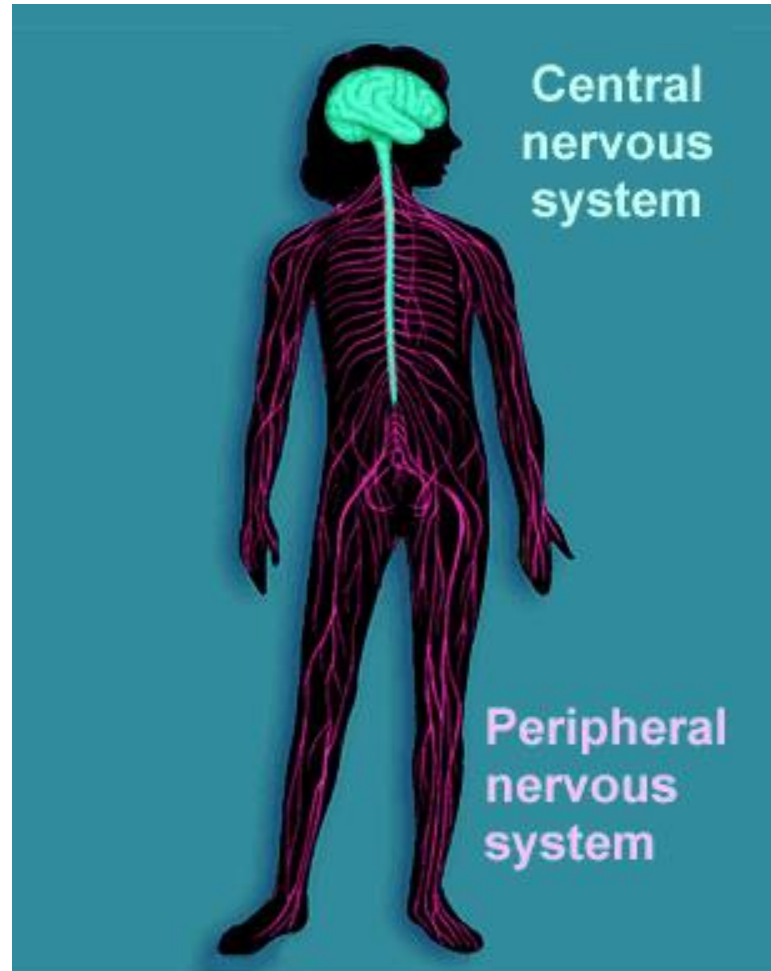


# The Nervous System

## Part -1-



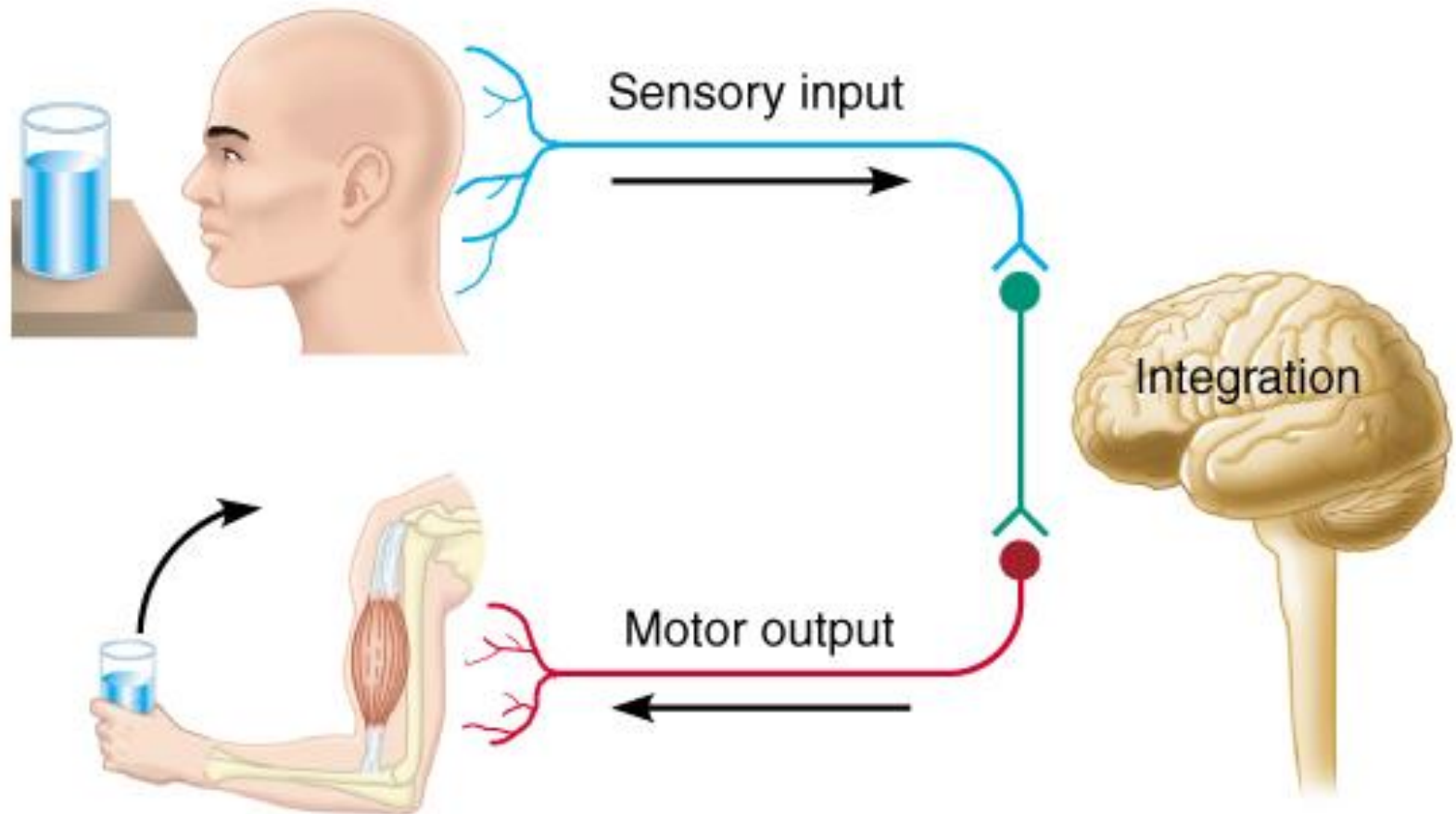
**Ms. Mais Abdelhaq**



# Introduction

- The master controlling and communicating system of the body
- **Functions:**
  - Maintain body homeostasis
  - Sensory input – monitoring stimuli occurring inside and outside the body
  - Integration – interpretation of stimuli
  - Motor output – response to stimuli

