Do

Name: _____ Date: _____ Group: _____

Homeostasis and Feedback Loops

Background Information

Homeostasis is the regulation and maintenance of the internal environment by an organism to maintain a condition of balance or equilibrium. The human body, for example, maintains a temperature of 37° C (98.6° F). However, if you were to run a mile, your temperature would rise and your body would make adjustments to return to its steady, homeostatic state.

Homeostasis is an internal feedback mechanism sustained by a complex system of feedback loops that utilizes communication between the brain and body to respond to stimuli, such as temperature fluctuations. A feedback loop consists of three basic parts: a receptor, control center, and effector.

Receptors gather information about conditions inside and outside of an organism. The control center is typically the brain and receives signals from the receptors. It processes this information and compares it to set points or ideal conditions at which the organism functions best. When conditions move above or below a set point, the control center responds by sending a signal to an effector. Effectors are targets such as cells, muscles, or glands that change their level of activity in response to the stimuli.

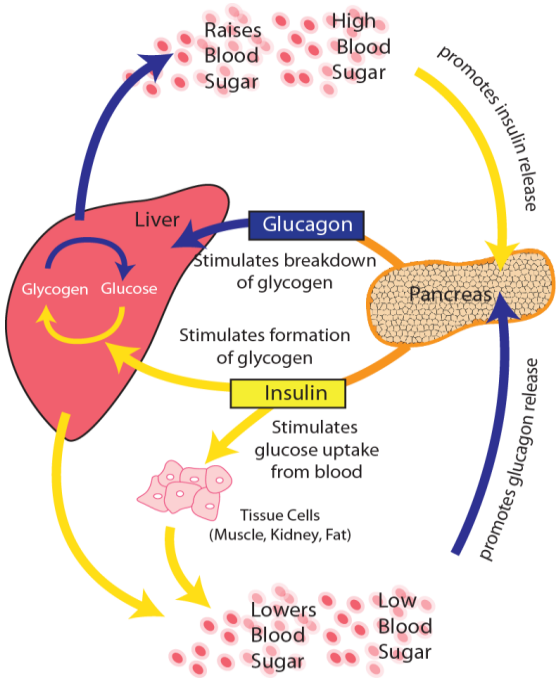
An example of an internal feedback mechanism is the control center in your brain, which is responsible for thermoregulation. It is a small structure called the hypothalamus, which contains receptors that detect slight changes in the temperature of your blood. When you exercise, your temperature rises and your brain sends signals to sweat glands, blood vessels in the skin, as well as the heart and lungs. In this case, the response is to cause the sweat glands to increase their activity, dilate blood vessels near the skin, and increase both heart and breathing rates. This allows heat to be carried away from the center of the body to the surface, so that excess heat is released outward. As the sweat evaporates and heat radiates away from your skin, the temperature of your blood cools down to normal levels and the control center stops its signals to sweat glands and blood vessels. This is similar to the way an air conditioner turns off after the room reaches a set temperature.

Homeostasis and Feedback Loops, continued

Negative Feedback

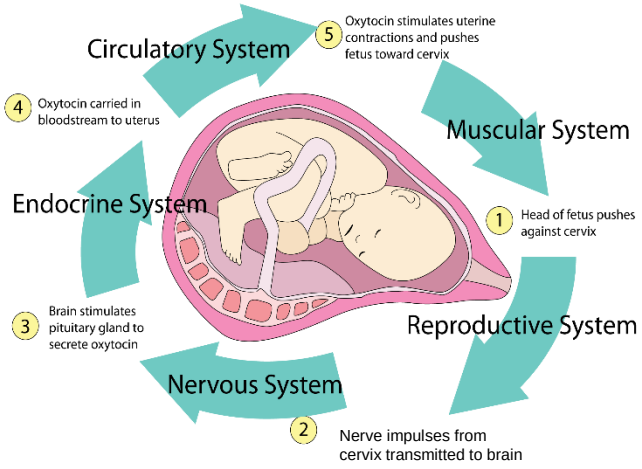
In negative feedback, a control center reverses any change in the body that moves conditions above or below a set point, thus keeping the internal environment stable. Body temperature and regulation of blood sugar levels are examples of negative feedback loops.

