

# OVERVIEW

Blood pressure, the force of blood against the walls of blood vessels, is responsible for the movement of blood through the arteries. When blood pressure is measured, two numbers are recorded. The first number represents the pressure while the heart is contracting to pump blood through the arteries. The second number represents the pressure while the heart is relaxing and refilling.

Students will measure their own blood pressure and learn about the health effects of high blood pressure.



## ACTIVITY 8

# WHAT IS BLOOD PRESSURE?

Students now have learned about the heart, the blood vessels, and blood. But what about blood pressure? Blood behaves like any other liquid and exerts pressure against the vessels in which it is contained. Blood pressure is the force of blood against the walls of blood vessels,

specifically the arteries, and is responsible for the movement of blood through the arteries. Blood pressure is much higher in arteries than in veins and capillaries.

Most students have had their blood pressure measured with a blood pressure meter consisting of a cuff attached to a mercury or mechanical measuring

Most students have had their blood pressure “taken” with a blood pressure cuff attached to a measuring device (sphygmomanometer). In this common practice, a cuff is secured just above the bend in a person’s elbow and inflated to increase pressure against the artery of the upper arm (brachial artery). A stethoscope is placed on the inside of the elbow to listen for the whooshing or pounding sound of blood flowing through the brachial artery. The cuff is inflated until no pulse or sound can be detected with the stethoscope. At this point, blood flow has stopped. Then, air is slowly released from the cuff, and the stethoscope is used to listen for the first sounds of blood flowing again through the brachial artery.

The force of blood flowing through the artery at this point, known as systolic pressure, is slightly greater than the pressure being exerted against the artery by the cuff. The systolic pressure indicates

### Blood Pressure and Gravity

On Earth, the heart must pump against two factors: 1) the normal resistance of the arteries to blood flow and 2) gravity. Additional pressure is required to push blood to the brain and other parts of the body above the heart. The pull of gravity actually aids blood flow down to the lower limbs. But then, leg muscles must help to squeeze blood back up through the veins, to the heart, against the force of gravity. In space, gravity does not affect blood movement in any direction.

#### 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.
- 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 to protect us from diseases.

##### SCIENCE, HEALTH & MATH SKILLS

- Measuring
- Collecting data

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



### AstroBlogs!

Continue the “blog-wall” with an AstroBlog entry written for Activity 8. It’s located on page 44.

### A Laughing Matter

Laughter has been linked to the healthy function of blood vessels. Researchers at the University of Maryland Medical Center found that watching funny movies caused volunteers’ blood vessels to relax, thereby promoting increased blood flow.

[www.umm.edu/news/releases/laughter2.htm](http://www.umm.edu/news/releases/laughter2.htm)

the amount of pressure in the artery while the heart’s ventricles are contracting. Systolic pressure is the larger (and first) of the two numbers in a blood pressure reading. For instance, it is the “120” in a blood pressure reading of “120 over 80.”

Once systolic blood pressure is measured, air is slowly released from the cuff until the beating or whooshing sounds no longer can be heard through the stethoscope. Then, another reading is taken to measure diastolic pressure, which is the pressure in the artery while the heart is relaxing and refilling. Diastolic pressure is the smaller (and second) number reported in a blood pressure reading (it is the “80” in a reading of “120 over 80”).

One of the first accurate tools for measuring blood pressure was a mercury manometer (measures pressure with a column of mercury, similar to a thermometer). That’s why today, blood pressure always is reported as millimeters of mercury, even when it is measured by an aneroid device (calibrated dial with a needle) or a digital monitor.

A blood pressure measurement of 100 mm Hg indicates a force of blood pushing against the arteries sufficient to hold up a column of mercury that is 100 millimeters high. And a blood pressure reading of 120/80 (or 120/80 mm Hg), means the systolic and diastolic pressures are 120 and 80 millimeters of mercury, respectively. Knowing what these two values mean is important to health and well-being. Normal blood pressures vary by age (see table, above right).

When a person has pressure in the arteries that is considerably higher than normal during inactivity, we say he or she has high blood pressure (also called hypertension). A doctor must make this diagnosis, but readings higher than 140/90 usually signal high blood

### Age-Appropriate Blood Pressure Ranges in mm Hg

Age	Systolic	Diastolic
Birth	50–70	25–45
Neonate (0–1 month)	60–90	20–60
Infant (1–8 months)	87–105	53–66
Toddler/pre-school (9 months–5 years)	95–105	53–66
School age (6 years)	97–112	57–71
Adolescent (15 years)	112–128	66–80
Adult (18+ years)	120	80

Source: *Pediatric Advanced Life Support Provider Manual*, American Heart Association.

pressure. A rise in heart rate, increased blood volume, or a narrowing of the blood vessels all can cause high blood pressure by increasing the force of blood against the artery walls. Uncontrolled high blood pressure is sometimes called the “silent killer,” because the individual who has it feels normal. High blood pressure can damage the arteries, heart, brain, kidneys or eyes in a number of ways.

