ACTIVITY 7

Hooray for Horseshoe Crabs

Estuary Principle

Animal species that live in the estuary have specialized physical, biological, and behavioral adaptations which allow them to survive in the ever-changing estuary environment.

Research Question

What are the basic anatomical features of horseshoe crabs that allow them to survive in the estuary environment?

Introduction

Atlantic horseshoe crabs are one of the many important organisms living in estuaries along the East and Gulf coasts of the United States. They are abundant from Virginia to New Jersey with the largest population of spawning horseshoe crabs found in the Delaware Bay, site of the Delaware NERR. However, the horseshoe crab population has been declining. What was once thought to be 1.2 million spawning female crabs is now down to only around 400,000. Overfishing of horseshoe crabs to use as bait may be one reason for the lower numbers. Programs have been set up to keep closer count of the horseshoe crabs and communities have banded together to form crab sanctuaries along town and private beaches. In this activity, students will learn about the anatomy and unique adaptations of these amazing animals.

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TEACHER GUIDE

Hooray for Horseshoe Crabs

Research Question

What are the basic anatomical features of horseshoe crabs that allow them to survive in the estuary environment?

Content Objectives

Students will understand that:

- Horseshoe crabs are arthropods, but are not true crabs.
- Horseshoe crabs are benthic or bottom dwellers.
- Horseshoe crabs move along the bottom of the ocean or estuary using their ten legs.
- Horseshoe crabs leave the water to crawl onto the beach to lay their eggs in the sand.

Exercises

Hooray for Horseshoe Crabs!

Students examine the form and function of different horseshoe crab anatomical features.

Assessment Questions

Assessment questions based on content covered in *Hooray for Horseshoe Crabs* can be downloaded on the web page for this activity in the Middle School Curriculum section of the Estuary Education website at estuaries.noaa.gov.

Vocabulary

Adaptation – adjustment to environmental conditions.

Arthropod – any of a phylum (Arthropoda) of invertebrates (as insects, arachnids, and crustaceans) that have a segmented body and jointed appendages.

Invertebrate – an animal without a backbone.

Exoskeleton – a hard outer covering

An extended vocabulary list of horseshoe crab anatomy is provided in the Student Master: *Hooray for Horseshoe Crabs.*

Taking It Further

Educate with Literature!

Purchase or borrow a copy of the children's picture book, *Crab Moon* by Ruth Horowitz. In 2001, this book was selected by the National Science Teachers Association as an "Outstanding Science Trade Book." It tells the story of a mother and son who witness horseshoe crabs laying their eggs on a beach under a full moon. Before you read this story to your students, explain that you know the book is for much younger kids, but that you have a reason for sharing the book with them. Read the book aloud to your students and discuss their reactions to the story. Then coordinate a time when your students can visit elementary school students in your district and share the story with them. The power of older students teaching younger students cannot be underestimated!

EXERCISE

Hooray for Horseshoe Crabs!

Estuary Concept

Horseshoe crabs are adapted to live along bottoms of estuaries.

Focus Questions

- What are the basic characteristics of horseshoe crabs?
- What are the functions of the major anatomical features found in horseshoe crabs?

Performance Tasks

Students will:

- Identify the key characteristics of the horseshoe crab, starting with its three main anatomical divisions.
- Identify the key characteristics which link this species to arthropods and not true crabs.
- Identify the horseshoe crab's external organs, including the book gills, telson (tail), compound eyes, mouth, chelicerae and other legs.
- Identify the horseshoe crab's internal organs including the brain, heart, crop and gizzard, and mid-gut.

Teacher Preparation

Background information for teachers and students is contained in the Background information sheet that accompanies the Student Master: *Hooray for Horseshoe Crabs.*

View the *Horseshoe Crabs* video on the web page for this activity in the Middle School Curriculum section of the Estuary Education website at estuaries.noaa.gov. This 10-minute video features Mark Maddox showing kids a horseshoe crab up close and discussing the animal's anatomy and importance.

Make copies of Student Master: *Hooray for Horseshoe Crabs,* including the Background information sheet and the four horseshoe crab diagrams students will be labeling in the exercise.

You may want to duplicate the color photos of horseshoe crab models found on the Teacher Masters. Projecting these for your class will make it easier to discuss the horseshoe crab's anatomy and for your students to check whether or not their diagrams are labeled correctly.

Procedure

1. To begin this exercise, show students the *Horseshoe Crabs* video that you will find on the web page for this activity in the Middle School Curriculum section of the Estuary Education website at estuaries.noaa.gov.

