nors Physiology

Name: _____

Homeostasis and Negative Feedback – Concepts and Breathing Experiments[i] Period: ____

I. Homeostasis and Negative Feedback

Homeostasis refers to the maintenance of relatively constant internal conditions. For example, your body maintains a relatively constant body temperature even when the external environment gets colder or hotter.

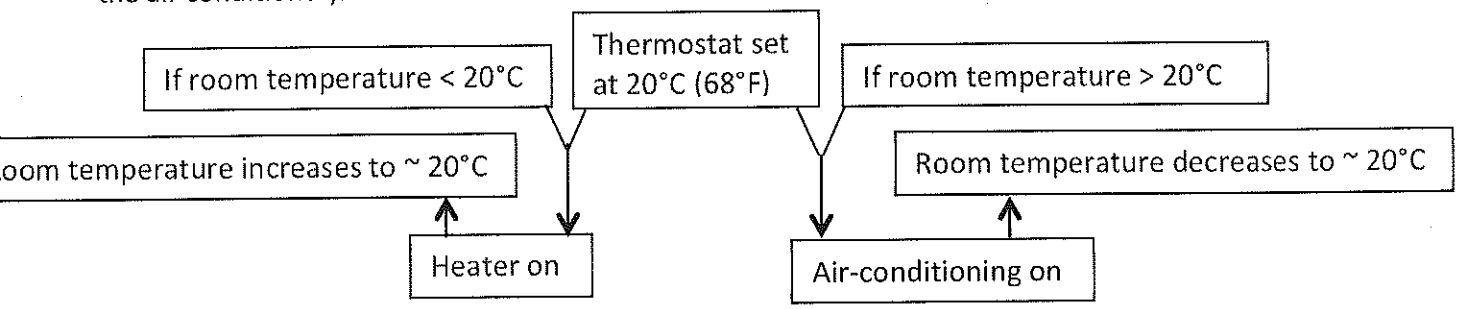
1. Describe one response of your body to a cold environment and explain how this response helps to keep your body temperature from falling too low.

2. Describe one response of your body to a hot environment and explain how this response helps to keep your body temperature from rising too high.

* These body responses are an example of negative feedback. **Negative feedback** occurs when a change in a **regulated variable** triggers a response which reverses the initial change and brings the regulated variable back to the **set point**.

↳ remember: negative = opposite (not BAD)

Example The flowchart shows negative feedback regulation of temperature in a home with central heating and air-conditioning. Negative feedback maintains the regulated variable (room temperature) relatively constant at approximately the set point (20°C). To keep the regulated variable relatively constant, negative feedback changes other components of the system (e.g. turning on the heater or the air conditioner).



3. Draw a similar flowchart to show negative feedback regulation of body temperature. (The thermostat for body temperature regulation is in the brain and normally has a set point of ~37°C.) or 98.6°F

4. Why is negative feedback regulation of body temperature useful? What are some problems that can occur if your body temperature gets too high or too low?

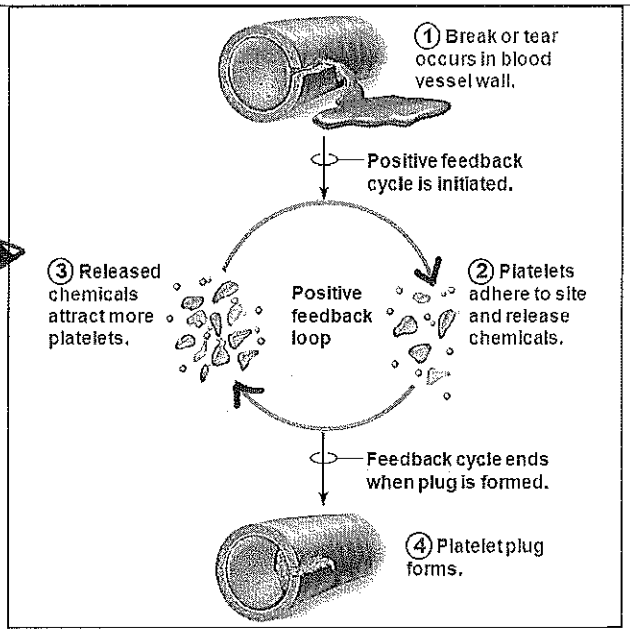
5. Explain how negative feedback contributes to homeostasis.

