Nervous system

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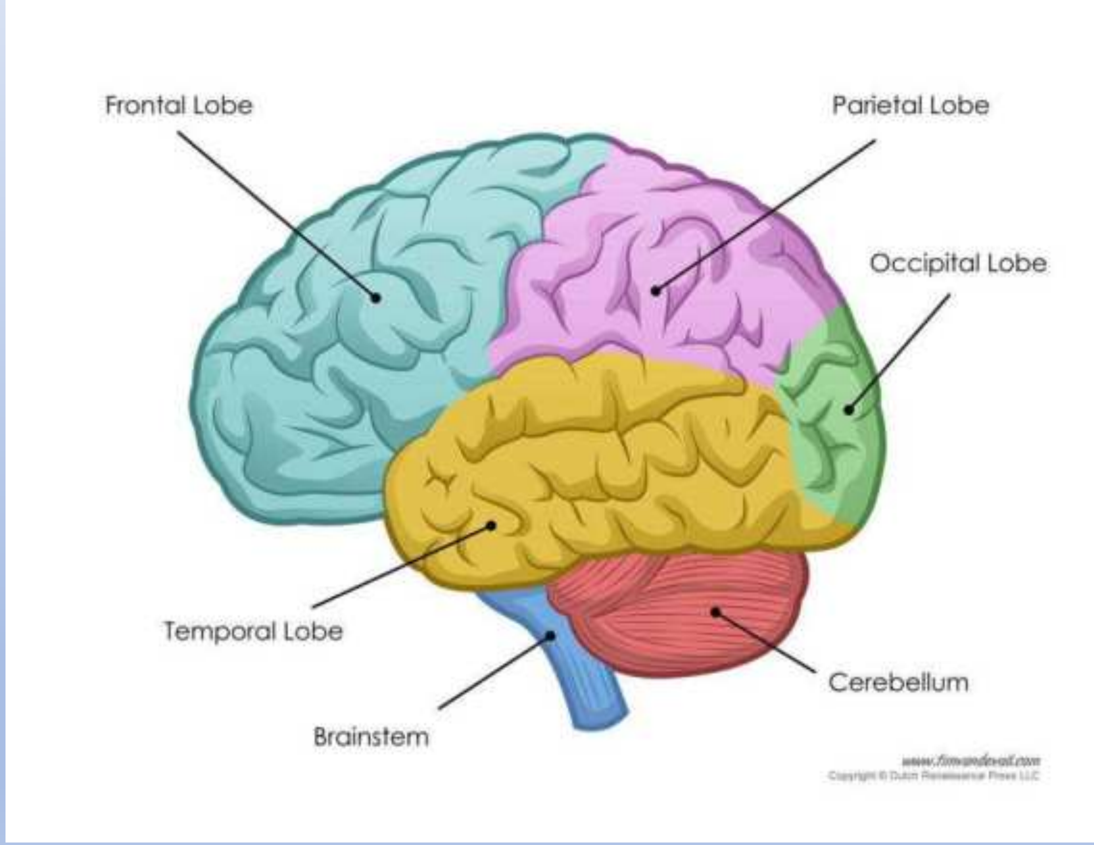
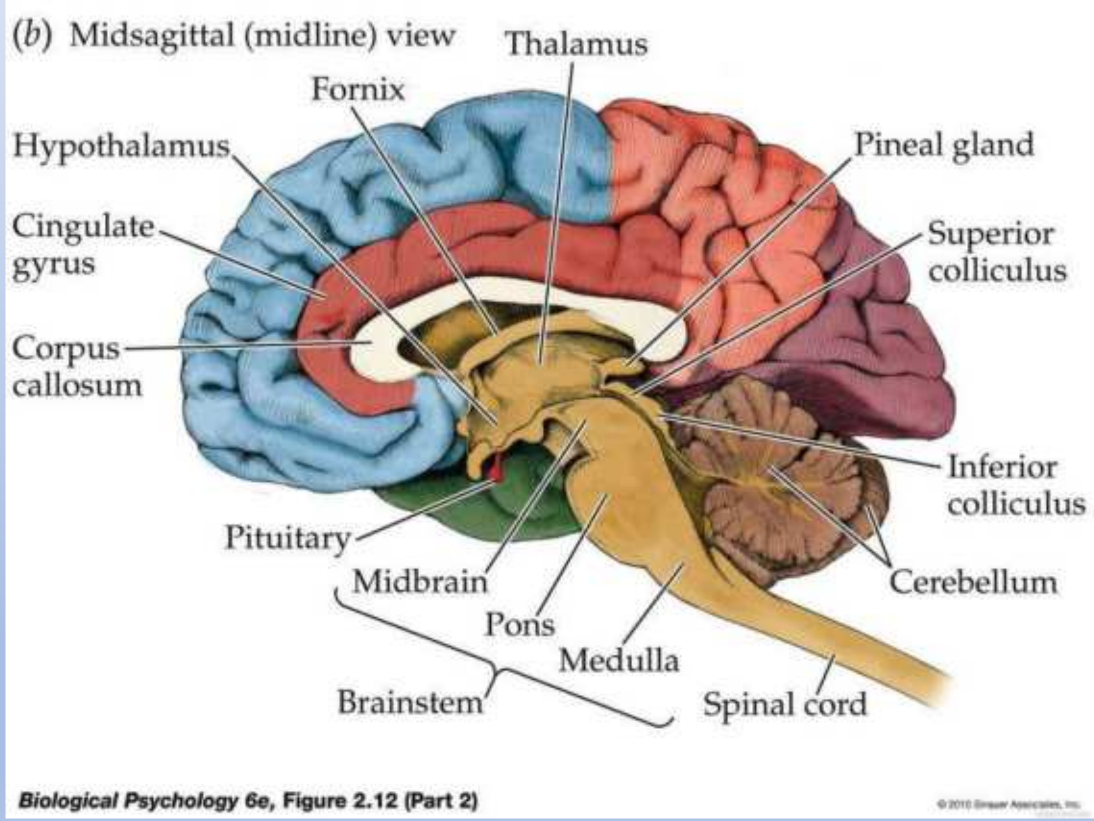
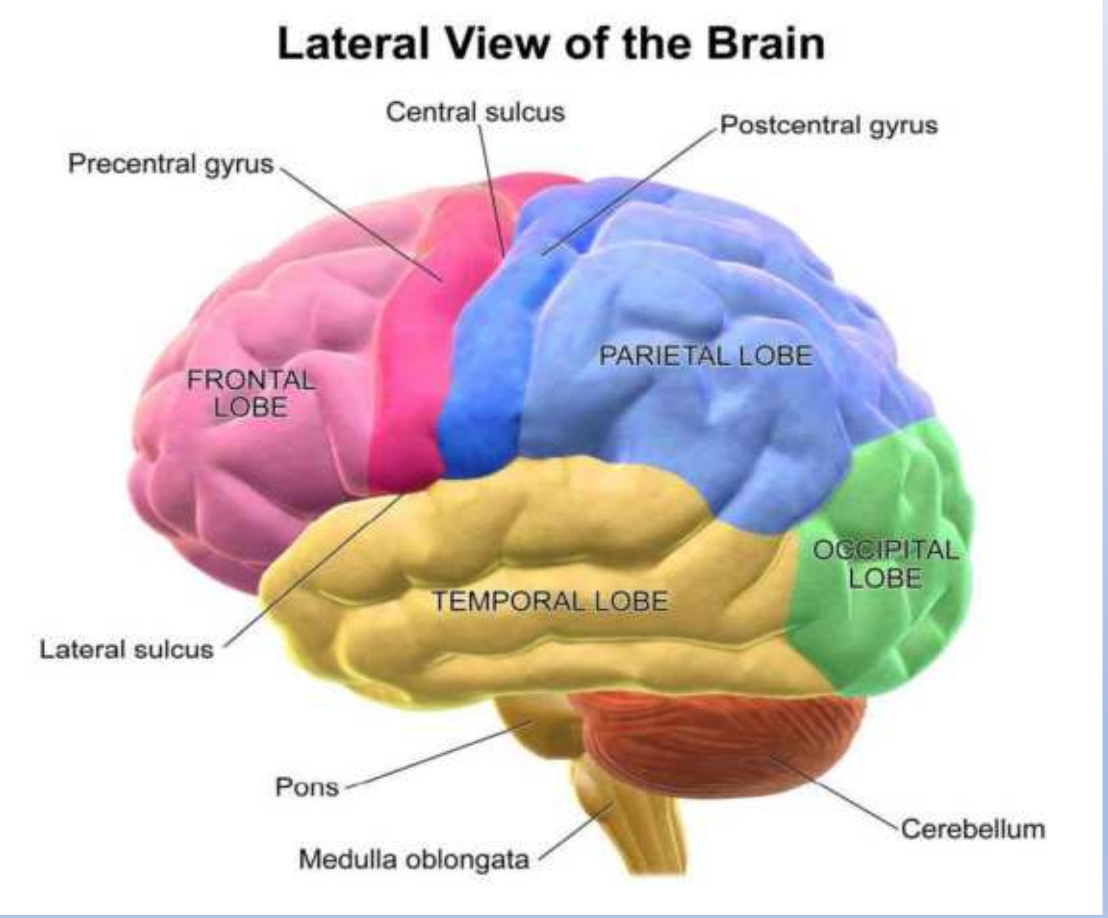
IMsc =Human Physiology

Parts of the brain





Brain



- The brain is a complex organ that controls thought, memory, emotion, touch, motor skills, vision, breathing, temperature, hunger and every process that regulates our body. Together, the brain and spinal cord that extends from it make up the central nervous system, or CNS. Weighing about 3 pounds in the average adult, the brain is about 60% fat. The remaining 40% is a combination of water, protein, carbohydrates and salts. The brain itself is a not a muscle. It contains blood vessels and nerves, including neurons and glial cells.

Deeper structures within the Brain

- **Pituitary Gland**
- Sometimes called the “master gland,” the pituitary gland is a pea-sized structure found deep in the brain behind the bridge of the nose. The pituitary gland governs the function of other glands in the body, regulating the flow of hormones from the thyroid, adrenals, ovaries and testicles. It receives chemical signals from the hypothalamus through its stalk and blood supply.
- **Hypothalamus**
- The hypothalamus is located above the pituitary gland and sends it chemical messages that control its function. It regulates body temperature, synchronizes sleep patterns, controls hunger and thirst and also plays a role in some aspects of memory and emotion.
- **Amygdala**
- Small, almond-shaped structures, an amygdala is located under each half (hemisphere) of the brain. Included in the limbic system, the amygdalae regulate emotion and memory and are associated with the brain’s reward system, stress, and the “fight or flight” response when someone perceives a threat.
- **Hippocampus**
- A curved seahorse-shaped organ on the underside of each temporal lobe, the hippocampus is part of a larger structure called the hippocampal formation. It supports memory, learning, navigation and perception of space. It receives information from the cerebral cortex and may play a role in Alzheimer’s disease.
- **Pineal Gland**
- The pineal gland is located deep in the brain and attached by a stalk to the top of the third ventricle. The pineal gland responds to light and dark and secretes melatonin, which regulates circadian rhythms and the sleep-wake cycle.