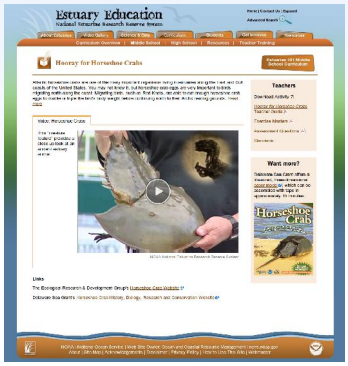
Overview

In this exercise, students will read about horseshoe crab anatomical features and match those features to diagrams of the horseshoe crab.

Time Required

One 45-minute class period

You'll find multimedia and other resources on the web page for this activity in the Middle School Curriculum section of the Estuary Education website: http://estuaries.noaa.gov.



2. Distribute copies of Student Master: *Hooray for Horseshoe Crabs*. Be sure to include the Background information sheet as well as the four horseshoe crab diagrams.
3. You may want students to read the Background information as homework the night before the activity. If you do, give students the Background information sheet to take home and read, but don't give them the Student Master and the four horseshoe crab diagrams until it is time for them to do the activity in class.
4. Students use information from the Student Master, the Background information sheet, and the clues on the horseshoe crab diagram sheets to label the diagrams with the 16 body parts listed on the Student Master.
5. Review student choices of diagram labels by duplicating the four Teacher Masters and projecting them in front of your class. These show color models of the same horseshoe crab anatomy as shown in the diagrams students have labeled.
6. Students then answer the questions on the Student Master. Possible student answers to the questions are provided below.

Materials

Per student

Student Master: *Hooray for Horseshoe Crabs* including the Background information sheet and the four horseshoe crab diagrams

Questions and Possible Answers

Q1. What are the three main divisions of the horseshoe crab called?

The three main divisions of the horseshoe crab are the prosoma, the opisthosoma, and the telson.

Q2. How do horseshoe crabs move? How is that different from fish, birds, and humans?

Horseshoe crabs use five of their six pairs of legs to walk or push themselves forward along the bottom of water bodies such as bays and up onto beaches to spawn. Humans and many types of birds use their legs to walk in and out of the water. Fish do not have legs; they swim.

Q3. Why are horseshoe crabs considered to be arthropods? Why are they in the class Merastomata?

Arthropods are segmented (or jointed) invertebrates with exoskeletons. Horseshoe crabs have three segments: the prosoma; the opithosoma; and the telson or tail. Horseshoe crabs are in the class Merastomata because their mouth is surrounded by the bases of their legs.

Q4. Where does the horseshoe crab begin its life and how does it grow?

Spawning takes place on the beach, out of the water. Female horseshoe crabs lay their eggs on the beach along the ocean or bay. Eggs that survive hungry shorebirds hatch in about four weeks. As the crab grows, it must molt. This means it sheds its hard shell (an exoskeleton called a carapace) and grows a new, larger shell. The horseshoe crab must molt many times until it becomes an adult.

