GRADE 9

SCIENCE

Remote Learning Activities

Expect great things.

Pittsburgh Public Schools
Grade 9 Science Remote Learning Activities

Below is a list of activities that students can work on during the unexpected closure of schools. Activities are designed to reinforce the learning already facilitated to students during the 2019-2020 Academic School Year. This Remote Learning Activity Packet was created for a minimum of ten (10) days of independent practice.

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Homeostasis Balancing Internal Conditions

What do you already know about homeostasis?
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Sometimes a chilly night turns into a warm afternoon. Air temperature can vary by 15°C or more in the course of a single day. Have you ever woken up to see frost on the grass, only to wear shorts later in the day? What happens to your body when it is exposed to large temperature changes?
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Body Heat under Control

Endotherms control their internal body temperature through biological and behavioral mechanisms. How does the body’s metabolism increase in response to lower external temperatures?

Human body temperature normally changes by only one or two degrees from the average of 37°C (98.6°F). Endothermic animals maintain an almost constant body temperature despite exposure to drastic environmental changes. Why does your body work hard to maintain this temperature control? Most of the chemical reactions that occur in the body require enzymes. Many enzymes cease to function above 41°C (106°F). At the other extreme, the heart is likely to stop beating when temperatures fall below 27°C (80°F).

What would happen to enzyme function if your body temperature rises above 106°F
_____________________________________________________________________________________
_____________________________________________________________________________________
_____________________________________________________________________________________

Do endothermic animals tolerate drastic changes in temperature? What is your claim? What is your evidence? What is your reasoning?

Claim:____________________________________________________________________________________

Evidence:____________________________________________________________________________________

Reasoning:____________________________________________________________________________________

Body temperature is not the only regulated internal condition. Many properties of our internal environment are kept within strict limits. Internal regulation is needed so that our bodies can function properly. This feature of the biological system is called **homeostasis**. Fluid, salt, gas, and nutrient levels are also regulated. Multiple systems are involved in **homeostasis**. For example, the respiratory and urinary systems act together to maintain blood pH at a critical 7.3. As the external and internal environments change, homeostatic mechanisms act to return the body to optimal conditions. As you might imagine, there are multiple mechanisms involved in keeping this balance.
Some Like It Hot

How does your body react to an increase in environmental temperature? Provide at least one behavioral and one physiological response to this environmental change and discuss how they might act to keep internal body temperature from rising.

**Behavior Change:**

____________________________________________________________________________________

**Physiological Change:**

Enter

The term **homeostasis** originates from two Greek words. Homeo means “similar.” Stasis means “standing still.” Collectively, **homeostasis** describes the property of a system that maintains a stable internal environment even when conditions in the external environment change.

Define homeostasis in your own words

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What is Homeostasis?

Homeostasis is a central concept in biology. **How does homeostasis help to keep an organism alive?**

All living things depend on homeostatic controls. They keep organisms alive as internal and external conditions change. Some of these controls keep internal conditions within a tolerable range throughout the life cycle.

**Explain why homeostasis is compared to a balancing act.**

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Balance

What happens if a body process becomes out of balance?

Negative Feedback Loop

The most critical mechanism of homeostasis is a negative feedback loop. It is similar to the way in which a thermostat keeps the temperature of a room constant. The thermostat is set to the desired temperature. If the room is too cold, the thermostat reacts by turning on the heat. If the room gets too hot, the thermostat causes the air conditioner to turn on.

This control system requires three parts:

1. A sensor that monitors the conditions.
2. A processor that determines how much the measured value differs from the set value.
3. An actuator that can change the particular property.

In the example of a thermostat, the sensor is a thermometer measuring the room temperature. The processor is a machine or computer that compares the measured room temperature with the set value. Finally, the actuator is a heater or an air conditioner that heats up or cools down the room.

A negative feedback loop, is a system where the result of an action or a chemical, leads to a decrease in that action or chemical. An opposite system is a positive feedback loop. A positive feedback loop, is a system where the result of an action or a chemical, leads to an increase in that action or chemical. An example of a positive feedback loop would be if fruit produced a chemical to ripen and this chemical caused nearby fruit also to produce the same chemical in greater quantities in response.

When the body is too cold, a signal is sent to increase the temperature and the body begins to shiver. A similar process occurs when the body temperature increase. When the body temperature rises, a signal is sent, and the body begins to sweat resulting in the temperature decreasing. This feedback loop keeps the body in balance- homeostasis.
The body works to keep optimum levels of pH, blood glucose, similarly as to how the body maintains temperature. These parts are linked together in order for the negative feedback mechanism. Serious diseases like diabetes, chronic high blood pressure, or kidney disease are the result of the body not maintaining homeostasis. Homeostatic imbalance can even lead to organ failure and death.

Negative Feedback Loop The pancreas controls insulin levels in the blood that control blood sugar levels.

What would happened if the negative feedback system breaks down, homeostasis is not maintained?

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___________________________________________________________________________________
How Do Different Systems in the Body Interact to Maintain Homeostasis?