Parts of the brain

- 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. Other functions relate to vision, hearing, touch and other senses.
- **Cerebral Cortex**
- Cortex is Latin for "bark," and describes the outer gray matter covering of the cerebrum. The cortex has a large surface area due to its folds, and comprises about half of the brain's weight.
- The cerebral cortex is divided into two halves, or hemispheres. It is covered with ridges (gyri) and folds (sulci). The two halves join at a large, deep sulcus (the interhemispheric fissure or the medial longitudinal fissure) that runs from the front of the head to the back. The right hemisphere controls the left side of the body, and the left half controls the right side of the body. The two halves communicate with one another through a large, C-shaped structure of white matter and nerve pathways called the corpus callosum. The corpus callosum is in the center of the cerebrum.

Brain stem

- 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. These features facilitate various functions, from hearing and movement to calculating responses and environmental changes. The midbrain also contains the substantia nigra, an area affected by Parkinson's disease that is rich in dopamine neurons and part of the basal ganglia, which enables movement and coordination.
- **Pons.** The pons is the origin for four of the 12 cranial nerves, which enable a range of activities such as tear production, chewing, blinking, focusing vision, balance, hearing and facial expression. Named for the Latin word for "bridge," the pons is the connection between the midbrain and the medulla.
- **Medulla.** At the bottom of the brainstem, the medulla is where the brain meets the spinal cord. The medulla is essential to survival. Functions of the medulla regulate many bodily activities, including heart rhythm, breathing, blood flow, and oxygen and carbon dioxide levels. The medulla produces reflexive activities such as sneezing, vomiting, coughing and swallowing.

CEREBELLUM

- The cerebellum ("little brain") is a fist-sized portion of the brain located at the back of the head, below the temporal and occipital lobes and above the brainstem. Like the cerebral cortex, it has two hemispheres. The outer portion contains neurons, and the inner area communicates with the cerebral cortex. Its function is to coordinate voluntary muscle movements and to maintain posture, balance and equilibrium. New studies are exploring the cerebellum's roles in thought, emotions and social behavior, as well as its possible involvement in addiction, autism and schizophrenia.
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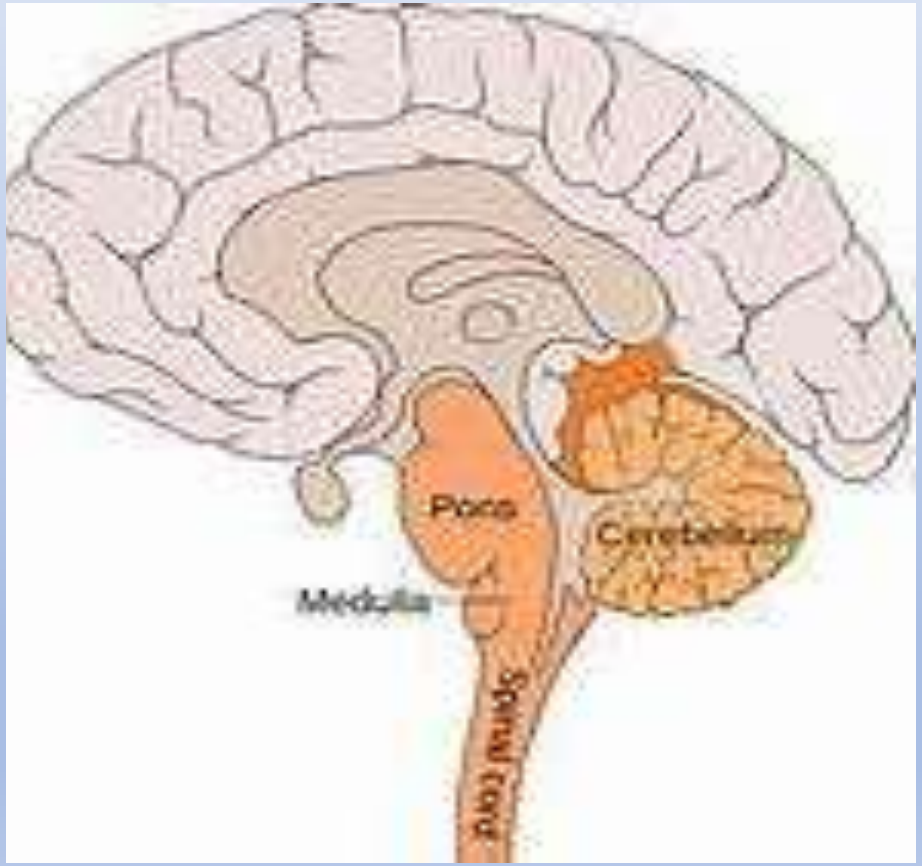

LOBES OF THE BRAIN

- Each brain hemisphere (parts of the cerebrum) has four sections, called lobes: frontal, parietal, temporal and occipital. Each lobe controls specific functions.
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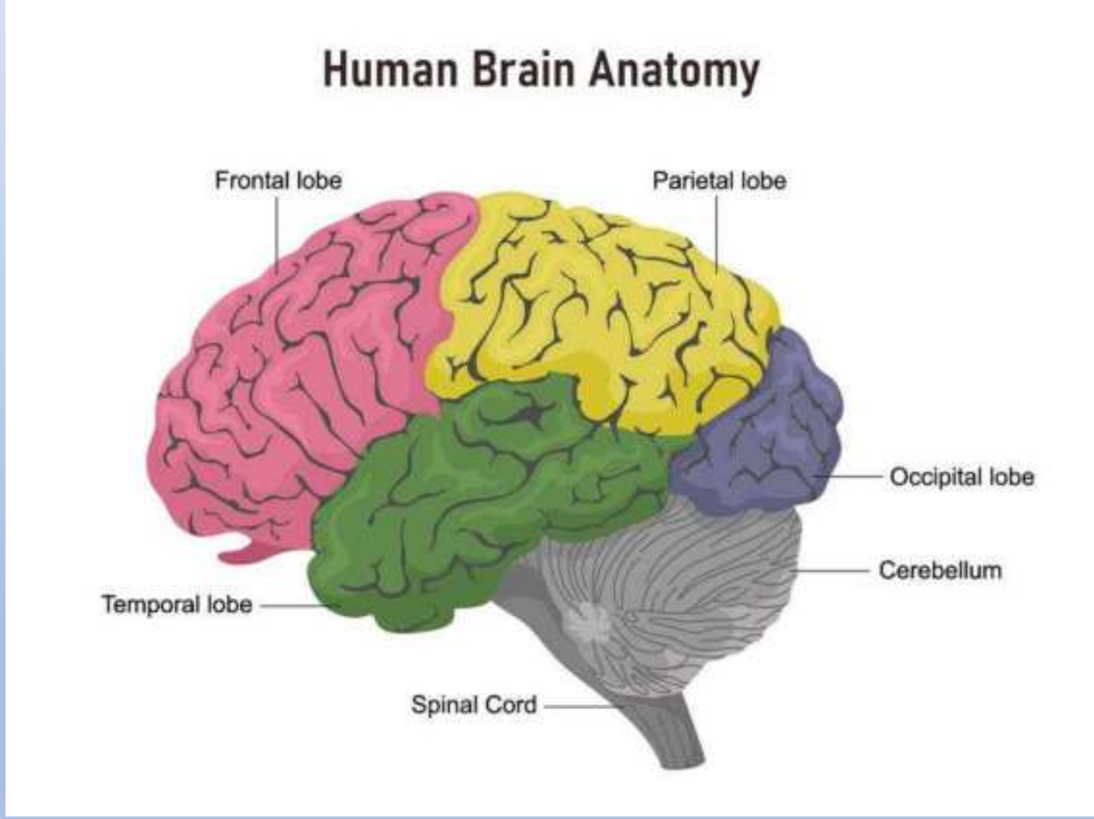
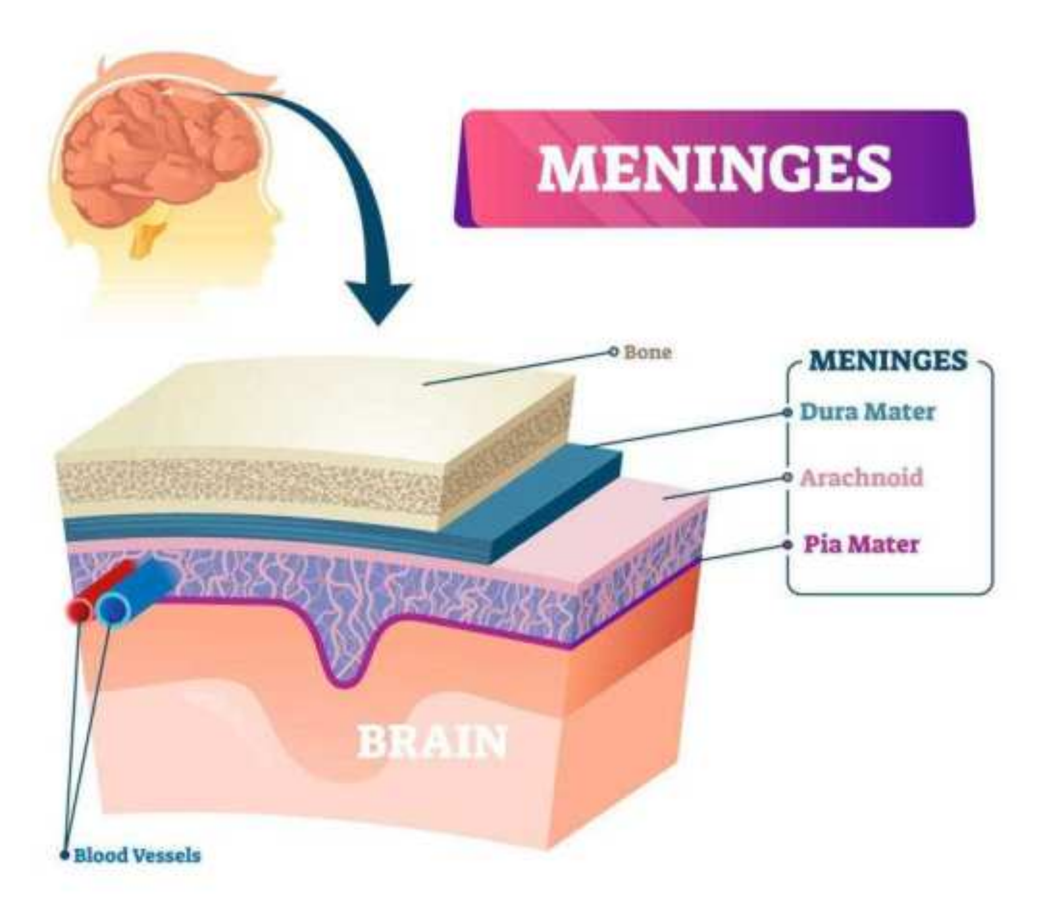


