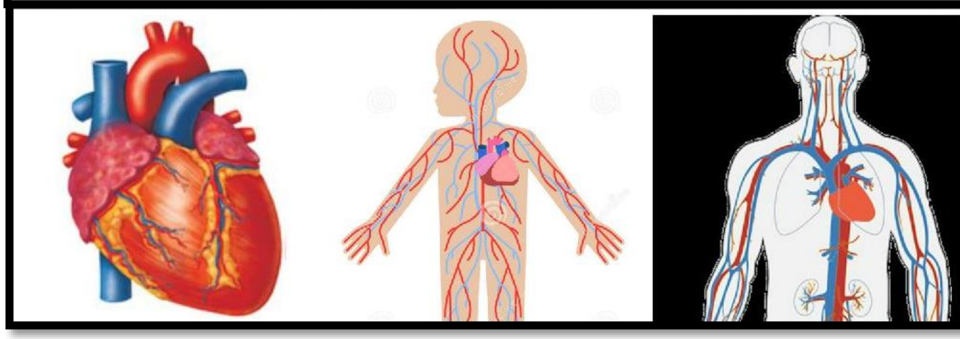
HAVE A HEART

Fifth Grade – Life Science



PURPOSE

IN *<u>HAVE A HEART</u>*, STUDENTS WILL:

- Design and build a circulatory system and explain how it interacts with the other systems to support life.
- Exhibit understanding of relevant science content/concepts
- Construct relevant questions
- Use appropriate materials provided to complete their task
- Determine effectiveness of their design
- Answer the Focus Question: <u>How can you show the function of the circulatory system in providing multicellular organisms with their basic needs?</u>

NEXT GENERATION SCIENCE STANDARDS (NGSS)

Students who demonstrate understanding can:

5-PS3-1. **Use models to describe that energy in animals' food (used for body repair, growth, and motion and to maintain body warmth) was once energy from the sun.** [Clarification Statement: Examples of models could include diagrams, and flow charts.]

The performance expectation above was developed using the following elements from the NRC document *A Framework for K-12 Science Education*:

Science and Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
Developing and Using Models Modeling in 3–5 builds on K–2 experiences and progresses to building and revising simple models and using models to represent events and design solutions. • Use models to describe phenomena.	**PS3.D: Energy in Chemical Processes and Everyday Life** • The energy released [from] food was once energy from the sun that was captured by plants in the chemical process that forms plant matter (from air and water). **LS1.C: Organization for Matter and Energy Flow in Organisms** • Food provides animals with the materials they need for body repair and growth and the energy they need to maintain body warmth and for motion. *(secondary)*	**Energy and Matter** • Energy can be transferred in various ways and between objects.

Connections to other DCIs in fifth grade: N/A

Articulation of DCIs across grade-levels:
K.LS1.C ; ***2.LS2.A*** ; ***4.PS3.A*** ; ***4.PS3.B*** ; ***4.PS3.D*** ; ***MS.PS3.D*** ; ***MS.PS4.B*** ; ***MS.LS1.C*** ; ***MS.LS2.B***

Common Core State Standards Connections:
ELA/Literacy -

RI.5.7	Draw on information from multiple print or digital sources, demonstrating the ability to locate an answer to a question quickly or to solve a problem efficiently. *(5-PS3-1)*
SL.5.5	Include multimedia components (e.g., graphics, sound) and visual displays in presentations when appropriate to enhance the development of main ideas or themes. *(5-PS3-1)*

3-5-ETS1 Engineering Design

3-5-ETS1 Engineering Design

Students who demonstrate understanding can:

3-5-ETS1-1. Define a simple design problem reflecting a need or a want that includes specified criteria for success and constraints on materials, time, or cost.

3-5-ETS1-2. Generate and compare multiple possible solutions to a problem based on how well each is likely to meet the criteria and constraints of the problem.

3-5-ETS1-3. Plan and carry out fair tests in which variables are controlled and failure points are considered to identify aspects of a model or prototype that can be improved.

