Lesson 1: Symptoms of a Mystery Disease


**If you plan to use the second sickle cell anemia lesson on pedigrees, it is important not to disclose during this first lesson that the disease is inherited.**

Engage

1) Hand out the sickle cell patient scenario reading to students (Appendix I). Using highlighters, have students individually mark information from the reading that they think would be useful clues for diagnosing the patient’s disease.

2) As a class, compile a list of the information gathered and discuss the results. ASK: What types of tests do you think the physician could do to determine what disease these symptoms represent? Ask students to justify their test ideas with information from the text. List and discuss class answers. (Ideally, students will come to determine that a blood test would be beneficial in diagnosing a disease. This will lead to activities in which students view red blood cell pictures and model blood flow in a “normal” individual and a person with sickle cell anemia.)

Explore

1) Students will work through two stations to determine the phenotypes of blood cells and blood flow associated with sickle cell anemia. These two stations allow students to use an inquiry-based approach to construct a connection between the RBC (red blood cell) structure of normal and SC (sickle cell) varieties and the symptoms of sickle cell disease that can result (Appendix II & III). Students will work in pairs. Half the class can start with Station 1; the other half can start with Station 2. Make sure there are enough sets of materials at each station for the number of pairs working there – groups of 3-4 will also work if materials are tight.

2) Station 1: Viewing Normal vs. Patient Red Blood Cells
   a. If possible, this station is best done with actual slides of normal and sickled blood. Prepared slides can be purchased from several biological supply companies.
   b. Compound microscopes with x1000 capability are needed to view these slides.
      • If students have trouble focusing the microscope, the following is a good tutorial: http://www.microscope-microscope.org/basic/how-to-use-a-microscope.htm. Do not focus the scopes for them!
      • If you are using binocular microscopes, remind students to adjust the distance between the eyepieces so that they see one clear field of vision with both eyes. Modify the handout in
Appendix II to provide spaces for students to draw each slide, then have them answer the Analysis questions.

c. If it is not possible to obtain actual slides, use the handout in Appendix II unaltered OR project the images of normal and sickled blood side by side on a screen and modify the handout so that students have to draw each slide. Have students also complete the Analysis questions.

3) Station 2: Tube Capillary and Clay Red Blood Cells Model

a. For each pair of students, provide a six-inch piece of clear tubing (of the type used to hook up gas lines in a lab), as well as one cup of disc-shaped, “normal” red clay blood cells and one cup of crescent-shaped “sickled” red blood cells (see photos below).

b. In their notebooks, ask students to predict how each type of blood cell will flow through the tube and how a combination of types will flow.

c. Once students have made blood flow predictions, ask them to complete the handout (Appendix III), including the Analysis questions. Analysis requires students to identify what the clay cells and tube are models for in the body and explain how misshapen cells can change the flow of blood. What symptoms do you think would result in a person with this change in blood flow? (Answer: Sickle-shaped red blood cells can clump together and block capillaries, tiny blood vessels. This prevents adequate delivery of oxygen to tissues and can result in pain, infections, fatigue, and organ damage.)
4) Once student groups have completed both stations, make a T-chart and ask students to contribute to compiling a list of observations from each station; then work together to come up with the two concluding concepts listed below. ASK: What did each of the stations teach you about how the disease works? What causes the symptoms of this disease? If students have not yet determined the name of the disease, discuss here—ask them what they think it should be called.

Conclusion concepts:

a. The blood cells are irregularly shaped and vary in quantity.
b. The irregular shape of the RBCs interferes with their ability to flow through the blood pathways. These two concluding concepts can then be referenced back to the opening Patient Scenario to determine that the symptoms described therein are a result of this disease.

Explain
Introduce students to sickle cell anemia with the following six-minute video entitled “Sickle Cell Anemia: A Patient’s Journey” about a 17-year-old girl named Alexandria. This video is produced by the American Society of Hematology. Importantly, this video focuses on the connection between the cellular deformation and the symptoms, not the molecular mechanism and inheritance, which is the focus of the next lesson. (http://www.hematology.org/Publications/Videos/5716.aspx or http://www.youtube.com/watch?v=2CsgXHdWqVs&feature=plcp)
Appendix I

Patient Description

In 1904, Dr. Herrick, a Chicago physician, met a student from the West Indies with a puzzling condition. Below is a summary of some of Dr. Herrick’s observations. Your job is to learn more about this condition and to find out how the disease is affecting this patient’s body. To begin, read the description below and highlight any information you think may be important for understanding the disease.

Dr. Herrick talked with the patient to learn more about the symptoms he was experiencing. The patient reported feeling well most of the time. However, he often had fevers and infections. The patient also reported that while he was young he repeatedly had trouble breathing. He had pain in the left abdominal area, and this area was tender to the touch. He also had pain in the joints and muscles in his legs and arms. He reported that he often felt so weak that he had to rest in bed a few weeks. As an example, one day after a short swim he became so tired that he could hardly move.

When Dr. Herrick examined the patient, he noticed the whites of his eyes had a yellowish tint. When Dr. Herrick asked about the patient’s family, he learned that his parents and his two brothers and three sisters have never experienced these problems. However, his uncle and his grandmother used to have similar attacks. His grandmother died at a young age.

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Appendix II

Station 1: Viewing Normal vs. Patient Red Blood Cells

Directions: Below are images of red blood cells (erythrocytes = erythro-red/cytes-cells) on slides viewed with a microscope. The picture on the left shows cells from a “normal” individual, whereas the picture on the right shows cells from Dr. Herrick’s patient.

Slide 1: Red blood cells from a “normal” person
Slide 2: Red blood cells from Dr. Herrick’s patient

Analysis: Answer the questions below in complete thoughts.

1. Write two observations for slide 1.

2. Write two observations for slide 2.

3. Compare: List one way the two slides are the SAME.

4. Contrast: List one way the two slides are DIFFERENT.

5. Which slide contains the most cells?

6. Why do you think it might negatively affect an individual to have fewer red blood cells in their body?
Appendix III

Station 2: Model the Flow of Clay Blood Cells through Tube Capillaries

Directions: Use the materials on the lab tray to model how blood cells flow through very small blood vessels called capillaries. The tube represents a capillary, and the red clay represents blood cells. Notice that some of the clay is donut-shaped, and some is flattened into a crescent shape.

Complete the following two model scenarios and carefully observe the differences. Draw a colored sketch of each model scenario in the correctly labeled box. Use red colored pencils for the RBCs.

Model 1: Hold the curved tube upright with the open end up and only allow round-shaped cells to flow through the tube.

Model 2: Hold the curved tube upright with the open end up and allow a mixture of round and crescent-shaped cells to flow through the tube.

Analysis: Answer the questions below in complete thoughts.
1. Compare how the flow of cells was the SAME in the two models.

2. Contrast how the flow of the cells was DIFFERENT between the models.


4. Explain how misshapen cells can change the flow of blood.

5. Given what you know about the function of blood in the body, how do you think the symptoms of Dr. Herrick's patient relate to the shape of his blood cells and their influence on blood flow?