Inspire Biology grade 9 adv تجميع هيكل

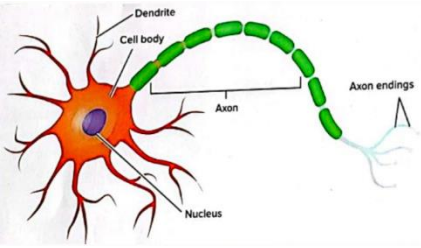
Chapter 5

G9. Module 23 Nervous system

Lesson 1: Structure of the nervous system

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**.



➢ **Neuron consist of 3 main regions:**

1. **Dendrite.**
2. **A cell body.**
3. **An axon.**

1) Dendrite:

Receive signals called impulses from other neurons and conduct the impulses to the cell body.

2) Cell body:

The nucleus of the neuron and many of the cell organelles are found in it.

3) Axon:

An axon carries the nerve impulse from the cell body to other neurons and muscles.

➢ **There are 3 kinds of neurons:**

1- **Sensory neurons.**
2- **Interneurons "found in the brain and spinal cord".**
3- **Motor neurons.**

1) Sensory neurons:

Send impulses from receptors in the skin and sense organs to the brain and spinal cord *Signal **interneurons**"

2) Interneurons:

Carry the impulse to **motor neurons**.

3) Motor neurons:

Carry impulses **away from** the brain and spinal cord **to** a gland or muscle, which result in a **response.**

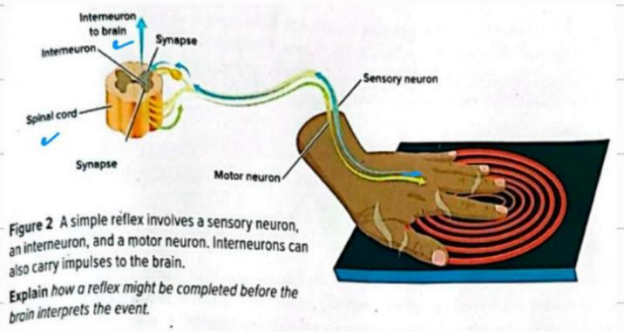


Figure 2 A simple reflex involves a sensory neuron, an interneuron, and a motor neuron. Interneurons can also carry impulses to the brain.

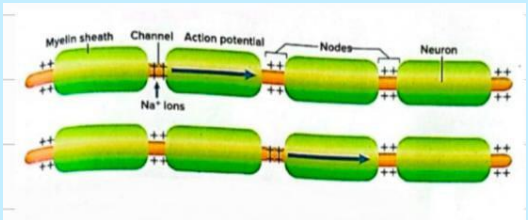
Explain *how a reflex might be completed before the brain interprets the event.*

The nerve impulse completes what is called a reflex arc.

Reflex arc: is a nerve pathaway that consists of a sensory neuron, an interneuron "spinal cord only" and motor neuron.

- **Notice that the brain isn't involved.**
- **A reflex arc is a basic structure of the nervous system.**

Speed of an action potential:

Axon with myelin sheath	Axon without myelin sheath
▪ Many axons have a covering of a lipid, insulating layer called a sheath, The myelin sheath has many gaps called **nodes** ▪ Sodium ions and potassium ions cannot diffuse through myelin, they can reach the plasma membrane at these nosed this allows the action potential to **jump** from node to node ⟶ **greatly increasing the speed of the impulse** ▪ Neurons that have myelin carry impulses that are associated with sharp pain. 	▪ Axon **without** myelin sheath **slower than** axons **with** myelin sheath. ▪ So, axons **without** myelin sheath **associated with dull, throbbing pain**

The synapse:

A small gap exists between the axon of one neuron and the dendrite of another neuron.

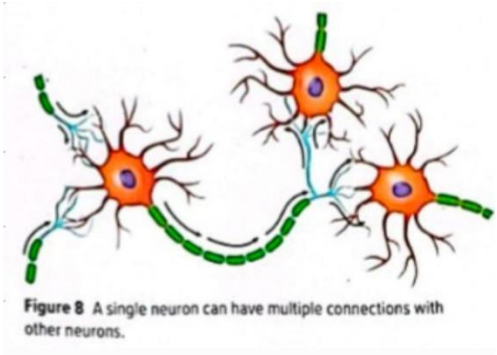


Figure 8 A single neuron can have multiple connections with other neurons.

