

LESSON:

Human Body Systems: The Domino Effect

Summary: Students build a domino course to simulate various body systems covered in the reading. Then, they topple the dominoes (by knocking the first one down) to see the interrelationships of the body systems. (See “Prepping the Lesson” for an alternative method not using dominoes.) This lesson is intended to serve as introduction or review of the human body systems.

EHP Article: “In Disaster’s Wake: Tsunami Lung”
EHP Student Edition, February 2006, p. A734
<http://ehp.niehs.nih.gov/docs/2005/113-11/forum.html>

Objectives: By the end of this lesson, students should be able to:

1. describe how bacteria and its effects travel through the body;
2. explain the interrelationships between the respiratory, circulatory, nervous, and muscular systems; and
3. hypothesize about how a substance may pass through the blood–brain barrier.

Class Time: 1 hour, or 30 minutes if Steps 6 and 7 are assigned as homework

Grade Level: 9–12

Subjects Addressed: Biology, Environmental Science, Health

► Prepping the Lesson (15–30 minutes)

INSTRUCTIONS:

1. Download the entire February 2006 *EHP Student Edition* at <http://ehp.niehs.nih.gov/science-ed/> or download just the article “In Disaster’s Wake: Tsunami Lung” at <http://ehp.niehs.nih.gov/docs/2005/113-11/forum.html>.
2. Make copies of the Student Instructions and the article.
3. Determine whether you will use dominoes or the alternative method of using butcher paper and colored pencils (see Implementing the Lesson). The alternative method has students draw the path through different body systems. If using the dominoes method, a space of about 4’ wide by 6’ long is needed to build each domino course. The tops of lab counters/desks should suffice.
4. Decide on the number of groups and how many students will be in each group. If using the dominoes method, groups of six to eight students may decrease the time needed to build the domino course but may also increase the likelihood of toppling the course prematurely.
5. Determine if there are any terms/phrases in the Student Instructions that should be eliminated or added based on your students’ knowledge. The critical terms/phrases are:
 - Arteries
 - Brain
 - Bronchi
 - Heart
 - Lungs
 - Mouth/nose
 - Muscles
 - Pharynx
 - Spinal cord
 - Trachea
 - Veins



MATERIALS (per student):

- 1 copy of *EHP Student Edition*, February 2006, or 1 copy of "In Disaster's Wake: Tsunami Lung"
- 1 copy of Student Instructions

MATERIALS (per group):

- Approximately 150 dominoes
- Sticky notes, 1.5" by 1" in size
- Butcher paper (for alternative method only)
- Colored pencils/markers (for alternative method only)

VOCABULARY:

- Abscess
- Blood–brain barrier
- Circulatory system
- Left ventricle
- Muscular system
- Nervous system
- Pulmonary vein
- Respiratory system
- Left atrium
- Tsunami lung

BACKGROUND INFORMATION:

During the December 2004 tsunami, many individuals were swept some distance by the tsunami waves, which forced contaminated water into people's mouth and nose, and down the pharynx. Some of the water was swallowed down the esophagus and went into the stomach. Some of it also went down the trachea and into the lungs. This caused the individuals to cough and sometimes vomit. The water that went into the lungs created an infection in the lungs. This infection was transported through the alveoli into the circulatory system, where it traveled via the pulmonary vein into the heart. The pulmonary vein, which carries oxygenated blood, brought the infection with the blood into the left atrium. Then the infection and blood traveled to the left ventricle, which pumped the blood into the aorta for distribution throughout the entire body. The bacteria from the infection could also affect the heart. Once the blood was pumped from the left ventricle, the infection and blood traveled to the entire body through the arteries. (For the purposes of this activity, only the carotid arteries are covered.) The infection could then travel in the carotid arteries to the brain. If the infection crossed the blood–brain barrier, it could affect the brain and its functions. While the infection did not "travel" through the nervous system, it could affect how the brain operated the body by impacting how nerve impulses were sent throughout the body.

