



Homeostasis: It's All A Matter of Balance

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**2000
Lesson
#12**

Homeostasis: It's All a Matter of Balance

Suggestions for Teachers

Purpose:

To have students explore homeostasis as a set of regulatory mechanisms and processes within the human body.

Age Level:

Appropriate for middle school grades 5 to 8.

Objectives:

Process Objectives:

Students will be able to:

- Design an experiment to investigate the body's ability to self-regulate
- Carry out an experimental design
- Collect and graph data
- Analyze data and draw conclusions
- Share data and conclusions with their peers
- Revise initial ideas and hypotheses

Content Objectives:

Students will be able to:

- Understand that the human body must be able to "maintain stable internal conditions while living in a constantly changing external environment." (NSES, p. 157)
- Understand that "regulation of an organism's internal environment involves sensing the internal environment and changing physiological activities to keep conditions within the ranges required to survive." (NSES, p. 157)
- Understand that homeostasis enables the body's systems, organs, tissues and cells to recover to its normal "set points" for each parameter.
- Understand that homeostasis involves all body systems.
- Understand that the nervous system coordinates the regulation of internal body conditions.

Materials:

- Temperature strips (fever scan type that measure forehead temperature)
- Oral thermometers
- Stethoscopes
- Water (room temperature)
- Cold packs (pre-cooled)
- Graph paper
- Stopwatches
- Bucket of ice
- Warm water (pre-warmed)

- Warm packs (pre-warmed)

Optional Materials:

- Sphygmomanometers or Blood Pressure Machines
- Pulse monitors
- Metronome to regulate jumping jacks
- Respiration Monitor

Background Information:

Homeostasis is the process by which the internal environment of the body is kept relatively stable despite changes in the external environment. Typically, we understand that our body's ability to regulate temperature is very important. Our body has a normal "set point" for its temperature, which varies slightly from person to person. We often forget that the body regulates its internal environment in many ways. The body senses changes in the environment and responds by making changes in functions. This is a dynamic process that keeps the internal conditions of the body relatively stable.

The body can adapt to many changing conditions, but there are limits to these conditions. The body's cells will not function well if they are too cold or too hot, our heart rates cannot endlessly increase and we cannot lose excessive water without putting our cells, tissues and organs at risk. As a result, reaching or exceeding these limits can be dangerous, so our body tends to function within certain normal ranges.

Using temperature as an example, we know that the hypothalamus in the brain can act as a thermostat and control the body's functioning to regulate temperature to keep us from overheating or getting too cold. The hypothalamus causes changes in the size of blood vessels in the skin, which then has a direct impact on the amount of heat lost or retained by the body. Most systems of the body maintain homeostasis by means of negative feedback mechanisms, which reverse a response back to a normal state.

There are many examples of this type of regulation in the body, which involve various body systems. The following activity will help students gain a basic understanding of homeostasis as a regulatory process that is more than just temperature. Additional detailed information about this can be found in many anatomy and physiology texts, including those listed below.

Background and Description of Activity:

- This sequence of activities is designed to help students understand that homeostasis is an active regulatory process involving multiple body systems.
- Most students will readily identify sweating and shivering as ways that the body responds to external temperature changes.
- Middle grade students will intuitively understand that their bodies' processes will change with exercise, but they often ignore their bodies' ability to self-regulate and recover to normal conditions.
- This set of activities uses an integrative approach to look at multiple body systems and their role within the homeostatic process.

- The key concepts to emphasize are that the body's ability to recover from a change in internal body conditions extends beyond temperature regulation and involves all body systems.
- At the conclusion of the activities, students should be able to describe the way exercise affects respiration rate, heart rate, skin temperature, internal body temperature, etc. and the way in which those parameters recover to normal "set points."
- The depth of the discussion will vary according to prior knowledge and grade level.
- If desired, further experiments may be carried out to answer questions generated during the activities.

Procedure:

Activity 1: Demonstration of changes in respiration rate after jumping jacks

This may be done with a single volunteer, a group of 3-4 volunteers or the entire class to collect more data. It is intended to be a qualitative introduction to changes, but you may choose to formally collect and analyze data.

Pre-Activity Questions: (May be done individually or as a class)

1. Predict the baseline (initial) breathing rate for the volunteers.
2. What do you expect to happen to the volunteer's breathing rate during jumping jacks? Why?
3. What do you expect to happen during the 5 minutes after the jumping jacks?

Activity Procedures:

1. Ask for a volunteer(s) who is/are willing to do jumping jacks or jog in place (or have entire class involved).
2. Instruct students to quietly observe while the volunteer counts respirations for 15 seconds. This is baseline data. Write the number on board and multiply by 4 to get respirations/minute.
3. Ask class to make predictions about respiration rate after 1 minute of exercise.
4. Do jumping jacks for 1 minute (+/- in order to induce an increase in respirations).
5. Count respirations for 15 seconds immediately after exercise. Calculate to respirations/minute.
6. Ask class to make predictions about respiration rate during the next 5 minutes.
7. Briefly discuss predictions while waiting for 3-5 minutes to elapse.

8. After 3-5 minutes, count respirations.

Optional: You may choose to graph the volunteer group or class data. Be sure to collect data before, immediately, and shortly after the exercise.