The performance expectations above were developed using the following elements from the NRC document *A Framework for K-12 Science Education*:

Science and Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
Asking Questions and Defining Problems Asking questions and defining problems in 3–5 builds on grades K–2 experiences and progresses to specifying qualitative relationships. ▪ Define a simple design problem that can be solved through the development of an object, tool, process, or system and includes several criteria for success and constraints on materials, time, or cost. (3-5-ETS1-1) **Planning and Carrying Out Investigations** Planning and carrying out investigations to answer questions or test solutions to problems in 3–5 builds on K–2 experiences and progresses to include investigations that control variables and provide evidence to support explanations or design solutions. ▪ Plan and conduct an investigation collaboratively to produce data to serve as the basis for evidence, using fair tests in which variables are controlled and the number of trials considered. (3-5-ETS1-3) **Constructing Explanations and Designing Solutions** Constructing explanations and designing solutions in 3–5 builds on K–2 experiences and progresses to the use of evidence in constructing explanations that specify variables that describe and predict phenomena and in designing multiple solutions to design problems. ▪ Generate and compare multiple solutions to a problem based on how well they meet the criteria and constraints of the design problem. (3-5-ETS1-2)	**ETS1.A: Defining and Delimiting Engineering Problems** ▪ Possible solutions to a problem are limited by available materials and resources (constraints). The success of a designed solution is determined by considering the desired features of a solution (criteria). Different proposals for solutions can be compared on the basis of how well each one meets the specified criteria for success or how well each takes the constraints into account. (3-5-ETS1-1) **ETS1.B: Developing Possible Solutions** ▪ Research on a problem should be carried out before beginning to design a solution. Testing a solution involves investigating how well it performs under a range of likely conditions. (3-5-ETS1-2) ▪ At whatever stage, communicating with peers about proposed solutions is an important part of the design process, and shared ideas can lead to improved designs. (3-5-ETS1-2) ▪ Tests are often designed to identify failure points or difficulties, which suggest the elements of the design that need to be improved. (3-5-ETS1-3) **ETS1.C: Optimizing the Design Solution** ▪ Different solutions need to be tested in order to determine which of them best solves the problem, given the criteria and the constraints. (3-5-ETS1-3)	**Influence of Engineering, Technology, and Science on Society and the Natural World** ▪ People's needs and wants change over time, as do their demands for new and improved technologies. (3-5-ETS1-1) ▪ Engineers improve existing technologies or develop new ones to increase their benefits, decrease known risks, and meet societal demands. (3-5-ETS1-2)

Connections to 3-5-ETS1.A: Defining and Delimiting Engineering Problems include:
Fourth Grade: 4-PS3-4
Connections to 3-5-ETS1.B: Designing Solutions to Engineering Problems include:
Fourth Grade: 4-ESS3-2
Connections to 3-5-ETS1.C: Optimizing the Design Solution include:
Fourth Grade: 4-PS4-3

Articulation of DCIs across grade-bands: **K-2.ETS1.A** (3-5-ETS1-1),(3-5-ETS1-2),(3-5-ETS1-3); **K-2.ETS1.B** (3-5-ETS1-2); **K-2.ETS1.C** (3-5-ETS1-2),(3-5-ETS1-3); **MS.ETS1.A** (3-5-ETS1-1); **MS.ETS1.B** (3-5-ETS1-1),(3-5-ETS1-2),(3-5-ETS1-3); **MS.ETS1.C** (3-5-ETS1-2),(3-5-ETS1-3)

Common Core State Standards Connections:

ELA/Literacy –

RI.5.1 Quote accurately from a text when explaining what the text says explicitly and when drawing inferences from the text. *(3-5-ETS1-2)*
RI.5.7 Draw on information from multiple print or digital sources, demonstrating the ability to locate an answer to a question quickly or to solve a problem efficiently. *(3-5-ETS1-2)*
RI.5.9 Integrate information from several texts on the same topic in order to write or speak about the subject knowledgeably. (3-5-ETS1-2)
W.5.7 Conduct short research projects that use several sources to build knowledge through investigation of different aspects of a topic. (3-5-ETS1-1),(3-5-ETS1-3)
W.5.8 Recall relevant information from experiences or gather relevant information from print and digital sources; summarize or paraphrase information in notes and finished work, and provide a list of sources. *(3-5-ETS1-1),(3-5-ETS1-3)*
W.5.9 Draw evidence from literary or informational texts to support analysis, reflection, and research. *(3-5-ETS1-1),(3-5-ETS1-3)*