First discovered in the 1900s, the blood–brain barrier keeps many harmful substances out of the brain. The blood–brain barrier is semipermeable, which means that it allows some substances to pass through and blocks others. Capillaries, which are the smallest blood vessels, are lined with endothelial cells throughout most of the body. In the brain, these endothelial cells form tight junctions that seal any space between cells to create the blood–brain barrier. The blood–brain barrier works in the following ways:

1. The tight junctures between cells keep out large molecules.
2. The barrier allows substances that have a sufficient amount of lipid solubility to pass through to the brain.
3. The barrier keeps out molecules that have high electrical charges.

RESOURCES:

Environmental Health Perspectives, Environews by Topic page, <http://ehp.niehs.nih.gov/topic>. Choose Infectious Disease, Neurology

Allworth AM. 2005. Tsunami lung: a necrotising pneumonia in survivors of the Asian tsunami [letter]. *The Medical Journal of Australia* 182(7):364, http://www.mja.com.au/public/issues/182_07_040405/all025_fm.html

British Broadcasting Corporation's Online Science, Interactive body, <http://www.bbc.co.uk/science/humanbody/>

University of Washington, Blood–brain barrier, <http://faculty.washington.edu/chudler/bbb.html>



► Implementing the Lesson

INSTRUCTIONS:

1. Hand out the Student Instructions and the article to students.
2. Review the Student Instructions and then have students read the article.
3. Depending upon your students' knowledge, you may want to review the purpose of the pulmonary vein, the left atrium and ventricle of the heart, the aorta, and the carotid arteries (see definitions below and refer to the Background Information section). You may want to have students use an anatomy or health book when they do this activity, or they could research the circulatory system online.

Pulmonary vein—brings oxygenated blood from each of the lungs to the left atrium of the heart; the only vein in the body that carries oxygenated blood.

Aorta—an artery that brings oxygenated blood from the left ventricle of the heart to the body.

Left atrium of the heart—receives oxygenated blood from the pulmonary vein; pumps into the left ventricle.

Left ventricle of the heart—receives oxygenated blood from the left atrium and pumps the blood into the aorta for distribution to the body through the arteries.

Carotid arteries—carry oxygenated blood to the neck, head, face, and brain.

4. Have students complete the Student Instructions.
5. Tell students which terms/phrases their simulation should include. **As an alternative to using the dominoes**, have students trace a life-size body outline on butcher paper and then use colored pencils/markers to draw the path the bacteria and its effects took through the body, starting with the respiratory system and including the circulatory, nervous, and muscular systems.
6. If you choose to use the dominoes, hand them out and have the groups build their courses. Before each group topples its domino course, review the course for accuracy.
7. Debrief activity and review homework assignment, if appropriate.

NOTES & HELPFUL HINTS:

- This lesson may serve as an anticipatory set to determine what your students know before beginning a unit on the human body systems. If used as an anticipatory set, you may want to use only the essential terms/phrases.
- This lesson may serve as a group assessment after you have completed a unit on the human body systems. If used as a group assessment, you may want to include additional terms/phrases depending upon your past lessons.
- This lesson can be easily extended to cover the interrelationships of the body systems in greater depth.
- To decrease the time needed, the domino course could be completed as a demonstration for the entire class.
- To assist students with building their domino courses, copy the diagram from the Assessing the Lesson section onto an overhead.
- If you have access to different-colored dominoes, students could visually differentiate between veins and arteries.

► Aligning with Standards

SKILLS USED OR DEVELOPED:

- Classification
- Communication (written)
- Comprehension (reading)
- Critical thinking and response
- Manipulation
- Observation
- Research

SPECIFIC CONTENT ADDRESSED:

- Human body systems



NATIONAL SCIENCE EDUCATION STANDARDS MET:**Unifying Concepts and Processes Standard**

- Systems, order, and organization
- Evidence, models, and explanation
- Evolution and equilibrium
- Form and function

Life Science Standard

- Interdependence of organisms
- Matter, energy, and organization in living systems
- Behavior of organisms

Science in Personal and Social Perspectives Standard

- Personal and community health
- Natural and human-induced hazards

▶ Assessing the Lesson

Step 3/4: Review students' diagrams for accuracy. On page 5 of this lesson is an example of a possible domino course. Remember, the domino course will be a simplified representation of the human body systems.

