BioEd℠

THE SCIENCE OF THE HEART AND CIRCULATION

Activity 2. A System of Transport

by

Barbara Z. Tharp, M.S.

Deanne B. Erdmann, M.S.

Marsha L. Matyas, Ph.D.

Ronald L. McNeel, Dr.P.H.

Nancy P. Moreno, Ph.D.

RESOURCES

This publication is available in PDF format at www.nsbri.org and in the Teacher Resources section at www.BioEdOnline.org.

For online presentations of each activity and downloadable slide sets for classroom use, visit www.BioEdOnline.org or www.k8science.org.

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Authors: Barbara Z. Tharp, M.S., Deanne B. Erdmann, M.S., Marsha L. Matyas, Ph.D., Ronald L. McNeel, Dr.P.H., and Nancy P. Moreno, Ph.D.
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NATIONAL SPACE BIOMEDICAL RESEARCH INSTITUTE
1 Baylor Plaza, NA-425, Houston, Texas 77030-3498
www.nsbri.org

CENTER FOR EDUCATIONAL OUTREACH
Baylor College of Medicine, 1 Baylor Plaza, BCM411, Houston, Texas 77030
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TEAMING WITH BENEFITS

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

Dr. Jeffrey P. Sutton

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

For current, in-depth information on NSBRI's cutting-edge research and innovative technologies, visit www.nsbri.org.

OVERVIEW

The circulatory system efficiently moves large volumes of blood through the body. It includes a large and complex array of different sized vessels that carry blood away from, and then back to the heart.

Students will work in teams to simulate the volume of blood moved through the circulatory system by transferring liquid into—and through—a series of containers.

ACTIVITY 2

A SYSTEM OF TRANSPORT

Every living organism—even single-celled organisms—must interact with its environment to exchange gases (oxygen and carbon dioxide), obtain nutrients and eliminate wastes. In general, larger and more complicated organisms (such as humans) have more sophisticated, efficient systems to transport needed materials to and remove waste from cells where exchanges occur. In this activity, students will simulate movement of blood through the circulatory system and learn about the challenges of moving large quantities of liquid a little at a time.

The circulatory system in most adult humans circulates approximately 5.0 liters (5,000 mL) of blood around the body every minute. In newborns, half this amount of blood is pumped. And approximately 4.1–4.3 liters of blood circulates each minute in children and adolescents. With each contraction, an adult heart pumps about 60–130 mL of blood out from the left chamber (also called left ventricle) into the artery that leads to the body. In children and adolescents, the amount pumped is about 40 mL per contraction.

Humans have a closed circulatory system. This means that whole blood, for the most part, stays inside the blood vessels and heart, and does not mix with other body fluids. A good example of a closed system is the water treatment facility in your town. The facility sends clean water to your home through pipes. If the pipes are working properly, the water does not leak out. After you use the water, you pour it down the drain. From there, it travels through a different set of pipes back to the water treatment plant, where it gets cleaned again for re-use.

Continued

SCIENCE EDUCATION CONTENT STANDARDS*
GRADES 5–8

PHYSICAL SCIENCE
Motion and forces
- The motion of an object can be described by its position, direction of motion, and speed. Motion can be measured and represented on a graph.

LIFE SCIENCE
Structure and function of living systems
- Living systems at all levels of organization demonstrate the complementary nature of structure and function. Important levels of organization for structure and function include cells, organs, tissues, organ systems, whole organisms and ecosystems.

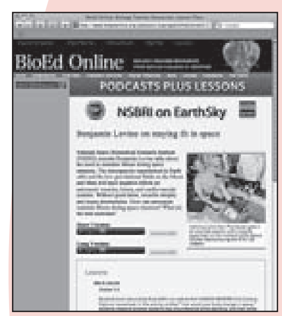
SCIENCE, HEALTH & MATH SKILLS
- Measuring
- Creating a model
- Comparing
- Questioning
- Calculating
- Drawing conclusions

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

Miles of Vessels

The average child has more than 60,000 miles of blood vessels. Adults have almost 100,000 miles of vessels!