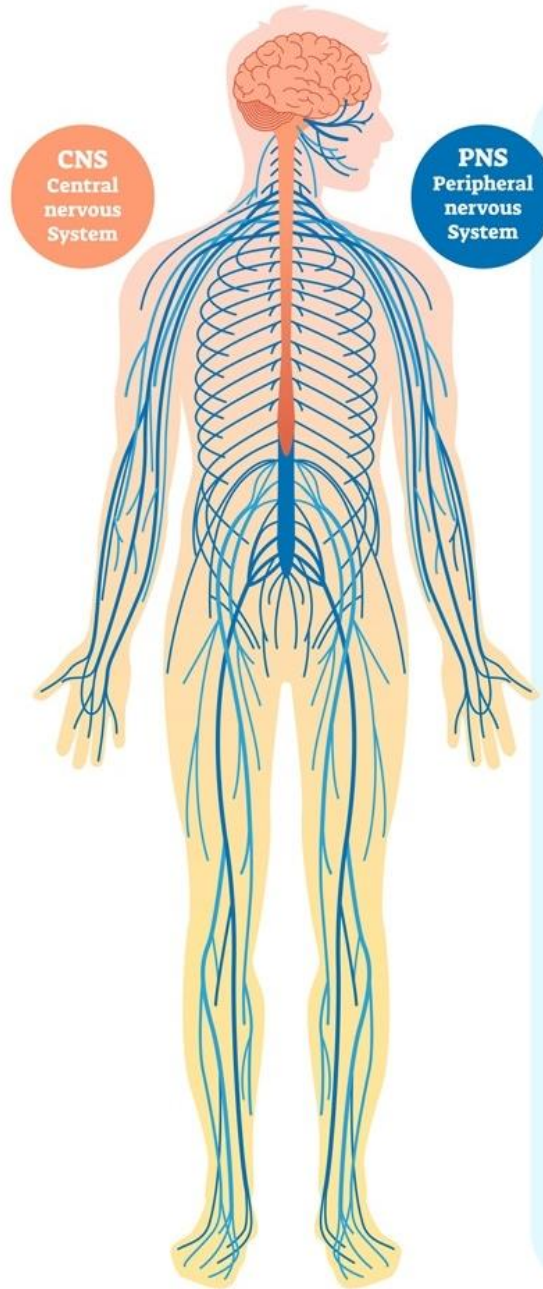
# Function of the Nervous System

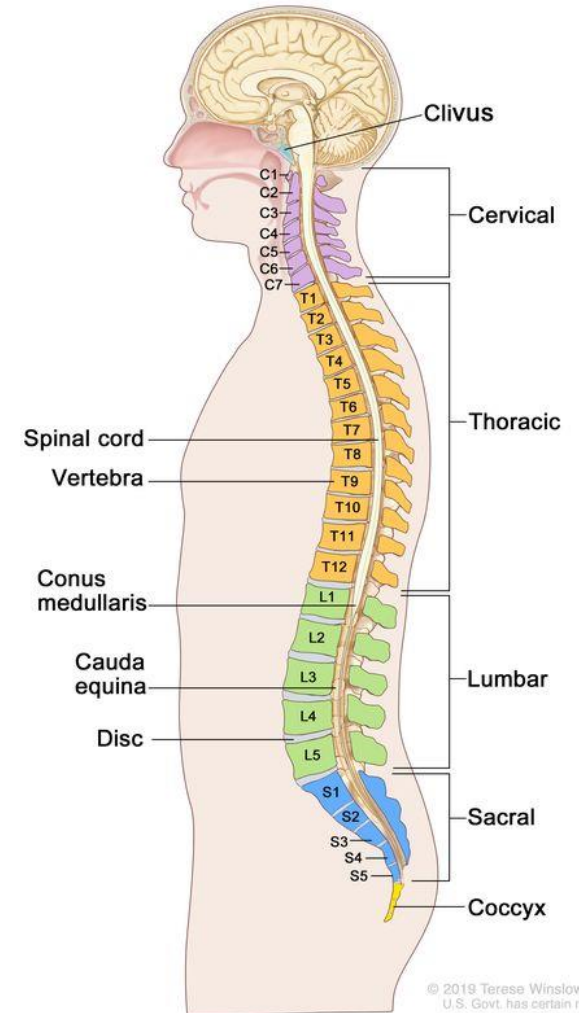
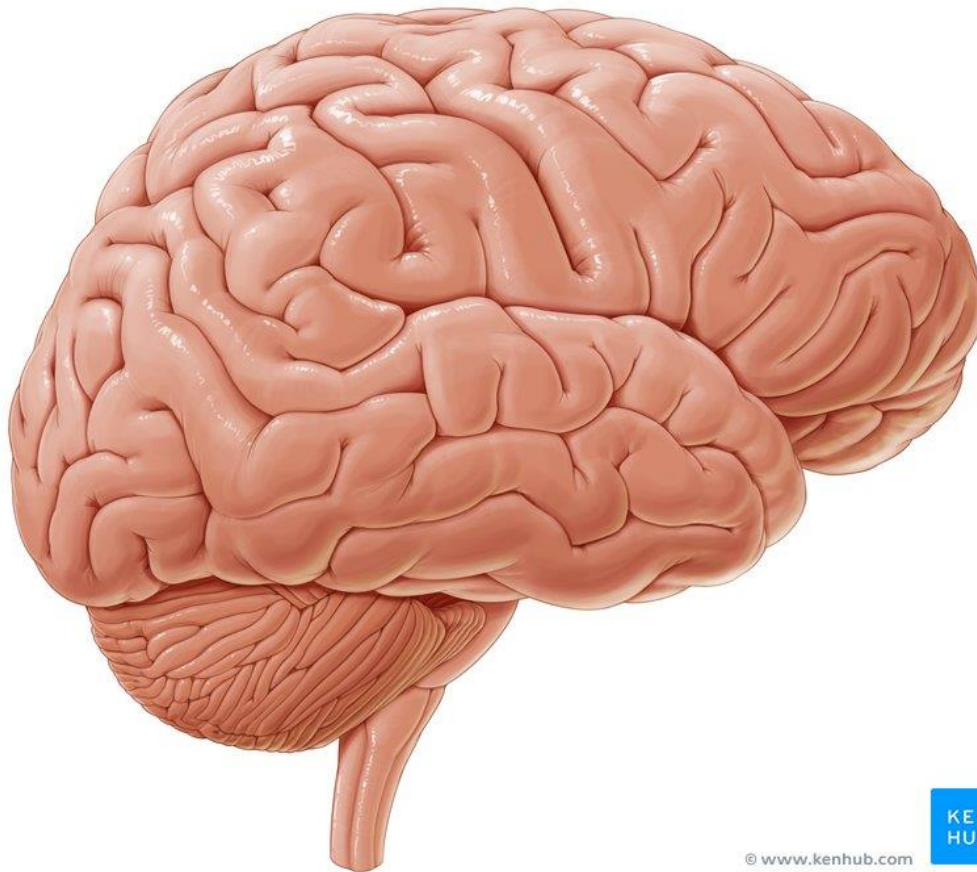
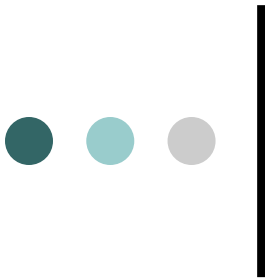




# Organization of the Nervous System

- Central nervous system (CNS)
  - Brain and spinal cord
  - Integration and command center
- Peripheral nervous system (PNS)
  - Paired spinal and cranial nerves
  - Carries messages to and from the spinal cord and brain







# Peripheral Nervous System (PNS): Two Functional Divisions

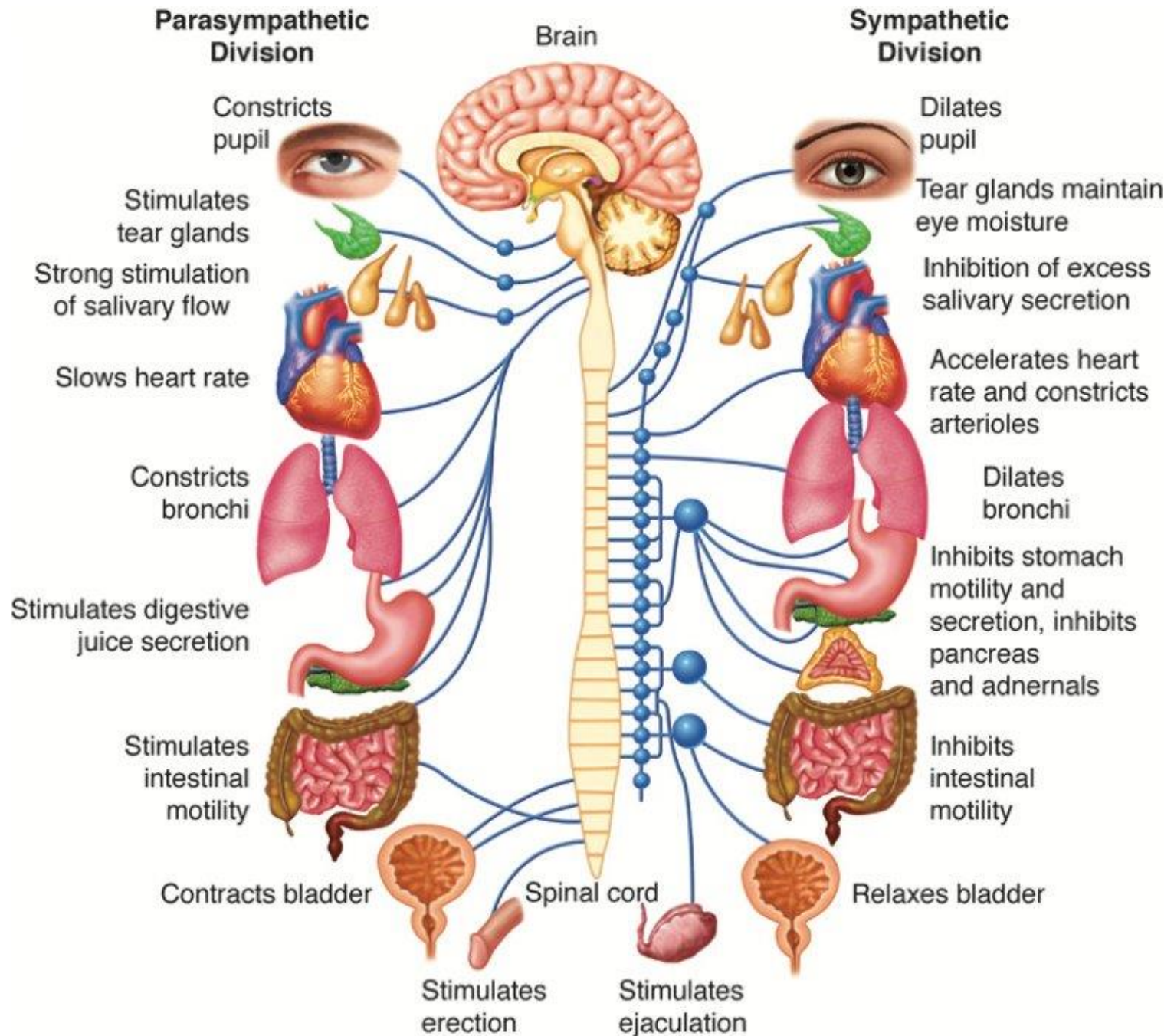
- Sensory (afferent) division
  - Carries impulses from skin, skeletal muscles, and joints to the brain
  - Transmits impulses from visceral organs to the brain
- Motor (efferent) division
  - Transmits impulses from the CNS to effector organs (muscle, gland)



# Motor Division: Two Main Parts

- Somatic nervous system
  - Conscious control of skeletal muscles
- Autonomic nervous system (ANS)
  - Regulate smooth muscle, cardiac muscle, and glands
  - Divisions – sympathetic and parasympathetic





