Hooray for Horseshoe Crabs

Activity Information

Grade Level

6-8, 9-12

Time Required

45-minute session

Topic

Adaptations

Overview

This activity teaches students about the specialized adaptations that horseshoe crabs have to survive in coastal and estuarine habitats.

Estuary Concept

Estuaries support an abundance of life and a diversity of habitat types. Estuarine plant and animal species have specialized physical, biological and behavioral adaptations that allow them to survive in the ever-changing estuarine environment.

Learning Objectives

- 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.

Teacher Preparation

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. In this activity, students will learn about the anatomy and unique adaptations of these amazing animals.

You may want to duplicate the color photos of horseshoe crab models found in Appendix 1. 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. If you have access to horseshoe crab molts or a plastic model they can be used in place of Appendix 1.

Print enough copies so each student has one of the Horseshoe Crab Background Information Sheet, Hooray for Horseshoe Crabs Worksheet, and the Horseshoe Crab Anatomy Labeling sheets. All resources are attached here and labeled as Appendix 2.

Materials Needed

- Color Copy of Appendix 1
- Copies of Appendix 2 for student
- Remarkable Horseshoe Crab Video Series

Optional Materials

- Horseshoe Crab Molts
- Plastic Horseshoe Crab Model

Procedure or Activity Steps

1. To begin this exercise, show students the Remarkable Horseshoe Crab video series from NOAA Ocean Today.

2. Distribute copies of the student materials found in Appendix 2. To reduce the amount of paper copies you can group students together in teams of two to four to complete the assignment using one set of printed materials.

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 Hooray for Horseshoe Crabs Worksheet and the Horseshoe Crab Anatomy Labeling sheets until it is time for them to do the activity in class.

4. Students use information from 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 Hooray for Horseshoe Crabs Worksheet.

5. Review student choices of diagram labels by duplicating Appendix 1 and projecting them in front of your class. These show color models of the same horseshoe crab anatomy included on the Horseshoe Crab Anatomy Labeling sheets that the students completed.

6. Students then answer the questions on the Hooray for Horseshoe Crabs Worksheet. Possible student answers to the questions are provided in Appendix 1.

