raft resource area for teaching
www.raft.net

Curriculum topics:

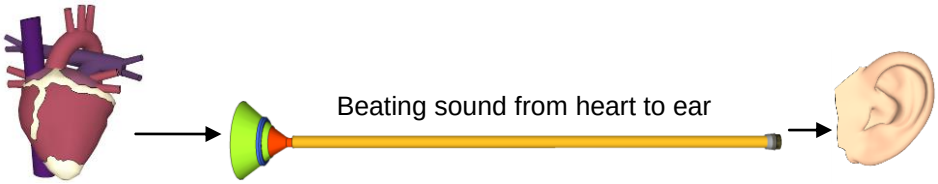
- Anatomy
- Blood Pressure
- Circulation
- Investigations
- Sound

Subjects:
Life Science,
Physical Science

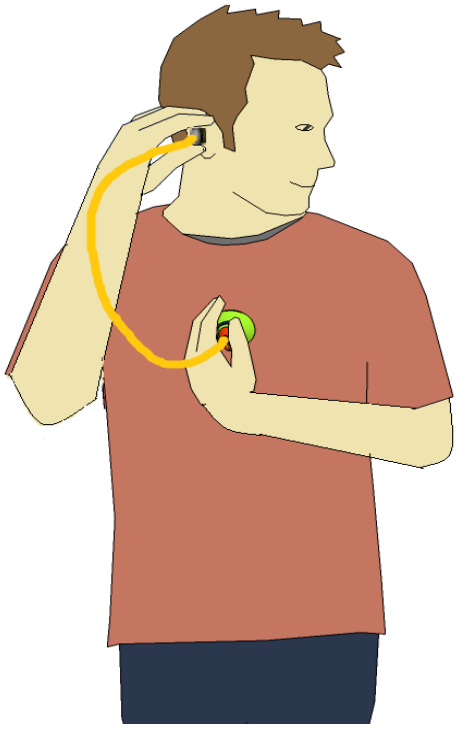
Grade range: 4 – 12

SIMPLE STETHOSCOPE

Catch the (heart) beat



Listening to the heart is a practical way to teach students about how the heart pumps blood through the circulatory system. The sounds of the beats provide information on heart valves, heart rate, and they reveal the relationship between circulation and respiration. This simple device allows students to appreciate the importance of the stethoscope in medicine and the study of human biology.



Who we are:

Resource Area for Teaching (RAFT) helps educators transform the learning experience through affordable "hands-on" activities that engage students and inspire the joy and discovery of learning.

For more ideas and to see RAFT Locations

www.raft.net/visit-raft-locations

http://www.raft.net/raft-idea?isid=673

Materials required

Per Stethoscope unit:

- Flexible rubber tubing or equal, 30 cm (12”) long with 11 mm- 13 mm (7/16” – ½”) diameter
- Rubber band, #70
- Balloon, 13 cm (9”) in diameter
- Funnel, top diameter 4.5 cm (1 ¾”), spout diameter 0.5 cm (7/32”), spout length at least 4.5 cm (1 ¾”)
- Ear bud foam piece, 1
- Scissors
- Tape

How to build it

Caution: Rubber bands and balloons contain natural rubber latex which may cause allergic reactions.

⚠ WARNING:
CHOKING HAZARD—Children under 8 yrs. can choke or suffocate on uninflated or broken balloons. Adult supervision required.

1 Starting from mouth end of balloon, cut off 2.5 cm (1”) of the stem and discard. See figure 1.

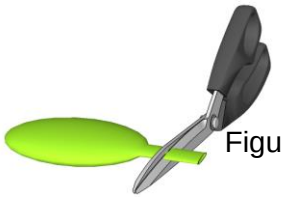


Figure 1

2 Carefully stretch cut end of balloon over top of funnel, making sure balloon forms a flat membrane across funnel opening. See figure 2.

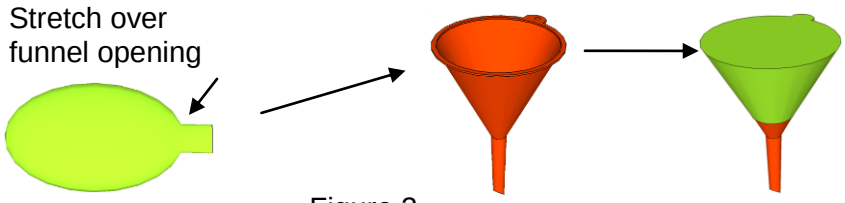


Figure 2

3 Secure balloon onto funnel with rubber band, wrapping rubber band around balloon and funnel until tight. Adjust balloon membrane if needed. See figure 3.