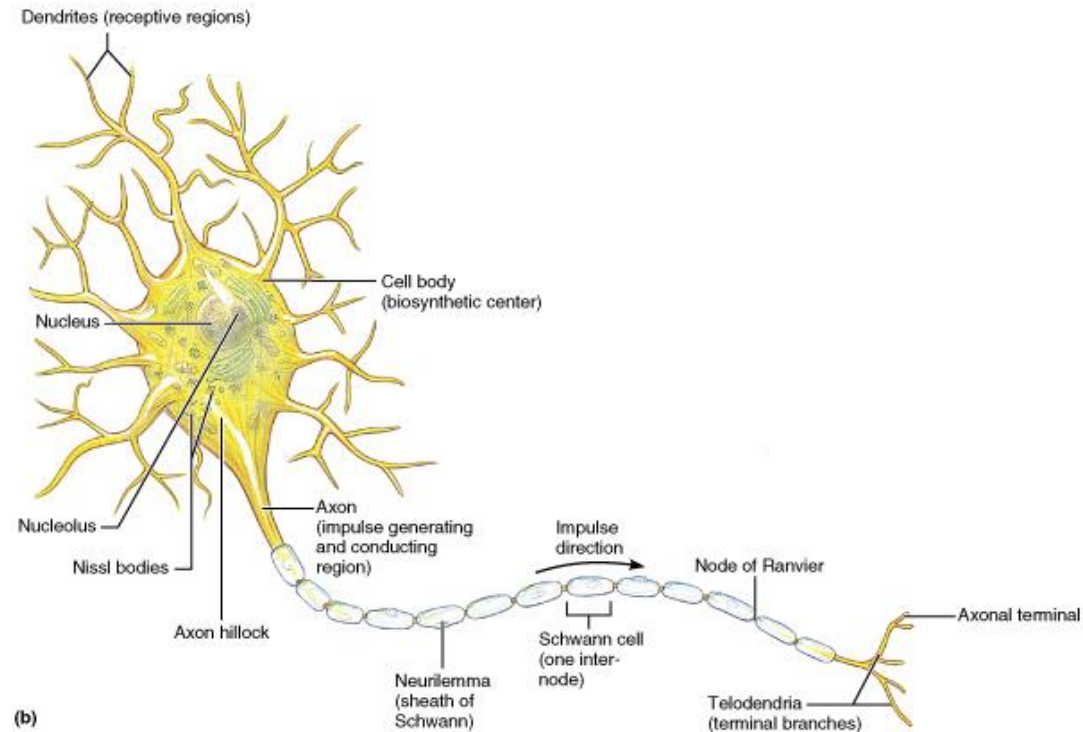


# Histology of Nerve Tissue

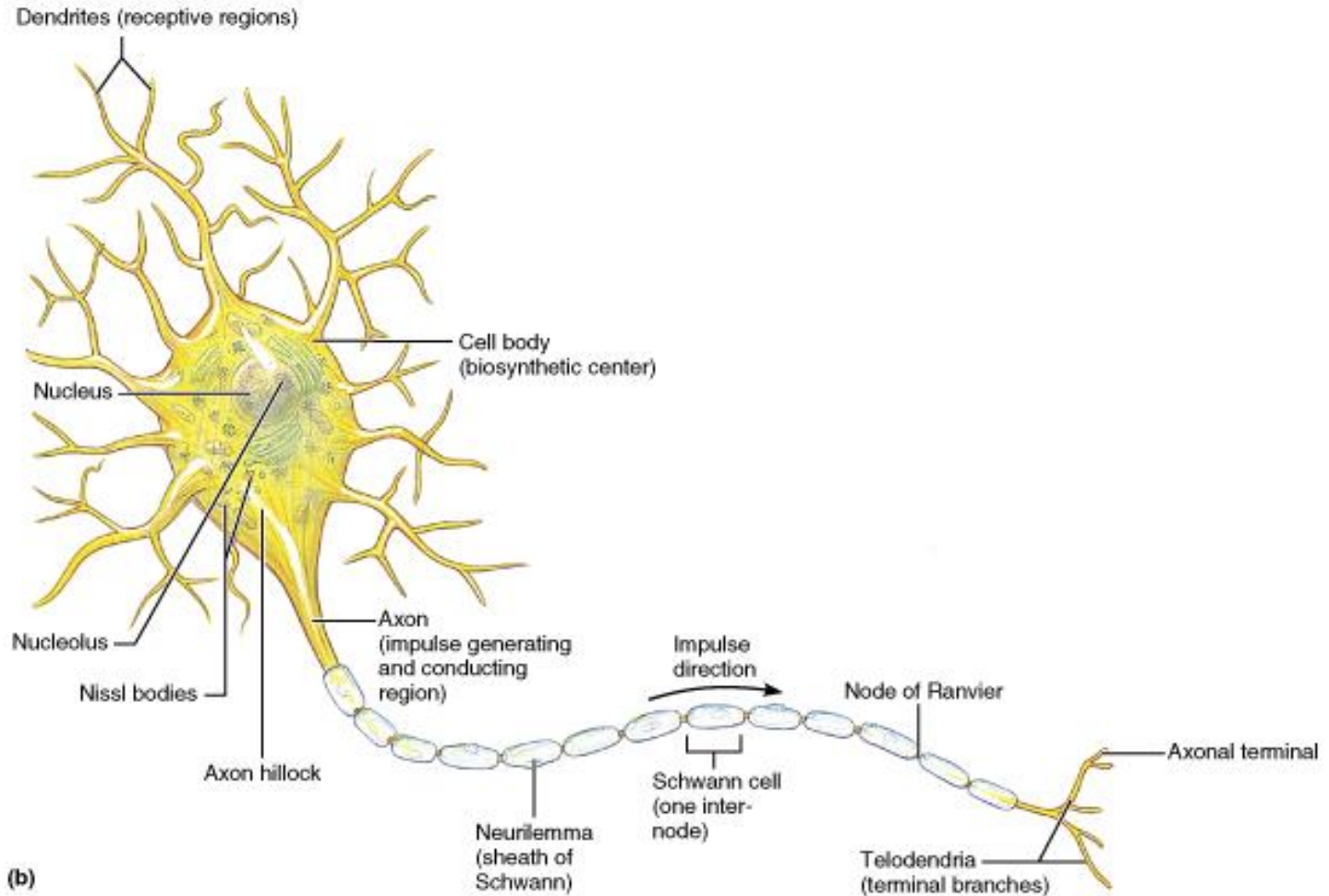
- The two principal cell types of the nervous system are:
  - Neurons – excitable cells that transmit electrical signals
  - Supporting cells – cells that surround and wrap neurons

# Neurons (Nerve Cells)

- Structural units of the nervous system
  - Composed of a body, axon, and dendrites

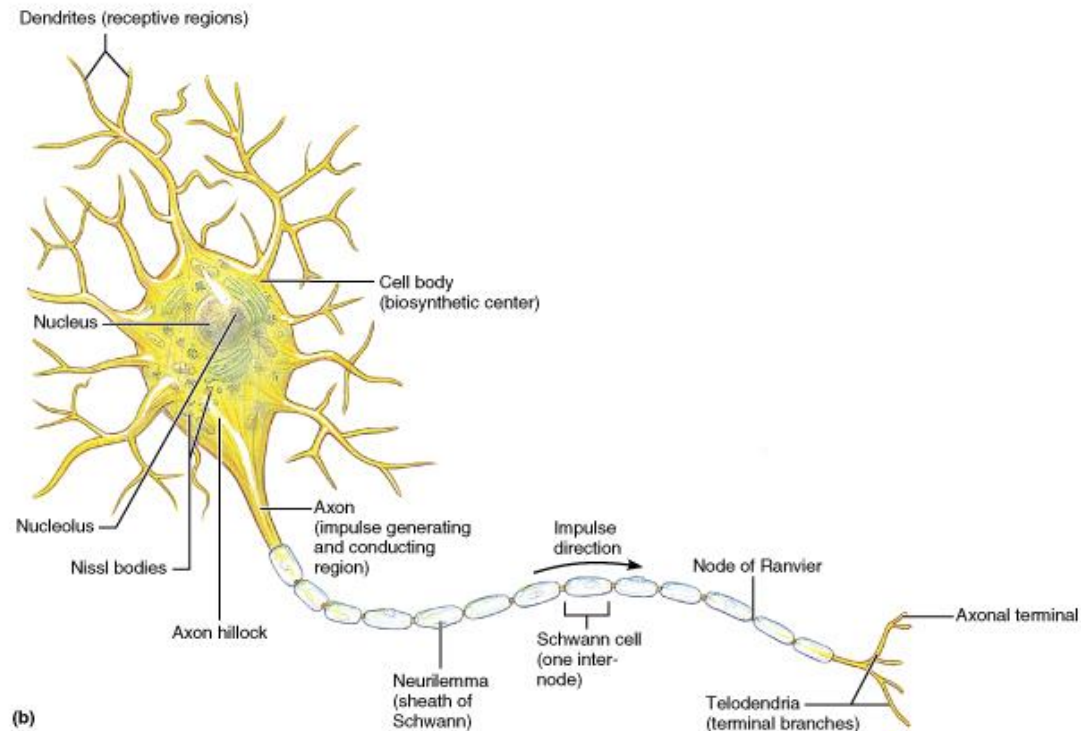


# Neurons (Nerve Cells)



# Nerve Cell Body (Soma)

- Contains the nucleus and a nucleolus
- Major metabolic center



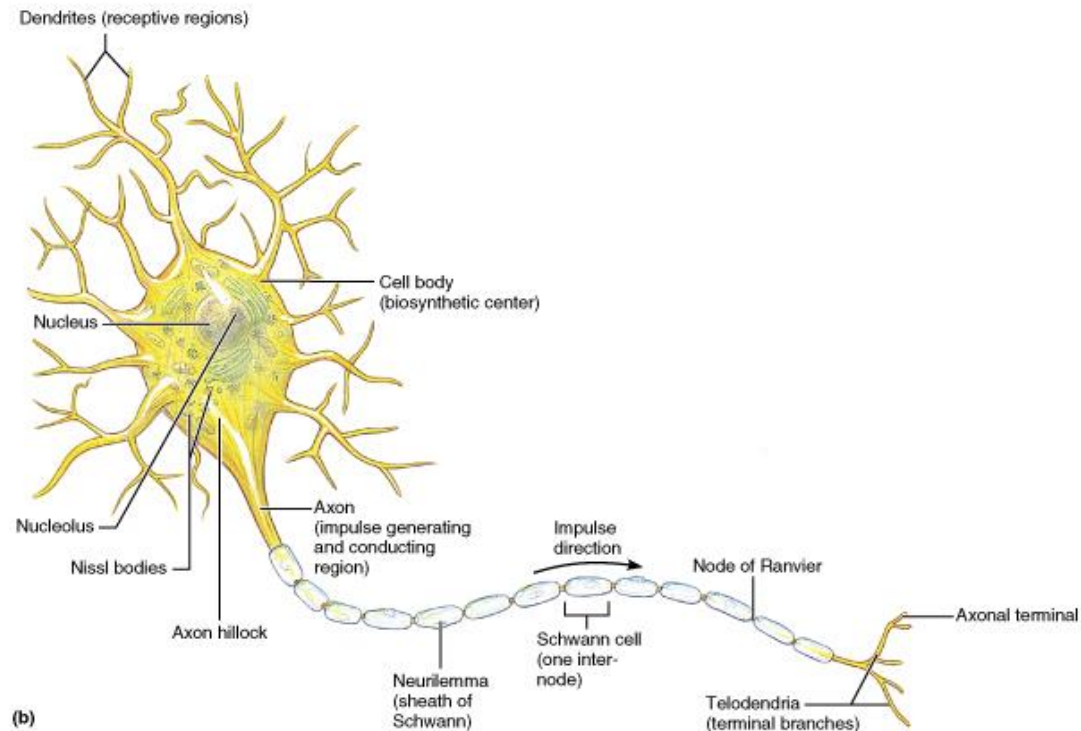


# Processes

- Armlike extensions from the soma
- Called tracts in the CNS and nerves in the PNS
- There are two types: axons and dendrites