The brain lobe and its functions

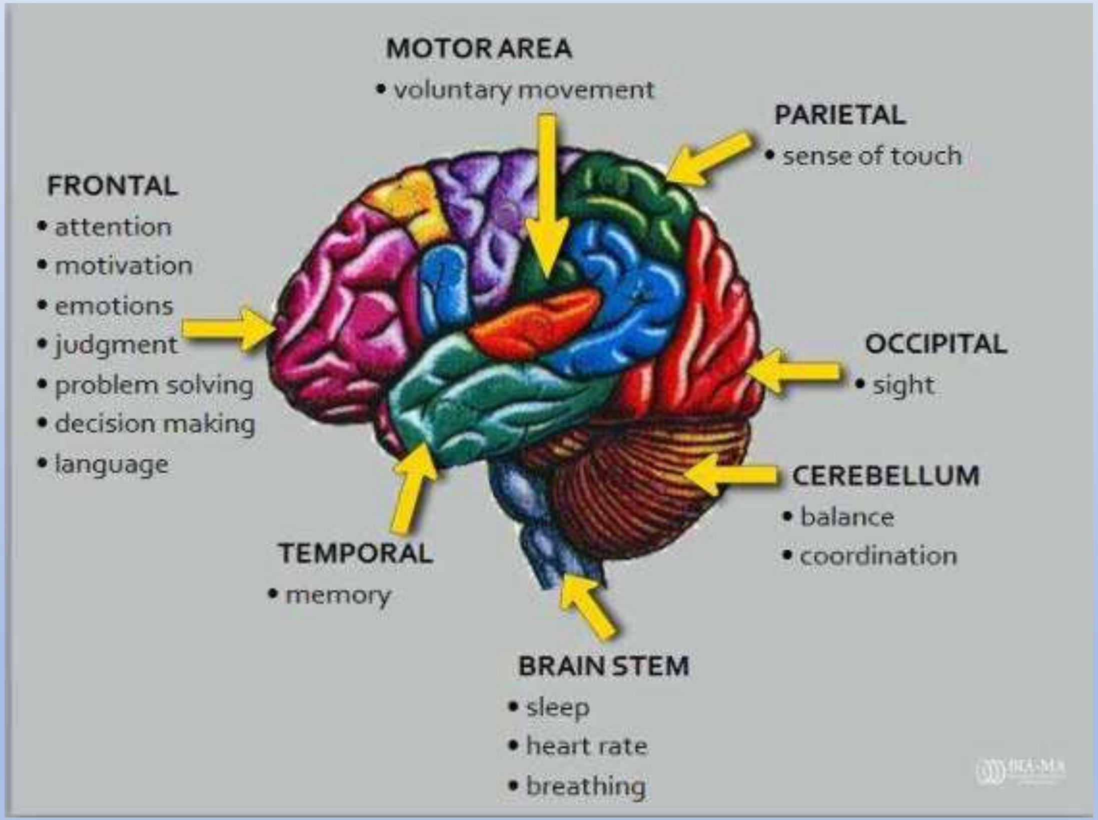
- **Frontal lobe.** The largest lobe of the brain, located in the front of the head, the frontal lobe is involved in personality characteristics, decision-making and movement. Recognition of smell usually involves parts of the frontal lobe. The frontal lobe contains Broca's area, which is associated with speech ability.
- **Parietal lobe.** The middle part of the brain, the parietal lobe helps a person identify objects and understand spatial relationships (where one's body is compared with objects around the person). The parietal lobe is also involved in interpreting pain and touch in the body. The parietal lobe houses Wernicke's area, which helps the brain understand spoken language.
- **Occipital lobe.** The occipital lobe is the back part of the brain that is involved with vision.
- **Temporal lobe.** The sides of the brain, temporal lobes are involved in short-term memory, speech, musical rhythm and some degree of smell recognition.

Brain covering -MENNINGES



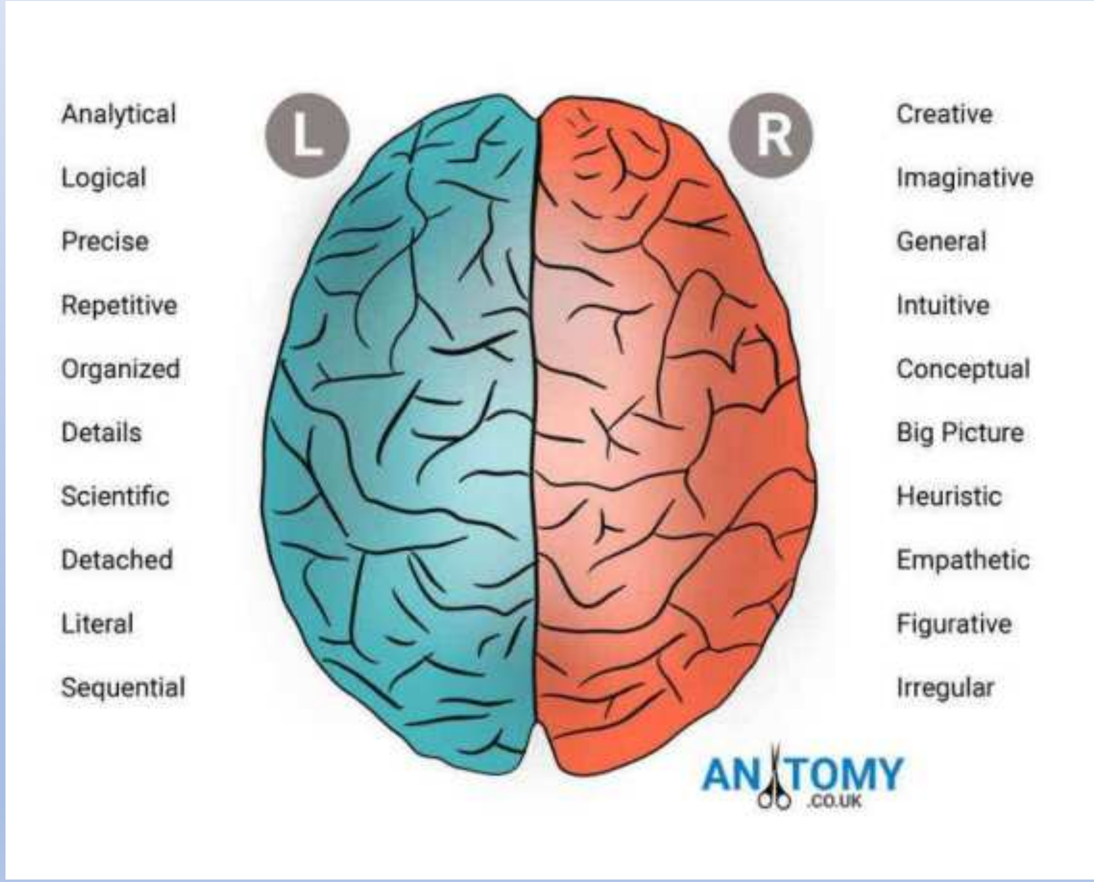
- Three layers of protective covering called **meninges** surround the brain and the spinal cord.
- The outermost layer, the **dura mater**, is thick and tough. It includes two layers: The periosteal layer of the dura mater lines the inner dome of the skull (cranium) and the meningeal layer is below that. Spaces between the layers allow for the passage of veins and arteries that supply blood flow to the brain.
- The **arachnoid** mater is a thin, weblike layer of connective tissue that does not contain nerves or blood vessels. Below the arachnoid mater is the cerebrospinal fluid, or CSF. This fluid cushions the entire central nervous system (brain and spinal cord) and continually circulates around these structures to remove impurities.
- The **pia mater** is a thin membrane that hugs the surface of the brain and follows its contours. The pia mater is rich with veins and arteries.

Areas of the brain



- Cranial Nerves
- Inside the cranium (the dome of the skull), there are 12 nerves, called cranial nerves:
- Cranial nerve 1: The first is the **olfactory nerve,** which allows for your sense of smell.
- Cranial nerve 2: The **optic nerve** governs eyesight.
- Cranial nerve 3: The **oculomotor nerve** controls pupil response and other motions of the eye, and branches out from the area in the brainstem where the midbrain meets the pons.
- Cranial nerve 4: The **trochlear nerve** controls muscles in the eye. It emerges from the back of the midbrain part of the brainstem.
- Cranial nerve 5: The **trigeminal nerve** is the largest and most complex of the cranial nerves, with both sensory and motor function. It originates from the pons and conveys sensation from the scalp, teeth, jaw, sinuses, parts of the mouth and face to the brain, allows the function of chewing muscles, and much more.
- Cranial nerve 6: The **abducens nerve** innervates some of the muscles in the eye.
- Cranial nerve 7: The **facial nerve** supports face movement, taste, glandular and other functions.
- Cranial nerve 8: The **vestibulocochlear nerve** facilitates balance and hearing.
- Cranial nerve 9: The **glossopharyngeal nerve** allows taste, ear and throat movement, and has many more functions.
- Cranial nerve 10: The **vagus nerve** allows sensation around the ear and the digestive system and controls motor activity in the heart, throat and digestive system.
- Cranial nerve 11: The **accessory nerve** innervates specific muscles in the head, neck and shoulder.
- Cranial nerve 12: The **hypoglossal nerve** supplies motor activity to the tongue.
- The first two nerves originate in the cerebrum, and the remaining 10 cranial nerves emerge from the brainstem, which has three parts: the midbrain, the pons and the medulla.

- **The Brain Hemispheres**
- The leading hemisphere in 98% of humans is the left one, responsible for logical reasoning, different skills, and communication.
- The right hemisphere is in charge for symbolic thinking and imagination. It is related to non-verbal expression, such as: Intuition, recognition of voices, faces or melodies. In the right hemisphere views and memories are manifested through images. In left-handed people roles are inverted.
- The left hemisphere lean towards dominance because it is located in two specialized zones: the Broca area, the motor cortex that directs the speech, and the Wernicke area, responsible for verbal understanding. The left hemisphere is dominant in most people, related to the verbal section, as well as the ability to analyze, logical reasoning, or mathematical problem resolving.
- The corpus callosum is located at the bottom of the interhemispheric fissure, in control for the connection between the two cerebral hemispheres. This frame, conformed by nerve fibers (involved in myelin), is responsible for information exchange among the different regions of the cerebral cortex.