TEACHER MASTER

Horseshoe Crab features

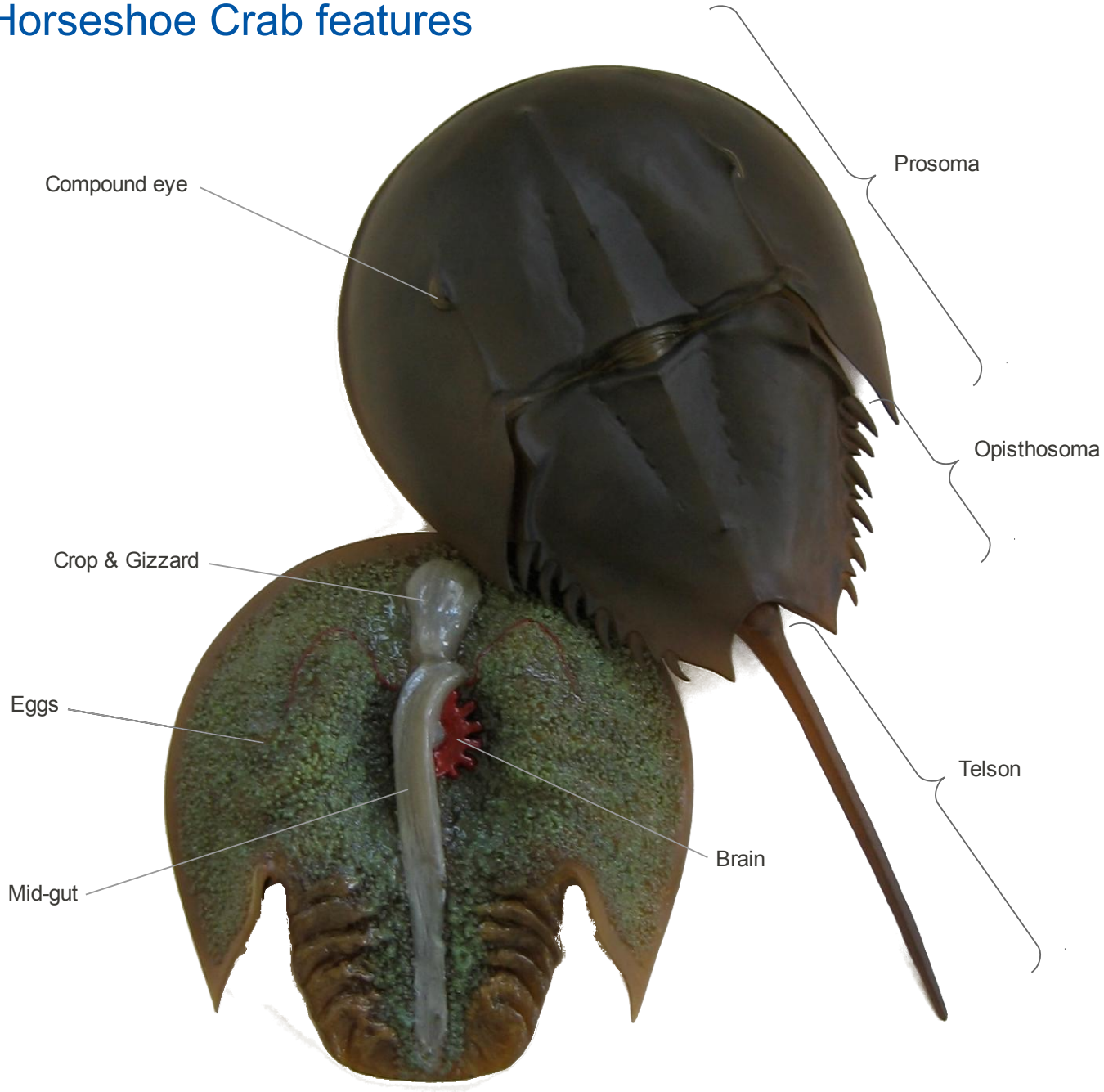


Photo: Ecological Research & Development Group Inc. www.horseshoecrab.org

TEACHER MASTER

Horseshoe Crab features

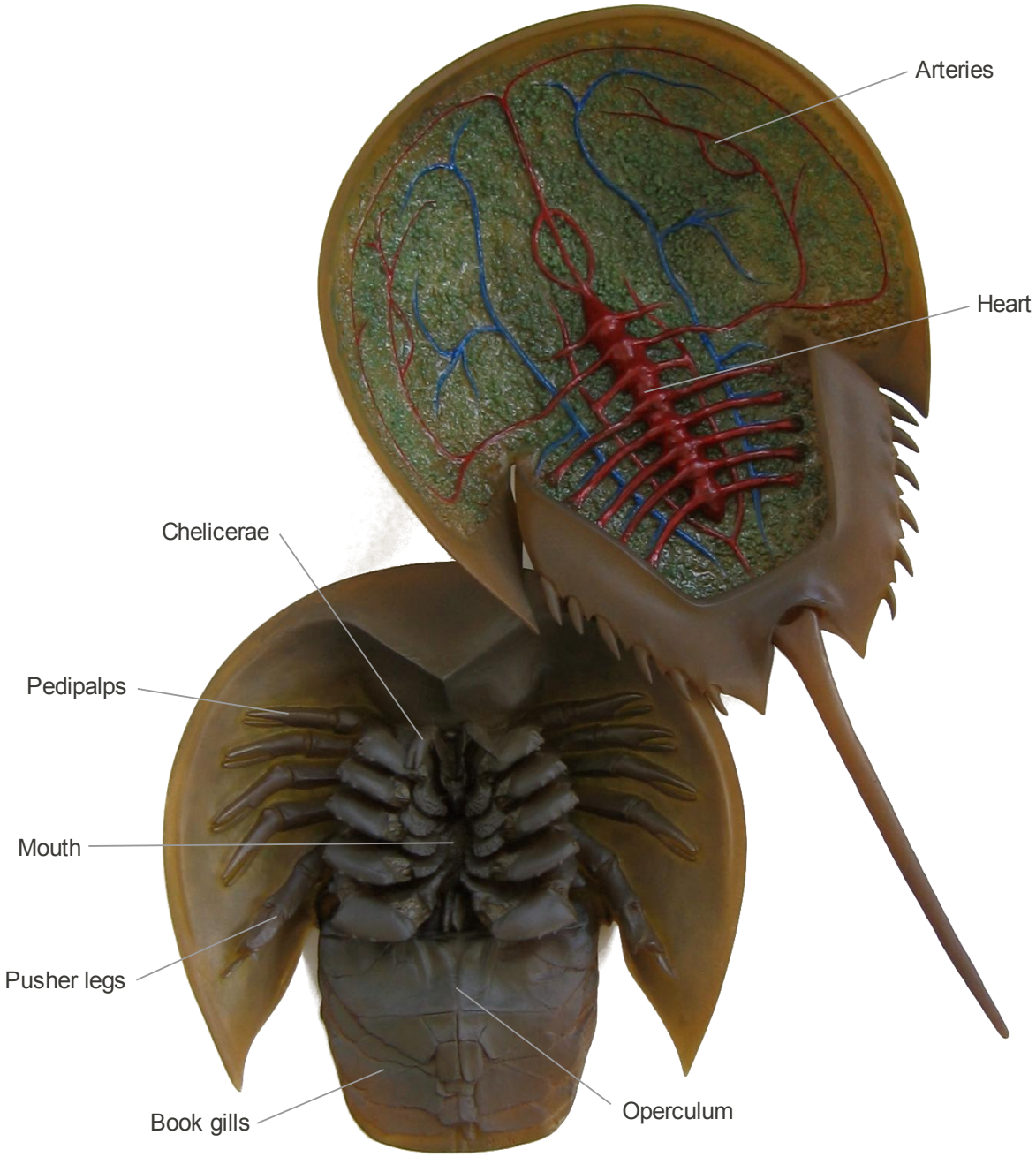


Photo: Ecological Research & Development Group Inc. www.horseshoecrab.org

STUDENT MASTER

Hooray for Horseshoe Crabs

Horseshoe Crab
Photo: Ecological Research & Development Group Inc.

Blue Crab
Photo: Mary Hollinger, NODC biologist, NOAA

Spider
Photo: Brooke Vallaster, NOAA, Sapelo Island NERR

When is a crab not a crab? Like other crabs, horseshoe crabs are arthropods. But so are spiders and scorpions. They all have exoskeletons, a body divided into segments, and legs with joints. But horseshoe crabs are not true crabs. They don't belong to the same class, Crustacea, as the blue crab and other crabs. True crabs have antennae, jaws, and only five pairs of legs. Horseshoe crabs don't have antennae or jaws and have six pairs of legs. Horseshoe crabs are in a class of their own: Merastomata, which means "mouth surrounded by legs.

Horseshoe crab fossils, similar in form to the ones you see in estuaries today, are found in rocks over 450 million years old. In this exercise, you are going to take a closer look at the anatomy of this ancient creature.

Procedure

1. Read the Background information sheet about horseshoe crab anatomy.
2. Read the clues on the four horseshoe crab diagrams (view of the top and bottom, external features and internal organs). Label the diagrams with the following features based on the clues and the information on the Background information sheet.