# Dendrites

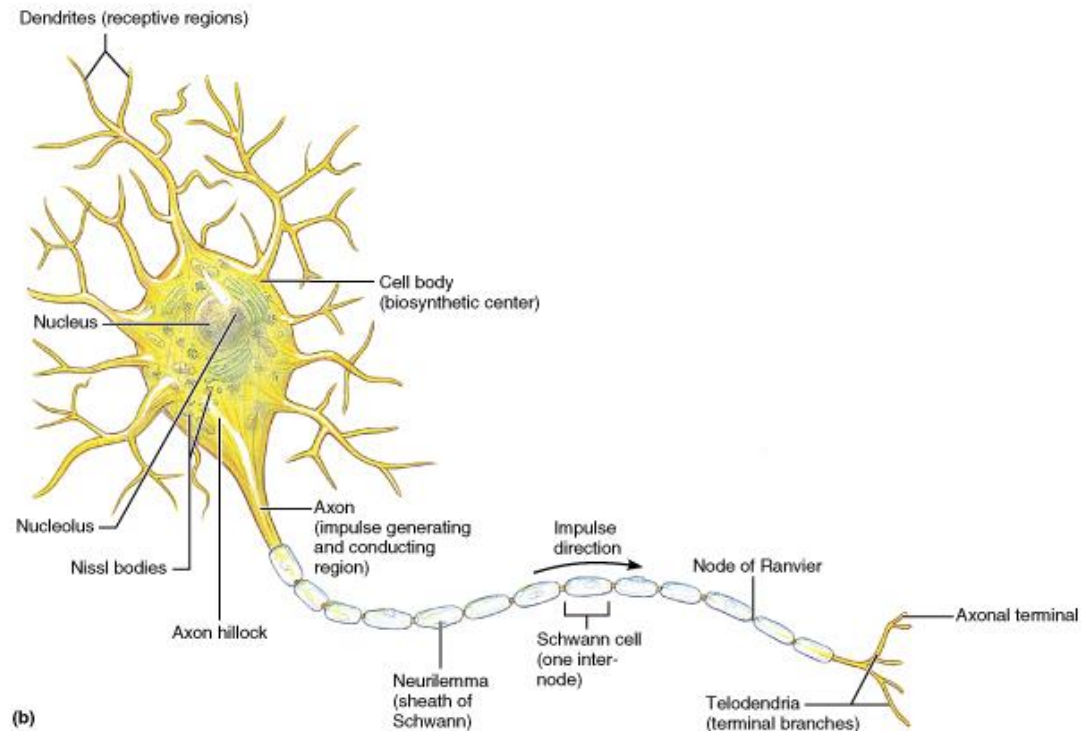
- Short diffusely branched processes
- Conduct impulses toward the soma





# Axons: Structure

- Long axons are called nerve fibers
- Conduct impulses away from the soma







# Myelin Sheath

- Whitish, fatty (protein-lipid), segmented sheath around most long axons
- It functions in:
  - Protection of the axon
  - Electrically insulating fibers from one another
  - Increasing the speed of nerve impulse transmission



# Supporting Cells: Neuroglia

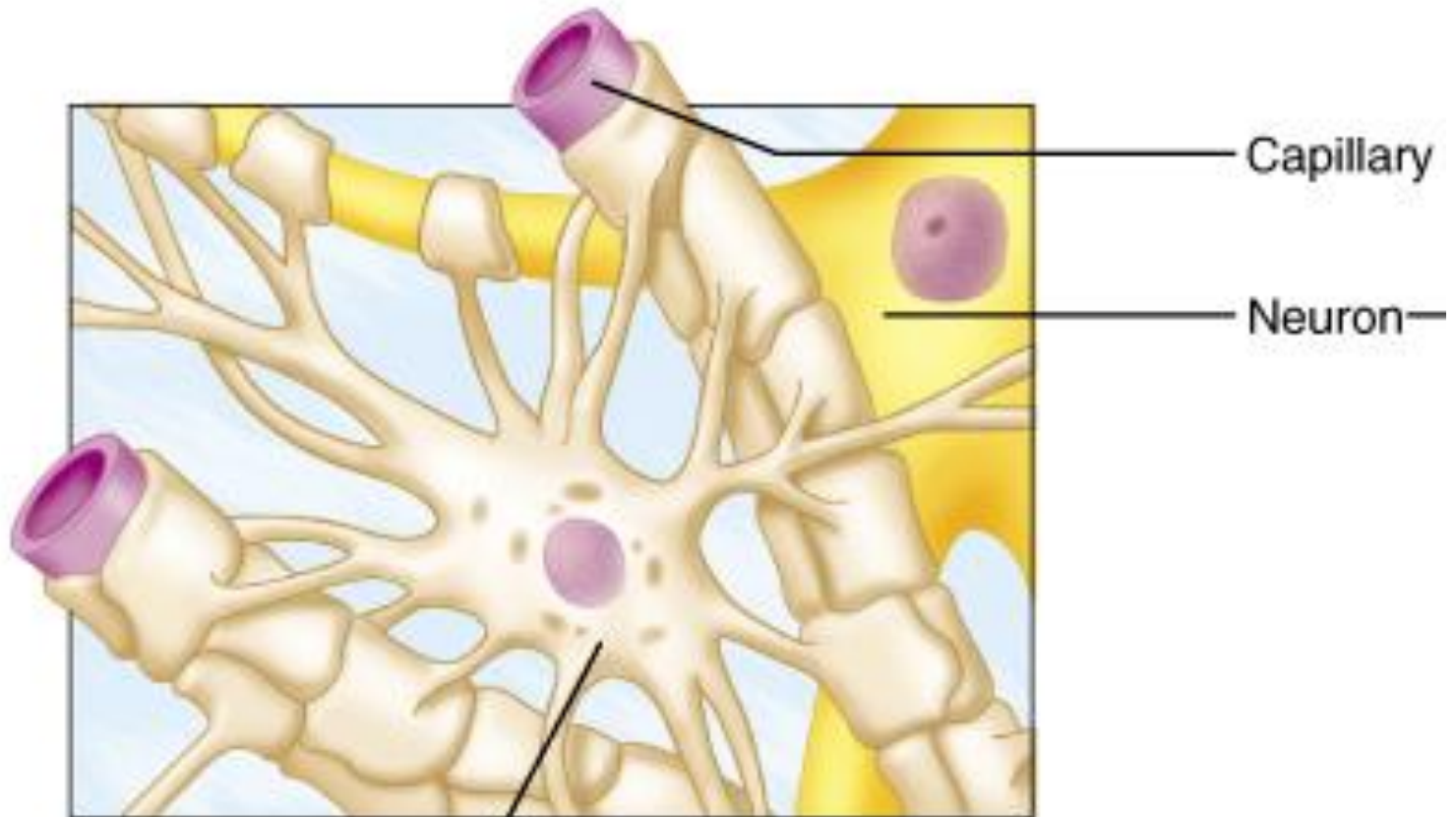
- The supporting cells (neuroglia or glial cells):
  - Provide support for neurons
  - Insulate neurons
  - Guide young neurons to the proper connections
  - Promote health and growth



# Supporting Cells (Neuroglial Cells)

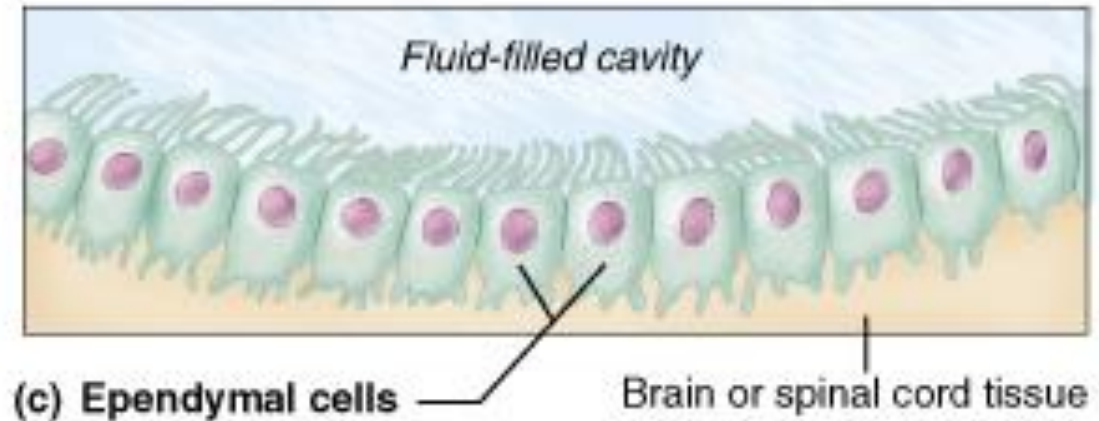
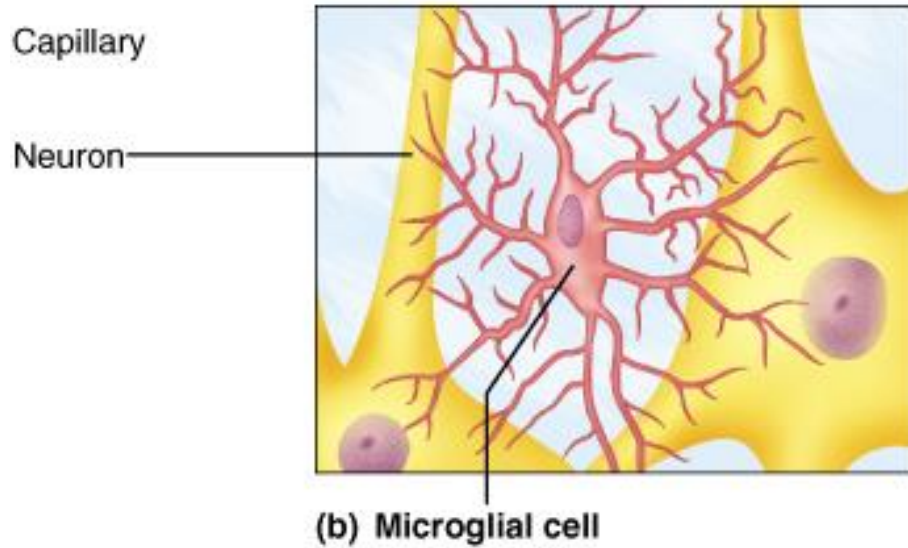
- **CNS:** Oligodendroglia, astrocytes, ependymal cells, microglia
- **PNS:** Schwann cells and satellite cells