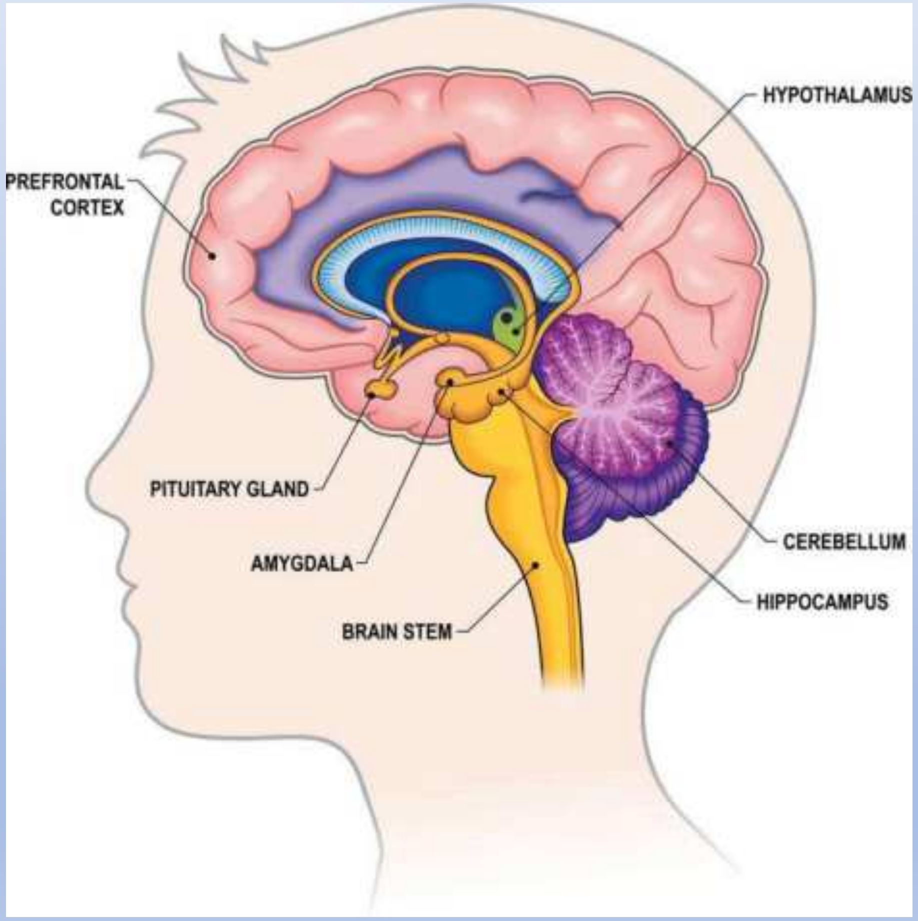
FUNCTIONS OF THE BRAIN

- Physiological functions of human brain involves in reception of information from the body, understanding it (through cognitive process), and guiding the body’s reply. Brain is the maximum responsible of the thinking and motion the body generates. The human brain also mediates in vital actions such as: To breath, to control blood pressure, and to release hormones. The brain allows human being to interact successfully with the environment, by communicating and interacting with others.
- Extensive of the physiological functions of the brain involve reception of information from the rest of the body, interpreting the information, and supervisory the body’s response. The main human brain functions are to keep the organism alive, so that it can interact with the environment. All the human being deliberates, feels and does is connected to specific functions of his/her brain:
- **Sensitive functions**, reception and processing of data (information of the different perceived stimuli). The stimuli of external or internal origin are apprehended through different receptors. These relevant receivers transform the stimuli by energy indicators.
- **Motor functions**: The brain controls voluntary and involuntary actions. The motor cortex is located in the frontal lobe, ahead the Rolando fissure, a cleft located in the upper brain of the higher mammals. This area is the central sulcus of the brain, and is characterized by separating the parietal lobe from the frontal lobe.
- **Integrative functions** are mental activities such as learning, memory, attention, language etc. Most patients who suffer from a kind of brain damage lose some cognitive capability.
- **Cognitive functions** are those mental processes that let individual to receive, interpretive, select, lay-up, transform, develop and recover information from the environment. Cognition allow people to understand and link to the world around them. The daily human activities involve millions of connections, also complex mental computations between different brain areas, to get a proper working in the surrounding world. Main cognitive functions:

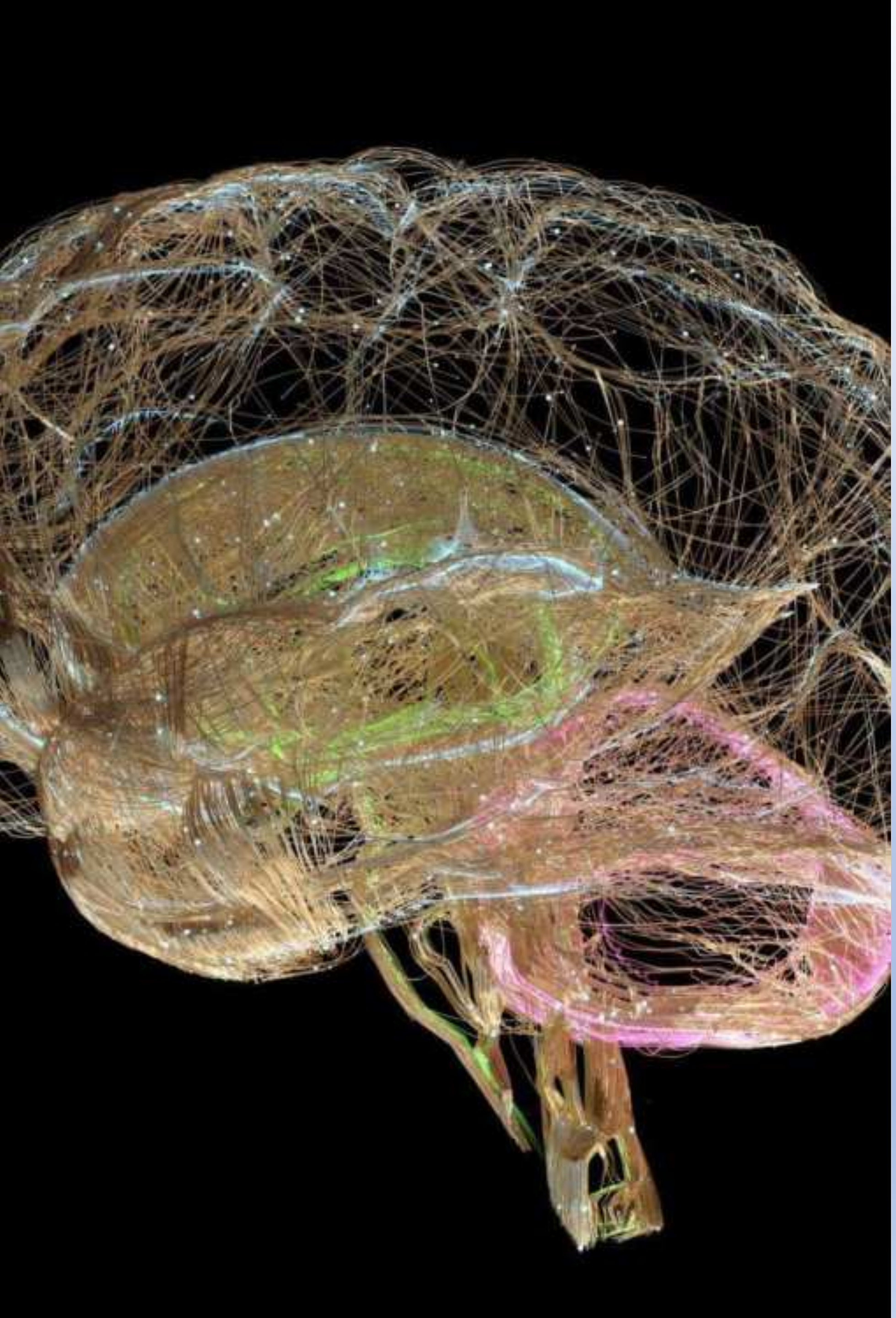
Blood supply to the brain

- Two sets of blood vessels supply blood and oxygen to the brain: the **vertebral arteries** and the **carotid arteries.**
- The external carotid arteries extend up the sides of your neck,(and are where you can feel your pulse when you touch the area with your fingertips.) The internal carotid arteries branch into the skull and circulate blood to the front part of the brain.
- The vertebral arteries follow the spinal column into the skull, where they join together at the brainstem and form the **basilar artery**, which supplies blood to the rear portions of the brain.
- The **circle of Willis**, a loop of blood vessels near the bottom of the brain that connects major arteries, circulates blood from the front of the brain to the back and helps the arterial systems communicate with one another.

CSF- cerebrospinal fluid



- Deep in the brain are four open areas with passageways between them. They also open into the central spinal canal and the area beneath arachnoid layer of the meninges.
- The ventricles manufacture **cerebrospinal fluid**, or CSF, a watery fluid that circulates in and around the ventricles and the spinal cord, and between the meninges. CSF surrounds and cushions the spinal cord and brain, washes out waste and impurities, and delivers nutrients.



Classification

- Structurally, the nervous system is classified into the central nervous system and the peripheral nervous system.
- Central nervous system. The CNS consists of the brain and the spinal cord. These organs occupy the dorsal body cavity and act as the INTEGRATING and COMMAND CENTERS of the nervous system. It is the CNS that interprets an incoming sensory information and sends and instruction basing on the past experience and current condition.
- Peripheral Nervous System. The PNS is consisting of the nerves that extend from the brain and the spinal cord. It is the part of the nervous system outside the CNS. There are varieties of nerves. The spinal nerves carry impulses to and from the spinal cord. The cranial nerves, on the other hand, carry impulses to and from the brain. These nerves serve as the communication lines of the body.

Somatic nervous system

- The somatic nervous system plays a vital role in initiating and controlling the movements of your body. The system is responsible for nearly all voluntary muscle movements, as well as for processing sensory information that arrives via external stimuli, including hearing, touch, and sight.The primary function of the somatic nervous system is to connect the central nervous system to the body's muscles to control voluntary movements and reflex arcs. The term somatic is drawn from the Greek word *soma*, which means "body," which is appropriate considering it is this system that transmits information back and forth between the central nervous system (CNS) and the rest of the body.

Somatic nervous system

- The somatic nervous system contains two major types of neurons (nerve cells):
- **Sensory neurons**, also known as afferent neurons, are responsible for carrying information from the body to the CNS.
- **Motor neurons**, also known as efferent neurons, are responsible for carrying information from the brain and spinal cord to muscle fibers throughout the body
- The neurons that make up the somatic nervous system project outwards from the CNS and connect directly to the muscles of the body, and carry signals from muscles and sensory organs back to the central nervous system.
- The body of the neuron is located in the CNS, and the axon (a portion of the neuron that carries nerve impulses away from the cell body) then projects and terminates in the skin, sensory organs, or muscles.

Autonomic nervous system

- autonomic nervous system includes a craniosacral parasympathetic portion and a thoracolumbar part sympathetic portion. These are sometimes thought of as being opposite to each other, ultimately striking a balance within the body. The sympathetic and parasympathetic functions:
- The parasympathetic is associated with rest and digestion. Its main function is to conserve the body’s energy and to help you sleep or break down and absorb the food you eat.
- The sympathetic is responsible for the "fight or flight" response that helps you quickly use your body's energy in an emergency situation—like running away from danger.
- The nerves of the autonomic nervous system synapse in a clump of nerves called a ganglion before the message is transmitted to the target organ, such as a salivary gland. This allows for another level of communication and control.

functions

the autonomic nervous system has many functions. The parasympathetic system performs basic housekeeping and controls things when you are at rest.