Step 6: Write a paragraph about how your diagram and domino course differed from each other and what you learned about the interrelationships of the human body systems.

Answers will vary. Review answers to see that students understand the systems and could clearly explain any limitations of using the dominoes. They also need to clearly explain what they learned about the interconnections between the body systems.

Step 7: Why do you think the bacteria responsible for tsunami lung were able to pass through the blood–brain barrier? Present this as a testable hypothesis with sufficient details to explain your idea.

Answers should be graded based on what the students have already learned in class about cells, membranes, and transport. Students with little background in this topic should be rewarded for reasonable and logical answers that contain adequate details, even if their answer is incorrect. If an answer is incorrect, point it out, but reward them for thinking, generating ideas, and communicating those ideas.

The blood–brain barrier works in the following ways:

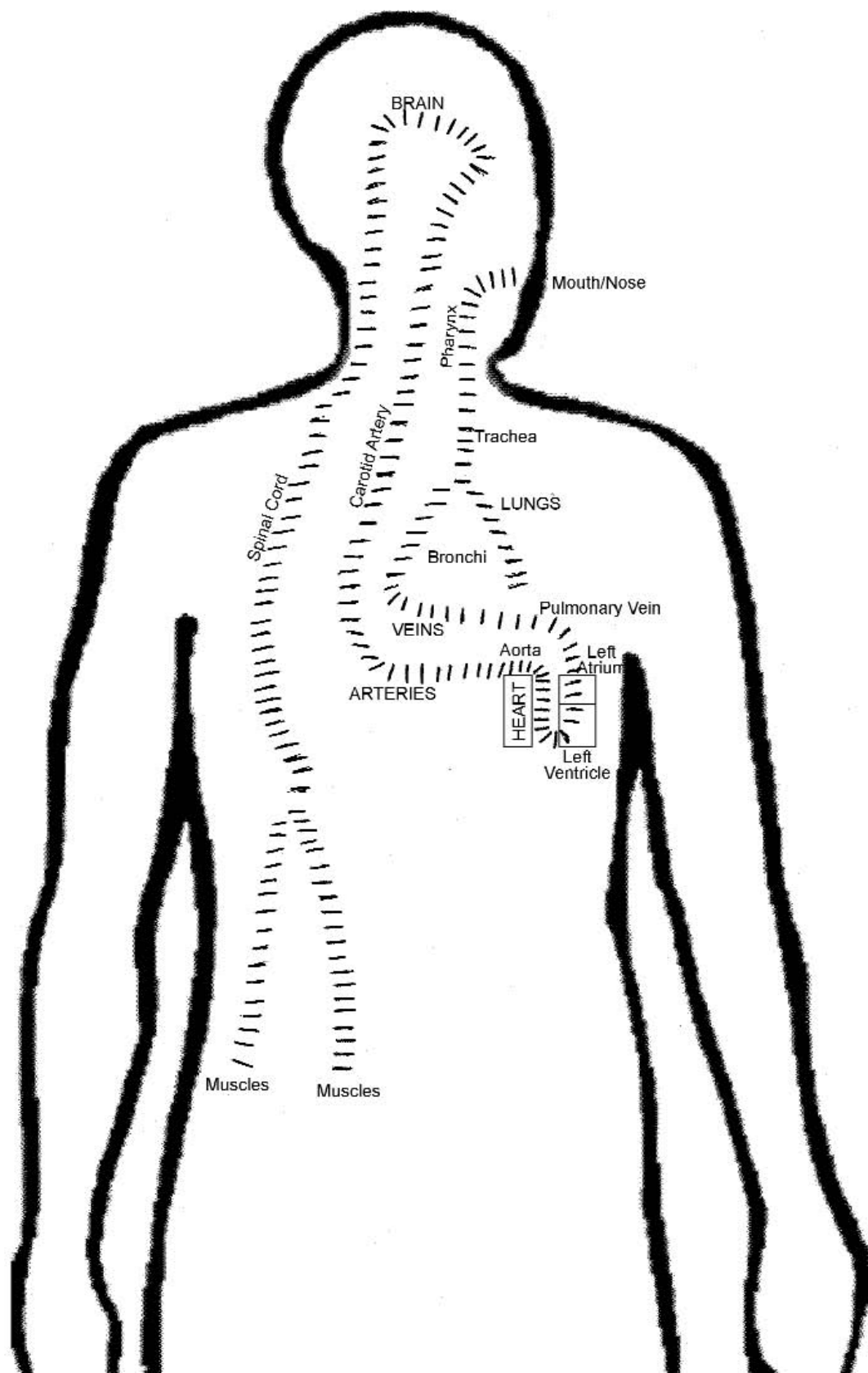
1. The tight junctures between cells keep out large molecules. Examples of student answers related to this may include that the molecule is small enough to pass through or that the juncture is damaged, which allows larger molecules through.
2. The barrier allows substances that have a sufficient amount of lipid solubility to pass through to the brain.
3. The barrier keeps out molecules that have high electrical charges. A possible answer that relates to 2 and 3 may include that the substance mimics or behaves like substances that are allowed through the barrier.