# Astrocytes

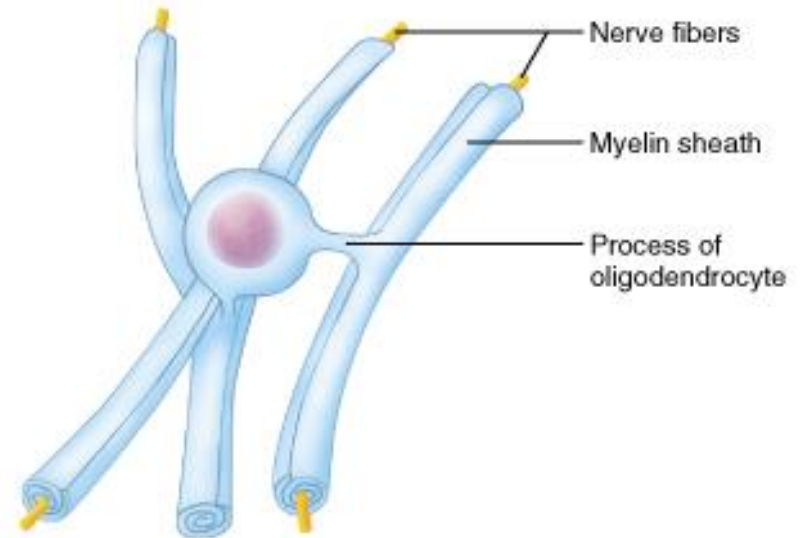


(a) Astrocyte

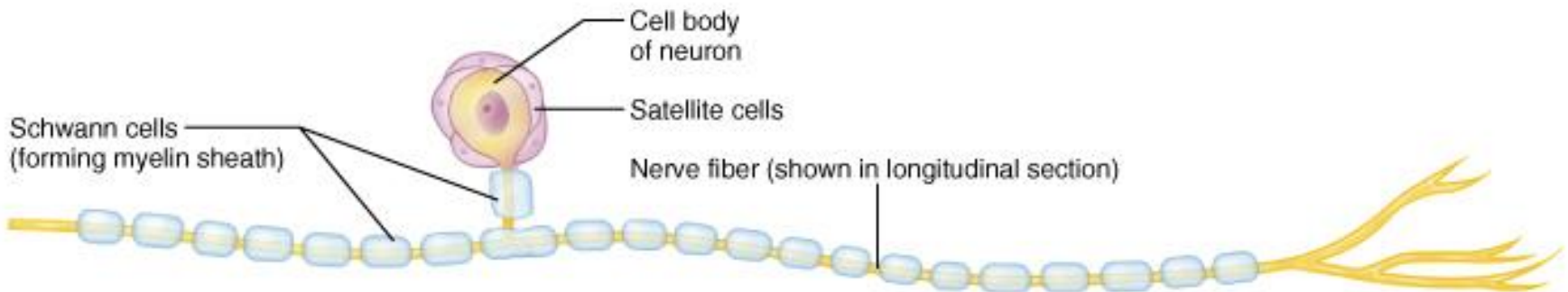
# Microglia and Ependymal Cells



# Oligodendrocytes



(d) Oligodendrocyte



(e) Sensory neuron with Schwann cells and satellite cells



# Neuron Classification

## ○ Structural:

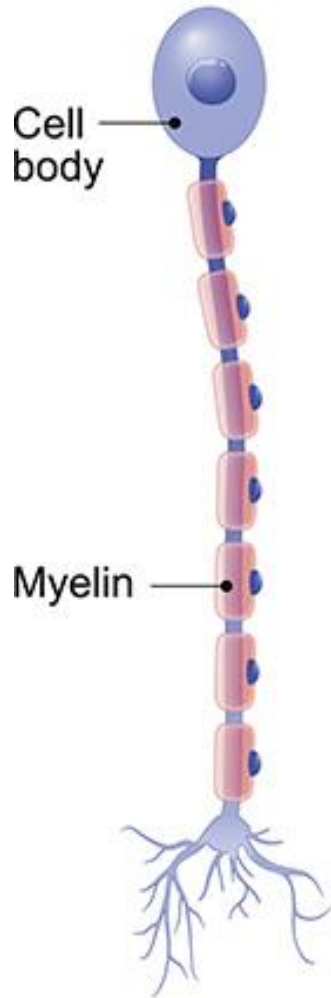
- Unipolar
- Bipolar
- Multipolar

## ○ Functional:

- Sensory (afferent)
  - Cell bodies in the ganglia in the PNS
- Motor (efferent)
  - Cell bodies in the CNS
- Interneurons (association neurons)
  - Cell bodies in the CNS, connect motor & sensory neurons



