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تجميع هيكل الاحياء

تعليم

Identify the direction that impulses travel through a neuron

LESSON 1

STRUCTURE OF THE NERVOUS SYSTEM

FOCUS QUESTION

What are the structures and functions of a neuron?

Neurons

When you stub your toe, you know right away what happened. How does your brain get the message so quickly? Electricity and chemistry are both involved in getting messages to your brain. **Neurons** are specialized cells that help you gather information about your environment, interpret the information, and react to it. Neurons make up an enormous communication network in your body called the nervous system.

Figure 1 shows that a neuron consists of three main regions: the dendrites, a cell body, and an axon. **Dendrites** receive signals called impulses from other neurons and conduct the impulses to the cell body. Each neuron contains several dendrites. The nucleus of the neuron and many of the cell organelles are found in the **cell body.** Lastly, an **axon** carries the nerve impulse from the cell body to other neurons and muscles.

Get It?

Relate dendrites, axons, and cell bodies.

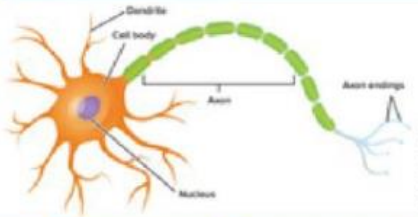

Figure 1 There are three main parts of a neuron: the dendrites, a cell body, and an axon. Neurons are highly specialized cells that are organized to form complex networks.

3D THINKING

COLLECT EVIDENCE

Use your Science Journal to record the evidence you collect as you complete the readings and activities in this lesson.

INVESTIGATE

GO ONLINE to find these activities and more resources.

BioLab: How do neural pathways develop and become more efficient?

Plan and carry out an investigation to determine the effect learning strategies have on a neural circuit.

Quick Investigation: Investigate the Blink Reflex

Carry out an investigation to determine the effect stimuli have on the blink reflex.

تعليم Differentiate between the central nervous system (CNS) and the peripheral nervous system (PNS) in terms of associated structures

Refer to **Figure 10**. The **cerebrum** (suh REE brum) is the largest part of the brain and is divided into two halves called hemispheres. The two hemispheres are not independent of each other; they are connected by a bundle of nerves. The cerebrum carries out thought processes involved with learning, memory, language, speech, voluntary body movements, and sensory perception. Most of these higher thought processes occur near the surface of the brain. The folds and grooves on the surface of the cerebrum, as shown in **Figure 10**, increase its surface area and allow more complicated thought processes.

Get It?
Explain the importance of the folds and grooves on the surface of the cerebrum.

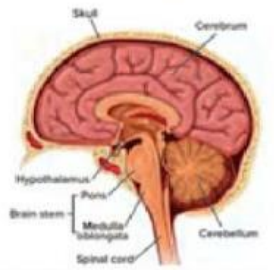

Figure 10 Top: A photograph of a human brain shows distinct sections. Bottom: The major sections of the brain are the cerebrum, the cerebellum, and the brain stem.
Describe the position of the cerebrum in relation to the cerebellum.

The Central Nervous System

The nervous system consists of two major divisions. The interneurons of the brain and the spinal cord make up the **central nervous system** (CNS). The **peripheral nervous system** (PNS) consists of the sensory neurons and motor neurons that carry information to and from the CNS.

The function of the CNS is the coordination of all the body's activities. It relays messages, processes information, and analyzes responses. When sensory neurons carry information about the environment to the spinal cord, interneurons might respond via a reflex arc, or they might relay this information to the brain. Some brain interneurons send a message by way of the spinal cord to motor neurons, and the body responds. Other neurons in the brain might store the information.

Get It?
Describe the function of the central nervous system.

The brain

Over 100 billion neurons are found in the brain. Because the brain maintains homeostasis and is involved with almost all of the body's activities, it is sometimes called the control center of the body. Refer to **Figure 9** on the next page to learn about important events that have led to understanding of the functions of the brain. For example, four thousand years ago surgeons drilled holes in people's skulls in an effort to reduce pressure on the brain after a head injury or to release "bad humors" from the heads of people who had a mental illness. Fast forward to 1981, and the first medication used to treat depression is available with a prescription. The noninvasive brain surgery first performed in 2009 has been used to treat patients with pain or uncontrollable tremors. Approximately 1,000 beams of ultrasound pass through the skull and are focused on a specific area of tissue.