The sympathetic system is the emergency system and helps you carry out life-saving flight or fight responses

Sympathetic nervous sytems

- The Parasympathetic
- Many nerves of the parasympathetic portion of the autonomic nervous system begin in the nuclei in your brainstem. From there, they travel through cranial nerves such as the vagus nerve, which slows the heart rate, or the oculomotor nerve, which constricts the pupil of the eye. Parasympathetic stimulation also causes your eyes to tear and your mouth to salivate.
- Other parasympathetic nerves terminate in the walls of thoracic and abdominal organs like the esophagus, gastrointestinal tract, pharynx, heart, pancreas, gallbladder, kidney, and ureter. The sacral parasympathetic nerves synapse in ganglia in the walls of the colon, bladder, and other pelvic organs.

- The Sympathetic
- Sympathetic fibers of the autonomic nervous system exit the lateral (side) part of your spinal cord. They receive information from parts of the brain such as the brainstem and the hypothalamus.
- Fibers run from synapses in ganglia just outside the spinal column to their targets, usually along blood vessels. For example, the sympathetic nerves that dilate your pupils exit the spinal cord in your neck and synapse in the ganglion called the superior sympathetic ganglion, they then run along the carotid artery to your face and eye. The sympathetic nervous system supplies nerves to the abdominal and pelvic visceral organs, as well as hair follicles, sweat glands, and more.

REFLEX ARCS

- Reflex Arcs
- In addition to controlling voluntary muscle movements, the somatic nervous system is also associated with involuntary movements known as reflexes (or reflex actions), which are controlled by a neural pathway known as a reflex arc.
- Reflex arcs include sensory nerves that carry signals to the spinal cord, often connect with interneurons there, and then immediately transmit signals down the motor neurons to the muscles that triggered the reflex.[3]
- During a reflex, muscles move involuntarily without input from the brain. This occurs when a nerve pathway connects directly to the spinal cord.
- Examples of reflex actions include:
- Jerking your hand back after accidentally touching a hot pan
- Involuntary jerking when your doctor taps on your knee

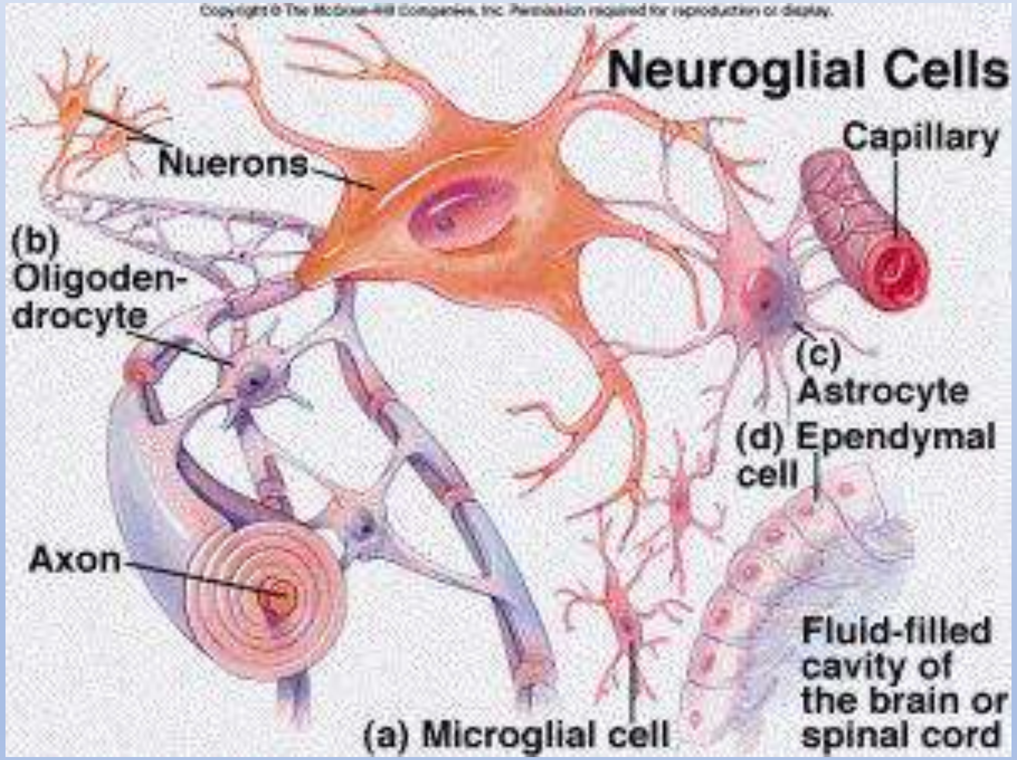
Autonomic nervous system

- The autonomic nervous system is the one that pertains to sympathetic and parasympathetic. The autonomic nervous system has three divisions: the **enteric nervous system**, the **sympathetic nervous system**, and the **parasympathetic nervous system**.
- *A key point to keep in mind with all three systems is that not only are all three involuntary, but all three systems are always at work. They regulate your body functions, at all times and cannot be switched off.*
- The **enteric nervous system** consists of neurons (nerve cells) that control your gastrointestinal tract. This system is sometimes referred to as a “second brain,” because it can work independently. While it typically communicates with the central nervous system through the sympathetic or parasympathetic nervous systems, it can function completely on its own.
- The **sympathetic nervous system** is responsible for preparing the body’s reactions to stress, injury, or perceived threats. This is commonly referred to as your “fight or flight” response. It is an involuntary reaction and happens in times of emergencies. The **sympathetic nervous system** originates in the thoracic and lumbar regions of the spine. The thoracic is in the middle of the back, and the lumbar is the lower back. The **sympathetic nervous system** has *short* neuron pathways and a *faster* system. This is because they must react quickly in times of stress and danger.
- The **parasympathetic nervous system** is responsible for preparing the body’s reactions at rest and maintaining homeostasis. Homeostasis is when a body seeks to maintain a condition of equilibrium regardless of outside influences. A common example is body temperature: regardless of the weather the human body always strives to maintain an internal temperature of 98.6 degrees Fahrenheit.
- The parasympathetic nervous system is commonly referred to as your “rest and digest” response. It is also an involuntary reaction and happens in non-emergency situations. The **parasympathetic nervous system** originates in the bottom region of the spinal cord (the sacral region) and the medulla oblongata (that connects the spinal cord to the brain stem). The **parasympathetic nervous system** has *longer* neuron pathways and is a much *slower* system. This is because they do not need to react quickly, and it can take a long time to counterbalance the effects of the sympathetic nervous system.

- the nervous system derives its name from nerves, which are cylindrical bundles of fibers that emanate from the brain and central cord, and branch repeatedly to innervate every part of the body. Even though it is complex, nervous tissue is made up of two principal types of cells namely, the supporting cells and the neurons

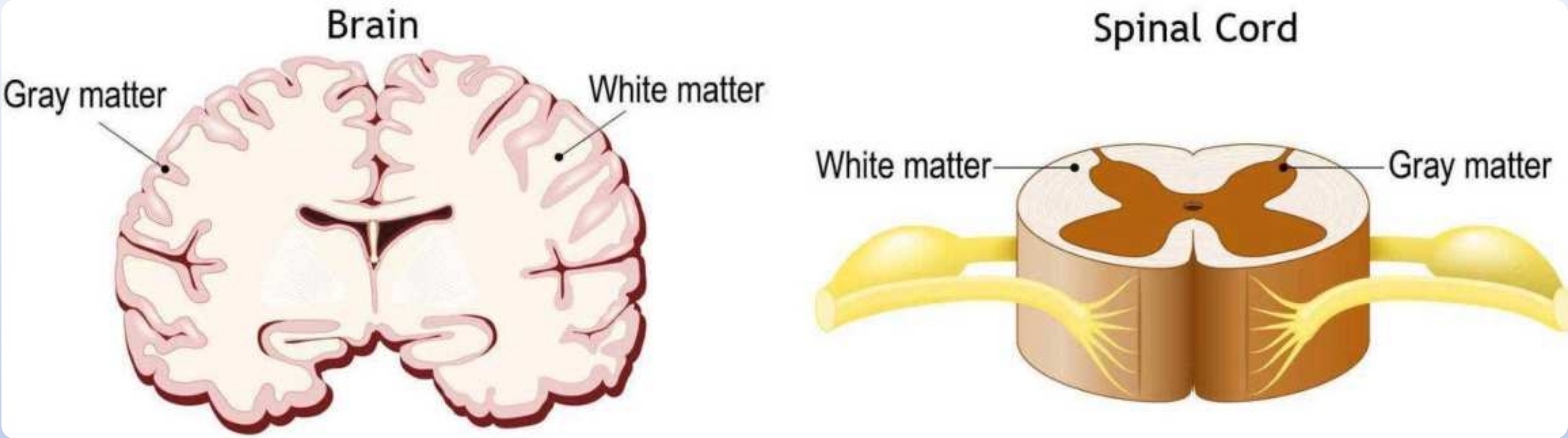
GLIAL CELLS

- The supporting cells in the CNS are “lumped together” as NEUROGLIA or GLIAL CELLS. Glial Cells are non-neuronal cells that provide support and nutrition, maintain homeostasis, form myelin and participate in signal transmission in the nervous system. In the human brain, it is estimated that the total number of glia roughly equals the number of neurons, although the proportions vary in different brain areas.
- The functions of glial cells are:
- to support neurons and hold them in place
- to supply nutrients to neurons
- to insulate neurons electrically
- to destroy pathogens and remove dead neurons
- to provide guidance cues directing the axons of neurons to their targets



SPINAL CORD

- The spinal cord is part of the central nervous system (CNS), which extends caudally and is protected by the bony structures of the vertebral column. It is covered by the three membranes of the CNS, i.e., the dura mater, arachnoid and the innermost pia mater. In most adult mammals it occupies only the upper two-thirds of the vertebral canal as the growth of the bones composing the vertebral column is proportionally more rapid than that of the spinal cord. According to its rostrocaudal location the spinal cord can be divided into four parts: cervical, thoracic, lumbar and sacral, two of these are marked by an upper (cervical) and a lower (lumbar) enlargement. Alongside the median sagittal plane the anterior and the posterior median fissures divide the cord into two symmetrical portions, which are connected by the transverse anterior and posterior commissures. On either side of the cord the anterior lateral and posterior lateral fissures represent the points where the ventral and dorsal rootlets (later roots) emerge from the cord to form the spinal nerves. Unlike the brain, in the spinal cord the grey matter is surrounded by the white matter at its circumference. The white matter is conventionally divided into the dorsal, dorsolateral, lateral, ventral and ventrolateral funiculi. Each half of the spinal grey matter is crescent-shaped, although the arrangement of the grey matter and its proportion to the white matter vary at different rostrocaudal levels. The grey matter can be divided into the dorsal horn, intermediate grey, ventral horn and a centromedial region surrounding the central canal (central grey matter) The white matter gradually ceases towards the end of the spinal cord and the grey matter blends into a single mass (conus terminalis) where parallel spinal roots form the so-called cauda equina.[1]

