Title: The People Pump; **NSF GK12 Fellow**: Jeffery Morton (Boulder, CO)

Grade Level: 7th (Mid-school Life Science)

Type of Lesson: STEM

Objective (Goals & Boulder Valley School District Essential Understandings):
Science Standard 3: Students know and understand the characteristics and structure of living things, the processes of life, and how living things interact with each other and their environment.

Enduring Understanding: Organs and organ systems work together within the human body to perform specific functions.

Essential Learning: LS7, Describes the functions and interactions of human body systems (for example: circulatory, respiratory, muscular, skeletal, digestive) and the levels of organization within the human body.

Goal: Students will understand that the heart is
1. a major organ,
2. a muscle,
3. the pump that drives the circulatory system.

They will think of the heart as two pumps, each consisting of two chambers. The idea that the circulatory system is how food (nutrients) and oxygen is delivered to the body will be reinforced.

Students will also have an understanding of how the circulatory system is linked to the respiratory system.

Background Information: A general overview of the human body and its being comprised of systems (respiratory, digestive, circulatory, muscular and skeletal) is assumed. Beyond this, an introduction to the circulatory system—that it is how the body gets what it needs to all its parts—is helpful.

Information for the teacher:
- The heart is composed of four chambers, atria and ventricles on both the left and right sides.

- Blood first enters the heart through the atria, then passes into the ventricles from which they are pumped out again.
- The right ventricle pumps blood to the lungs. The left ventricle pumps blood to the rest of the body.
- Separating the atria from the ventricles is a valve. On the right side, the valve is tricuspid, or has three (3) leaflets. On the left side the valve is bicuspid, or has two (2) leaflets. The reason for this difference is unknown.

References:

Reece, J.B., L.A. Urry, M.L. Cain, S.A. Wasserman, P.V. Minorsky, R.B. Jackson. Campbell Biology (9^{th} edition).

Basey, John. General Biology Lab II Instructor, University of Colorado, Boulder. Pers. comm..

Lesson Vocabulary: atrium (pl., atria); ventricle; vessels; artery; vein; valves. These are introduced at the lab stations (see below).

Materials Required: All materials can be obtained from Carolina Biological Supply at Carolina.com, but many items are likely in stocked science classrooms.

- sheep hearts (at least 3; more depending upon how you set up the lab stations; $4.50 per heart);
- probes (8; $3.95 each);
- dissections trays (3-4; $47.50 each);
- non-latex gloves (enough for each student and teacher(s) ($14.95 for box of 100) ;
- human heart and/or model of human heart (1-2; optional). Small models can be as little as $53.00. For obtaining a real specimen, your best bet is to contact a nearby College/University or Medical School and contact the individual or department responsible for teaching anatomy.
- teacher will need a scalpel (~$3.00-4.50 depending on scalpel).

Preparation: This lab will likely necessitate permission from parents. In my case, we provided written notification to parents and asked that they notify the school if they would prefer that their child NOT participate in the lab or human heart portion of the lab. We only had one of some 150 students abstain.

The teacher will set up four different lab stations.

1. The teacher must first dissect the sheep hearts. Using a scalpel and cutting starting from the right atrium diagonally toward the left ventricle is generally effective for best viewing.
2. Place 1 to 2 sheep hearts at each lab station. Each station will have the heart(s) on dissecting trays. At least one probe should be provided per station. The stations are:

i. *Valves*: have students observe the valves separating the atria from the ventricles and note their appearances, including any differences. Make notes about observations.

ii. *Vessels*: have students use a probe to track the path of two (2) vessels. They should note to which chamber of the heart the vessel is connected and hypothesize about its function (i.e., bringing low-oxygen blood back to the heart, taking low-oxygen blood to the lungs, bringing oxygenated blood from the lungs back to the heart, pumping oxygenated blood from the heart to the rest of the body). The students do not need to know the names of the vessels, but this is a possible extension.

iii. *Ventricles*: students identify the two ventricles and measure the thickness of the muscle wall. Have students note the widths. Time allowing, data can be pooled and viewed as a class with a discussion of an appropriate graph to depict the data and means.

iv. *Human heart or model* (optional): An adult (parent volunteer, classroom assistant, etc.) should be at this station if you have it. This is meant to be a free form station that allows students to explore and ask questions. For instance, I was able to borrow two human hearts from a local University's anatomy lab. One of the hearts had a pacemaker attached, which inspired many questions about nutrition, human health and heart disease. Similarly, students could play with a model, gently disassembling and reassembling it and asking questions along the way.

For larger classes (20+), it is helpful to have two sets of each lab station. In that way, you need not have any more than 4-5 students at any one station at any given moment. This requires one to have at least 6 sheep hearts.

Safety Information: None with a reminder that it is likely best to give parents notice about the lab and an opportunity to opt their student out of it. Dissection of the sheep hearts is done prior to the lab and executed by the teacher.

