Homeostasis in Animals

A Carolina Essentials™ Activity

Overview

Introduce students to the phenomenon of homeostasis with this activity. Students gather data on set point or resting heart rate, exercise, collect data again, and relate the data to negative feedback mechanisms. Students visualize and explain homeostasis through graphing and graph interpretation. Minimal equipment is needed.

Life Science

Grades: 9–12

Essential Question

How do feedback mechanisms maintain homeostasis in animals?

Activity Objectives

1. Determine set point, or normal resting heart rate.
2. Using student data, identify and explain negative feedback mechanisms and the role they have in maintaining homeostasis.

Next Generation Science Standards* (NGSS)

PE HS-LS1-3. Plan and conduct an investigation to provide evidence that feedback mechanisms maintain homeostasis.

Science and Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
Planning and Carrying Out Investigations • Conduct an investigation individually and collaboratively to produce data to serve as the basis for evidence, and in the design: decide on types, how much, and accuracy of data needed to produce reliable measurements and consider limitations on the precision of the data (e.g., number of trials, cost, risk, time), and refine the design accordingly.	**LS1.A: Structure and Function** • Feedback mechanisms maintain a living system's internal conditions within certain limits and mediate behaviors, allowing it to remain alive and functional even as external conditions change within some range. Feedback mechanisms can encourage (through positive feedback) or discourage (negative feedback) what is going on inside the living system.	**Stability and Change** • Feedback (negative or positive) can stabilize or destabilize a system.

Safety Procedures and Precautions

Make certain students are healthy enough to run in place for 2 minutes prior to beginning the activity. Use this activity only in accordance with established laboratory safety practices, including appropriate personal protective equipment (PPE) such as gloves, chemical splash goggles, and lab coats or aprons. Ensure that students understand and adhere to these practices. Students should not eat, drink, or chew gum in the lab and should wash their hands after entering and before exiting the lab.

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TIME REQUIREMENTS

PREP	ACTIVITY
15 min	45-60 min

Teacher Prep: 15 min

Student Activity: 45-60 min depending on group size

SAFETY REQUIREMENTS

No PPE required

MATERIALS

1 timer per pair of students (stopwatch, smartphone, or access to a clock with a second hand)

HELPFUL LINKS

The New Living Body: Homeostasis DVD

Maintaining Conditions for Life CD-ROM

REFERENCE KITS

Carolina BioKits®: Homeostasis in Animals

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Teacher Preparation and Disposal

Pass out stopwatches. There is no chemical disposal.

Student Procedure

1. Lab partners will take turns as test subject and observer to determine the set point for the test subject's resting heart rate.
2. For each person in the lab group, determine the set point for resting heart rate by taking each person's pulse 3 times for 15 seconds.
3. Average the three 15-second values.
4. Run in place for 2 minutes.
5. Determine pulse rate for 15 seconds immediately after running.
6. Take the pulse rate again for 15 seconds, at intervals of 1 minute, for a total of 5 minutes.
7. Record data for each person in the group.

Teacher Preparation and Tips

Prior to beginning the activity, demonstrate how to find and take a pulse, both on the neck and on the wrist.

Emphasize the importance of accurate timekeeping.

If necessary, remind students that they will add the 3 resting pulse numbers and divide by 3 to get the average.

Step 5 must happen quickly. Remind students to have the timekeeping device ready to record the 15 seconds.

You may want to combine each group's data and look at data from the whole class.

Data and Observations

Student answers will vary slightly but should be within normal range (60 to 100 beats/minute or 15 to 25 beats/15 seconds).

Resting Heart Rate

Resting Heart Rate 1 (beats/15 sec)	Resting Heart Rate 2 (beats/15 sec)	Resting Heart Rate 3 (beats/15 sec)	Average Heart Rate (beats/15 sec)
15–25 beats	*15–25 beats*	*15–25 beats*	*15–25 beats*

Post-Exercise Heart Rate

Immediately After Exercise (beats/15 sec)	1 Minute (beats/15 sec)	2 Minutes (beats/15 sec)	3 Minutes (beats/15 sec)	4 Minutes (beats/15 sec)	5 Minutes (beats/15 sec)
30–40 beats	*20–30 beats*	*18–28 beats*	*17–27 beats*	*16–26 beats*	*15–25 beats*

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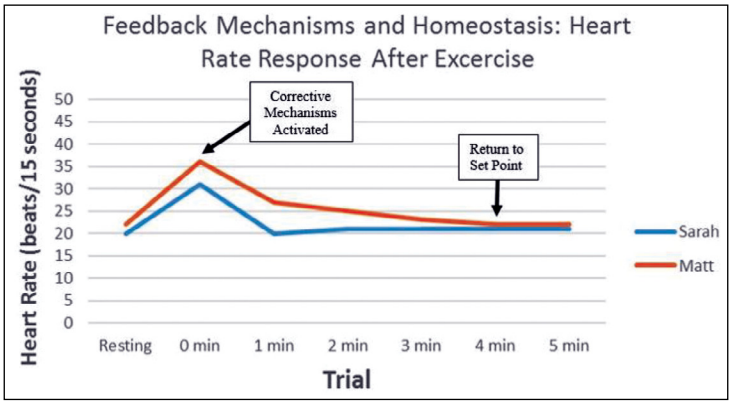
Analysis and Discussion

1. Compare the set point heart rate for each group member. *If students are healthy, the range of set point heart rates should not vary widely and will probably be within normal ranges. Students may notice slight differences between genders or athletes and non-athletes.*
2. On the same axes, graph every group member's average set point heart rate and post- exercise heart rates. Color code or label each line. On the graph, identify the set point, where exercise is taking place, and where corrective mechanisms are activated. Remember to title the graph, label the axes, include units, and include a key.



3. Using the concepts of homeostasis and negative feedback mechanisms, explain each segment of the graph.
   Segment 1: The slope of the line segment is positive, indicating an increase in heart rate. Exercise with an increased need for oxygen to the muscles is the stimulus to which the circulatory system must respond to maintain homeostasis.

   Segment 2: The slope of the line segment is negative, indicating the circulatory system is using self-correcting negative feedback mechanisms. Heart rate is decreasing, returning the body to normal through the process of homeostasis.

   Segment 3: The slope of segment 3 is negative and very small, indicating that the body is returning to set point heart rate and homeostasis is maintained.

4. If you collected data for a positive feedback mechanism, how would the graph change?
   Segment 1: The slope of the line segment would be negative, indicating a decrease in rate or amount.

   Segment 2: The slope of the line segment would be positive, indicating a self-correcting, positive feedback mechanism.

   Segment 3: The slope of segment 3 would be positive and very small, indicating that the body is returning to set point rate or amount, and homeostasis is maintained.

5. Convert your heart rates to beats/minute. Compare your heart rate to the normal range of 60 to 100 beats/minute.

   Example: $\frac{22 \text{ beats}}{15 \text{ sec}} \times \frac{4}{4} = \frac{88 \text{ beats}}{60 \text{ sec}} \times \frac{60 \text{ sec}}{1 \text{ min}} = \frac{88 \text{ beats}}{1 \text{ min}}$

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TEACHER NOTES

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