Hypothalamus and Pituitary Gland

The hypothalamus and pituitary gland are the main regulators of **homeostasis** in humans. The hypothalamus is located in the brain. It is found just below the thalamus and above the **brain stem**. The pituitary gland is a protrusion from the hypothalamus. They are connected by neural fibers.

![Diagram of the human brain showing the hypothalamus and pituitary gland](image)

**Hypothalamus**

The hypothalamus and pituitary gland are important structures in the human brain that regulate **homeostasis** in humans. How are these structures involved in homeostasis?

The hypothalamus is part of the autonomic **nervous system**. It is sensitive to many properties of the internal environment. It controls the secretion of pituitary hormones into blood circulation. These pituitary hormones in turn act on different parts of the human body to maintain **homeostasis**. Together, the hypothalamus and pituitary gland play the role of the main processor for **homeostasis**. They bridge the nervous system and the **endocrine system**.

**Explain why the hypothalamus is so important in regulating homeostasis.**

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Control of Body Temperature

The ability of animals to control their body temperature is called thermoregulation. Animals have a range of temperature in which their bodies work efficiently. Outside this range the animal may be unable to function. For some animals this range is very limited. These animals have internal mechanisms for maintaining optimal body temperatures. These animals are called endotherms. Endotherms produce heat from their body to maintain their temperature. Mammals and birds are endotherms. Other animals obtain their body heat from the environment. Their activity may vary with temperature. They become more active at warm temperatures. These animals are called ectotherms. Reptiles such as lizards are ectotherms. This is why lizards bask in the sun. They are trying to raise or maintain their body temperature.

Explain the difference between endotherms and ectotherms. Provide an example of each.

Humans are endotherms. Humans maintain a core body temperature of about 37°C (98.6°F). Human body temperature may fluctuate about 0.5°C throughout the day. A departure of one or two degrees from this temperature results in illness. Raised body temperatures are called hyperthermia. Body temperatures of over 43°C result in brain damage and death. Lowered body temperatures are a condition called hypothermia. Body temperatures less than about 25°C/77°F usually stop breathing and heartbeat, causing death. Some people have survived with lower body temperatures.

Define hyperthermia.

Explain how hyperthermia different from hypothermia?

Heat transfers from hot to cold places. When the surroundings are colder than the body’s temperature, the body loses heat. The body needs to generate more heat. On the other hand, if the surrounding temperature is warmer, the body gains heat. This heat must be lost. A number of mechanisms are employed to cope with these situations. Temperature receptors throughout the body monitor temperature. These temperature receptors transmit signals to the brain. The hypothalamus monitors blood temperature. This information is integrated to control body temperature.

If the body is too cold, signals from the hypothalamus:

- **Stimulate cells to increase cellular respiration. This generates more heat.**
- **Stimulate blood vessels in the skin to constrict. This decreases blood flow to the skin. This reduces heat loss from the blood.**
- **Cause shivering. Shivering generates heat.**
- **Raises hair (goose pimples). This traps a layer of warm air closer to the skin.**
Explain how the body responds when the body is cold.

Explain how heat is transferred.
Thermoregulation

The skin is a key organ in thermoregulation. How does it interact with other organs and body systems to control temperature?

If the body gets too hot, signals from the hypothalamus:
- **Stimulate panting. This increases heat loss through evaporation from the lungs and mouth.**
- **Stimulates blood vessels in the skin to dilate. This increases blood flow to the surface. More heat is lost from the skin.**
- **Stimulates sweat glands. This increases evaporative heat-loss from the skin.**

Humans have behavioral adaptations to control the body’s heat-balance. The most obvious are seeking shelter and shade. It is likely that human nakedness is an adaptation to thermoregulation. As humans migrated to colder climates, they adopted new strategies to keep warm. The most obvious is the use of clothing. Many societies use clothing for thermoregulation.

**Explain how the skin helps to regular temperature.**

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**Explain how behavioral adaptations help humans regulate body temperature.**

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**Humans maintain body temperature through a variety of responses. How do feedback loops determine these responses?**

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Other animals have sophisticated adaptations for thermoregulation. Endotherms usually have insulating feathers, fur or hair. These can be very efficient insulators. The down of birds is a layer of fine feathers found under outer feathers. Down is an excellent thermal insulator. This is why some birds can survive the extreme cold of the Arctic and Antarctic. Polar bears are insulated by 10 cm of fat. This fat layer is called blubber. Polar bear fur consists of a dense under-fur and an outer layer of transparent fur. Polar bears lose little heat and are nearly invisible with an infrared camera. Blubber is widely used by aquatic mammals. This is because aquatic mammals rapidly lose body heat to water. Seals and whales are insulated by layers of blubber. Aquatic mammals and birds have evolved heat exchange mechanisms to retain body heat. For example, birds exchange heat between blood vessels in their legs to keep warm. Blood entering the legs transfers heat to blood re-entering the body from the legs. This keeps heat within the body. Animal adaptations to hot temperatures include avoiding high daytime temperatures. They have also evolved structures that radiate heat such as large ears, thin fur, and naked skin.

