Homeostasis Overview

Vocabulary: cell, tissue, organ, organ system, homeostasis/dynamic equilibrium/steady state, dynamic equilibrium, feedback mechanism, stimulus, response, insulin, glycogen

Levels of Organization

Living things have different levels of organization. The simplest level of organization is that of the **cell**. A group of cells with a similar function is called a **tissue**. Groups of tissues working together to perform a common function are called **organs**. An example of this would include the nervous, muscle, and other tissues which make up the heart. Groups of organs working together to perform a common function are referred to as a **system** or **organ system**. The blood vessels, blood, and the heart are organs which work together to form the circulatory system. Many different systems function together to allow a complex organism to function.

Homeostasis

All the components of the living things, from the cells and the organelles within them to the organ systems of complex organisms must interact to maintain a balanced internal environment within the organism. Organisms possess many control mechanisms to detect internal and external changes and make changes to correct any deviations. This maintenance of a stable internal environment by an organism is called **homeostasis**. Homeostasis in an organism is constantly threatened. Failure to respond effectively can result in disease or death.

Homeostasis

The ability to carry on the life processes allow a living thing to maintain **dynamic equilibrium** or **homeostasis** with their surroundings. Homeostasis is a state of balance or steady state between a living thing and its environment. Homeostasis in an organism is constantly threatened. Failure to respond effectively to a failure of homeostasis can result in disease or death.

Feedback Mechanisms

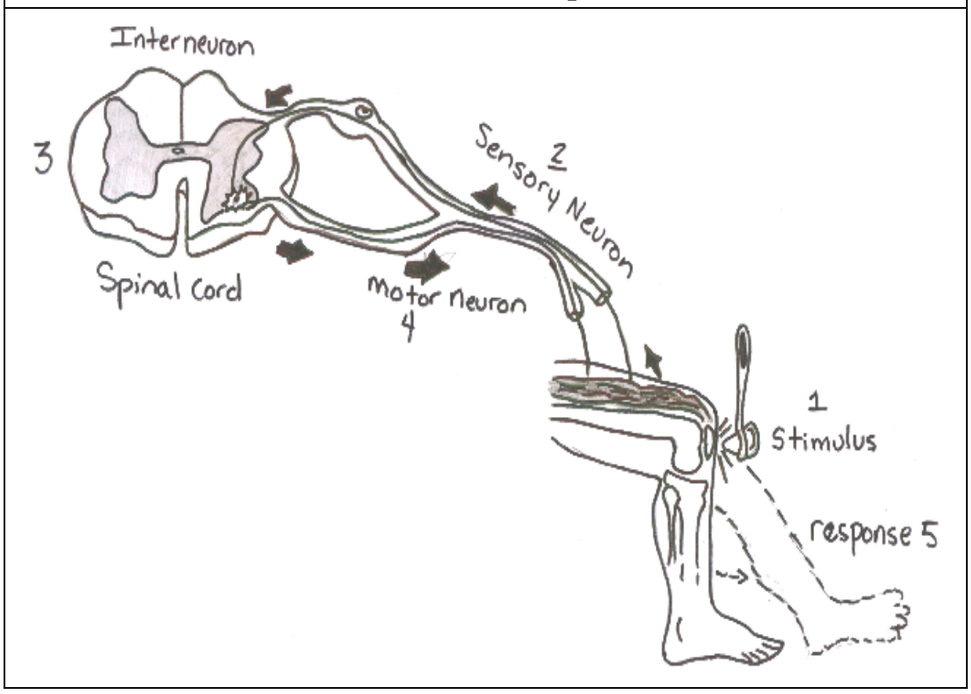
Dynamic equilibrium or **homeostasis** results from the ability of organisms to detect and respond to stimuli. Feedback mechanisms are specific ways which have evolved in different living things to respond to internal or external environmental changes and maintain homeostasis. A **feedback mechanism** is a process where the level of one substance or activity of an organ or structure influences another substance or structure in some manner.

Dynamic Equilibrium and Feedback

Homeostasis is the maintenance of a stable internal state within an organism.

Homeostasis is also known as **steady state**. Organisms must respond and maintain homeostasis in relation to many factors.

Stimulus and Response



Organisms detect changes in their environment and respond to these changes in a variety of ways. These changes may occur at the cellular or organism level.

The graphic above shows the response of a human to being struck on the knee with a hammer. A change in the environment is called a **stimulus.** In this situation, the stimulus is the being struck with the hammer. A **response** is the manner in which the organism reacts to the stimulus. The knee jerk reflex which is pictured above is the response of this individual to being hit with this hammer.