Many factors contribute to hypertension. Some, such as genetics or age, cannot be changed. A person is more likely to develop high blood pressure if his or her parents have the condition. And the chances for developing hypertension increase with age. High blood pressure also can be caused by medical conditions, such as kidney disease and diabetes. Fortunately, we can control some of the risk factors for high blood pressure. For instance, we can get regular exercise, limit the consumption of alcohol, salt and saturated fats (fats that are solid at room temperature), maintain a healthy body weight, and reduce stress.\*

Since there are so many negative health effects of high blood pressure, it may seem desirable to have low blood pressure (called hypotension). And it is true that people who exercise regularly tend to have lower blood pressure than those who are not as fit. However, blood pressure that is too low may signal the presence of

\* [www.americanheart.org/presenter.jhtml?identifier=4650](http://www.americanheart.org/presenter.jhtml?identifier=4650)

*Continued*



underlying problems, such as a heart condition, low blood sugar, or even dehydration. Some experts say that readings below 90 systolic or 60 diastolic indicate low blood pressure, but since there are so many factors involved, these numbers can be misleading. What is normal for one person might be considered low for someone else.

## TIME

10 minutes for setup; two 45–60 minute sessions

## MATERIALS

### Teacher (see Setup)

- Electronic blood pressure monitor with a self-inflating cuff (sold in drugstores)

### Each student will need:

- Lab notebook

## SAFETY

Make sure all students are seated while taking blood pressure. Over-inflation or excessive duration of inflation of the blood pressure cuff may cause discomfort or injury. 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

Obtain an electronic blood pressure monitor with a self-inflating cuff. Do not use a manual blood pressure monitor because students easily could over-inflate the cuff and cause injury. Read and follow the manufacturer's instructions, which can vary between models.

Place the monitor in a central location, where students can take turns measuring their blood pressure. While students are waiting their turn at the blood pressure center, teams may begin to research and discuss the provided questions (see Procedure, Item 6).

If a blood pressure monitor is not available, ask students to measure their blood pressure, under the supervision of

their parents/guardians, at a public blood pressure kiosk, usually found in drug or grocery stores.

Have students work in teams of two.

## PROCEDURE

1. Ask, *Have you ever had your blood pressure taken? If so, what do you think was being measured?* Explain that when a health care provider takes a patient's blood pressure, he or she briefly restricts the flow of blood through one of the patient's arteries by applying pressure to the artery. The health care provider then slowly reduces the pressure until he or she hears (using a stethoscope) the sound of blood forcing its way through the vessel. The measurement taken at this point is called the systolic pressure. The health care professional continues to reduce the pressure until he or she no longer hears any sounds. The measurement taken at this point is called the diastolic pressure.

Explain that the top number in a blood pressure reading (systolic) represents the pressure when blood is forced from the ventricles, and the bottom number (diastolic) represents the pressure when the ventricles are at rest, or between beats (filling with blood). Remind students that even when blood is not being forced from the heart, it continues to flow. There always is a certain amount of pressure maintained in the blood vessels.

2. With a student volunteer, demonstrate how to take a blood pressure reading. Have the student sit in a chair with feet flat on the floor and with shirt sleeves rolled up. Place the monitor cuff just above the bend of the student's upper arm. Ask the student to raise his or her arm to the level of the heart. Place your arm underneath the student's arm to support it. Ask the student to relax his or her arm. Take a reading according to the manufacturer's instructions for the monitor.

## Can High Blood Pressure be Cured?

High blood pressure is the most common disease of the circulatory system. For most people, it cannot be "cured." But it can be controlled by changes in lifestyle (exercise and diet) and/or by medications. Some medicines relieve pressure by causing the arteries to relax and open up. Others lower blood pressure by reducing the heart's output, or by causing the body to lose salt and water. Of course, each medicine has side effects, and a healthy diet and exercise always are important factors in the treatment of high blood pressure.

