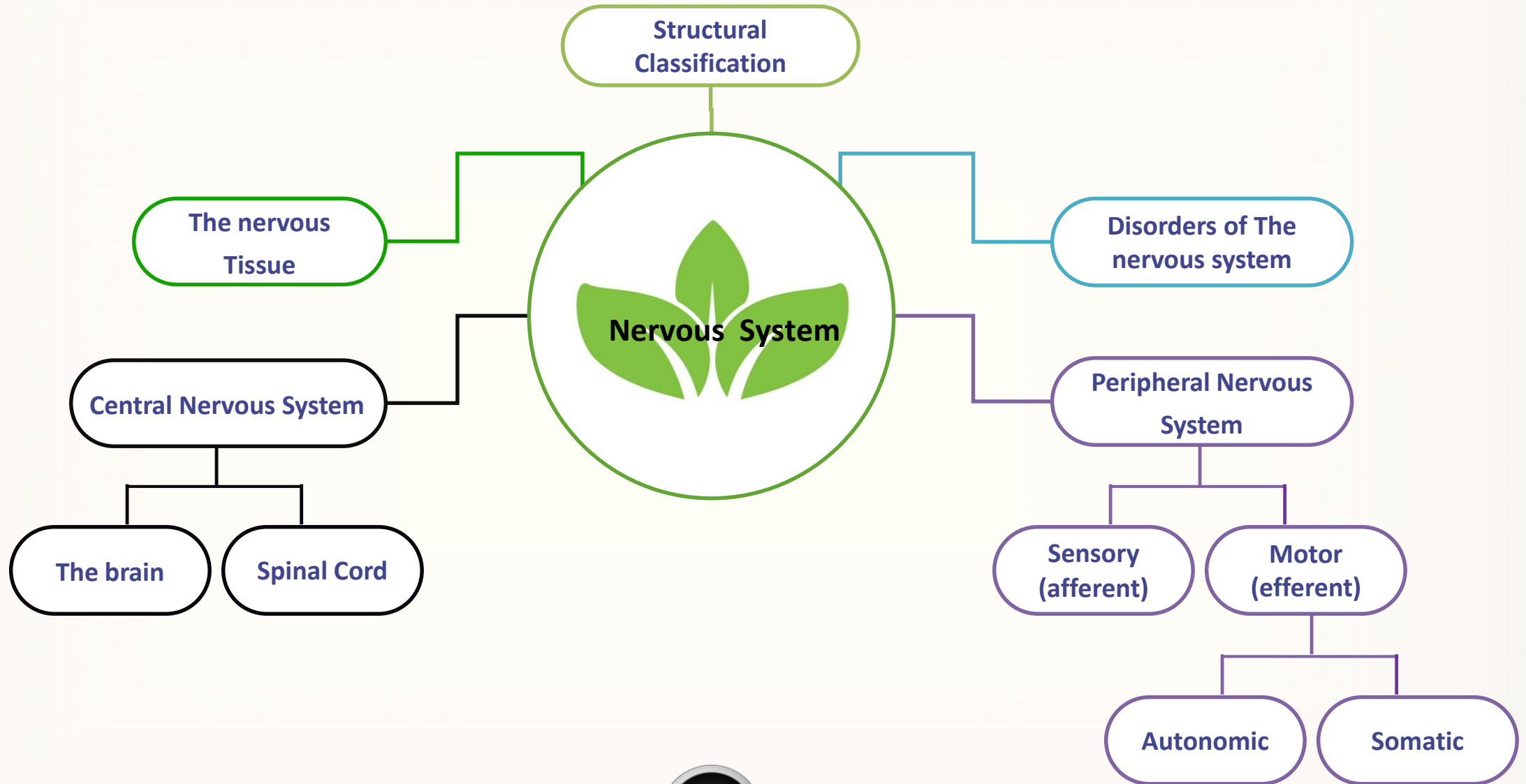
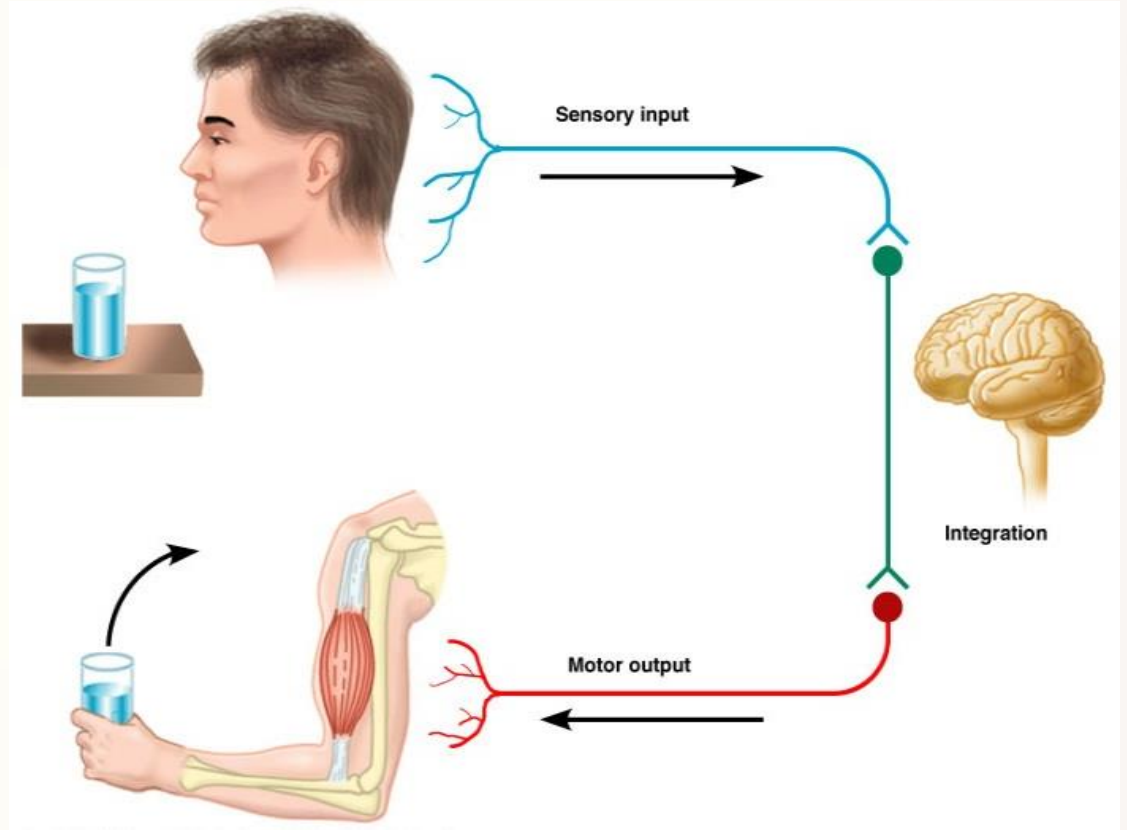


Mind Map



Preface

What can you figure out?



Index

1. Preface
2. Introduction
3. Objectives
4. First Activity
5. The nervous System
6. Structural Classification of the Nervous System
7. Classification of Neurons
8. Transmission of information
9. Middle Activity
10. The brain
 - Cerebral Hemispheres (Cerebrum)
 - Diencephalon
 - Brain Stem
 - Cerebellum
11. Protection of the CNS
12. Spinal Cord
13. Peripheral Nervous System
14. Disorders of The nervous system
15. Final Activity
16. Summary
17. Quiz



Introduction

- The nervous system is formed during the first month of embryonic development.
- The hypothalamus is one of the last areas of the brain to develop.
- No more neurons are formed after birth, but growth and maturation continues for several years (new evidence!)
- The brain reaches maximum weight as a young adult.
- However, we can always grow dendrites!

Functions

- Control center for all body activities
- Responds and adapts to changes that occur both inside and outside the body (Ex: pain, temperature, pregnancy).



Objectives

- Explain the difference between the central nervous system and the peripheral nervous system.
- Describe the structure and function of a neuron, of a synapse.
- Describe the function of a nerve impulse and how a nerve impulse is created.
- Give the major divisions of the brain and describe the general functions of each.
- Describe the structure and functions of the spinal cord.
- Explain the two divisions of the autonomic nervous system.
- Describe the differences between the somatic nervous system and autonomic nervous system.
- Describe the various diseases and disorders of the nervous system.



The nervous System

Structural Classification of the Nervous System

- **Central nervous system (CNS)**

- Brain
- Spinal cord

- **Peripheral nervous system (PNS)**

Nerve outside the brain and spinal cord.

Cranial nerves (12 pairs) & Spinal nerves (31 pairs)

- **Sensory (afferent) division**

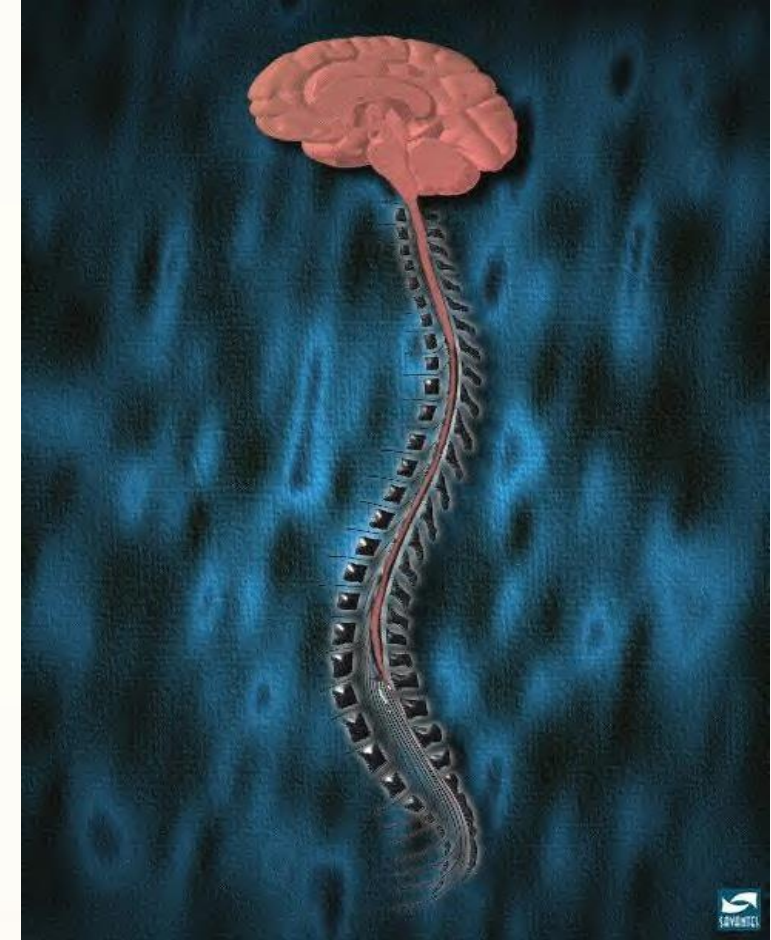
Nerve fibers that carry information to the central nervous system

- **Motor (efferent) division**

Nerve fibers that carry information away from the central nervous system.

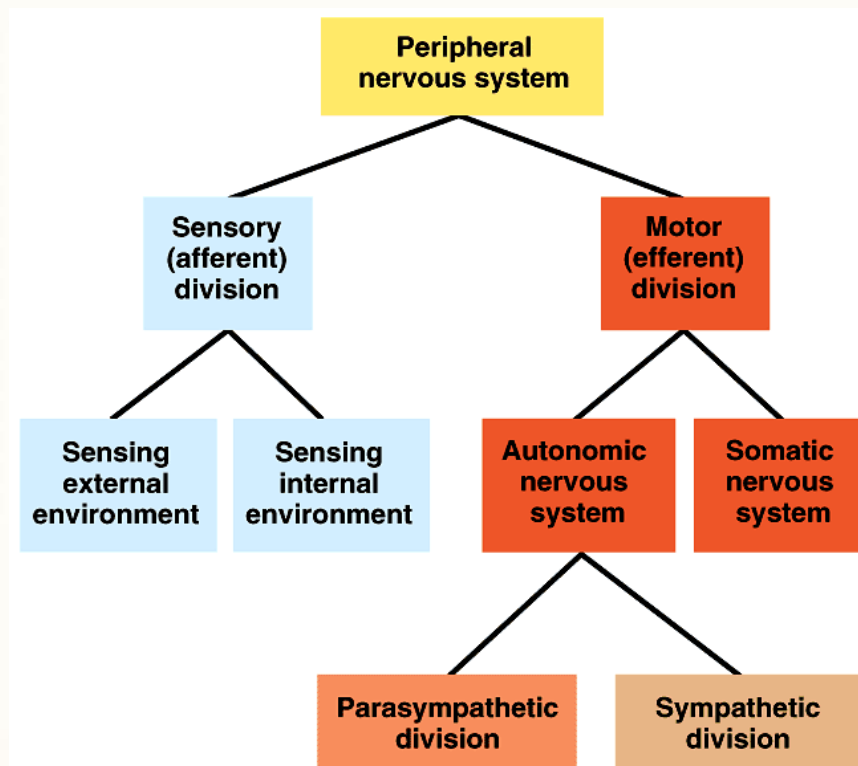
Two subdivisions of the motor division:

- **Somatic nervous system** = voluntary
- **Autonomic nervous system** = involuntary