Teacher Resources



Downloadable activities in PDF format, annotated slide sets for classroom use, and other resources are available free at www.BioEdOnline.org or www.k8science.org.

In much the same way, the human circulatory system moves blood to all parts of the body through the blood vessels (pipes or tubes). The pump that drives the blood through these vessels is the heart. Like water in pipes, whole blood stays inside the blood vessels. And just as large water mains divide into smaller and smaller pipes (like those under your sink), the large blood vessels attached to the heart divide into smaller and smaller vessels, so that each cell in the body is near to or touching tiny blood vessels. On the way back to the heart, blood vessels merge together into larger veins. Like water in a treatment facility, blood gets cleaned during each round-trip, and is made ready to use again and again.

The circulatory system is the "transportation system" for the body, and blood serves as the transport vehicle. Just as trucks deliver food, clothes, and other goods to houses and stores, blood circulates around the body, carrying and delivering the oxygen and nutrients needed by each cell. And like trucks that carry garbage away from our homes, the blood in our bodies picks up waste products (carbon dioxide and cellular waste) from cells, and takes wastes to organs that eliminate them from the body. As blood travels through some organs, it also makes special drop-offs and pick-ups.

- At the lungs, blood drops off carbon dioxide (waste), water and heat, and picks up oxygen.
- At the kidneys, blood drops off waste products, excess water, salts and vitamins.
- At the intestines, blood picks up nutrients, minerals, water and some vitamins.
- At other organs and glands, blood picks up hormones that help regulate body functions.

TIME

10 minutes for setup; 45 minutes to conduct activity

MATERIALS

Teacher (see Setup)

- Marker or labels for tubs
- Timer or clock

Each group of six students will need:

- 6 tubs or buckets labeled A–F (5-liter capacity each)
- 4 flexible plastic cups (soft plastic that can be cut with scissors)
- 2 15-mL tablespoons for measuring
- Graduated cylinder (100-mL or higher)
- Pad of sticky notes
- Pair of scissors
- Paper towels
- Roll of masking tape

Each student will need:

- Copy of student sheet (p. 9)

SAFETY

Clean up spilled water promptly to avoid slippery floors. Always follow all district and school laboratory safety procedures. It is a good idea for students to wash their hands with soap and water before and after any science activity.

SETUP & MANAGEMENT

Have students conduct the activity in teams of six. For easier management, have two teams carry out the activity simultaneously, possibly as a relay race.

For each team, label each of six large (at least five-liter) containers with a letter, A through F. Place five liters of water in container "A." Leave the remaining containers empty.

Before students begin the activity, write "5,000 mL" on a large sticky note and place it on the board. This number represents the five liters of blood pumped through the average adult circulatory system in one minute. But do not mention its significance until students post their group numbers (see Procedure, Item 10).

Note: It may be advisable to review metric units for measuring volume.

PROCEDURE

1. Divide students into teams of six. Then have team members count off

The Circulatory System

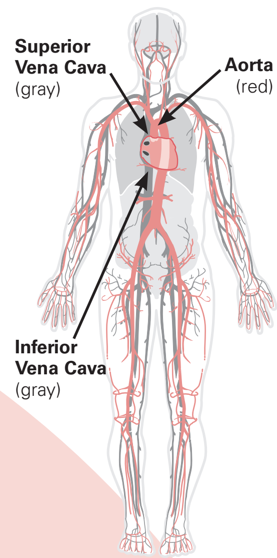


Fig. 1. The Circulatory System is the "transportation system" for the body, and blood serves as the transport vehicle.

Veins (shown in gray) take blood to the heart. Arteries (shown in red) take blood away from the heart.

The Liter

The liter (L) is the basic unit of volume in the metric system.

One liter represents the capacity of a 10-centimeter cube. One liter is approximately 1.75 pints.