Feedback Mechanism Examples

Feedback mechanisms have evolved in living things as a mechanism by which they maintain **homeostasis** or **dynamic equilibrium**.

A **feedback mechanism** occurs when the level of one substance influences the level of another substance or activity of another organ.

An example of a feedback mechanism in humans would be the increase in heart rate and respiratory rate which occurs in response to increased exercise or other increased muscle cell activity. Some other examples of feedback mechanisms in living things appear below.

Temperature Homeostasis

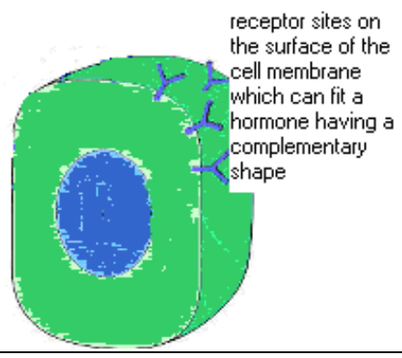
Humans maintain a relatively constant body temperature of about 37° C.

- when we "heat up" we sweat if possible
- the evaporation of this perspiration returns the body to its original temperature

Endocrine System

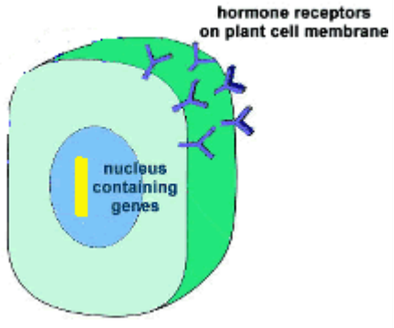
Vocabulary: hormone, target cell/organ

Cell Membrane Receptors

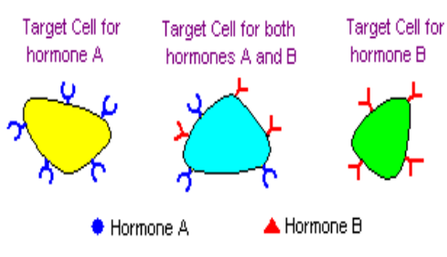
Cell Membrane Receptors	
Many cell membranes have **receptor molecules** on their surface. These receptor sites play an important role in allowing cells and organs to communicate with one another.	

Hormonal Regulation

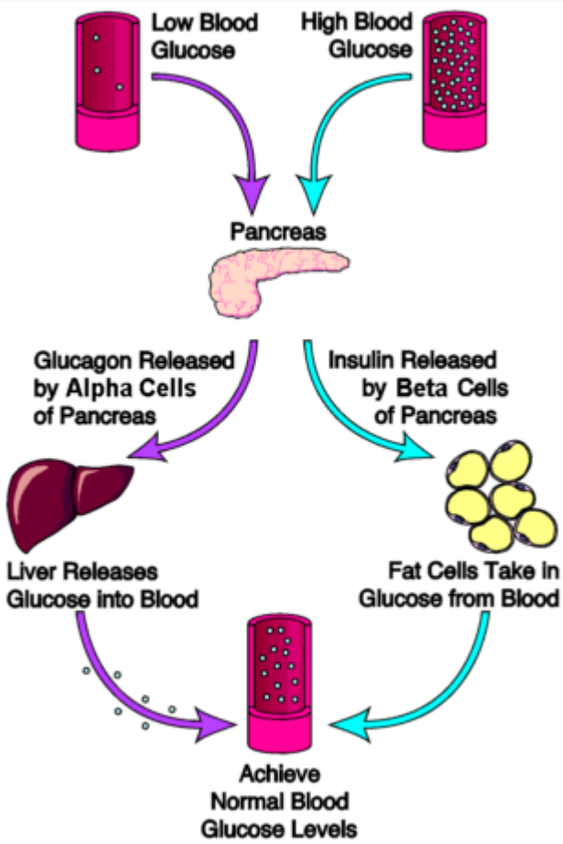
Hormones provide a primary way for cells to communicate with each other. A **hormone** is a chemical messenger with a specific shape that travels through the bloodstream influencing another **target cell** or **target organ**. Upon reaching the cell the hormone is targeted for, the hormone often activates a gene within a cell to make another necessary compound. One example of this is provided by the pituitary gland. This gland at the base of the brain makes a hormone called LH (luteinizing hormone). This hormone travels through the bloodstream and stimulates the ovary to produce yellow tissue that produces the hormone **progesterone**, which maintains the thickness of the uterus lining. The graphic below illustrates how this kind of hormonal regulation can work in a plant cell. Animal cell hormonal regulation involves a similar mechanism.