1. When an action potential reaches the end of an axon, small sacs called vesicles carrying neurotransmitter fuse with the plasma membrane and release a neurotransmitter by exocytosis.
2. When a motor neuron synapses with a muscle cell, the released neurotransmitter crosses the synapse and causes a muscle to contract.

Lesson 2: organization of the nervous system

- **The brain:** called **control centre of the body** because the brain maintains homeostasis, and involved with almost all of the body's activities.

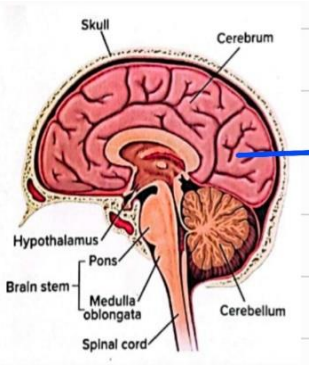
  - **The cerebrum:** is the **largest** part of the brain, and is divided into two halves called **hemispheres.**

  The 2 hemispheres are **connected by nerves.**

Function of cerebrum:

- Carries out **thought processes** involved with
- Learning
- Memory
- Language
- Speech
- Voluntary body movements
- Sensory perception

Folds and grooves on the surface of cerebrum increase it's surface area and allows more complicated thought processes.



❖ **The cerebellum:** located at the back of the brain

Function of cerebellum:

- Controls balance, posture and coordination
- Responsible for the smooth and coordinated movement of skeletal muscles.
- Involved with motor skills, such as playing the piano or riding a bike.

❖ **The brain stem:** connects the brain and spinal cord

Pons **Medulla oblongata**

Medulla oblongata	Pons
▪ Relays signals between the brain and the spinal cord. ▪ It helps control breathing rate, heart rate, blood pressure rate. ▪ responsible for the swallowing, gagging, vomiting, coughing, and sneezing.	▪ Relays signals between the cerebrum and the cerebellum. ▪ It helps control beathing rate.

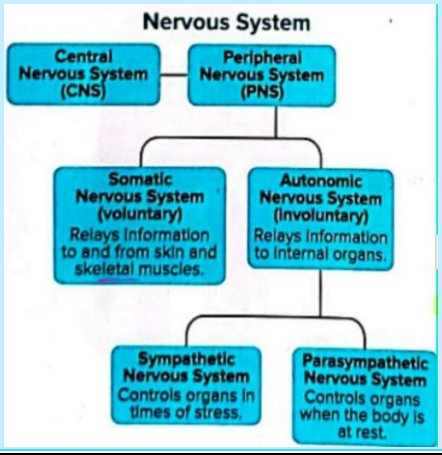
❖ **The hypothalamus:**

Function:

- Essential for maintaining homeostasis
- Regulates body temperature, thirst, appetite and water balance.
- Partially regulates: blood pressure, sleep, aggression fear, and sexual behaviour.

➢ Hypothalamus Is about the size of **fingernail** and **performs more functions than any brain region.**

The somatic nervous system	Autonomic nervous system
▪ Relays information to and from **skin** and **skeletal muscle.** ▪ Usually this is **voluntary**, but not reactions of the central nervous system are voluntary, some responses are **involuntary, result of a reflex.**	▪ Carries impulses **from** the **central nervous system to** the **heart** and other **internal organs.** ▪ The body responds **involuntarily**, not under conscious control. ▪ 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.** **There are two branches of the autonomic nervous system, and they act together.** 1. **Sympathetic nervous system.** 2. **The parasympathetic nervous system.**



Lesson 3: The senses

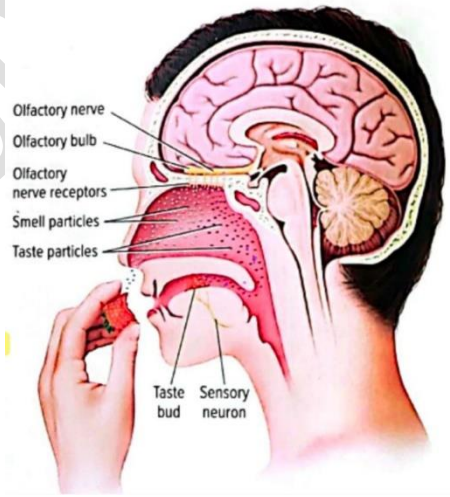
Specialized sensory receptors enable you to:

1. **Taste and smell**
2. **Sight**
3. **Hearing and Balance**
4. **Touch**

➢ Taste and smell:

the receptors associated with taste and smell function together, and signals from the receptors that work together to create a combined effect in the brain.