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Identify the different sensory structures and their corresponding sensory receptors and stimuli

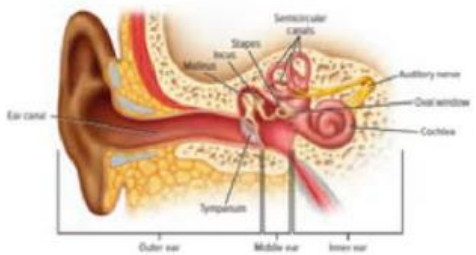

Figure 15 Sound waves cause the tympanum to vibrate, and the vibrations travel through the bones of the middle ear to the cochlea. Hair cells in the cochlea generate nerve impulses, which are sent to the brain through the auditory nerve.

Hearing

Vibrations called sound waves cause particles in the air to vibrate. **Figure 15** illustrates the path of sound waves as they travel through the ear.

PHYSICS Connection Sound waves enter the auditory, or ear, canal and cause a membrane, called the eardrum or tympanum, at the end of the ear canal to vibrate. These vibrations travel through three bones in the middle ear: the malleus (also called the hammer), the incus (anvil), and the stapes (stirrup). As the stapes vibrates, it causes the oval window, a membrane that separates the middle ear from the inner ear, to move back and forth. In the inner ear, a snail-shaped structure called the **cochlea** (KOH klee uh) is filled with fluid and lined with tiny hair cells. Vibrations cause the fluid inside the cochlea to move like a wave against the hair cells. The hairs cells respond by generating nerve impulses in the auditory nerve and transmitting them to the brain.

Got It?
Summarize how each sense organ detects changes in the environment.

Balance

The inner ear also contains organs for balance, including three semicircular canals. **Semicircular canals** transmit information about body position and balance to the brain. The three canals are positioned at right angles to one another, and they are fluid-filled and lined with hair cells. When the position of your head changes, fluid within the semicircular canals moves. This causes the hair cells to bend, which in turn sends nerve impulses to the brain. The brain then is able to determine your position and whether your body is still or in motion.

Identify the nephron as the functional unit of the kidney, to include its anatomy and function in waste excretion

The Kidneys

As shown in **Figure 18**, the **kidneys** are bean-shaped organs that filter out wastes, water, and salts from the blood. The kidneys are divided into two distinct regions, also illustrated in **Figure 18**. The outer portion is called the renal cortex and the inner region is called the renal medulla. Each of these regions contains microscopic tubes and blood vessels. In the center of each kidney is a region called the renal pelvis, where urine collection occurs. Follow **Figure 18** as you read about how the kidneys function.

Nephron filtration

Each kidney contains approximately one million filtering units called nephrons. Blood enters each nephron through a long tube that is surrounded by a ball of capillaries called the glomerulus (glah MER uh lus) (plural, glomeruli). The glomerulus is surrounded by a structure called the Bowman's capsule.

The renal artery transports nutrients and wastes to the kidney and branches into smaller and smaller blood vessels, eventually reaching the tiny capillaries in the glomerulus. The walls of the capillaries are very thin, and the blood is under great pressure. As a result, water and substances dissolved in the water, such as the nitrogenous waste product called **urea**, are pushed through the capillary walls into the Bowman's capsule. Larger molecules, such as red blood cells and proteins, remain in the bloodstream.

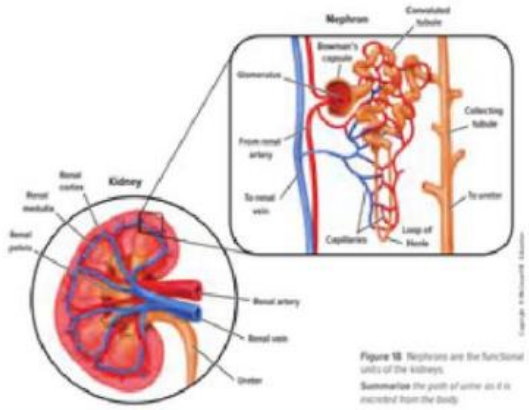

Figure 18 Nephrons are the functional units of the kidneys.

