# **Negative Feedback, Homeostasis, and Positive Feedback, with Breathing Experiment**[[1]](#footnote-1)

**Changes in Breathing**

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| **1a.** You will investigate how your breathing changes as you  re-breathe the air in a medium-size plastic trash bag. How do you think your breathing will change after several minutes of breathing into the bag? (Check all that apply.) bigger breaths \_\_\_  faster breathing \_\_\_ slower breathing \_\_\_ smaller breaths \_\_\_  **1b.** Explain your reasoning. |  |

Procedure

1. If you have asthma or some other breathing difficulty, check with your teacher about whether or not you should breathe into a bag. Each person whose health permits should complete steps B and C while other group members observe.
2. To prepare to breathe into your 8-gallon plastic trash bag, open the bag completely and swish it through the air until the bag is nearly full of air. Then, gather the top of the bag in both hands, and open a small hole in the center just big enough to surround your nose and mouth. To make a good seal, hold this opening tightly over your nose and mouth.
3. Breathe into your bag for 4 minutes (or as long as you can). Breathe as normally as you can.

Notice any changes in breathing rate (number of breaths per minute) and

volume of each breath (the amount of air taken in with each breath).

If you are observing another member of your group, watch how a crease in the bag changes as the person breathes in and out. This will help you to notice any changes in breathing rate and/or volume of each breath. Record your observations in question 2.

Results and Analysis

**2a**. Describe how your breathing changed as you re-breathed the air in the bag for several minutes. Include any changes in breathing rate and/or volume of each breath.

**2b**. Describe how breathing changed for each of the other subjects in your group.

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| Subject Name | Changes in Breathing Rate and/or Volume of Each Breath |
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**3a.** Summarize the overall pattern of changes in breathing rate and volume of each breath.

**3b.** What do you think caused these changes in breathing?

Questions 4-9 will help you to understand the reasons for the changes in breathing you have observed.

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| **4a.** Circle the two gases in this figure.  **4b.** Why do you need to keep breathing all day and all night? |  |

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| **5.** The statements below describe how O2 moves from the air in your lungs to the cells in your body. Write the letter of each statement next to the part of the figure that the statement describes.  a. In your lungs there are millions of tiny air sacs, each surrounded by many tiny blood vessels. O2 diffuses from the air in the air sacs to the blood in the surrounding tiny blood vessels.  b. Your blood carries O2 from your lungs to your heart.  c. Your heart pumps your O2-carrying blood throughout your body.  d. Your O2-carrying blood flows through tiny blood vessels near every cell in your body.  e. O2 diffuses from your blood into your cells.  **6a.** Draw a long arrow that shows how the CO2 produced by your body’s cells gets to the air sacs in your lungs.  **6b**. How is the CO2 in the air sacs in your lungs removed from your body? | C:\Users\Ingrid\AppData\Local\Microsoft\Windows\Temporary Internet Files\Content.Word\figure 3 breathing.png |

**7a.** Compared to the air you breathe in, the air you breathe out has \_\_\_\_\_\_\_\_\_ O2.

(less / more)

**7b**. Compared to the air you breathe in, the air you breathe out has \_\_\_\_\_\_\_\_\_ CO2.

(less / more)

**8.** As you re-breathed the air in the bag over and over again:

* what happened to the level of O2 in the air in the bag? decreased \_\_\_ increased \_\_\_
* what happened to the level of CO2 in the air in the bag? decreased \_\_\_ increased \_\_\_

**9a**. If there were no change in your breathing rate or the volume of each breath while you

re-breathed the air in the bag over and over again:

* what would happen to the levels of O2 in your blood? decrease \_\_\_ increase \_\_\_
* what would happen to the levels of CO2 in your blood? decrease \_\_\_ increase \_\_\_

(Hint: Check your answers to question 8.)

**9b.** What changes in breathing could bring more O2 into your lungs?

**9c.** As your group members re-breathed the air in the bag, how did the changes in breathing help to prevent decreases in blood levels of O2?

The changes in breathing that maintained high enough blood levels of O2 and prevented excessive accumulation of CO2 are an example of **negative feedback**. Negative feedback keeps a regulated variable (e.g. blood levels of O2 or CO2) near a set point.

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**10.** Complete this sentence to describe how negative feedback keeps a regulated variable near its set point.

When anything causes a regulated variable to move away from its set point, negative feedback \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ the initial change, which brings the regulated variable back to the \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_.

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**11a.** In this diagram, what is the regulated variable?

**11b.** Underline the changes in breathing that keep CO2 levels in the blood from rising too high.

**Negative Feedback Regulation of Body Temperature**

Negative feedback maintains body temperature within an optimum range, even when the external environment gets colder or hotter. Part of your brain functions as a temperature control center. Usually, the set point for body temperature regulation is approximately 37°C (~37°C = ~98.6°F). If your body temperature starts to fall below ~37°C or increase above ~37°C, then the temperature control center triggers responses that bring your body temperature back to the set point (~37°C).