- Specialized receptors located high in the nose respond to chemicals in the air and send the information to the **olfactory bulb** in the brain.
- **Taste buds:** are areas of specialized chemical receptors on the tongue that detect the tastes of sweet, sour, salty ...

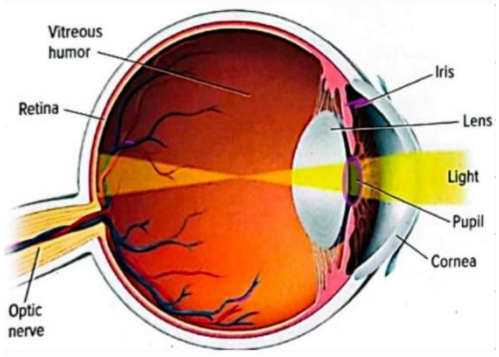


➢ Sight:

a) light first enters the eye through a cornea.
Cornea: transparent, yet durable layer of cells.

b) the cornea focuses the light through the pupil.
pupil: an opening in the eyes.

c) the size of the pupil is regulated by the iris.
iris: the coloured part of the eye.



d) Behind the iris is the lens.

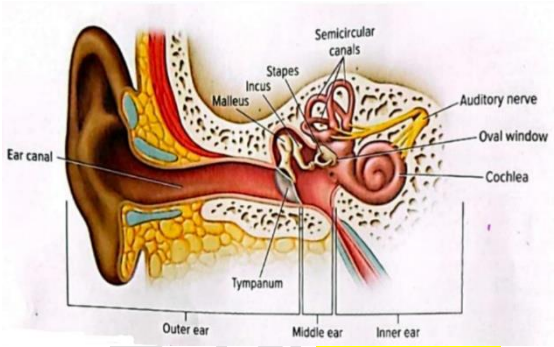
e) the lens inverts the image onto the retina through the vitreous humour.
Vitreous humour: colourless, gelatine like liquid between the lens and the retina.

f) the retina contains rods and cons.
rods: are light sensitive cells, exited by low levels of light.
Cones: function in bright light, and provide information about colour to the brain.

g) **these receptors "rods and cones" send action potential to the brain via the neurons in the optic nerve.**

h) **the brain then interprets the specific signals and forms a visual image.**

➢ Hearing and Balance:



Hearing and balance are two major functions of the ear.

Hearing:

1. Vibrations called sound waves cause particles in the air to vibrate.
2. sound waves enter the **auditory, or ear canal** and cause a membrane called **ear drum or tympanum** at the end of the ear canal to vibrate.
3. these vibrations travel through **three bones in the middle ear**. (The malleus (hammer), the incus (anvil) and the stapes (stirrup))
4. when the stapes vibrations, it causes the **oval window** to move back and forth.

Oval window: a membrane that separates the middle ear from the inner ear.

5. in the inner ear, a snail shape called **cochlea** is filled with fluid and lined with tiny hair cells.
6. vibration causes the fluid inside the cochlea to move.
7. the tiny hair cells transmit impulses in the auditory nerve in the brain.

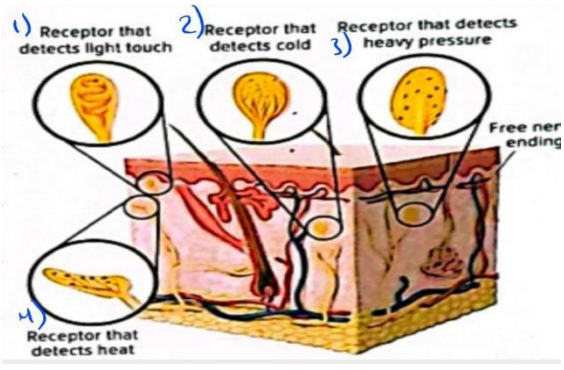
Balance:

Three **semi-circular canals** transmit information about body position and balance to the brain.

- The brain then is able to determine your position and whether your body is still or in motion.

➢ Touch:

Receptors found in the epidermis and dermis layers respond to temperature, pressure, and pain.



Lesson 4: Effects of Drugs

How do drugs work?