The nervous System

Structural Classification of the Nervous System



The nervous System

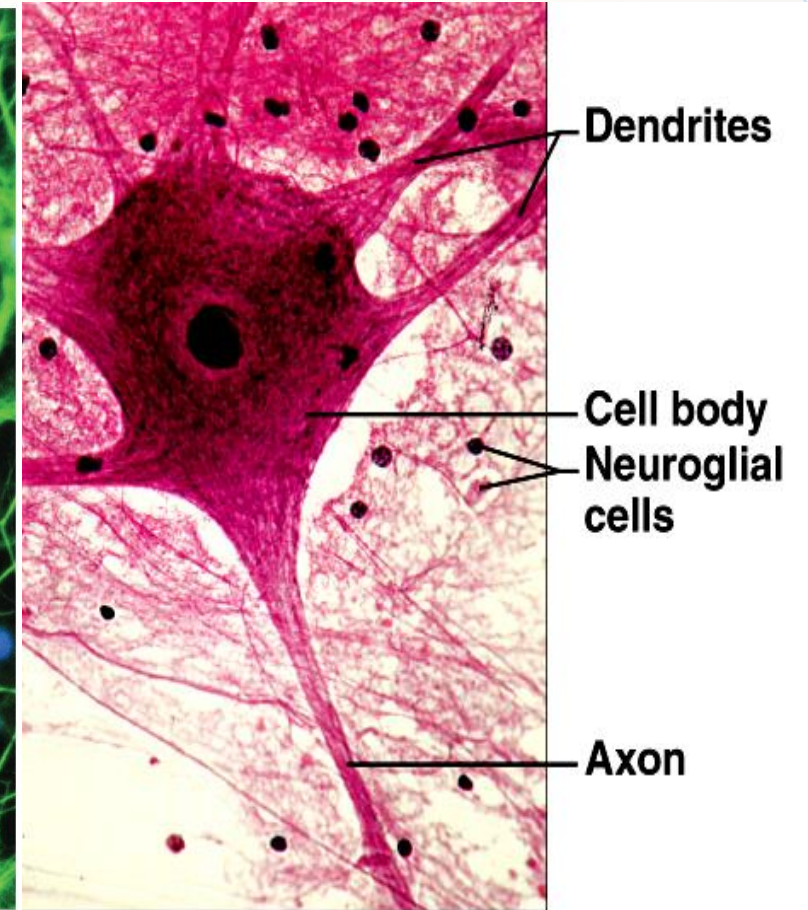
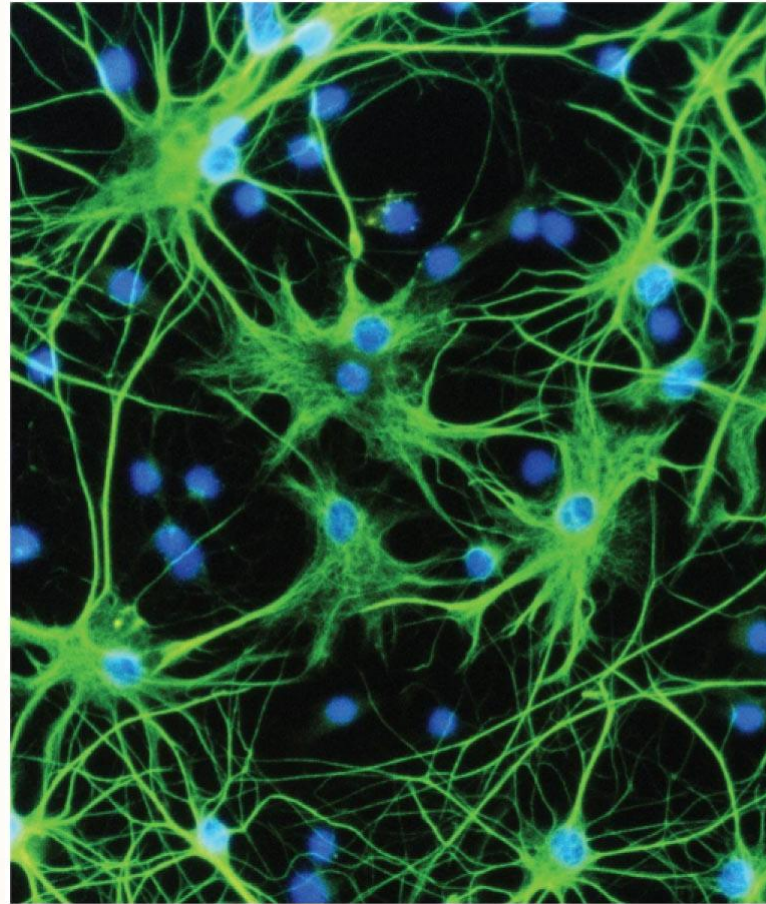
The nervous tissue is composed of:

- **Neurons:** nerve cells specialized to transmit messages called **nerve impulses**.

- **Neuroglia:** supporting cells.

Neuroglia divide whereas neurons do not.

- **Nerves** are cable-like bundles of axons of the neurons.



Nervous Tissue

Neurons

Major regions of neurons are:

- **Cell body**

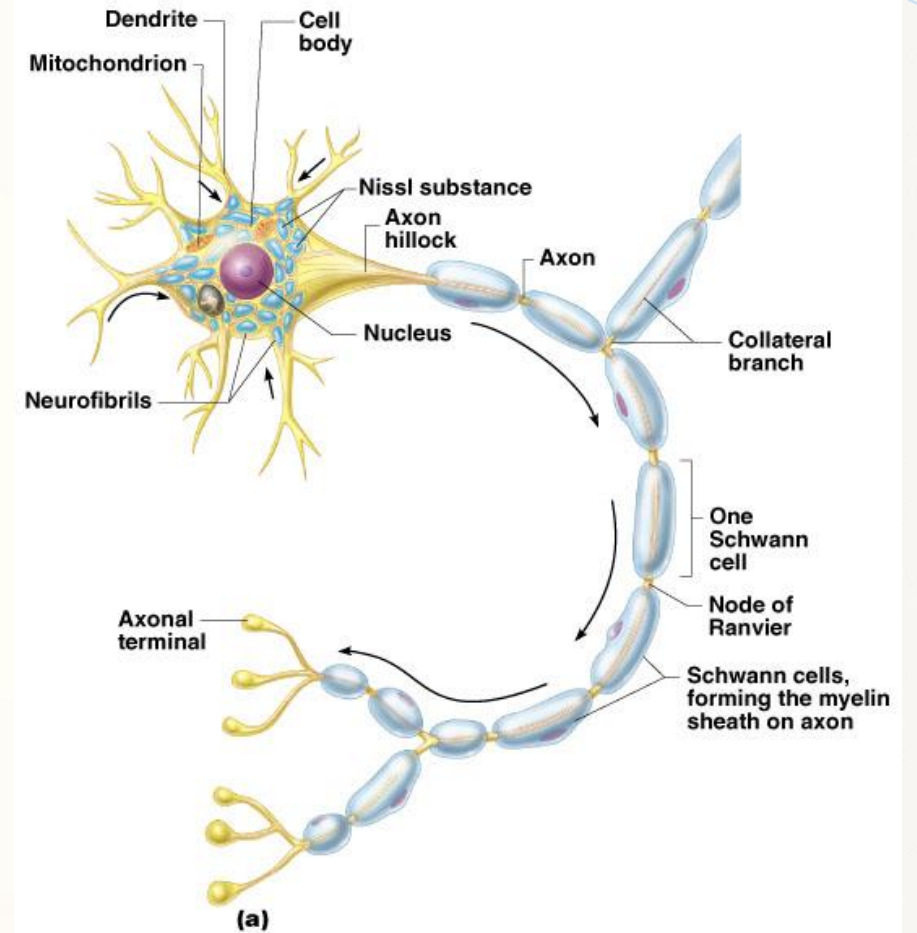
nucleus and metabolic center of the cell

- **Fibers that extend from the cell body**

- **Dendrites:** short fibers that receive information from other neurons.
- **Axons:** long Fibers that send messages to other neurons.

Larger axons (**motor nerves**) are enclosed by sheaths of **myelin** (lipid and protein covering) produced by **Schwann cells**. This sheath increases the speed of nerve impulse conduction (saltatory conduction)

Narrow gaps in the myelin sheath between Schwann cells are called **nodes of Ranvier**.



Classification of Neurons

Neurons can be classified based on **function** or by **structure**.

Structure

Multipolar

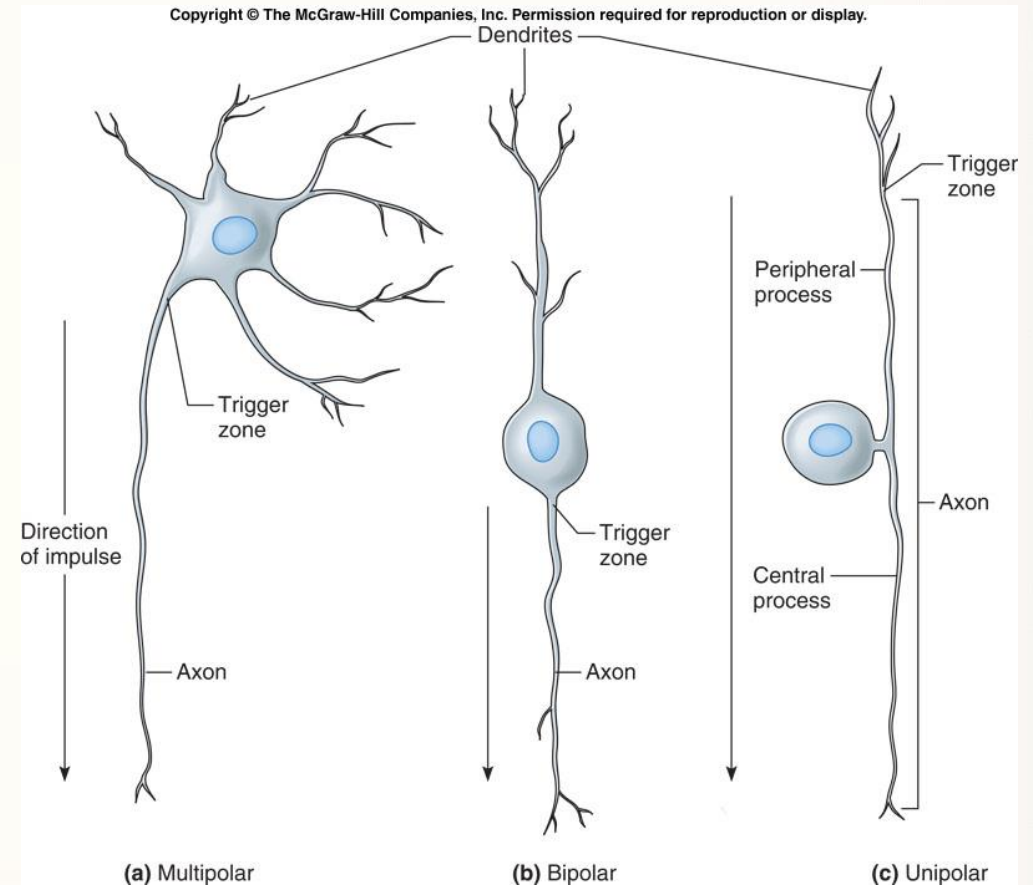
- Many processes arising from cell body.
- Brain or spinal cord

Bipolar

- 2 processes (1 from each end of cell body)
- Ear, eyes, nose

Unipolar

- Single process extends from cell body
- Outside of brain and spinal cord



Classification of Neurons

Function

Sensory Neurons (afferent)

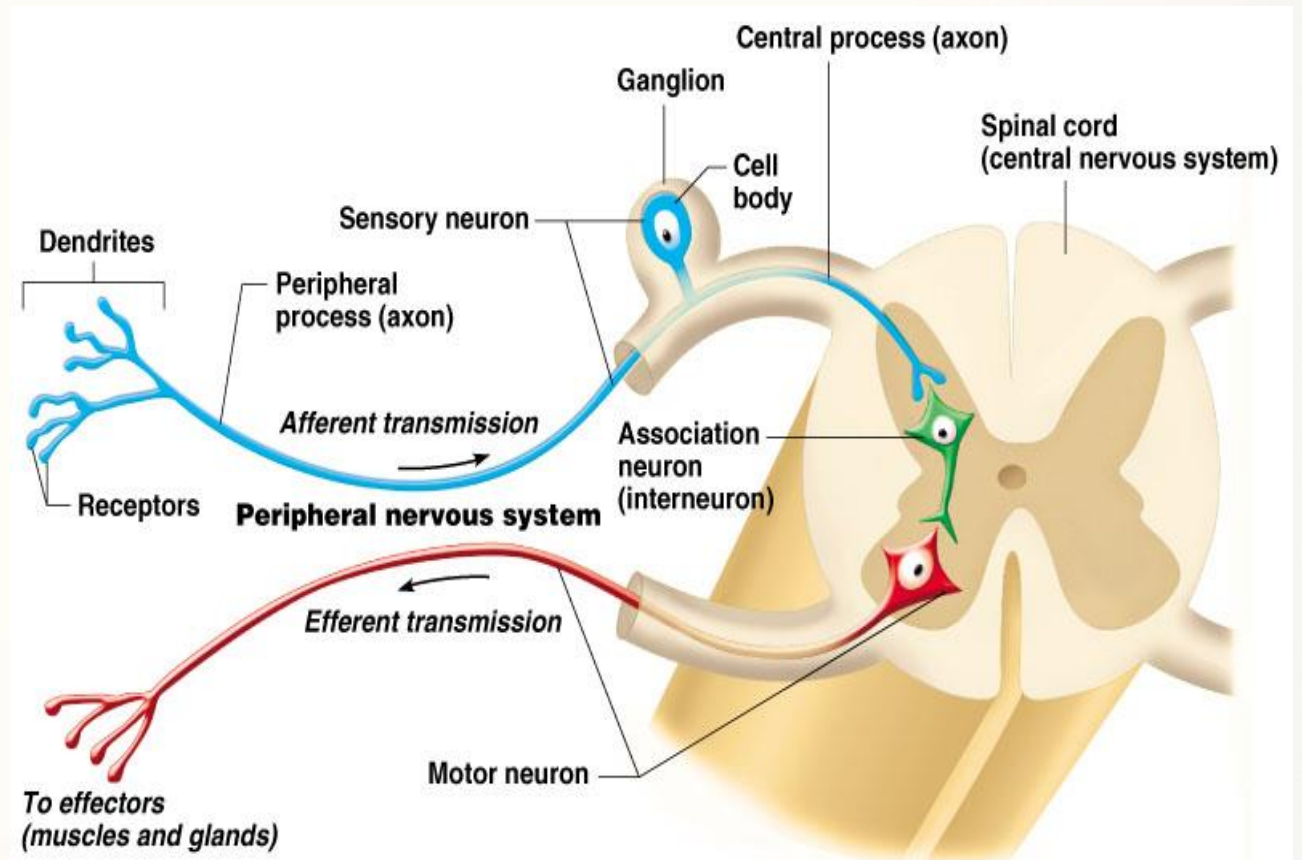
- They carry information from peripheral body parts to brain or spinal cord.