Eggs	Compound eye	Prosoma	Crop & gizzard
Telson	Mid-gut	Chelicerae	Brain
Mouth	Pedipalps	Arteries	Pusher legs
Heart	Operculum	Book gills	Opisthosoma

3. When you have finished labeling the horseshoe crab diagrams, answer the following questions.

Questions

Q1. What are the three main divisions of the horseshoe crab called?

Q2. How do horseshoe crabs move through the water? How is that different than fish, birds, and humans?

Q3. Why are horseshoe crabs considered to be arthropods? Why are they in the class Merastomata?

Q4. Where does the horseshoe crab begin its life and how does it grow?

STUDENT MASTER

Background: Horseshoe Crab Anatomy

The horseshoe crab's body is divided into three sections. The front section is called the **prosoma**. The middle section is called the **opisthosoma**. And the horseshoe crab's tail is called the **telson**. While the telson may look dangerous, the crab mainly uses it for digging and to help turn itself back over if it gets flipped over on the beach. The telson is very fragile. Horseshoe crabs should never be picked up by their tails.

Horseshoe crabs are benthic animals, meaning that they normally live along the seafloor or bottom of an estuary's bay or lagoon. Horseshoe crabs move underwater along the bottom or out of the water along the flat beach by using their five pairs of jointed legs. The fifth pair of larger **pusher legs**, found nearer the tail, is used to push the animal forward.

