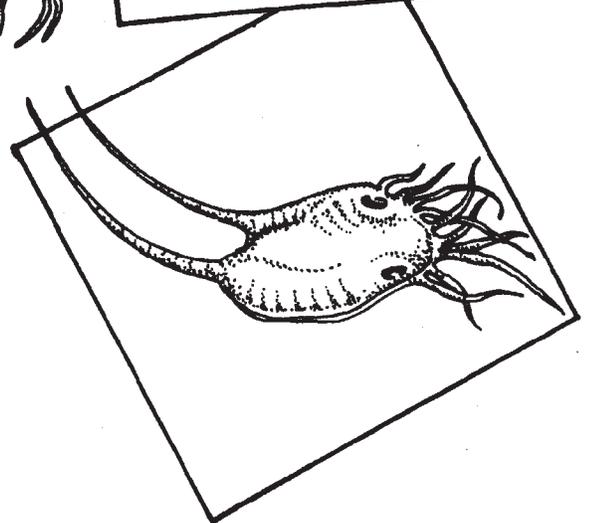
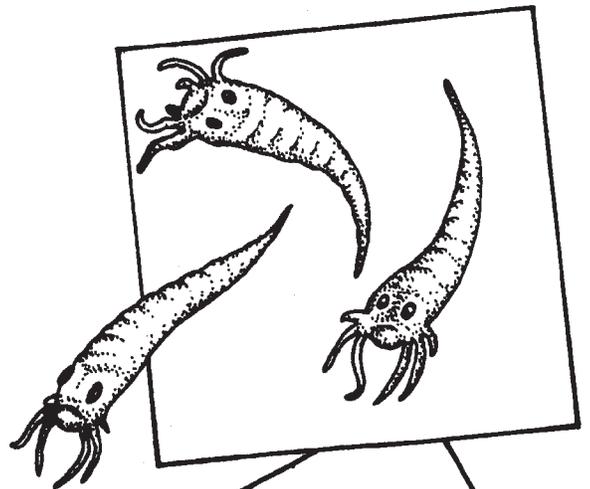
avrlae