Interneurons

- Lie entirely within the brain or spinal cord; direct incoming sensory impulses to appropriate parts for processing and interpreting.
- Connect sensory and motor neurons

Motor Neurons (efferent)

- They Carry information (impulses) from the brain or spinal cord to effectors (muscles, glands).

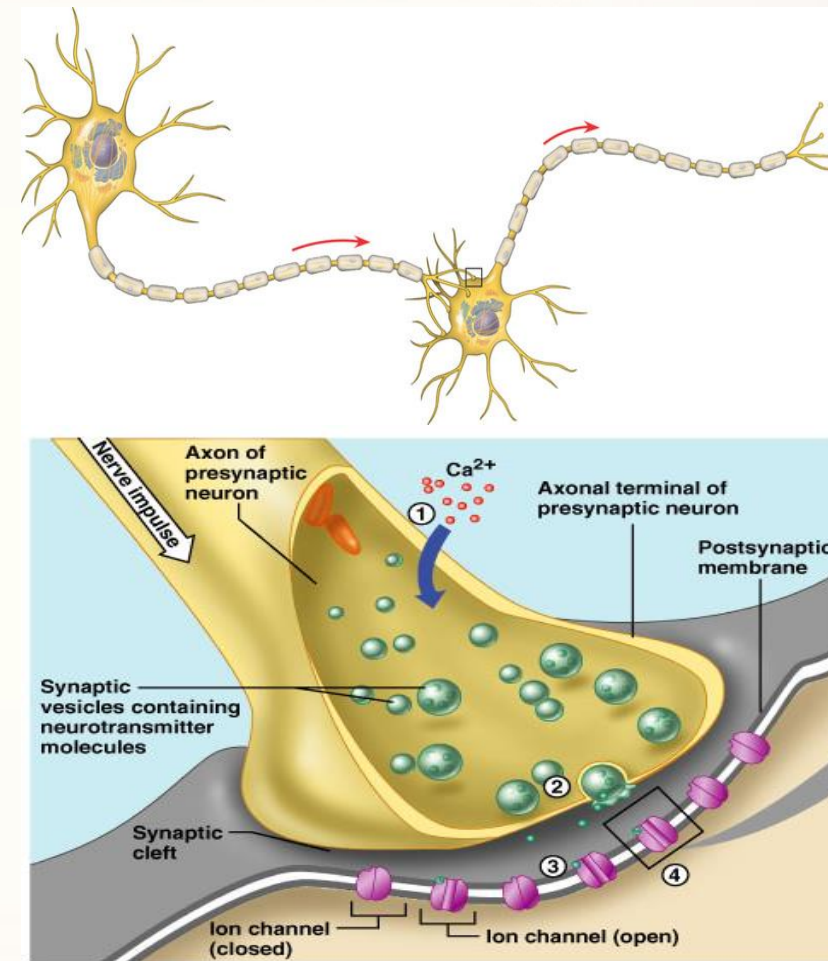


Transmission of information

What happens when the signal reaches the end of the axon?

The information is transmitted due to the communication between neurons using a mixture of electrical and chemical signals through a gap called **synapse**.

- Axons end in **axonal terminals** which contain vesicles with **neurotransmitters**.
- Electrical impulse triggers vesicles to move to the synapse membrane.
- Vesicles fuse with the membrane and release neurotransmitters which diffuse toward the next cell's plasma membrane (receiving neuron).
- Once enough receptors have neurotransmitters bound to them, the signal is transmitted...



Nervous Tissue

- Between birth and age 3 the brain makes lots of new synapses. A toddler has 2-3 times more synapses than an adult.
- As the brain matures, it prunes synapses to make it more efficient. During adolescence the brain has a major tidy-up and gets rid of lots of connections it isn't using.
- This is a critical and delicate process. It is thought that conditions such as **schizophrenia** could be the result of it going wrong.
- Some evidence suggests that using drugs can disrupt this process

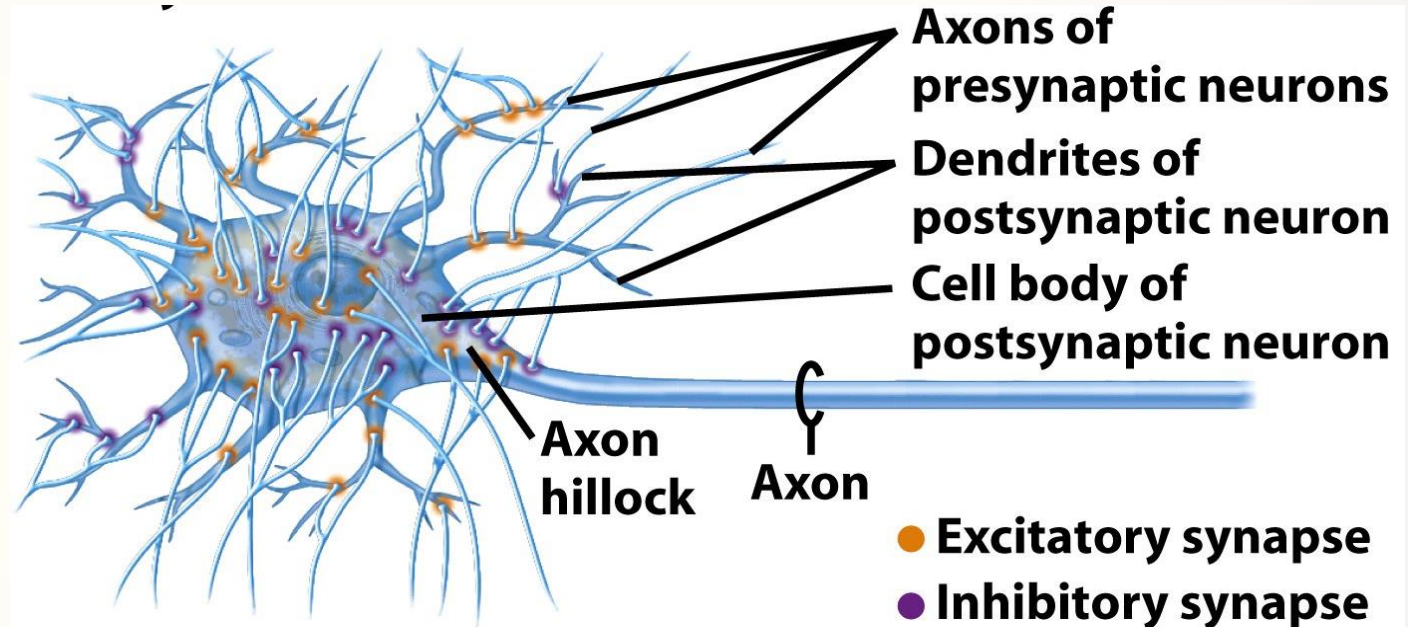


Figure 45-17a Biological Science, 2/e
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Nervous Tissue

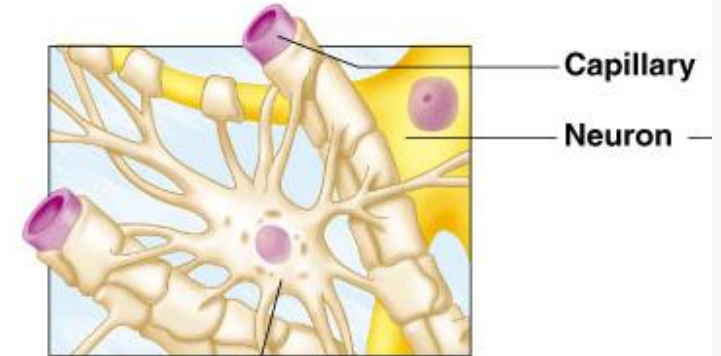
Neuroglia or Glia

Astrocytes

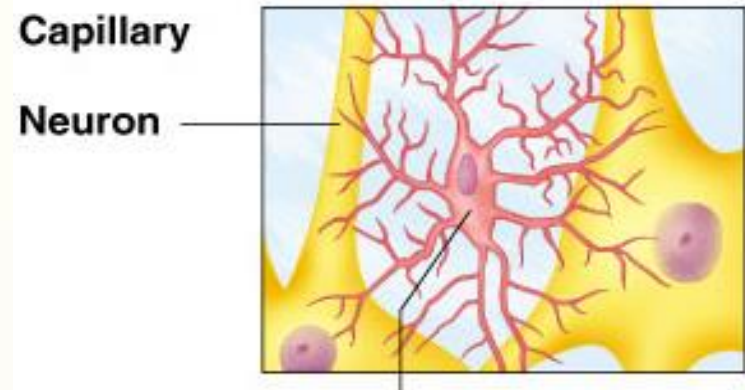
Abundant, star-shaped cells that brace neurons and maintain the nutrient and chemical levels in neurons.

Microglia (CNS)

Spider-like phagocytes that remove debris



(a) Astrocyte



(b) Microglial cell

Nervous Tissue

Ependymal cells (CNS)

Line cavities of the brain and spinal cord

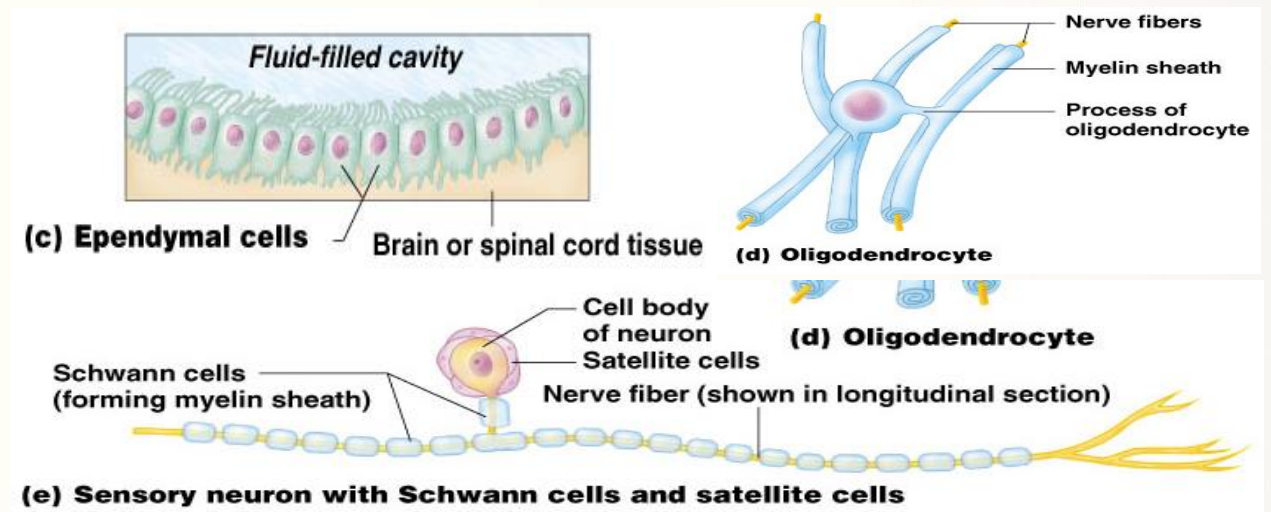
Circulate cerebrospinal fluid.

Oligodendrocytes(CNS)

Produce myelin sheath around nerve fibers in the central nervous system and help in supporting the neurons.

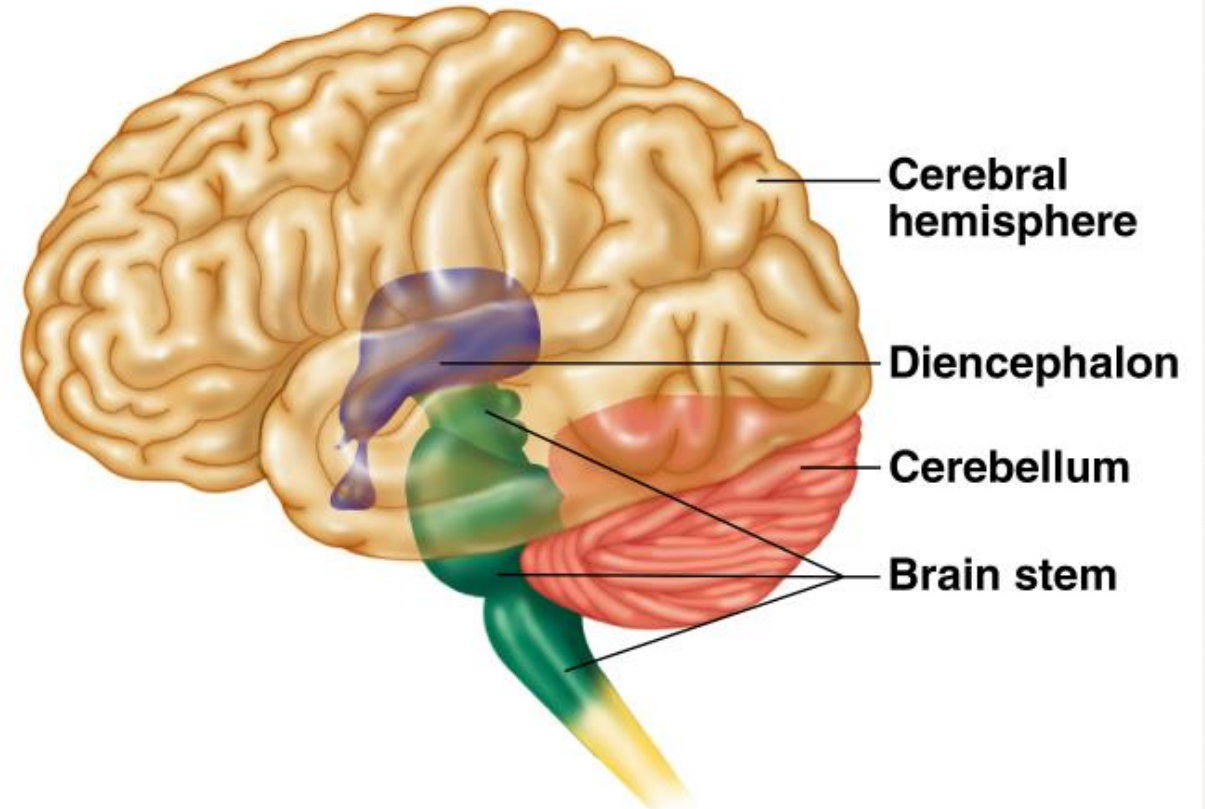
Satellite cells

Protect neuron cell bodies at the peripheral nerve system.