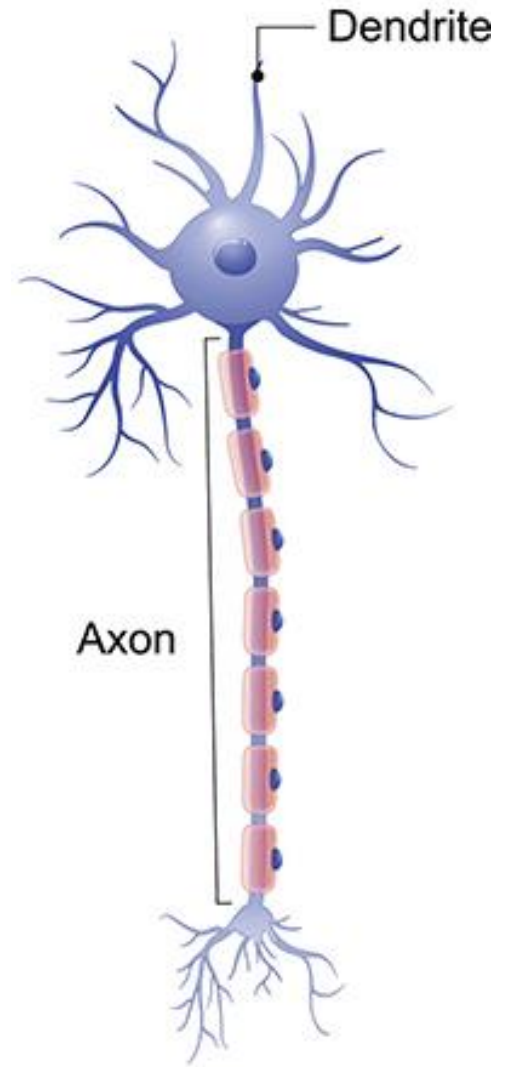
## Unipolar



## Bipolar



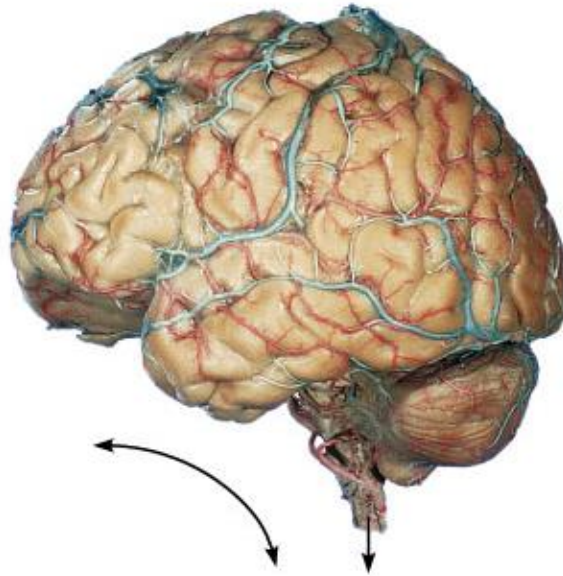
## Multipolar





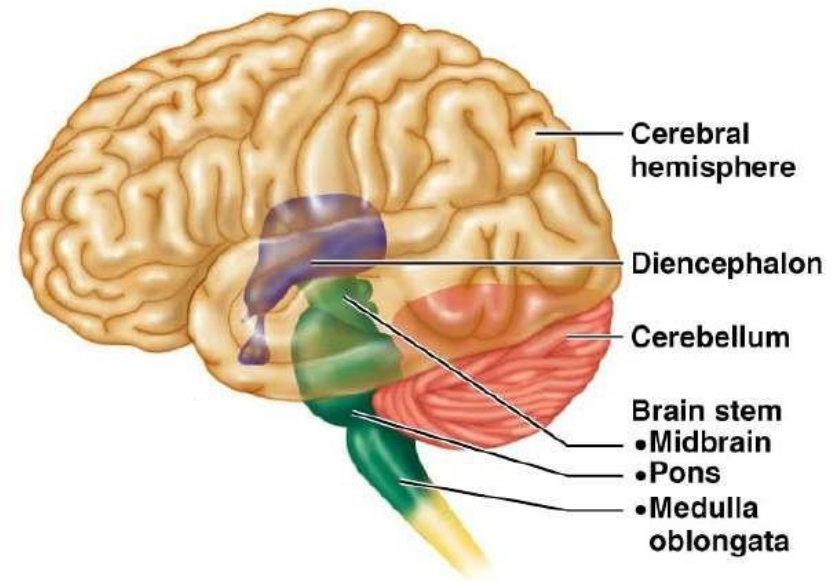


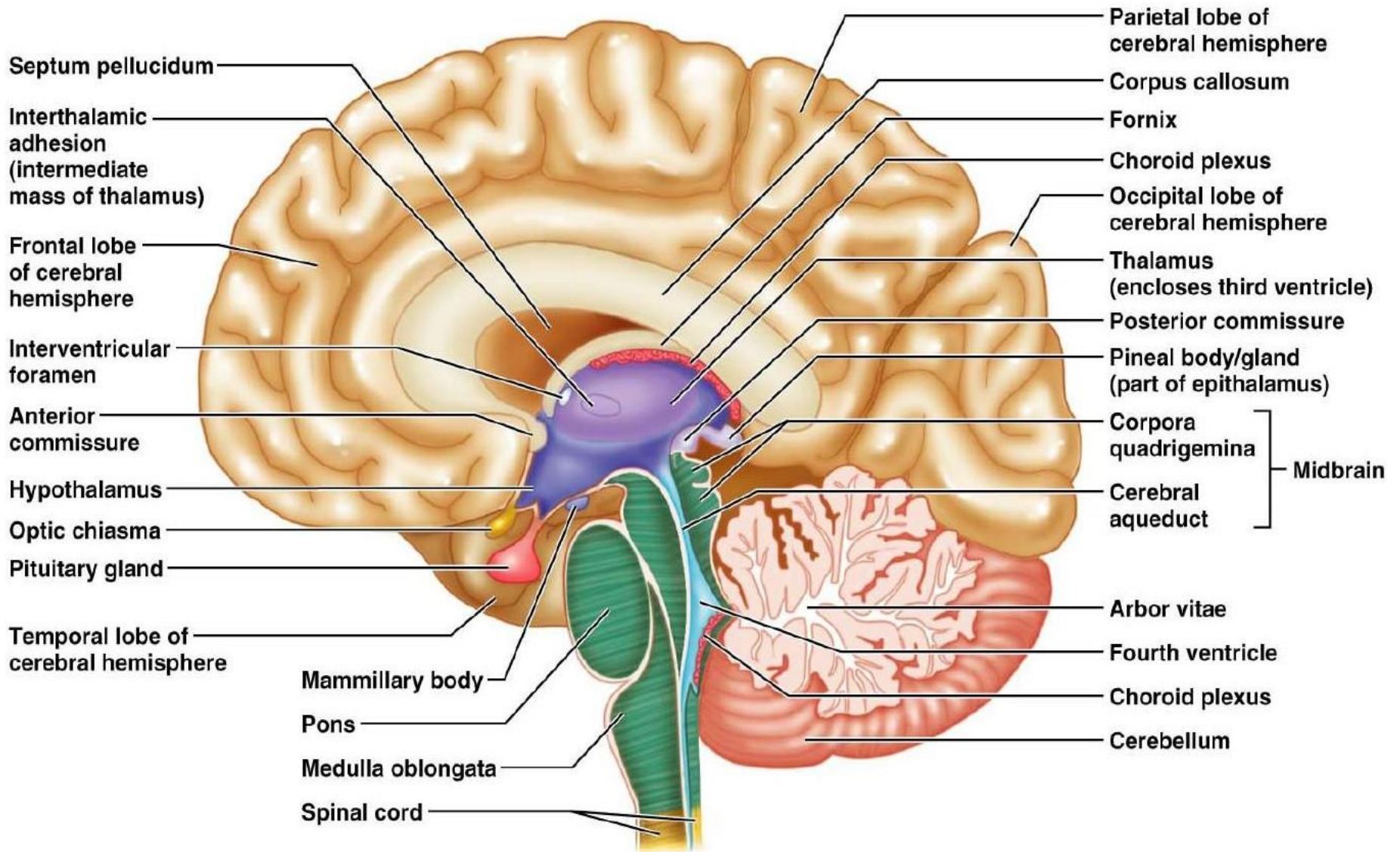
# CNS



# CNS: Functional Anatomy of the Brain

- Four sections
  - Cerebrum
  - Diencephalon
  - Brain stem
    - Midbrain
    - Pons
    - Medulla oblongata
  - Cerebellum







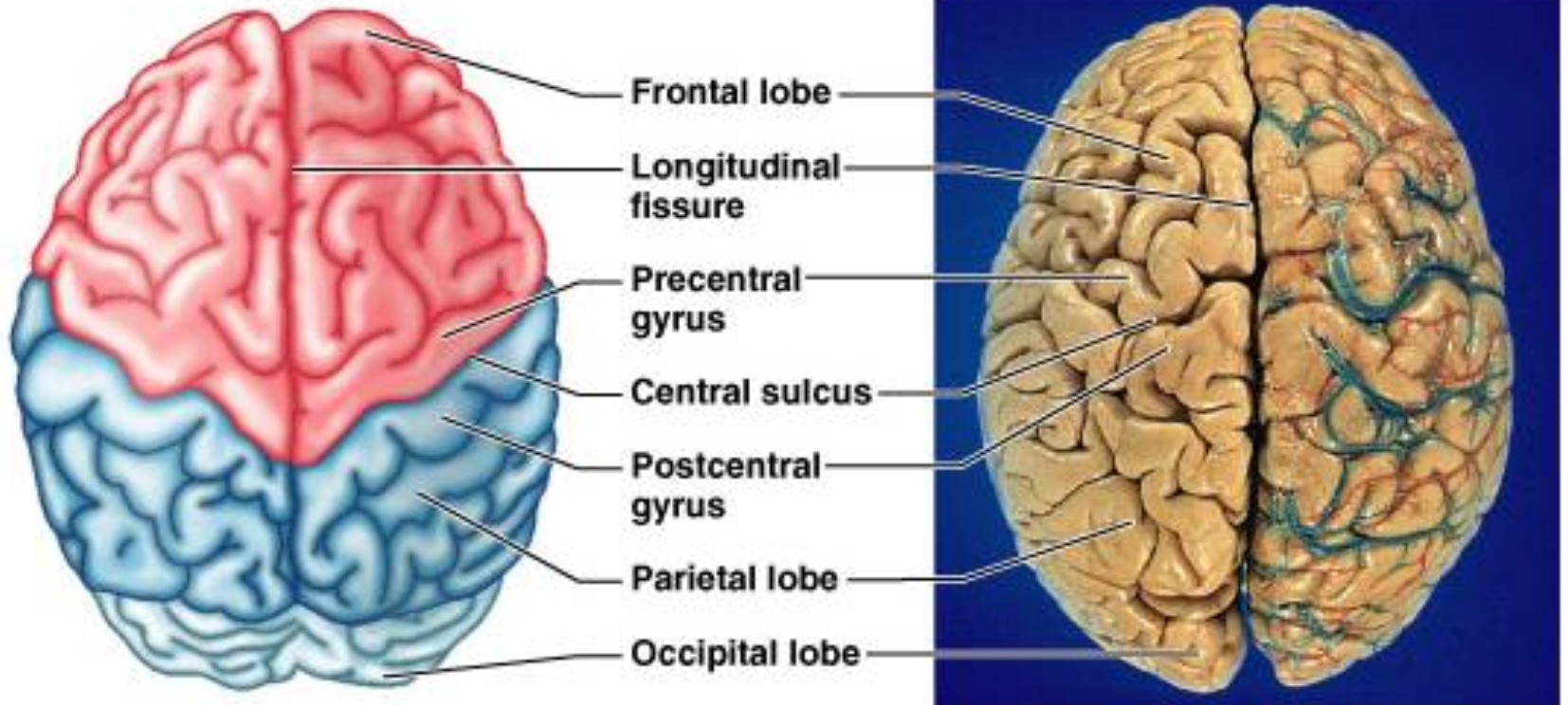
# Cerebrum

- Largest section
- Two cerebral hemispheres
  - Connected by a thick bundle of nerve fibers called the **corpus callosum**
  - Longitudinal fissure between hemispheres
- **Sulci** – grooves on surface
- **Gyri** – bumps of brain matter between sulci

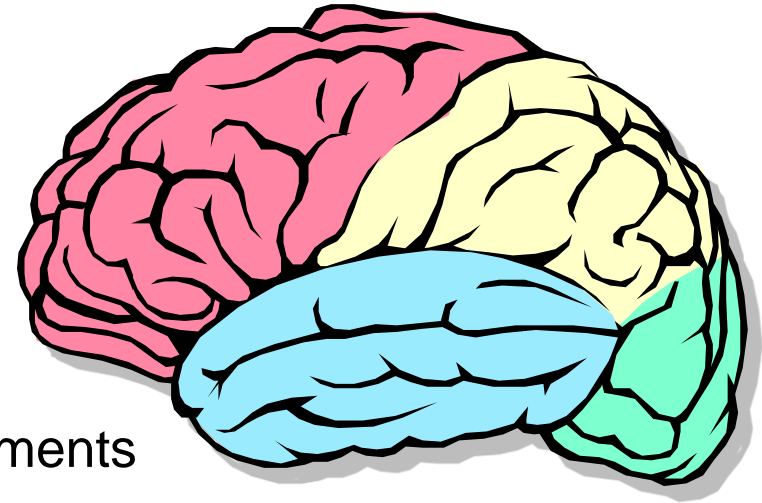




*Anterior*



# Cerebrum



## ○ Lobes

- **Frontal**
  - Motor areas for voluntary body movements
- **Parietal**
  - Somatosensory – interprets sensations
- **Temporal**
  - Auditory – interprets sounds
- **Occipital**
  - Interprets what a person sees (vision)