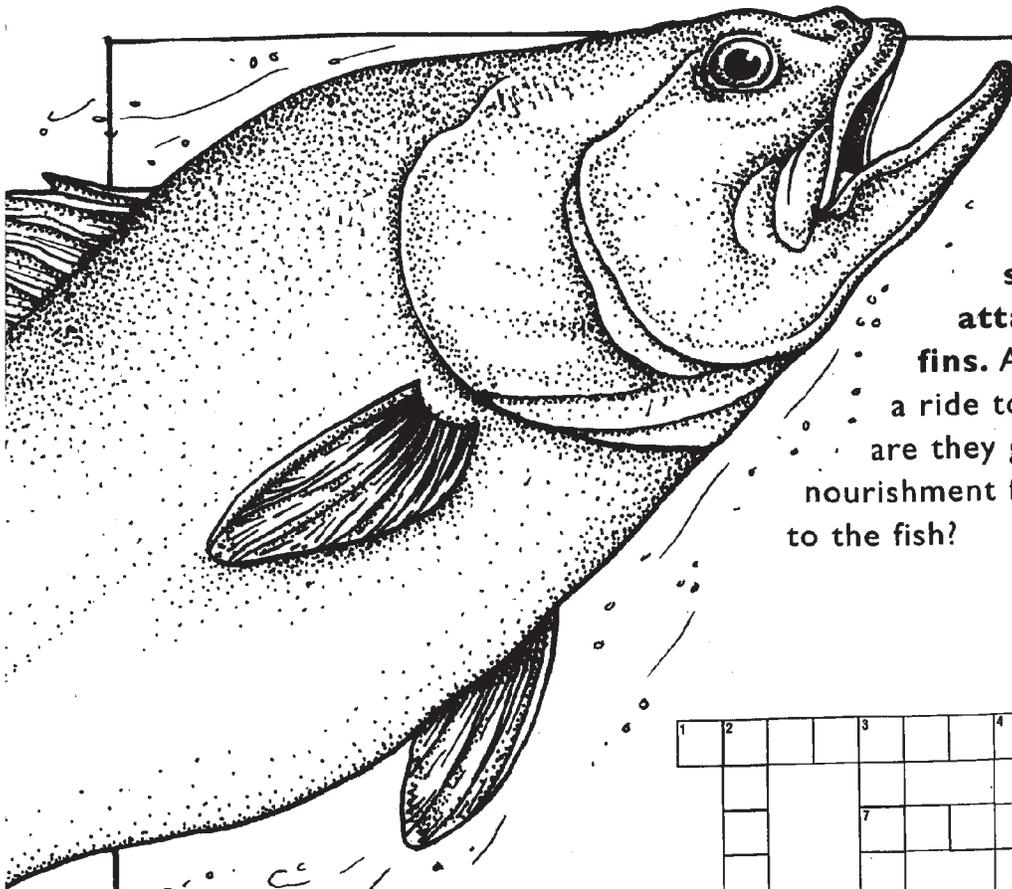
loiluoptn

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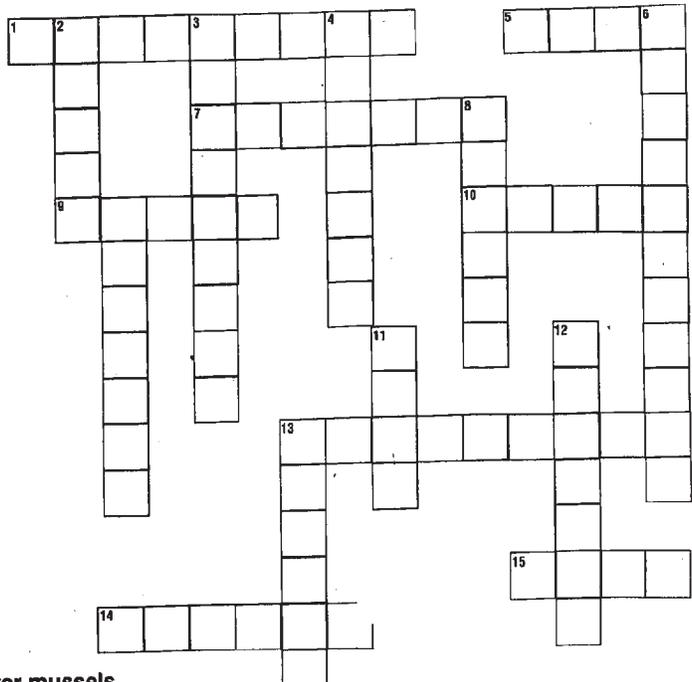
fnfour

esepisc





**Nobody is really sure why glochidia attach to fish gills or fins. Are they just catching a ride to a new location? Or are they getting some form of nourishment from being attached to the fish?**



**ACROSS**

- 1. Mussel larvae
- 5. A place you would find freshwater mussels
- 7. Unionids
- 9. Crystalline \_\_\_\_\_
- 10. A place you would find freshwater mussels
- 13. Chemicals in the water that can kill freshwater mussels
- 14. Animals that have a single foot like mussels
- 15. A host for freshwater mussel larvae