1 milliliter (mL) = 0.001 L

1,000 mL = 1L

1 teaspoon (t) = 5 mL

1 tablespoon (T) = 15 mL

The Aorta

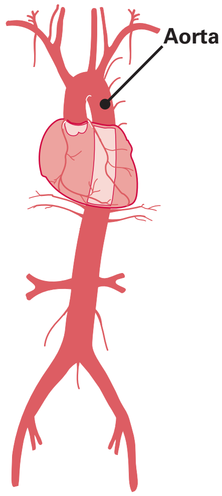


Fig. 2. There is no larger artery in the body than the aorta. It carries blood and nutrients away from the heart (see Fig. 1, p. 6).

The Vena Cavas

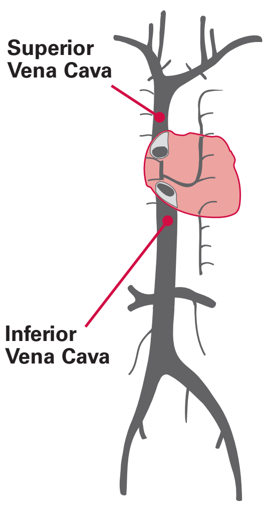


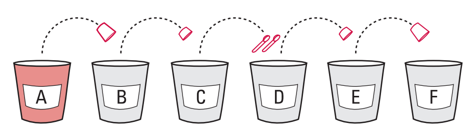
Fig. 3. The vena cavas are the two largest veins in the body. The superior vena cava brings blood from the arms and head to an opening at the top of the heart. The inferior vena cava brings blood from the legs and trunk to an opening in the bottom of the heart (see Fig. 1, p. 6).

STUDENT ACTIVITY: PATHWAY MODELED

Student Number	Location	Volume (mL) Per Move	Pathway Modeled
1	A to B	60	One contraction or "beat" from the heart to large arteries
2	B to C	30	From large arteries to small arteries
3 and 4 (students work in parallel; each has a tablespoon)	C to D	15 (1T)	From small arteries through capillaries into small veins
5	D to E	30	From small veins into large veins
6 =	E to F	60	From large veins back to the heart

from one through six. Each number designates a different role on the team.

2. Ask the Materials Manager and a helper from each group to pick up student worksheets, container "A" with five liters of water, other containers marked as B–F, a beaker or graduated cylinder, four plastic cups, scissors, two tablespoons, masking tape and several paper towels.
3. Have students calibrate four plastic cups as measuring tools, as follows.
   - Using the graduated cylinder, fill two cups with 60 mL of water and two cups with 30 mL of water.
   - Wrap a piece of tape around each cup, with the top edge of the tape lined up with the level of the water.
   - Empty all cups and cut off the top of each at the upper edge of the masking tape.
4. Explain to students that they will be participating in a "water relay race" by following a specific set of procedures. Each six-member relay team will work together to move five liters of water from container "A" all the way to container "F." Each team member may move water only by using the measuring cup or tablespoon assigned to him or her. Teams may not skip any steps. Review the assignment for each team using the "Move It" student page.
5. Set a time limit (three minutes is suggested) and tell student groups that they will measure the amount of water they are able to move to container "F" before the set time expires. Set up a system of tubs (A–F) arranged in a line to demonstrate a few steps in the procedure and ask if there are any questions.



6. Have students set up their relay systems, two groups at a time. Before they begin, check each team's setup. Start the activity with both groups simultaneously. All team members should stop when time is called.
7. Each team should record on a sticky note the number of mL of water in container "F" (total volume moved during the relay). Each team's note should be placed on the board in numerical order, before or after the 5,000 mL note that you had earlier placed on the board.
8. When all teams have posted their results, ask, *What do you think was modeled by the water relay race?* Take time to consider all responses. [The relay models the amount of blood pumped

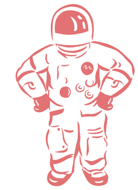
Continued

around the body (cardiac output) for an average adult, per minute.]

9. Next, refer to the numbers posted by each group. Ask, *Why is the number, 5,000, on the board?* Discuss and explain that this number represents the 5,000 mL (or five liters) of blood that typically are pumped from the heart through the body of an adult each minute.
10. Ask, *Which part of your team's system modeled the amount of blood that leaves the heart with each contraction?* [transfer of 60 mL of liquid into Container A] Sixty mL represents a typical amount of blood exiting the heart into the body (varies between 60 and 130 mL in adults). In the model, what other parts of the circulatory system were represented? Use a simplified illustration of the circulatory system (photocopy and make a transparency of the diagram on p. 6, or download a PowerPoint® slide of the circulatory system from www.BioEdOnline.org to explain how, after blood is pumped from the heart into the body, it travels through a series of vessels, called arteries.