Respiratory System

Like many other aquatic animals, horseshoe crabs breathe through gills. They have six pairs of gills along the bottom of the opithosoma. These are called **book gills** because they look like pages in a book. The first pair of book gills is called the **operculum**, which helps protect the other gills and covers the opening of the pore through which the crab releases either eggs or sperm.

Circulatory System

Horseshoe crabs have a long, tube-like **heart** that runs the length of their body (not the tail). It beats about 32 times per minute, pumping the horseshoe crab's blue blood through **arteries** and out into the rest of the crab's body.

Digestive System

Horseshoe crabs eat small bivalves, mollusks, fish, worms, and algae. The horseshoe crab's legs are covered with bristles that grind up the food as the crab walks, eventually pushing it toward the crab's **mouth**, which is located at the point where all the legs meet. Two of those legs, called **chelicerae**, are not used for movement at all but rather for pushing food into the horseshoe crab's mouth. Food that enters the mouth is first ground up in the **crop and gizzard** before passing into the **mid-gut**, which is where the food is finally digested.

Nervous System

The horseshoe crab's **brain** rests in the middle of the prosoma. Nerves run from the brain to the rest of the body, including to the horseshoe crab's many eyes. The horseshoe crab has two **compound eyes** on the top of the prosoma. These eyes have many lenses, making them similar to the eyes of a housefly. There are five other eyes on the top of the horseshoe crab and two eyes near the mouth on the crab's bottom. There are also light-sensitive photoreceptors on the horseshoe crab's tail.

Life Cycle

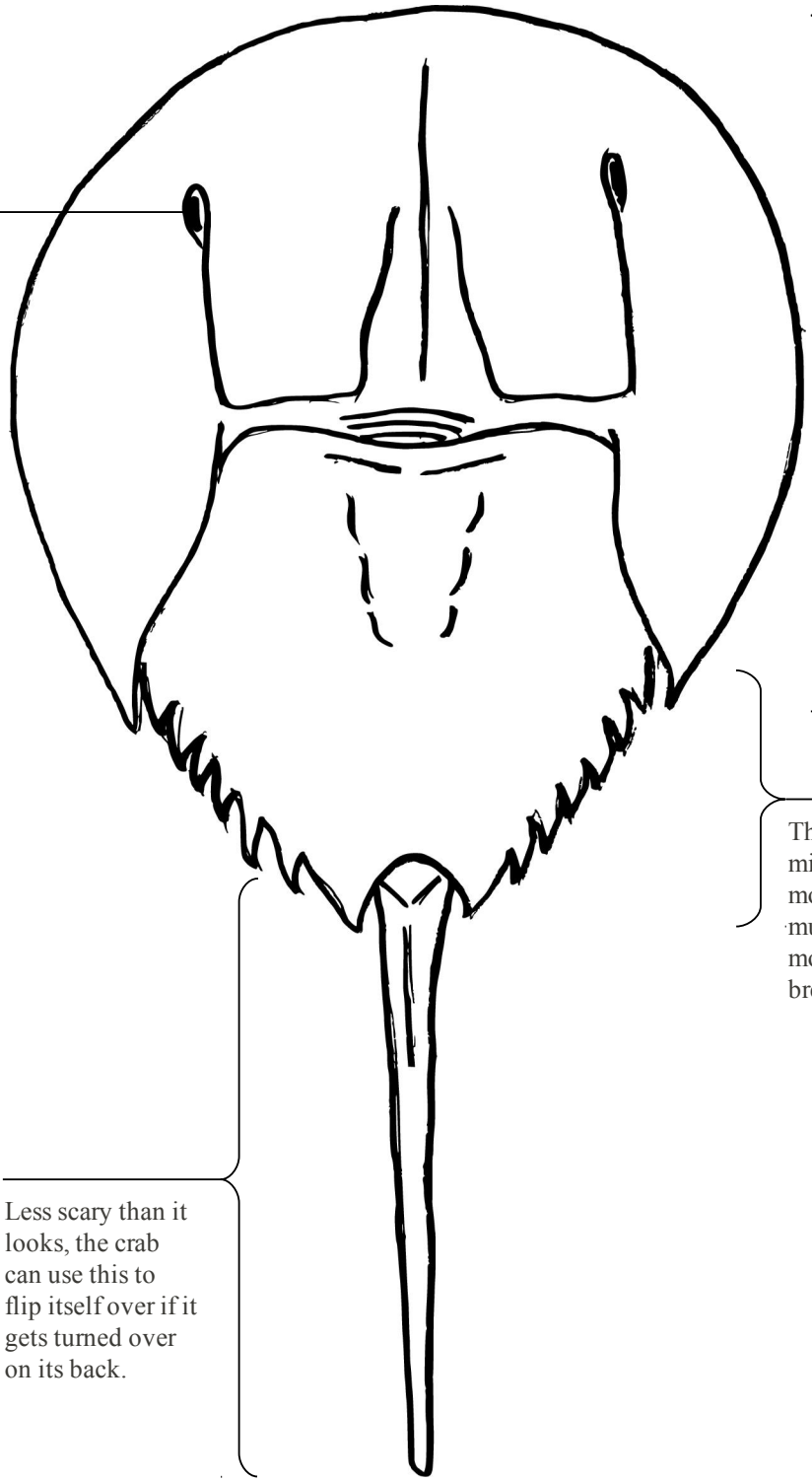
Horseshoe crabs live in the water, but come up onto the sandy beach to reproduce. The male horseshoe crab is usually about one-third the size of the female. The male has two "boxing glove" like claws on its first set of walking legs. These specialized legs are called **pedipalps** and allow the male to hold onto the female during spawning. The female horseshoe crab is said to be larger than the male in order to hold a vast number of **eggs** within her body. Females lay between 80,000 and 100,000 eggs in the sand during one spawning season. The eggs are about 1.5 mm (1/16 inch) in diameter and greenish tan in color. Fertilization of the eggs occurs outside of the body while the female is burying the eggs on the beach.