# Functional Areas of the Cerebral Cortex

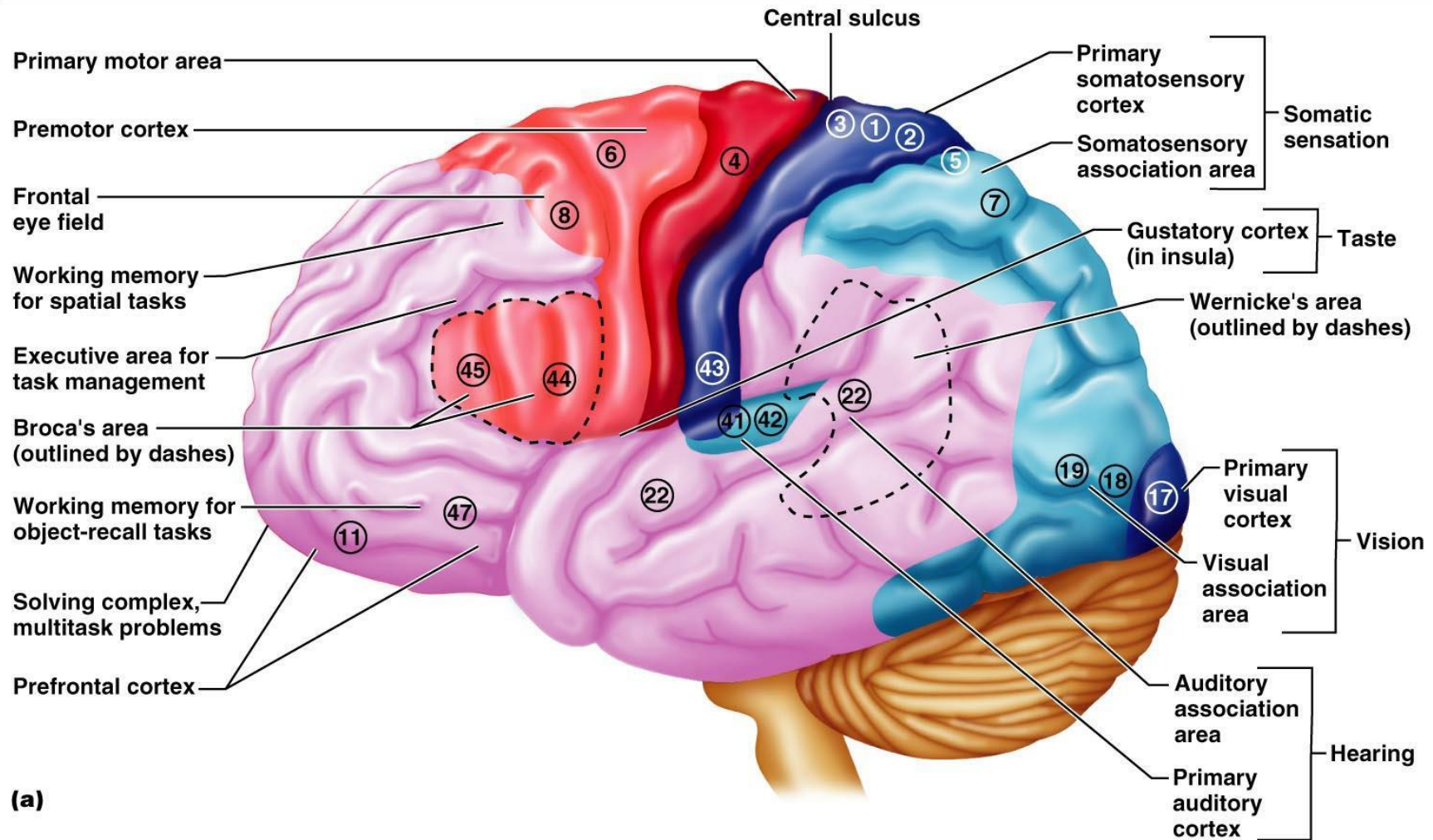


Figure 12.8a

# Cerebrum

## ○ Cortex

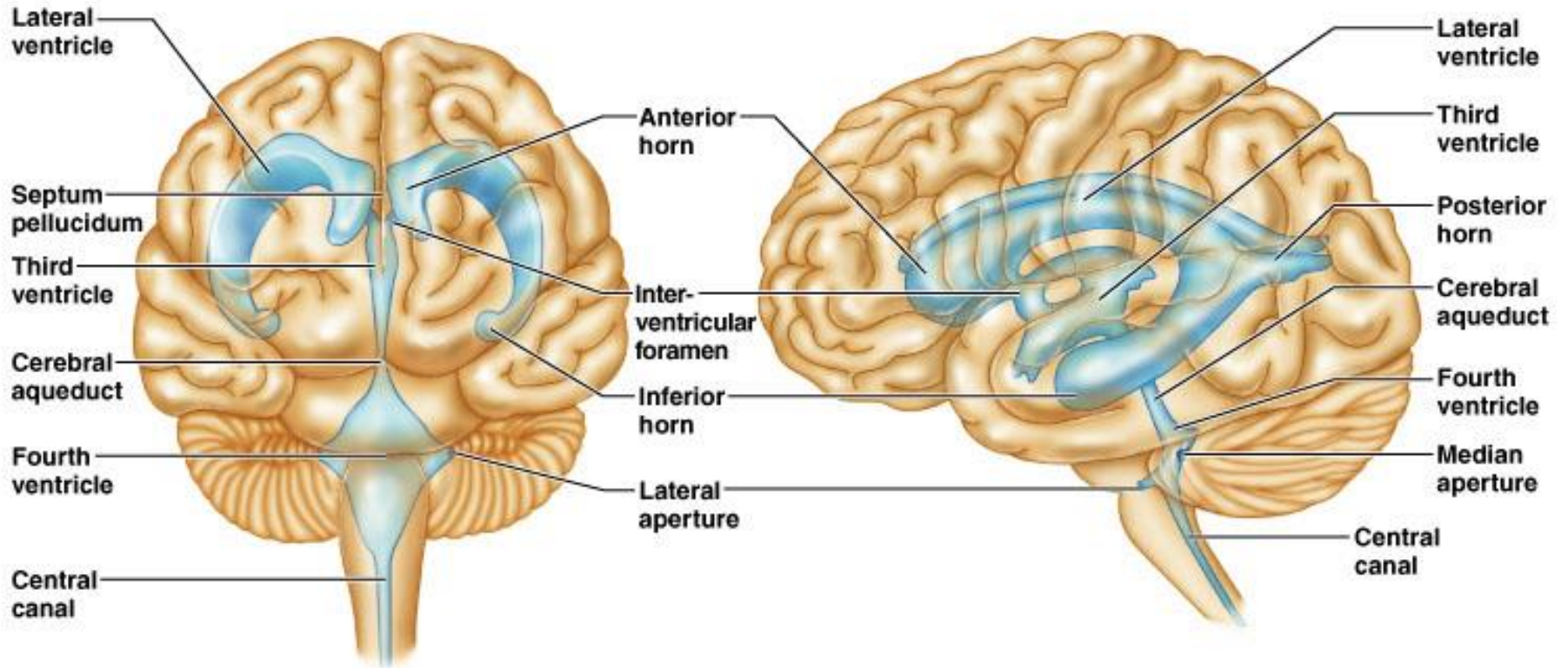
- Outer layer – gray matter
- Inner layer – white matter

