



Objectives

- Students will learn about elements of the human cardiovascular system.
- Students will relate exercise to cardiovascular health.
- Students will recognize that the body can adapt to new environments.
- Students will learn about the STEM career, Flight Surgeon.



Vocabulary

- | | |
|-------------------------------|----------------------|
| • cardiovascular system | • mitral valve |
| • atria/atrium | • pulmonary artery |
| • ventricle | • pulmonary veins |
| • vein | • leukocyte |
| • artery | • erythrocyte |
| • capillary | • platelet |
| • tricuspid valve | • oxygenated blood |
| • inferior/superior vena cava | • deoxygenated blood |
| • aorta | • Flight Surgeon |

About the Lesson

- The lesson tells the story of NASA's history of manned space exploration from Alan Shepard to future missions to Mars and how an understanding of long-term residence in microgravity environments can change the heart's ability to properly function.
- During the lesson, students will realize the importance of what will be learned from the One Year Mission and Twins Study as well as why non-astronaut careers, such as flight surgeons, are critically important to astronaut health.
- Teaching time:** one to two 45-minute class period(s).

Tech Tips:

- This lesson includes screen captures taken from the TI-Nspire™ CX handheld. It is also appropriate for use with the TI-Nspire family of products, including TI-Nspire™ software and TI-Nspire™ Apps. Slight variations to these directions might be required if using other technologies besides the handheld.
- Watch for additional Tech Tips throughout the lesson for the specific technology you are using.
- Access free tutorials at <http://education.ti.com/calculators/pd/US/Online-Learning/Tutorials>.



TI-Nspire™ Navigator™

- Send out the Heart to Heart.tns file.
- Monitor student progress using Class Capture.
- Use Live Presenter to spotlight student answers.

Lesson Materials

- Compatible TI Technologies: TI- Nspire™ CX Handhelds, TI-Nspire™ Apps for iPad®, TI-Nspire™ Software

Lesson Files:

Student Activity

- Heart to Heart_Student.doc
 - Heart to Heart_Student.pdf
- TI-Nspire document*
- Heart to Heart.tns

Background

STEM CAREER

This lesson focuses on the heart health of NASA astronauts through the experiments involved in the One Year Mission, the Twins Study, and the work by NASA Flight Surgeons such as Dr. Natacha Chough.

OVERVIEW

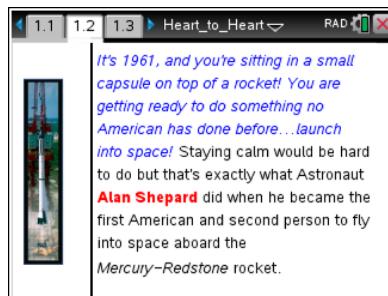
Students will be engaged in determining how the heart functions by interacting with a virtual heart in an attempt to route blood through the proper chambers in the proper order. During this process, students will learn about the four chambers of the human heart and why blood moves through the lungs back to the heart and then out to the rest of the body.

They will then explore effects of microgravity on an astronaut's body, specifically their heart, in an animation that models possible effects of spending extended time in microgravity.

Finally, they will attempt to keep an avatar astronaut healthy enough to "stand when they land" on Mars. To do this, they will need to exercise during their "6 month" journey to Mars.

Move to page 1.2.

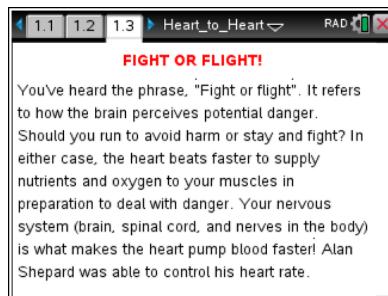
1. Page 1.2 gives students the perspective of Alan Shepard's historic ride into space as the first American, and only second human, to ever achieve that feat at the time.



*It's 1961, and you're sitting in a small capsule on top of a rocket! You are getting ready to do something no American has done before... launch into space! Staying calm would be hard to do but that's exactly what Astronaut **Alan Shepard** did when he became the first American and second person to fly into space aboard the **Mercury-Redstone** rocket.*

Move to pages 1.3 – 1.4

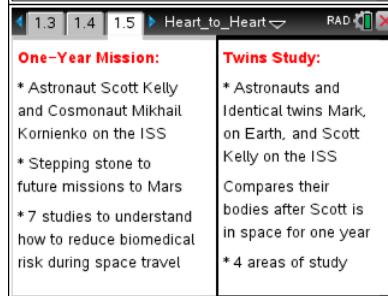
2. Pages 1.3 to 1.4 discuss the nervous system as a mechanism for changing heart rate as well as the introduction of the One-Year Mission and the Twins Study.