**12.** Complete this flowchart to show how a person’s temperature control center keeps body temperature close to 37° C.

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**13a.** What could go wrong if your body temperature got too low?

**13b.** What could go wrong if your body temperature got too high?

Thus far, you have seen that your body maintains a relatively constant body temperature and your body maintains relatively constant levels of CO2 and O2 in your blood. Your body also keeps other internal conditions in an optimum range. This maintenance of relatively constant internal conditions is called **homeostasis**.

**14.** Explain how negative feedback contributes to homeostasis.

Homeostasis and negative feedback do *not* mean that body temperature is always constant. For example, when you have an infection, you may develop a fever (i.e., your body temperature increases). Your higher body temperature helps your immune system fight the infection. This flowchart shows how a person who has an infection develops a fever.

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| A cartoon of a child wrapped in a blanket  Description automatically generated with low confidence |

**15.** Notice that the person described in this flowchart is shivering, even though his body temperature is at the normal set point (37°C). Explain why he is shivering.

**Diabetes – A Failure of Negative Feedback Regulation of Blood Glucose Levels**

When negative feedback doesn’t work correctly, this can result in illness. For example, defects in negative feedback regulation of blood glucose levels can result in diabetes. In a person with diabetes, too much glucose in the blood injures blood vessels and nerves, which can cause heart disease, kidney disease, stroke, and/or blindness.

**16.** Negative feedback keeps blood glucose levels near an optimum. What problems could result if a person’s blood glucose levels get too low, so the person’s cells do not get enough glucose?

The figure on the next page shows normal negative feedback regulation that prevents blood glucose levels from rising too high or falling too low.

Diagram, timeline

Description automatically generated

**17a.** When blood glucose levels are high, excess glucose is stored in glycogen, which is a polymer of glucose. Write polymer next to glycogen in the figure.

**17b.** Insulin and glucagon are hormones, which are chemical messengers that travel in the blood. Write hormone next to insulin and glucagon in the figure.

**18a.** After a person eats a meal, glucose is absorbed from the gut into the blood, so blood glucose levels begin to rise. Describe the physiological responses that prevent an excessive rise in blood glucose levels after a meal.

**18b.** When a person has not eaten for a long time, what physiological responses help to prevent blood glucose levels from falling too low?

**19a.** In a person with type 1 diabetes, the pancreas produces little or no insulin. Cross out the parts of the above figure that would not occur in a person who produces no insulin.

**19b.** The lack of insulin results in blood glucose levels that are \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ than normal.

(higher/lower)

**19c**. Type 2 diabetes begins with insulin resistance – when a given amount of insulin has less effect than normal. To describe type 2 diabetes, fill in the blanks in this chart.

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**Positive feedback produces rapid change.**

In **positive feedback**, an initial change stimulates more change in the same direction. Therefore, positive feedback produces rapid change from one state to another. For example, positive

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| feedback contributes to a rapid transition from an injured blood vessel (which allows blood to leak out) to a platelet plug (which stops the blood from leaking out).  ● Blood contains platelets, which stick  to the injured part of the blood  vessel.  ● When platelets stick to the injured  area, they begin to secrete chemical  signals that attract more platelets.  ● Many platelets accumulate quickly  and plug the hole in the injured  blood vessel.  ● Once the hole is plugged, different  chemical signals prevent further  platelet accumulation.  **20.** Explain how positive feedback helps to prevent excessive blood loss after a | http://images.slideplayer.com/9/2488629/slides/slide_56.jpg |

blood vessel has been injured.

**21.** In some basic ways, positive feedback is the opposite of negative feedback. To illustrate this, fill in each blank in this table.

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| **Positive Feedback** |  | **Negative Feedback** |
| An initial change stimulates more  change in the \_\_\_\_\_\_\_\_ direction. | An initial change away from the set point stimulates a  response that \_\_\_\_\_\_\_\_\_\_\_\_\_ the initial change. |
| Positive feedback results in  \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_. | Negative feedback keeps a regulated variable (e.g.,  body temperature) \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_. |

**22a.** If you are cold, shivering can increase your body temperature. Is shivering part of

positive feedback \_\_\_? negative feedback \_\_\_?

**22b.** Explain your reasoning.

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

1. By Drs. Ingrid Waldron, Lori Spindler and Jennifer Doherty, Dept Biology, Univ Pennsylvania, © 2024. Teachers are encouraged to copy this Student Handout for classroom use. This Student Handout and Teacher Preparation Notes (with background information, instructional suggestions, and information to guide optional student investigations) are available at <https://serendipstudio.org/sci_edu/waldron/#breath>. [↑](#footnote-ref-1)