DESCRIPTION

Puffy Head, Bird Legs

CONTENTS

- Information for Teachers
- Student Activities
- Assessment
- Adaptations & Extensions

Science Concepts

Collect, organize, analyze, evaluate, make inferences, and predict trends from data.
Investigate and identify how organisms, including humans respond to external stimuli.

Math Connections

Gather, record, graph, and analyze data

Grade Levels

Grades 5-10

Instructional Strategy

Directed Procedures

Time Line

Laboratory Activity: 1-2 hours with pre-lab and post-lab assignments

Standards

National Science Education Content Standards
5-8 Science Content Standard C
As a result of their activities in grades 5-8, all students should develop understanding of

- Structure and function in living systems
- Regulation and behavior
- Diversity and adaptations of organisms

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Puffy Head, Bird Legs	**Information for Teachers**

BACKGROUND:

Normally, gravity pulls blood downward into the legs and feet. The body has adapted to this condition and directs the circulation of blood accordingly. With the legs up, gravity pulls blood from the legs and feet into the upper part of the body. The legs, having lost a significant amount of their volume through the loss of fluid, will become thinner while the position is maintained. The head, on the other hand, will gain blood. Veins are likely to protrude. The head will become bloated with the extra fluid and have a fuller appearance.

This blood shift occurs to astronauts while in the microgravity of orbital space travel. The facial appearance of the astronauts on Earth is noticeably different from their appearance in space, and the legs become thinner in microgravity; thus, the terms "puffy head" and "bird legs." Upon returning to normal gravity, the head resumes its normal appearance, and the legs should revert to their normal sizes.

A longer stay in space might result in more lasting changes. After the fluid shift to the upper body, adaptations would be made. The body establishes a new equilibrium with a decreased total volume of blood. With less blood to pump, the heart could decrease in muscle mass. The legs, in a prolonged thinner condition, might also decrease in muscle mass. This adaptation in the legs would be exacerbated by the relative lack of exercise of the legs in microgravity.

If the human body were exposed to the opposite conditions (an increase in gravitational pull) the pull of gravity on body fluids would be greater. More blood would flow into the legs and feet, increasing their volume. Blood would be pulled from the head with more force. Until the body could compensate, there would be less fluid in the head and it would appear thinner.

TEACHING HINTS:

- Prompt the students to notice the texture, color, and shape of the head. Such descriptive words as lean, muscular, firm would be appropriate. (The head change is more easily observed in slimmer subjects.)
- It is important to measure the "before" and "after" leg circumferences at the same place on the leg. A mark on the subject's calf could be made with a piece of tape or a small ink mark.
- If you don't have tape measures, calf circumference may be determined by string which is marked then measured on a meter stick.
- A transparency of the data tables is helpful to display the data and assist the students in compiling the data from the various groups.

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Answer Key:

Hypothesis:
(a) Accept any reasonable answer. One might expect a greater fullness in the head and face due to the extra volume of fluid being pulled towards the head by gravity.
(b) Accept any reasonable answer. One might expect a decrease in leg volume due to gravity's pull of blood from the legs and feet.

Data:

1. Answers should reflect the normal appearance of the head and face.
2. Answers are objective. An increased fullness would be expected. Blood vessels might become more prominent.
3. Answers will vary. Subject may report feelings of stuffiness in the sinuses and fullness or heaviness in the head.
4. Answers depend upon the experimental data.
5. Answers depend upon the experimental data. (A decreased circumference from #4 is expected.)

Data Table:

Answers depend upon experimental data. Use the following formula for determining percent change.

$$\% \text{ change} = \frac{\text{Post Test Circumference} - \text{Pre Test Circumference}}{100}$$

Conclusions:

1. Yes. Changes were due to gravity's pulling additional fluid into the head.
2. Yes. Decreased calf circumference is due to gravity's pulling fluid from the legs.
3. Answers must reflect an accurate comparison of the stated hypotheses to the recorded data.
4. No. Gravity would again exert an Earth-normal pull on the body fluids. The extra fluid in the head would be pulled downward. The decreased fluid in the legs would again be supplemented by the downward pull of gravity on the body fluids. (Note: If the astronaut has spent more than one in space, it would take several days for the body to regain its normal volume of fluids. This is because, in space, the kidneys have eliminated what they perceive to be an excess of body fluid.)

Going Beyond:

1. The astronaut's head and face would appear more stark or thinner due to gravity's greater pull of fluid downward from the head.
2. The astronaut's legs would have a greater circumference because the increased gravity would pull more fluid into the feet and legs.

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Illustration of Correct Student Position for "Puffy Head, Bird Legs"

Before **After**

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Puffy Head, Bird Legs: The effect of gravity on the circulatory system	**Student Activities**

BACKGROUND: The activity you will be doing is not actually under conditions of microgravity (very little gravity). This lab models on Earth the similar distribution of blood toward the upper body that astronauts experience in microgravity conditions.

PROBLEM:

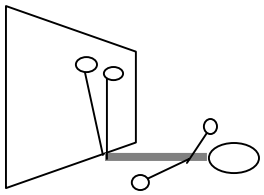
How is circulation and the distribution of fluids affected by gravity?