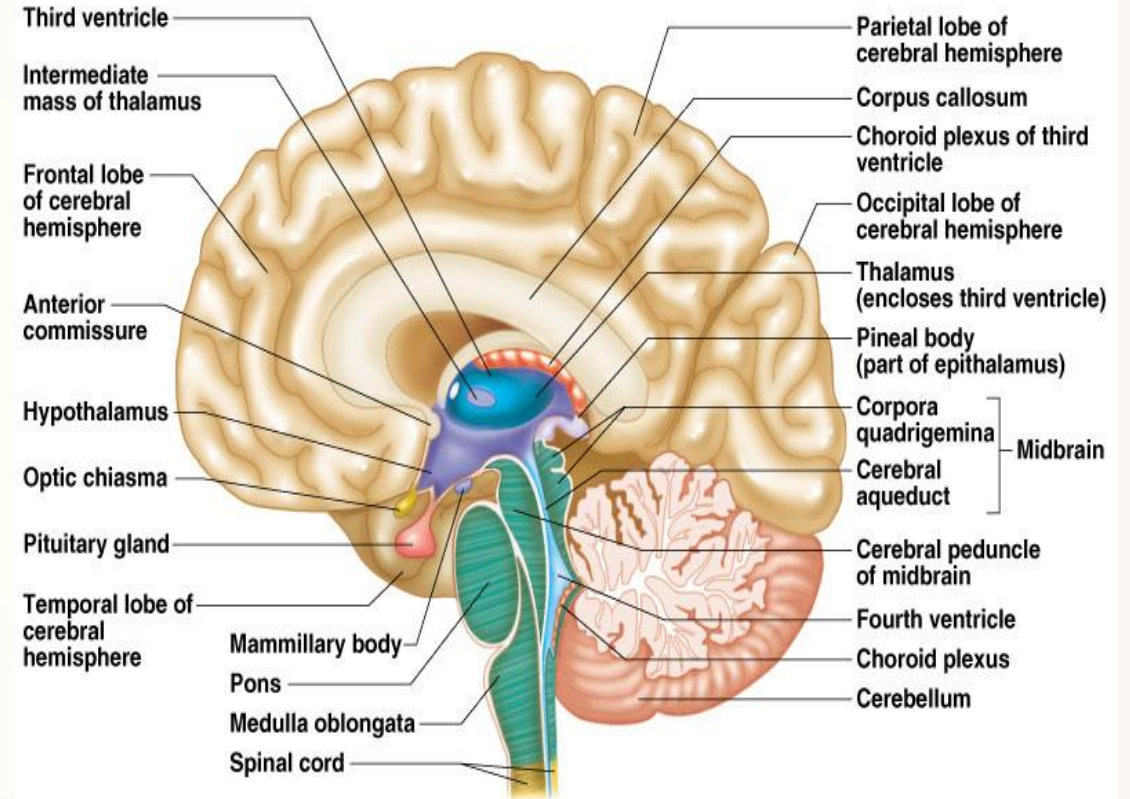
The brain

- The brain **interprets** the information it gets through your senses in order to monitor and regulate your body **functions**. The brain is being responsible for **thinking, learning, memory** and **emotion**.
- The brain is composed of four chambers filled with cerebrospinal fluid (**CSF**):
 - Cerebral hemispheres or Cerebrum
 - Diencephalon
 - Brain stem
 - Cerebellum



Cerebral Hemispheres (Cerebrum)

- Contains two hemispheres with an outer portion called the **cerebral cortex**
- The two hemispheres are divided in two lobes and still connected by a bridge called the **corpus callosum** of nerve fibers that relay information between the two hemispheres.
- The left and right lobes are each divided into four lobes or parts:
 - Frontal lobe
 - Parietal lobe
 - Occipital lobe
 - Temporal lobe

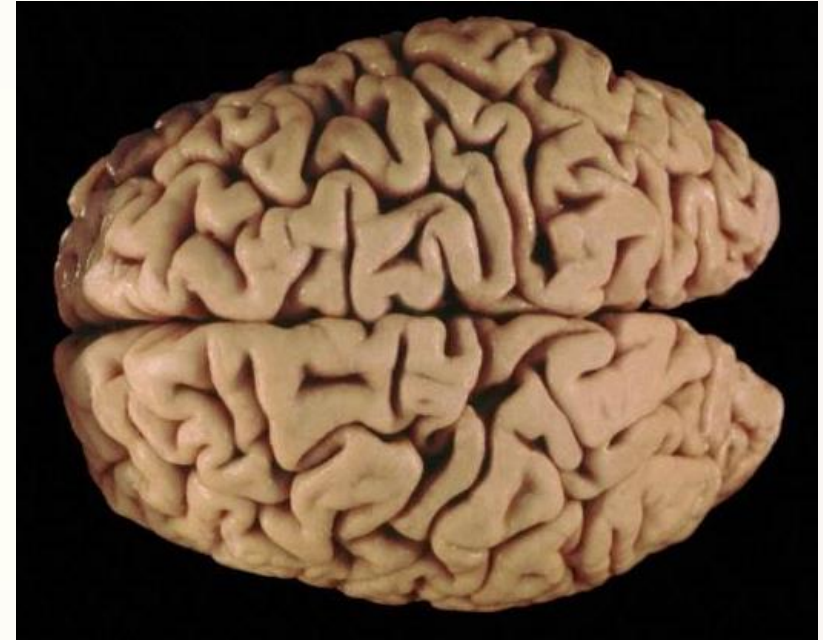


(a)



The Cerebrum

- Involved with higher brain functions.
- Processes sensory information.
- Initiates motor functions.
- Integrates information.
- **The left hemisphere**
 - Specializes in language, math, logic operations, and the processing of serial sequences of information, and visual and auditory details.
 - Specializes in detailed activities required for motor control.
- **The right hemisphere**
 - Specializes in pattern recognition, spatial relationships, nonverbal ideation, emotional processing, and the parallel processing of information.



The Cerebrum

Specialized area of the cerebrum

Cerebral areas involved in special senses

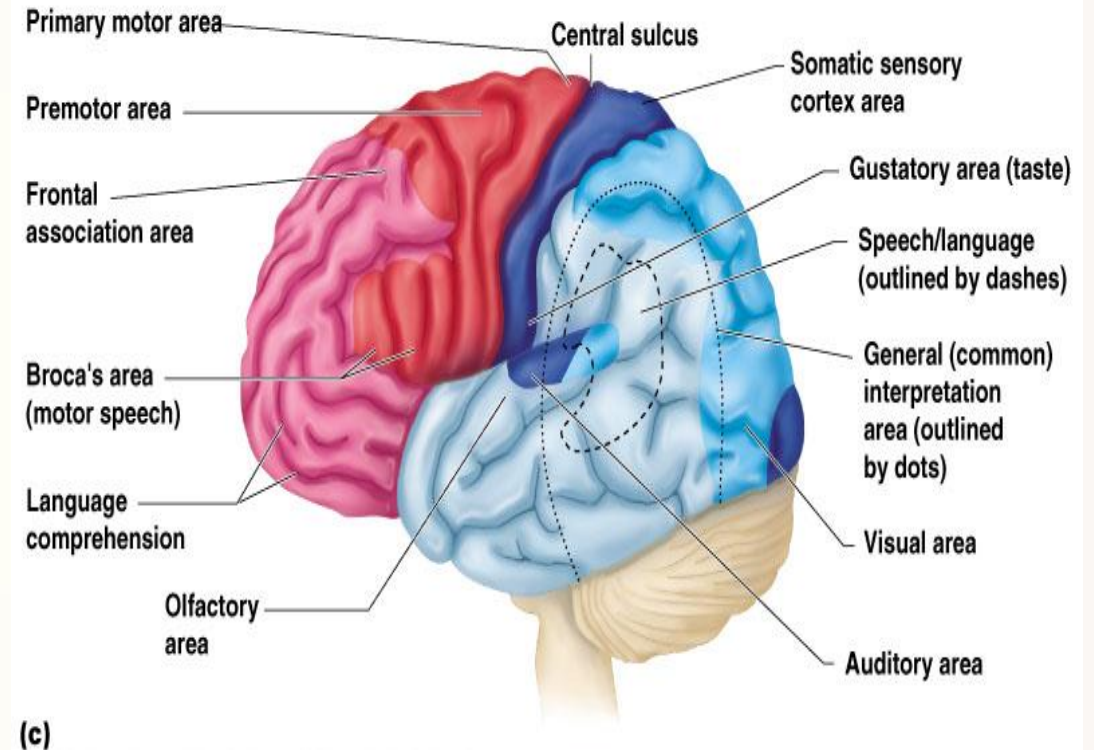
- Gustatory area (taste)
- Visual area
- Auditory area
- Olfactory area

Interpretation areas of the cerebrum

- Speech/language region
- Language comprehension region
- General interpretation area.

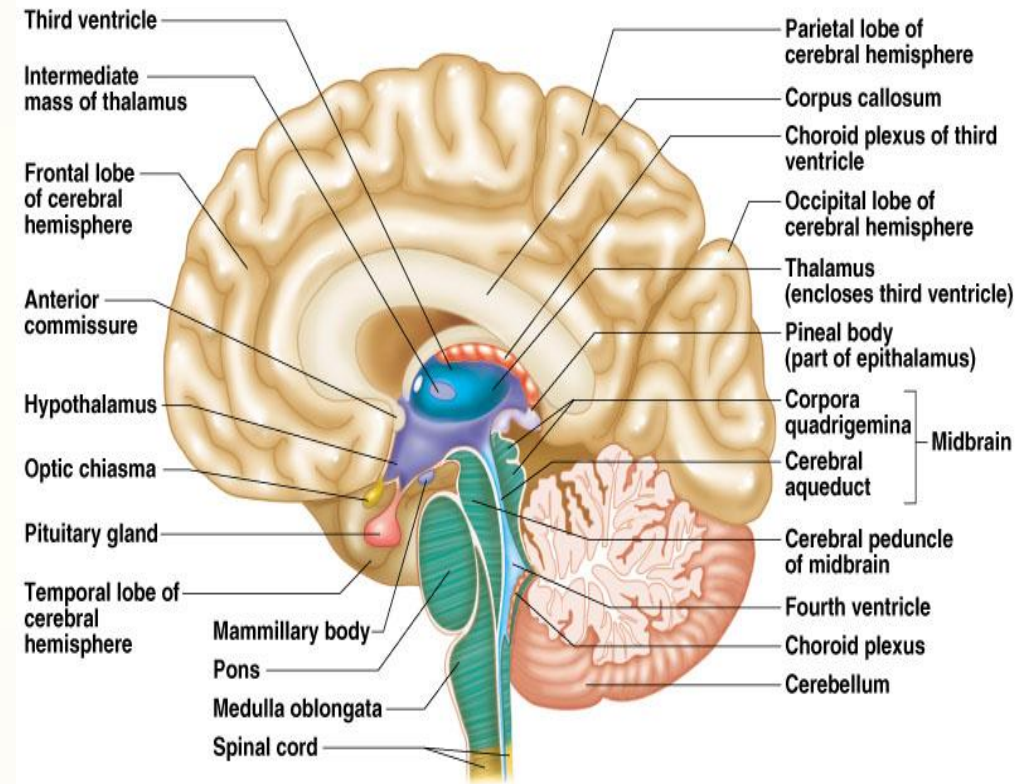
Memory and Learning.

- Short-term memory stored in the frontal lobes.
- The establishment of long-term memory involves the hippocampus.



Diencephalon

- Enclosed by the cerebral hemispheres
- Made up of three parts:
 - Thalamus
 - Hypothalamus
 - Epithalamus
- Surrounds the third ventricle
- The relay station for sensory impulses
- Transfers impulses to the correct part of the cortex for localization and interpretation.

