



NSBRI TAP Classroom Activity

Title: IN-FLIGHT EXERCISES

Grade Level: 5-8

Content Area: Life Science and Health

National Science Content Standards:

Standard A. Science as Inquiry (Grades 5-8 & 9-12)

- Abilities necessary to do scientific inquiry
- Understandings about scientific inquiry

Standard C. Life Science (Grades 5-8)

- Structure and function in living systems
- Regulation and behavior

Standard F. Science in Personal and Social Perspectives (Grades 5-8 & 9-12)

- Personal health

Behavioral Objectives:

- The student uses scientific inquiry methods during laboratory investigations and collects data by observing and measuring.
- The student knows the relationship between structure and function in living systems.

Lesson Objective:

- In this lesson the student will engage in a study of the importance of exercise in maintaining the musculoskeletal system and why this type of exercise is important to astronauts during long duration space flights.

Time:

- Two 45 minute periods; One 90 minute block period
- Note: Exercises can be performed prior to beginning class. This lesson spans two weeks but only requires a minimal amount of time (approximately 12 minutes) to obtain data each day.

Materials:

1. Clothespins (spring loaded)
2. Timer, watch, or clock
3. Student Data Sheet (provided with the lesson)

Extension Materials (for Resistance Exercises)

- Stretchy bands (ex. Bungee cords, Rubber bands, latex tubing)
- Bicycle inner tube
- Broomstick or other pole

This lesson was developed by participants and staff of the Teacher Academy Project at Texas A&M University with support from the National Space Biomedical Research Institute through NASA NCC 9-58.

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Procedure:

Activity

- 1) Predict the number of times you can fully compress the clothespin between your thumb and index finger in your dominant hand during a one-minute period. Record your prediction on the Student Data Sheet table in the column labeled “Trial One – Prediction”.
- 2) Hold the clothespin in your dominant hand between your thumb and index finger. While your partner is watching the timer, count the number of times you are able to compress the clothespin in a one-minute period. Record the result under “Trial One – Actual”.
- 3) Rest for one minute, then repeat Steps 1 and Step 2 a second time. Record the data in the Trial 2 column of the Data Sheet. To ensure consistency of measurement, hold the clothespin the same way for each timed trial.
- 4) Rest for one minute, then repeat Steps 1 and 2 a third time. Record the data in the Trial 3 column of the Data Sheet.
- 5) Switch roles with your partner and have him or her conduct the same experiment, Steps 1-4, with their dominant hand and record the results.
- 6) After completing the trials, write a paragraph on a separate sheet describing whether any of your numbers changed from Trial 1 to Trial 3. If they did, describe the change using specific data.
- 7) On the same sheet of paper, describe how your muscles felt during this experiment.
- 8) You will repeat this activity over the next two weeks. Write a prediction about how you expect your results will change over that period.
- 9) Repeat steps 1-6 every other day for two weeks for a total of seven days. Record your predictions and results in the table below.
- 10) After two weeks, write another paragraph about the results of your experiments. Tell what happened and explain why you think things turned out as they did.

Student Name - _____

Student Data Sheet

Number of Compressions in One Minute

| Date | <u>Trial 1</u> | | <u>Trial 2</u> | | <u>Trial 3</u> | |
|------|----------------|--------|----------------|--------|----------------|--------|
| | Prediction | Actual | Prediction | Actual | Prediction | Actual |
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Extension:

- Working in groups, have students create and test various exercises using a stretchy band (ex. Bungee cords, Rubber bands, latex tubing), bicycle inner tube, broomstick or other pole. In order to test their new exercise, the students have to plan how long this exercise will need to be performed. The data recorded should indicate if increased stamina is viewed (i.e. repetitions/time). Students record results in a table and write or illustrate exercise directions. This lesson could also be made cross-curricular by integrating it into the physical education program.

Resources:

Muscles and Bones, 2000, Baylor College of Medicine. Available online at:

http://www.nsbri.org/Education/Elem_Act.html

Human Physiology in Space (pp.189-284) by R. J. White & B. F. Lujan, NASA Life and Biomedical Sciences and Applications Division, 1994. Available online at:

<http://www.nsbri.org/HumanPhysSpace/>

Background Information:

*Note: This information is necessary to the understanding of why we need exercise on earth and in space. This material should be used as introductory information before the activity.