Mathematics –

MP.2 Reason abstractly and quantitatively. *(3-5-ETS1-1),(3-5-ETS1-2),(3-5-ETS1-3)*
MP.4 Model with mathematics. *(3-5-ETS1-1),(3-5-ETS1-2),(3-5-ETS1-3)*
MP.5 Use appropriate tools strategically. *(3-5-ETS1-1),(3-5-ETS1-2),(3-5-ETS1-3)*
3-5.OA Operations and Algebraic Thinking *(3-5-ETS1-1),(3-5-ETS1-2)*

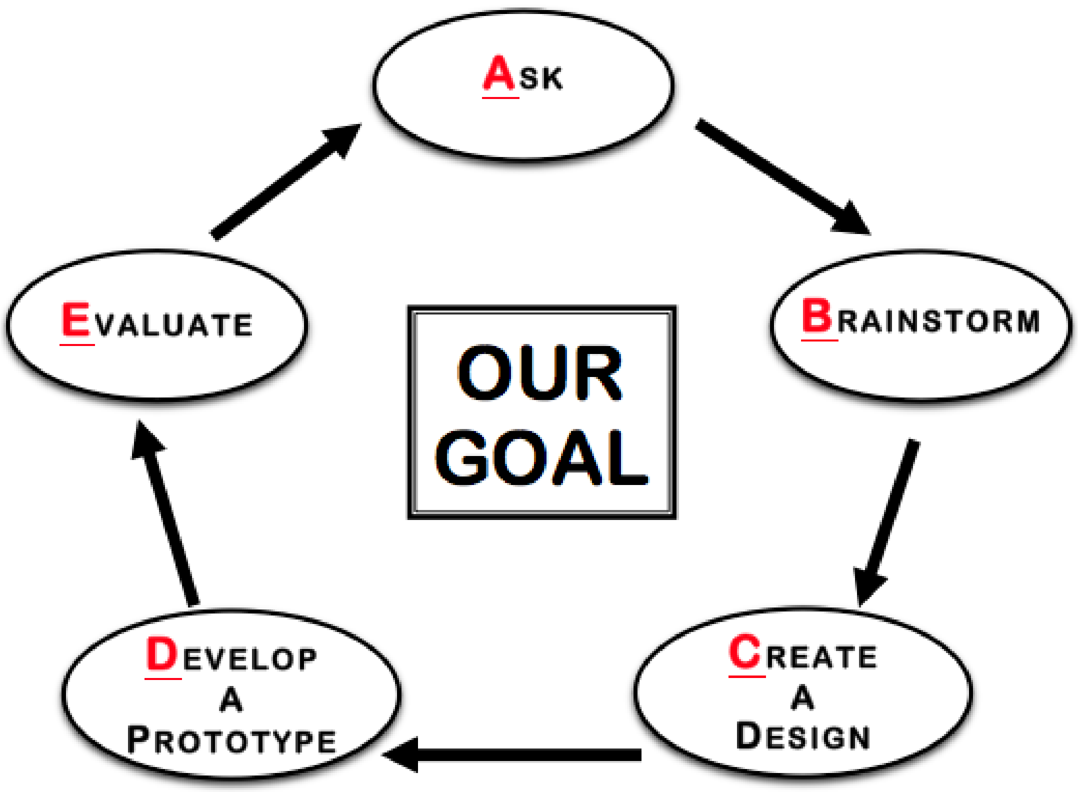
CA ENGLISH LANGUAGE DEVELOPMENT CONNECTIONS

- **P1.5.A.1** Exchanging information and ideas with others through oral collaborative discussions on a range of social and academic topics
- **P1.5.A.2** Interacting with others in written English in various communicative forms (print, communicative technology, and multimedia)
- **P1.5.A.3** Offering and supporting opinions and negotiating with others in communicative exchange

SPECIAL EDUCATION (SPED):

To make accommodations or modifications for students with special needs, provide simple directions, instructions, provide multiple opportunities for repetition, make frequent checks for understanding, use visuals to accompany all vocabulary, simplify questions, be specific with sequence and steps, provide opportunity for paraphrasing, and adjust time and pacing.

