

THE SCIENCE OF THE
HEART AND
CIRCULATION



Pre- and Post-Assessment Activities

by

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RESOURCES

For online presentations of each activity and
downloadable slide sets for classroom use, visit
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TEAMING WITH BENEFITS

by Jeffrey P. Sutton, M.D., Ph.D., Director, National Space Biomedical Research Institute (NSBRI)

Space is a challenging environment for the human body. With long-duration missions, the physical and psychological stresses and risks to astro-



Dr. Jeffrey P. Sutton

nauts are significant. Finding answers to these health concerns is at the heart of the National Space Biomedical Research Institute's program. In turn, the Institute's research is helping to enhance medical care on Earth.

The NSBRI, a unique partnership between NASA and the academic and industrial communities, is advancing biomedical research with the goal of ensuring a safe and productive long-term human presence in space. By developing new approaches and countermeasures to prevent, minimize and reverse critical risks to health, the Institute plays an essential, enabling role for NASA. The NSBRI bridges the research, technological and clinical expertise of the biomedical community with the scientific, engineering and operational expertise of NASA.

With nearly 60 science, technology and education projects, the NSBRI engages investigators at leading institutions across the nation to conduct goal-directed, peer-reviewed research in a team approach. Key working relationships have been established with end users, including astronauts and flight surgeons at Johnson Space Center, NASA scientists and engineers, other federal agencies, industry and international partners. The value of these

collaborations and revolutionary research advances that result from them is enormous and unprecedented, with substantial benefits for both the space program and the American people.

Through our strategic plan, the NSBRI takes a leadership role in countermeasure development and space life sciences education. The results-oriented research and development program is integrated and implemented using focused teams, with scientific and management directives that are innovative and dynamic. An active Board of Directors, External Advisory Council, Board of Scientific Counselors, User Panel, Industry Forum and academic Consortium

help guide the Institute in achieving its goals and objectives.

It will become necessary to perform more investigations in the unique environment of space. The vision of using extended exposure to microgravity as a laboratory for discovery and exploration builds upon the legacy of NASA and our quest to push the frontier of human understanding about nature and ourselves.

The NSBRI is maturing in an era of unparalleled scientific and technological advancement and opportunity. We are excited by the challenges confronting us, and by our collective ability to enhance human health and well-being in space, and on Earth.



NSBRI RESEARCH AREAS

CARDIOVASCULAR PROBLEMS

The amount of blood in the body is reduced when astronauts are in microgravity. The heart grows smaller and weaker, which makes astronauts feel dizzy and weak when they return to Earth. Heart failure and diabetes, experienced by many people on Earth, lead to similar problems.

HUMAN FACTORS AND PERFORMANCE

Many factors can impact an astronaut's ability to work well in space or on the lunar surface. NSBRI is studying ways to improve daily living and keep crewmembers healthy, productive and safe during exploration missions. Efforts focus on reducing performance errors, improving nutrition, examining ways to improve sleep and scheduling of work shifts, and studying how specific types of lighting in the craft and habitat can improve alertness and performance.

MUSCLE AND BONE LOSS

When muscles and bones do not have to work against gravity, they weaken and begin to waste away. Special exercises and other strategies to help astronauts' bones and muscles stay strong in space also may help older and bedridden people, who experience similar problems on Earth, as well as people whose work requires intense physical exertion, like firefighters and construction workers.

NEUROBEHAVIORAL AND STRESS FACTORS

To ensure astronaut readiness for spaceflight, preflight prevention programs are being developed to avoid as many risks as possible to individual and

group behavioral health during flight and post flight. People on Earth can benefit from relevant assessment tests, monitoring and intervention.

RADIATION EFFECTS AND CANCER

Exploration missions will expose astronauts to greater levels and more varied types of radiation. Radiation exposure can lead to many health problems, including acute effects such as nausea, vomiting, fatigue, skin injury and changes to white blood cell counts and the immune system. Longer-term effects include damage to the eyes, gastrointestinal system, lungs and central nervous system, and increased cancer risk. Learning how to keep astronauts safe from radiation may improve cancer treatments for people on Earth.

