

SIEMENS STEM DAY ACTIVITY

BODY SYSTEMS IN SPACE

OBJECTIVES

Students will be able to:

- **Discover** the functions of human body systems and how space travel or life on another planet can affect them.
- **Design** a product that could help solve a health-related problem that astronauts face.

STEM LESSON FOCUS

Engineering Design Cycle

- Designing Solutions
- Creating or Prototyping
- Communicating Results

21st Century Skills

- Collaboration
- Communication
- Critical Thinking
- Creativity

STEM CATEGORY

Science

TOPIC

Healthcare

OVERVIEW

In this lesson, students will learn about the upcoming planned missions to Mars from various space companies. They will then design a product that could be used to help astronauts as their bodies face the rigors of space on the long journey to Mars.

Students will form groups and will be assigned a particular body system with a problem that their product will address. Each group will get a card or info sheet that will introduce them to the function of their system in the human body and how space travel or life on Mars can negatively affect this system.

Students will work together to design a product that can help astronauts solve a problem that their body system faces during space travel. They will create a sketch or blueprint of their product using a free modeling program on the Internet, and present a brief sales pitch to the class as if they were selling this product to NASA or other space exploration companies.

MATERIALS

- Student devices (computer or tablet with internet access)
- Body System Capture Sheet
- 3D modeling software programs:
 - [Solid Edge](#)
 - [Sketchup](#)
 - [Tinkercad](#)
 - [Autodesk123D](#)
 - [Autodesk Fusion 360](#)

HAVE YOU EVER WONDERED...

- How space travel and life in zero gravity affects the bodies of astronauts?
- What health challenges we will face in the future as we prepare to leave our own planet and travel deep into space to colonize others?

MAKE CONNECTIONS!

How does this connect to students?

Engineering, innovation, and the ability to solve problems are extremely important when planning for space travel in the future. As we learn how zero gravity and other aspects of space impact the human body, we will need to create solutions to keep astronauts safe and healthy.

How does this connect to careers?

Aerospace engineers design or build aircraft, missiles, systems for national defense, or spacecraft. They are involved in manufacturing, analysis and design, and research and development.

Aerospace medicine physicians provide healthcare to those who work in airplanes and spaceships, including Pilots, Flight Attendants, and Astronauts. They diagnose, treat, and prevent conditions to which those involved in aviation and spaceflight are susceptible.

Astronauts do many different jobs both while in space and on Earth. They may serve as space shuttle and international space station pilots and commanders who are responsible for the crew, the mission, the mission success, and the safety of the flight. They may conduct experiments, launch satellites, and maintain spacecraft and equipment.

How does this connect to our world?

As humans draw closer to exploring and colonizing Mars, it is important to learn as much as we can about how space travel and the conditions of space and other planets affects our bodies. By studying astronauts' anatomy and physiology before and after time in space, we can design missions and create products that will minimize the health risks to our future Mars astronauts as they travel to and explore the red planet.

BLUEPRINT FOR DISCOVERY

1. Begin by asking students if they have heard of any of the proposed crewed space missions to Mars. Explain that this means humans will set foot on and possibly colonize Mars. Have students briefly share what they know about this with the class.
2. Tell students that currently there are several organizations that are planning crewed missions to Mars in the not-so-distant future. You may invite students to explore the following link that gives an overview of NASA and Space X's plans to put people on Mars: <https://www.nasa.gov/content/nasas-journey-to-mars>
3. Explain that we have learned that space travel and spending time in zero gravity can have many different effects on the human body. Show the following video clip to students: <https://www.youtube.com/watch?v=QsZWVBmpj18>.
4. Explain to students that in this lesson they will learn about one of the systems of the body and how space impacts its function. They will design and create a 2-D model of a product that will help astronauts solve a problem for their assigned body system.
5. Assemble students into groups of 3 or 4. Give each group a copy of one of the Body Systems in Space Information Sheets. This will determine their assigned body system.
6. Groups should read through the information on their sheet and brainstorm about a product that could be created to help solve the problems space presents to their body system. Allow 30 minutes for student groups to create a sketch or blueprint of their product using CAD software on their device (laptop, tablet). If students do not have access to CAD software, they can create their sketch/blueprint on large poster paper.
7. For the final 15 minutes of the activity, allow each group to give a brief "sales pitch" (think Shark Tank-style) for the product they have created to the class. They should introduce their body system, the problem that space travel causes, and how their product can help solve it. They should display their CAD sketch or blueprint on the overhead screen as they present. Sales pitches should not exceed 3 minutes per group.

Take action!

Extensions of this lesson could require that student groups create a 3-D prototype model of their product using simple materials from their blueprint to present as part of their sales pitch.