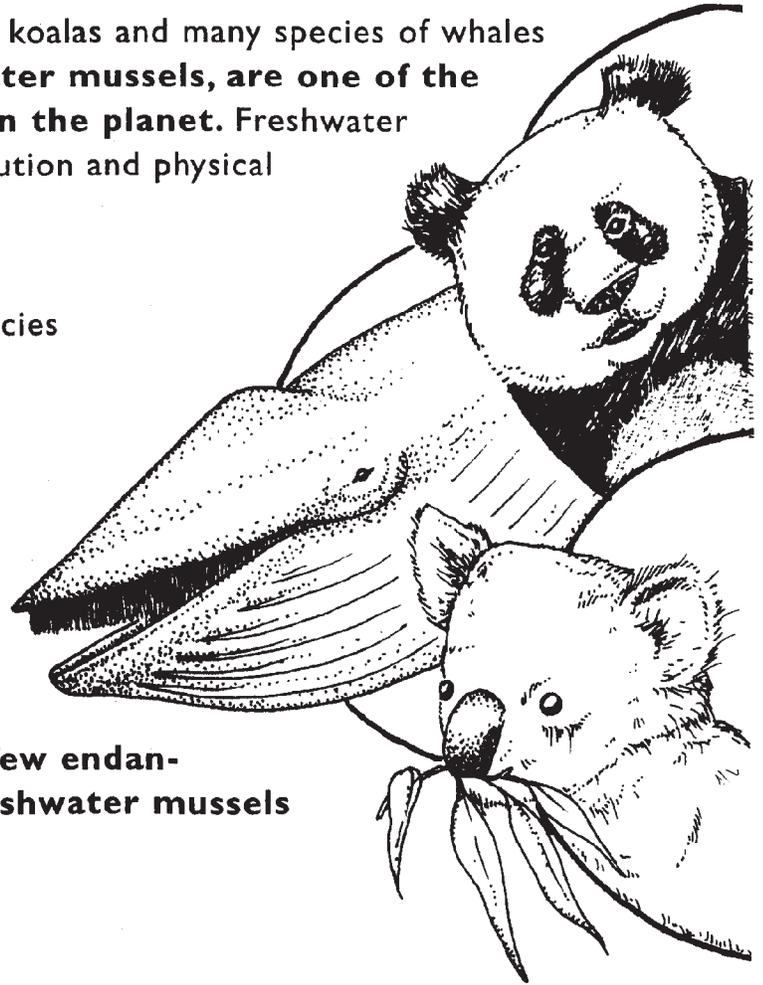
**DOWN**

- 2. Used to attract fish
- 3. Freshwater mussel blood
- 4. Animals that mussels mimic to attract fish
- 6. The world (surroundings) in which humans and animal live
- 8. A place where freshwater mussels live
- 11. What mussels use to filter the water
- 12. Another name for freshwater mussels
- 13. The Latin word Unio means \_\_\_\_\_ in English

You've probably read about how pandas, koalas and many species of whales are endangered. **But unionids, freshwater mussels, are one of the most imperiled groups of animals on the planet.** Freshwater mussels are disappearing because of pollution and physical changes in their habitat.

More than 70% of freshwater mussel species are imperiled.

Freshwater mussels have unusual and sometimes humorous common names based on a unique characteristic or something the mussel closely resembles. The common and scientific names of a few endangered and threatened species of freshwater mussels are named below:



## Scientific Names

(Genus species)