Horseshoe crabs begin their lives as eggs buried in the sand on a beach. Many of the horseshoe crab eggs get uncovered and eaten by birds. Those that aren't eaten are left to incubate in the sand. In about four weeks, baby horseshoe crabs emerge from the eggs. Horseshoe crabs are like other animals with exoskeletons. As it grows, the

horseshoe crab outgrows its shell, called a carapace. The crab molts, leaving its old shell behind and growing a new, larger shell. A horseshoe crab will molt 16 to 18 times over a period of about 10 years until it reaches adulthood. Horseshoe crabs can live to be about 20 years old if they do not get eaten by predators, get stranded on the beach, become injured, or get a disease.

STUDENT MASTER

Horseshoe Crab: External features (top view)



These might be the most obvious, but the horseshoe crab has 5 additional eye on its top, 2 on its bottom, plus light sensors along the top and bottom of its tail.

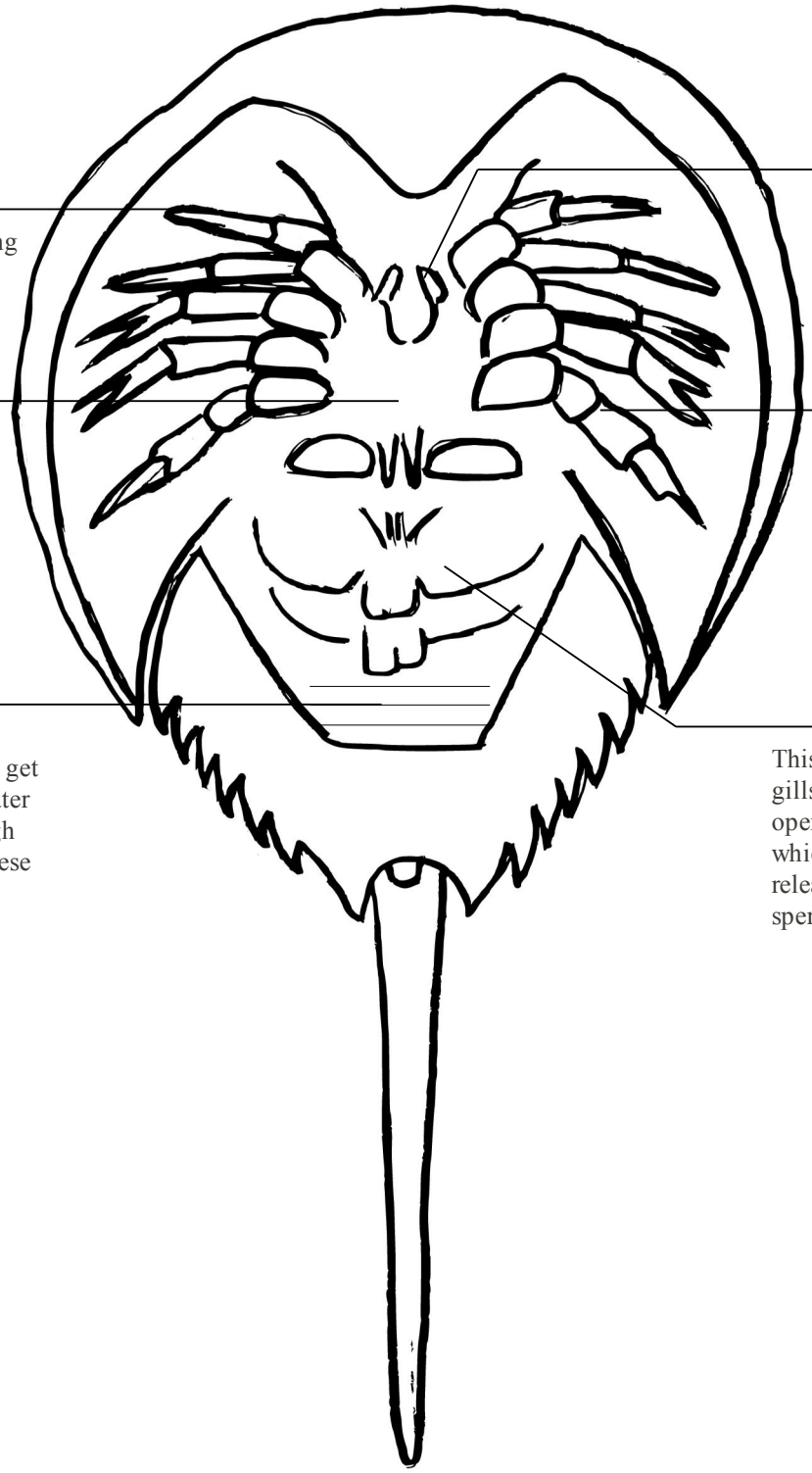
The "head" section of the horseshoe crab contains much of the crab's nervous and digestive system, plus the muscles to move its legs.