A Hormonal Feedback Mechanism	
The animation at the right illustrates how a hormone can bind to matching receptors on a cell membrane and then a second messenger molecule enters the nucleus which triggers that cell to produce a needed compound.	

Hormones are specific in their actions. Only the target cells with receptors that match the shape of the hormone are activated.



Blood Sugar Regulation



The pancreas is an endocrine gland which produces hormones which regulate blood glucose (sugar) levels

An **increase** in blood sugar level triggers the release of the hormone **insulin** by the pancreas. The hormone lowers blood sugar level restoring the body to its original blood glucose level in two major ways:

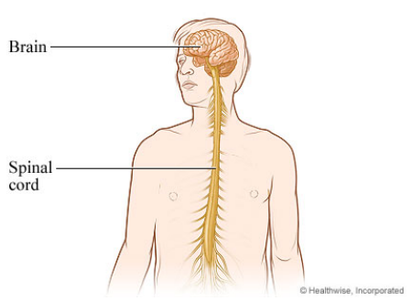
- it increases the ability of body cells to take in glucose from the blood
- it converts blood glucose to the compound **glycogen** -- this compound is also called animal starch and is stored in our liver and muscles

Nervous System

Nervous Regulation

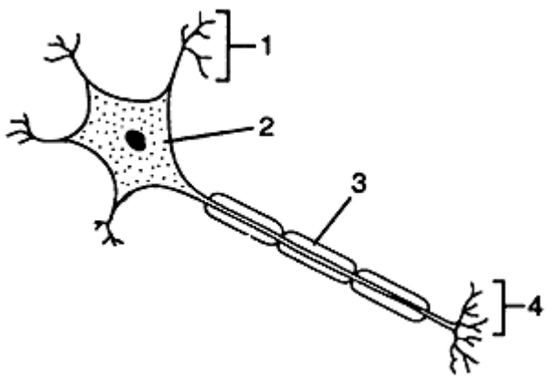
Nerve cells or neurons also allow cells to communicate with each other. Neuron communications are one way organism can detect and respond to stimuli at both the cellular and organism level. This detection and response to stimuli helps to maintain homeostasis in the cell or organism. Neurons may stimulate other nerve cells or muscle cells, thus causing the latter to contract and produce movement.

In organisms such as humans, specialized sensing organs take in a wide range of environmental stimuli and send complex information, via nerves, to the central-processing centers of the brain and spinal cord.



Structure and Function of a Nerve Cell

Neuron Diagram



Structures and their Functions

1. **dendrite** -- neuron branch which detects stimuli (changes in the environment)

2. **cell body** -- body of the neuron where normal metabolic activities occur

3. **axon** -- longest branch covered by a **myelin sheath**(which provides electrical insulation) -- carries nerve message or impulse to the axon terminals

4. **terminal branches** -- release chemicals called **neurotransmitters** which stimulate adjacent dendrites on the next neuron or a muscle cell

Any change in nerve or hormone signals will change the communication between cells and organs in an organism and thus may cause problems for organism's stability and ability to maintain homeostasis.

Disorders of the Endocrine System

A *goiter* is an enlargement of the thyroid gland that is most commonly caused by a lack of iodine in the diet. *Diabetes* is a disorder in which the Islets of Langerhans in the pancreas do not secrete adequate amounts of insulin into the bloodstream and, as a result, the blood glucose level is elevated. Disorders in the pituitary gland may affect the release of growth hormone, resulting in a negative effect on a person's growth. Recent advances in recombinant DNA technology have allowed the synthesis of human growth hormone, as well as insulin. These hormones (made by genetically engineered bacteria) can be used to replace or supplement the inadequate amount of hormone being made by the person with the disorder.

Nervous System Disorders

Cerebral palsy is a group of diseases caused by damage to the parts of the brain that control voluntary movement. This damage occurs during embryonic development. *Meningitis* is an inflammation of the membranes that surround the brain and spinal cord. Meningitis may be caused by viral or bacterial infections, and symptoms include headache, muscle stiffness, fever, and chills. A *stroke* is a disorder in which the brain is damaged as a result of a *cerebral hemorrhage* (a broken blood vessel) or a blood clot (in a blood vessel) in the brain. *Polio* is a disease that affects the central nervous system; it may result in paralysis. Polio is caused by a virus and can be prevented by immunization. *Alzheimer's* is a degenerative disease in which neurons in the brain are gradually destroyed. This fatal illness generally strikes older people and begins with such symptoms as forgetfulness, mood swings, and unusual behavior. As the disease progresses, the person becomes less and less capable of handling simple daily tasks such as dressing, bathing, and eating on his or her own.