Homeostasis, Negative Feedback, and Positive Feedback

I. Homeostasis and Negative Feedback

Your body maintains a relatively constant body temperature, even when the external environment gets colder or hotter. Your body also maintains relatively constant levels of O₂, CO₂, H⁺ and other internal conditions. This maintenance of relatively constant internal conditions is called homeostasis.

1. Why is homeostasis important? For example, what could go wrong if your body temperature got too low or too high?

2a. Answer the questions in these flowcharts to describe how your body’s responses prevent body temperature from getting too low or too high.

When you get chilled, how does your body respond?

- How does this response help to warm your body?

When you get too hot, how does your body respond?

- How does this response help to cool your body?

2b. Propose a hypothesis about how each response is turned on when needed. Your hypothesis should include answers to questions like these. What type of sensory information would a temperature control center need in order to turn on the right response at the right time? Where in the body would a temperature control center probably be located?

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1 By Dr. Ingrid Waldron, Dept Biology, Univ Pennsylvania, © 2019, but teachers are encouraged to make copies for classroom use. This Student Handout and Teacher Preparation Notes with background information and instructional suggestions are available at http://serendipstudio.org/exchange/bioactivities/homeostasis.
Your brain has a **temperature control center** that keeps your body temperature near a **set point**. Usually, the set point for body temperature is approximately 37°C (~37°C = ~98.6°F). The temperature control center compares this set point to actual body temperature (measured by temperature receptors in the brain and in other parts of the body). If your body temperature is too low or too high, then the temperature control center triggers a response that brings your body temperature back to the set point.

3. Complete this flowchart to summarize how a person’s temperature control center can keep his or her body temperature close to the set point of 37°C (98.6°F).

![Flowchart](chart.png)

4. The top row of the flowchart below defines **negative feedback**. Complete the second and third rows to show how body temperature regulation is an example of negative feedback.

<table>
<thead>
<tr>
<th>In negative feedback, if the regulated variable deviates from the set point,</th>
<th>this stimulates a response that reverses the initial change</th>
<th>which brings the regulated variable back to the setpoint.</th>
</tr>
</thead>
<tbody>
<tr>
<td>e.g., if body temperature falls below ~37°C,</td>
<td>this stimulates</td>
<td>which</td>
</tr>
<tr>
<td>e.g., if body temperature rises above ~37°C</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

5a. Does the flowchart in question 3 show negative feedback? **yes ___ no ___**

5b. Explain your reasoning.
6. How does negative feedback contribute to homeostasis?

When your warm blood flows through the surface blood vessels in your skin, it warms your skin which radiates heat away from your body. When more blood flows through these surface blood vessels, more heat is lost from your body. The amount of blood flow through these surface blood vessels is regulated by your temperature control center as part of the negative feedback regulation of your body temperature.

7a. Which diagram shows the pattern of blood flow that would be expected when a person is in a cold environment? A ___  B___

7b. Explain your reasoning.

7c. To show a more complete picture of negative feedback regulation of body temperature, add increased and decreased blood flow through surface blood vessels to the flowchart in question 3.

8. Behavioral responses also help to regulate body temperature. For example, in hot weather you may move into the shade which can help prevent overheating. What is one behavior that can help to keep you warm in a cold environment?

9. If an injury causes damage to the small blood vessels just under the skin, the blood that leaks out of the injured blood vessels can cause swelling and a black and blue bruise or a black eye. Doctors advise cooling the injured area (for about 10 minutes, several times during the first day or two). How could cooling the injured area minimize swelling and the dark color of a bruise or black eye?
This figure is another way of showing negative feedback regulation of body temperature.

10a. Fill in the boxes to describe the body’s responses to changes in body temperature. (Hint: See your answers to questions 3 and 7c.)

10b. The top half of this figure corresponds to the [left / right] half of the flowchart in question 3.

Homeostasis and negative feedback do not mean that body temperature is always constant. For example, when you have an infection, your body temperature may increase and you may develop a fever. The fever helps your immune system fight the infection.

11. This flowchart shows how a person who has an infection develops a fever. Notice that the person is shivering, even though his body temperature is at the normal set point = 37°C. Explain why he is shivering.
II. Positive Feedback

In many ways, positive feedback is the opposite of negative feedback. In positive feedback, an initial change stimulates more change in the same direction. So, positive feedback produces rapid change.

This figure shows how positive feedback contributes to the rapid formation of a platelet plug in an injured blood vessel.

- The injured tissue attracts platelets.
- These platelets secrete chemical signals that attract more platelets to the site of the injury.
- Many platelets accumulate quickly and plug the hole in the injured blood vessel.

12. Explain how positive feedback helps to prevent excessive blood loss after a blood vessel has been injured.

13. To show two important differences between positive feedback and negative feedback, fill in each blank with one of the following: close to a set point / rapid change / reverses / same.

<table>
<thead>
<tr>
<th>Positive Feedback</th>
<th>Negative Feedback</th>
</tr>
</thead>
<tbody>
<tr>
<td>An initial change stimulates more change in the ________ direction.</td>
<td>An initial change away from the set point stimulates a response that __________ the initial change.</td>
</tr>
<tr>
<td>Positive feedback produces __________________________.</td>
<td>Negative feedback keeps a regulated variable (e.g. body temperature) __________________________.</td>
</tr>
</tbody>
</table>

14. Explain why positive feedback and negative feedback are appropriate names for these two different types of feedback.

15a. If you are in a cold environment, shivering can increase your body temperature. Is shivering part of positive feedback ____ or negative feedback ____?

15b. Explain your reasoning.