Activity 2: Brainstorm and Discussion

Summarize the observations made during the first activity. Brainstorm and discuss observations about the changes in breathing rates from the beginning of the exercise to the end. List as many ideas about changes in body conditions as possible. Accept all responses from students, but emphasize the idea that respirations did ultimately return to normal. Examples of student responses might include changes in skin temperature, internal body temperature, heart rate, blood pressure. Do not give them these examples, but guide them to articulate these ideas.

Concept to address: Recovery to normal should be emphasized at this time.

Extending this Activity:

- Students can utilize terms on the board to create a concept map about changes in internal body conditions. This may also be used as an assessment tool at the conclusion of the lesson.

Activity 3: Inquiry Exploration

Students will use jumping jacks to induce a change in body conditions. The goal is to discover the ways in which the body recovers from changes. Their task is to develop and carry out an experimental design. Instruct students to use the Student Activity Sheet to brainstorm ideas and create an experimental design. Each group must focus upon one parameter to test. Ask students to consider other parameters and functions that change during exercise. Students might explore changes in skin temperature, internal body temperature, heart rate, blood pressure. Instruct students to utilize any of the available materials in order to answer and address at least one of the questions listed below.

Questions to Ask:

1. What other body systems might undergo a change in conditions (and recovery)?
2. What other body processes change during and after?
3. What other factors may play a role in the body's response to exercise?

Activity Procedure :

- Assign students to groups of 3 to 4 (you may want to utilize grouping strategies and assign jobs within these groups).

- Instruct students to use the Student Activity Sheet to brainstorm ideas and create an experimental design. Each group must focus upon one parameter to test.
- Students must submit their plan for approval.
- Students will carry out their design.
- Students will record and graph data.
- Students will analyze data and complete the Student Activity Sheet
- Students will present their data and conclusions to their peers.

Safety Considerations :

- Students should be told to wear sneakers for the day of the activity.
- Students should be reminded about safely doing the exercises in the classroom.
- Students that are with asthma, illness or physical disability should not be required to participate in the physical activity. They may participate as recorder, timer, etc.

Activity 4: Tying it all together

Students will present their findings to the class. After findings are presented, a summary discussion should follow to review the relevant findings and illustrate the main points. The concept of homeostasis should be fully defined and explained at this time. Students should be able to discuss the body's ability to stay within normal limits and regulate numerous systems at once. Students should be given time to complete assigned assessments.

Ideas for Assessment:

Students may be asked to:

- Write full lab reports describing their experiments, results and conclusions.
- Create a poster display describing their experiments, results and conclusions.
- Make oral presentations of their results and conclusions.
- Design an experiment for further study or exploration.
- Create concept maps about homeostasis.
- Write brief essays describing their activity, class results and homeostasis.
- Evaluate their lab report or poster display with a grading rubric

Where to Go From Here...Further Exploration:

You may want to have students participate in each group's experiment to obtain more data.

Numerous follow-up activities about the circulatory, respiratory and nervous systems could be appropriate at this time. The following activity units have been developed by the American Physiological Society and are available through the APS web site:

- Physiology of Fitness
- Neural Networks

References and Resources:

American Physiological Society. www.the-aps.org

Martini, Frederic. *Fundamentals of Anatomy and Physiology*. Prentice-Hall, Inc., Englewood Cliffs, NJ. 1992.

Wingerd, Bruce D. *The Human Body: Concepts of Anatomy and Physiology*. Saunders College Publishing, New York. 1994.

Student Exploration Activity: The Effects of Jumping Jacks on Human Physiology

Name: _____

Date: _____

Team Members: _____

Objective:

You will create an experiment to determine the effects of exercise on human physiology. After designing and running your experiment, you will analyze your data and present your findings. The important questions to think about are:

1. What body systems might undergo a change in conditions (and recovery)?
2. What body processes change during and after exercise?
3. What factors may play a role in the body's response to exercise?

Materials:

You will be provided with various tools by your teacher.

Procedure:

1. With your partners, decide which physiological process you will study (heart rate, blood pressure, temperature, etc.). You may use any tools provided by your teacher.
2. Design your procedure. Use the Experimental Design Worksheet.
3. Present your experimental design to your teacher.
4. Once approved, begin your experiment.
5. Record data.
6. Analyze data (use data tables, graphs, etc. as instructed by your teacher).
7. Present data and findings to the class as instructed.

Discussion Questions:

Answer the following questions after the class has completed their activities and presented their findings.

1. What body systems undergo a change in conditions ?
2. What body processes change during and after exercise?
3. In what ways did the body change during exercise?

4. In what ways did the body change after exercise?
5. What factors may play a role in the body's response to exercise?
6. What body systems control or influence the body's ability to recover to normal?
7. Why do you think that it is important for body functions to return to normal after exercise?
8. What is homeostasis?

Consider This:

The heart rate of an anesthetized, unconscious person will increase if their arms are moved for them. Why do you think that this happens?

Experimental Design Worksheet

Name: _____

Date: _____

Team Members: _____

1. Identify the Problem to be Solved: _____

2. Hypothesis: _____

3. Procedures:

List the steps to the Procedure: _____

4. Data: Include a data table/chart if appropriate:

5. Discussion/Conclusions: _____