The Engineering Design Process (EDP)



ENGINEERING DESIGN PROCESS (EDP)

ASK

- What is the **problem** or **need**?
- What is already out there?
- What are the **requirements (criteria)** and **restrictions (constraints)**?

BRAINSTORM

- What are possible **solutions**?
- Choose your two best solutions.

CREATE - A - DESIGN

- **Draw** a diagram with labels.
- Have a critical design review (peer review & input).
- What materials are available?

DEVELOP - A - PROTOTYPE

- Follow your best diagram and **build** a prototype.
- **Test** the prototype!

EVALUATE

- **Improve** your prototype!
- Conduct more compatibility tests.

BACKGROUND FOR THE TEACHER

Excerpt taken from FOSS CA: LIVING SYSTEMS Teachers' Guide - page 45

THE CIRCULATORY SYSTEM

Multicellular organisms have evolved specialized systems to supply every cell with the requirements for life. The delivery system in mammals, birds, reptiles, fish, and amphibians is called the **circulatory system**. The delivery vehicle is **blood**. The role of the circulatory system is to provide water, food, and gases to the cells and to carry wastes away from the cells.

The circulatory system is essentially a pump and a bunch of pipes running throughout the body. Blood continuously flows through the system. The four-chambered human heart is the workhorse that drives our circulatory system. The familiar heartbeat occurs about 100,000 times every day and pumps enough blood to fill a backyard swimming pool every couple of days. All that pumping ensures that resource-rich blood reaches every cell without interruption from the moment you are born until you die.

Blood flows through three kinds of **blood vessels, arteries, veins,** and **capillaries.** Arteries are large vessels that carry blood from the heart to the capillaries. Veins are large vessels that carry blood from the capillaries back to the heart. The capillaries are the tiny vessels that serve each and every cell. This is where resources (water, food, oxygen) are passed to the cells, and where wastes (carbon dioxide and other wastes) are passed from the cells.

COORDINATION WITH RESPIRATION AND DIGESTION

The blood must be refreshed constantly. The digestive system replenishes food for the cells. The respiratory system extracts oxygen from air and exhausts carbon dioxide into the air. Both systems interface with the circulatory system. Both systems provide resources to keep cells alive."

You may teach this lesson once students have completed:

FOSS CA – LIVING SYSTEMS

- **Investigation 1, Parts 1-3**

Students will have enough content knowledge to engage in the Have a Heart engineering challenge. Students enter the challenge understanding that blood circulation is essential to the health of our bodies. Students will be challenged to create a working model of the circulatory system using various materials.

MATERIALS

FOR EACH TEAM

- Butcher paper with markers (for tracing bodies)
- Materials will be determined by the teams' plans and designs

FOR THE LESSON _

- Individual student engineering notebooks
- Water
- Food coloring [Solid Earth: 4th grade]
- Disposable plastic water bottles
- Straws [Air & Weather: 1st grade]
- Rubber bands [Balance & Motion: 2nd grade]
- Balloons [Air & Weather: 1st grade]
- Scissors
- Duct tape [Solid Earth: 4th grade]
- Red and blue yarn
- Red and blue math manipulative squares
- Syringes [Air & Weather: 1st grade]
- Hole-punches [Insects & Plants: 2nd grade]
- Funnels [Mixtures & Solutions: 5th grade]
- Other found materials...
- Heart-diagram (see attached)
- "Your Health and Circulatory System" website: https://kidshealth.org/en/kids/heart.html
- "Circulation" You-Tube video: www.youtube.com/watch?v=PgI80Ue-AMo

GETTING READY

1. **Schedule the Investigation**
   The challenge will take a minimum of four days of 45-minute sessions to complete.

2. **Gather/Obtain Materials**

3. **Prepare Materials**
   - Set up a materials station where students can retrieve needed materials
   - Make 6 copies of the attached HEART DIAGRAM for optional team use

4. **Plan Teams**
   Create teams of 4 students.

GUIDING THE ACTIVITY

Students will engage in the Engineering Design Process (EDP).

1. ASK

Setting Up the Context

- Review what students have learned about the different body systems.