[www.americanheart.org/downloadable/heart/119626772541850%20WhatIsHBPMedication%209\\_07.pdf](http://www.americanheart.org/downloadable/heart/119626772541850%20WhatIsHBPMedication%209_07.pdf)

## A Silent Killer

According to the American Heart Association, almost one-third of adult Americans have high blood pressure. And about a third of those people don't even know they have it! They may have high blood pressure for years, unaware that it is damaging their heart, blood vessels and other tissues.

[www.americanheart.org/presenter.jhtml?identifier=2114](http://www.americanheart.org/presenter.jhtml?identifier=2114)

## Reliable Sources

Reliable information about heart health and related topics is available online at the following Web sites.

### American Heart Association

[www.americanheart.org](http://www.americanheart.org)

### Centers for Disease Control and Prevention

[www.cdc.gov](http://www.cdc.gov)

### MedLine Plus\*

<http://medlineplus.gov>

### National Heart, Lung, and Blood Institute

[www.nhlbi.nih.gov](http://www.nhlbi.nih.gov)

### U.S. Food and Drug Administration

[www.fda.gov/hearthealth](http://www.fda.gov/hearthealth)

\*Health information is available in more than 40 languages.

- Mention that several factors might lead to an inaccurate blood pressure reading. These include physical activity (standing up quickly, walking fast, etc.), posture, medications, emotions, temperature and diet. Ask, *Why would blood pressure be an important measure of a person's overall health? Do you think it is more dangerous to have high or low blood pressure? Why?* Remind students of earlier lessons about the heart and valves.

Just as too much air pressure can damage an over-inflated tire, high blood pressure, over time, places additional stress on the heart, valves, arteries and other organs of the body.

- Have teams of two students visit the blood pressure center, one team at a time. Students should take turns using the blood pressure monitor and recording their pressure readings in their lab notebooks. Be sure students record their results by writing the higher number on top and the lower number below (for example, 115/75). You may want teams to begin working on their research questions (see Item 6, below) while they wait to use the blood pressure monitor.
- Discuss healthy ranges for blood pressure (see table, p. 35). Remind students that if their readings do not fall within the healthy range, they may want to have their blood pressures checked by a health care professional. You may wish to construct a class graph of students' blood pressure measurements.
- Have each student team investigate one of the following questions related to blood pressure. Each team should



**Astronaut Jeffrey N. Williams**, Science Officer and Flight Engineer, NASA ISS Expedition 13, holds up two finger cuffs on a Continuous Blood Pressure Device. Small, portable medical devices created for use by astronauts also can be used here on Earth.

Photo courtesy of NASA.

conduct its research on the Internet and/or in the library, and then present its findings to the class during the next class period. Teams may want to develop their own topics for investigation. Students should include lists of the sources they consulted.

- What is the relationship between eating high-fat foods and blood pressure?
- How does family history (for example, whether one of your parents has high blood pressure) affect your chances of developing high blood pressure at some time?
- How does diabetes affect a person's chances of having high blood pressure?
- What effect does walking or running three times per week have on blood pressure?
- Do stress levels influence blood pressure? If so, what is the effect?
- How does heavy alcohol consumption affect blood pressure?
- How does eating a lot of salty food affect blood pressure?
- What types of foods, if any, help to maintain blood pressure in a healthy range?



# CARDIAC RESEARCH

NSBRI Web site: [www.nsbri.org](http://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

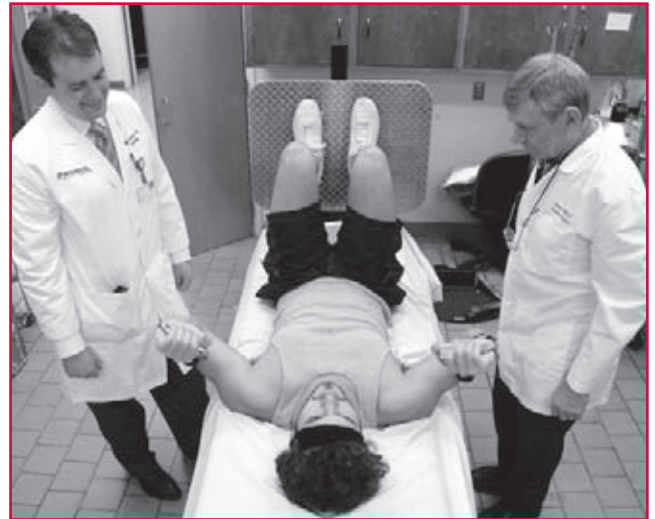


Photo courtesy of UT Southwestern Medical Center at Dallas.

**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.**

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.

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

### 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 microgravity 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](http://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!*