    Arteries become progressively smaller further away from the heart. The smallest vessels, called capillaries, are thinner than a hair. They allow the transfer of nutrients, oxygen, waste and carbon dioxide between blood and individual cells. In most of the body, nutrients and oxygen are transferred from blood into cells, while waste and carbon dioxide move from cells into blood, which carries them away to be eliminated from the body.

    Vessels that convey blood back to the heart, called veins, become progressively larger in diameter until they reach the vena cavas, through which blood enters the heart. Ask, *Is your team's system a good model of the circulatory system? What are the shortcomings? How might we make it better?*
11. Have student groups create a literary representation of arteries, veins and capillaries to help them remember the function of each vessel. The representations can take the form of a poem, acronym, acrostic, rebus or other mnemonic. All representations should convey the following concepts: arteries carry blood away from the heart and have a larger diameter than capillaries; capillaries are very narrow and very numerous, which permits the transfer of materials—such as nutrients, oxygen, carbon dioxide and waste—to cells; veins are comparable in size to arteries and bring blood back to the heart.
12. Have students display their representations around the classroom. Ask, *Why do you need to know about your blood vessels? Have you ever heard or seen an advertisement about health problems related to blood vessels?* [for example, high blood pressure or blood clots]
13. Have student groups add information to their concept maps, including answers to any questions posed earlier.



AstroBlogs!

An AstroBlog entry for Activity 2 can be found on page 42.

Memory Aids

Acronym: A word formed from the combination of the initial letters of a phrase or name (such as LASER, derived from "light amplification by stimulated emission of radiation").

Acrostic: A series of lines or verses in which certain letters, usually the first of each line, spell out a word or phrase when read in sequence (such as the poem below, which is an acrostic for "vein").

Veritable tube that

Efficiently

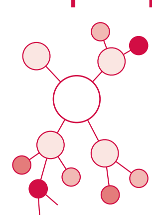
Is designed to carry

Notable wastes from cells

Mnemonic: Any memory aid, such as a rhyme or acronym.

Rebus: A representation of words through pictures or symbols.

Update Concept Maps



ACTIVITY 2
MOVE IT!

During a relay race, members of each team take turns swimming or running parts of a circuit or course. In this activity, you and your team members will complete a water relay. Each team member will play a different role.

1. Within your team, count off from one through six. Each team member will have a specific job, based on his or her number (see chart below).

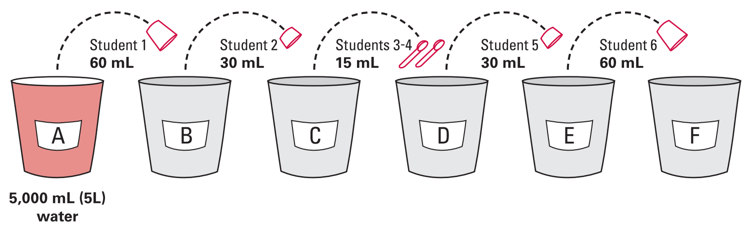
2. Gather six tubs or buckets, labeled A–F, a graduated cylinder, four plastic cups, two tablespoons, paper towels, a roll of masking tape and a pair of scissors.

3. Follow the instructions below to create and calibrate four special measurement cups.

    A. Fill a graduated cylinder with 60 mL of water and pour the water into one plastic cup.
    B. Wrap a long piece of tape around the outside of the cup, making sure that the top edge of the tape is level with the top of the water. Pour out the water.
    C. Cut off the extra plastic that is above the top edge of the tape. Label the cup "60 mL."
    D. Repeat to make another 60-mL cup and two 30-mL cups.*

    *To make two 30-mL cups, follow the instructions above, but begin 30 mL of water instead.