SENSORIMOTOR AND BALANCE ISSUES

During their first days in space, astronauts can become dizzy and nauseous. Eventually they adjust, but once they return to Earth, they have a hard time walking and standing upright. Finding ways to counteract these effects could benefit millions of Americans with balance disorders.

SMART MEDICAL SYSTEMS AND TECHNOLOGY

Since astronauts on long-duration missions will not be able to return quickly to Earth, new methods of remote medical diagnosis and treatment are necessary. These systems must be small, low-power, noninvasive and versatile. Portable medical care systems that monitor, diagnose and treat major illness and trauma during flight will have immediate benefits to medical care on Earth.

OVERVIEW

To evaluate their current understanding of the heart and circulatory system, students will complete a pre-assessment. Students also will develop group concept maps. At the conclusion of this unit, students will repeat the assessment and compare their prior knowledge about the heart to what they have learned (see Answer Key, sidebar, p. 2).



ACTIVITY

PRE- AND POST-ASSESSMENT

This unit introduces students to the circulatory system in humans and other mammals. Using examples from current research on human space travel, it engages students in authentic questions and investigations. Students will learn that the circulatory system distributes materials to and from all regions of the body, and that it plays a role in regulating body temperature by transferring heat from warmer regions of the body to

cooler ones, and vice versa. Circulation in mammals relies on the following components.

- **The heart** serves as a pump.
- **Blood** carries oxygen, carbon dioxide, nutrients, vitamins, minerals, waste products, water and other substances.
- **Blood vessels** serve as the “roadways” or “pipes” for delivery and pick-up.

Throughout the unit, students will work in groups to build concept maps that provide a visual representation of the groups’ progress in understanding and linking concepts (see “Concept Maps,” sidebar, p. 3). But first, students will complete a pre-assessment, which will prompt them to ask questions regarding a new topic, and provide an opportunity for you to gauge students’ existing knowledge.

Students will repeat this assessment at the end of the unit as a post-assessment.

PRE-ASSESSMENT TIME

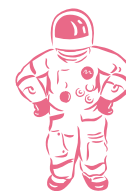
10 minutes for setup; 45 minutes to conduct activity

MATERIALS

Each group will need:

- Markers and writing materials
- Pad of sticky notes
- Poster board or large sheet of paper

Continued



AstroBlogs!

Unit Extension: To enrich students’ experiences throughout the unit, and to provide more opportunities for students to write about what they are learning, create a “blog wall” in the classroom, where students can post their comments and ideas.

Image Citations

Source URLs are available at the front of this guide.

SCIENCE EDUCATION CONTENT STANDARDS* GRADES 5–8

INQUIRY

- Identify questions that can be answered through scientific investigations.
- Think critically and logically to make the relationships between evidence and explanations.
- Recognize and analyze alternative explanations and predictions.
- Communicate scientific procedures and explanations.

LIFE SCIENCE

- Living systems at all levels of organization demonstrate the complementary nature of structure and function.
- The human organism has systems for digestion, respiration, reproduction, circulation, excretion, movement, control and coordination, and for protection from disease. These systems interact with one another.

SCIENCE, HEALTH & MATH SKILLS

- Graphing

* National Research Council. 1996. National Science Education Standards. Washington, D.C., National Academies Press.



Cooperative learning is a systematic way for students to work together in groups of two to four. It provides organized group interaction and enables students to share ideas and to learn from one another. Students in such an environment are more likely to take responsibility for their own learning. Cooperative groups enable the teacher to conduct hands-on investigations with fewer materials.

Organization is essential for cooperative learning to occur in a hands-on science classroom. Materials must be managed, investigations conducted, results recorded, and clean-up directed and carried out. Each student must have

a specific role, or chaos may result.