Students can further explore how space travel impacts the body and find answers to many space-health related questions by going to the Canadian Space Agency's YouTube channel and exploring some of the many videos that show life on the International Space Station by astronaut Chris Hadfield: <https://www.youtube.com/playlist?list=PLUaartJaon3LV-ZQ4J3bNQj4VNVG2ByIG>

NATIONAL STANDARDS

<p>Computer Science Teachers Association</p>	<p>Collaboration (CL) Apply productivity/multimedia tools and peripherals to group collaboration and support learning throughout the curriculum.</p> <p>Collaboratively design, develop, publish and present products (e.g., videos, podcasts, websites) using technology resources that demonstrate and communicate curriculum concepts.</p>
<p>International Society for Technology in Education</p>	<p>III. Technology Operations and Concepts—Students demonstrate a sound understanding of technology concepts, systems and operations. Students:</p> <p>A. understand and use technology systems</p> <p>B. select and use applications effectively and productively</p>

ADDITIONAL RESOURCES

https://www.nasa.gov/audience/forstudents/9-12/features/F_Astronauts_Work.html

<https://www.nasa.gov/hrp/bodyinspace>

<https://www.smithsonianmag.com/science-nature/what-happens-human-body-space-180958259/>

http://peer.tamu.edu/curriculum_modules/OrganSystems/Module_2/index.htm <https://faculty.washington.edu/chudler/organ.html>

https://www.nasa.gov/audience/foreducators/stem-on-station/ditl_eating

<https://www.theverge.com/2017/2/3/14498904/nasa-scott-kelly-year-in-space-iss-gi-tract-digestion>

<https://www.nasa.gov/offices/marsplanning/faqs/>

<https://www.ncbi.nlm.nih.gov/pubmedhealth/PMH0072574/>

<https://www.nasa.gov/feature/space-radiation-is-risky-business-for-the-human-body>

https://www.nasa.gov/mission_pages/station/research/cciss_feature.html

https://www.nasa.gov/mission_pages/station/research/experiments/245.html

https://science.nasa.gov/science-news/science-at-nasa/2001/ast02aug_1

What does it do?

The job of the digestive system is to store and break down the food we eat. It transfers nutrients to the other parts of the body, eliminates waste and absorbs water.

What organs are involved?

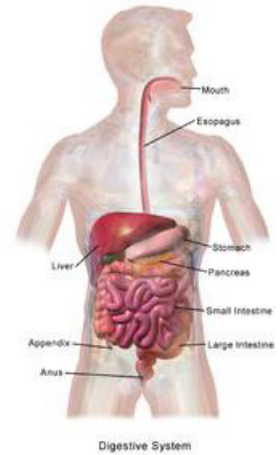
Mouth, esophagus, stomach, liver, gallbladder, pancreas, small intestine, large intestine

How does space travel affect this body system?

One of the first problems that an astronaut's digestive system faces when preparing for space travel, is how they will prepare and eat food in microgravity. There is no refrigeration on a space shuttle, so foods are often dehydrated or freeze-dried. Condiments such as salt and pepper must be liquefied, or they will float away!

Another problem is storage of food and a lack of fresh foods on a space shuttle. There are no trips to the grocery store while on a space mission, so all the food that will be eaten by astronauts must be taken with them. It will likely take 8 months or longer for astronauts to reach Mars, which will require a lot of space on the shuttle to store all of the food and drink required for the mission, not to mention the food required when they reach their destination. To help solve this problem, astronauts on the International Space Station are working on finding ways to grow fresh produce in space, such as lettuce, peas, and radishes.

Finally, a recent discovery about how space travel affects the digestive system has to do with an astronaut's microbiome. A microbiome is a collection of important and beneficial bacteria and microbes that live in a person's gut and perform services such as aiding in the digestion of foods that are difficult for our bodies to break down. When scientists studied the microbiome of Scott Kelley, an astronaut who had returned from a year of living in space, they found changes in the types and numbers of microbes in his digestive system.



What does it do?

The skeletal system makes up the framework of the body and allows us to move when our muscles contract. It stores minerals and releases them into the body when they are needed. The skeletal system also protects internal organs and produces blood cells.

What organs are involved?

The 206 bones in the human body, as well as a network of tendons, ligaments, and cartilage that connects them.

How does space travel affect this body system?