*Alasmidonta heterodon*

*Lampsilis abrupta*

*Quadrula cylindrica strigillata*

*Plethobasus cooperianus*

*Pleurobema plenum*

*Epioblasma obliquata obliquata*

*Lasmigona decorata*

*Elliptio steinstansana*

## Common Name

**DWARF WEDGE** mussel

Pink **MUCKET**

Rough **RABBITSFOOT**

Orange-foot **PIMPLEBACK**

Southern **PIGTOE**

**CATSPAW**

Carolina **HEELSPLITTER**

Tar **SPINYMUSSEL**

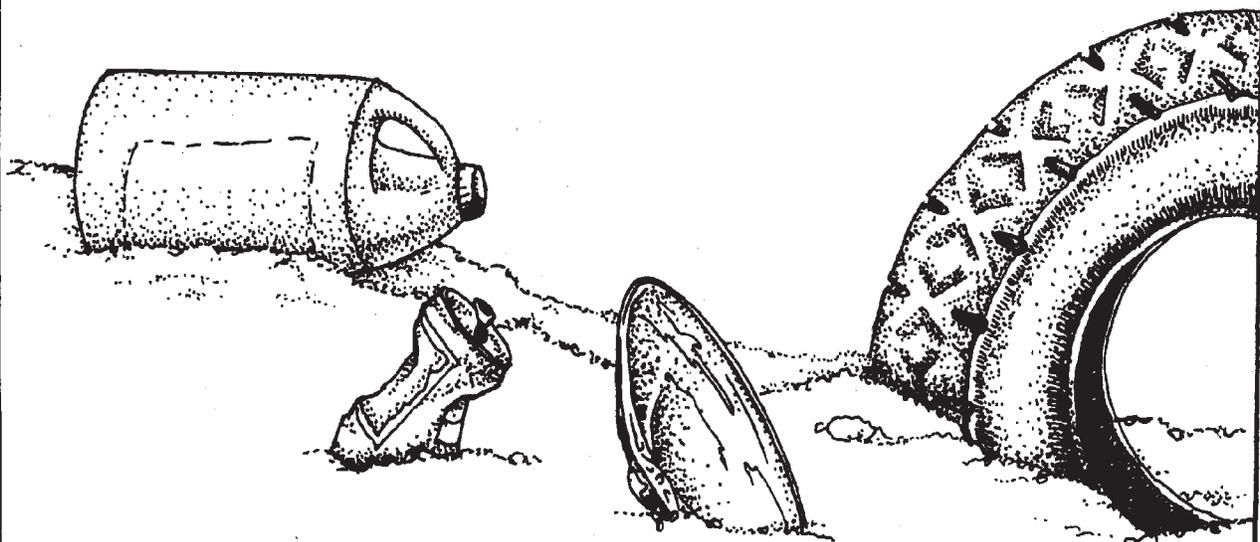
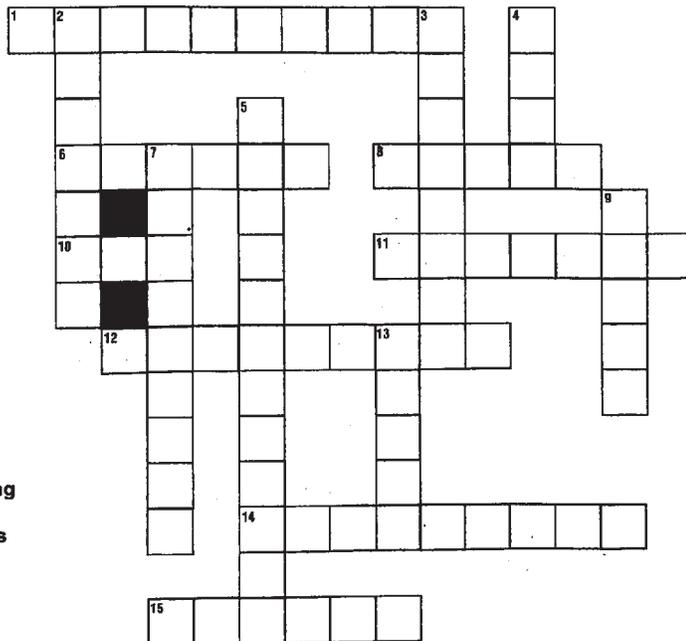
Water runoff from roads, agricultural fields, homes, and businesses often carries chemicals and other pollutants into streams, rivers and lakes. Many of these chemicals kill mussels, fish and their young. **Even chemicals we use in our own home or yard like pesticides to kill insects, or detergents to wash our clothes, can enter the water and harm freshwater mussels.** Eroded soil swirling in the water makes it difficult for mussels to breathe and feed. At times, a large amount of soil might actually bury the mussels and prevent them from filtering food out of the water.