Appendix 1: Teacher Materials

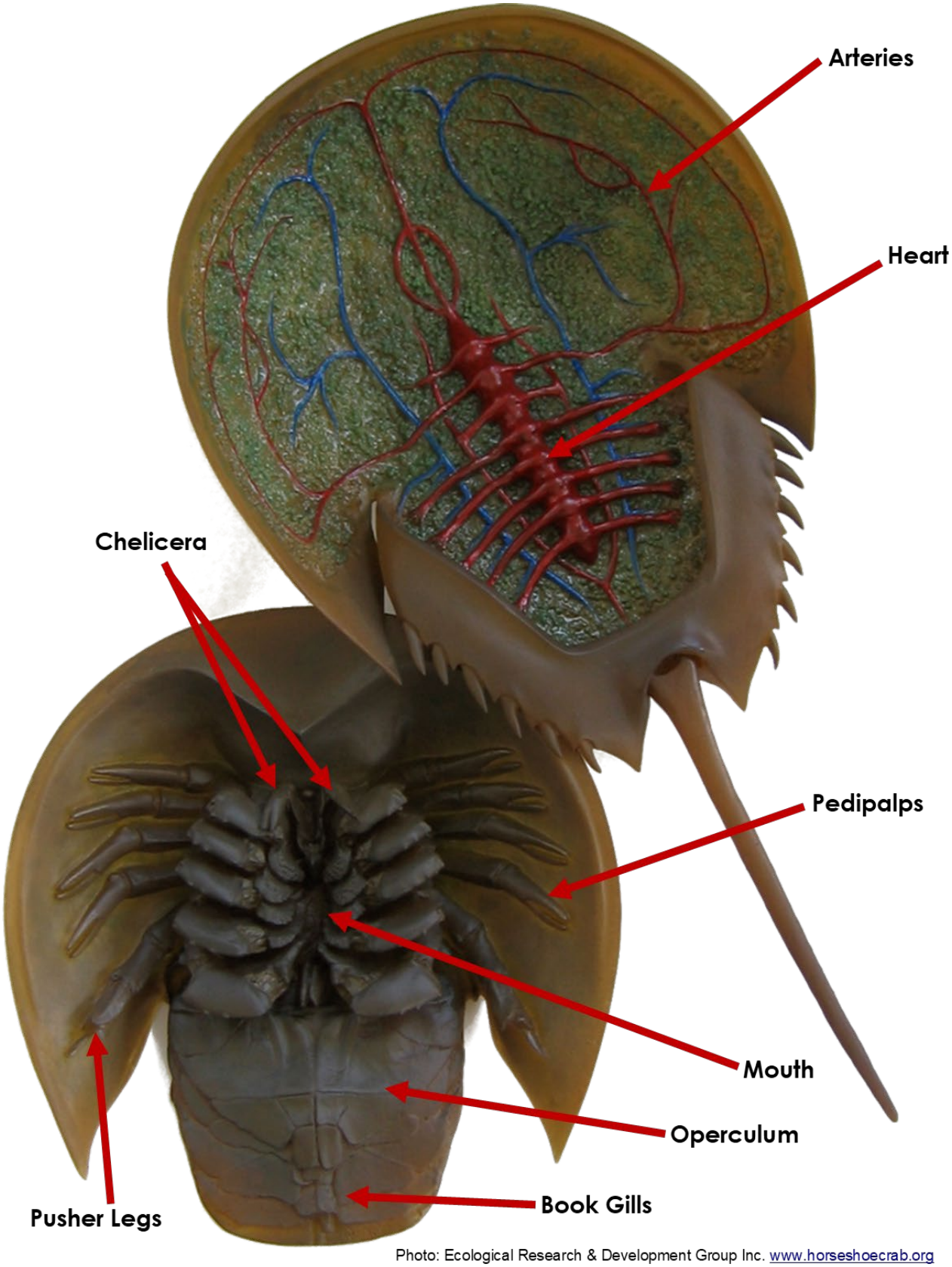


Photo: Ecological Research & Development Group Inc. www.horseshoecrab.org

Anatomy Answer Key

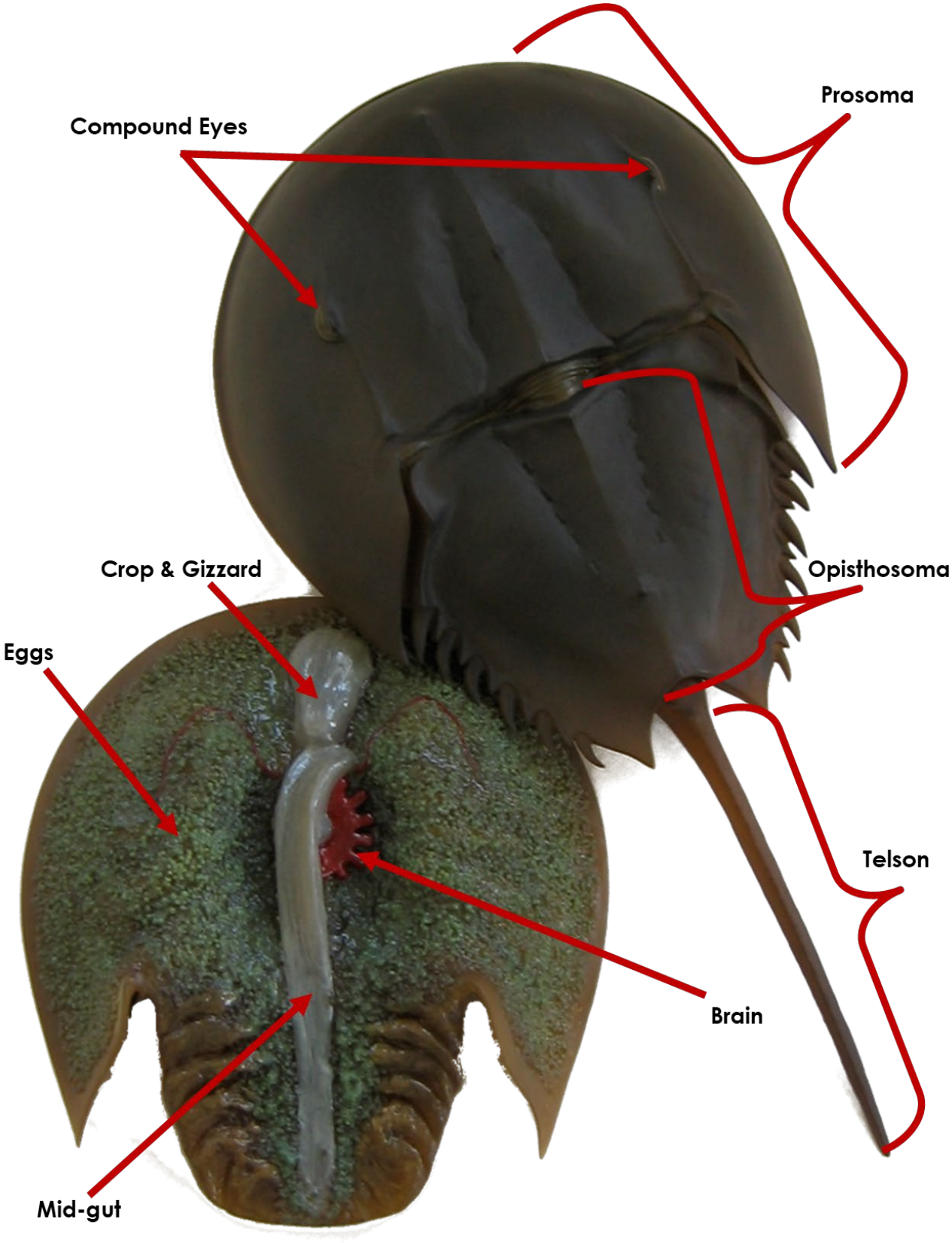


Photo: Ecological Research & Development Group Inc. www.horseshoecrab.org

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?

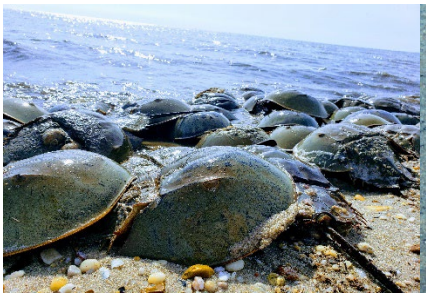
Spawning takes place on the beach, out of the water. Female horseshoe crabs lay their eggs on the beach along the ocean or bay. Eggs that survive hungry shorebirds hatch in about four weeks. As the crab grows, it must molt. This means it sheds its hard shell (an exoskeleton called a carapace) and grows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

Q5. What specialized adaptations does the horseshoe crab have that help it survive in ever-changing coastal habitats?

Hard external shell, blood clots very quickly to keep bacteria out if injured, soft body parts on the bottom, ability to stay out of water as long as gills are damp, mass spawning events, reproduce outside of the water, and lots of eyes and light sensors.

Appendix 2: Student Materials

Hooray for Horseshoe Crabs Worksheet



Horseshoe Crab
Photo: Maggie Pletta, DNREC

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 eyes	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 questions on Page 9.

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?

Q5. What specialized adaptations does the horseshoe crab have that help it survive in ever-changing coastal habitats?

Background: Horseshoe Crab Anatomy

Body Structure

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 also has a variety of photoreceptive, or light sensing, cells to help the crab understand the environmental around them. 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 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 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. When in the water the horseshoe crab can also use their book gills to swim. While laying on their back they flap the gills. The gill movement pushes them forward through the water at surprisingly fast speeds.

Circulatory System

Horseshoe crabs have a long, tube-like **heart** that runs the length of their body, or prosoma (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. Horseshoe crab blood is blue because it is copper based unlike human blood that is iron based.

Horseshoe crab blood is very special and used in the biomedical industry. Their blood contains a compound that congeals, or becomes gel-like, when it comes into contact with endotoxins (an external cell wall on some bacteria). Endotoxins are found all over us and in the environment, but when they are introduced into a blood stream they can cause illness and fevers. This means that when horseshoe crabs are injured their blood will quickly clot around the endotoxins keeping them out of their body. Scientists found that if the blood is taken from the crab and put through a series of processes a compound called Limulus Amebocyte Lysate (LAL) can be extracted and used to test any medical equipment or supplies that will come in contact with human blood. If the LAL gels they know the items have endotoxins on them and need to be sterilized.