4. Find an empty area on the floor. Place the six tubs or buckets on the ground in a straight line, one next to the other. Make sure the tubs or buckets are labeled A–F.



5. Fill container A with five liters of water. Your team will work together to move water from tub A to tub F, with each student using his or her assigned cup or spoon to move only the specified amount from one tub to the next. All team members will be working at the same time.

6. Wait for your teacher's instruction to begin. Try not to spill any water.

7. After the teacher has called time to end the relay, measure the total amount of water in tub F. Record the number in the table below.

Team Member	Location	mL to Move
1	A to B	60
2	B to C	30
3 and 4	C to D	15 (Team members 3 and 4 each use a tablespoon to move water from container C to container D.)
5	D to E	30
6	E to F	60

	Water mL
Starting Amount in Tub A	**5,000 mL**
Amount in Tub F at End of Relay	**mL**

8. What do you think the water relay race was modeling?

CARDIAC RESEARCH

NSBRI Web site: www.nsbri.org

If one part of a car isn't properly maintained, it can affect the performance of the entire vehicle—especially if it's driven on a long trip. The same can be said for the human body. That's why, when it comes to fitness in space, it's important to create a program for the whole body.

To keep astronauts healthy on long missions, researchers with the National Space Biomedical Research Institute (NSBRI) are developing an exercise program that addresses many of the physical changes caused by microgravity. In one experiment conducted on Earth, participants stayed in a bed tilted at a six-degree angle, with their feet positioned at the higher end of the bed. In this position, the heart works about 15–20% less than it does under normal living conditions. In addition, blood pressure changes and work capacity is lessened. All of these things also happen to astronauts during long-term spaceflights.

The study involved 24 subjects divided into three groups. One group (the control group) stayed in bed and did no exercise. The remaining two groups performed exercise training while in bed. Half of the training subjects received a dietary supplement.

Strength training (rowing, lifting weights) forces muscles to contract enough to briefly interfere with blood flow into muscles. Endurance training exercise (swimming, running and cycling) forces large-muscle groups to contract regularly.

The test subjects exercised using a rowing machine (strength and endurance training in one) with their knees level to their hearts. Subjects also trained with the same regimen athletes use to achieve maximal physical benefit: a program consisting of base training, followed by threshold, interval and recovery training.

The base-training session consisted of moderate rowing exercise performed at a level where subjects could still carry on a conversation, but with slight shortness of breath. With threshold training (one to two days per week), subjects worked at their maximum sustainable effort. For example, at this level, professional marathon runners run hard, but do not sprint.

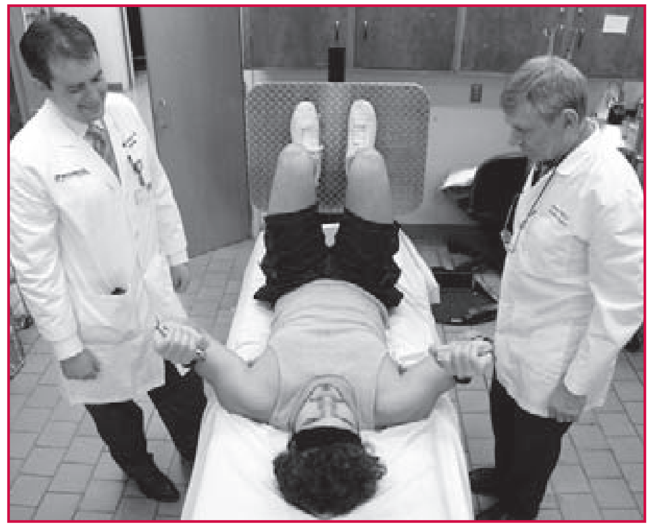


Photo courtesy of UT Southwestern Medical Center at Dallas.

To preserve astronaut health on long missions, scientists are researching the benefits of an exercise program to counteract space-related heart, lung, muscle and bone problems.

The interval-training segment was a high-intensity exercise effort in which subjects pushed their hardest for one to three minutes, building power and explosive energy. Each interval training session was followed by a recovery session, during which subjects exercised at low intensity. The regimen included one long, slow distance effort. Scientists found that this kind of exercise routine preserved heart size and function, muscle size and bone strength.