One of the most serious problems that an astronaut's skeletal system faces is a loss of bone mass when they spend an extended time in space. Studies of cosmonauts and astronauts who spent many months on space station Mir revealed that space travelers lost 1 to 2 percent of bone mass each month on average. This loss of bone mass (called osteoporosis) occurs as people age on Earth and can cause bones to become brittle and weak. Being in a weightlessness environment appears to speed up this process, and it is important that astronauts monitor their diet carefully to see that they are getting the proper amount of nutrients that our bones need, such as calcium and Vitamin D. They should also make sure that they are exercising regularly and lifting weights, which can be a difficult task when there is no gravity!



What does it do?

The nervous system controls both voluntary action and involuntary actions by sending signals from the brain to different parts of the body. We use the nervous system to communicate with the outside world by taking in information through our senses, processing the information and triggering a reaction, such as making your muscles move or causing you to feel pain. The nervous system is also in charge of controlling the mechanisms of our body and regulating metabolic processes.

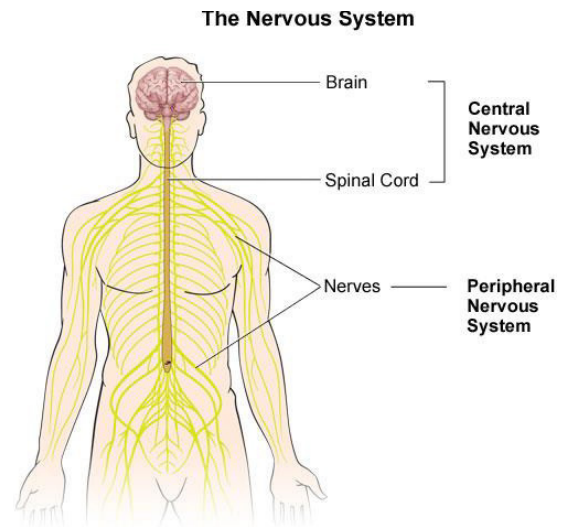
What organs are involved?

Brain, spinal cord, nerves

How does space travel affect this body system?

Radiation in space is potentially a big problem for astronauts and could have a negative impact on their nervous system during prolonged space travel. Radiation exposure can hinder neurogenesis, the process of generating new nerve cells in the brain. If neurons or supporting cells are damaged or killed, there is less potential for the development of new cells, which could lead to cognitive impairment and memory deficits.

Another problem for astronauts is isolation from friends and family and being confined to the space shuttle for long periods of time. Our nervous system controls our mood and the way we feel. Astronauts may experience depression or a decline in morale, mood, or how they interact with others. They could develop sleeping disorders due to the change in circadian rhythm or the stress of prolonged isolation and confinement.



What does it do?

The circulatory system delivers nutrients and oxygen to all cells in the body. Blood moves through the heart and delivers oxygen and nutrients to every part of the body through arteries. On the return trip, the blood picks up waste products so that your body can get rid of them.

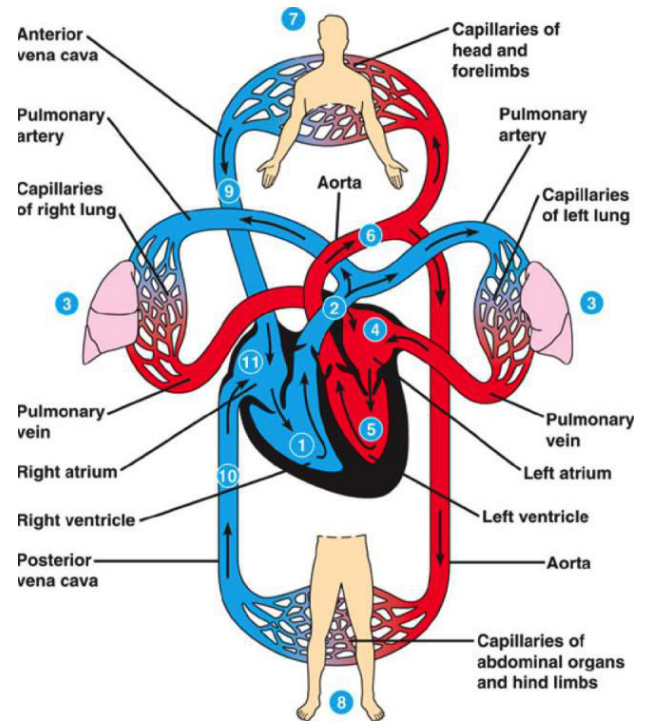
What organs are involved?

Heart, lungs, arteries, veins, capillaries, blood

How does space travel affect this body system?

The lack of gravity causes problems for the circulatory system of astronauts. Without gravity to pull blood into the lower part of the body, the blood goes to the chest and head and can cause astronauts to have puffy faces and bulging blood vessels in their necks. The lack of blood flowing to and from the brain can cause problems with vision and make astronauts feel dizzy and sometimes even faint when they return to Earth's gravity. Compression cuffs can be worn by astronauts to help keep the blood in the lower extremities to counteract problems such as vision changes.