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 simple eyes on the top of the horseshoe crab and two simple eyes near the mouth on the crab's bottom. There are also light-sensitive photoreceptors on the horseshoe crab's tail.

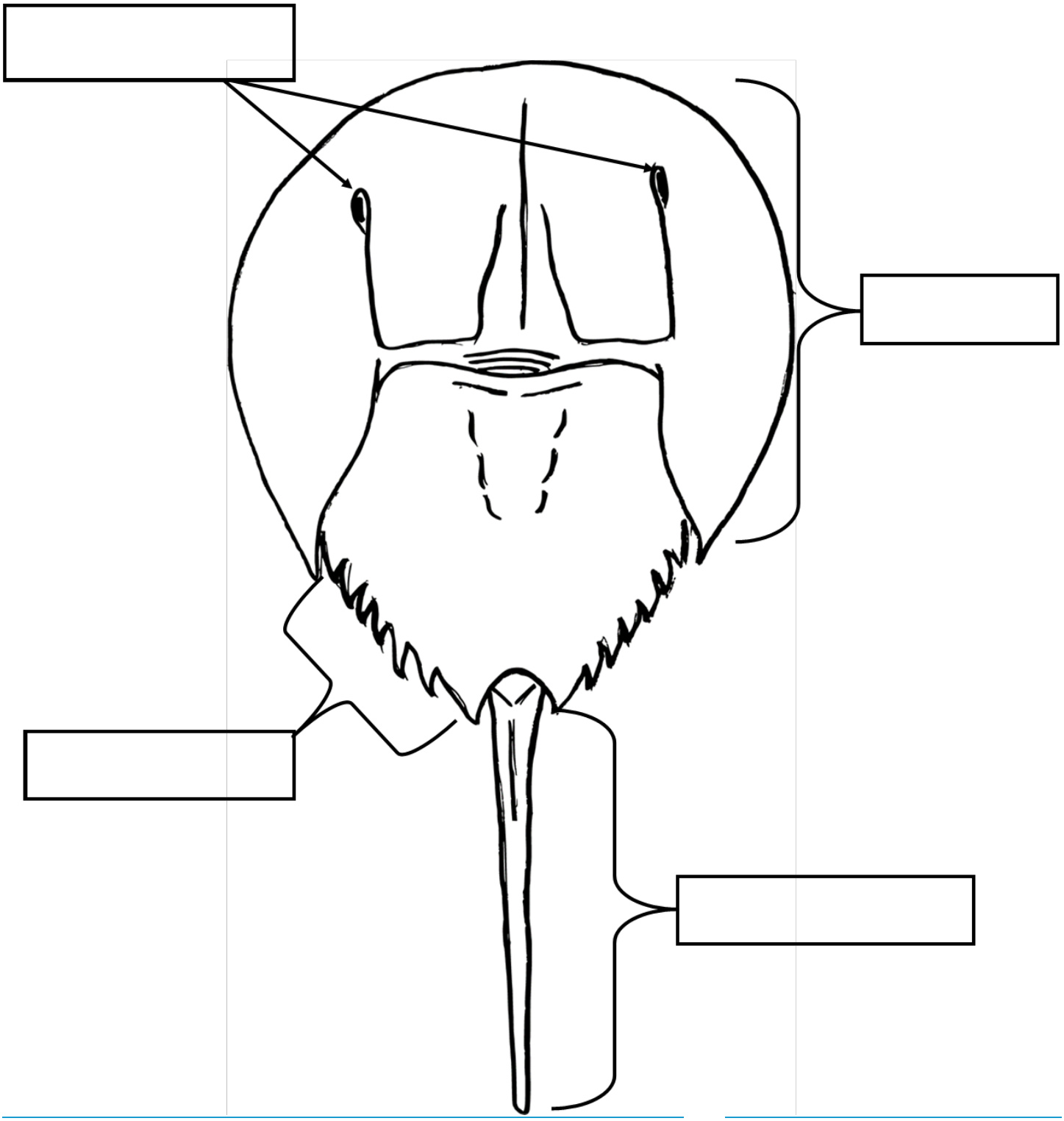
Life Cycle

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.