- Increase content knowledge by reading "Your Heart & Circulatory System" http://kidshealth.org/en/kids/heart.html and watching the video "Circulation" www.youtube.com/watch?v=PgI80Ue-AMo

Present Problem or Need

- The challenge is to create a working model of the circulatory system using various materials.

- Have students record the Focus Question in their engineering notebooks - How can you show the function of the circulatory system in providing multicellular organisms with their basic needs?

- Encourage students to come up with their OWN questions about materials, criteria, and constraints.

Present Requirements and Restrictions

- **Requirements** (Criteria) *standards that must be met; rules/directions that must be followed)*:
  - Students must work in collaborative teams of 3 to 4 members.
  - The circulatory system model must show the movement of blood throughout the body. (Clarification: limited to arteries and veins)
  - Student teams must be able to explain how blood is reoxygenated.
- **Restrictions** (Constraints) *limitations that keep something from being the best it could be; may be problems that arise or issues that come up*:
  - Use only materials provided by the teacher

- The team design must incorporate an aspect of each team member's design

2. BRAINSTORM

- Teams evaluate the available materials and determine their usefulness based on their properties.
- Teams discuss how they will show the movement of blood throughout the body.
- Teams record ideas in their student engineering notebooks.

3. CREATE - A - DESIGN

- Each member must draw a design individually, without team member input, into his/her science notebook.
  - Title the page "My design"
  - Students should label the parts of their design (i.e. cardstock, lightbulb, insulated wires, etc.)
- Team members share designs with one another, compromise, and collaborate in order to create into a "team design."
  - Title the page "Team design"
  - Team members should label the parts of their design

4. DEVELOP - A - PROTOTYPE

- "Getters" gather the materials listed on the Team Design from the materials table.
- Teams build according to their plan.
- Test design to see if blood circulation is accurately depicted

5. EVALUATE

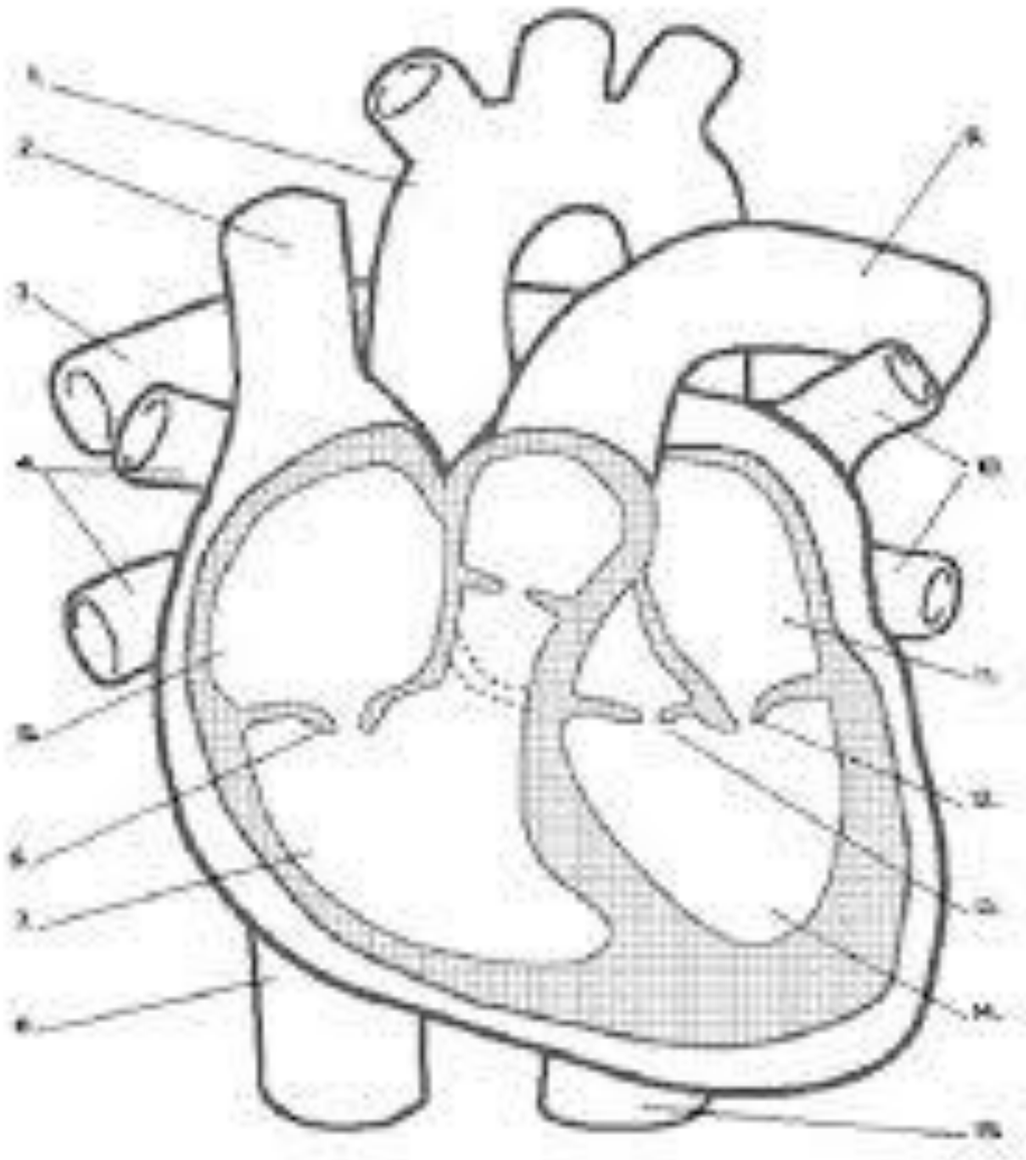
- Student teams present their model of the circulatory system.