The Teaming Up! model* provides an efficient system for cooperative learning. Four “jobs” entail specific duties. Students wear job badges that describe their duties. Tasks are rotated within each group for different activities so that each student has a chance to experience all roles. For groups with fewer than four students, job assignments can be combined.

Once a cooperative model for learning is established in the classroom, students are able to conduct science activities in an organized and effective manner. The job titles and responsibilities are as follow.

Principal Investigator

- Reads the directions
- Asks questions of the instructor/teacher
- Checks the work

Maintenance Director

- Directs carrying out of safety rules
- Directs the cleanup
- Asks others to help

Reporter

- Records observations and results
- Shares results with group or class
- Tells the teacher when the investigation is complete

Materials Manager

- Picks up the materials
- Directs use of equipment
- Returns the materials

Pre- and Post-Assessment Answer Key

- | | |
|------|-------|
| 1. c | 9. d |
| 2. a | 10. b |
| 3. b | 11. d |
| 4. a | 12. a |
| 5. a | 13. b |
| 6. c | 14. c |
| 7. b | 15. d |
| 8. b | |

Each student will need:

- Copy of assessment sheet (p. 4)

SETUP & MANAGEMENT

The pre-assessment should be administered as an individual student activity prior to beginning the group activities (see Procedure, Items 1 and 2).

At the conclusion of the unit, you will conduct a post-assessment using a clean copy of the assessment sheet and the completed pre-assessments.

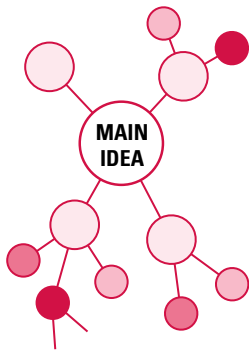
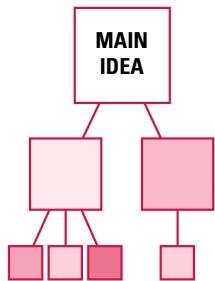
Unless noted, each activity in this guide is designed for students working in groups of four (see “Using Cooperative Groups in the Classroom,” above).

PROCEDURE

1. Explain to students that they will be learning about the heart and circulatory system. Tell them that first, they will take a pre-assessment to help them identify what they already know and what they might want to learn about this topic.
2. Distribute the pre-assessment to students. Have them complete the form individually, and then collect the assessments. (Save for use during the post-assessment.)
3. Instruct students to write any questions they have about topics covered on the assessment on a “sticky note.” Then have students place their notes in a “parking lot” (a part of a bulletin board reserved just for student questions).
4. Use student questions to begin a discussion about the unit. This is a good time to identify any misconceptions the students may have. Explain to students that their questions will be answered as they learn more over the course of the unit.
5. Next, have students organize into groups of four to begin building their concept maps. Have student groups discuss what they know about their hearts and circulatory systems. Ask each group to begin a concept map

Concept Maps

Concept maps are web-like representations of knowledge, concepts and ideas. Concepts are expressed as words or phrases. They are connected by lines or arrows, and by linking words that describe relationships between two concepts.



Shown above are two different approaches to creating concepts maps. Students may use sticky notes to position and reposition concepts on their maps as they learn.

Computer-based graphics software also may be used to create concept maps.

or other form of graphic organizer that represents its collective knowledge and questions. Tell students that while they may not have much information now, they will be adding to their concept maps throughout the unit. You may want to describe concept maps as a way for students to “picture” what they are learning, including relationships among concepts and other pertinent information. Then suggest some ways for groups to begin. Concept maps may be computer generated or built on large poster paper or poster board. Students may prefer to use sticky notes on their concept maps, so that ideas and concepts can be rearranged as students’ knowledge increases. Display the concept maps around the room.

POST-ASSESSMENT

To be conducted at the end of this unit.