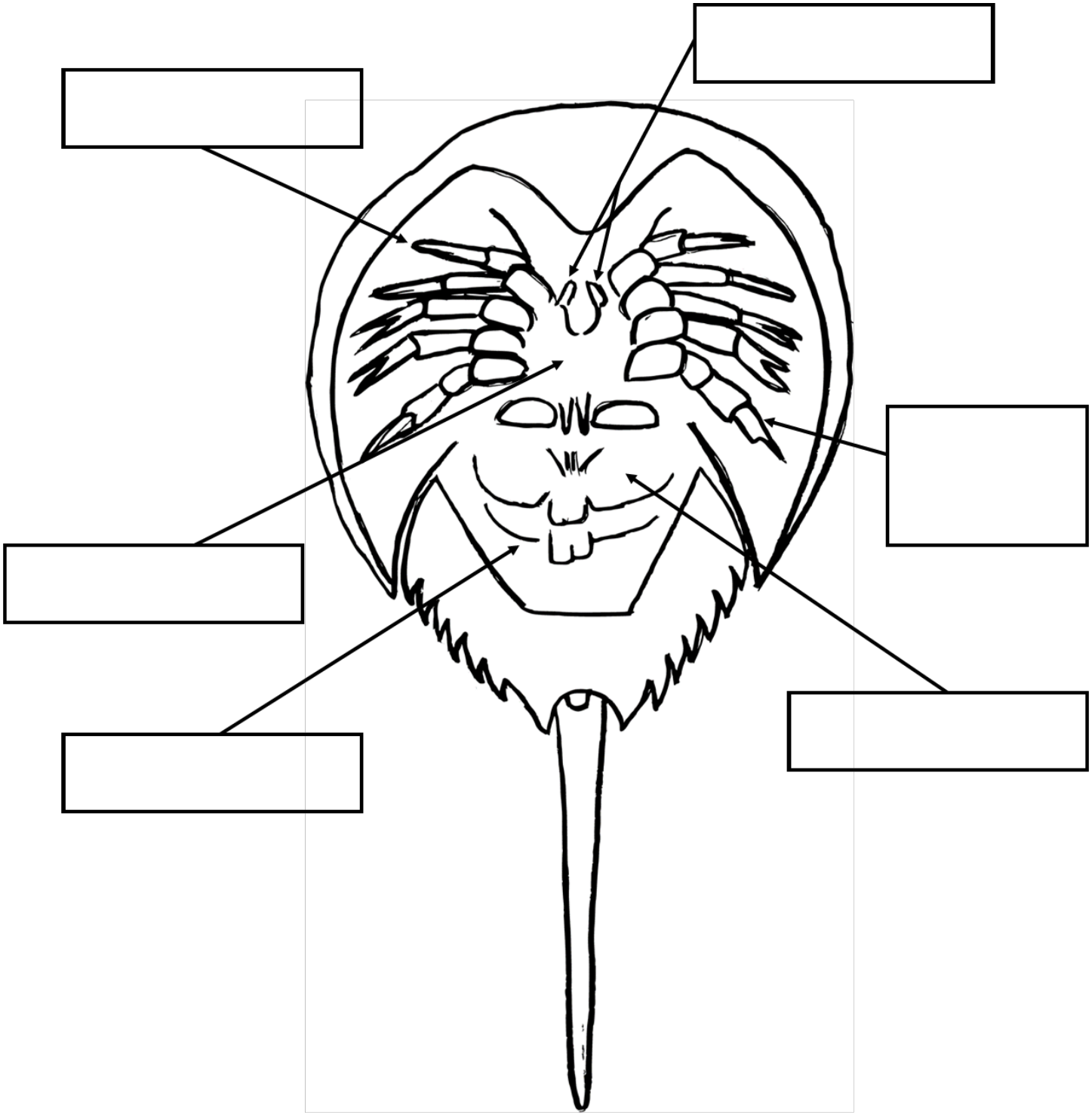
Horseshoe crabs begin their lives as eggs buried in the sand on a beach. Many of the horseshoe crab eggs get uncovered and eaten by birds. Those that aren't eaten are left to incubate in the sand. In about four weeks, baby horseshoe crabs emerge from the eggs. Horseshoe crabs are like other animals with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

Horseshoe Crab Anatomy Labeling Worksheet

Horseshoe Crab: External features (top view)



Horseshoe Crab: External features (bottom view)



Horseshoe Crab: Internal Features