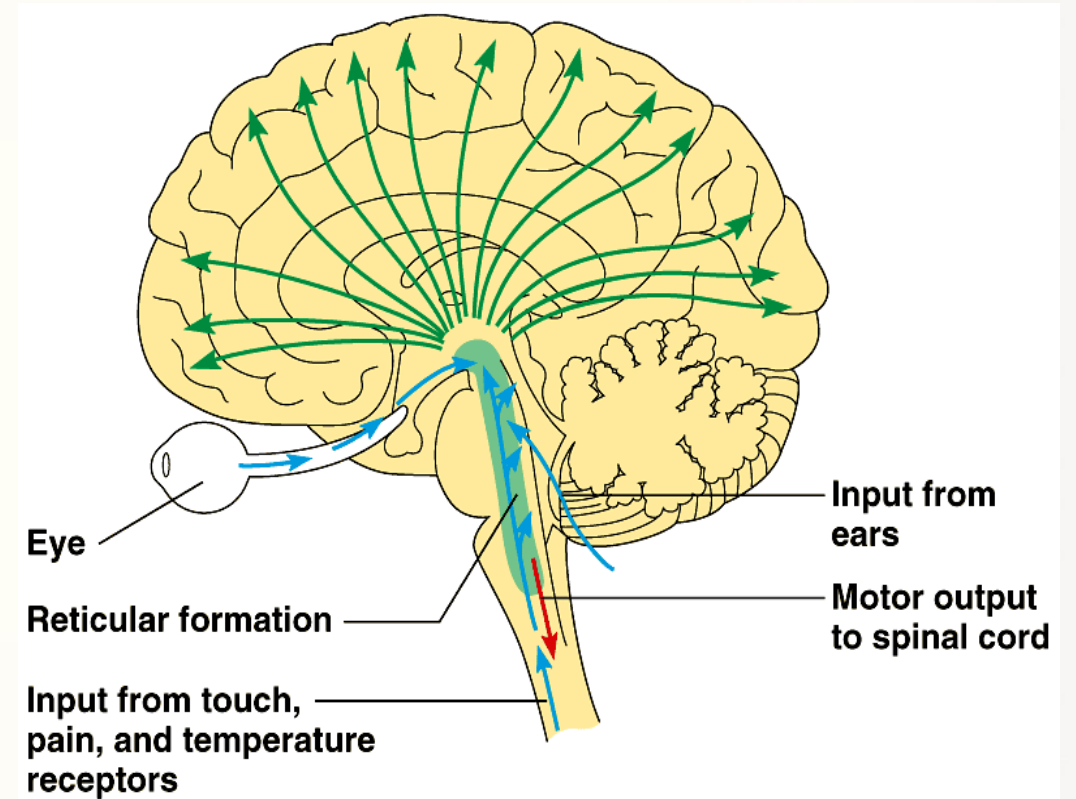


(a)

Diencephalon

Thalamus

- Relay center for sensory tracts from the spinal cord to the correct part of the cortex for localization and interpretation.
- Contains centers for sensation of pain, temperature, and touch.
- Involved with emotions and alerting or arousal mechanisms.
- Regulates sleep and arousal.



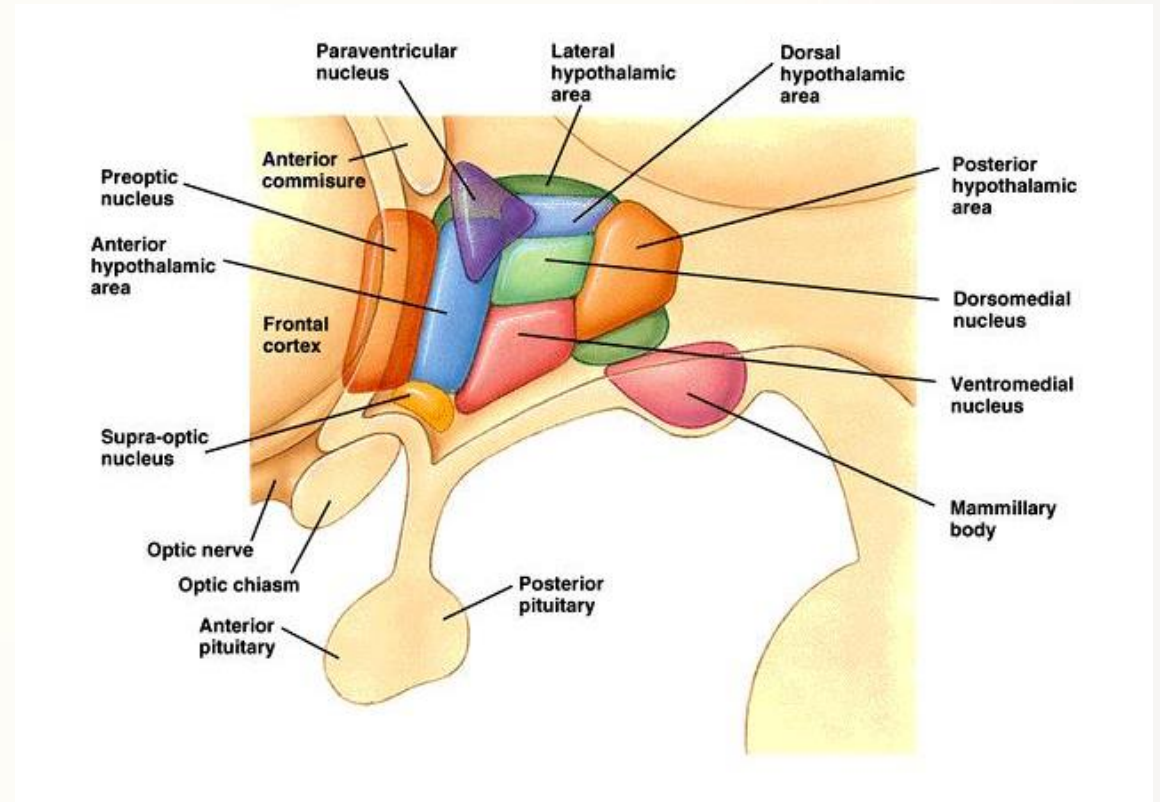
Diencephalon

Hypothalamus

- Important autonomic nervous system center
 - Helps regulate body temperature
 - Controls water balance and thirst.
 - Regulates metabolism and blood pressure
- Sleep/wake cycles, appetite, sexual arousal
- Control of endocrine functioning: acts on the pituitary gland (synthesizes PP hormones & regulates functions of AP by releasing hormones).

Epithalamus

- Houses an endocrine gland, the pineal body



Brain Stem

Attaches to the spinal cord and made up of:

- Midbrain
- Pons

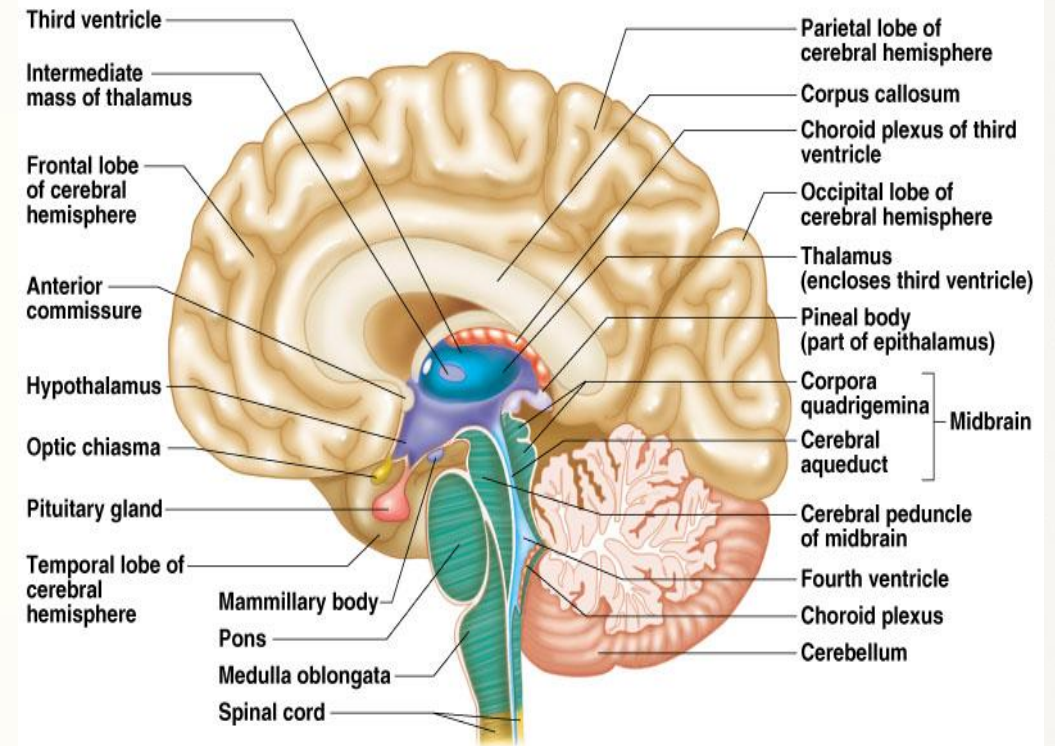
Medulla oblongata

Midbrain

- Contains ascending and descending tracts to the cerebrum and thalamus.
- Involved with visual reflexes (center for eye muscles).

Pons

Controls certain respiratory functions



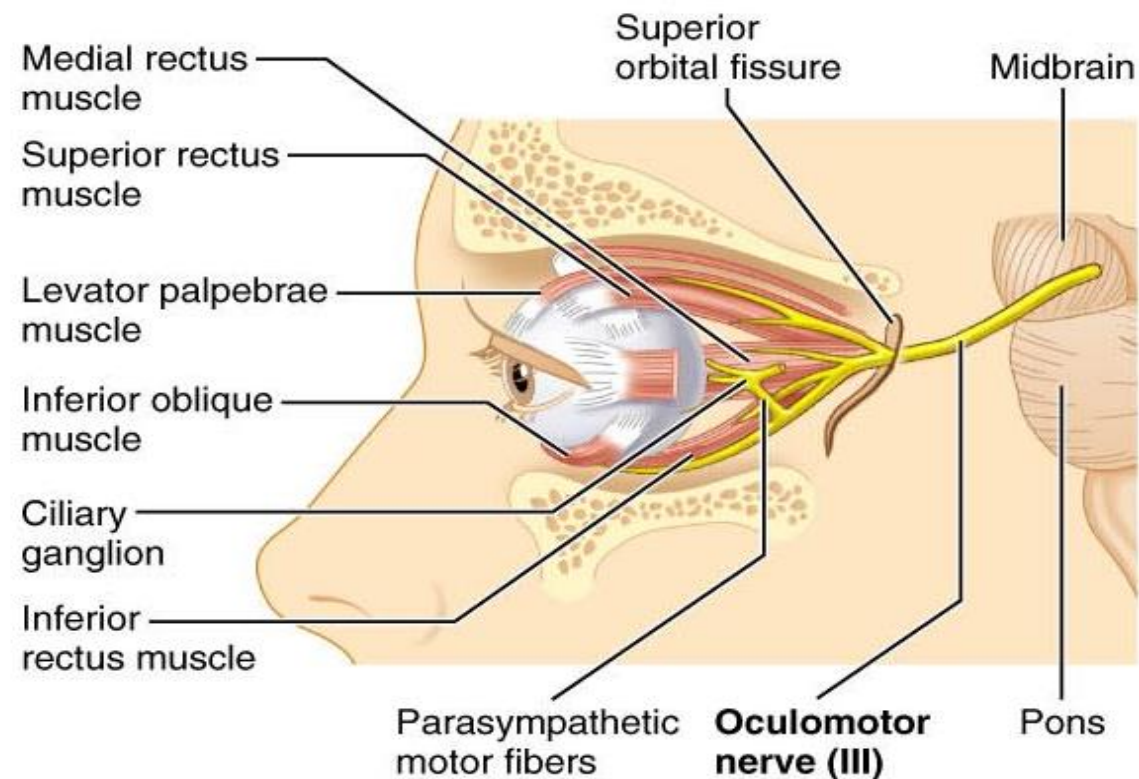
(a)



Brain Stem

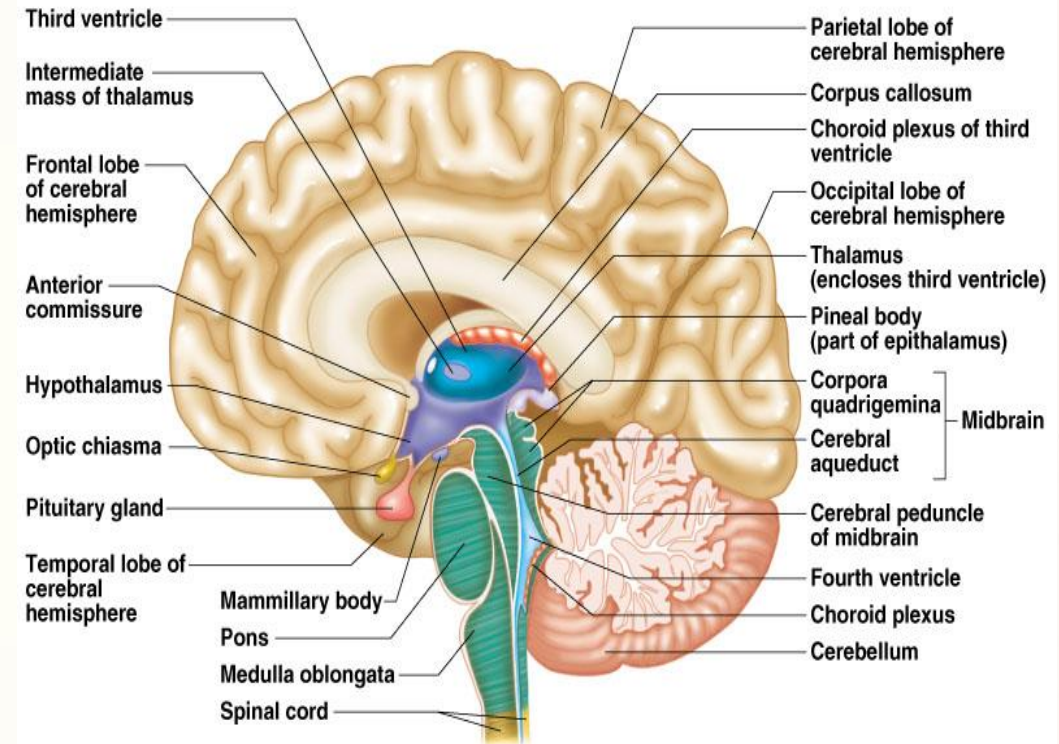
Medulla Oblongata

- The lowest part of the brain stem and may be regarded as an extension of the spinal cord.
- Almost all of the cranial nerves arise from this region.
- Contains important control centers that regulate many functions: Heart rate control, blood pressure, breathing, swallowing, vomiting.