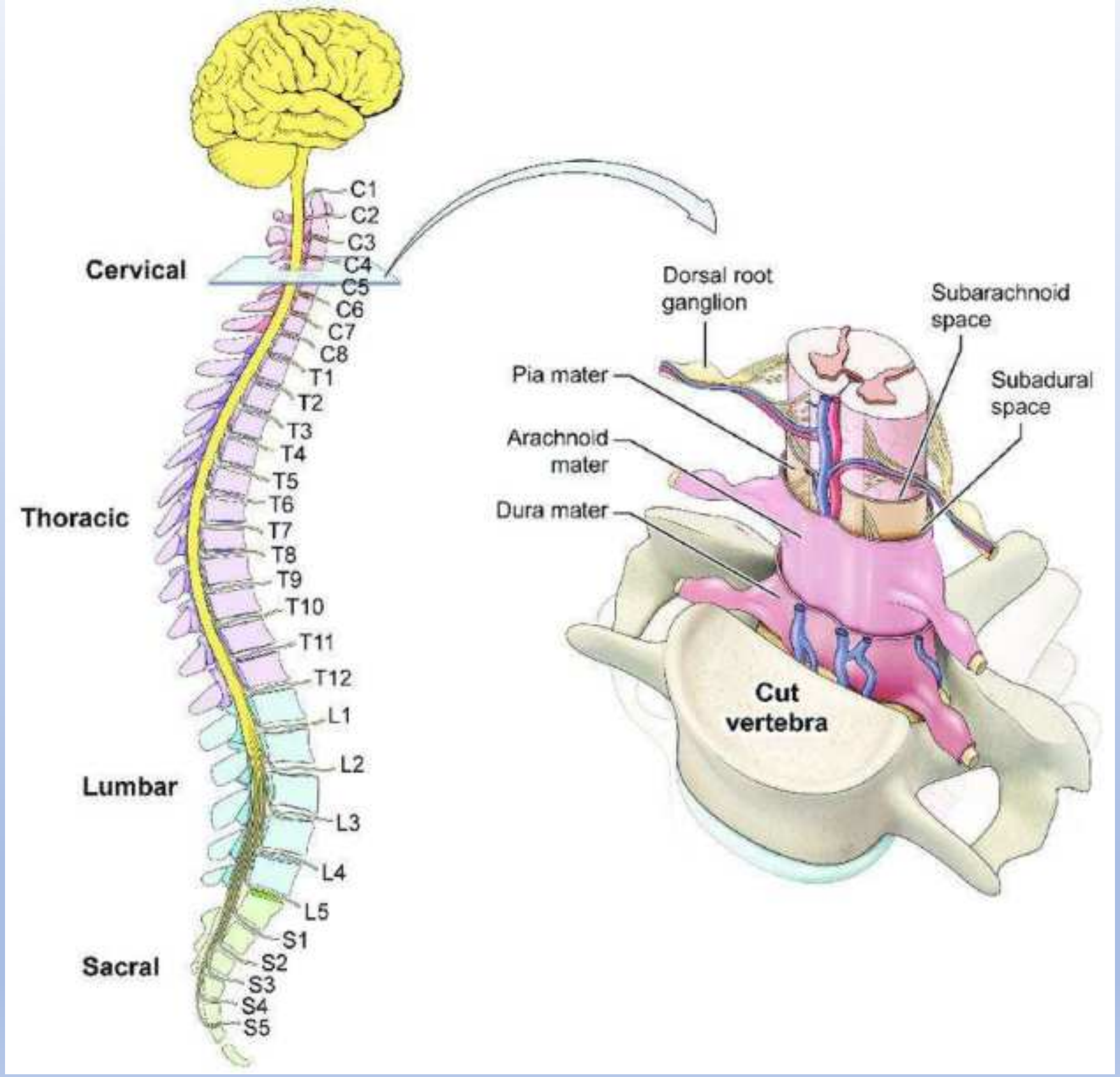


Grey and White Matter

Gray and white matter are two different regions of the central nervous system. In the brain, gray matter refers to the darker, outer portion, while white matter describes the lighter, inner section underneath. In the spinal cord, this order is reversed: The white matter is on the outside, and the gray matter sits within.

Spinal cord

- The Spinal cord runs through a hollow case from the skull enclosed within the vertebral column. Spinal nerves arise from different regions of the vertebral column and are named accordingly, the regions are – Neck, chest, pelvic and abdominal.
- Cross-section of spinal cord displays grey matter shaped like a butterfly surrounded by a white matter.
- Grey matter consists of the central canal at the centre and is filled with a fluid called CSF (Cerebrospinal fluid). It consists of horns (four projections) and forms the core mainly containing neurons and cells of the CNS. There are two dorsal and two ventral horns.
- The white matter consists of a collection of axons permitting communication between different layers of CNS. A tract is a collection of axons and carries specialized information. Ascending tracts and descending tracts send and transmit signals from the brain respectively to various nerve cells across the body.
- Spinal nerves act as mediators, communicating information to and from the rest of the body and the spinal cord. We have 31 pairs of spinal nerves.
- Three layers of meninges surround the spinal cord and spinal nerve roots.
- Dura mater
- Arachnoid mater
- Pia mater
- Dura mater consists of two layers- periosteal and meningeal. Epidural space is present between the two layers.
- Subarachnoid space lies between the arachnoid mater and pia mater. It is filled with cerebrospinal fluid



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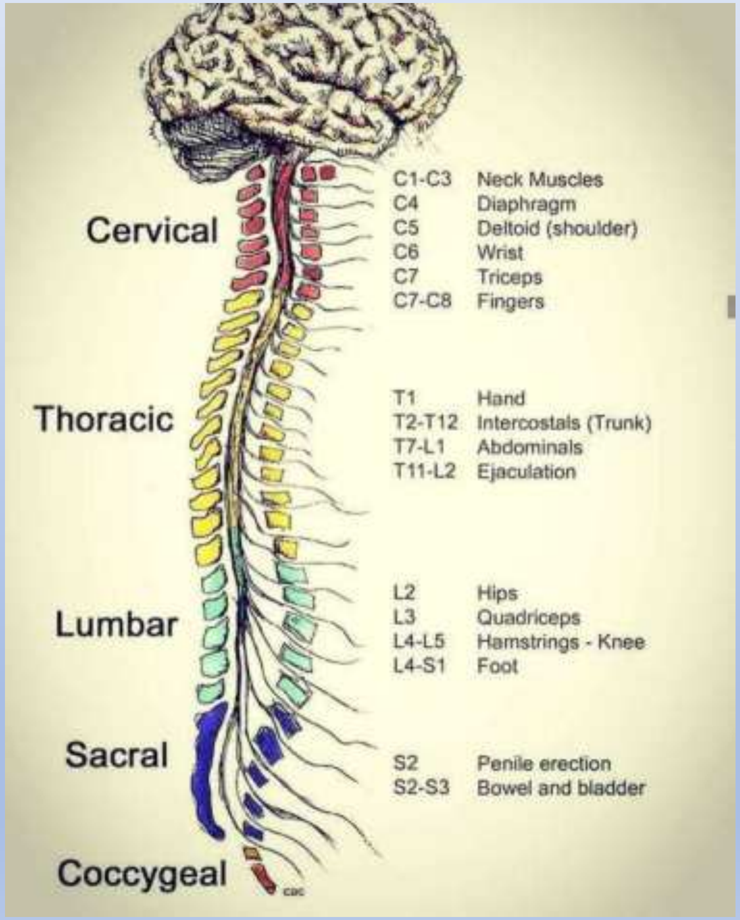
Cervical
Thoracic
Lumbar
Sacral
Dorsal root ganglion
Subarachnoid space
Subadural space
Pia mater
Arachnoid mater
Dura mater
Cut vertebra

Spinal nerves

- The spinal nerves consist of a group of 31 nerves. These nerves are attached to the spinal cord by two roots- dorsal sensory root and ventral motor root.
- The sensory root fibres carry sensory impulses to the spinal cord. The motor roots, on the contrary, carry impulses from the spinal cord.
- The spinal nerves carry messages to and from the skin of specific regions of the body called dermatomes.
- The spinal cord nerves can be grouped as:
- Cervical
- Thoracic
- Sacral
- Lumbar
- Coccygeal
- Cervical Nerves
- Cervical means of the neck. There are 8 cervical nerves that emerge from the cervical spine (C1-C8).
- Thoracic Nerves
- Thoracic means of the chest. There are 12 thoracic nerves that emerge from the thoracic spine (T1-T12).
- Lumbar Nerves
- Lumbar means from the lower back region. There are 5 lumbar nerves that emerge from the lumbar spine (L1-L5).
- Sacral Nerves
- Sacral means of the sacrum. The sacrum is a bony plate at the base of the vertebral column.
- There are 5 sacral nerves that emerge from the sacral bone (S1-S5).
- Coccygeal Nerves
- Coccygeal means of the tailbone. There is 1 nerve that emerges from the coccygeal bon