The horseshoe crab's middle section mostly contains the muscles needed to move its tail and to breathe.

Less scary than it looks, the crab can use this to flip itself over if it gets turned over on its back.

STUDENT MASTER

Horseshoe Crab: External features (bottom view)



This first pair of walking legs is also used by the male during spawning.

More like arms than legs, these are useful for getting food into the crab's mouth.

The start of the crab's digestive tract is located where all the legs come together.

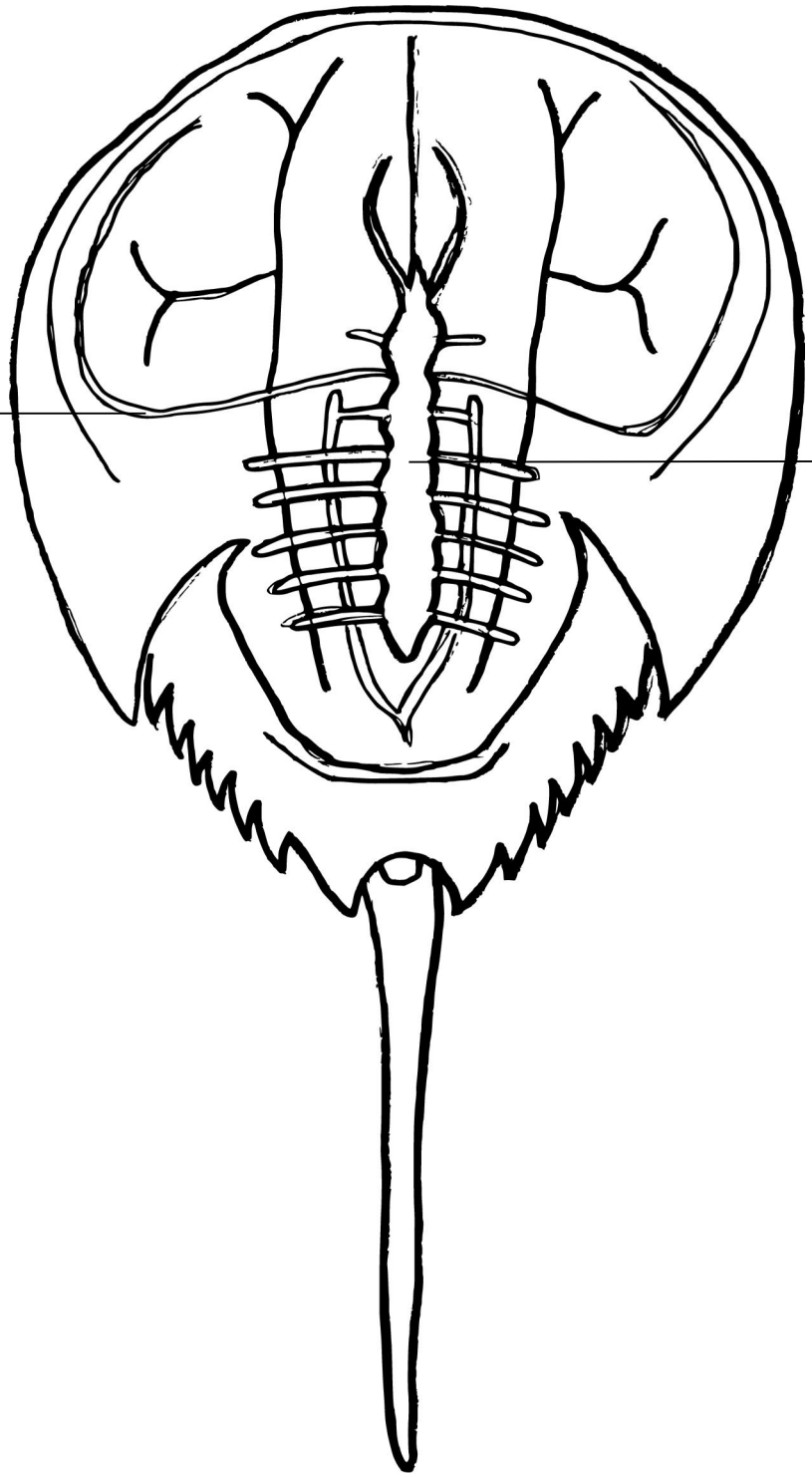
When it comes time to move, the last pair of legs gets the crab scuttling across the sand.

