Body and Space Travel

OVERVIEW:

In this activity, students will simulate the effect of weightlessness on the human body. Students will calculate their pulse after a workout and a period of rest. Additionally, students will measure body parts after simulating a weightlessness activity.

CONCEPTS:

National Science foundation Standards:

Standard C: Life Science (Structure and Function in Living Systems)

- Systems of the human body.

(Regulation and Behavior)

- Regulation of an organism's internal environment.
- Adaptive behaviors.

Standard D: Earth and Space Science (Earth in the Solar System)

- The solar system.

Benchmark 3: The Nature of Technology

A: Technology and Science

- Technology is essential to science for such purposes as access to outer space and other remote locations, sample collection and treatment, measurement, data collection and storage, computation, and communication of information.

Benchmark 4: The Physical Setting

A: The Universe

- The sun is a medium-sized star located near the edge of a disk-shaped galaxy of stars, part of which can be seen as a glowing band of light that spans the sky on a very clear night. The universe contains many billions of galaxies, and each galaxy contains many billions of stars. To the naked eye, even the closest of these galaxies is no more than a dim, fuzzy spot.
- Nine planets of very different size, composition, and surface features move around the sun in nearly circular orbits. Some planets have a great variety of moons and even flat rings of rock and ice particles orbiting around them. Some of these planets and moons show evidence of geologic activity. The earth is orbited by one moon, many artificial satellites, and debris.

F: Motion

- An unbalanced force acting on an object changes its speed or path of motion, or both. If the force acts toward a single enter, the object's path may curve into an orbit around the center.

G: Forces of Nature

- Every object exerts a gravitational force on every other object. The force depends on how much mass the objects have and on how far apart they are. The force is hard to detect unless at least on of the objects has a lot of mass.

- The sun's gravitational pull holds the earth and other planets in their orbits, just as the planets' gravitational pull keeps their moons in orbit around them.

OBJECTIVES:
Students will:
- Recognize the effect of space travel on the body.
- Identify two types of energy that deals with motion.
- Calculate heart rate after rest and movement
- Identify challenges one will face in a weightless environment

PROCEDURES:
- Allow 2 hours to present the background information and to complete the activity.
- Present the background information.
- Complete the activity (Part A.)
- Follow up lecture with discussion questions (see Part B.) These questions may be used for assessment purposes.

MATERIALS:
- Background information
- Tape measure
- Towel (or other item to elevate the hips)
- Chart paper
- Markers/colored pencils
- Stop watch or clock with second hand
- Weights (or other item that can be lifted repeatedly)

BACKGROUND:

Why does our heart have to use more energy when we stand up on a planet that has gravity as compared to being in space of gravity toward Earth. This causes an astronaut will feel weightless in space.

In cases such as the above scenario, the body is always willing to adapt, but the muscles and circular system gets lazy, thus making the heart use more energy. Think about this in terms of space flights.

Out in space the body will react differently because the gravitational pull is about one-millionth what it is on earth. One of the most important things to do in space flights is exercise. On earth, simple things like getting up from a chair, is a form of exercise, but consider this, being in space with very little gravitational pull and your body just floating around and not doing anything. If you were an astronaut, the recommendation, if staying in space for more than a few weeks is exercising two hours a day!

One of the problems encountered by astronauts when they return back to earth after a year is that they are very weak. While in space, the human body will feel weightless despite the mass not changing. This is not because of the lack of gravity. It is instead the feeling of being in orbit. When in orbit, the centrifugal force is balanced by the force. They have no force in their body in order to exercise is space as needed. When they return, it normally takes them 4-6 months to return to "normal".

Standing up will drain blood from your head to your feet, then when lying down the blood is more balanced but more in the head. Plasma, the fluid part of blood is filtered by kidneys at night. It then drips out of the kidneys into the bladder and becomes urine. When you get up in the morning, blood will then shift down to your legs when you stand up and your heart has to work harder to pump blood to the brain. When you empty your bladder, you will get thirsty and want to replenish liquid, which will now take about 2 hours to get filtered again. This happens throughout the day, and day in day out, and is called Cardiovascular Reconditioning, which is a response to going to bed.