Drug: is substance, natural and artificial that alters the function of the body.

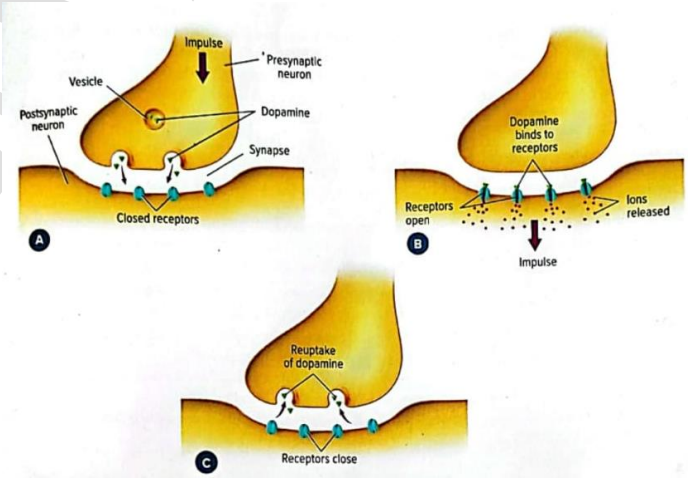
Drugs that affect the nervous system work in one or more of the following ways:

1) A drug can cause an increase in the amount of neurotransmitter that is released into a synapse.
2) A drug can block a receptor site on a dendrite, preventing a neurotransmitter from binding.
3) A drug can prevent a neurotransmitter from leaving a synapse.
4) A drug can imitate a neurotransmitter.

Alcohol	Caffeine	Prescription Drugs	Over-the-Counter Drugs	Tobacco
				
beer, wine	coffee, tea, soda, chocolate	antibiotics, pain medications	aspirin, cold medications	cigarettes, cigars

Many drugs that affect the nervous system influence the level of a neurotransmitter called **dopamine.**

Dopamine: is a neurotransmitter found in the brain that is involved with the control of body movements, and involved with feelings of pleasure or reward.



Classes of commonly Abused drugs:

Stimulants	Depressants
▪ Drugs that increase alertness and physical activity are stimulants. 1) Nicotine: in a cigarette increase the amount of dopamine. - Constricts blood vessels. - Raising blood pressure. - Causing the heart to work harder than normal. - Cause lung cancer. 2) Caffeine: found in coffee, Tea, Chocolate… - Caffeine binding to adenosine receptors in the brain. - Adenosine slows down neural activity, causing drowsiness. - When caffeine binds to adenosine receptors, it has opposite effect that makes users feels awake and alert. - Caffeine increases adrenaline levels in the body temporarily.	▪ Drugs thar slow down the central nervous system are depressants. ▪ These drugs can lower blood pressure, interrupt breathing and slow the heart rate. ▪ Relieve anxiety and can cause effect of sedation. 1) Alcohol: produces by the fermentation of grains and fruits. - Alcohol results in feeling of relaxation and sluggishness. - Short-term alcohol use impairs judgment, coordination and reaction time. - Long-term effects of alcohol include a reduction brain mass, liver damage, stomach and intestinal ulcer, and high blood pressure. 2) Inhalants: are chemical fumes that have influence on the nervous system. - Short-term effect of intoxication, nausea and vomiting. - Long-term cause memory loss, hearing loss, vision problems and brain damage.

The Excretory system

Parts of the Excretory System

What happens to the wastes in our bodies?

1- The excretory system removes them from the body.
2- In addition, the excretory system regulates the amount of fluid and salts in the body.
3- It maintains the pH of the blood.

All of these functions help to maintain homeostasis.

The components that make up the excretory system include:

1- **Lungs** 2- **Skin** 3- **kidneys**

As illustrated in Figure,

1. The lungs primarily excrete carbon dioxide.
2. The skin primarily excretes water and salts contained in sweat.
3. The kidneys, are the major excretory organs in the body.
   a) The kidneys filter wastes and other substances from the blood.
   b) The ureters carry urine produced in the kidneys to the bladder.
   c) Urine exits the body through the urethra.

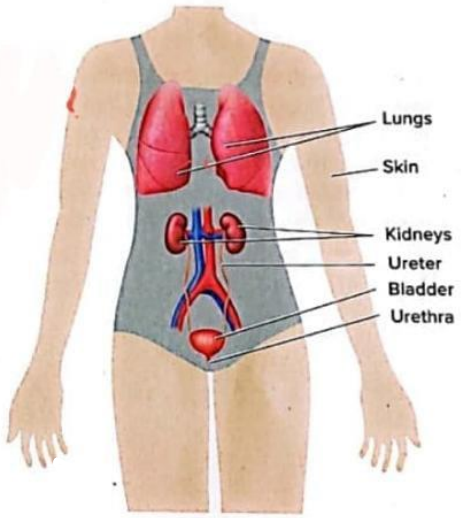


Figure 17 The organs of excretion work together to eliminate wastes from the body. These organs include the lungs, skin, and kidneys.

The Kidneys

kidneys are bean-shaped organs that filter out wastes, water, and salts from the blood.
The kidneys are divided into two distinct regions, 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.

Nephron filtration

Each kidney contains approximately **one million** filtering units called **nephrons**.

1- Blood enters each nephron through the **glomerulus**, The glomerulus is surrounded by a structure called the **Bowman's capsule**.
2- 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.
3- The walls of the capillaries are very thin, and the blood is under great pressure.

4- 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.

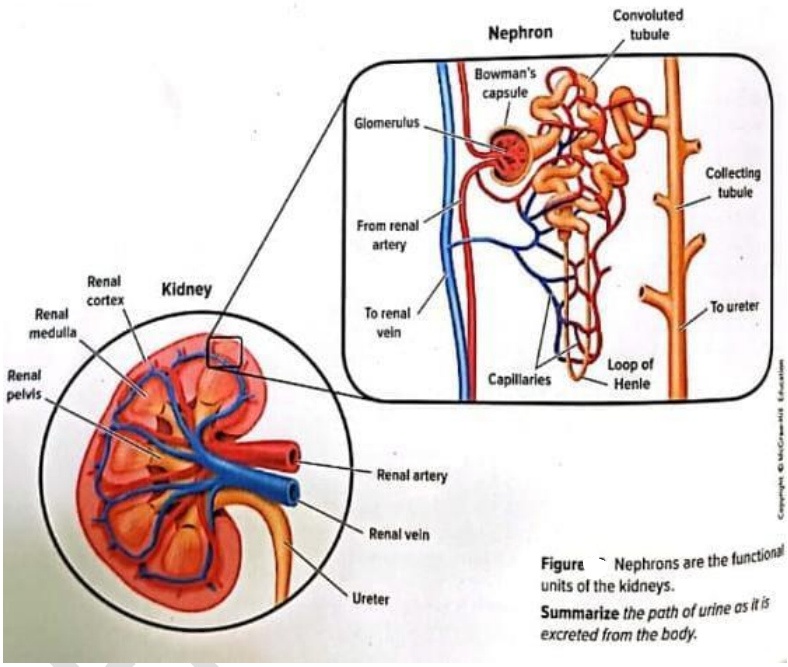


Figure Nephrons are the functional units of the kidneys.
Summarize *the path of urine as it is excreted from the body.*

Reabsorption and the formation of urine

Much of the lost water and useful substances, such as glucose and minerals, are reabsorbed into the capillaries surrounding the renal tubule. This process is called **reabsorption.**
At the same time, excess fluids and toxic substances in the capillaries are passed to the **collecting tubules.** This waste product is called **urine,** Urine leaves the kidney through ducts called the **ureters**, Urine is then stored in the **urinary bladder** and exits the body through the **urethra**.
The kidneys filter about 180 L of blood each day in adults but produce only about 1.5 L of urine. The processes of filtration and reabsorption from the blood require large amounts of energy, they use 20 to 25 percent of the body's oxygen.
Because biological processes normally require pH between 6.5 and 7.5, the kidneys help to maintain homeostasis by keeping pH levels within the normal range.

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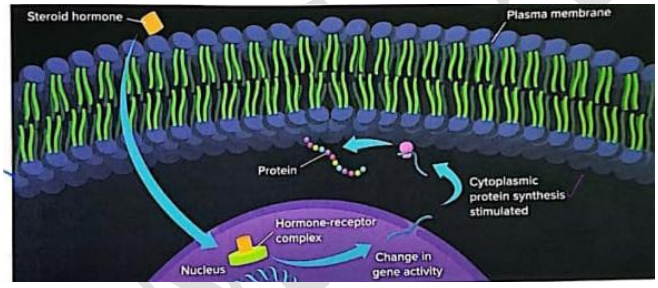
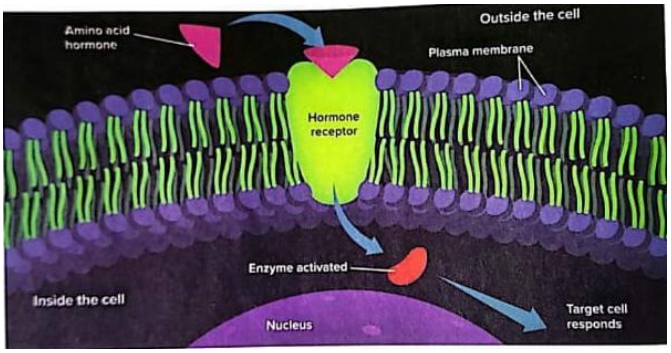
Lesson 1: THE ENDOCRINE SYSTEM

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	Nonsteroid hormones (Amino acid hormones)
1. Estrogen and testosterone are two examples of steroid hormones. 2. All steroid hormones work by causing the target cells to initiate protein synthesis. 3. Steroid hormones are soluble in lipids and therefore **can diffuse through the plasma membrane** of a target cell. 4. Once inside a target cell, they bind to a receptor in the cell, The hormone and the receptor that are bound together bind to DNA in the nucleus, which activates specific genes. https://youtu.be/m9jOXiYdMeY  **Figure** A steroid hormone passes through a cell membrane, binds to a receptor within the cell, and stimulates protein synthesis.	1. Insulin and growth hormones are two examples of nonsteroid, or amino acid, hormones. As the name implies. 2. these hormones are composed of amino acids. 3. Amino acid hormones must bind to receptors found on the plasma membrane of a target cell because they **cannot diffuse through the plasma membrane.** 4. Once the hormone binds to the receptor, the receptor activates an enzyme found on the inside of the membrane. 5. This usually initiates a biochemical pathway, eventually causing the cell to produce the desired response.  **Figure** An amino acid hormone binds to a receptor on the plasma membrane before entering the cell. Explain the difference between amino acid hormones and steroid hormones.

Endocrine Glands and Their Hormones

The endocrine system includes all the glands that secrete hormones pituitary, thyroid, parathyroid, adrenal glands, pancreas, ovaries, testes.

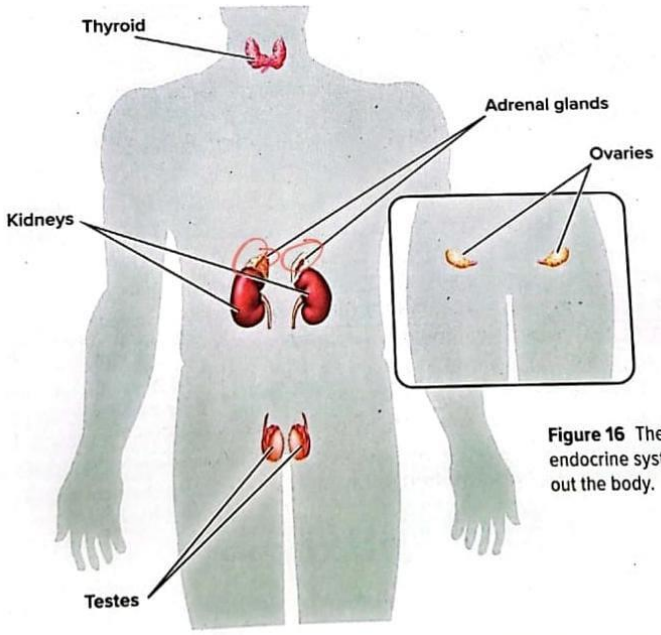


Figure 16 The principal glands of the endocrine system are located throughout the body.

Pituitary gland (master gland)

The pituitary gland is situated at the base of the brain.
This gland is sometimes called the "master gland" because it regulates so many body functions.

1- The **pituitary gland** secretes hormones that regulate many body functions.
2- It also regulates other endocrine glands, such as the thyroid gland, adrenal glands, testes, and ovaries.

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.

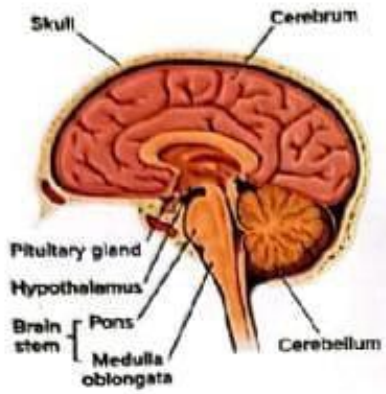


Figure 17 The pituitary gland is located at the base of the brain.

Thyroid (Thyroxine hormone- Calcitonin hormone) and Parathyroid glands (Parathyroid hormone)

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.

Calcitonin (CT)	Parathyroid hormone (PTH)
▪ The thyroid gland also produces calcitonin ▪ **Calcitonin** is a hormone that is partly responsible for the regulation of calcium. ▪ 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 or 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.	

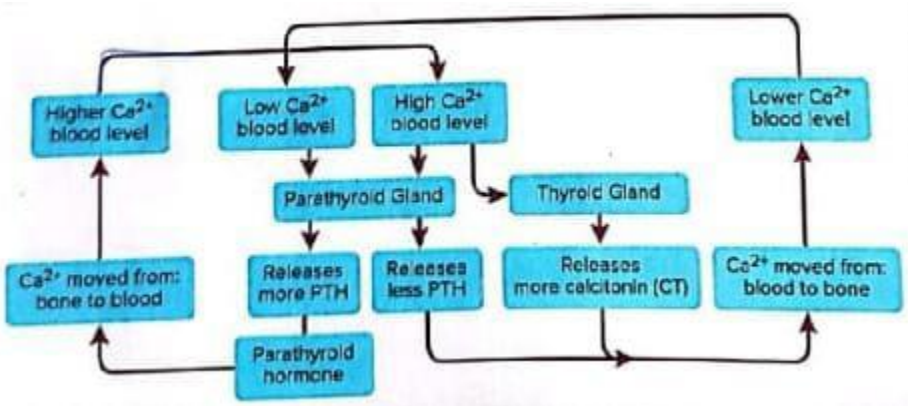


Figure 18 Parathyroid hormone (PTH) and calcitonin (CT) regulate the level of calcium in the blood.

Explain *how PTH and CT illustrate negative feedback.*

Pancreas
- Secrets enzymes (digestive system)
- Secrets enzymes (digestive system)

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.

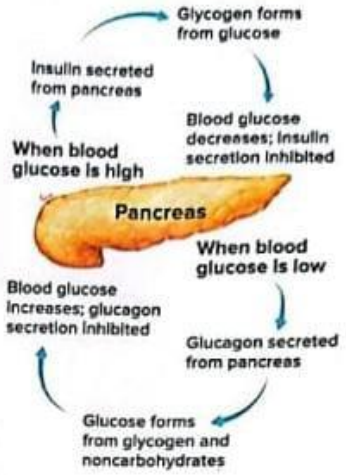


Figure 19 Glucagon and insulin work together to maintain the level of sugar in the blood.

Insulin	glucagon
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** binds to liver cells, signaling them to convert glycogen to glucose and release the glucose into the blood.

Diabetes is a disease that results from the body not producing enough insulin or not properly using insulin.

1- Type 1 diabetes, which usually appears in people by the age of 20, occurs when the body cannot produce insulin.
2- 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.

Hormones of adrenal gland

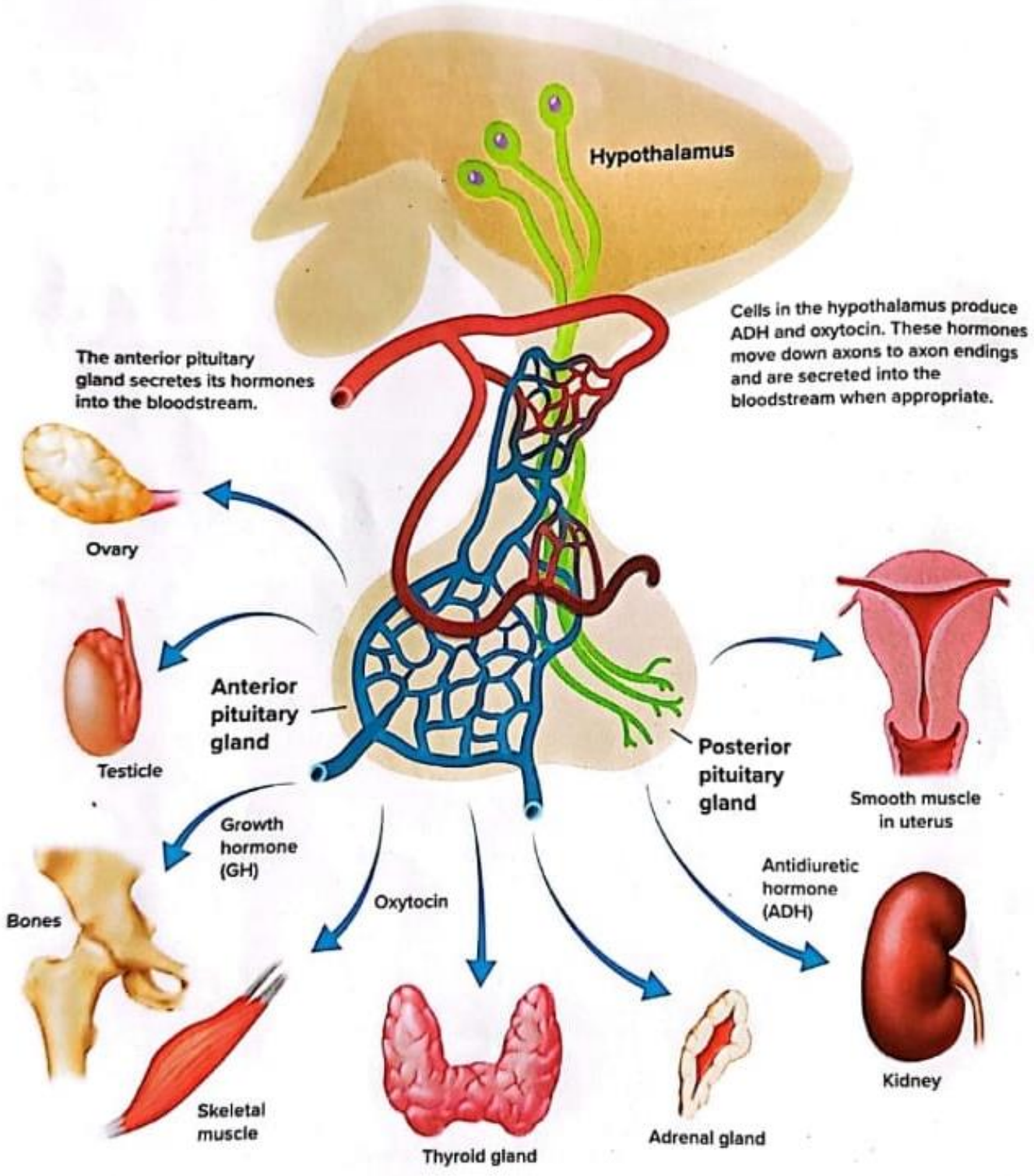
1) Aldosterone hormone.
function: reabsorbing sodium Na^+.

2) group of hormones glucocorticoids.
↓
(Cortisol)
function: raises blood glucose and reduces inflammation.

3) epinephrine and norepinephrine
↓
(Fight or flight response)
function: increases heart rate, blood pressure, breathing rate, blood sugar levels.

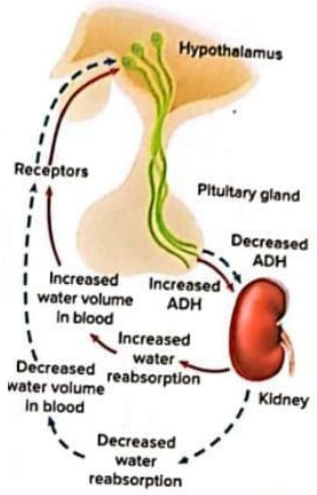
Figure 20 Visualizing the Endocrine System

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.



Link to the Nervous System

The nervous and endocrine systems are similar in that they both are involved in regulating the activities of the body and main taining homeostasis.



The hypothalamus produces two hormones:

1- Oxytocin
2- Antidiuretic hormone (ADH).

The antidiuretic hormone (ADH) functions in homeostasis by regulating water balance.

ADH travels in the blood to the kidneys, where it binds to receptors on certain kidney cells.

This causes the kidneys to reabsorb more water and decrease the amount of water in the urine ⟶ increasing the water level in the blood.

If there is too much water in a person's blood, the hypothalamus decreases the release of ADH, and the urine tends to be more dilute.