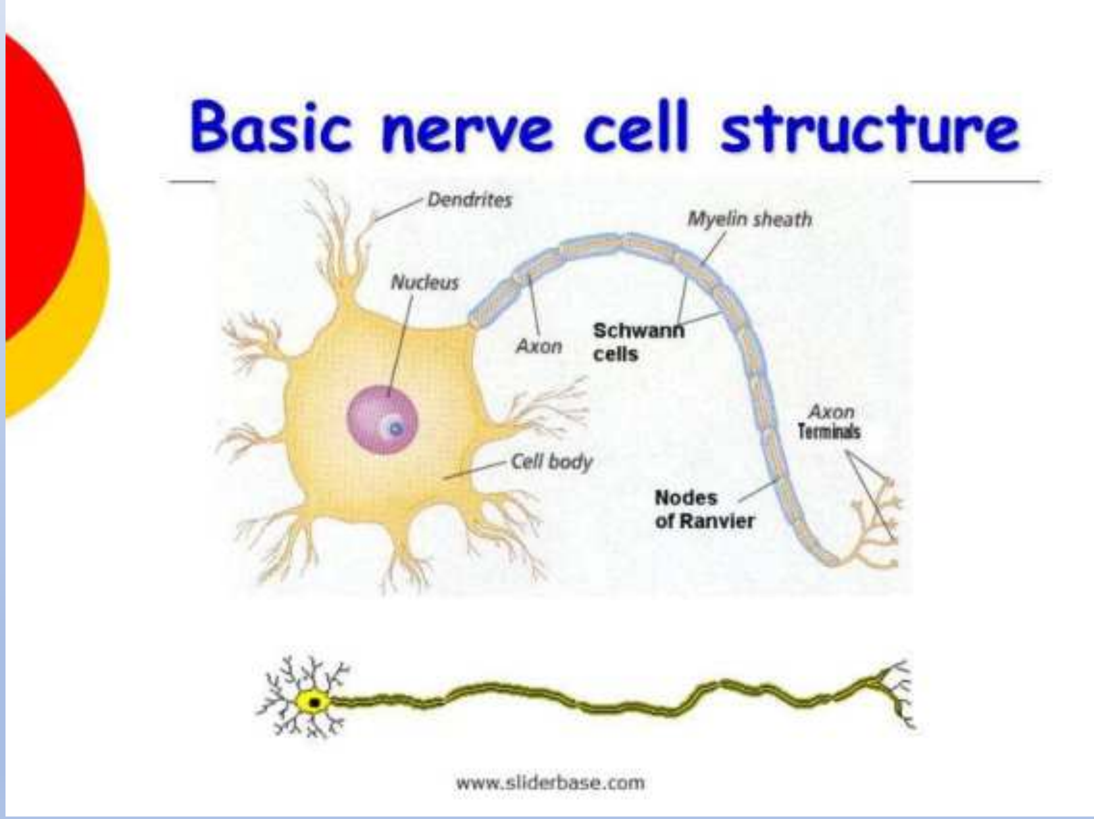
Functions of the Spinal Cord

- The spinal cord is a highly organized and complex part of the central nervous system. Its complexity is due to the role it plays in the 3 most important functions of the individual: sensation, autonomic and motor control. If it was to simply report to the brain the information that it receives from the large number and variety of afferent inputs and relay back to the motoneurons and preganglionic neurons the outcome of processing performed by the supraspinal centres the situation would be more straight forward. However, as is well established, this is not the case and the spinal cord has, in addition to relaying information from the rest of the body to the brain and receiving efferent commands from varied portions of the brain the ability to integrate and modify both afferent signals from the periphery, and efferent signals from segmental afferents and supraspinal centres. Thus there is a complicated network of neurons that normally operates in conjunction with the rest of the CNS to allow perfect control of sensory, autonomic and motor functions. This complex circuitry is critically dependent on its connections with the brain and it can not function appropriately when it is either completely or even partially disconnected from it. It is rather regrettable, that we understand so little of the potential of the complex intrinsic circuitry of the spinal cord that when it looses connection with the brain we are unable to exploit its' potential function and restore deficits caused by spinal cord lesions.
- In spite of the fact that the physiology of the spinal cord has been intensively investigated for at least a century it keeps revealing new surprising phenomena.

FUNCTIONS OF THE SPINAL CORD

- **Sensory Processing**
- **Pain and Temperature**
- **Touch and Tactile Discrimination**
- **Motor Control**
- **Reflexes - Patterned Movements Organised by the Circuitry of the Spinal Cord**
- **Autonomic Function**

Neurons



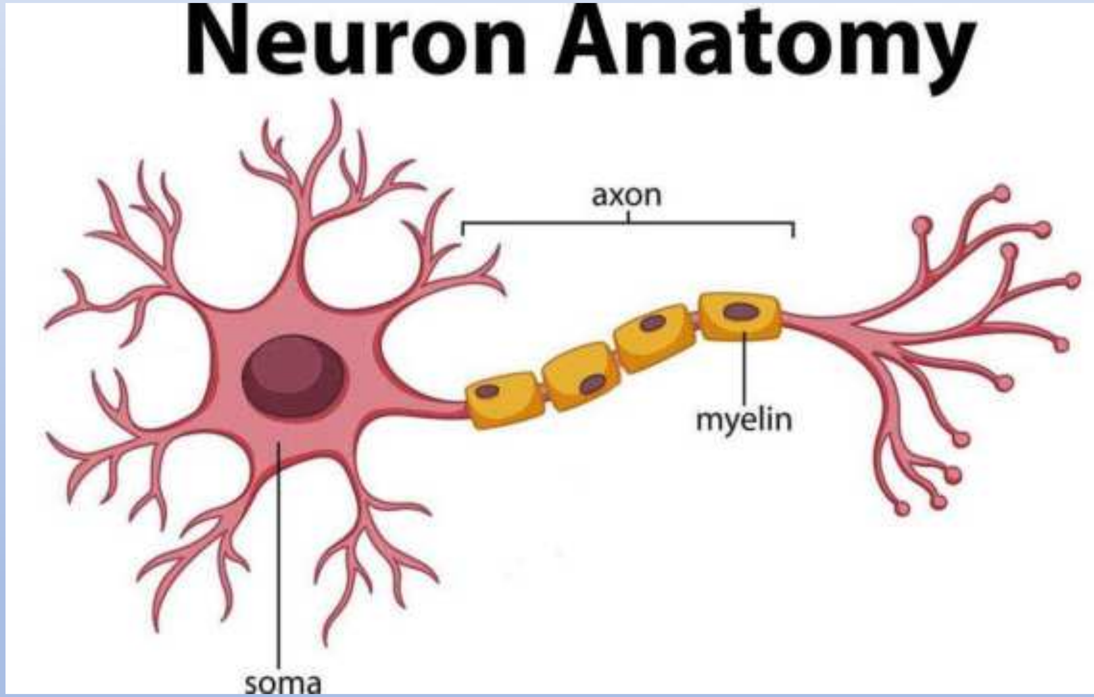
- Neurons are the information processing units of the brain which have a responsibility for sending, receiving, and transmitting electrochemical signals throughout the body.
- Neurons, also known as nerve cells, are essentially the cells that make up the brain and the nervous system. Neurons do not touch each other, but where one neuron comes close to another neuron, a synapse is formed between the two.

Neuron -function

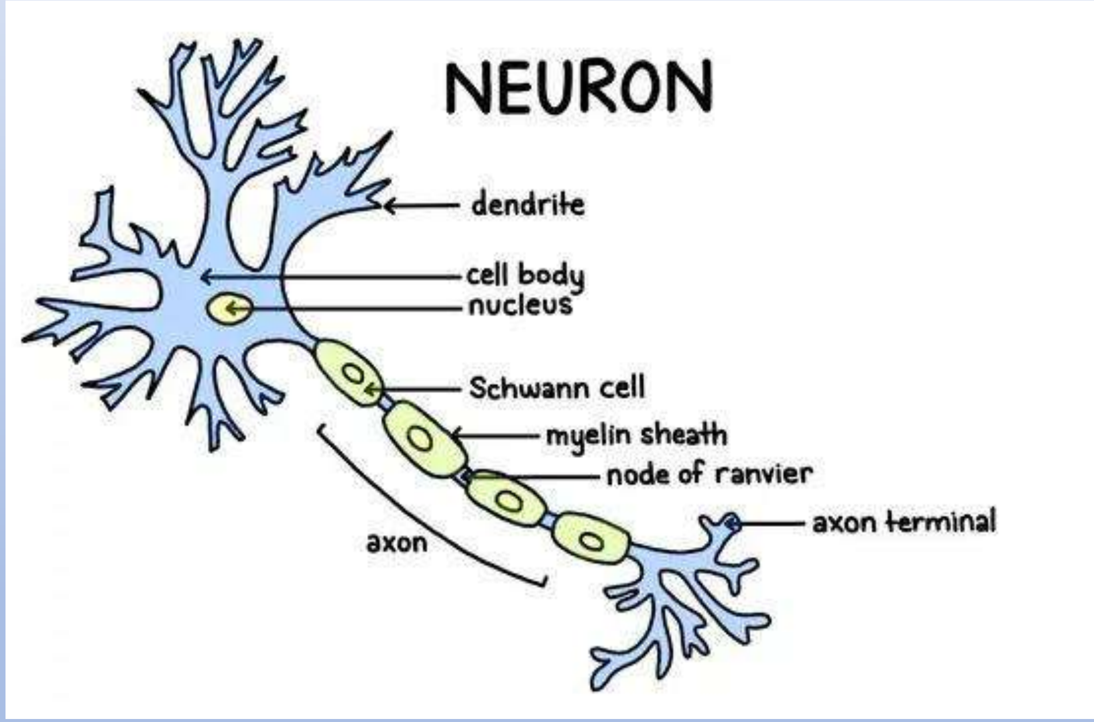
- The function of a neuron is to transmit nerve impulses along the length of an individual neuron and across the synapse into the next neuron.
- The central nervous system, which comprises the brain and spinal cord, and the peripheral nervous system, which consists of sensory and motor nerve cells all contain these information processing neurons.
- According to new research, the human brain contains around 86 billons neurons (Herculano-Houzel, 2009). These cells develop around fully around the time of birth but unlike other cells, cannot reproduce or regenerate once they die.

Neuron

- . Gray matter is primarily composed of neuron somas (the round central cell bodies), and white matter is mostly made of axons (the long stems that connects neurons together) wrapped in myelin (a protective coating). The different composition of neuron parts is why the two appear as separate shades on certain scans Each region serves a different role. Gray matter is primarily responsible for processing and interpreting information, while white matter transmits that information to other parts of the nervous system.



Neuron -structure



- The neuron contains the soma (cell body) from which extend the axon (a nerve fiber conducting electrical impulses away from the soma) and dendrites (tree-like structures that receive signals from other neurons). The [myelin sheath](#) is an insulating layer that forms around the axon and allows nerve impulses to transmit more rapidly along the axon.
- Neurons do not touch each other, and there is a gap, called the synapse, between the axon of one neuron the dendrite of the next.
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Soma ---- Myelin sheath

- The soma, or cell body, is essentially the core of the neuron. The soma’s function is to maintain the cell and to keep the neuron functioning efficiently (Luengo-Sanchez et al., 2015).
- The soma is enclosed by a membrane which protects it, but also allows it to interact with its immediate surroundings.
- The soma contains a cell nucleus which produces genetic information and directs the synthesis of proteins. These proteins are vital for other parts of the neuron to function.

- The myelin sheath is a layer of fatty material that covers the axons of neurons. Its purpose is to insulate one nerve cell from another and so to prevent the impulse from one neuron from interfering with the impulse from another. The second function of the myelin sheath is to speed up the conduction of nerve impulses along the axon.
- The axons which are wrapped in cells known as glial cells (also known as oligodendrocytes and Schwann cells) form the myelin sheath.
- The myelin sheath which surrounds these neurons has a purpose to insulate and protect the axon. Due to this protection, the speed of transmission to other neurons is a lot faster than the neurons that are unmyelinated.
- The myelin sheath is made up of broken up gaps called nodes of Ranvier. Electrical signals are able to jump between the nodes of Ranvier which helps in speeding up the transmission of signals.

Dendrites and Axons

- Dendrites are the tree-root-shaped part of the neuron which are usually shorter and more numerous than axons. Their purpose is to receive information from other neurons and to transmit electrical signals towards the cell body.
- Dendrites are covered in synapses, which allows them to receive signals from other neurons. Some neurons have short dendrites, whilst others have longer ones.
- In the central nervous system, neurons are long and have complex branches that can allow them to receive signals from many other neurons.
- For instance, cells called Purkinje cells which are found in the cerebellum have highly developed dendrites to receive signals from thousands of other cells.

- The axon, also called a nerve fiber, is a tail-like structure of the neuron which joins the cell body at a junction called the axon hillock.
- The function of the axon is to carry signals away from the cell body to the terminal buttons, in order to transmit electrical signals to other neurons.
- Most neurons just have one axon which can range in size from 0.1 millimeters to over 3 feet (Miller & Zachary, 2017). Some axons are covered in a fatty substance called myelin which insulates the axon and aids in transmitting signals quicker.
- Axons are long nerve processes that may branch off to transfer signals to many areas, before ending at junctions called synapses.