Summarize *the path of urine as it is excreted from the body.*

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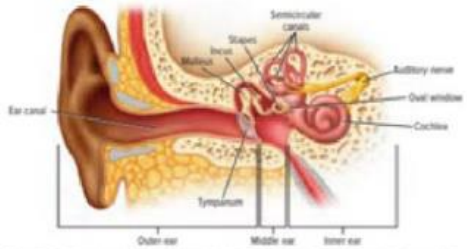
Identify the anatomy of the ear and function



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Identify the anatomy of the eye and function

Sight

Figure 14 shows the path of light as it travels through the eye. Light first enters the eye through a transparent, yet durable, layer of cells called the cornea. The cornea helps to focus the light through an opening called the pupil. The size of the pupil is regulated by muscles in the iris—the colored part of the eye. Behind the iris is the **lens,** which inverts the image and projects it onto the retina. The image travels through the vitreous humor, which is a colorless, gelatinlike liquid between the lens and the retina. The **retina** contains numerous receptor cells called rods and cones. **Rods** are light-sensitive cells that are excited by low levels of light. **Cones** function in bright light and provide information about color to the brain. These receptors send action potentials to the brain via the neurons in the optic nerve. The brain then interprets the specific combination of signals received from the retina and forms a visual image.

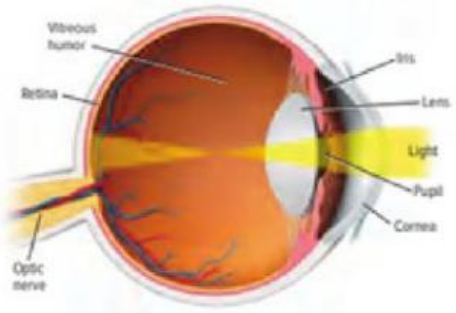

Figure 14 Light travels through the cornea and the pupil to the lens, which focuses the image on the retina. Rods and cones in the retina send information to the brain through the optic nerve.

Hearing and Balance

Hearing and balance are the two major functions of the ear. From a soft sound, such as whispering, to a loud sound, such as a crowd cheering at a sporting event, specialized receptors in the ear can detect both the volume and the highness and lowness of sounds. How can you stand on one foot without falling over? Canals in the inner ear are responsible for your sense of balance, or equilibrium. Receptors in the inner ear send messages to your brain about the position of your body and help you balance on one foot, even when your eyes are closed.

تعليم Differentiate between the types of sensory receptors in the skin (temperature, pressure, pain)

Touch

Many types of sensory receptors that respond to temperature, pressure, and pain are found in the epidermis and dermis layers of the skin. **Figure 16** illustrates the different types of receptors—some that respond to light touches and others that respond to heavy pressure. Notice that receptors that respond to light touches are just below the surface of the skin. Receptors that respond to deep pressure or vibrations are further below the skin's surface. Other receptors in the skin send signals when hair is moved.

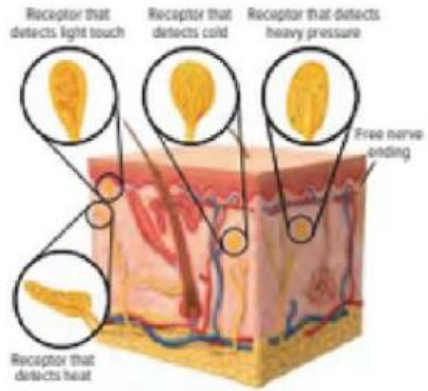

Figure 16 Many types of receptors are found in the skin. A person can tell if an object is hot or cold, sharp or smooth.

Distribution of receptors is not uniform in all areas of the body. The tips of the fingers have many receptors that detect light touch. The soles of the feet have many receptors that respond to heavy pressure. Pain receptors are simple, consisting of free nerve endings that are found in all tissues of the body except the brain. Pain receptors respond to external stimili, such as extreme hot or cold temperatures, as well as to internal stimuli, such as chemicals released by injured cells, making the area more sensitive to painful stimulation. The brain constantly receives signals from these receptors and responds appropriately.

تعليم

Explain the main structure and function of the excretory system

LESSON 3

THE EXCRETORY SYSTEM

FOCUS QUESTION

Can exercise affect the excretory system?

Parts of the Excretory System

As you breathe, eat, walk, study, and sleep, your body collects wastes. These wastes include toxins, waste products, and carbon dioxide, that result from metabolic functions that occur in your body constantly and without you thinking about it.

What happens to all of these wastes? The excretory system removes them from the body. In addition, the excretory system regulates the amount of fluid and salts in the body, and it maintains the pH of the blood. All of these functions help to maintain homeostasis.

The components that make up the excretory system include the lungs, skin, and kidneys, as illustrated in **Figure 17**. The lungs primarily excrete carbon dioxide. The skin primarily excretes water and salts contained in sweat. The kidneys, however, are the major excretory organs in the body. The kidneys filter wastes and other substances from the blood. The ureters carry urine produced in the kidneys to the bladder. Urine exits the body through the urethra.