MATERIALS:

Metric tape measure, exercise pad or blanket (optional), clock, chair

PROCEDURE:

1. Work in groups of three or four. Select one of the members of the group to be the test subject.
2. With the test subject in a sitting position, observe the facial shape and skin features. Record your description on the Student Data Sheet.
3. Use the tape measure to encircle the thickest part of the of the subject's calf. Measure the calf circumference to the nearest millimeter. Record the data on the Student Data Sheet. (Note: It is helpful to mark the level on the calf where the measurement was made, so the calf will be measured at the same place at the end of the experiment.)
4. Have the subject lie down, back to the floor, with legs against the wall at as close to a 90 degree angle to the torso as is reasonably comfortable.



5. Have the subject maintain this position for 10 minutes.
6. Observe and record facial shape and skin features while the subject is still in the test position.
7. Determine whether the subject has any unusual feelings in the head and face.
8. With the subject still in the test position, measure the calf circumference at the same location. Record your data on the Student Data Sheet.
9. Calculate the percent change in the calf circumference and record your results.
10. Gather data for the circumference of the leg from the other groups in the class. Record on the Group Data Sheet.
11. Design a double bar graph to display the two calf measurements (before and after) collected from each test subject in the class.
12. Write your conclusions.

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Student Data Sheet

Name: _____ Date: _____ Period: ____

HYPOTHESIS:

3. How would circulation be affected if gravity weren't pulling blood into the legs and feet?

_____

_____

4. If the legs are raised above the head and torso,

   a. what would you expect the observable effect on the head to be?

   _____

   b. what would you expect the observable effect on the legs to be?

   _____

INDIVIDUAL DATA:

1. Describe the facial shape and skin features of the test subject prior to experiment.

_____

_____

2. Circumference of calf prior to elevation (to the nearest millimeter): _____

3. Describe the facial shape and skin features at the end of the experiment.

_____

_____

4. Did the test subject report any unusual feelings in the head and face?

_____

5. What was the circumference of calf after elevation (to the nearest millimeter)? _____

6. What was the percent change in the circumference of the subject's calf? _____

EQUATION:

$$\% \text{ change} = \frac{\text{Post Test Circumference} - \text{Pre Test Circumference}}{100}$$

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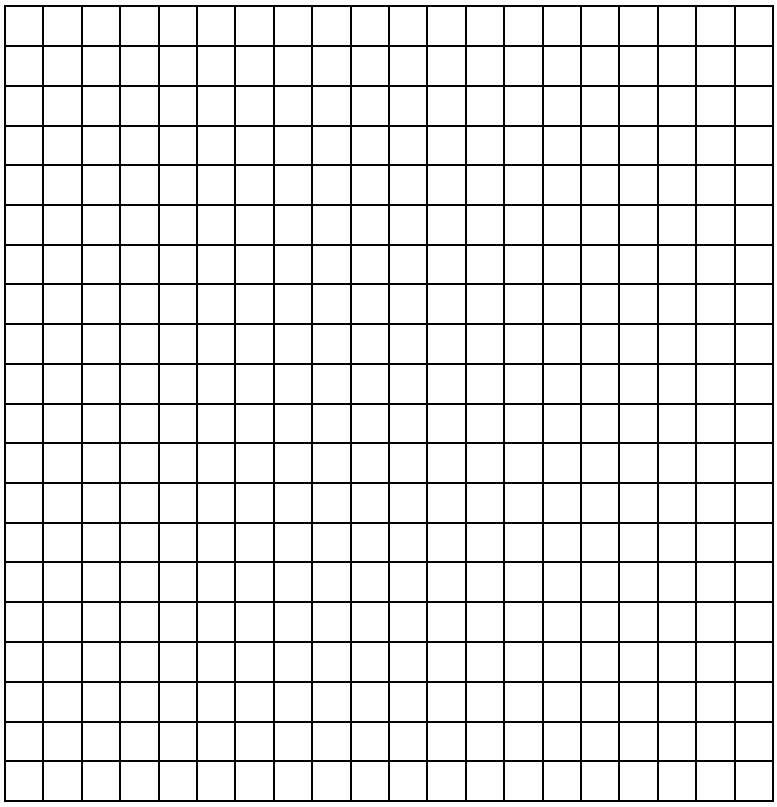
GROUP DATA TABLE:

Compiled Data on the Circumference of Calves of Test Subjects Before and After Experiment

Student Name	**Pre Test**	**Post Test**	% Change
1.			
2.			
3.			
4.			
5.			
6.			
7.			
8.			

GROUP DATA GRAPH:



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CONCLUSIONS:

1. Were head and facial changes observed? If so, why do you think these changes occurred?

_____

_____

2. Were changes found in the circumference of the calf? If so, why did these changes occur?

_____

_____

3. Were your hypotheses verified or disproved? Explain.

_____

_____

4. An astronaut with a "puffy head" and "bird legs" returns to Earth, after a short time in space. Would you expect these changes in his body to be permanent? Why or why not?

_____

_____

Going Beyond:

1. If an astronaut walked around on a planet with two times the gravitational pull as that of Earth, what changes would you expect in the face and head?

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2. On the same planet mentioned in #1, what changes would you expect in the circumference of the legs?

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