Cerebellum

- (Two hemispheres with convoluted surfaces.
- Provides involuntary coordination of body movements.
- Area that coordinates musculoskeletal movement to maintain posture, balance, and muscle tone.



(a)

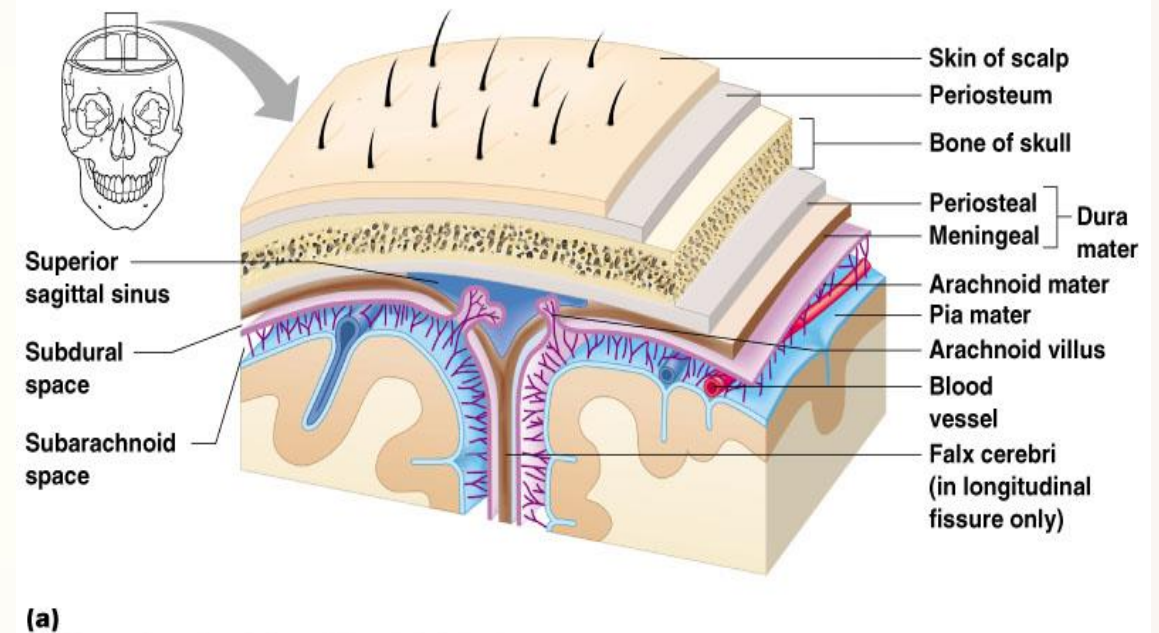


Protection of the CNS

The CNS is protected by the meninges composed of three layers of membranes that cover the brain and spinal cord :

Meninges

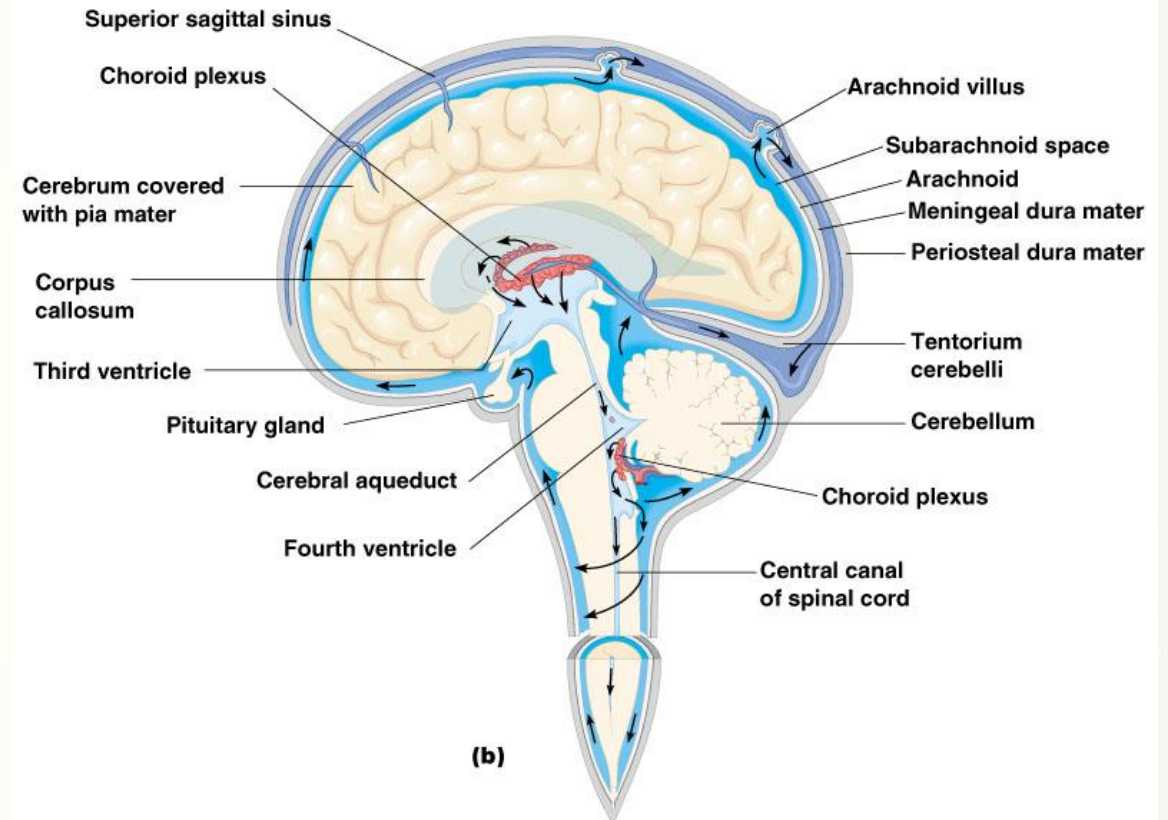
- **Dura mater:** Outer layer fibrous membrane.
- **Arachnoid layer:** middle membrane
- **Pia mater:** inner layer containing several blood vessels



Protection of the CNS

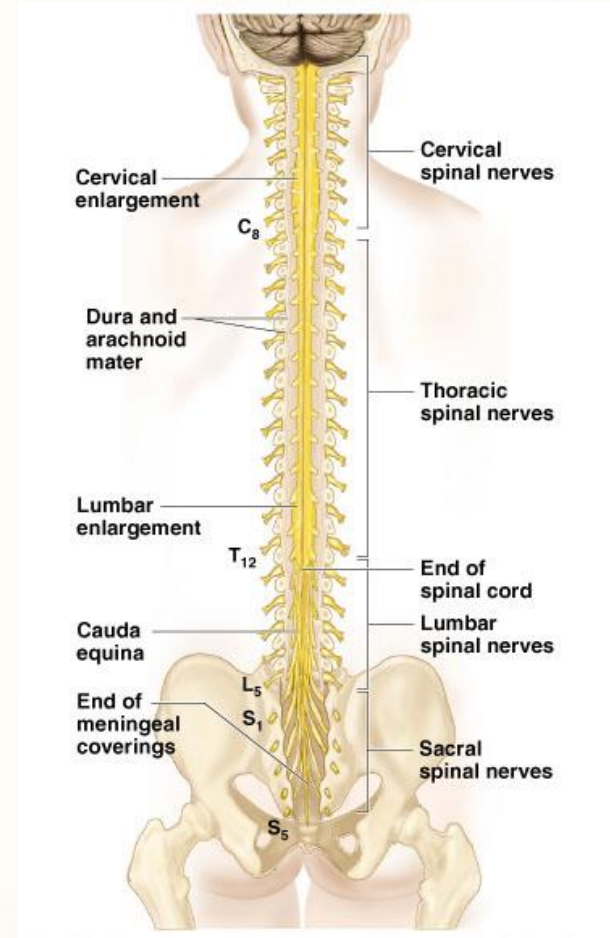
Cerebrospinal Fluid

- Similar to blood plasma composition
- Formed by the choroid plexus
- Forms a watery cushion to protect the brain (between the first 2 layers).
- Circulated in arachnoid space, ventricles, and central canal of the spinal cord



Spinal Cord

- Extends from the medulla oblongata to the region of T12
- Below T12 is the cauda equina (a collection of spinal nerves)
- Enlargements occur in the cervical and lumbar regions



Spinal Cord

Spinal Cord Anatomy

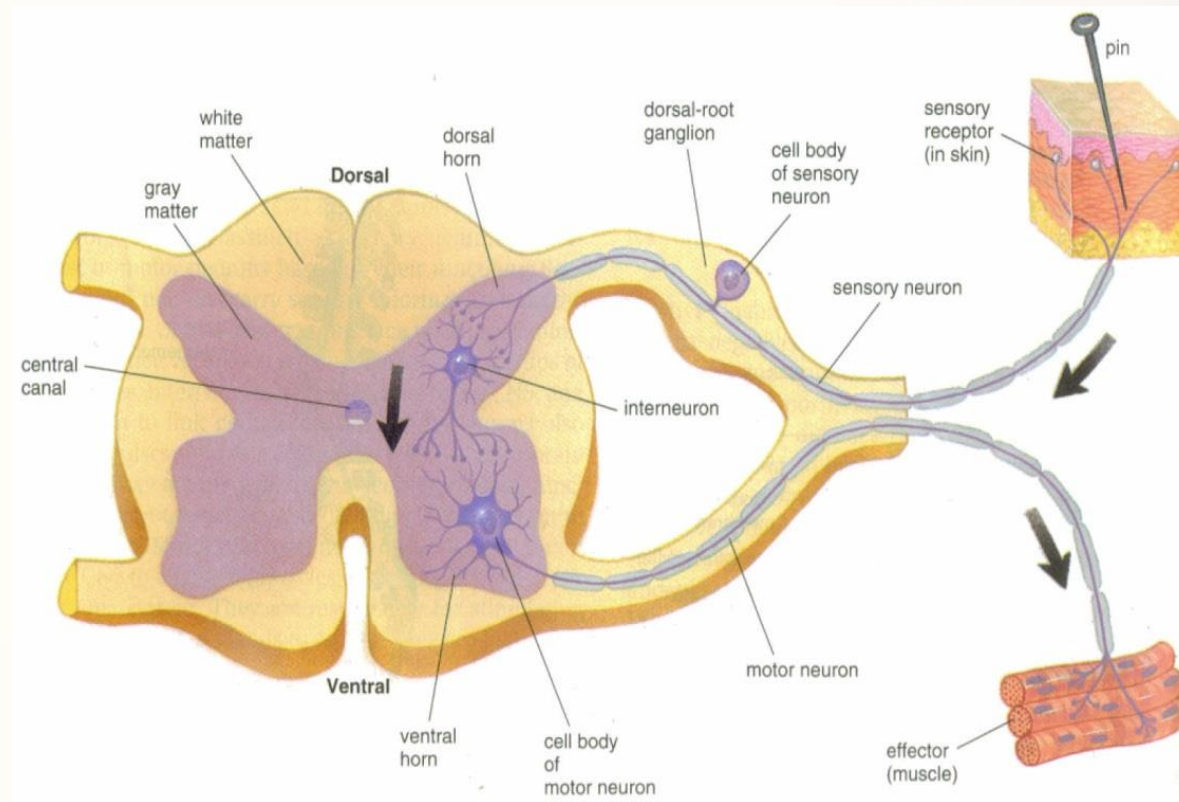
- **Exterior white mater**

Contains myelinated axons (conduction tracts).

- **Internal gray matter**

Inner tissue with darker color that contains neuron cell bodies and their dendrites and unmyelinated nerve fibers.

- Dorsal (posterior) horns (**sensory pathway**)
- Anterior (ventral) horns (**motor pathway**)
- The white matter surrounds an inner core of gray matter.



Spinal Cord

Spinal Cord Anatomy

- **Central canal**

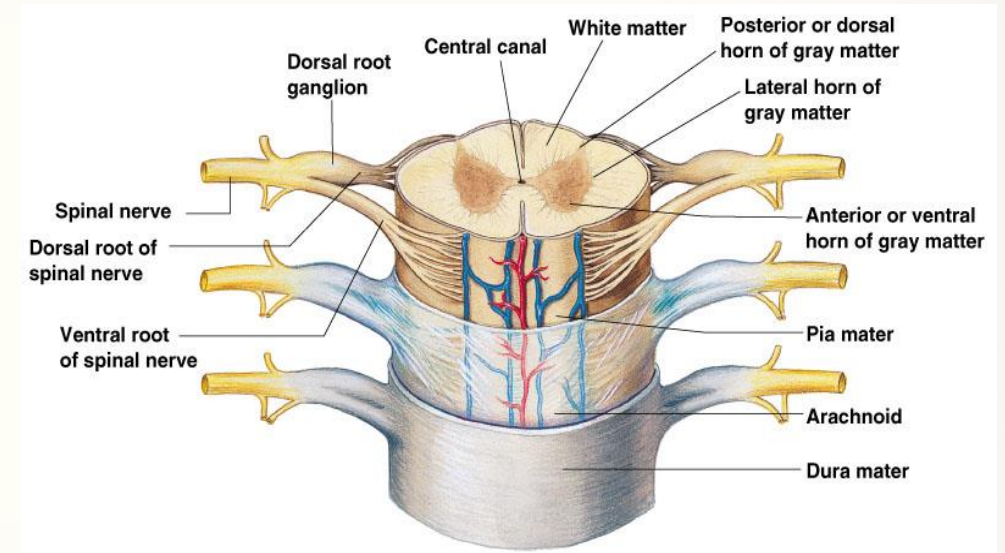
Filled with cerebrospinal fluid that runs down the entire length of the spinal cord.