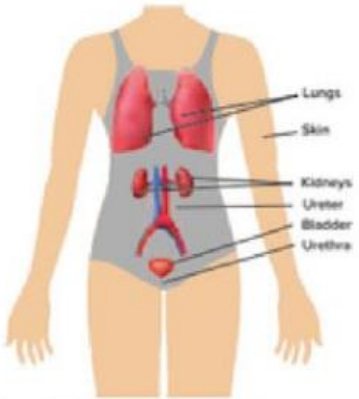

Figure 17 The organs of excretion work together to eliminate wastes from the body. These organs include the lungs, skin, and kidneys.

Get It?

Identify the components of the excretory system.

تعليم

Identify the anatomy of the kidney.

The Kidneys

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Each kidney contains approximately one million filtering units called nephrons. Blood enters each nephron through a long tube that is surrounded by a ball of capillaries called the glomerulus (gluh MER uh lus) (plural, glomeruli). The glomerulus is surrounded by a structure called the Bowman's capsule.

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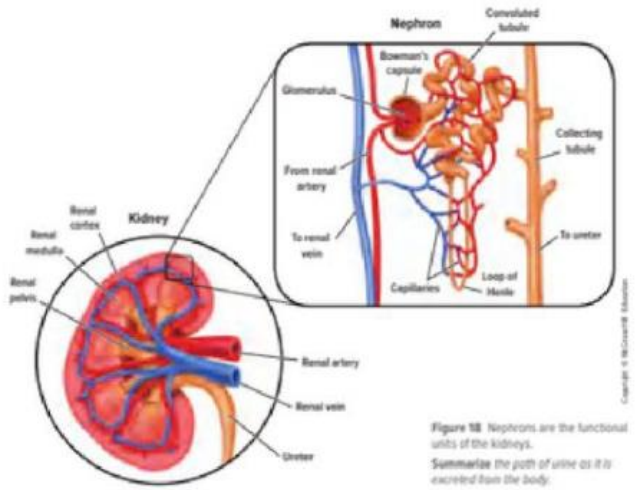

Figure 18 Nephrons are the functional units of the kidneys.

Summarize *the path of urine as it is excreted from the body.*

تعليم

Compare and contrast, using visuals, the two different types of hormone actions: Steroid hormones and amino acid hormones

Actions of Hormones

The endocrine system is composed of glands and functions as a communication system. **Endocrine glands** produce hormones, which are released into the bloodstream and distributed to body cells. A **hormone** is a substance that acts on certain target cells and tissues to produce a specific response. Hormones are classified as steroid hormones and nonsteroid or amino acid hormones, based on their structure and mechanism of action.

Steroid hormones

Estrogen and testosterone are two examples of steroid hormones. All steroid hormones work by causing the target cells to initiate protein synthesis, as illustrated in **Figure 13**.

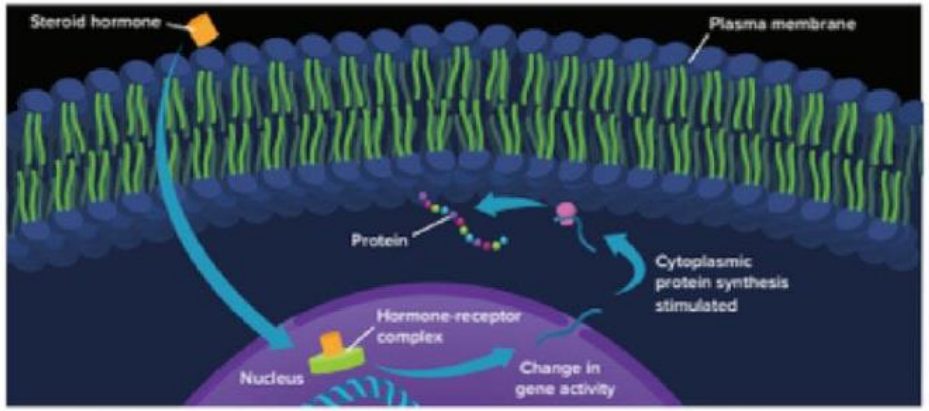

Figure 13 A steroid hormone passes through a cell membrane, binds to a receptor within the cell, and stimulates protein synthesis.