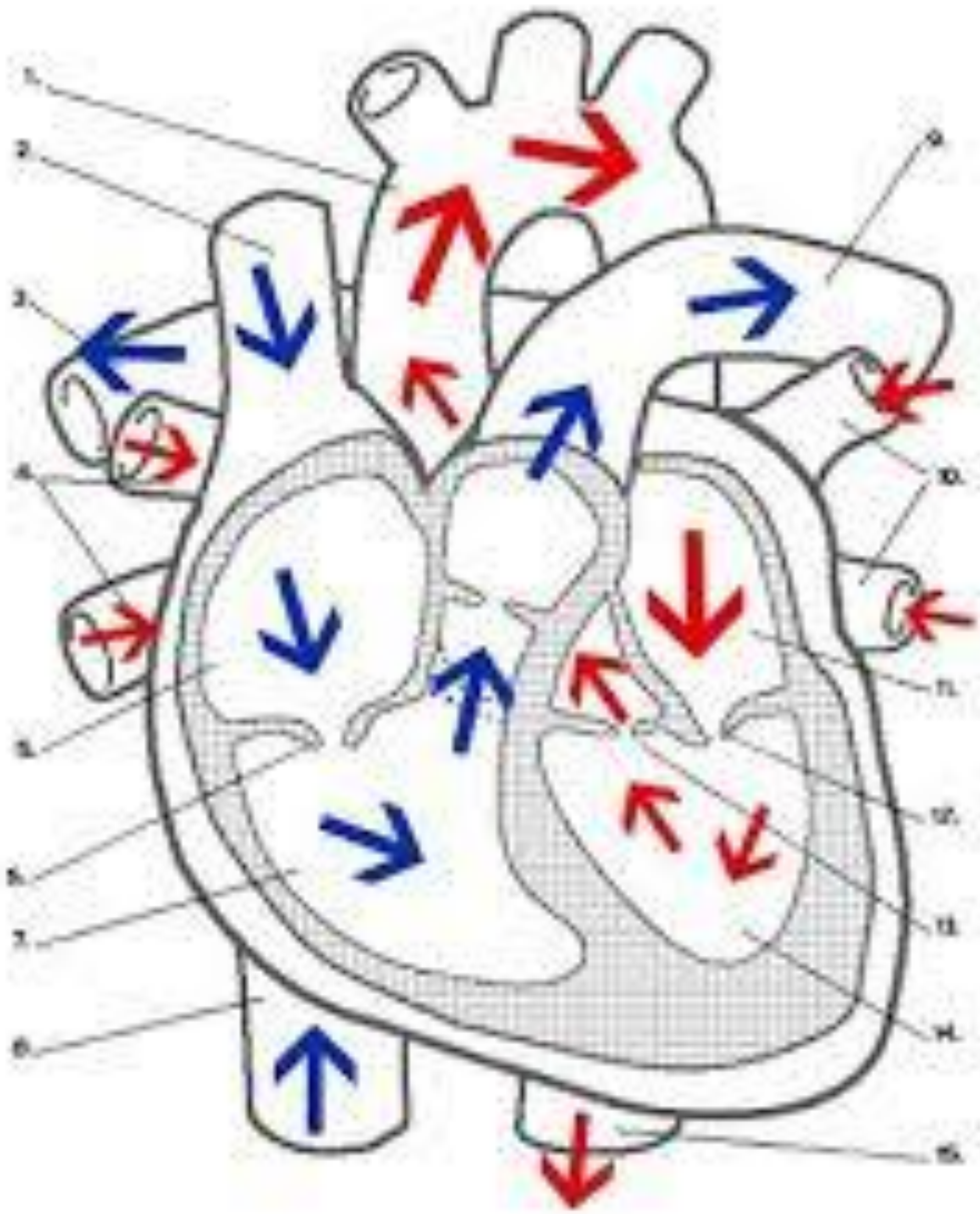
- Teacher facilitates discussion about student successes and challenges.