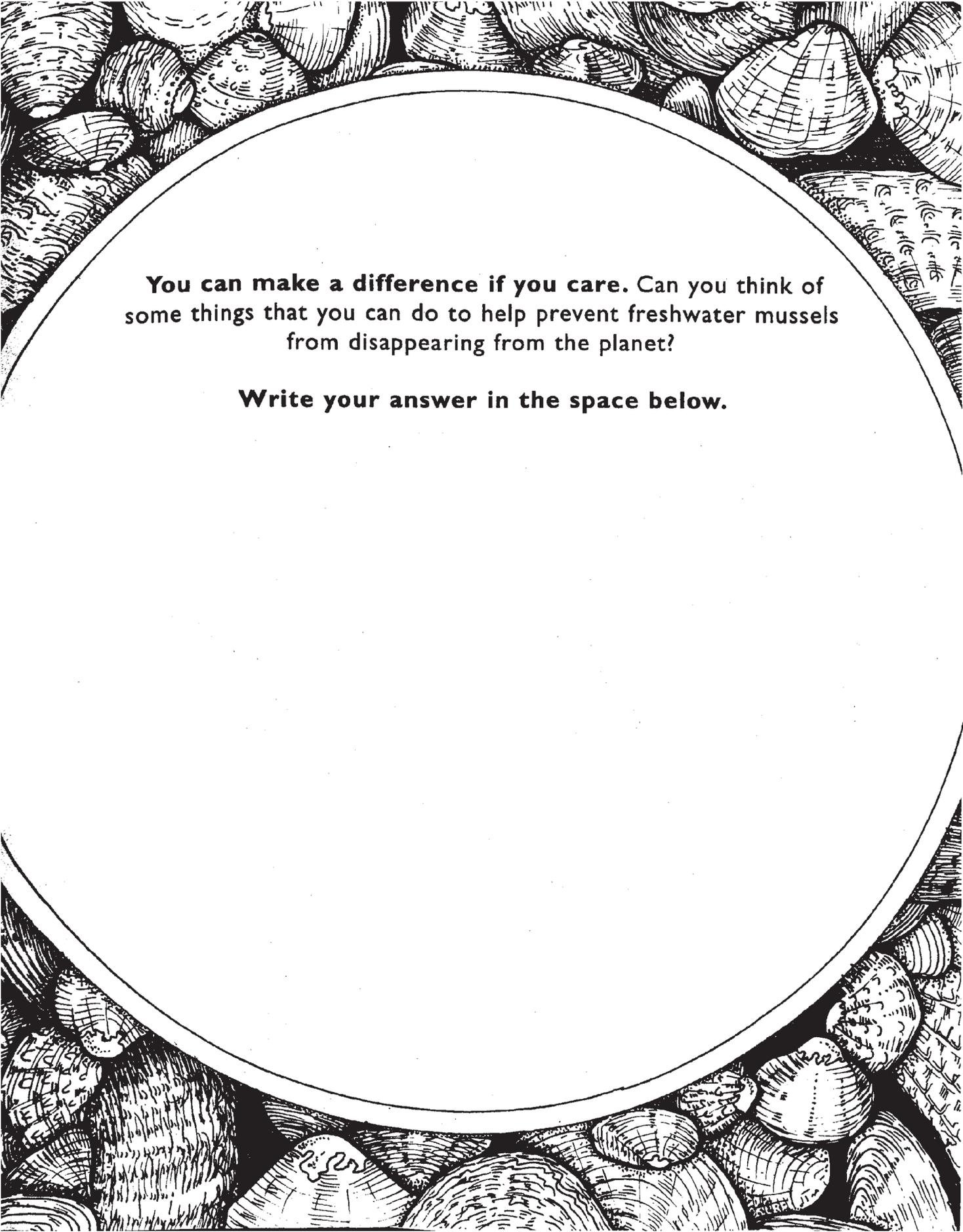
**ACROSS**

1. Chemical used to kill pests that can also kill mussels \_\_\_\_\_.
6. Mussels \_\_\_\_\_ water to feed
8. Freshwater mussels breath and filter water by using \_\_\_\_\_.
10. A lubricant used in cars that is sometimes in road runoff \_\_\_\_\_.
11. A way to reduce waste by reusing materials.
12. Nitrogen, phosphorous and potassium that is often in runoff from gardens
14. Endangered or threatened
15. Water moving off roads, fields and gardens into streams