Neuro transmitters

- A neurotransmitter is a chemical messenger that allow nerve cells to communicate with each other. A neurotransmitter signal travels from a neuron, across the synapse, to the next neuron. The synapse is the name given to the space between the two neurons. Neurotransmitters are important in boosting and balancing signals in the brain and for keeping the brain functioning. They help manage automatic responses such as breathing and heart rate, but they also have psychological functions such as learning, managing mood, fear, pleasure, and happiness.
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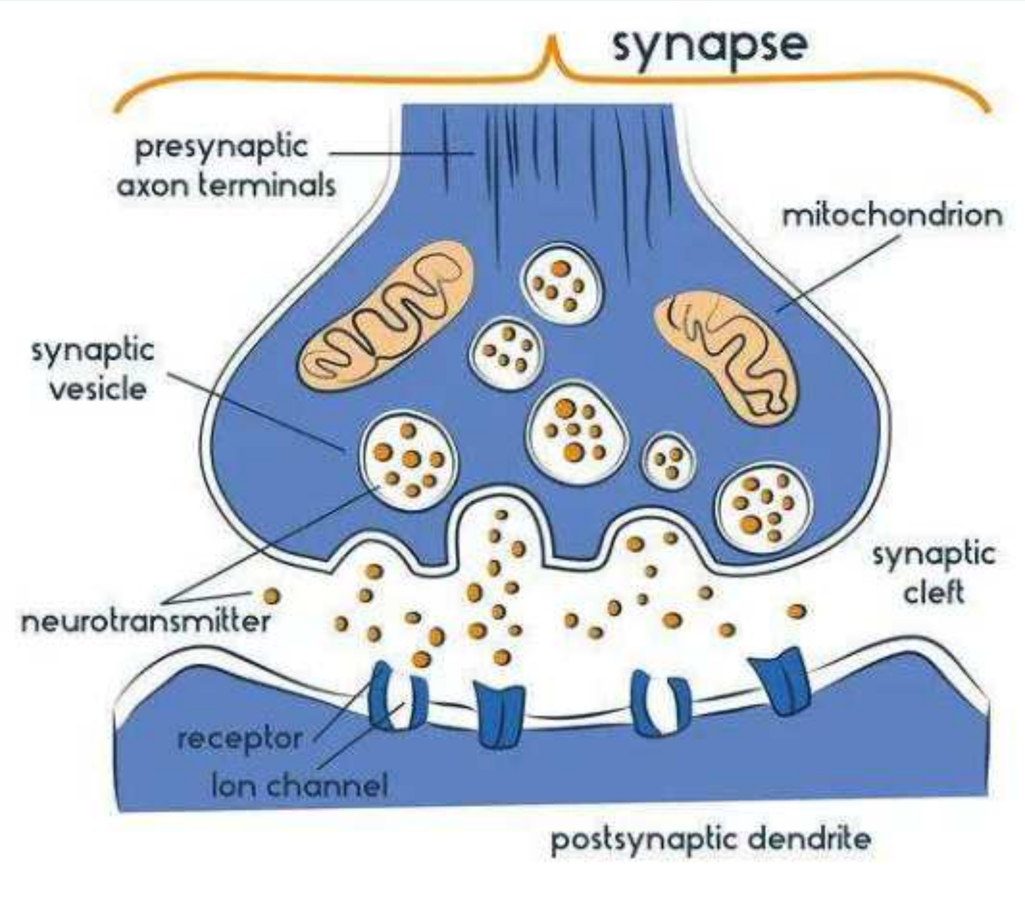


- In order for neurons to send messages via neurotransmitters, they need to communicate with each other, which they do through synapses.
- When signals travel through a neuron and reach the end of that neuron, they cannot simply travel through to the next one. Instead, the neuron must trigger the release of neurotransmitters, which then carry signals across the synapses with the goal of reaching the next neuron.

Neurotransmitters

- During synaptic transmission, the action potential (an electrical impulse) triggers the synaptic vesicles of the pre-synaptic neuron to release neurotransmitters (a chemical message).
- These neurotransmitters diffuse across the synaptic gap (the gap between the pre and post-synaptic neurons) and bind to specialised receptor sites on the post-synaptic neuron.
- The neuron which released the neurotransmitters is called the presynaptic neuron. The neuron which receives the neurotransmitters is called the postsynaptic neuron.
- The end of each neuron has presynaptic endings and vesicles, which are sacks containing neurotransmitters.
- When a nerve impulse (or action potential) triggers the release of neurotransmitters, these chemicals are then released into the synapse and then is taken up by the receptors on the next neuron. This process is known as neurotransmission.

- The neurotransmitters released from the presynaptic neuron may either excite or inhibit the postsynaptic neuron, telling it to either release neurotransmitters, slow down the release, or stop signaling completely.
- After neurotransmission, the signal is terminated, allowing the neurons to return to a resting state. When neurotransmitters get released into the synapse, not all are able to be attached to the receptors of the postsynaptic neuron. However, the gap between the neurons needs to be clearer of neurotransmitters at signal termination.

Types of neurotransmitters

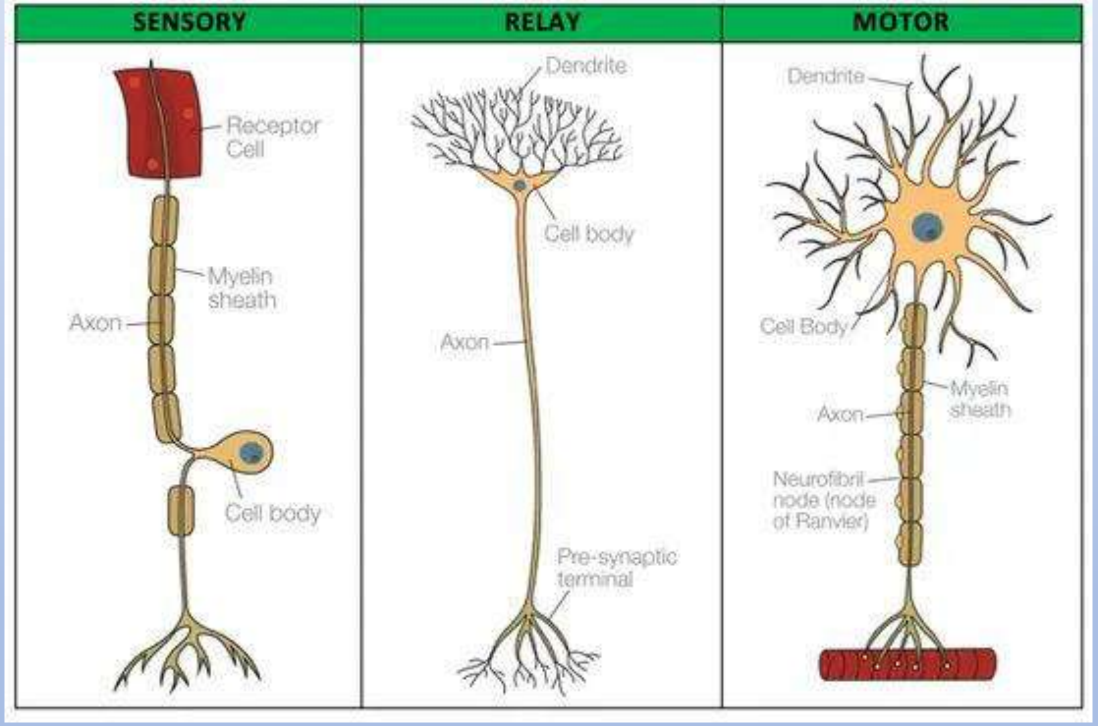
- A neurotransmitter can influence neurons in one of three ways: it can excite, inhibit, or modulate them.
- **Excitatory neurotransmitters** – these types have an excitatory/stimulating effect on the neurons. If a neurotransmitter is excitatory, it will increase the likelihood that the neuron will fire action potential. Examples of these types of neurotransmitter are epinephrine and norepinephrine.
- **Inhibitory neurotransmitters** – in contrast to excitatory neurotransmitters, inhibitory neurotransmitters have the opposite effect, inhibiting/hindering the neurons. If a neurotransmitter is inhibitory, it makes the likelihood of the neuron firing action potential will be decreased. Examples of these types of neurotransmitter are GABA and endorphins.
- **Modulatory neurotransmitters** – these are often called neuromodulators. If a neurotransmitter is a neuromodulate, this means it can affect a large number of neurons at the same time, as well as being able to influence the effects of other neurotransmitters. Neuromodulators do not directly activate the receptors of neurons but work together with neurotransmitters to enhance the excitatory or inhibitory responses of the receptors.Examples of these types of neurotransmitter are serotonin and dopamine.

Types of neurotansmitters

- Types
- There are over 50 known types of neurotransmitters. Some of the main classifications are described below in a few categories: monoamines, amino acids, peptides, purines, and acetylcholine.

Types of NEURONS

- Although there are billions of neurons and vast variations, neurons can be classified into three basic groups depending on their function: sensory neurons (long dendrites and short axons), motor neurons (short dendrites and long axons) and relay neurons (short dendrites and short or long axons).



AFFERENT NEURONS

- Sensory neurons (sometimes referred to as afferent neurons) are nerve cells which carry nerve impulses from sensory receptors towards the central nervous system and brain. When these nerve impulses reach the brain, they are translated into 'sensations', such as vision, hearing, taste and touch.
- This sensory information can be either physical – through sound, heat, touch, and light, or it can be chemical – through taste or smell. An example of this can be when touching an extremely hot surface. Once this happens, the sensory neurons will be sending signals to the central nervous system about the information they have received.
- Most sensory neurons are characterized as being pseudounipolar. This means that they have one axon which is split into two branches.

EFFERENT NEURONS

- Motor neurons (also referred to as efferent neurons) are the nerve cells responsible for carrying signals away from the central nervous system towards muscles to cause movement. They release neurotransmitters to trigger responses leading to muscle movement.
- Motor neurons are located in the brainstem or spinal cord (parts of the central nervous system) and connect to muscles, glands and organs throughout the body.
- These types of neurons transmit signals from the spinal cord and brainstem to skeletal and smooth muscle to either directly or indirectly control muscle movements.
- For instance, after touching a hot surface with your hand, the message has been received from the sensory neurons. The motor neurons then cause the hand to move away from the hot surface.
- There are two types of motor neurons:
- Lower motor neurons – these are neurons which travel from the spinal cord to the muscles of the body.
- Upper motor neurons – these are neurons which travel between the brain and the spinal cord.
- Motor neurons are characterized as being multipolar. This means that they have one axon and several dendrites projecting from the cell body.

INTERNEURONS

- A relay neuron (also known as an interneuron) allows sensory and motor neurons to communicate with each other. Relay neurons connect various neurons within the brain and spinal cord, and are easy to recognize, due to their short axons.
- Alike to motor neurons, interneurons are multipolar. This means they have one axon and several dendrites.
- As well as acting as a connection between neurons, interneurons can also communicate with each other through forming circuits of differing complexities.
- The communication between interneurons assists the brain to complete complex functions such as learning and decision-making, as well as playing a vital role in reflexes and neurogenesis – which means the regeneration of new neurons.

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