Generally, when we think of stress, we think of being over-worked, mentally tired or overwhelmed by our daily lives. While too much stress can be detrimental to the body, too little of some kinds of stress can be harmful. Activities like walking, carrying packages and mopping the floor are physical stresses. Activities like doing crossword puzzles, balancing the checkbook and reading are mental stresses. There also are emotional stresses, like receiving a bad grade on a test or walking into a surprise birthday party. Our bodies, including muscles and bones, require some physical and mental stresses to be healthy and grow.

Physical stress is created when bones and muscles are made to work against a force. It occurs when we pick up something heavy, like a 20-pound bag of cat litter. The force of gravity pulls down on the bag and we have to work to overcome that force to lift the bag. Swimming also causes stress because muscles and bones have to work against the resistance of the water to move the body. The force of gravity pulls on our bodies and our muscles and bones constantly work to counteract that force and keep us balanced.

Stress from physical activity is necessary for bone growth and maintenance. The body builds bone based on its needs. The need for any particular bone is dictated by the amount of stress placed on it. During the years a person's bones are growing (birth to about age 25), physical stress on bones causes builder cells to work more, which makes bones grow. Builder cells produce collagen fibers that form the framework of bones. The framework is then filled in with minerals, producing a strong, thick bone. Even after they stop growing, bones still need physical stress to maintain thickness and strength.

Muscles also rebuild and grow as a result of physical stress. Stress can lead to change in either muscle strength or muscle stamina (the ability to perform an activity for a long time without becoming tired). High-intensity, short-duration exercises (or stresses), like weight lifting, cause muscles to increase in strength. Low-intensity, long-duration activities, such as running and swimming, cause muscles to increase in stamina. This increase in stamina is due to an increased efficiency in the muscle cell to perform oxidative respiration (process by which sugars are burned in the cell).

When a person does not use his or her muscles for a period of time, the muscles themselves begin to waste away, or "atrophy". For instance, people who are confined to bed during an illness or even astronauts who, while in space, do not require the use of their "anti-gravity" muscles both experience this natural atrophy. Such muscle atrophy can cause problems for people here on Earth and for astronauts who fly in space.

On long missions, rehabilitation strategies designed for space flight will be critically important in the event of injuries or accidents. Researcher's overall goal is to determine the appropriate nutrition, fitness and rehabilitation measures needed as astronauts' transition between Earth gravity and weightlessness.

Student Assessment

Title: IN-FLIGHT EXERCISES

1. What causes physical stress?
2. Why is stress from physical activity necessary for our body?
3. Were you able to click the clothespin more times after two weeks as opposed to the first day of the experiment? Explain why this happened and discuss the physiological concepts behind this.
4. Would you consider the clothespin experiment one that increases stamina, increases strength, or both?
5. Resistive exercise is an activity that increases strength and muscle tone. Why is muscle tone important?
6. Why is it important for astronauts to maintain physical fitness during a long duration space flight?

Student Assessment**Title: IN-FLIGHT EXERCISES**

1. What causes physical stress?

Ans: Physical stress is created when bones and muscles work against a force.

2. Why is stress from physical activity necessary for our body?

Ans: Stress is necessary for bone/muscle growth and maintenance. Bone is built based on the body's needs dictated by the amount of stress placed on it. Muscles need stress in order to keep tone and efficiently help move blood through the axial skeleton.

3. Were you able to click the clothespin more times after two weeks as opposed to the first day of the experiment? Explain why this happened and discuss the physiological concepts behind this.

Ans: Due to increased usage, the muscles in the hand have increased in strength due to increased numbers of muscle fibers in the fingers. Increased stamina is due to increased efficiency of muscle cells in the fingers to perform oxidative respiration.

4. Would you consider the clothespin experiment one that increases stamina, increases strength, or both?

Ans: Initially the experiment will increase both.

5. Resistive exercise is an activity that increases strength and muscle tone. Why is muscle tone important?

Ans: Muscle tone is important to provide stress on the bone to prevent bone loss. It also helps with blood flow from the lower extremities.

6. Why is it important for astronauts to maintain physical fitness during a long duration space flight?

Ans: If the muscles and bones of the astronauts are too atrophied, they will be unable to leave the spacecraft upon arrival to their destination.