- **Meninges**

Cover the spinal cord.

Nerves leave at the level of each vertebrae

- Dorsal root: associated with the dorsal root ganglia – collections of cell bodies outside the central nervous system.
- Ventral root

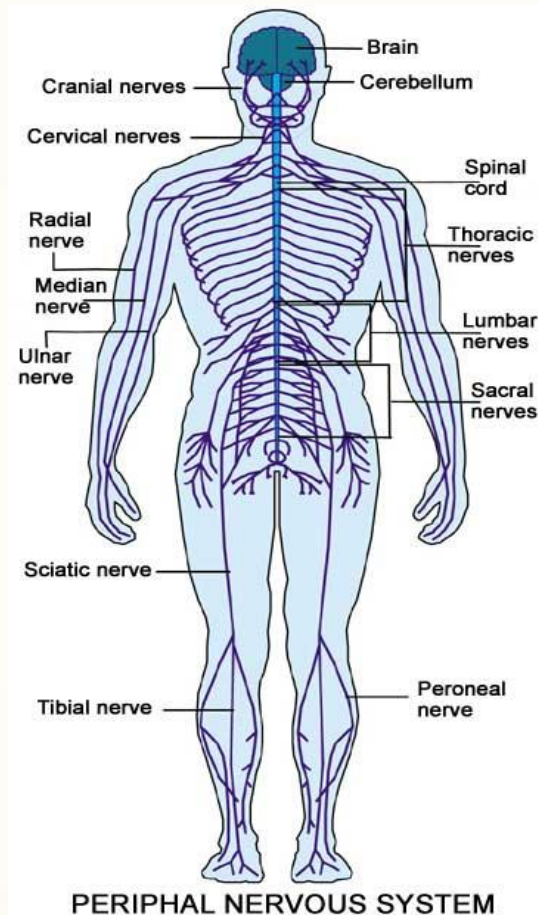


Peripheral Nervous System

- Nervous structures outside the brain and spinal cord
- Nerves allow the Central nervous system to receive information and take action.
- Functional components of the PNS
 - Sensory inputs and motor outputs categorized as somatic or visceral
 - Sensory inputs also classified as general or special.

Nerves

Visible bundles of axons and dendrites that extend from the brain and spinal cord to all other parts of the body



Peripheral Nervous System

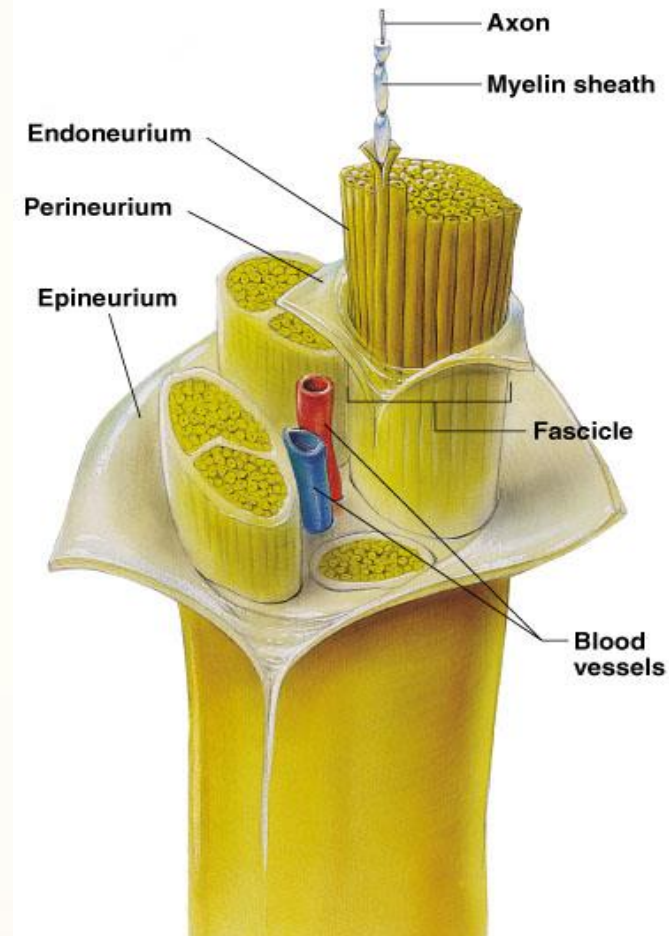
Structure of a Nerve

- Nerve = bundle of neuron long fibers (axons)
- Nerve fibers are bundled by connective tissue
- Endoneurium surrounds each fiber
- Groups of fibers are bound into fascicles by perineurium
- Fascicles are bound together by epineurium

Classification of Nerves

- **Mixed nerves:** both sensory and motor fibers
- **Afferent (sensory) nerves:** carry impulses toward the CNS
- **Efferent (motor) nerves:** carry impulses away from the CNS

There is a pair of spinal nerves at the level of each vertebrae



Peripheral Nervous System

Anatomy of the Autonomic Nervous System

Is the **involuntary (motor)** branch of the nervous system and is divided into:

- Sympathetic division
- Parasympathetic division

Sympathetic

- neurotransmitter is **norepinephrine**.
- Remember as the “E” division: exercise, excitement, emergency, and embarrassment.

Parasympathetic

- neurotransmitter is **acetylcholine**
- Remember as the “D” division: digestion, defecation, and diuresis (urinating)

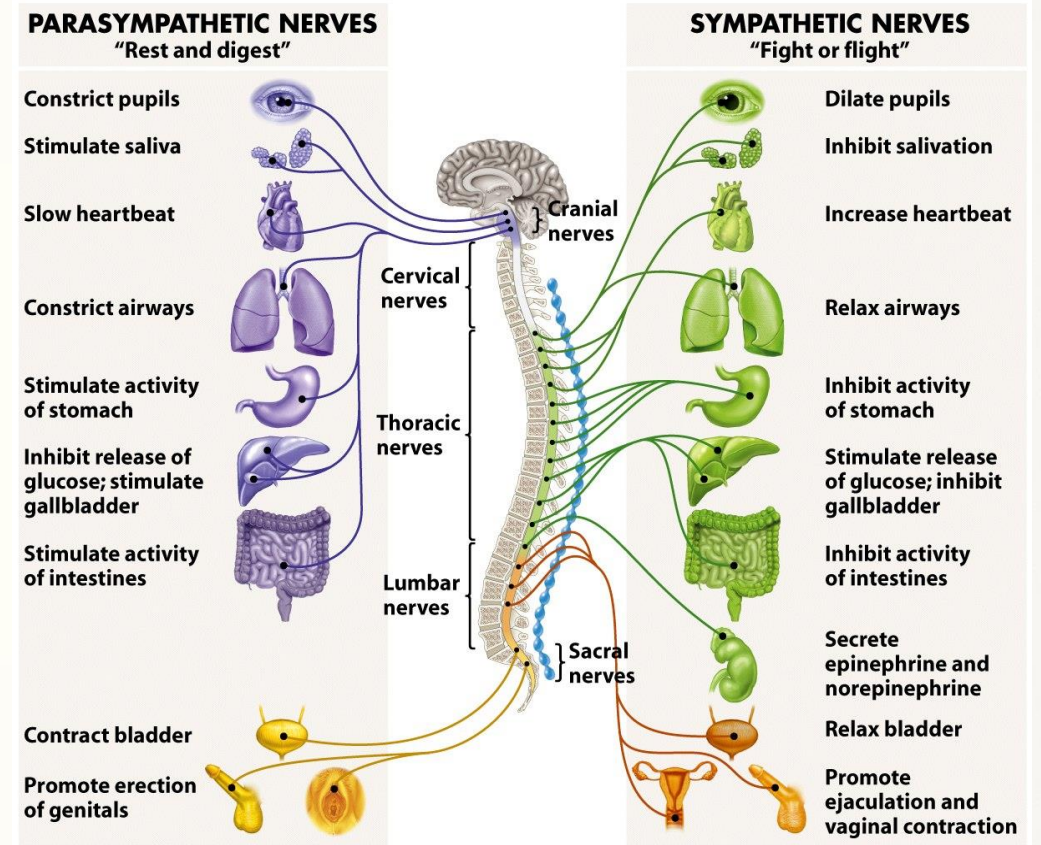
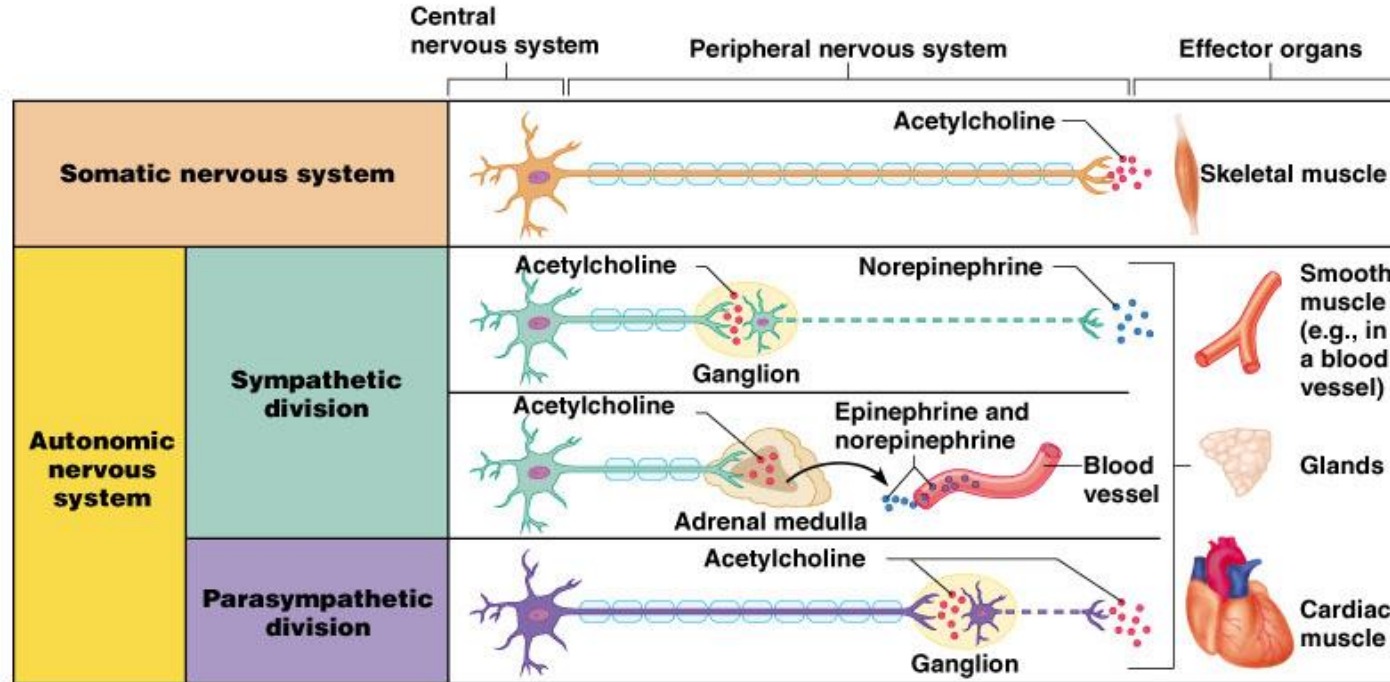


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Peripheral Nervous System

Comparison of Somatic and Autonomic Nervous Systems



KEY:

— Preganglionic axons (sympathetic)

- - - Postganglionic axons (sympathetic)

⊖ Myelination

— Preganglionic axons (parasympathetic)

- - - Postganglionic axons (parasympathetic)



Disorders of The nervous system

Cerebrovascular Accident (CVA)

- Commonly called a stroke
- The result of a ruptured blood vessel supplying a region of the brain
- Brain tissue supplied with oxygen from that blood source dies
- Loss of some functions or death may result

Degenerative brain diseases

- Schizophrenia
- Parkinson's
- Alzheimer's
- Huntington's Chorea
- Epilepsy



Disorders of The nervous system

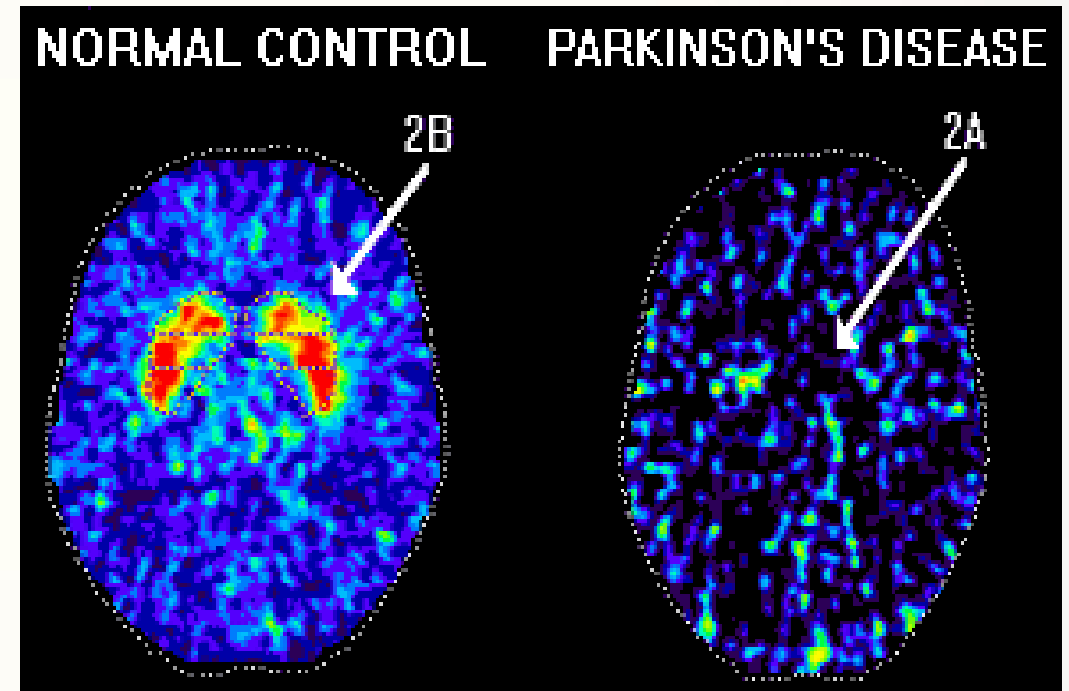
Degenerative brain diseases

Parkinson's disease

- The brain does not produce enough of the neurotransmitter that transmits messages from the brain to the muscles which causes tremors, weakness of muscles, and difficulty walking and loss of facial expression.

