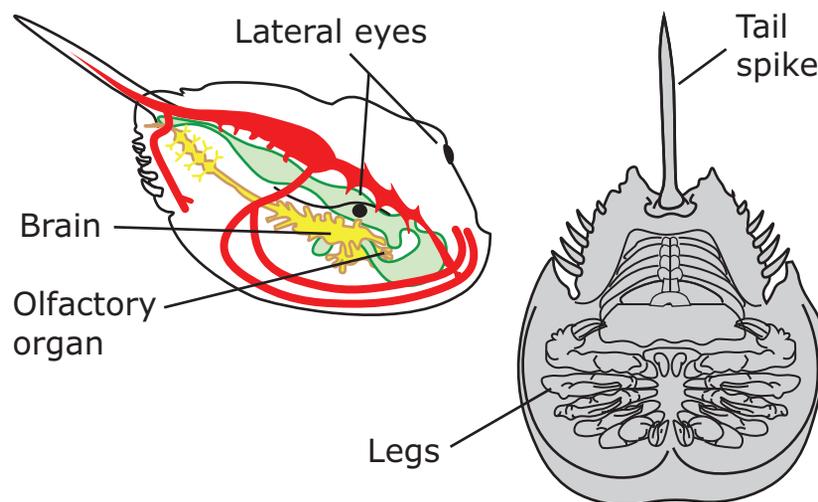


Stimulus 1

Students visiting the Chesapeake Bay are surprised to find a beach covered with horseshoe crabs. As the male crabs surround the female crabs, the students wonder how the males find the females. By doing some research, the students learn that horseshoe crabs are a type of ocean organism. Each horseshoe crab has a hard outer shell, five pairs of walking legs, and a long tail spike. Each also has eight simple eyes, a pair of image-forming lateral compound eyes, and a large network of optic nerves. The olfactory organ is used to detect odors. Figure 1 shows the general anatomy of a horseshoe crab.

Figure 1. Horseshoe Crab Anatomy

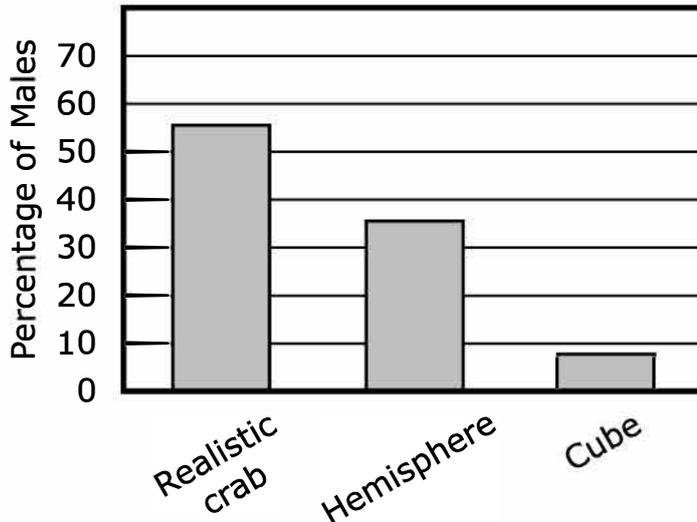


KEY	
	Circulatory system
	Digestive system
	Nervous system

Stimulus 2

The students read about a study that was conducted to test the idea that male crabs use vision to find females. In the study, scientists built three types of cement crab models. The first model was the shape of a real crab. The second model was in the shape of a hemisphere. The third model was shaped like a cube. The scientists placed the different models on the beach. Then they counted the number of male crabs that approached each model. Figure 2 shows the percentage of males that approached each model.

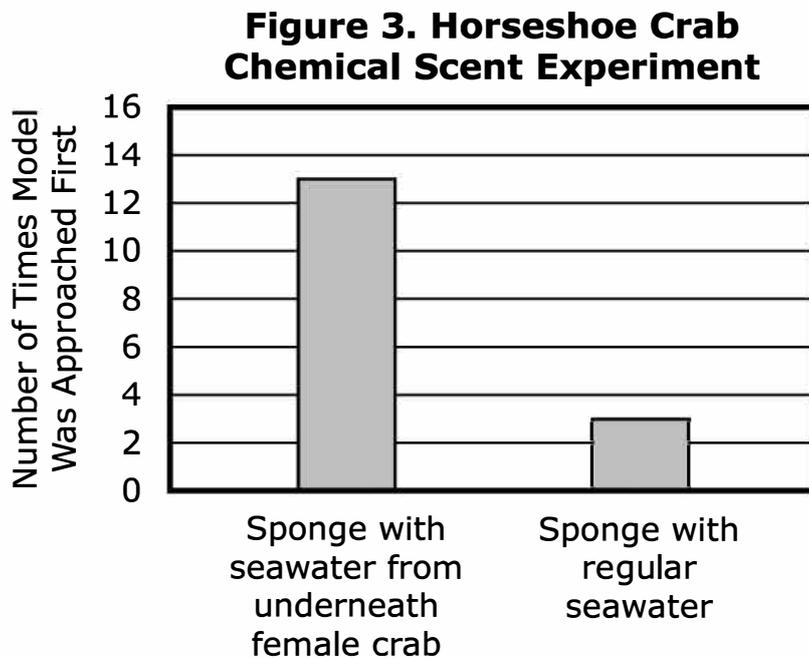
Figure 2. Shape of Horseshoe Crab Model Preference by Male Crabs



Source: R. Barlow, et al., *Nature*, 1982

Stimulus 3

The students read about another study that tested the theory that female crabs release a chemical scent, like a perfume, that the males detect. Scientists placed two realistic concrete models of female crabs at the shoreline. Next, they used a household sponge to absorb water from underneath a real female crab. They placed this sponge under one of the realistic concrete models. Then they placed a sponge filled with regular seawater under the other realistic model. The scientists counted the number of times each model was approached first by male crabs. Figure 3 shows their data.