Researchers now are developing a single exercise routine for astronauts that will prevent damage to their cardiovascular systems, bones and muscles. On Earth, doctors already are using this type of exercise regimen with patients, and are seeing very satisfying results.

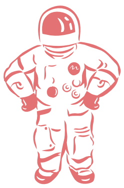
The NSBRI, funded by NASA, is a consortium of institutions studying the health risks related to long-duration spaceflight. The Institute's science, technology and education projects take place at more than 60 institutions across the U.S.

An Astronaut's Point of View

AstroBlogs

Create a "blog-wall" in your classroom to stimulate students' thinking and encourage students to express their ideas in writing. Periodically, post a copy of one of the AstroBlog entries below to spark students' interest. Suggested use with specific activities is noted with each entry.

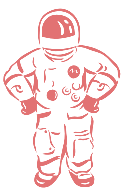
Activity 2



AstroBlogs

The human circulatory system is very well adapted to work under normal Earth gravity. In fact, some parts of the circulatory system count on gravity to help move blood through the body. When I'm floating in space, where humans hardly feel the effects of gravity, my circulatory system faces some real challenges. But even in low gravity, my circulatory system still has to accomplish its transportation function. If it doesn't, I (and my fellow humans!) would not be able to survive space travel. In this unit, you'll learn how the circulatory system functions on Earth, and discover some of the challenges we space travelers face when we're in orbit and when we return home. More on that later…

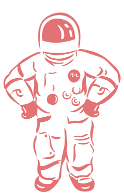
Activity 3



AstroBlogs

The floating food coloring in this activity shows how things float when we are orbiting the Earth. In orbit, we don't feel the effects of gravity. This condition is called microgravity. You may have experienced microgravity conditions momentarily on Earth. For example, if you ever felt like you've floated out of your seat as you reached the top of a roller coaster, you experienced a moment of what some people call "weightlessness." Do you think we actually become weightless in a situation like this one, on the roller coaster?

Activity 4



AstroBlogs

We use lots of pumps in our spacecraft—pumps for water and fluids that drive different mechanical devices. These pumps have to work in microgravity just as they do on Earth. Can a pump really work in microgravity? As long as it doesn't need gravity to operate, yes.

For example, a sump pump, like those used in basements, would have a hard time working in space. It depends on water flowing "downhill" to refill the pump each time. In space, that water would float right where it was! So in microgravity, it is better to have a pump with elastic walls. Think of a sponge underwater. If you squeeze the sponge and let it go, it will refill with water, due to the negative pressure left when the elastic sponge walls return to their original shape. The water is drawn into these spaces because the water pressure outside the sponge is greater than the pressure in the empty spaces inside.

Our hearts work in a similar way. The strong, elastic walls of our hearts are like the sponge. After they contract and push blood into the next chamber or arteries, they spring back to their original shape so the chamber can refill with blood. Therefore, my human heart pump works just fine while I'm floating in space. Whew! That's a relief!

An Astronaut's Point of View

AstroBlogs

Activity 6

AstroBlogs

As you can see, the heart is a powerful pump. But like any pump, it can malfunction, sometimes because of our choices for exercise and diet. What about when we are floating in space? Does microgravity affect the heart muscle? Yes!

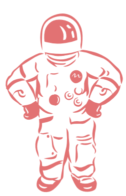
If you think about it, a lot of the work done by the cardiovascular system involves moving blood upward against gravity. For example, your heart has to push blood more than a foot upward to your brain. If you've ever sucked soda up a super-long straw, you know it takes some work to move liquid against gravity through a narrow tube.