FIGHT OR FLIGHT!
You've heard the phrase, "Fight or flight". It refers to how the brain perceives potential danger. Should you run to avoid harm or stay and fight? In either case, the heart beats faster to supply nutrients and oxygen to your muscles in preparation to deal with danger. Your nervous system (brain, spinal cord, and nerves in the body) is what makes the heart pump blood faster! Alan Shepard was able to control his heart rate.

Move to page 1.5.

3. This page explains the One-Year Mission and Twins Study which are two research projects happening aboard the International Space Station. They are both intended to determine health changes while spending extended time in microgravity. The Twins Study is a comparison between physiological changes that could occur between identical twin brothers Mark and Scott Kelly.



One-Year Mission: <ul style="list-style-type: none"> * Astronaut Scott Kelly and Cosmonaut Mikhail Kornienko on the ISS * Stepping stone to future missions to Mars * 7 studies to understand how to reduce biomedical risk during space travel 	Twins Study: <ul style="list-style-type: none"> * Astronauts and Identical twins Mark, on Earth, and Scott Kelly on the ISS Compares their bodies after Scott is in space for one year * 4 areas of study
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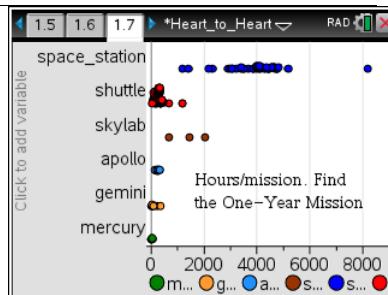
Heart to Heart

TEACHER NOTES



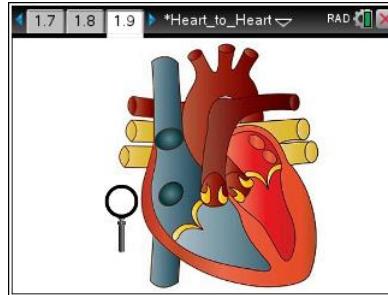
Move to pages 1.6 -- 1.7.

4. Students are presented with a graph that shows the length of hours for each of the manned space missions from Mercury through the Space Station. It is intended to show students that missions are spending longer hours in microgravity.



Move to pages 1.8 – 1.9.

5. These pages explain the basic parts of the cardiovascular system such as the heart and vessels. Students can examine the major parts of the heart with an interactive image.



Move to pages 1.10 – 1.12.

6. Students are introduced to the various components of blood (white and red blood cells, and platelets). This section also discusses the differences between oxygenated and deoxygenated blood and the three main functions of the cardiovascular system.

Blood – liquid connective tissue made up of platelets and two types of cells.
1. **White blood cells a.k.a. leukocytes**– fight pathogens (foreign invaders – bacteria and viruses).
2. **Red blood cells a.k.a. erythrocytes**– transports oxygen and nutrients to cells and removes carbon dioxide and waste away from cells.
3. **Platelets** – pieces of cells that clump together in damaged areas and form a plug that reduces blood loss.

Move to page 1.13.

7. Students are presented with a simulation where they must select the correct order in which blood flows into and out of the heart. Students should answer questions to ensure they understand the information that has been provided thus far.



Questions related to pages 1.1 -- 1.13

Q1. What is the function of the atria?

Sample Answer: Both the right and left atria receive blood from outside the heart. They then pump blood into the ventricles.

Q2. What is the difference between the right and left ventricles?

Sample Answer: While the right ventricle moves blood to the lungs for gas exchange, the left ventricle moves blood to the rest of the body.

Q3. What other body system is responsible for changing the pace of the heart?

Answer. A: The nervous system

Q4. Why does blood move from the right ventricle into the lungs?

Sample Answer: Blood in the right ventricle has low oxygen and must be returned to the lungs to receive more oxygen and to get rid of carbon dioxide.

Q5. What is the function of the heart valves?

Sample Answer: Heart valves regulate the flow of blood from the atria to the ventricles and from the ventricles into the lungs or body.

Q6. What would happen if one of the valves didn't work correctly?

Sample Answer: In general, if a valve is non-functional or partially functional, there could be a problem when the chamber contracts to push blood into the next chamber or artery. For example, if the muscle in the ventricle contracts it may push blood back into the atria if the valve isn't able to seal properly. That could lead to less blood being sent into the body or the lungs.