REVIEW

Two Types of Feedback:
Negative feedback occurs when a change in a variable triggers a response which reverses the initial change. −
Positive feedback occurs when a change in a variable triggers a response which causes more change in the same direction. +

Positive feedback is useful when there is an advantage to making a rapid change. For example, when a blood vessel is injured it is useful to have rapid formation of a platelet plug to prevent excessive blood loss.

This figure shows how positive feedback contributes to the rapid formation of a platelet plug in an injured blood vessel. The injured area attracts platelets, and each of these platelets secretes chemicals that attract more platelets. Thus, many platelets accumulate quickly and together these platelets plug the hole in the injured blood vessel and prevent excessive blood loss.



6. Shivering in a cold environment can raise your body temperature. Is shivering part of positive feedback or negative feedback? Explain your reasoning.

* **7.** What would go wrong if your body used positive feedback to regulate body temperature? For example, what would happen if a person sweated in response to a decrease in temperature?

II. Respiration and Circulation

All the cells in your body use energy to do their work. For example, cells use energy to move and to synthesize needed molecules. The energy for most cellular processes is provided by **ATP** molecules. Most of the ATP in your cells is produced by **cellular respiration** which transfers energy from food molecules like the sugar glucose to ATP molecules. Cellular respiration uses O_2 and produces CO_2.

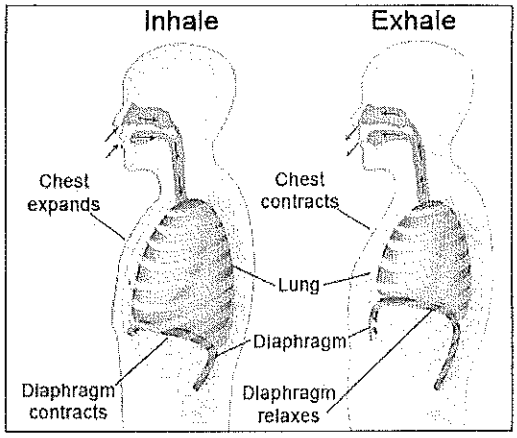
Cellular Respiration of Glucose

$$C_6H_{12}O_6 + 6\,O_2 \longrightarrow 6\,CO_2 + 6\,H_2O$$

$$\downarrow\ energy$$

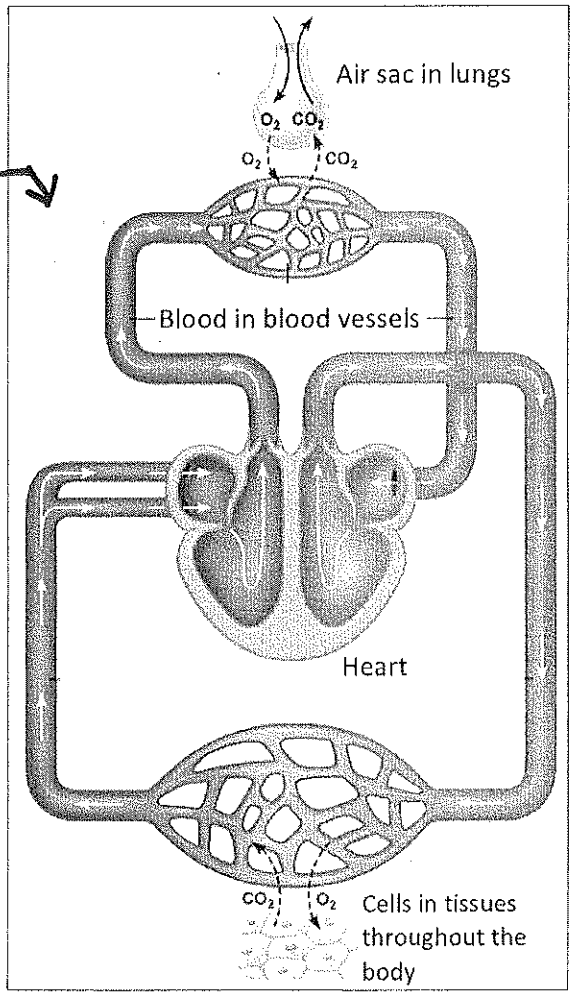
$$\sim 29\ ADP + \sim 29\ P_i \longrightarrow \sim 29\ ATP$$

During **inhalation** the breathing muscles expand the lungs; this brings fresh air with needed O_2 into the lungs.
During **exhalation** the lungs get smaller and air with excess CO_2 is pushed out of the lungs.