TIME

Two 45-minute sessions (2 days)

MATERIALS

Each group will need:

- Group concept maps (ongoing)

Each student will need:

- Clean copy of Assessment sheet (p. 4)
- Copy of previously completed pre-assessment (hold for distribution, see Session Two, Item 2)

PROCEDURE

Session One

1. After completing this unit, have students work in their original groups to review their concept maps. Each group should discuss the additions made to its concept map and decide



Astronaut Carl E. Walz, Flight Engineer, NASA International Space Station (ISS) Expedition 4, performs cardiopulmonary resuscitation on an improvised “human chest” dummy while onboard the space station. Astronauts not only need to keep themselves healthy; they also must be prepared to serve as health care providers for their fellow astronauts.

Photo courtesy of NASA.

2. which findings were most important.
2. Review each group’s concept map for accuracy and help students to correct any misconceptions. Discuss any remaining questions placed on the board (“parking lot”) over the course of the unit. Ask for volunteers or assign student teams to research unanswered questions. Provide time for student groups to change, add to or correct their concept maps.
3. Have each group, or a spokesperson from each group, present the group’s concept map. The presentation should explain the group’s approach to organizing material and concepts that it found particularly interesting or challenging. The presentations may be used as formative or summative assessments.

Session Two

1. Distribute copies of the post-assessment for each student to complete.
2. After students have finished, have them compare their answers on both pre- and post-assessments to see how much they have learned during the unit. Discuss any remaining student questions and collect the assessments, which can become part of students’ portfolios or science notebooks.



ACTIVITY: ASSESSMENT

WHAT DO YOU KNOW?

Name _____

Circle the best response to questions 1 through 15.

- The heart is located
 - on the left side of the chest.
 - on the right side of the chest.
 - near the center of the chest.
 - in the abdomen.
- During exercise, heart rate increases to
 - supply muscles with more oxygen.
 - improve breathing.
 - aid digestion.
 - supply the lungs with more oxygen.
- What is the advantage of having a heart with four chambers?
 - There is extra capacity when needed.
 - Blood can be pumped separately to the lungs and to the rest of the body.
 - There is a chamber to supply blood to each of the four limbs (arms and legs).
 - It is twice as large as a heart with two chambers.
- Once it leaves the heart, blood flows from
 - arteries to capillaries to veins.
 - veins to arteries to capillaries.
 - capillaries to arteries to veins.
 - none of the above.
- Why do some blood vessels have thicker walls than others?
 - To handle blood at a higher pressure.
 - To carry thicker blood.
 - To force blood into the heart.
 - To handle blood at a lower pressure.
- Under normal standing conditions on Earth, blood is pulled toward the
 - arms.
 - heart.
 - legs.
 - head.
- Blood pressure is a measurement of the force of blood against the walls of the
 - heart.
 - arteries.
 - veins.
 - capillaries.
- In outer space, where gravity is not felt, the heart must work
 - harder than on Earth.
 - not as hard as on Earth.
 - about the same as on Earth.
 - about the same as on the Moon.
- Blood pressure usually is reported as two measurements, such as "120 over 80." What does the second measurement describe?
 - Pressure that is calculated based on a person's age.
 - Pressure while the heart is contracting.
 - Pressure that is typical for a person with hypertension.
 - Pressure while the heart is relaxing.
- Animals without a circulatory system rely on this process to transport nutrients and waste.
 - Transfusion
 - Diffusion
 - Perfusion
 - Respiration
- When astronauts return from space, they often experience temporary changes in the circulatory system, which can cause
 - loss of hearing.
 - heart murmurs.
 - spikes in blood pressure.
 - dizziness.
- Pulse results from
 - a surge of pressure through an artery.
 - filling of a chamber of the heart.
 - valves found in veins.
 - the heart relaxing.
- The role of each atrium is to
 - pump blood out of the heart.
 - receive blood coming into the heart.
 - serve as a doorway between chambers.
 - connect the heart to the lungs.
- What might you do if you wanted to lower your resting heart rate?
 - Take frequent naps.
 - Eat carbohydrates.
 - Get more exercise.
 - Get at least eight hours of sleep every night.
- About how much blood circulates around the body of a typical adult each minute?
 - 100 mL
 - 500 mL
 - 1,000 mL
 - 5,000 mL