How the lab flows

Engagement:

1. Start out by writing
   "I ♥ NY" and
   "Yo ♥ Mexico" (this if class consists of native Spanish-speaking English language learners).

Ask the class what it means. Then, ask the class why? They may not be able to answer the 2nd question. Do not wait long for an answer. Instead, segue into the question, why has the heart come to mean love?

2. Now show a slide of a picture from the Egyptian Book of the Dead that depicts a heart being weighed against a feather. You can ask the students about it (I was surprised at how many students were familiar with the image) or just discuss how in ancient Egypt, a person's heart was thought to contain their sole. In the picture, a person's heart is being weighed against a "feather of truth," and if the heart weighs out well, the person is admitted to the afterlife.

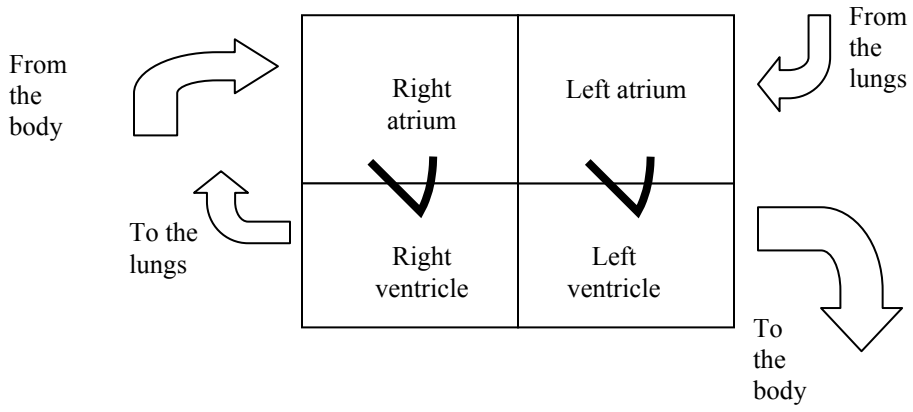
The idea that the heart contains the sole, therefore, goes back at least 5,000 years. Classical philosophers later promoted the idea that the heart was where emotions and thought originated (i.e., Aristotle [~350 BCE]). So, the idea that our emotions come from our hearts has a long history.

BUT, what does the heart really do?

Exploration: Let students offer ideas as to what the heart does. This can also serve as an assessment of the class' general knowledge. This can be done in small groups amongst themselves or as a class. This is more of a brainstorming session, so there are no wrong answers, just idea generation.

Then, tell them that you'd like for them to think of the heart as the pump that drives the circulatory system. In fact, it is two pumps. One pump takes blood to the lungs to get oxygen, the other receives that oxygen rich blood and pumps it to the rest of the body.

Present the picture:



Emphasize the new vocabulary (atria and ventricles as chambers; valves represented by doors; vessels represented by arrows). Highlight that the atria receive blood, the ventricles pump it away.

Now, ask them what they think the heart will look like. Will all of the 4 chambers look alike? Will some be bigger than the others? If the chambers are just spaces surrounded by the muscular tissue of the heart, will the muscle be as strong around each of the chambers? Let them think about this and develop a hypothesis.

After about 5-8 minutes, set them loose on the lab stations, giving clear instructions of what is to be done at each lab.

Explanation: Bring students back as a group. Have the share:

1. What did the valves look like? How many were there on each side? Why do they think this is (answer, we don't know)? Why are the valves necessary (answer: to keep blood from flowing back).

2. Were they able to track vessels? To where did their vessels lead?

3. Share the thickness of the muscle walls for the right and left ventricles. Put this data into a single table. If you enter this into excel, you can ask them what kind of graph might be good for the data and have a bar graph ready to go.

Reassert the idea that the heart is two pumps with the ventricles doing the pumping. One pump goes to the lungs, the other to the rest of the body. Then ask them, why are the muscles different for the right and left ventricles and let them kick that around. Help them get to the idea that the lungs are much closer and the right ventricle doesn't have to work as hard. The left ventricle, however, must be stronger to get the blood flowing throughout the whole body. This discussion serves as an **Elaboration/Extension** activity.

Other **Extensions** for more advanced students can include naming the major vessles (vena cava, pulmonary artery, pulmonary vein, aorta), discussing the idea that not all animals' hearts look the same (there are accessory storage structures on the sheep heart that are not on the human; other organisms have a different number of chambers, i.e., amphibians, etc.).

Evaluation and Wrap-up:
Tell the students the following; ____ indicates where you allow the students to answer to fill in the blanks; answers are below.

The human heart is a major organ; it is a muscle. You can think of a human heart as _____ pumps with four chambers. The heart does the work for the _____ system. The

heart sends blood to the _____ to get oxygen. The heart gets blood back from the lungs and sends it out to _____.

Answers: two; circulatory; the rest of the body.