Explain how polar bears and other aquatic mammals keep their body temperature even when in very cold conditions.

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After reading the thermoregulation section, complete the thinking routine below.

I used to think ________________________________________________________________
_____________________________________________________________________________________
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Now I think ________________________________________________________________
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Control of Fluids, Electrolytes and Waste

Human activities vary greatly throughout the day. One could exercise in the morning, sit in classes for hours, and then eat at night. Different activities require different amounts of energy. These activities also produce different amounts of wastes. Moreover, the exact times of eating and drinking are irregular. These factors all cause the properties of blood in our bodies to vary. Some of these blood properties are acidity, electrolyte level, and waste level.

The primary sensors of these blood properties are located in the hypothalamus. The hypothalamus is sensitive to the osmolarity—the solute concentration—of the blood and controls the secretions of pituitary hormones from the pituitary gland. These pituitary hormones then signal organs such as the kidneys and liver to perform particular functions. The waste management system is the excretory system. Excretory organs remove waste substances from the blood to maintain homeostasis. In addition, the excretory organs can get rid of metabolic wastes produced by cells. If too much water is drunk, the kidneys can remove the excess water from the blood. In contrast, if the water level is low, the hypothalamus will stimulate the pituitary gland. The pituitary gland then sends a signal to the kidneys to conserve water and produce the sensation of thirst. Details of this process are provided in the concept “Excretory System.”

Summary how electrolytes and fluids are controlled in the human body. Be sure to include the role of the pituitary gland.

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How would you act if you were at football practice on a very hot day? Explain
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The Excretory System

The kidneys filter out toxic substances from the body in order to maintain proper fluid, electrolytes, and waste levels in the blood. What feedback mechanisms control the waste that is produced by the kidneys?

The kidneys filter out toxic substances from the body in order to maintain proper fluid, electrolytes, and waste levels in the blood. What name is given to the waste that is produced by the kidneys?

What is the role of the excretory system in homeostasis?

What is the role of the kidneys in maintaining homeostasis?
Control of Blood Pressure

A critical property of the circulatory system that must be maintained is blood pressure. Blood pressure is the pressure of circulating blood on artery walls. Normally, blood pressure is influenced by several factors such as:

- the rate at which the heart beats (heart rate)
- the volume of blood that is sent out per beat (stroke volume)
- the amount diameter of the veins and arteries

The body controls these factors in order to increase or decrease blood pressure. Regulating blood pressure keeps it within healthy limits.

Blood pressure is constantly measured by receptors in the heart and arteries. These receptors then send signals back through nerve fibers to part of the brain called the medulla. The medulla acts as the processor in the negative feedback loop that controls blood pressure. It either increases the heart rate and stroke volume if the pressure is too low or decreases both when the pressure is too high. Hormones are also released to signal the blood vessels to increase or decrease resistance in order to maintain blood pressure within an optimum range.

The list below includes a few of the ways the body reacts to raised or lowered blood pressure. Classify these choices according to whether the response would raise or lower blood pressure.

- Arteries constrict
- Veins constrict
- Slower pulse
- Arteries dilate
- Veins dilate
- Faster pulse

Increase Blood Pressure
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____________________________________________________________________________________

Decrease Blood Pressure
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Pittsburgh Public Schools March 2020
Homeostasis Review

A negative feedback loop, is a system where the result of an action or a chemical, leads to a decrease in that action or chemical. An opposite system is a positive feedback loop. A positive feedback loop, is a system where the result of an action or a chemical, leads to an increase in that action or chemical. An example of a positive feedback loop would be if fruit produced a chemical to ripen and this chemical caused nearby fruit also to produce the same chemical in greater quantities in response.

Create a graphic model of a negative feedback loop.

Create a graphic model of a positive feedback loop.
**Homeostasis Review**

Read about each biological process and determine whether it is an example of a negative or positive feedback loop. Place a check mark to the correct box.

<table>
<thead>
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<th>Negative Feedback Loop</th>
<th>Positive Feedback Loop</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. A breastfeeding mother produces oxytocin and prolactin, which stimulate milk production. The action of her baby nursing at the mother’s breast stimulates the production of more oxytocin and prolactin, which stimulate more milk production.</td>
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<tr>
<td>2. When blood glucose rises, the pancreas releases insulin; when blood glucose concentration falls, the pancreas stops releasing insulin.</td>
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<tr>
<td>3. The adrenal gland produces adrenaline in response to a threatening situation. Adrenaline increases alertness and sends energy to muscles to prepare to fight or run away from danger. When the danger is averted, the adrenal gland stops producing adrenaline.</td>
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<tr>
<td>4. Wounded skin and blood cells send out chemical signals that increase the flow of blood, which causes swelling in the area. This sends out more signals that increase the flow of blood and blood products to the area, which increase the chemical signals.</td>
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Explain why maintaining homeostasis is important for animals to survive.

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