Due to the downward pull of gravity, our blood tends to pool in the lower half of our bodies. While I float in the space shuttle as it orbits the Earth, the blood in my body is not being pulled by gravity toward my feet. Because, of course, there is very little gravity in space! Therefore, more blood than usual will stay in the upper half of my body, and less will stay in the lower half. After just one day in space, my legs start to look skinny and my face starts to look puffy. My nose and ears feel stuffy, too… not fun! It's no surprise that while I'm floating in space, my body doesn't have to use its muscles to hold me upright against the Earth's gravity. This makes my heart rather lazy. It slows down and doesn't have to work as hard to pump blood to the different parts of my body. And we all know what happens to muscles when we don't work them, right? They get weaker and smaller.

*This can happen to an astronaut's heart, too. How do we avoid this? The same way we do on Earth: exercise, and lots of it! We have treadmills and stationary bikes in space to keep our skinny chicken legs and our hearts strong. When I get back to Earth, I'll feel a little dizzy and weak-kneed for a while. But my body will readjust to Earth's gravity pretty quickly and my heart will get strong again. The recovery time happens even faster if I keep exercising. Gotta go… Time to ride the bike!**

* www.esa.int/esaHS/ESAGO90VMOC_astronauts_0.html

Activity 7



AstroBlogs

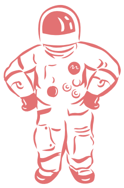
It's another beautiful day in space! I just finished my lunch. Did you know that we eat tortillas instead of sliced bread up here? Why? Well, if you drop a few crumbs on Earth, they just fall to the floor. If I drop a few crumbs in space, they float around the spacecraft and get in everyone's noses or eyes, or worse, into the machinery. Not cool. But tortillas don't crumble. And besides, I like them with my fajitas, with lots of hot sauce to get my blood moving.

Speaking of blood, did you know that even my blood will change while I'm floating in microgravity? Yep! I get a little dehydrated up here. In fact, my blood plasma volume will drop as much as 20% during a space mission. Then my body reduces my red blood cells so my blood isn't too "thick." We have to work hard to keep hydrated. Luckily, our bodies will return to normal after we're back on Earth for a while. I can eat crumbly potato chips then, too!*

* www.esa.int/esaHS/ESAGO90VMOC_astronauts_0.html. Note: Another resource is Donald E. Watenpaugh. Fluid Volume Control During Short-term Spaceflight and Implications for Human Performance. *J. Exp. Biol.* 2001 204: 3209-32.

ASTROBLOGS

Activity 8



AstroBlogs

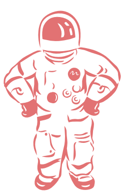
Exercise! You can't imagine how important it is to those of us who travel through space. We don't just exercise for a half hour or an hour. Sometimes we exercise several hours a day! Why so much?

Well, first, we need to keep strong. Floating around inside the shuttle is easy, but working outside, in a pressurized suit with tools, is really hard. You have to be fit to do this kind of work. More important, exercise helps to slow down, or even reverse, some of the changes that micro-gravity causes in my circulatory system. Exercise even helps to relieve the stuffy head I get when extra blood collects in the upper part of my body.*

When astronauts exercise, we often collect information about our heart and breathing rates, our muscle mass and our strength. That data is really important for planning long-term spaceflights. Speaking of which, did you know we are working towards launching the first human mission to Mars? That trip will last more than two years. We need to know how to exercise in space, so that we don't end up being Martian couch potatoes when we get there!

* www.esa.int/esaHS/ESAGO90VMOC_astronauts_0.html

Activity 9



AstroBlogs

Blood pressure is an important issue for astronauts, especially during take off and landing. When we blast off from Earth, our hearts have to push the blood against Earth's gravity. Then, as we move into orbit and the microgravity of space, our bodies' control systems tell the circulatory system to adjust. This causes our blood pressure to drop.

When we return home, we have a bigger problem. As we approach Earth, the pull of gravity increases. This makes the heart work harder to move the blood to all parts of the body, including the brain. If the heart doesn't respond quickly enough, we can get light headed, and even faint. Not cool, especially when you're flying a spacecraft at several thousand miles per hour!

Not all astronauts get light headed during reentry, and it's hard to predict who will react this way. I hope that when we land from this mission, I will be clear-headed all the way down. I'm not flying the shuttle, but I want to see the whole landing process. Besides, if I pass out, I might drool inside my helmet. That would be embarrassing!