8. Why do your cells need a constant supply of O_2? Why does your body constantly need to get rid of CO_2?

This figure shows how O_2 diffuses from the air in the millions of tiny air sacs in the lungs to the blood in the tiny blood vessels that surround each air sac. Then blood with O_2 is pumped by the heart through blood vessels to reach tiny blood vessels near all the cells in the body. There, the O_2 diffuses from the blood into the cells.



9. Draw a long arrow to show how CO_2 moves from the cells of the body via the blood to the air in the air sacs of the lungs.
(on the figure to the right →)

10. The **respiratory system** includes the lungs and breathing muscles and the **circulatory system** includes the heart, blood and blood vessels. Explain why a person needs to have both a respiratory system and a circulatory system to provide the body's cells with the O_2 needed for cellular respiration.

III. Negative Feedback and the Regulation of Breathing

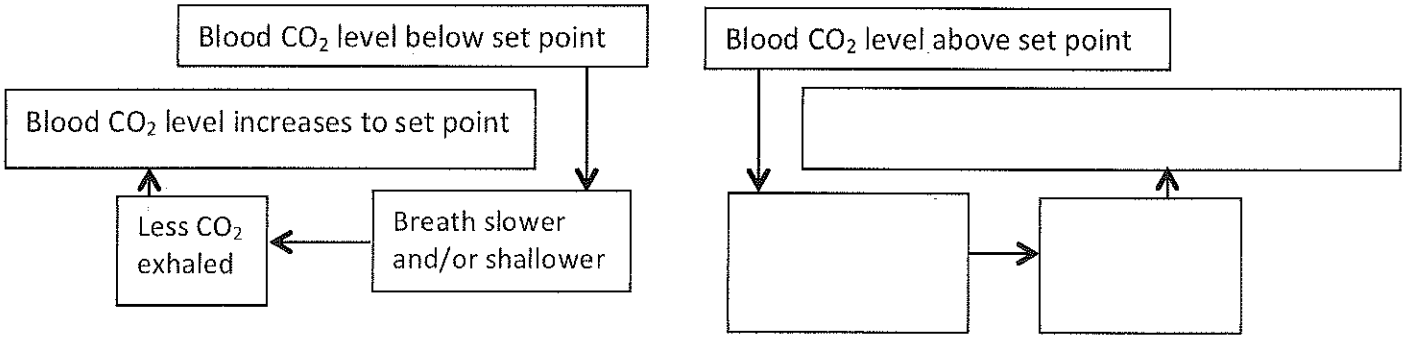
Your brain regulates the rate and depth of your breathing to match the needs of your body. Rate of breathing refers to the number of breaths per minute and depth of breathing refers to the amount of air taken in with each breath. To increase the amount of air breathed into your lungs per minute, your brain stimulates increased rate of breathing and/or increased depth of breathing.

11a. On the top of a high mountain, air pressure is significantly lower than at sea level so there is less O_2 in a given volume of air. Suppose a person at high altitude maintained the same rate and depth of breathing as he had at sea level. What would happen to the O_2 levels in his blood? Explain your reasoning.

11b. What changes in breathing could maintain relatively constant O_2 levels in the blood for a person who has gone from sea level to high altitude?

Whenever blood levels of O_2 and CO_2 get too low or high, negative feedback regulation restores these blood levels to a healthy set point. This negative feedback regulation can increase or decrease the rate and depth of breathing.

12. Complete this flowchart diagram to show how negative feedback regulation could change the rate and depth of breathing to maintain relatively constant levels of CO_2 in the blood.



Next, you will do an experiment to test how negative feedback regulation of blood levels of CO_2 and O_2 influences the rate and depth of breathing. In this experiment, each subject will breathe the air in an 8 gallon plastic garbage bag for four minutes. Think about this experiment...

13. Based on the negative feedback hypothesis, predict how your breathing will change by the end of four minutes of breathing into the plastic bag. Explain your reasoning. (Hint: Think about what will happen to the levels of CO_2 and O_2 in the air in the bag and in your lungs, blood and brain as you breathe into the bag for several minutes.)