Causes

- Genetics
- Environmental chemicals (e.g., PCBs)
- Thyroid disorders
- Repeated head injury



Disorders of The nervous system

Degenerative brain diseases

Alzheimer's Disease

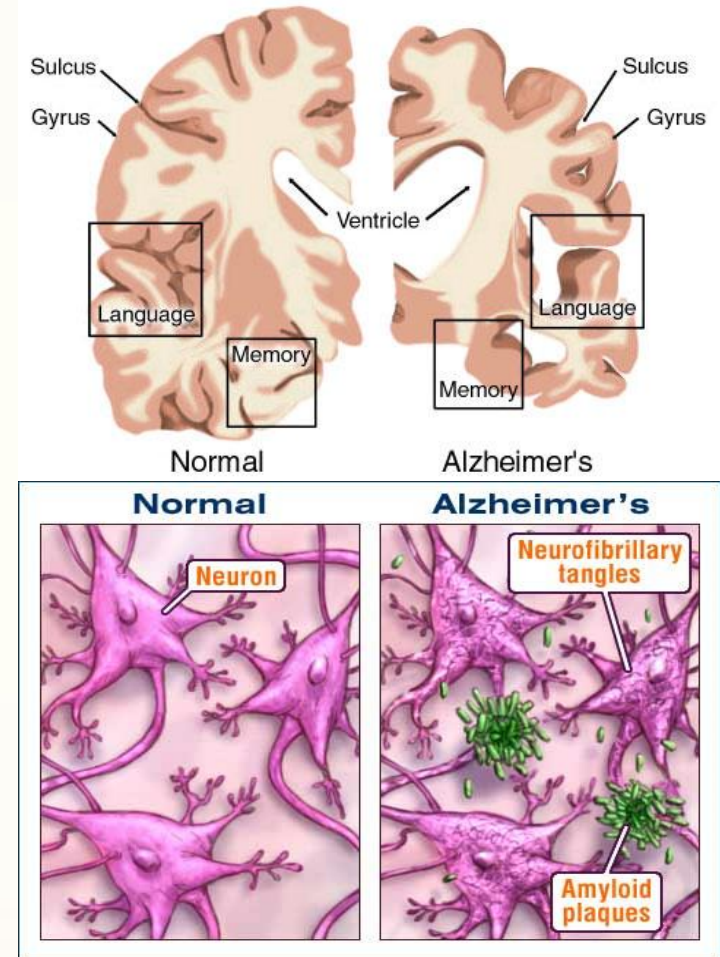
- Progressive degeneration of neurons in the brain, eventually leading to death
- Mostly seen in the elderly, but may begin in middle age
- Structural changes in the brain include abnormal protein deposits and twisted fibers within neurons
- Victims experience memory loss, irritability, confusion and ultimately, hallucinations and death.

Huntington's Chorea

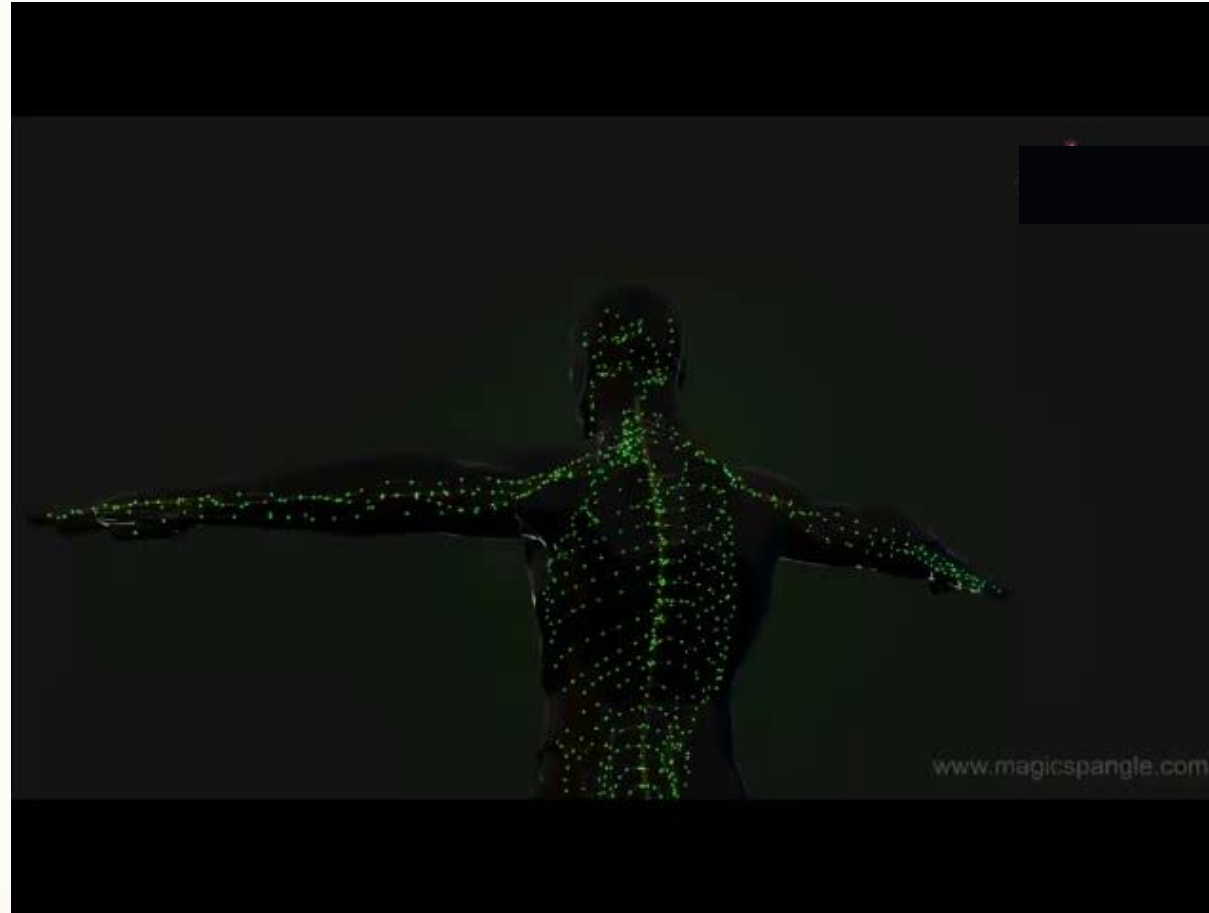
- Hereditary disease with uncontrollable, jerking movements and progressive loss of neural control.

Epilepsy

- Abnormal transmission of messages between the neurons in the brain
- Symptoms: seizures

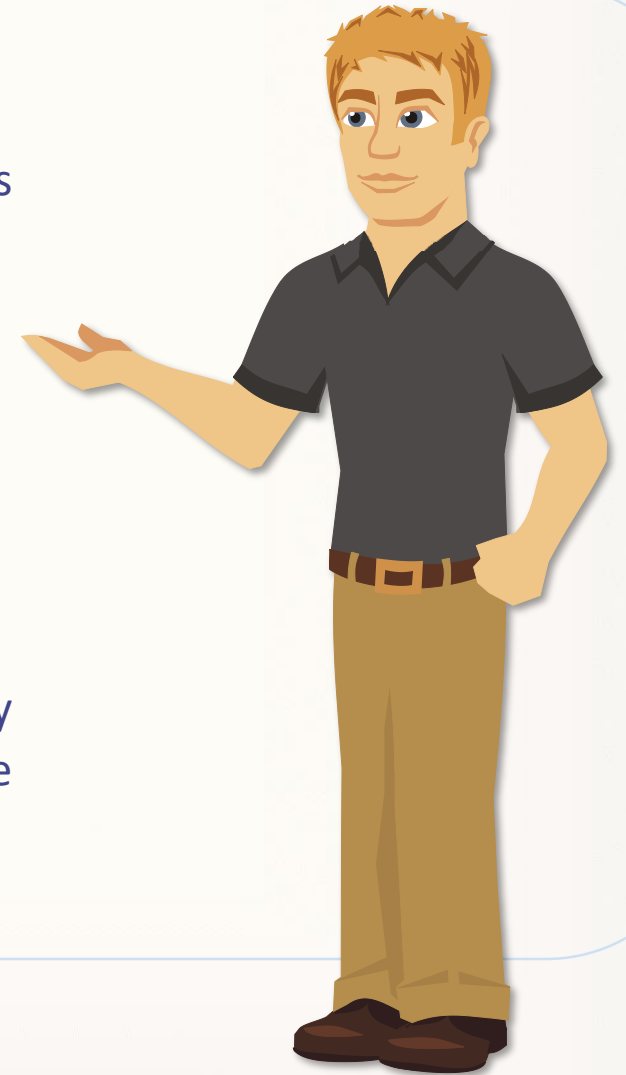


Final Activity



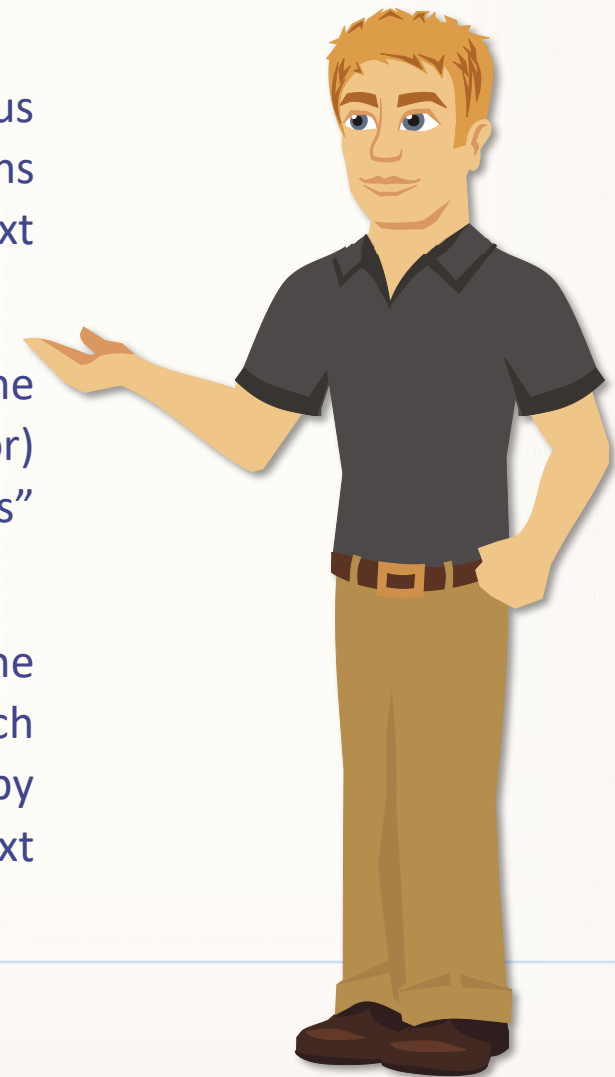
Summary

- The central nervous system is composed of the brain and spinal cord.
- The cerebrum is the largest part of the brain and is divided into two hemispheres subdivided into four lobes: frontal, parietal, temporal and occipital.
- The diencephalon contains the thalamus and hypothalamus.
- The brain stem consists of three parts: the midbrain, pons, and medulla oblongata.
- The cerebellum is the final (hind) area of the brain.
- The spinal cord is continuous with the brain and consists of 31 spinal segments.
- The basic function of the spinal cord is to carry sensory information from the body to the brain and motor information from the brain to the muscles and glands of the body.



Summary

- All neurons are composed of a cell body, the shorter and more numerous dendrites that receive information for the cell body, and the longer axons that bring an impulse from the cell body to the dendrite of the next neuron.
- There are three separate types of neurons to carry out the functions of the nervous system: the afferent (sensory) nerves, the efferent (motor) nerves, and the interpretive interneurons that act as “interpreters” between the afferent and efferent nerves.
- A synapse is the space (**gap**) between the axon of one neuron and the dendrite of the next. At the end of each axon is the synaptic knob, which contains vesicles that produce neurotransmitters. These are released by the synaptic bulb to allow impulse transmission to continue to the next neuron.



Summary

- The peripheral nervous system consists of the peripheral nerves located throughout the body. It is divided into two distinct systems: the somatic and autonomic nervous systems.
- The somatic nervous system connects the CNS to the skin and skeletal muscle (voluntary functions).
- The autonomic nervous system connects the CNS to the internal organs (involuntary functions). Its motor portion is divided into the sympathetic system, which prepares the body for “fight or flight” (stressful) situations, and the parasympathetic system, which is the body’s everyday “resting” system for normal situations.
- There are many and varied diseases and disorders related to the nervous system.