**DOWN**

2. Soil washing off of construction sites
3. Particles in the water that settle to the bottom
4. Can bury mussels and prevent them from breathing and feeding
5. The \_\_\_\_\_ of new roads, homes and businesses and frequently causes erosion
7. Waste chemicals that get washed into streams
9. A type of food eaten by freshwater mussels and other bivalves
13. The pearly inside of a freshwater mussel shell



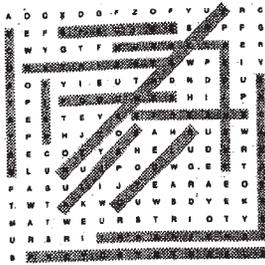


**You can make a difference if you care. Can you think of some things that you can do to help prevent freshwater mussels from disappearing from the planet?**

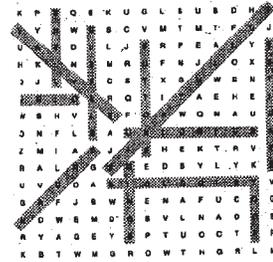
**Write your answer in the space below.**

# Key/Answers

## Page 5 Answers



## Page 7 Answers

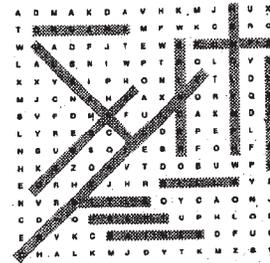


## Page 10 Answers

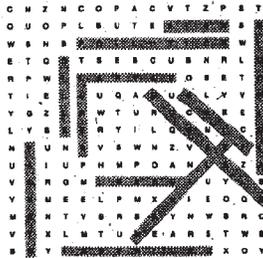
### Word Match Key:

- |                   |                |
|-------------------|----------------|
| algae             | = mussel food  |
| blood             | = hemolymph    |
| pearl             | = unio         |
| aperture          | = siphon       |
| freshwater mussel | = unionid      |
| valve             | = mussel shell |

## Page 13 Answers



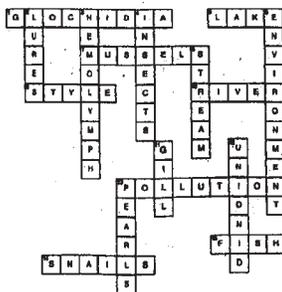
## Page 16 Answers



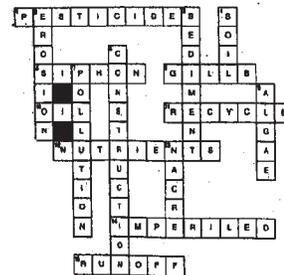
## Page 17 Answers

- |               |               |
|---------------|---------------|
| mussel        | lure          |
| glochidia     | fish host     |
| mantle flap   | endangered    |
| threatened    | metamorphosis |
| caterpillar   | attach        |
| conglutinates | larvae        |
| pollution     | erosion       |
| runoff        | species       |

## Page 18 Answers



## Page 20 Answers





*Contact Info:*

For additional information about the NC Freshwater Mussel Conservation Partnership or about becoming a sponsor please contact Dr. Jay Levine, Department of Farm Animal Health and Resource Management, College of Veterinary Medicine, North Carolina State University, Box 8401, Raleigh, NC.  
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E-mail: Jay\_Levine@ncsu.edu

Donations in support of the Partnership's research and conservation activities can be made to: NC Freshwater Mussel Conservation Partnership, NC Veterinary Medical Foundation, Box 8401, Raleigh, NC 27606.  
Phone: 919-513-6660  
E-mail: Richard\_Clarke@ncsu.edu

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