Source: K. Saunders, et al., *Current Zoology*, 2010

Item 1

Based on Figure 2 and Figure 3, which conclusion can be reached about why realistic female crab models are approached by male crabs more often than other crab models are?

- A. Crabs respond to inputs from taste and smell.
- B. Crabs respond to inputs from vision and smell.
- C. Crabs respond to inputs from hearing and vision.
- D. Crabs respond to inputs from touch and hearing.

Item 2

Which claim about the organization of a crab's cells, tissues, and organs is supported by the data in Figure 3?

- A. Specialized cells in the male crab are made of organs that communicate information from outside the crab.
- B. Tissues of the male crab are made of organs that work together in the nervous system to help the crab find new mates.
- C. Tissues and organs in the male crab nervous system are made of specialized cells that communicate information received from the environment.
- D. Specialized cells in the male crab are made of tissues that work together in the nervous system to communicate information between the senses and brain.

Item 3

When a male crab approaches a realistic female crab model, systems within the male crab are interacting. Based on Figure 1, identify which system is activated for each process.

Circle the correct answers from the lists to complete the sentences.

The brain receives information from the eyes; the system that is

activated by the eyes is the

- | |
|------------------|
| nervous system |
| muscular system |
| digestive system |

. Information is sent to

the legs; the system that is activated in the legs is the

- | |
|--------------------|
| muscular system |
| respiratory system |
| excretory system |

Rubric	
Score	Description
2	The student selects the correct answer choices for both sentences. <ul style="list-style-type: none">• The brain receives information from the eyes; the system that is activated by the eyes is the nervous system.• Information is sent to the legs; the system that is activated in the legs is the muscular system.
0	The response is incorrect or irrelevant.

Item 4

Scientists use data from their experiments to support their hypotheses about how male horseshoe crabs find females. Based on Figure 3, construct a statement that provides a reasonable explanation for the crabs' behavior.

Circle the correct answers from the lists to complete the sentences.

Data from Figure 3 suggest that male crabs are attracted to

chemicals from
the shape of
the color of

the females. The sense receptors in the male crab

respond to the input and send signals to the

eyes
brain
tail spike

. This

influences the male crab's behavior.

Rubric	
Score	Description
1	The student correctly selects both drop-down answer choices. Data from Figure 3 suggest that male crabs are attracted to chemicals from the females. The sense receptors in the male crab respond to the input and send signals to the brain . This influences the male crab's behavior.
0	The response is incorrect or irrelevant.

Item 5

Consider the following statement: "Male horseshoe crabs surround female crabs because when the males' sense receptors receive certain inputs, that information is processed by the brain, resulting in attraction." Based on the data in Figure 2 and Figure 3, determine whether each piece of evidence (1) supports the statement or (2) does not support the statement.

Place a check mark in the circle to indicate your answer choice in each column.

	Male crabs can release a chemical scent.	Male crabs most often approached models that smelled like females.	Both male and female crabs have hard outer shells.
Supports the Statement	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Does not Support the Statement	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

Rubric	
Score	Description
1	The student selects the correct answers in all three columns. Evidence: Male crabs can release a chemical scent. - Does not support the statement Evidence: Male crabs most often approached models that smelled like females. - Supports the statement Evidence: Both male and female crabs have hard outer shells. - Does not support the statement
0	The response is incorrect or irrelevant.

Item 6

A student argues that because the male horseshoe crab has many eyes, it needs to rely only on its sense of vision to detect females.

- Decide whether the student’s explanation is correct or incorrect. Support your argument with evidence from Figure 1, Figure 2, and Figure 3.
- Explain how the nervous system interacts with another body system of the horseshoe crab.
- Explain how the nervous system and other body systems of the horseshoe crab may be considered subsystems of a larger complex system.

Analyze the information carefully. Then write your answer in the space provided. Support your answer with details.

B <i>I</i> <u>U</u>     ABC 

Scoring Rubric	
Score	Description
3	The student answers all three parts correctly.
2	The student answers any two parts correctly.
1	The student answers any one part correctly.
0	The response is blank, incorrect, or irrelevant.
	<ul style="list-style-type: none"> • This explanation is incorrect. A crab can use many sensory organs to locate females. Figure 1 shows that a crab has eyes for vision and an olfactory organ for smell. The data from Figure 2 show that males do use vision to discern the shapes of crab models, and the data from Figure 3 show that males are also able to detect smells emitted by females. • The nervous system interacts with the digestive system by coordinating the mouth and stomach as food is being processed. • The nervous system and digestive system may be considered as subsystems of the greater living system that is the horseshoe crab. <i>[Note: Any selected reasonable body system that interacts with the nervous system should receive credit as long as there is some correct justification in the explanation.]</i>