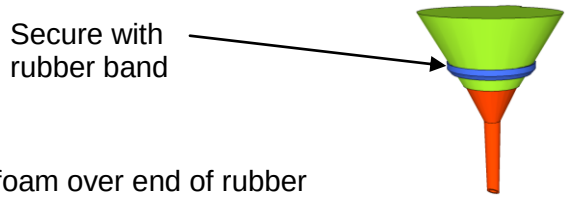


Figure 3

4 Place ear bud foam over end of rubber tubing and secure with tape. See figure 4.

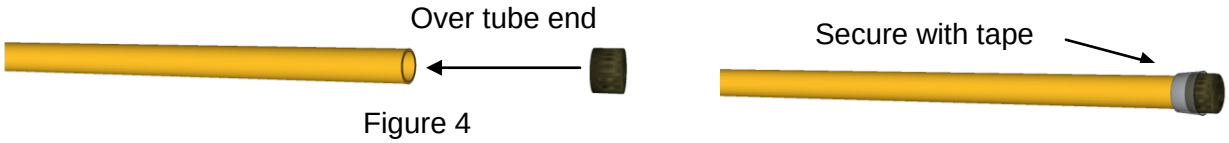


Figure 4

5 Insert funnel spout into uncovered end of rubber tubing until funnel stays firmly attached to tubing. See figure 5.

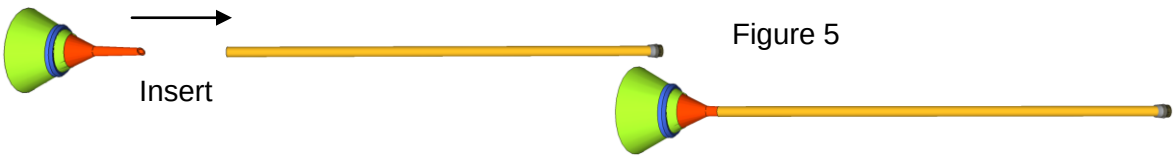


Figure 5

6 Hold foam end of tubing to ear opening to test for comfort. Do not force the tubing into the ear canal! If needed, remove tape from foam and adjust foam for a more comfortable fit. See figure 6.

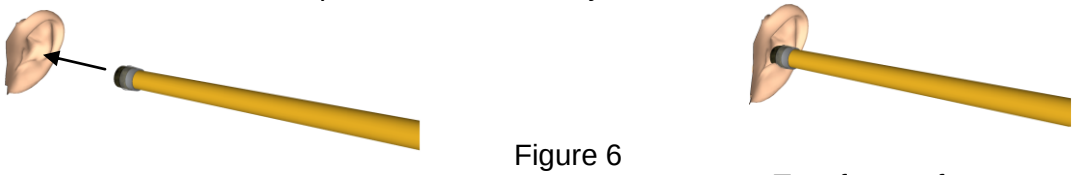


Figure 6

Test for comfort on ear

To do and notice

1. Carefully place foam end of tubing up to ear. Do not force tubing into ear canal!
2. Lightly stroke balloon membrane. Can sound be heard? Try stroking membrane progressively more lightly until no audible sound is heard.
3. Repeat step 1. Position membrane on chest over heart and then press firmly. Can a heartbeat be heard? Move funnel around in 1 cm (~½“)-steps until heartbeat is audible. Where is the loudest location?
4. Count number of heartbeats in 1 minute.
5. Run in place for two minutes to speed up heart rate and then count again.
6. Compare number of heartbeats before and after exercise. Which one was higher? Was the relative number of breaths taken after exercise higher than before? Develop a hypothesis relating heartbeat and breathing rate.