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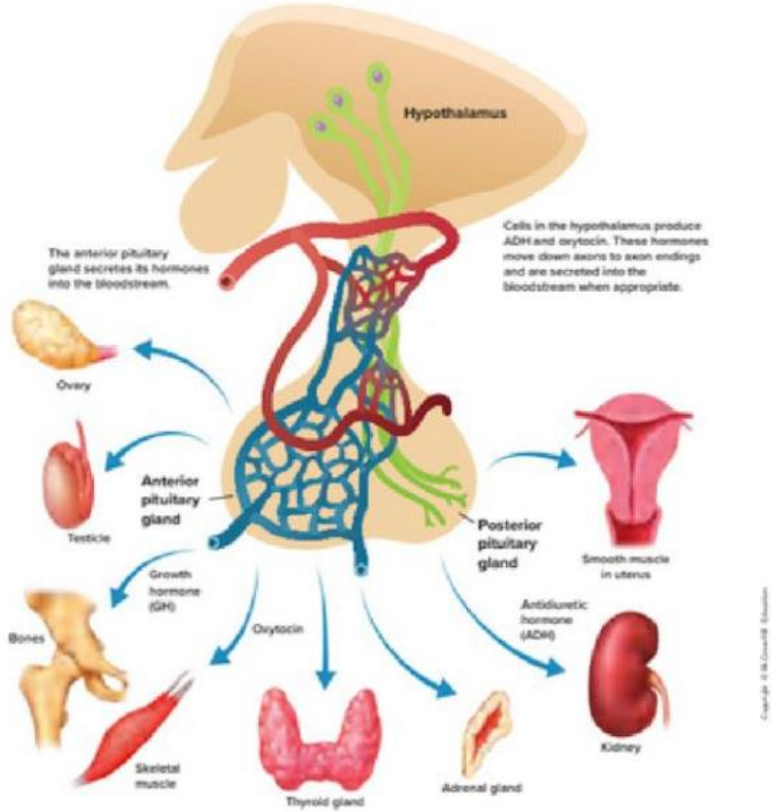
Identify the major glands of the endocrine system and their related hormones

Figure 20 Visualizing the Endocrine System

The hypothalamus maintains homeostasis by serving as a link between the nervous system and the endocrine system. The pituitary gland releases growth hormone, ADH, and oxytocin as needed by the body. The pituitary gland also manufactures and secretes hormones that regulate the testes, the ovaries, and the thyroid and adrenal glands.



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Describe the three types of neurons (sensory, motor, and interneurons) and their involvement in the reflex arc

Figure 2 A simple reflex involves a sensory neuron, an interneuron, and a motor neuron. Interneurons can also carry impulses to the brain.
Explain *how a reflex might be completed before the brain interprets the event.*

There are three kinds of neurons: sensory neurons, interneurons, and motor neurons. Sensory neurons send impulses from receptors in the skin and sense organs to the brain and spinal cord. Sensory neurons signal interneurons, which are found in the spinal cord and brain. Interneurons carry the impulse to motor neurons, which carry impulses away from the brain and spinal cord to a gland or muscle, which results in a response. Refer to **Figure 2** to follow the path of an impulse for a simple involuntary reflex. The nerve impulse completes what is called a reflex arc. A **reflex arc** is a nerve pathway that consists of a sensory neuron, an interneuron, and a motor neuron. Notice that the brain is not involved. A reflex arc is a basic structure of the nervous system.

A Nerve Impulse

PHYSICS Connection A nerve impulse is an electrical charge traveling the length of a neuron. An impulse results from a stimulus, such as a touch or a loud bang, which causes a person to react.

A neuron at rest

The neuron in **Figure 3** is at rest, which means it is not conducting an impulse. Notice that there are more sodium ions (Na^+) outside the cell than inside the cell. The reverse is true for potassium ions (K^+)—there are more potassium ions inside the cell than outside the cell.

Figure 3 The distribution of Na^+ and K^+ ions, and the presence of negatively charged protein molecules in the cytoplasm, keep the inside of the cell more negatively charged than the outside when a neuron is at rest.

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Explain how a nerve impulse is transmitted through the neuron and through the synapse between the three types of neurons

Recall that ions tend to diffuse across the plasma membrane from an area of high concentration of ions to an area of low concentration of ions. Proteins found in the plasma membrane work to counteract the diffusion of the sodium ions and potassium ions. These proteins, called the sodium-potassium pump, actively transport sodium ions out of the cell and potassium ions into the cell.

For every two potassium ions pumped into a neuron, three sodium ions are pumped out. This maintains an unequal distribution of positively charged ions, resulting in a positive charge outside the neuron and a negatively charged cytoplasm inside the neuron.

