
Problem 4.3.3: The Heart as a Pump

Introduction

As you learned in Lesson 4.1, the cardiovascular system provides your body's cells the resources needed for life and provides a transport system to get rid of waste. The human heart is a pump, designed to efficiently propel blood to the lungs to pick up oxygen and send it to the cells and tissues of the body that need this precious resource. If the pump or its associated vessels fail, there can be disastrous consequences.

In this activity you and a partner will design and build a simple pump to simulate the heart on the most basic level. You will then design an experiment to simulate the effects of cholesterol plaques on blood flow rate.

Equipment

- Computer with Internet access
- Design Process Resource Sheet
- Experimental Design resource sheet
- Activity 4.1.2 Autopsy Report resource sheet
- Laboratory journal
- 2 Flasks, 250 mL
- 2 Lengths of rubber tubing, (4/16" diameter, 15 cm, and 25 cm)
- Additional tubing of various diameters
- 1 Two-holed stopper that fits a 250 mL flask
- 2 Lengths of glass tubing (7 mm outside diameter, 20 cm, and 10 cm length)
- 1 Pinch clamp
- 1 Screw compression clamp
- 1 Balloon
- 1 Piece of string, 1 meter in length
- 1 Piece 2-inch wide duct tape (20 cm)
- Sharpie pen
- Water
- Microscope
- Prepared slides of arteries and arteries with atherosclerosis
- Colored pencils

Procedure

Part I: Build A Pump

1. Obtain the following materials:
 - 2 Flasks, 250 mL
 - 2 Lengths of rubber tubing, (4/16" diameter, 15 cm, and 25 cm)

- 1 Two-holed stopper that fits a 250 mL flask
 - 2 Lengths of glass tubing (7 mm diameter, 20 cm, and 10 cm length)
 - 1 Pinch clamp
 - 1 Balloon
 - 1 Piece of string, 1 m in length
 - 1 Piece of 2-inch wide duct tape (20 cm)
2. Design and build a pump, using only the materials obtained in Step 1, which will move 150 mL of water from one flask into the second flask. Sketch ideas in your laboratory journal. NOTE: You may refer to the Design Process Resource Sheet located in the PLTW Resource Sheets section of your course file for guidance, but you do not need to formally document each step. Get an approval stamp for design.
 3. When your design is successful, demonstrate it to your teacher. Get a stamp (2nd one) for working pump.
 4. Make a sketch of your final design in your laboratory journal.
 5. Answer Conclusion questions 1 and 2.

Part II: Experimental Design

6. Take out your Experimental Design resource sheet as a reference.
7. Using your pump, design an experiment to determine the effect that narrowing vessels, as caused by cholesterol plaques, plays on flow rate. In your experiment, you must do the following:
 - Simulate at least two different scenarios that demonstrate varying vessel diameters
 - Include a procedure or a calculation to determine how the diameter of the tubing affects overall flow rate. Complete additional research if needed.
8. Gain approval (stamp) for your design from your teacher and run your experiment. Capture all data in your laboratory journal. Write a formal lab report if directed to do so by your teacher.
9. Take out the Activity 4.1.2 Autopsy Report resource sheet. Note that on Anna's autopsy report, the medical examiner references *atherosclerosis*. Research this term and take notes in your laboratory journal about how this condition is related to cholesterol. Think about how this condition could have been linked to her death.
10. Obtain a microscope and prepared slides of coronary arteries with and without atherosclerosis.
11. View the slide of a normal artery. Draw what you see in your laboratory journal. Note the magnification on your drawing.
12. View the slide of an artery with atherosclerosis. Draw what you see in your laboratory journal. Note the magnification on your drawing.
13. Write a sentence or two under your slide drawings that highlights the difference between the two images.