To maintain a constant blood glucose level, your body relies on the hormones insulin and glucagon. If blood sugar levels are low, glucagon is released by the pancreas, which stimulates the liver to increase blood sugar levels. If the amount of glucose is too high, signals are sent to the pancreas to release insulin. Insulin causes the liver to convert more glucose to glucagon resulting in lower blood sugar.



Positive Feedback

In positive feedback, a stimulus increases a rate of change away from set points. For example, during childbirth, as the baby moves toward the birth canal, it pushes on receptors in the muscular part of the cervix. Nerve signals are sent to the hypothalamus, stimulating the pituitary gland to release the hormone oxytocin. Oxytocin stimulates contractions and speeds up labor. The loop will stop when the pressure is relieved, as the baby and the placenta leave the birth canal.



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Homeostasis and Feedback Loops, continued

1. Define homeostasis.

2. Describe two examples of the homeostasis process in humans.

3. What is the relationship between the control center and the effector in a feedback loop?

4. How does your body respond to overheating? Explain this process in terms of both internal and external signals and homeostasis.

Do

Homeostasis and Feedback Loops, continued

Part I: Plan Your Investigation

You will conduct an experiment to measure the changes in your blood pressure, heart rate, and breathing rate after a given stimulus. Many stimuli exist that can cause changes (in either direction) to these systems such as running in place, holding your breath, lying down, and doing push-ups. Select a stimulus that can be tested in your classroom, and determine how long the stimulus will last (at least one minute is recommended).

Question of Inquiry:
With your class and teacher, discuss the question of inquiry and list the materials that you will need to conduct your investigation.

1. My question of inquiry:
   _____
   _____

2. My hypothesis:
   _____
   _____

3. My prediction:
   _____
   _____

4. What is the independent variable (also known as the manipulated variable)?
   _____
   _____

5. What is the dependent variable (also known as the responding variable)?
   _____
   _____

6. Is there a control group or control variable for this investigation? Explain.
   _____
   _____

7. What materials, equipment, and technology will be needed for this investigation?
   _____ _____
   _____ _____
   _____ _____

Do

Homeostasis and Feedback Loops, continued

8. List all safety precautions that must be taken.

_____

_____

Procedure:

With your class and teacher, discuss a list of procedures to conduct this experiment.

9. Create and record the procedures you discussed with your teacher and peers for this investigation. Use additional paper as necessary.

Do

Homeostasis and Feedback Loops, continued

Part II: Implement Your Investigation

Collect, Record, and Organize Data

1. Based on the procedure you outlined in Part I, draw a table to record the data you collect. Use one column for “Before Stimulus”, one column for “During Stimulus”, and one column for “After Stimulus.” Include one row each for blood pressure, heart rate, and breathing rate. Include units. Remember, in order to measure any changes, you must know the initial values, so be sure to collect your baseline blood pressure, heart rate, and breathing rate before beginning the activity.

2. Develop a bar graph that communicates your findings before, during, and after the stimulus. Title your graph, label your axes, include the units of measure, and provide a legend. Use additional paper as needed.

Do

Homeostasis and Feedback Loops, continued

Part II: Implement Your Investigation, continued

Analyze Data

1. Summarize what you observed regarding blood pressure before, during, and after performing your stimulus.

_____
_____
_____
_____
_____

2. Summarize what you observed regarding heart rate before, during, and after performing your stimulus.

_____
_____
_____
_____
_____

3. Summarize what you observed regarding breathing rate before, during, and after performing your stimulus.

_____
_____
_____
_____
_____

4. Explain what might happen if your body were unable to maintain a constant temperature.

_____
_____
_____
_____
_____

Do

Homeostasis and Feedback Loops, continued

Reflections and Conclusions

1. Does the data support or refute the hypothesis? Explain.

   _____
   _____

2. Was your prediction correct or incorrect? Explain.

   _____
   _____

3. How did the results reveal a relationship between the independent and dependent variables?

   _____
   _____

4. Where could errors have been made while collecting or organizing data?

   _____
   _____

5. What do you conclude from this investigation?

   _____
   _____

6. What would you do differently if you were to conduct this experiment again?

   _____
   _____

7. What type of data did you collect, qualitative or quantitative? Justify your answer.

   _____
   _____

8. Using all of the following terms, develop a graphic organizer. Use additional paper, if needed.

   Terms: homeostasis, feedback loop, control center, effector, receptor, response, signal, stimulus, hypothalamus, and pituitary gland.