The science behind the activity

Background information

Originally doctors would place an ear directly over a patient’s chest in order to hear how the heart was beating. In 1816 Rene Laennec, a French physician, used a cylinder of rolled up paper to listen to a patient’s heart beating so that his head did not touch the patient’s chest. He refined the concept and developed a wooden tube with a tapered, funnel-like, end. His original stethoscope was a rigid (stiff), acoustical (sound based), monaural (single ear), bell (open ended) stethoscope. Modern designs are flexible, acoustic (could be electronic based and thus amplified), binaural (2-ear), with both a bell and a diaphragm (sealed end) at the “head” of the stethoscope. Modern stethoscopes have two types of heads because the bell head with an uncovered opening is better at collecting low frequency sounds while the diaphragm’s sealed chamber is better at collecting high frequency sounds.

Key content

The tube-shaped ear canal directs sound waves toward the ear drum. Placing an end of the plastic tubing to an ear creates an extended “ear canal”, permitting faint stroking of the membrane at the other end of the plastic tubing to be heard. The outer ear has a wide opening to help funnel sound waves toward the narrower inner ear canal, amplifying the sound waves in the process. In the same way, the plastic funnel connects both a wide and a narrow opening to amplify sound waves. The balloon material seals the end of the funnel in the same way the ear drum seals the ear canal. The vibrations due to the sudden closing of the heart valves are transmitted through the chest to move the balloon material back and forth which then vibrates the column of air in the funnel. The air moving back and forth in the funnel sends sound waves through the tubing to the ear drum. Clothing will dampen (lessen) the amplitude (“volume”) of the vibrations, which is why medical personnel usually place the head of a stethoscope against bare skin when listening to the heart.

Curriculum Standards:

Body structures and systems (Next Generation Science Standards: Grade 4, Life Science, 1-1; Middle School, Life Science, 1-3)

Science & Engineering Practices (Next Generation Science Standards: Grades 4-12)

Additional standards at: http://www.raft.net/raft-idea?isid=673

The science behind the activity (continued)

The heart is located in the center of the chest with the lower end of the heart tilted slightly to the left. A heart beat usually consists of a "lub" followed by a "dub" sound. The sound is caused by the four one-way valves of the heart closing in sequence to prevent the blood from flowing in the wrong direction as the heart contracts and relaxes. The "lub" sound consists of the sounds from two of the four valves closing nearly at the same time and then the "dub" sound is caused by the other two valves closing. The subtle sound variations of the beating heart may not be noticeable when using a simple stethoscope.

Learn more

- Draw a picture of the heart based on own understanding, then write a paragraph about the function of the heart.
- Draw an outline of the human body and fill in with known features, leaving room for drawing in the heart and lungs.
- Try to hear the heartbeats of various organisms such pets, classmates, or family members and compare heart rates between them.
- Investigate how sound travels through different media such as water and solid materials using stethoscope.
- This stethoscope is a monaural design (single-ear). Modern stethoscopes are binaural (use both ears), which makes it easier to hear a heartbeats and other sounds. Work with a partner/team and design a binaural stethoscope using other accessible materials. Test the design using the steps in "To do and notice". Discuss the performance of the binary stethoscope compared to the monaural design.

Related activities: See RAFT Idea Sheets:

Bloodless Hematocrit –
http://www.raft.net/ideas/Bloodless Hematocrit.pdf
Breathe In Breathe Out -
http://www.raft.net/ideas/Breathe In Breathe Out.pdf
Heart Size, Blood Volume, and Flow-
http://www.raft.net/ideas/Heart size Blood Volume and Flow.pdf
I Can Hear Your Heartbeat -
http://www.raft.net/ideas/I Can Hear Your Heartbeat.pdf
Red Blood looks "Blue"? -
http://www.raft.net/ideas/Red Blood looks Blue.pdf

Resources

Visit www.raft.net/raft-idea?isid=673 for "how-to" video demos & more ideas! See these websites for more information on the following topics:

- **Heartbeats** - http://www.myuniversalfacts.com/2005/08/what-causes-sound-of-your-heart-beat.html
- **How a heart works** – http://health.howstuffworks.com/heart.htm/printable
- **Normal and abnormal heartbeats** – http://depts.washington.edu/physdx/heart/demo.html
- **Stethoscope history** - http://medicine.utah.edu/alumni/students_residents/history_stethoscope.php
- **Videos and exercises on the Circulatory system from the Khan Academy** – https://www.khanacademy.org/science/health-and-medicine/circulatory-system