- After observation of other designs and input from colleagues, students **redesign** and **rebuild**.

- Students will answer the Focus Question in their notebooks.
  - Sentence frames can be used for scaffolding. For example, "We were able to show how the circulatory system provides our bodies with its basic needs by ____."
  - Encourage students to include information about both their successes and failures.

Students MAY use this diagram in their model.

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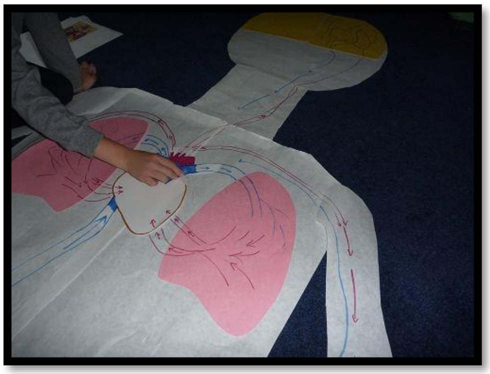
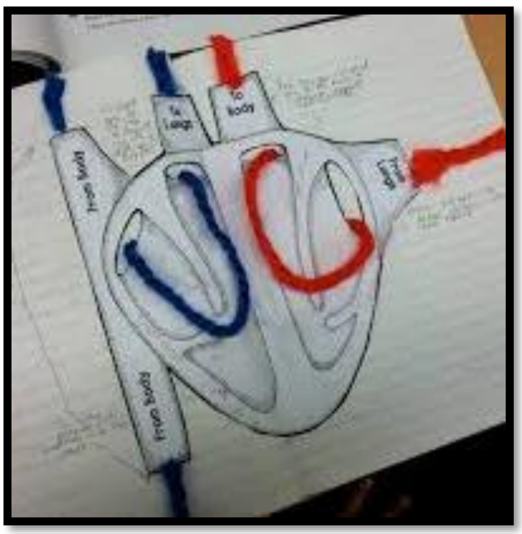
Possible Outcomes:

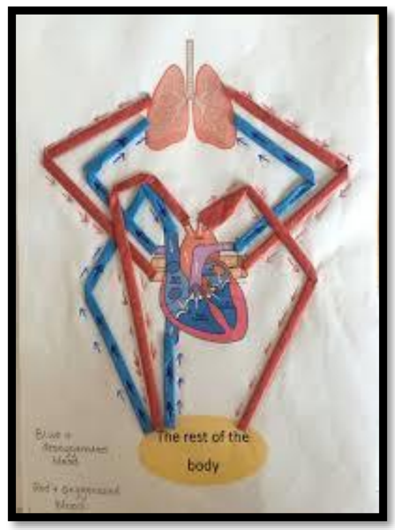
Using red/blue math manipulatives / tissue paper squares to depict circulation:



Using yarn:



Using straws:



Using colored water: