Nervous System

Mr. Ashley Fernandis.
Clinical Instructor
MES College of Nursing, Ghanekhunt-Lote.

The basic structural and functional unit of the nervous system is the individual nerve cell, the Neuron. Billions and trillions of such neurons constitute the Nervous System.

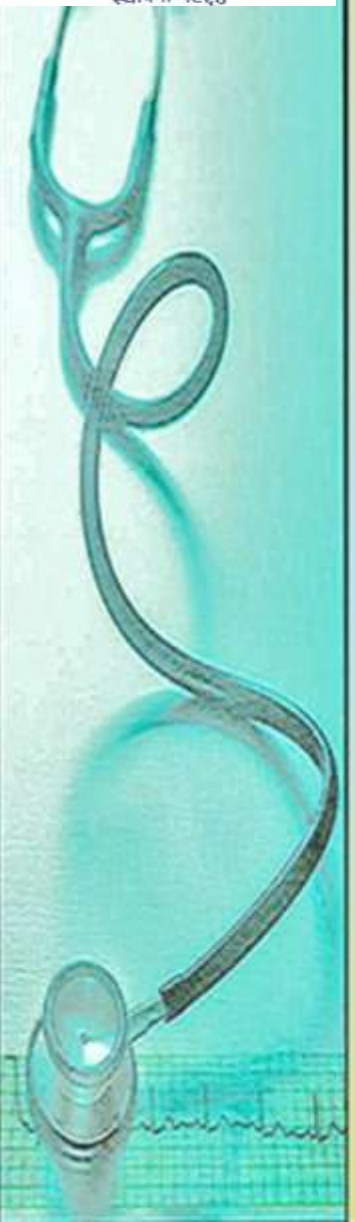
The various parts of the nervous system are interconnected, but for convenience the nervous system can be broadly divided into two major parts:

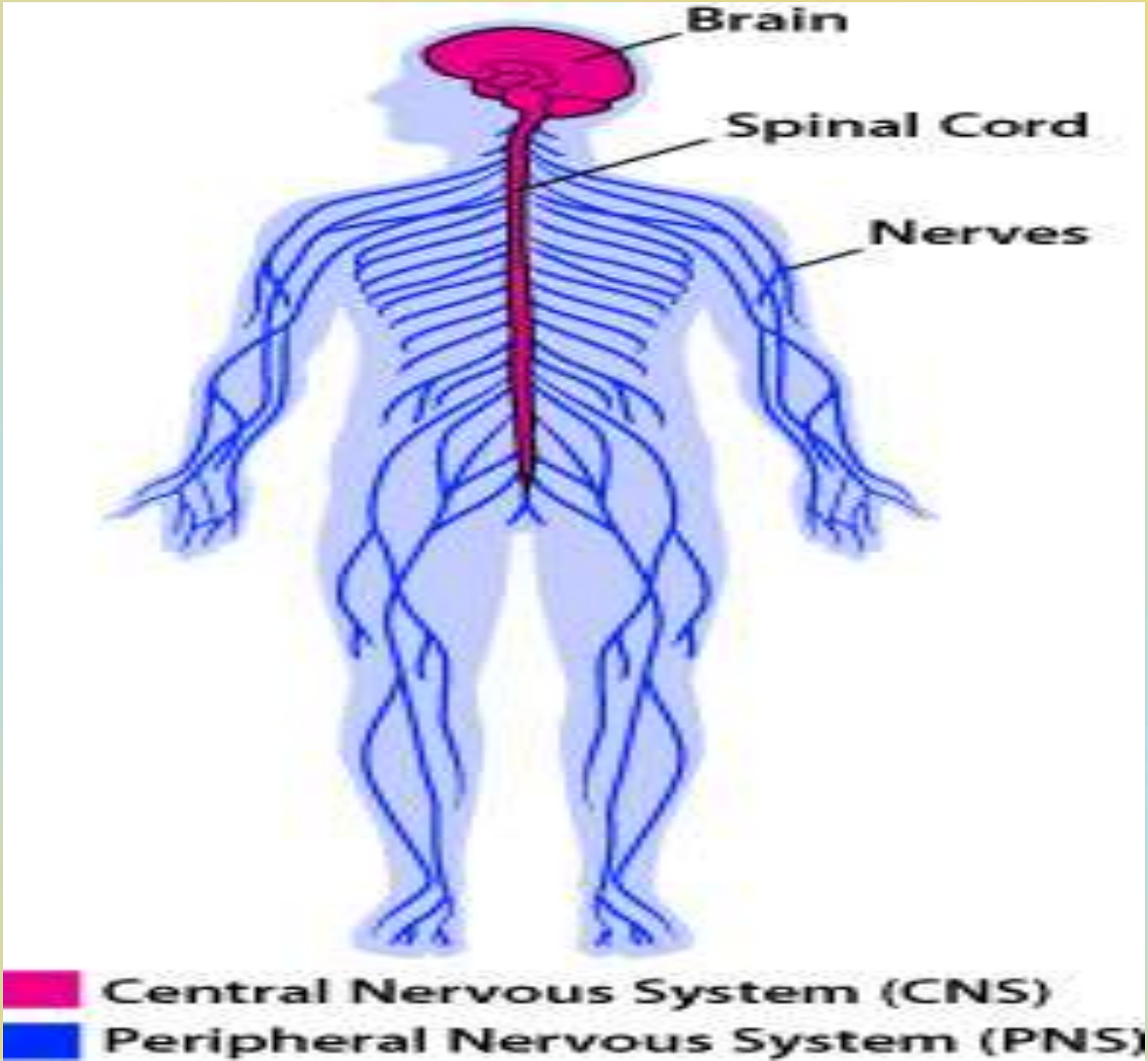
(1) Central Nervous System (CNS) consisting of brain and spinal cord

(2) Peripheral Nervous System (PNS) which includes the nerves that connects the CNS to other body parts

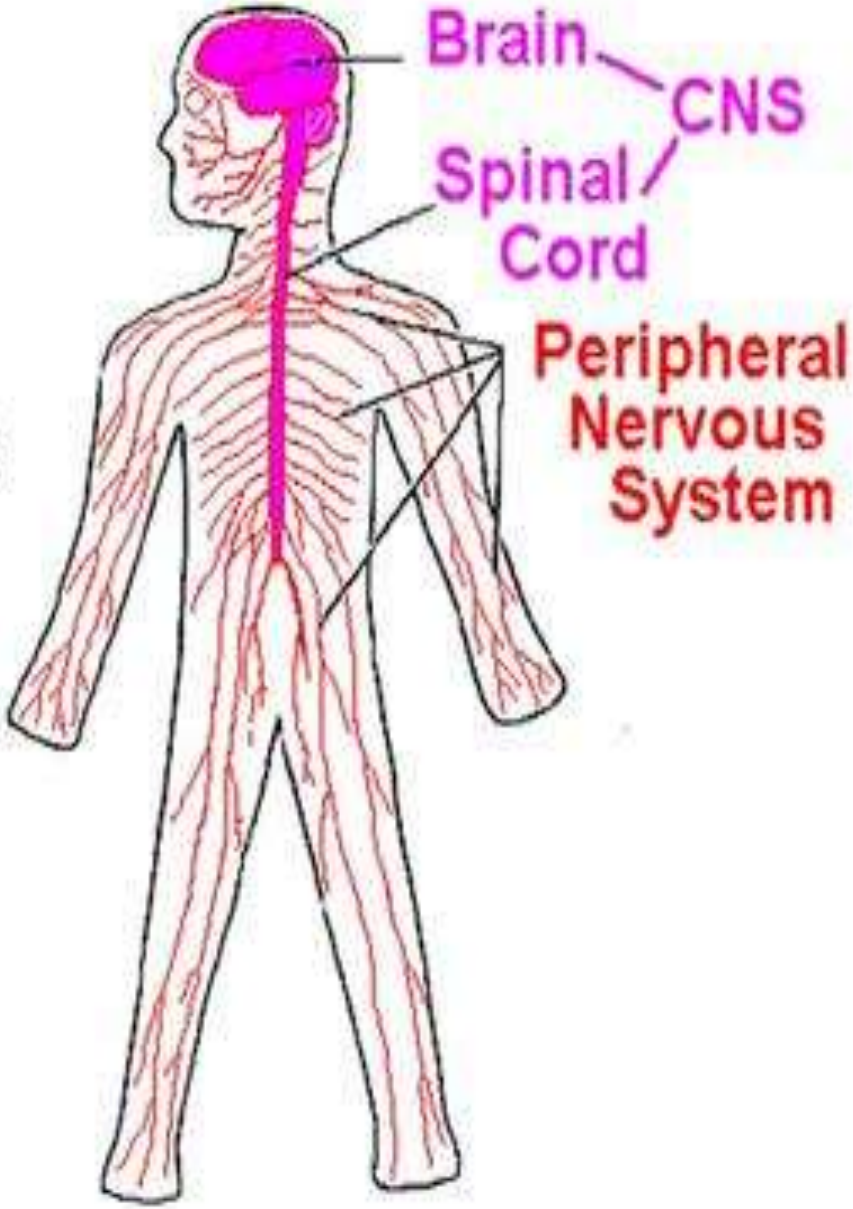
क्रियेवीण वाचाळता व्यर्थ आहे

महाराष्ट्र एज्युकेशन सोसायटी, पुणे
स्थापना १८६०





The Nervous System



Functions of the Nervous System

A. Sensory function

1. The sensory function of the nervous system involves sensory system which consists of:

(i) **Sensory receptors** that receive informations from the external environment and within the body itself (internal environment);

(ii) **Neural pathways** that conduct information from the receptors to the brain i.e. ascending (or sensory) tracts in the spinal cord.

(iii) **Somatosensory cortex** i.e. parts of the brain that deal primarily with processing the information

B. Motor function

It involves the peripheral nerves which carry information from the CNS to the effectors i.e. responsive parts in effectors are:

(i) muscles that contract when they are stimulated by nerve impulse.

(ii) glands that produce a secretion when they are stimulated.

C. Autonomic (integrative) function

It involves the autonomic nervous system (ANS) which integrates the vegetative functions such as regulation of the activity of CVS **(heart and blood vessels)**, respiration, glands of GIT, sweat glands, adrenal gland and certain endocrine glands.

Neurons

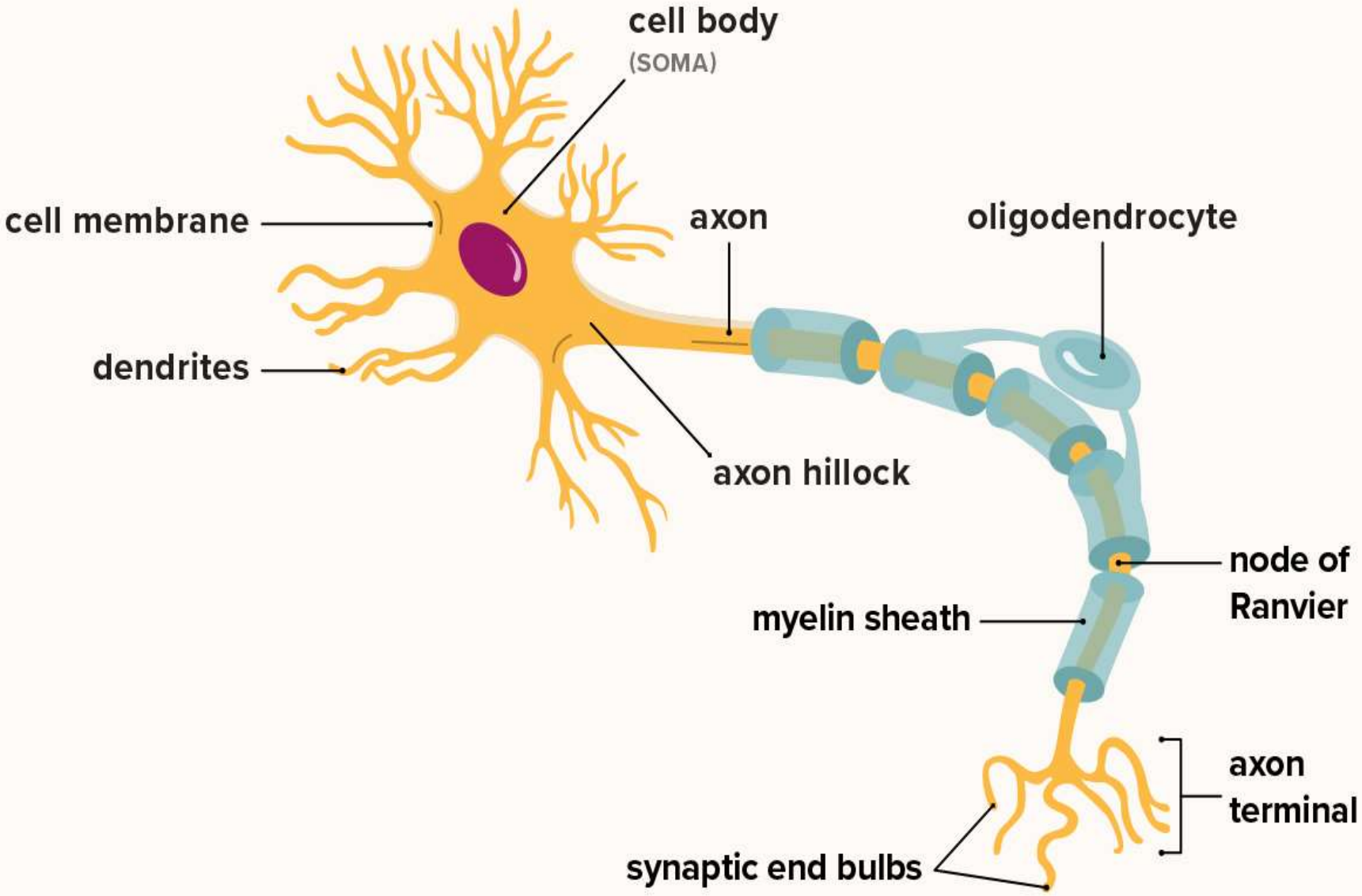
Neurons, also known as nerve cells, send and receive signals from your brain.

Specialized projections called **axons** allow neurons to transmit electrical and chemical signals to other cells.

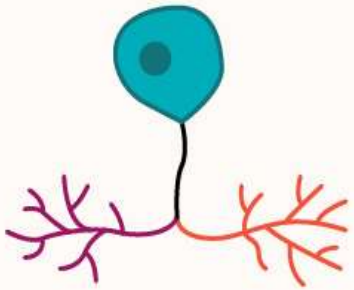
Neurons can also receive these signals via rootlike extensions known as **dendrites**.

A 2009 study estimated that the human brain houses about 86 billion neurons

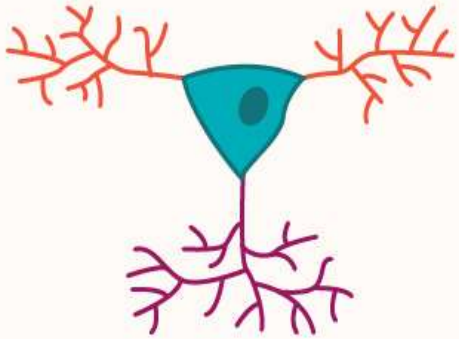
Structure of a neuron



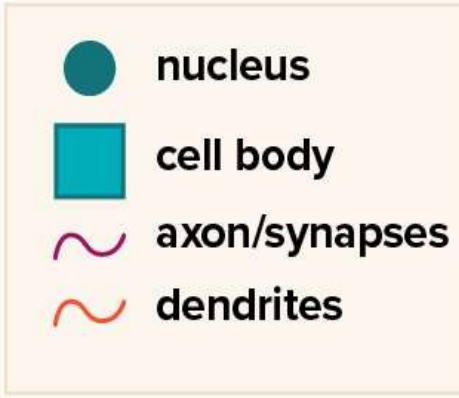
Types of neurons

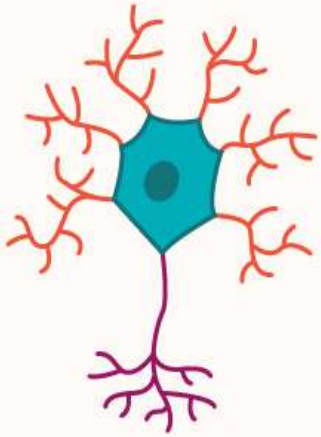


unipolar



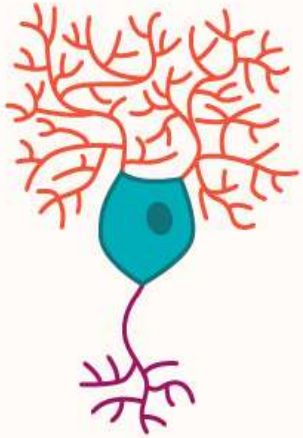
pyramidal



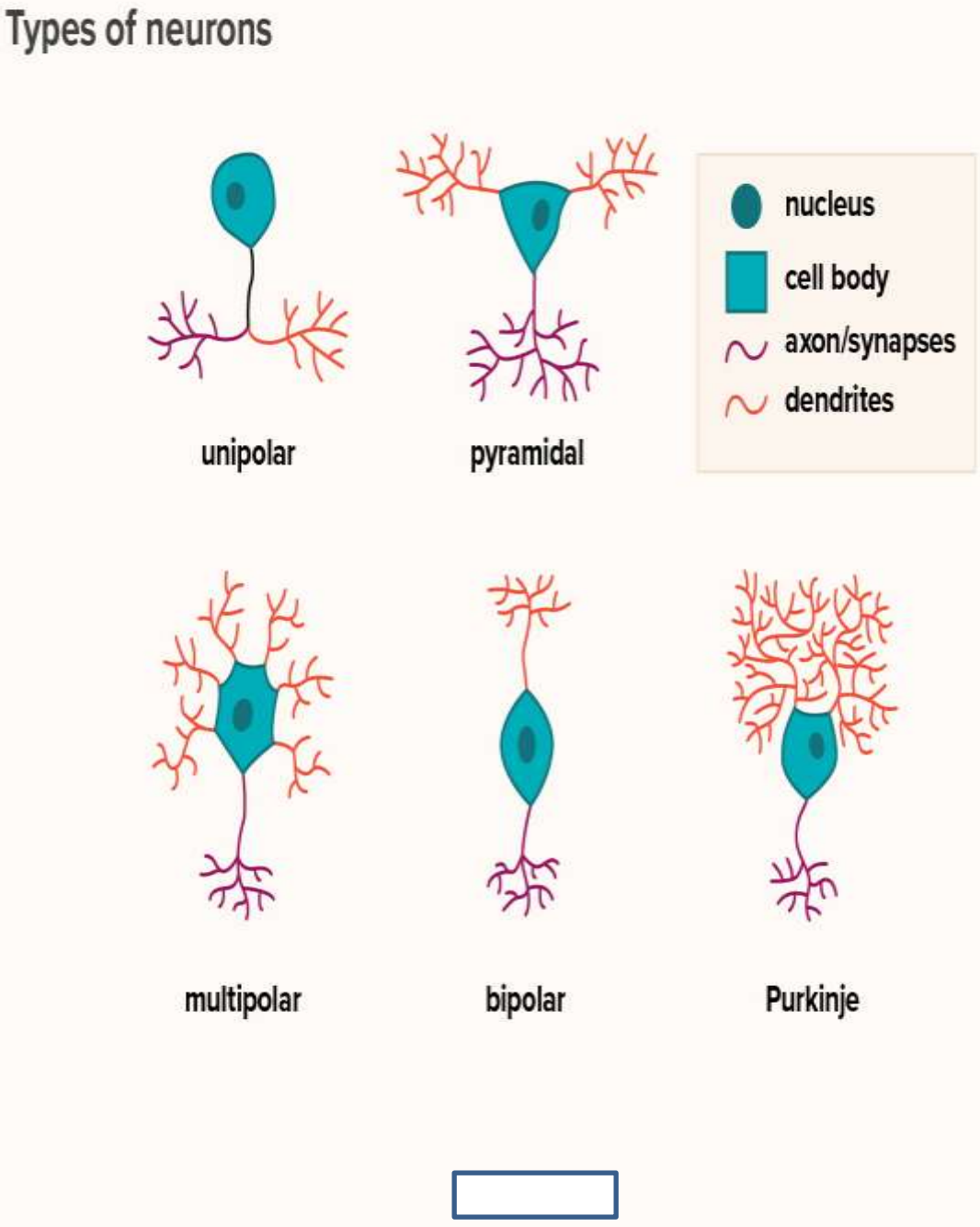


multipolar

bipolar

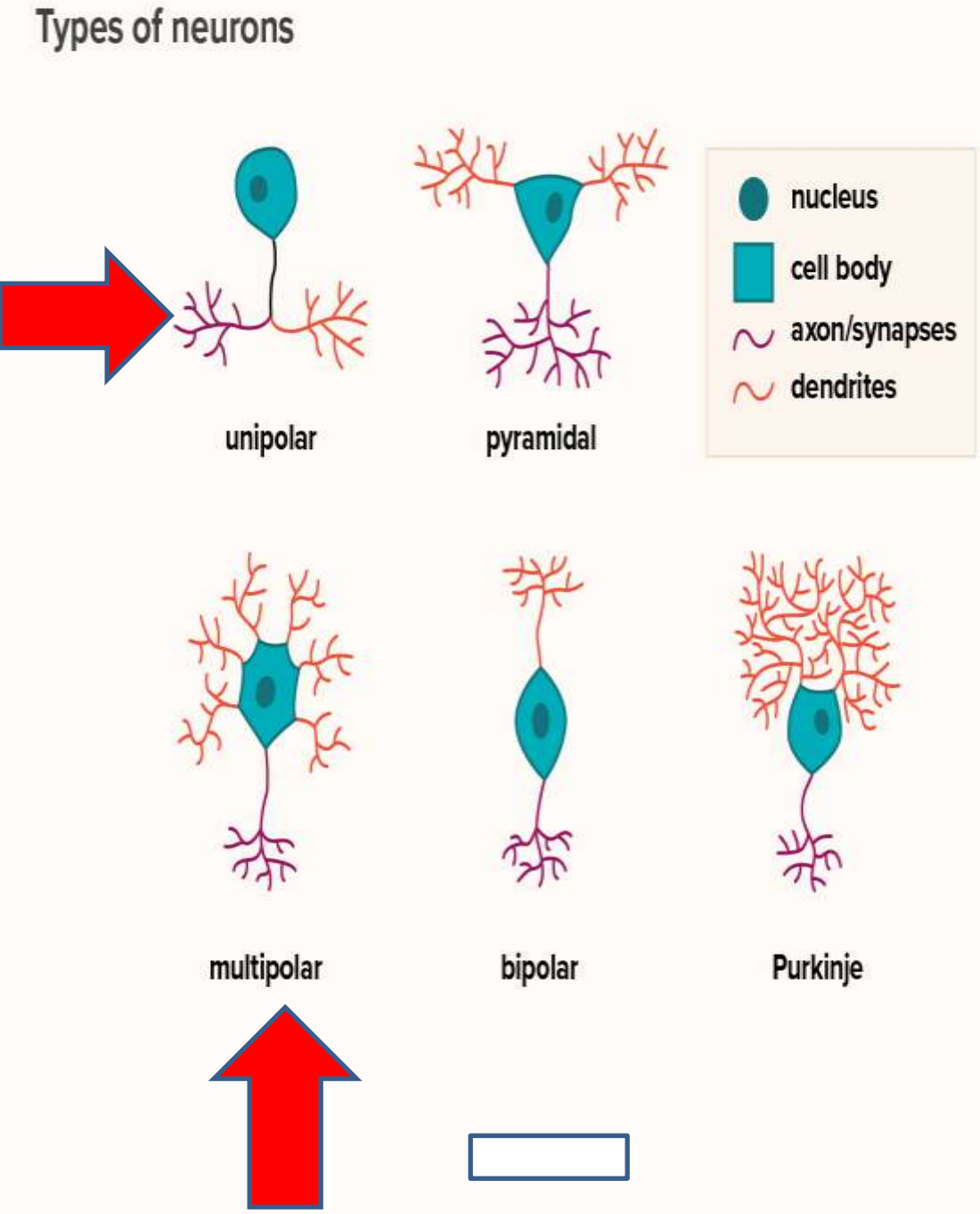


Purkinje



Types of neurons

Neurons vary in structure, function, and genetic makeup. Given the sheer number of neurons, there are thousands of different types

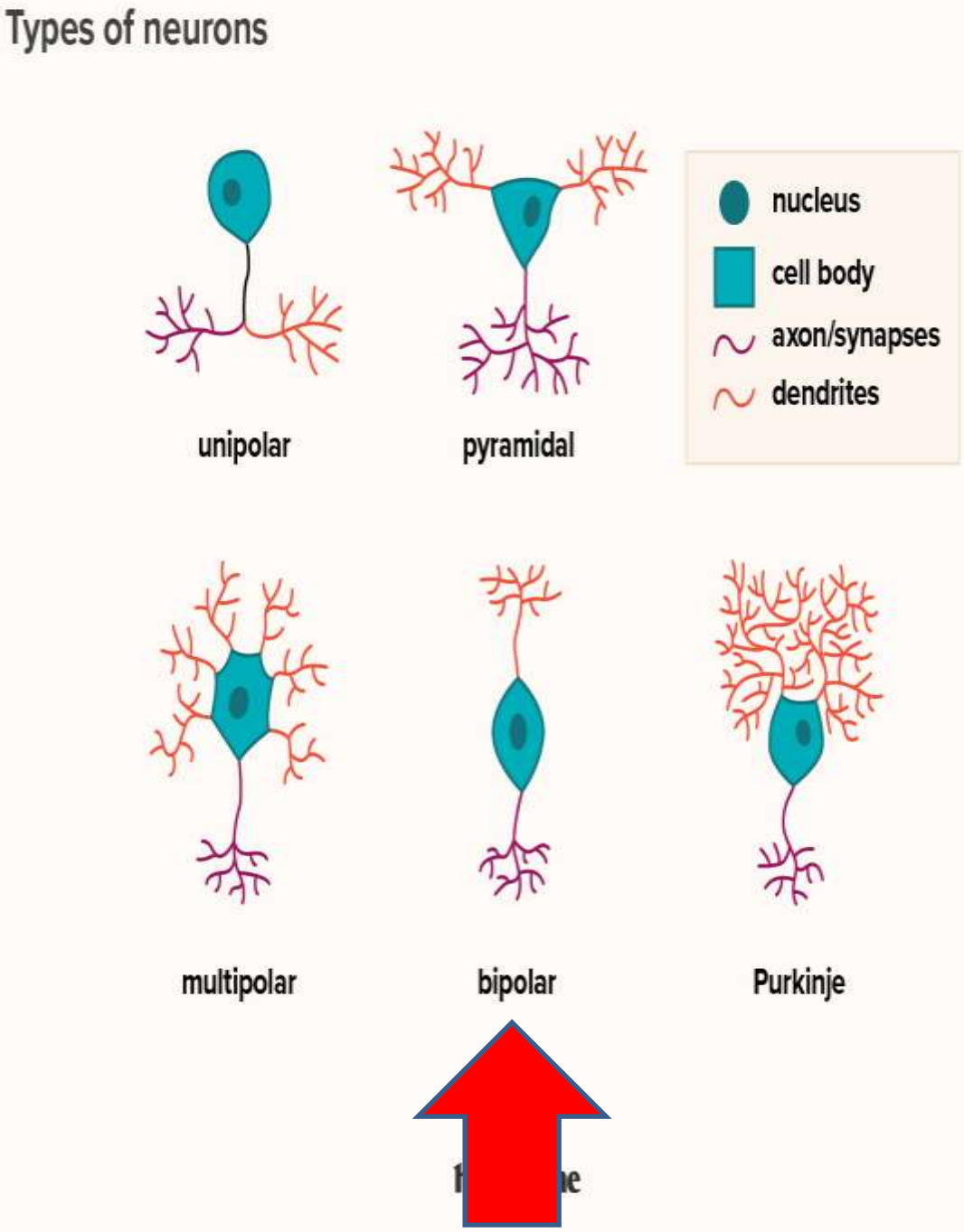


Multipolar neurons.

These neurons have a single axon and symmetrical dendrites that extend from it. This is the most common form of neuron in the central nervous system.

Unipolar neurons.

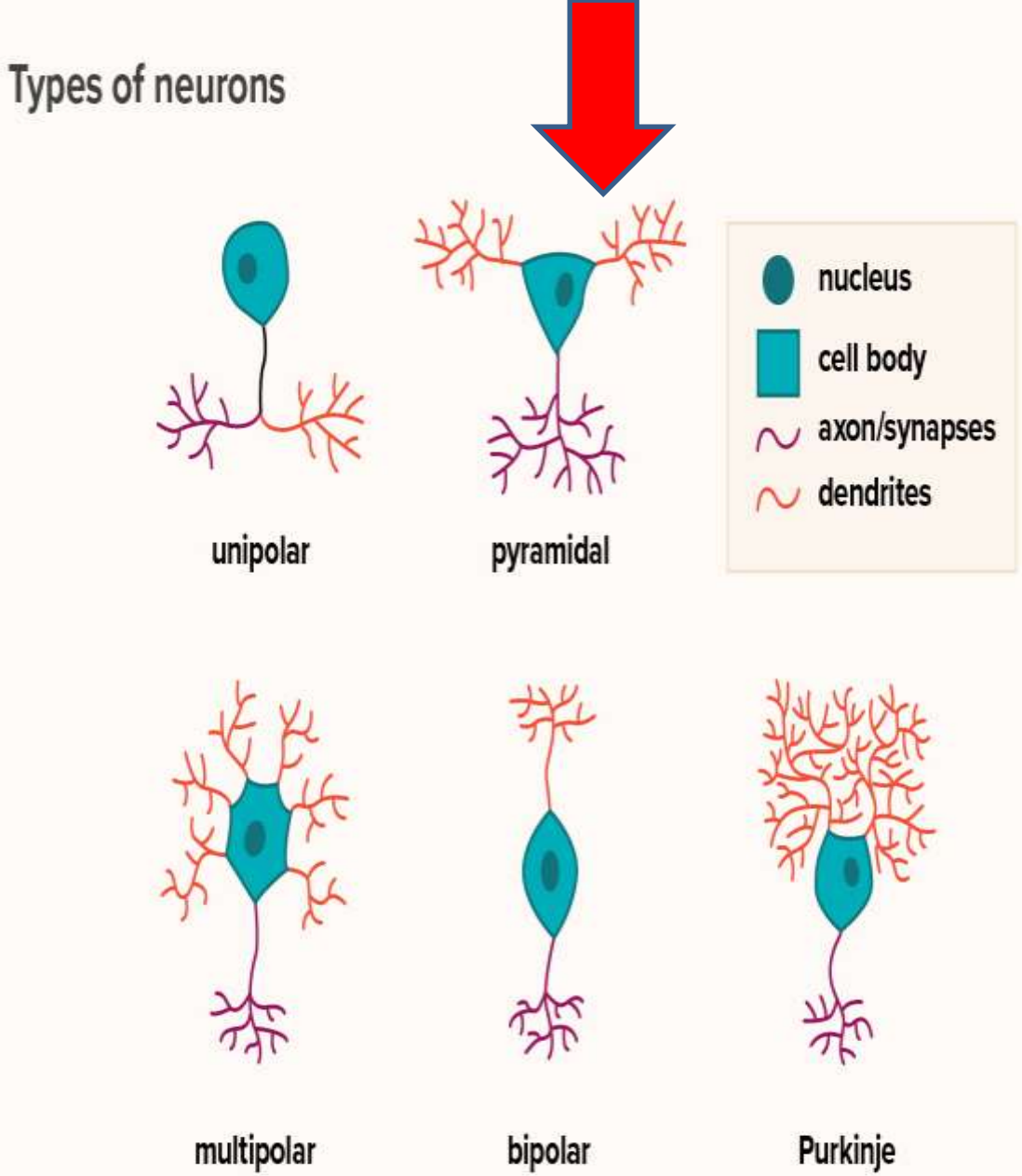
Usually only found in invertebrate species, these neurons have a single axon.



Bipolar neurons.

Bipolar neurons have two extensions extending from the cell body. At the end of one side is the axon, and the dendrites are on the other side.

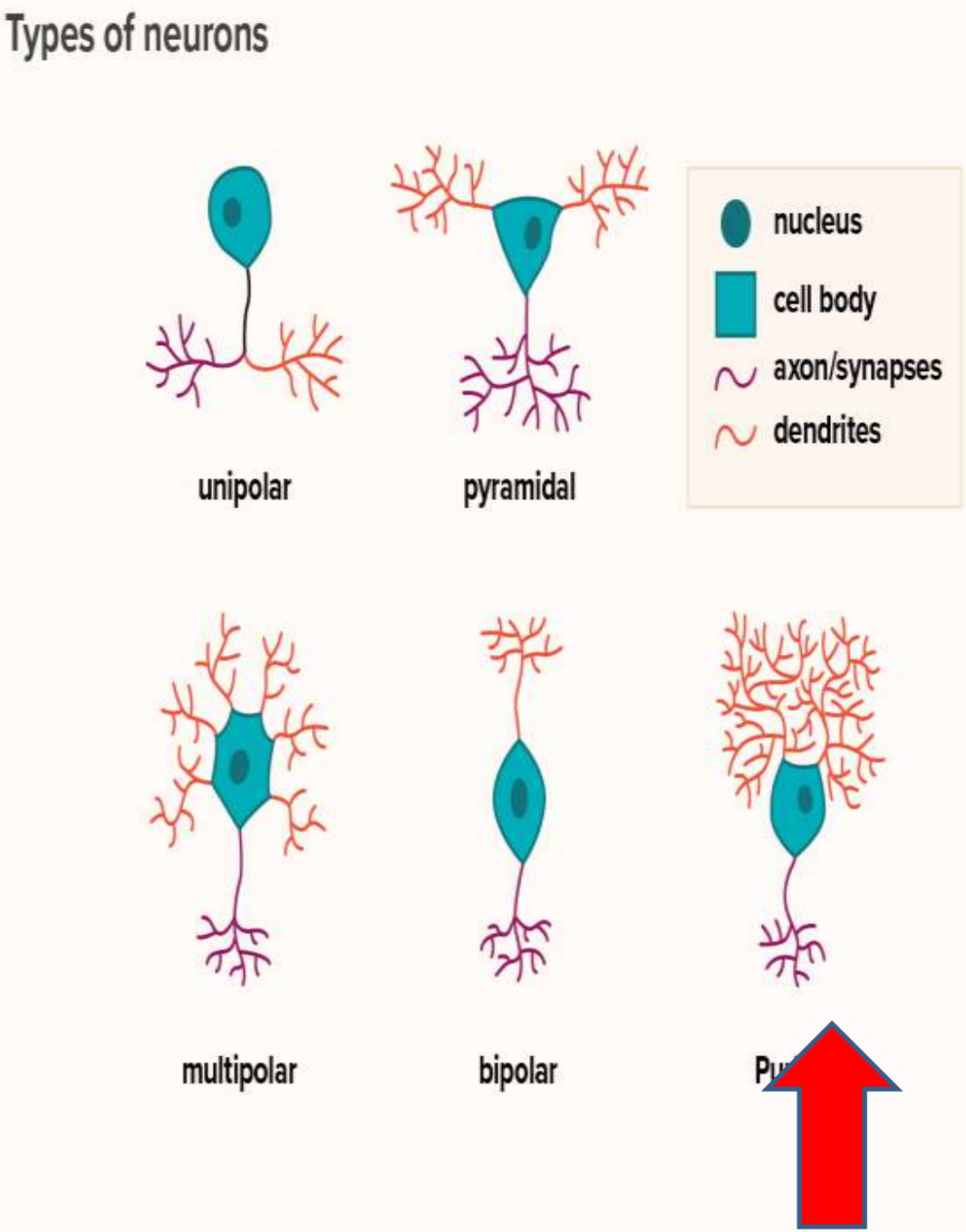
These types of neurons are mostly found in the **retina of the eye.**



Pyramidal neurons.

These neurons have one axon but several dendrites to form a pyramid type shape.

These are the largest neuron cells and are mostly found in the cortex. The cortex is the part of the brain responsible for conscious thoughts.



Purkinje neurons.

Purkinje neurons have multiple dendrites that fan out from the cell body.

These neurons are inhibitory neurons, meaning they release neurotransmitters that keep other neurons from firing.

Sensory neurons

Sensory neurons help you:

- taste
- smell
- hear
- see
- feel things around you

Sensory neurons are triggered by physical and chemical inputs from your environment. Sound, touch, heat, and light are physical inputs. Smell and taste are chemical inputs.

For example, stepping on hot sand activates sensory neurons in the soles of your feet

Motor neurons

Motor neurons play a role in movement, including voluntary and involuntary movements. These neurons allow the brain and spinal cord to communicate with muscles, organs, and glands all over the body.

Interneurons

They are multipolar in structure. Their axons connect only to the nearby sensory and motor neurons. They help in passing signals between two neurons.

Neuron Functions

The important functions of a neuron are:

Chemical synapses

In a chemical synapse, the neuron releases of chemical messengers called neurotransmitters.

(Synapses refer to **the points of contact between neurons where information is passed from one neuron to the next**. Synapses most often form between axons and dendrites)

Electrical Synapse

When two neurons are connected by a gap junction, it results in an electrical synapse.

These gaps include ion channels that help in the direct transmission of a positive electrical signal. These are much faster than chemical synapses.

Nerve impulse

A **nerve impulse** is the way nerve cells (neurons) communicate with one another.

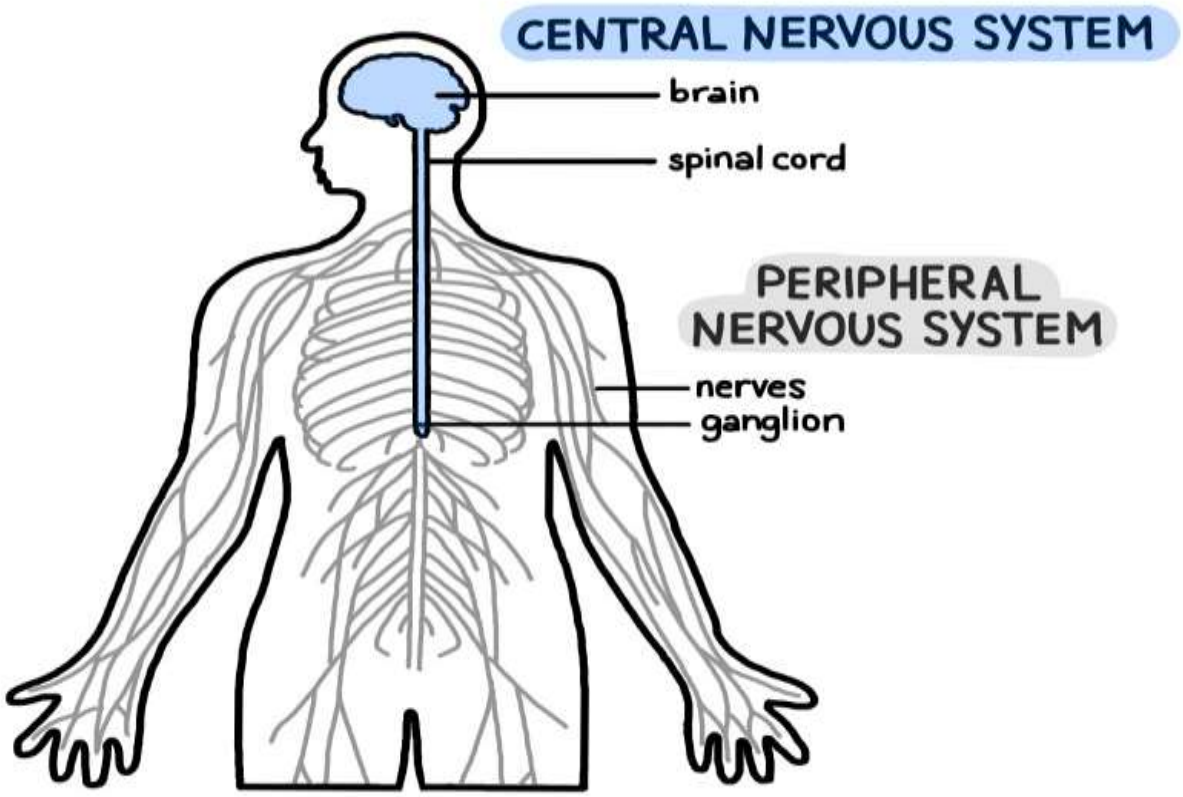
An electrical signal that travels along a nerve fiber in response to a stimulus and serves to transmit a record of sensation from a receptor.

The action potential is the result of ions moving in and out of the cell. Specifically, it involves potassium (K^+) and sodium (Na^+) ions.

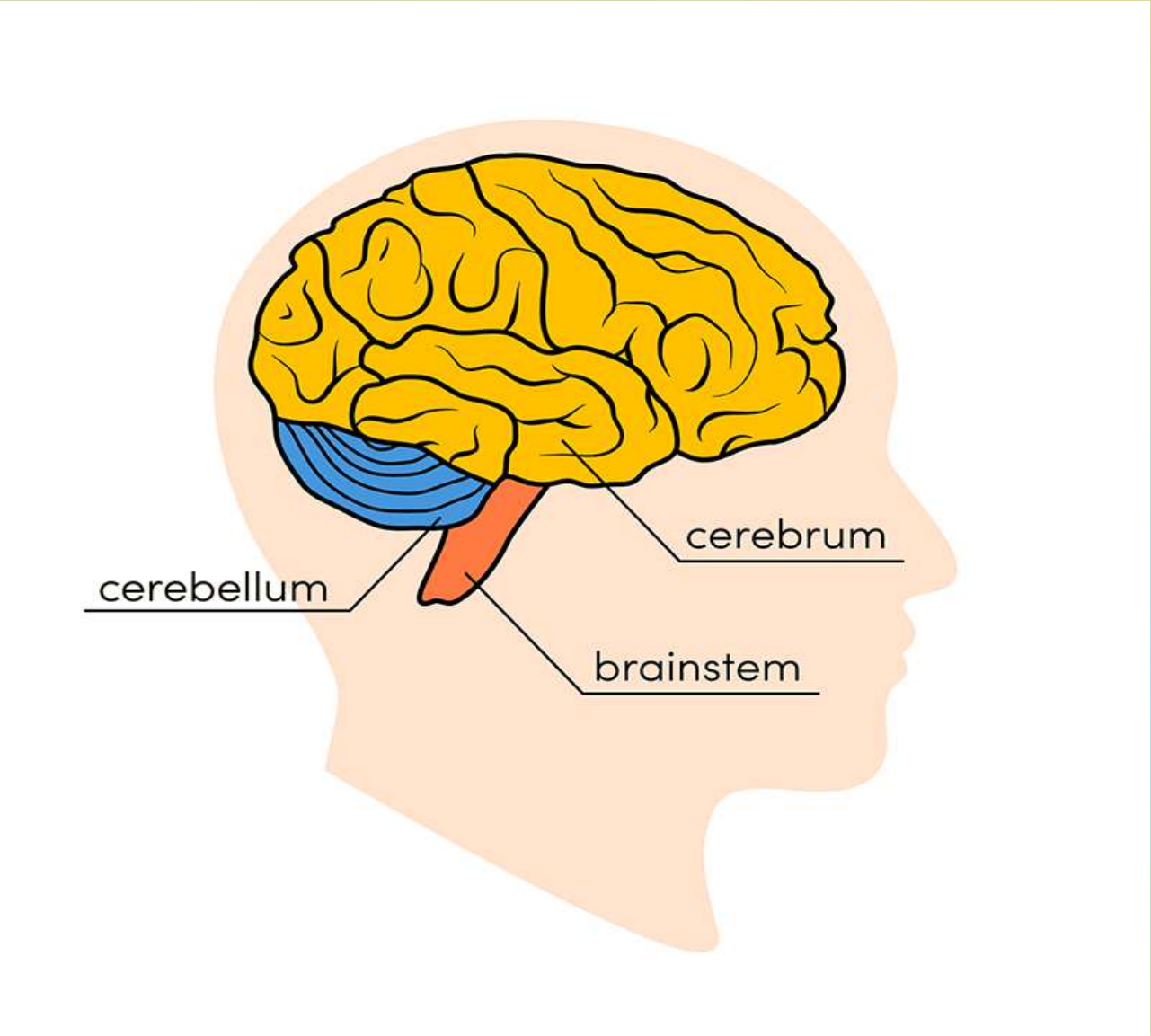
Central nervous system

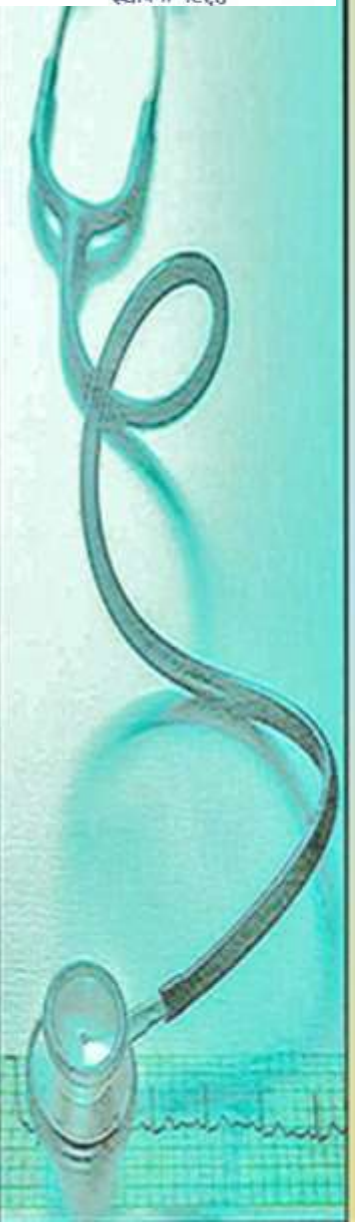
The central nervous system is made up of **the brain and spinal cord**.

The peripheral nervous system is made up of nerves that branch off from the spinal cord and extend to all parts of the body.



At a high level, the brain can be divided into the cerebrum, brainstem and cerebellum.





Cerebrum

The cerebrum (front of brain) comprises gray matter (the cerebral cortex) and white matter at its center.

The largest part of the brain, the cerebrum initiates and coordinates movement and regulates temperature.

Other areas of the cerebrum enable speech, judgment, thinking and reasoning, problem-solving, emotions and learning.

Brainstem

The brainstem (middle of brain) connects the cerebrum with the spinal cord. The brainstem includes the midbrain, the pons and the medulla.

Midbrain.

The midbrain (or mesencephalon) is a very complex structure with a range of different neuron clusters (nuclei and colliculi), neural pathways and other structures.

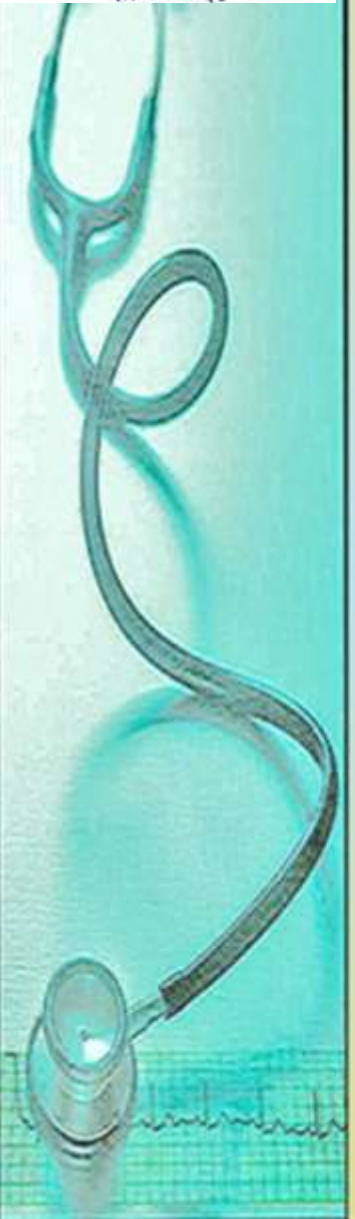
Pons.

The pons is the origin from 12 cranial nerves, which enable a range of activities such as tear production, chewing, blinking, focusing vision, balance, hearing and facial expression.

Medulla.

At the bottom of the brainstem, the medulla is where the brain meets the spinal cord.

Functions of the medulla regulate many bodily activities, including heart rhythm, breathing, blood flow, and oxygen and carbon dioxide levels.



Cerebellum

Its function is to coordinate voluntary muscle movements and to maintain posture, balance and equilibrium.

The cerebellum's roles in thought, emotions and social behavior, as well as its possible involvement in addiction

Sensory system

The **sensory nervous system** is a part of the nervous system responsible for processing sensory information.

A **sensory system** consists of sensory neurons (including the sensory receptor cells), neural pathways, and parts of the brain involved in sensory perception.

Commonly recognized sensory systems are those for vision, hearing, touch, taste, smell, and balance.

Motor Nervous system

A motor nerve is **a nerve located in the central nervous system (CNS), usually the spinal cord, that sends motor signals from the CNS to the muscles of the body**.

There are two types

1. Somatic nerves – Involved in voluntary & reflex skeletal muscle contraction
2. Autonomic nerves – Involved in cardiac & smooth muscle contraction & glandular secretion, all involuntary functions.

Peripheral Nervous System

The peripheral nervous system comprises the network of nerves connected to the brain and the spinal cord.

The nerves fibres are of two types – **Afferent fibres and Efferent fibres.**

The **afferent nerve fibres** are responsible for the transmission of impulses from the tissues to the central nervous system.

While the **efferent nerve fibres** are responsible for the transmission of impulses from central nervous system to the concerned tissues or organs.

Peripheral Nervous System Divisions

The peripheral nervous system has two divisions:

1. **Somatic Nervous System**

The main function of the somatic nervous system is to transfer impulses from CNS to skeletal muscles.

It consists of;

a. **Cranial Nerves** - are 12 pairs and they emerge from the brain. Some of the examples of cranial nerves are optic, olfactory, etc.

b. **Spinal nerves** have their point of emergence as the spinal cord. There are 31 pairs of spinal nerves.

2. Autonomic Nervous System

The autonomic nervous system relays impulses from the central nervous system to the involuntary organs and smooth muscles of the body.

It is divided into two parts –

a. Sympathetic nervous system -

The **sympathetic nervous system** consists of nerves arising from the spinal cord between the neck and waist region.

b. Parasympathetic nervous system -

The **parasympathetic nervous system** is located anterior in the head and neck and posterior in the sacral region.

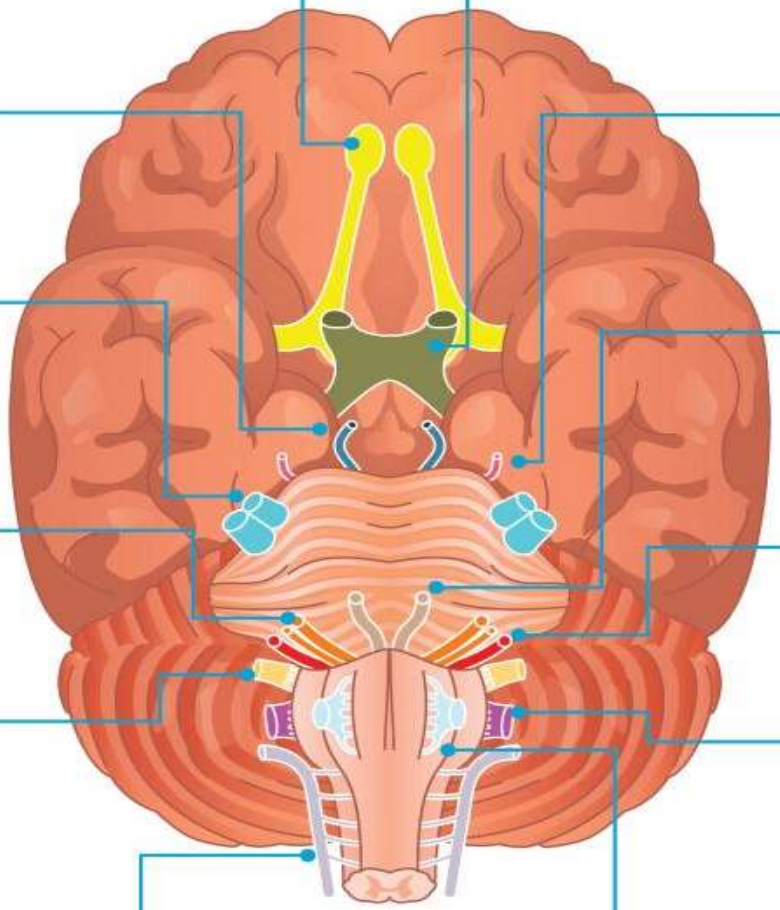
Peripheral Nervous System Functions

- The peripheral nervous system connects the brain and the spinal cord to the rest of the body and the external environment.
- It regulates the internal homeostasis.
- It can regulate the strength of muscle contractility.
- It controls the release of secretions from most exocrine glands.

Cranial nerves

The cranial nerves are a set of 12 paired nerves **in the back of your brain**. Cranial nerves send electrical signals between your brain, face, neck and torso. Your cranial nerves help you taste, smell, hear and feel sensations.

12 Cranial Nerves



olfactory
smell

optic
vision

oculomotor
eye movement and pupil reflex

trochlear
eye movement

trigeminal
face sensation and chewing

abducens
eye movement

facial
face movement and taste

vestibulocochlear
hearing and balance

glossopharyngeal
throat sensation, taste, and swallowing

vagus
movement, sensation, and abdominal organs

accessory
neck movement

hypoglossal
movement, sensation, and abdominal organs

Functions of cranial nerves

1.Olfactory nerves

2. Optic nerves

3. Oculomotor, trochlear, and abducens nerves

4. Vestibulocochlear nerves

5. Glossopharyngeal and hypoglossal nerves

6. Vagus nerves

7. Spinal accessory nerves

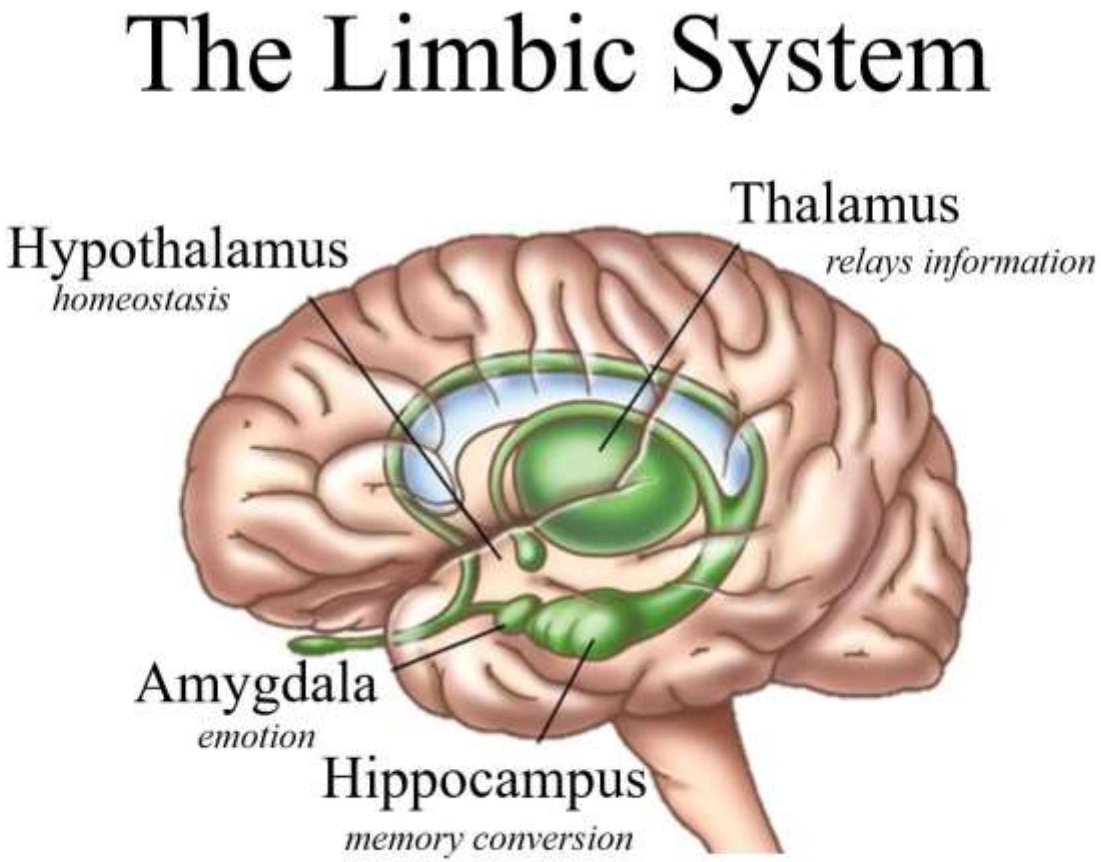
8. Facial nerves

9. Trigeminal nerves

The limbic system

The limbic system is the part of the brain involved in our behavioural and emotional responses.

Especially when it comes to behaviours we need for survival: feeding, reproduction and caring for our young, and fight or flight responses.



It supports many different functions, including emotion, behaviour, motivation, long-term memory, and olfaction.

It is the part of the brain involved when it comes to behaviours we need for survival: feeding, reproduction and caring for our young, and fight or flight responses.

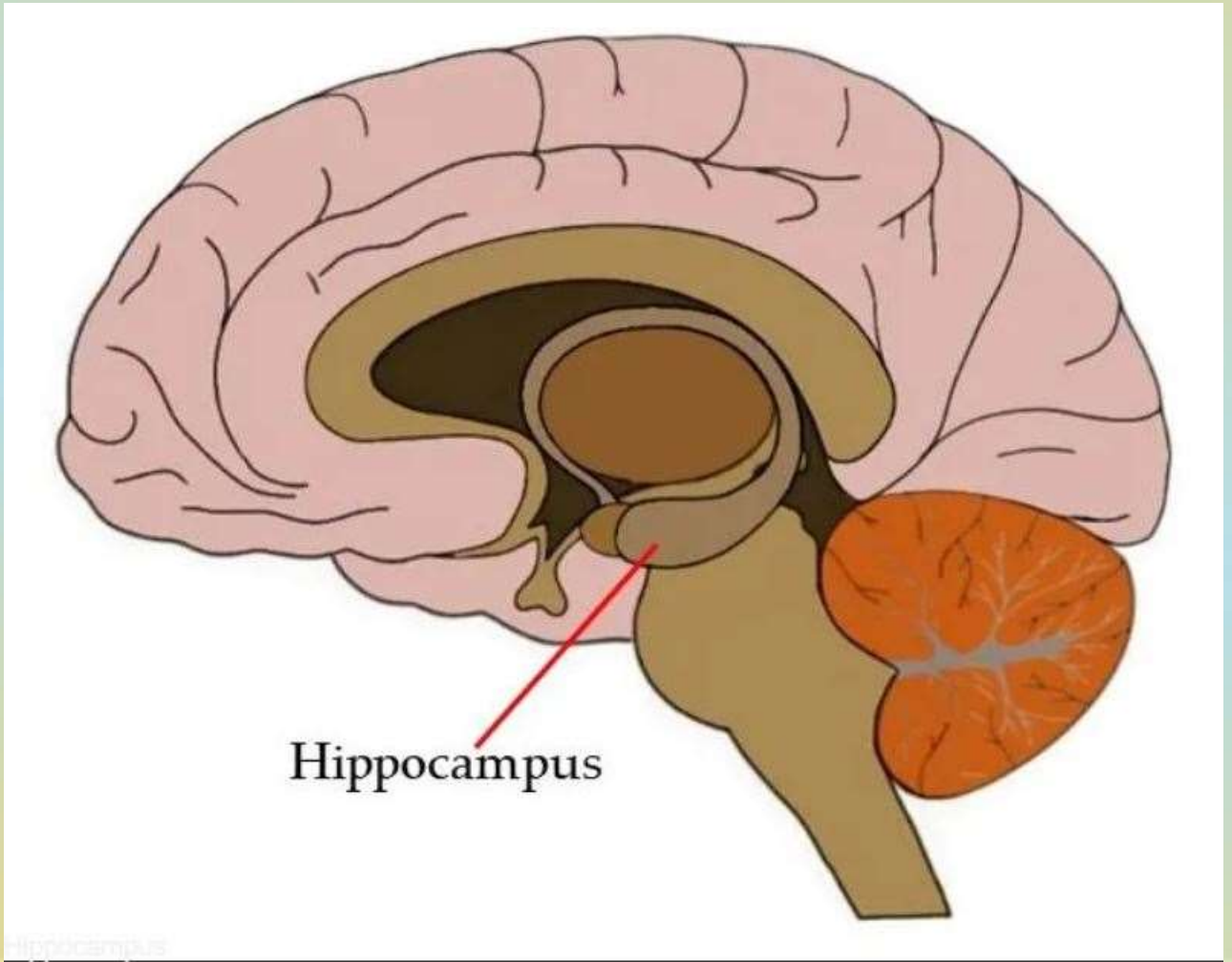
Higher mental functions

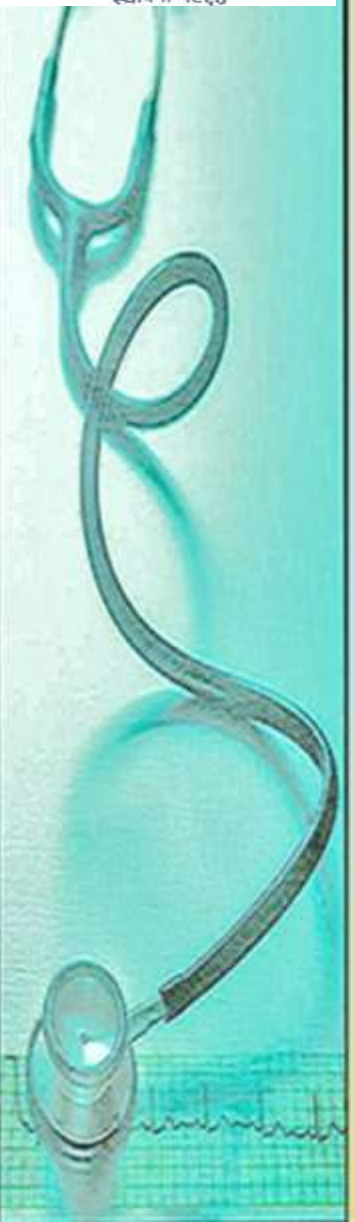
- It combines higher mental functions and primitive (**anger, fear, sadness, disgust, surprise, anticipation, trust and joy)** emotion into a single system often referred to as the emotional nervous system.
- It is not only responsible for our emotional lives but also our higher mental functions, such as learning and formation of memories.

,

Hippocampus

The hippocampus is under the cerebral cortex. It is important in spatial memory and navigation, and helps turn short-term memory into long-term memory.





Functions of hippocampus

- Declarative memories are those related to facts and events.

  E.g., learning how to memorize speeches or lines in a play.

- Spatial relationship memories involve pathways or routes.

  E.g., when a cab driver learns a route through a city, they use spatial memory.

Functions of thalamus

- Relaying sensory information.
- Relaying motor (movement) information.
- Prioritizing attention.
- Role in consciousness.
- Role in thinking (cognition) and memory.

Functions of hypothalamus

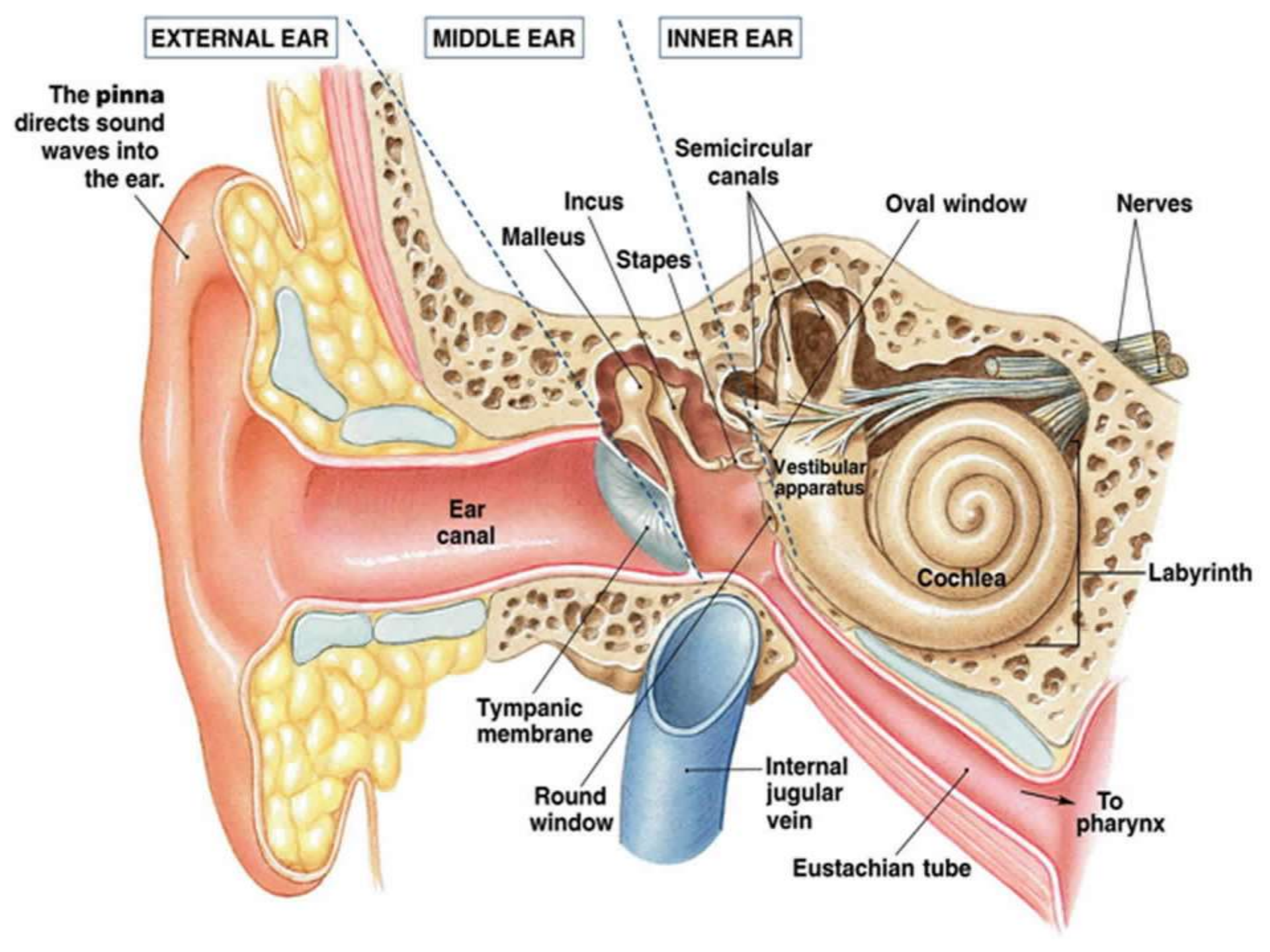
Hypothalamus is your body's **"smart control"** coordinating center.

It plays a part in many essential functions of the body.

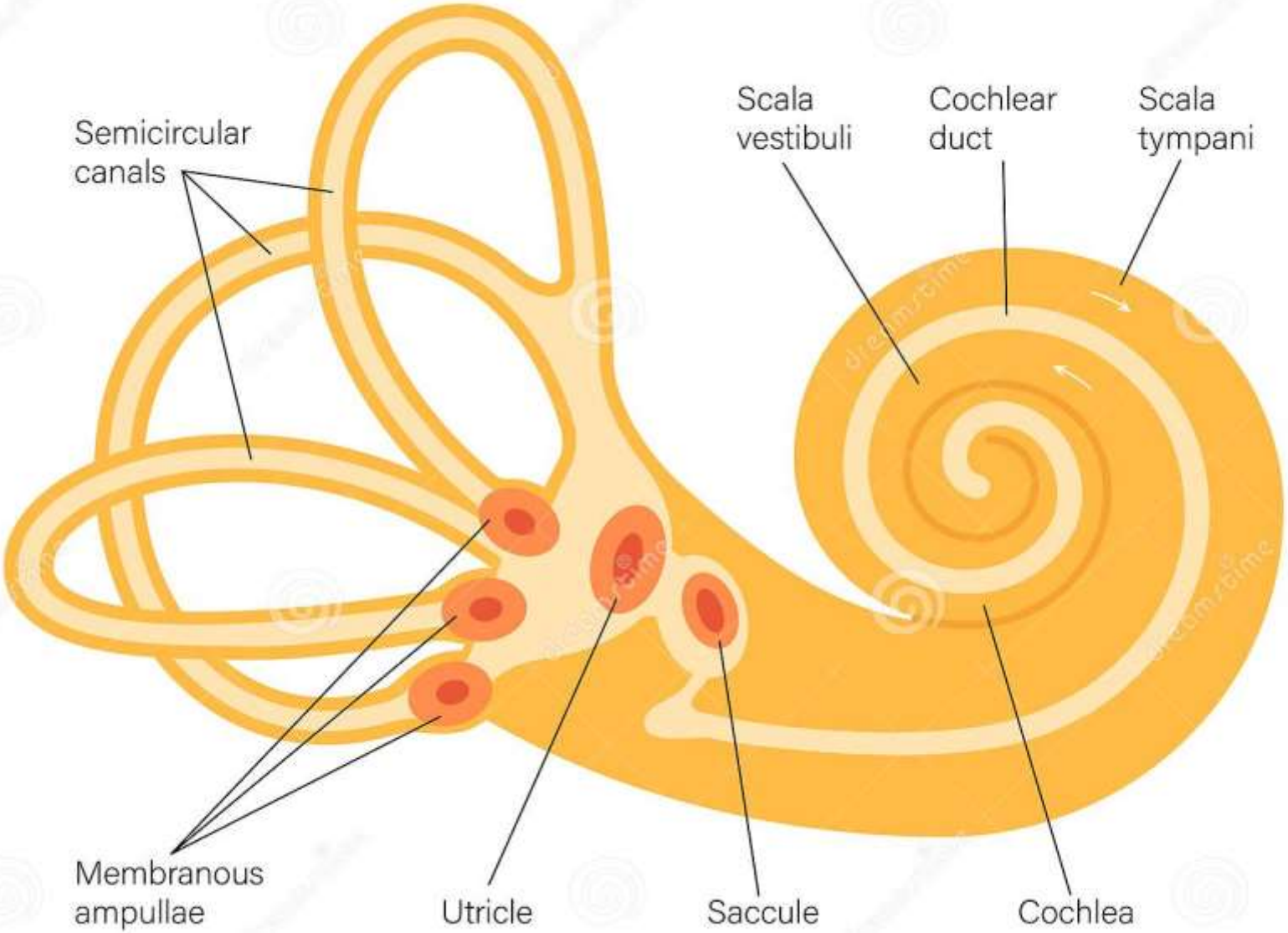
- Body temperature
- Thirst
- Appetite and weight control
- Emotions
- Sleep cycles
- Sex drive
- Childbirth
- Blood pressure and heart rate
- Production of digestive juices
- Balancing bodily fluids

Vestibular system

The **vestibular system**, in vertebrates, is a sensory system that creates the sense of balance and spatial orientation for the purpose of coordinating movement with balance.


EXTERNAL EAR
MIDDLE EAR
INNER EAR
The pinna directs sound waves into the ear.
Semicircular canals
Incus
Malleus
Stapes
Oval window
Nerves
Vestibular apparatus
Ear canal
Cochlea
Labyrinth
Tympanic membrane
Round window
Internal jugular vein
To pharynx
Eustachian tube

VESTIBULAR APPARATUS



Vestibular apparatus

Vestibular apparatus (Equilibrium organ) Vestibular apparatus maintains the equilibrium and is present above the cochlea.

It is present in the membranous labyrinth. It has two sac-like chambers called saccule and utricle and three semicircular canals.

(The vestibular nerve is primarily responsible for **maintaining body balance.)**

Pain

"**An unpleasant sensory and emotional experience associated with, or resembling that associated with, actual or potential tissue damage**".

Pain is a **subjective experience** with two complementary aspects:

One is a **localized sensation** in a particular body part.

Somatic pain

Somatic pain is **the most common type of pain in patients with cancer are the most prevalent cause**.

Somatic comes from the skin, muscles, and soft tissues.

Somatic pain is generally described as musculoskeletal pain.

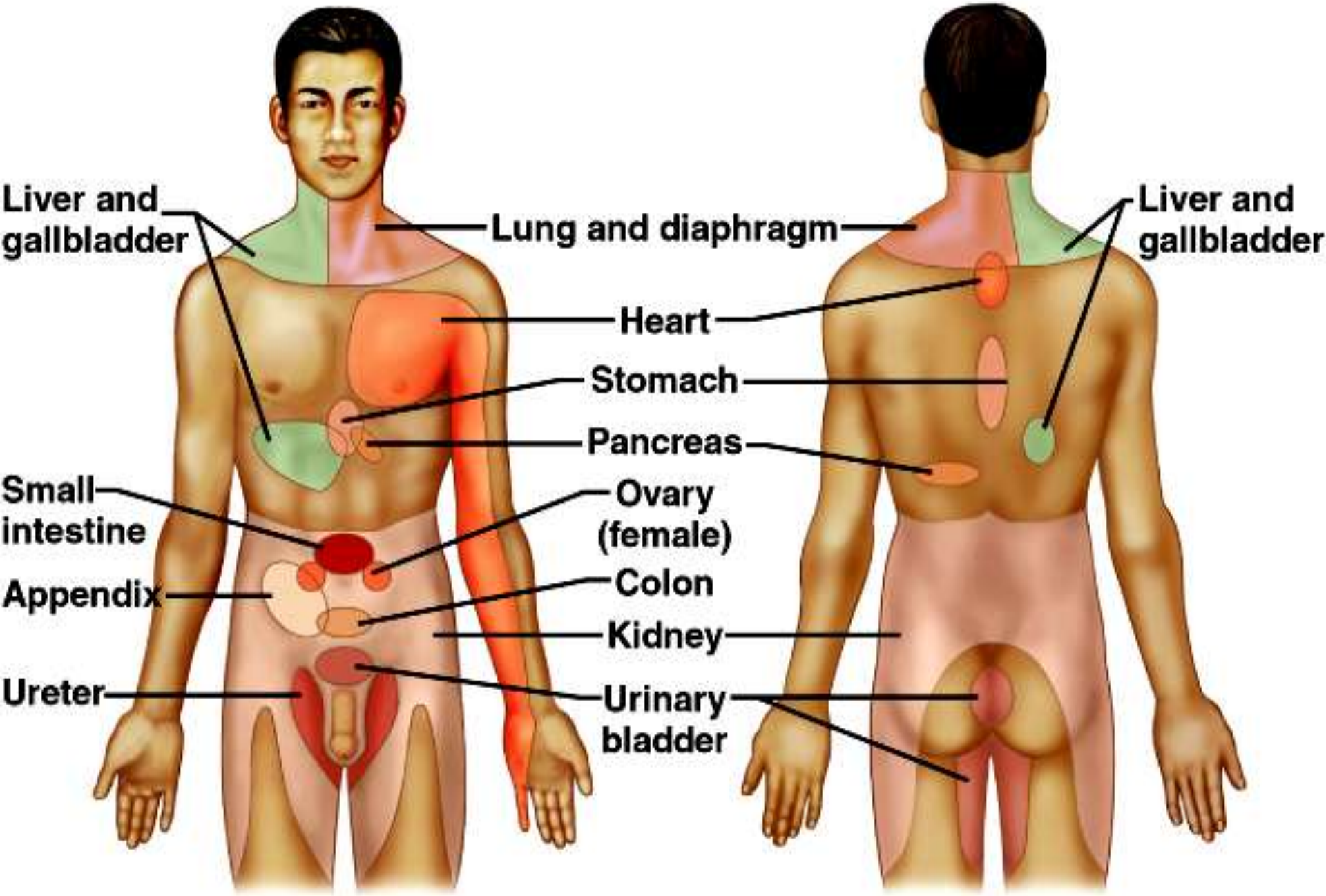
somatic pain is usually easier to locate than visceral pain.

Somatic pain can be either superficial or deep

Visceral pain

Visceral pain is pain that arises from, in, or around internal organs.

Visceral pain is the pain you feel from your internal organs, such as your stomach, bladder, uterus, or rectum.


Liver and gallbladder
Lung and diaphragm
Heart
Stomach
Pancreas
Small intestine
Ovary (female)
Appendix
Colon
Kidney
Ureter
Urinary bladder
Liver and gallbladder

Referred pain

Referred pain is **when the pain you feel in one part of your body is actually caused by pain or injury in another part of your body**.

OR

Referred pain is when the **pain** you feel in one part of your body is actually caused by **pain** or injury in another part of your body.

E.g.,

An injured pancreas could be causing pain in your back, or a heart attack could be triggering pain in your jaw.

Reflexes

An action or movement that is made automatically without thinking as a reaction to a stimulus.

OR

A sudden movement or action that you make without thinking.

A reflex is **an involuntary or automatic, action that your body does in response to something — without you even having to think about it**.

Types Of Reflex Actions

Accommodation reflex:

The most common reflex of eyes, that helps the pupils, lens change the shape to accommodate of sight, when we look at distance object and near object.

Pupillary light reflex:

If a light is flashed near one eye, the pupils of both eyes contract. Light is the stimulus, impulses reach the brain via the optic nerve, and the response is conveyed to the pupillary musculature by autonomic nerves that supply the eye.

Acoustic Reflex:

The word acoustic might ring a bell in your ears? Well yes, it is related to contraction of stapedius and tensor tympani muscles in the middle ear that responses to high decibel sounds.

Ankle jerk reflex:

The jerking of ankle is the common reflex action that is tested by the doctors to check the reflex.

Biceps reflex:

The jerking of forearm when biceps brachii tendon is struck with tendon hammer leads to biceps reflex.

Blushing:

This, perhaps doesn't need any introduction. Blushing refers to the reddening of the face caused by embarrassment, shame or modesty.

Corneal reflex —

Refers to blinking of both eyes when the cornea of either eye is touched. This reflex is responsible to act when dust or foreign particles accidentally enters our eyes.

Cough reflex —

When a dust enters our trachea or respiratory tract, the cough receptors produces a cough which in turn remove the foreign material from the tract before it reaches the lungs.

Sneeze:

Irritation of nasal mucosa in the nose create a sneeze that helps get rid of the foreign particle in the nostrils.

CSF is **Cerebrospinal Fluid**

CSF is a transparent substance located in the brain & spinal cord that is colourless.

CSF is made by **tissue that lines the ventricles (hollow spaces) in the brain**. It flows in and around the brain and spinal cord to help cushion them from injury and provide nutrients.

It consisting of;

- Water
- Mineral salts
- Glucose
- Plasma protein
- Few leukocytes
- Small amounts of creatinine
- Small amounts of urea

Circulation

Cerebrospinal fluid is constantly produced at a secretion rate of 0.2-0.7 ml/min, i.e. 600–700 ml of newly produced CSF per day.

Blood brain barrier

A network of blood vessels and tissue that is made up of closely spaced cells and helps keep harmful substances from reaching the brain.

It is made up of **capillary endothelial cells and basement membrane, neuroglial membrane, and glial podocytes.**

Blood CSF barrier

The blood-cerebrospinal fluid (CSF) barrier is **formed by tight junctions between neighboring choroid plexus epithelial cells.**

Purpose

A primary function of the blood–brain and blood–csf barriers is **to preserve homeostasis within the cerebral compartment so that the complex neural integrative functions of the CNS can operate optimally**.