An action potential

Another name for a nerve impulse is an **action potential.** The minimum stimulus to cause an action potential to be produced is a **threshold.** However, a stronger stimulus does not generate a stronger action potential. Action potentials are described as being "all or nothing," meaning that a nerve impulse is either strong enough to travel along the neuron or it is not strong enough.

When a stimulus reaches the threshold, channels in the plasma membrane open. Sodium ions rapidly move into the cytoplasm of the neuron through these channels, causing a temporary reversal in electrical charges. The inside of the cell then has a positive charge, which causes other channels to open. Potassium ions leave the cell through these channels, restoring a positive charge outside the cell. **Figure 4** shows that this change in charge moves like a wave along the length of the axon.

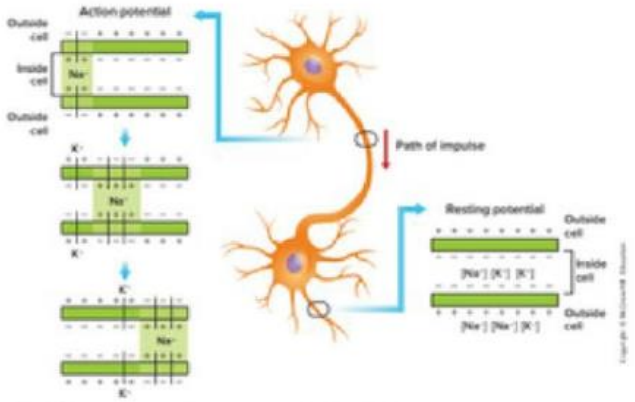

Figure 4 Follow as an action potential moves along an axon from left to right. Notice what happens to the

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Differentiate between the two types of sensory receptors in the eye (rods and cones)

Sight

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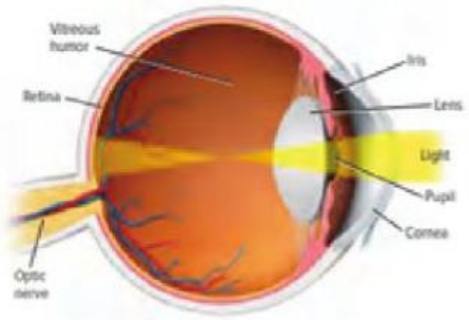

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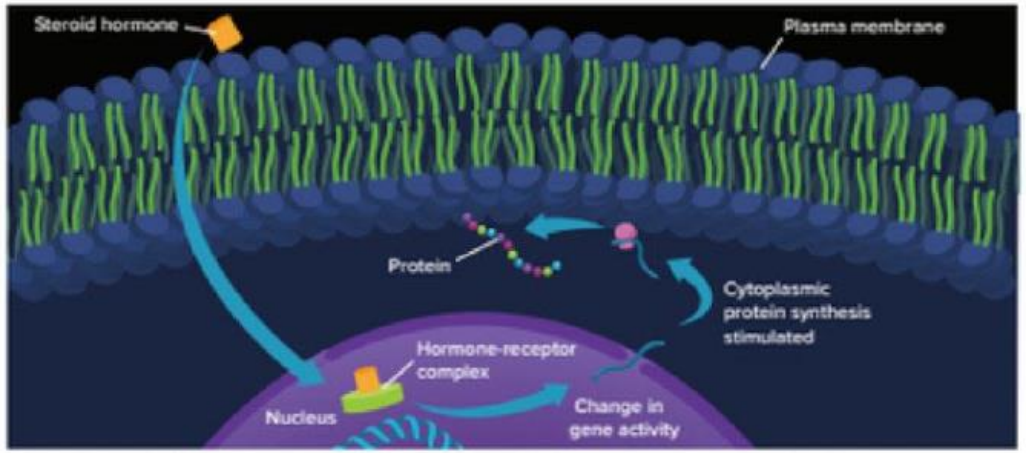

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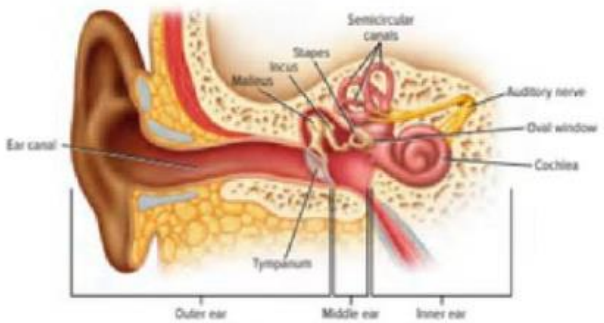
Identify the anatomy of the ear and function



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Differentiate between the central nervous system (CNS) and the peripheral nervous system (PNS) in terms of associated structures and functions.