- Q7. Describe the differences between leukocytes and erythrocytes?

Sample Answer: While both cell types exist in the blood stream, leukocytes are responsible for defending the body from foreign bacteria and viruses. Erythrocytes transport nutrients and oxygen to the rest of the body.

- Q8. Blood exists in two states; oxygenated and deoxygenated. Which side of the heart receives and distributes oxygenated blood? Describe the function of each chamber.

Sample Answer: The left atrium receives oxygenated blood from the lungs and pumps it into the left ventricle. The left ventricle then pumps blood through the aorta to be distributed to the rest of the body where it will deliver oxygen.

Move to page 2.1 – 2.6

8. These pages offer students a glimpse into the life of Dr. Natacha Chough, a flight surgeon working for NASA. She is a medical doctor who works with astronauts before, during, and after missions into space. Dr. Chough describes her career choice and why it has been so rewarding for her.



Questions related to 2.1 – 2.6

- Q9. What is the role of a flight surgeon?

Sample Answer: Flight surgeons monitor the health of astronauts before, during, and after missions in which they are spending time in microgravity (space).

- Q10. Math and science are critical for doing the job of a flight surgeon.

Answer. A: True – Without math and science, Dr. Chough wouldn't know much about the human body or how to treat patients.

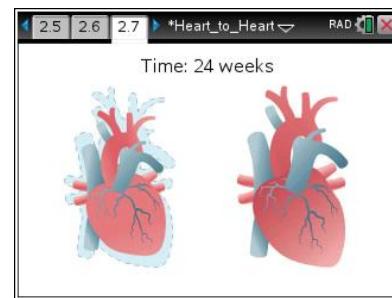
- Q11. Would you want to have a doctor who did very well in their math and science courses or would you be okay with lower grades? Why?

Sample Answer: When it comes to our healthcare providers, we want to make sure they are very knowledgeable about all things related to the body and medicine.



Read pages 2.7 – 2.8

9. Students might not realize that the heart is dynamic. It changes based on the amount of work it needs to perform to keep the body functioning properly. In microgravity, the heart doesn't have to work as hard. Without a lot of exercise, it will both shrink and change shape! Have students run through the animation to see what could be happening to astronaut Kelly's heart if he didn't exercise while on the One-Year Mission.



Questions related to 2.7 – 2.8

- Q12. Why would the heart change shape to become more spherical in space?

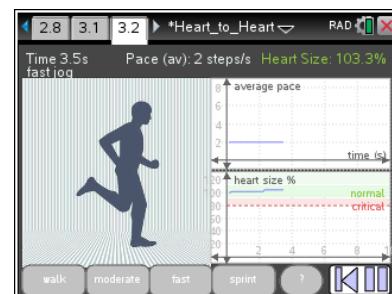
Sample Answer: Although scientists are studying this affect, one possible reason may be that Earth's gravity gives the heart its elongated shape. In microgravity, the force of gravity is much lower.

- Q13. If astronauts did not exercise while in space, would their heart shrink at a constant rate?

A. **Answer: B.** No, their hearts would shrink more quickly at first and then slow down over time.

Move to page 3.1 to 3.2.

10. Students will now run through a simulation where they need to "exercise" to keep their avatar's heart healthy enough to complete the mission when they arrive on Mars after a six-month journey.



Questions related to 3.1 to 3.2

- Q14. Because Martian gravity is only 38% that of Earth's, why should astronauts worry about exercising while they are on a trip to Mars?

Sample Answer: Although it is true that Martian gravity is much less than Earth's, it is still much higher than what the astronaut will be accustomed to while in a weightless environment for 6 months. It will therefore be difficult for the astronaut to stand and perform their mission if they aren't at least capable of dealing with that new force pulling blood into their legs.

- Q15. Would exercising on a treadmill in microgravity be the same as running on Earth? Choose the best answer.

Sample Answer: It is not the same since gravity holds you to the Earth while in microgravity you must be strapped to the treadmill to stay on it!



TI-Nspire™ Navigator Opportunities

Make a student the Live Presenter to demonstrate his or her tank solutions that fill in a given time, or their data collection tables from the tank filling simulation.

Assessment

Students will answer questions throughout the lesson to ensure they understand the concepts of heart structure and function as well as the different components and states of blood. They will also be asked about changes to the heart in a microgravity environment

For more information about NASA's One-Year Mission and Twins Study check out the links below:

<https://www.nasa.gov/1ym>

<https://www.nasa.gov/twins-study>