Crabs have to breathe and they get oxygen when water circulates through the "pages" of these features.

This covers the other gills and the opening through which the crab releases eggs or sperm.

STUDENT MASTER

Horseshoe Crab: Internal features (top view)

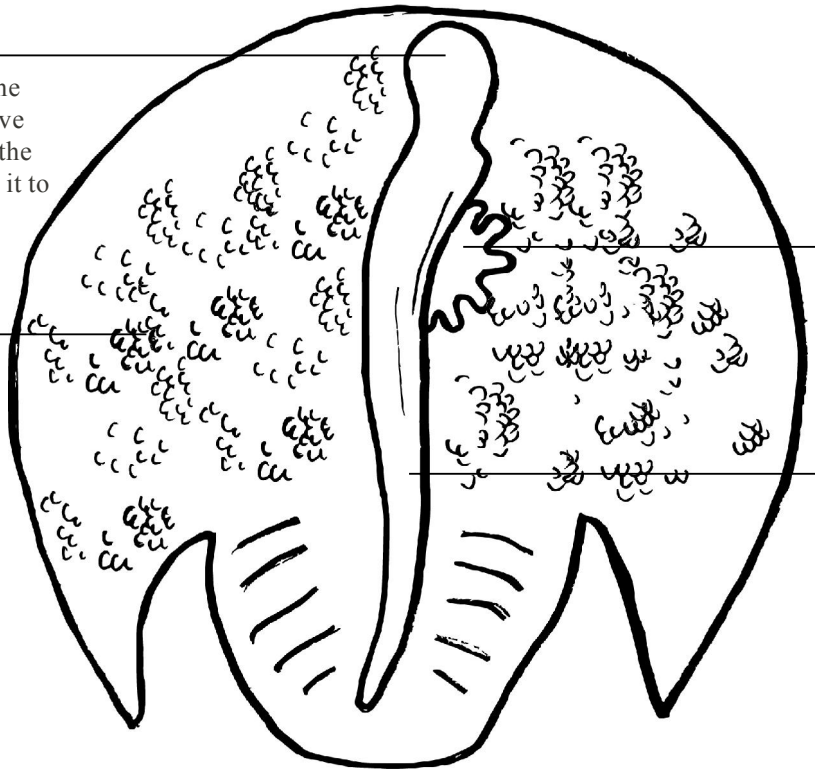


The horseshoe crab's blood leaves through these tubes, eventually going into the book gills to get oxygen before returning to the heart.

This circulatory organ extends almost the entire length of the horseshoe crab's body and beat 32 times per minute.

STUDENT MASTER

Horseshoe Crab: Internal features (bottom view)



Near the beginning of the horseshoe crab's digestive tract, these parts gather the food together and grind it to a pulp.

An adult female horseshoe crab can lay over 80,000 of these each year.

Like other animals, this organ is the center of the horseshoe crab's nervous system.

Pulverized food passes into this part of the horseshoe crab to be digested.