Responses to Weightlessness:

Earth's Gravity 1g	Space 0g
Normal Volume	Volume shifts to chest and head Face becomes puffy

Eventually, the body adapts and the volume while in space is low. Then upon return, the volume is still low, because of the adaptation.

A solution that can be tried out is a Human Powered Centrifuge. This basically involves pedaling in order to rotate a platform beneath you. This in turn help imitate the earth's gravity by making the body think it has gone to earth for that amount of time.

There are biodynamic labs that are set up in space centers. These help study human movement and thermodynamics. Thermodynamics deals with energy and how it is transferred from one form to another. Remember that energy cannot be created or destroyed.

They types of energy that deal with motion are:

Kinetic – the faster you move, the more energy you have

Potential – based on where something is in relation to the ground

Other forms of energy include, mechanical, chemical, thermal, electrical, and nuclear. Chemical energy comes from the food we eat and it gets stored in the body. Thermal energy on the other hand comes from the body heating up during movement. The ground applies force upward to counter gravitational pull.

ACTIVITY:

Activity 1: Upper Body Fluid Shift

Materials:

- Tape Measure
- Towel
- Stop Watch

Directions:

- Measure the mid-calf section of your leg.
- Record the measurement. (or mark the placement of the tape measure with a marker pen.)
- Lay on the floor near the wall.
- Place the folded towel under the hips and place your legs so they are resting up the wall.

- Remember any sensations you feel, especially in the head and upper body.
- Remain in that position for 5 minutes.
- Measure the calf again (in exactly the same place as before).

Calf measurement before reclining:
_____
_____

Calf measurement after resting with legs up the wall:
_____
_____

Describe any sensations you felt while lying on the floor:
_____
_____
_____

Was there a difference in the two measurements?
_____
_____

What might cause these differences?
_____
_____
_____
_____

Activity 2: Heart Rate, Exercise, and Weightlessness

Materials:
- Weights
- Towel

Directions:

- Measure your pulse rate (in beats per minute) while standing at rest.
- Lift weights or do jumping jacks for 4 minutes.
- Again, measure your pulse rate.
- Lay on the floor with your feet up the wall (as in the previous activity).
- Rest for 5 minutes and then measure your pulse rate.
- In the reclining position with your feet elevated, exercise for 4 minutes (lift weights).
- Measure your pulse rate.

Position	Pulse Rate	Cardiac Output (milliliters per minute)
Pulse rate- standing (resting)		
Pulse rate-after exercise		
Pulse rate-reclining with feet elevated		
Pulse rate-reclining with feet elevated (after exercising)		

The cardiac output = stroke volume X heart rate. Standing stroke rate is 75 ml/beat and Reclining stroke rate is 95 ml/beat. Reclining/bed rest would simulate a weightless environment.

Compare your standing (resting) cardiac output with your reclining (resting) cardiac output.

Compare your standing (exercising) cardiac output with your reclining (exercising) cardiac output.

What conclusion can you draw?

Activity 3: It could be a Problem

Materials:

- Poster Board
- Markers

Directions:

- Make a list of 10 things you do on a daily basis.
- Next to each thing explain the challenge you might face if you were in a weightless environment.
- Then explain how you modify the "thing" so that it could be done in a weightless environment.
- Display your ideas in a chart, to be displayed and shared with the class.

	Challenge	**Modification**
1.		
2.		
3.		
4.		
5.		
6.		
7.		
8.		
9.		
10.		

Part B:
Ask the following questions and allow time for discussion.

Share:
Share your results from the activity “Upper Body Fluid Shift” and “Heart Rate, Exercise, and Weightlessness.”

Process:
Why is it important to be aware of the physical changes that occur in the human body while in a weightless environment?

Generalize:
What are some things that could be done in a weightless environment that would not present any problems?

Apply:
What can astronauts do in a weightless environment to counteract the effects on the body?