Refer to **Figure 12** as you read about the peripheral nervous system. This system includes all neurons that are not part of the central nervous system, including sensory neurons and motor neurons. Neurons in the peripheral nervous system can be classified further as being either part of the somatic nervous system or part of the autonomic nervous system.

The somatic nervous system

Nerves in the **somatic nervous system** relay information from external sensory receptors to the central nervous system. Somatic motor nerves relay information from the central nervous system to skeletal muscles. Usually, this is voluntary. However, not all reactions of the central nervous system are voluntary. Some responses are the result of a reflex, which is a fast response to a change in the environment. Reflexes do not require conscious thought and are involuntary. Most signals in reflexes go only to the spinal cord and not to the brain. Remember the example of someone putting their hand near a hot stove burner? Refer to **Figure 2** in Lesson 1, and note that the illustrated reflex is part of the somatic nervous system.

The autonomic nervous system

Remember the last time you had a scary dream? You might have awakened and realized that your heart was pounding. This type of reaction is the result of the action of the autonomic nervous system. The **autonomic nervous system** carries impulses from the central nervous system to the heart and other internal organs. The body responds involuntarily, not under conscious control. The autonomic nervous system is important in two different kinds of situations. When you have a nightmare or find yourself in a scary situation, your body responds with what is known as a fight-or-flight response. When everything is calm, your body rests and digests.

Get It?

Explain why the nervous system is essential to the human body.

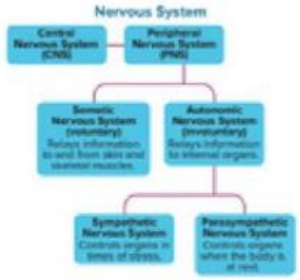

Figure 12 Each division of the nervous system functions in the control of the body and the communication within the body.

تعليم

Identify the anatomy of the kidney.

The Kidneys

As shown in **Figure 18**, the **kidneys** are bean-shaped organs that filter out wastes, water, and salts from the blood. The kidneys are divided into two distinct regions, also illustrated in **Figure 18**. The outer portion is called the renal cortex and the inner region is called the renal medulla. Each of these regions contains microscopic tubes and blood vessels. In the center of each kidney is a region called the renal pelvis, where urine collection occurs. Follow **Figure 18** as you read about how the kidneys function.

Nephron filtration

Each kidney contains approximately one million filtering units called nephrons. Blood enters each nephron through a long tube that is surrounded by a ball of capillaries called the glomerulus (gluh MER uh lus) (plural, glomeruli). The glomerulus is surrounded by a structure called the Bowman's capsule.

The renal artery transports nutrients and wastes to the kidney and branches into smaller and smaller blood vessels, eventually reaching the tiny capillaries in the glomerulus. The walls of the capillaries are very thin, and the blood is under great pressure. As a result, water and substances dissolved in the water, such as the nitrogenous waste product called **urea**, are pushed through the capillary walls into the Bowman's capsule. Larger molecules, such as red blood cells and proteins, remain in the bloodstream.

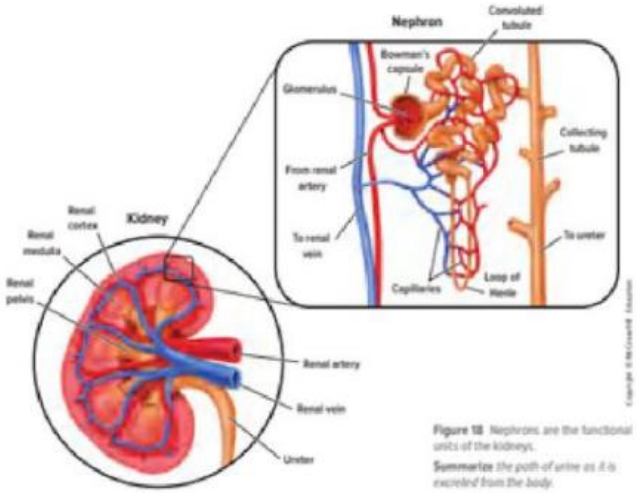

Figure 18 Nephrons are the functional units of the kidneys.

Summarize *the path of urine as it is excreted from the body.*

تعليم

Explain how negative feedback is important in maintaining homeostasis

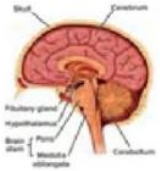

Figure 17 The pituitary gland is located at the base of the brain.