Space radiation can also alter the circulatory system, damaging the heart, harden and narrow arteries, and/or eliminate some of the cells in linings of the blood vessels, leading to disease. Cardiovascular exercise is important for astronauts to keep the heart strong and maintain proper blood flow.



What does it do?

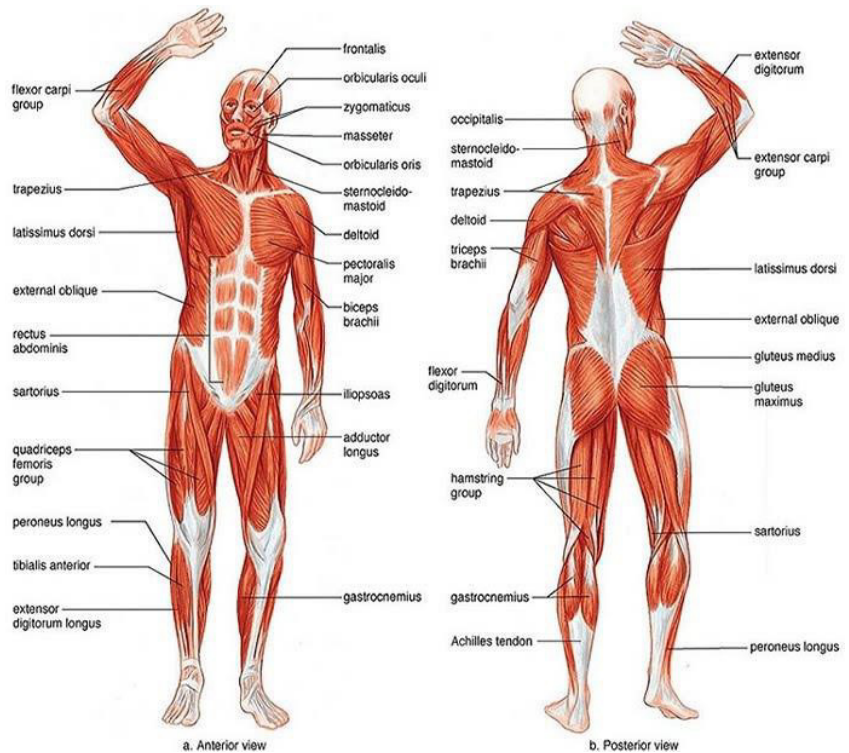
There are over 650 muscles in the body that not only support voluntary movement such as walking, talking, standing, and running, but also help us to complete involuntary actions like breathing, digestion, and circulating blood and other substances throughout the body. Muscles, such as those that attach to the bones of the skeletal system, contract to produce essential movement for our survival.

What organs are involved?

Skeletal, cardiac, and smooth muscles

How does space travel affect this body system?

Maintaining strong muscles is very difficult to do in space where there is no gravity. Gravity is a signal that tells muscles and bones how strong they must be. Without gravity, muscles atrophy quickly, because the body perceives it does not need them. The muscles used to fight gravity—like those in the calves and spine, which maintain posture—can lose around 20 percent of their mass if they aren't used and muscle mass can vanish at a rate as high as 5% a week. A study done of astronauts' calf muscle mass and strength before flight and after a six months mission on the International Space Station revealed that even when crew members had regular aerobic and resistance exercise, muscle volume and power still decreased.



What does it do?

The main function of the urinary system is to filter waste products and excess water from the blood and excrete them from the body.

What organs are involved?

Kidneys, ureter, bladder, urethra

How does space travel affect this body system?

While the urinary system is essential to filter waste and empty it from our bodies, it also creates a problem for astronauts that are confined to a space shuttle for long periods of time—what do they do with the urine they produce? Whether it sounds gross or not, urine is about 95% water, and one way to get rid of urine on a space mission, and benefit from it, is to—you guessed it—turn urine into drinking water for astronauts. Not only will this help to get rid of waste, it can help keep astronauts hydrated and save space on the shuttle. Water could be continuously recycled from urine rather than carried on and stored for an extended journey in space.

Space shuttle crew members face an increased risk of developing kidney stones, which form when urine becomes concentrated and allows minerals to stick together and harden. This increase in the formation of kidney stones in astronauts is due to decreased urine output, urine acidity, and increased calcium excretion, which is a result of bone loss. Options to help combat this problem are few on a space mission, and the results of tests suggest that mineral supplements may decrease the risk for developing three types of kidney stones both during and immediately after missions.