▶ Authors and Reviewers

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STUDENT INSTRUCTIONS: Human Body Systems: The Domino Effect

INDIVIDUALLY:

Step 1: Read the article "In Disaster's Wake: Tsunami Lung," *EHP Student Edition*, February 2006, p. A734. As you read the article, underline appropriate sections that refer to the respiratory, circulatory, nervous, and/or muscular systems.

IN YOUR GROUP:

Step 2: Write the following terms/phrases on individual sticky notes:

Mouth/nose	Left atrium
Pharynx	Left ventricle
Trachea	Arteries
Bronchi	Aorta
Lungs	Carotid arteries
Veins	Brain
Pulmonary vein	Spinal cord
Heart	Muscles

Step 3: On the human body outline, draw the path the bacteria took through the body to the brain and then how its effects were transmitted to the muscles. Start with the respiratory system, and include the circulatory, nervous, and muscular systems. Be sure to label your diagram with the terms/phrases listed in Step 2.

Step 4: Use dominoes to build a course (with dominoes standing on end) based on your diagram. Your domino course may be a simple representation of your diagram, but the course should still include the parts of the body listed in Step 2. Use the sticky notes to label the parts of the body on your domino course.

- Set up your dominoes on a smooth, level surface.
- For dominoes in a straight line, leave a space about the width of one domino between the dominoes.
- For dominoes in a curved line, leave less than half an inch between each domino.
- Set up your dominoes in groups of ten, then leave some space and set up another group. When the course is almost done, fill the spaces in between. That way, if a domino is accidentally knocked down during setup, all the dominoes in the course won't be knocked over.

Step 5: Once your teacher has approved your domino course, then your group can topple your dominoes to simulate how the bacteria and their effects traveled in the body by knocking the first domino down. (If your domino course stops, feel free to help your course by knocking down the domino that broke the flow to continue the simulation.)

Step 6: Write a paragraph about how your diagram and domino course differed from each other and what you learned about the interrelationships of the human body systems.

Step 7: The blood-brain barrier is an area near the brain where capillary cells are very close together to prevent unwanted substances from entering the brain. Why do you think the bacteria responsible for tsunami lung were able to pass through the blood-brain barrier? Present this as a testable hypothesis with sufficient details to explain your idea.