Pituitary gland

The pituitary gland is situated at the base of the brain, as illustrated in **Figure 17**. This gland is sometimes called the "master gland" because it regulates so many body functions. Despite its small size, it is the most important endocrine gland. The **pituitary gland** secretes hormones that regulate many body functions. It also regulates other endocrine glands, such as the thyroid gland, adrenal glands, testes, and ovaries.

Several pituitary hormones act on tissues in the body rather than on specific organs. Human growth hormone (hGH) regulates the body's physical growth by stimulating cell division in muscle and bone tissue. This hormone is especially active during childhood and adolescence.

Thyroid and parathyroid glands

Identify the thyroid and parathyroid glands in **Figure 18**. One hormone produced by the thyroid gland is thyroxine. Like hGH, **thyroxine** does not act on specific organs; rather, it causes cells of the body to have a higher rate of metabolism. The thyroid gland also produces calcitonin. **Calcitonin** (kal suh TOH nun) is a hormone that is partly responsible for the regulation of calcium, an important mineral for bone formation, blood clotting, nerve function, and muscle contraction. Calcitonin lowers blood calcium levels by signaling bones to increase calcium absorption and also signaling the kidneys to excrete more calcium.

When blood calcium levels are too low, the parathyroid glands increase production of parathyroid hormone. **Parathyroid hormone** increases blood calcium levels by stimulating the bones to release calcium. The action of this hormone also causes the kidneys to reabsorb more calcium and the intestines to absorb more calcium from food. The thyroid and parathyroid glands have opposite effects on blood calcium levels. However, as they work together, they maintain homeostasis.

Get It?

Explain how negative feedback is important in maintaining homeostasis.

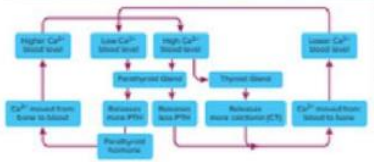

Figure 18 Parathyroid hormone (PTH) and calcitonin (CT) regulate the level of calcium in the blood.

Explain *how PTH and CT illustrate negative feedback.*

تعليم

Identify the major glands of the endocrine system and their related hormones

Pancreas

As discussed in Lesson 1, the pancreas has a crucial role in the production of enzymes that digest carbohydrates, proteins, and fats. The pancreas also secretes the hormones insulin and glucagon, which work together to maintain homeostasis, as illustrated in **Figure 19**. When blood glucose levels are high, the pancreas releases insulin. **Insulin** signals body cells, especially liver and muscle cells, to accelerate the conversion of glucose to glycogen, which is stored in the liver. When blood glucose levels are low, glucagon is released from the pancreas. **Glucagon** (GLEW kuh gahn) binds to liver cells, signaling them to convert glycogen to glucose and release the glucose into the blood.

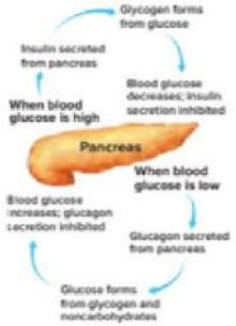

Figure 19 Glucagon and insulin work together to maintain the level of sugar in the blood.

Diabetes is a disease that results from the body not producing enough insulin or not properly using insulin. Type 1 diabetes, which usually appears in people by the age of 20, occurs when the body cannot produce insulin. Type 2 diabetes occurs in 70–80 percent of people diagnosed with diabetes, and usually occurs after the age of 40. It results from the cells of the body becoming insensitive to insulin. In both types of diabetes, the blood glucose levels must be monitored and maintained to prevent complications from the disease.

Adrenal glands

Refer again to **Figure 16**. The adrenal glands are located just above the kidneys. The outer part of the adrenals is called the cortex, which manufactures the steroid hormone aldosterone and a group of hormones called glucocorticoids. **Aldosterone** (al DAWS tuh rohn) primarily affects the kidneys and is important for reabsorbing sodium. **Cortisol,** another glucocorticoid, raises blood glucose levels and also reduces inflammation.

The body has different mechanisms for responding to stress, such as the role of the nervous system and the "fight or flight response." The endocrine system also is involved with these types of responses. During a stressful situation the inner portions of the adrenal glands secrete epinephrine (eh puh NEH frun) and norepinephrine. Together, these hormones increase heart rate, blood pressure, breathing rate, and blood sugar levels, all of which are important in increasing the activity of body cells.