## ○ Ventricles

- Interconnected cavities within the brain
- Filled with CSF







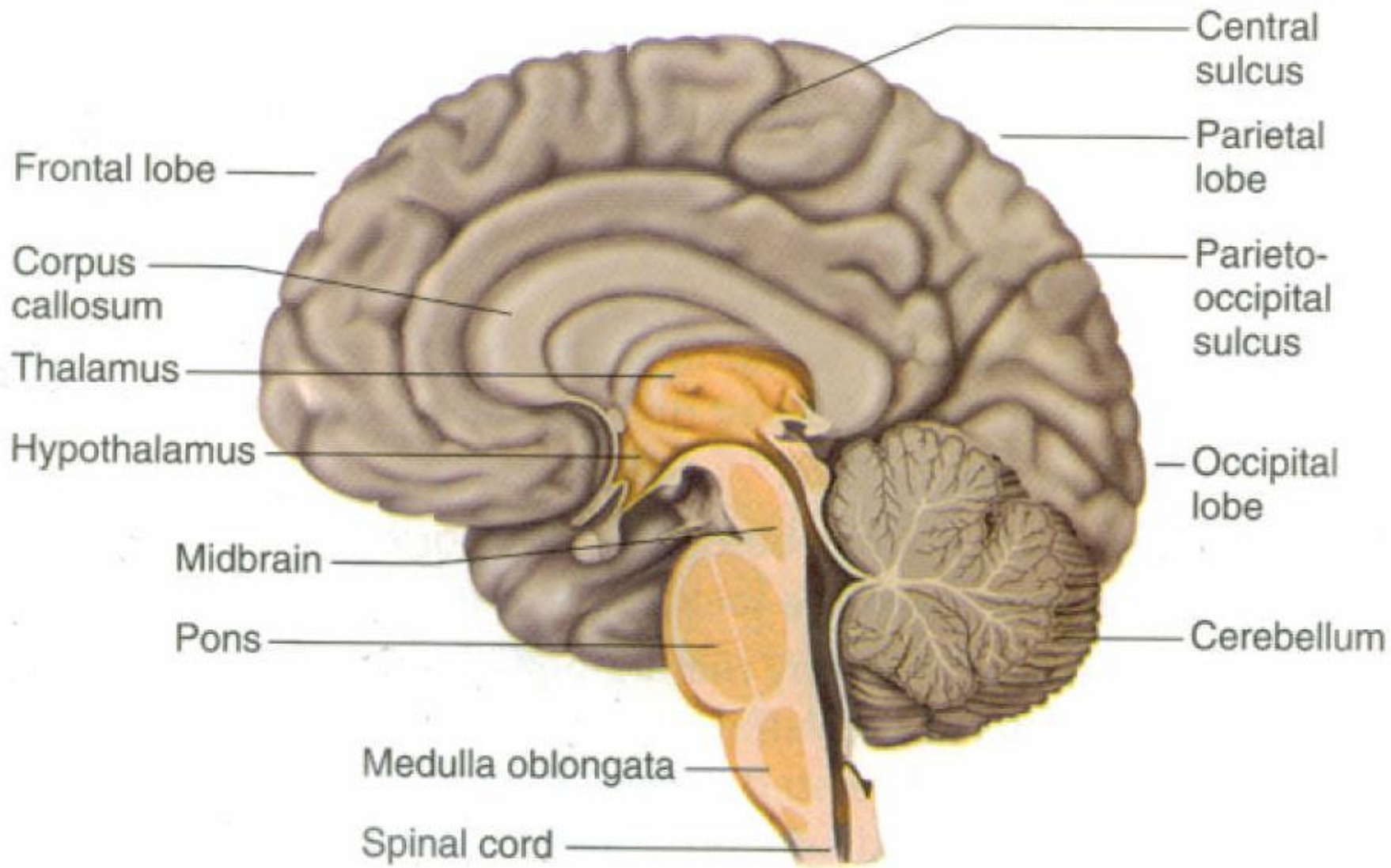
**(a) Anterior view**

**(b) Left lateral view**



# *Diencephalon*

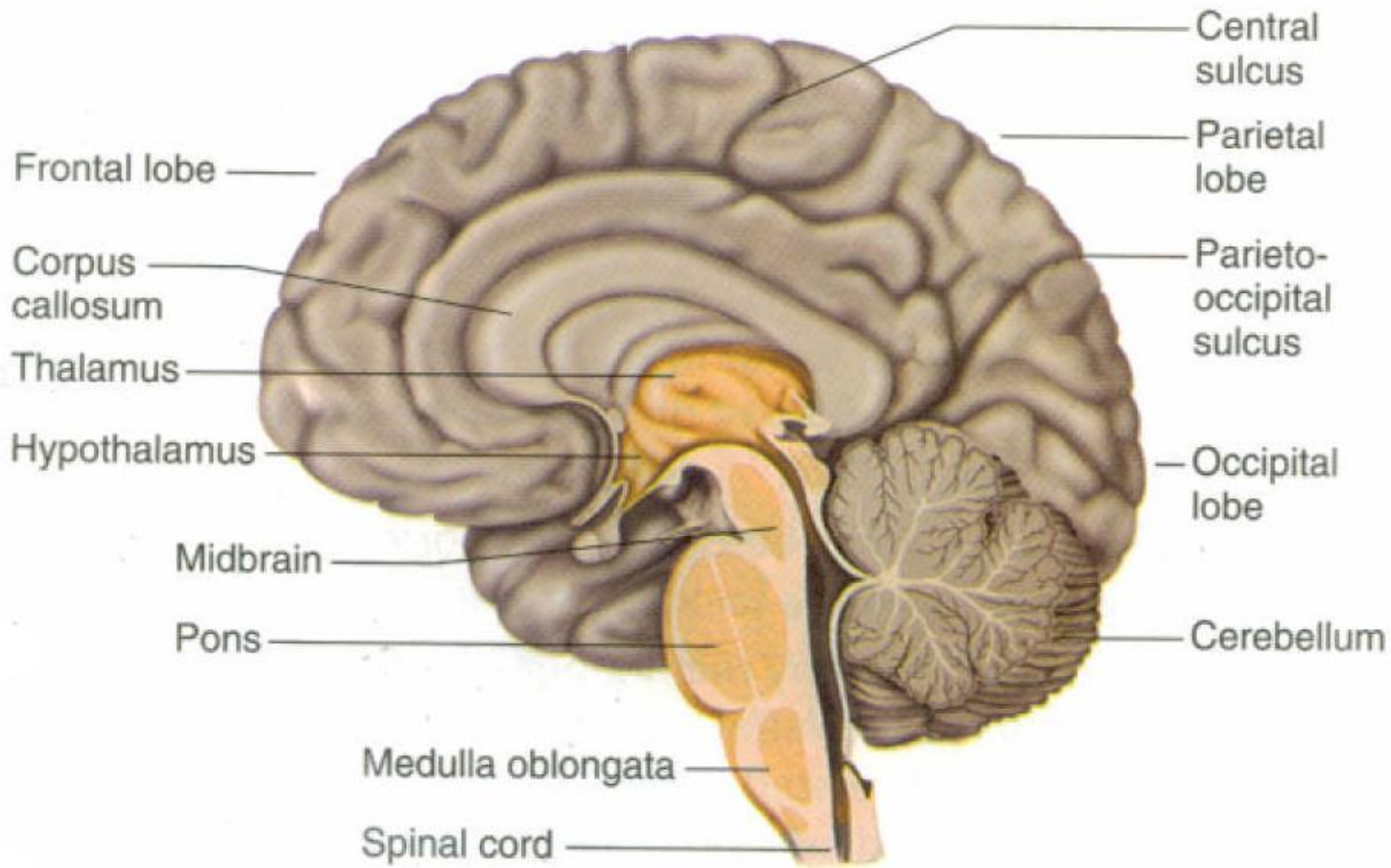
- Between the cerebral hemispheres superior to the brain stem
- **Thalamus**
  - Relay station for sensory information going to the cerebral cortex for interpretation
- **Hypothalamus**
  - Maintains homeostasis by regulating vital activities



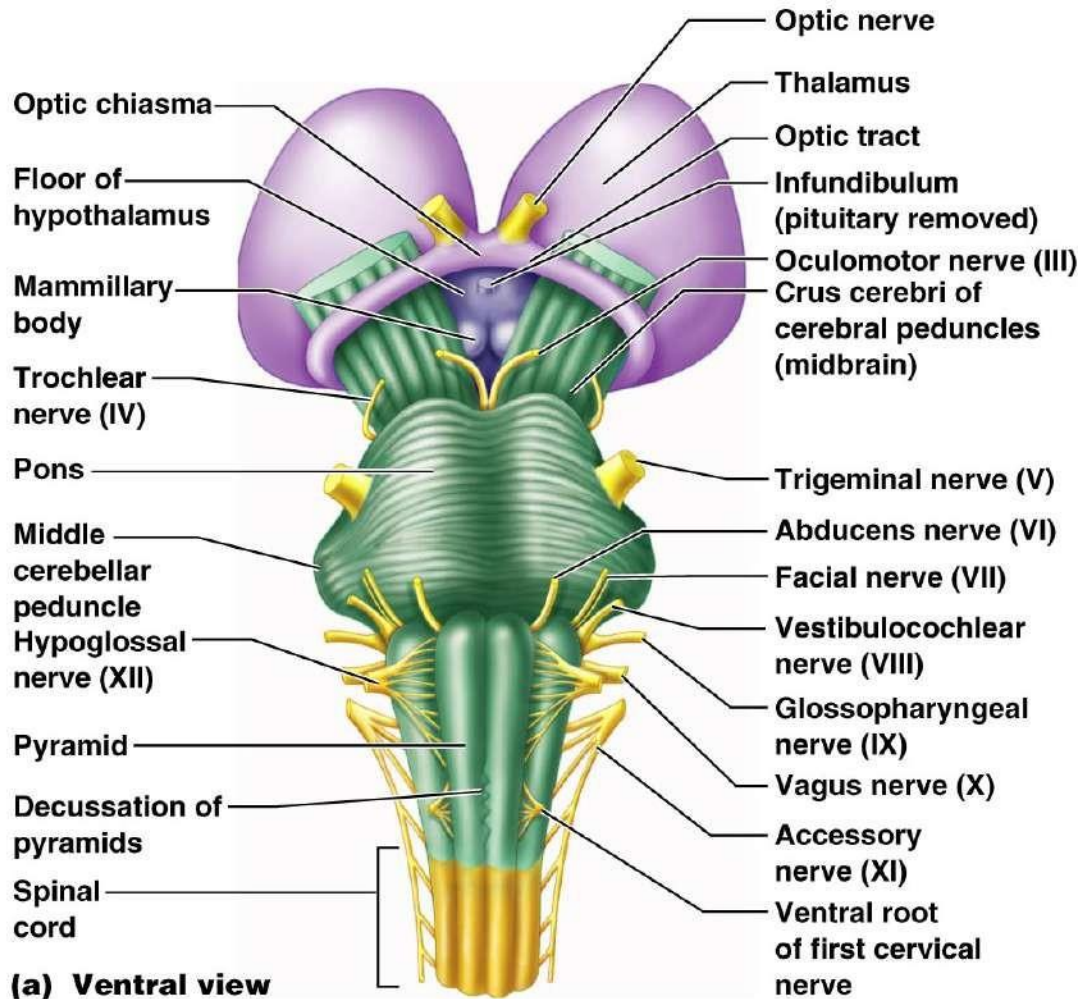
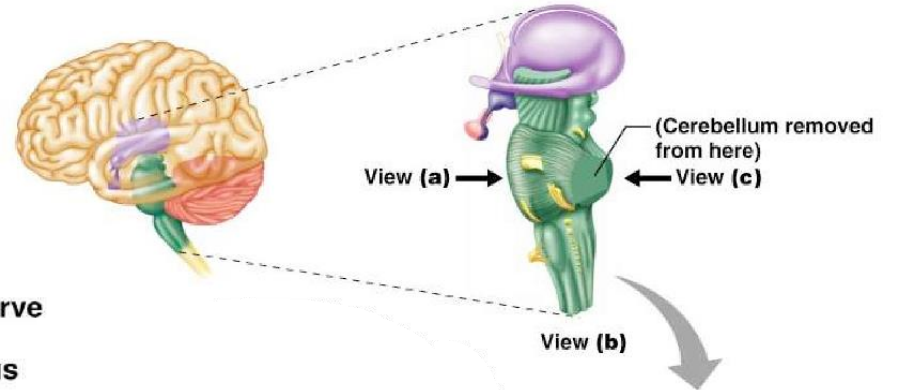


# Brain Stem

- Connects the cerebrum to the spinal cord
- **Midbrain**
  - Just beneath diencephalon
  - Controls both visual and auditory reflexes
- **Pons**
  - Rounded bulge on underside of brain stem
  - Regulates respiration
- **Medulla oblongata**
  - Directly connected to spinal cord
  - Controls many vital activities, such as heart rate, blood pressure, and breathing









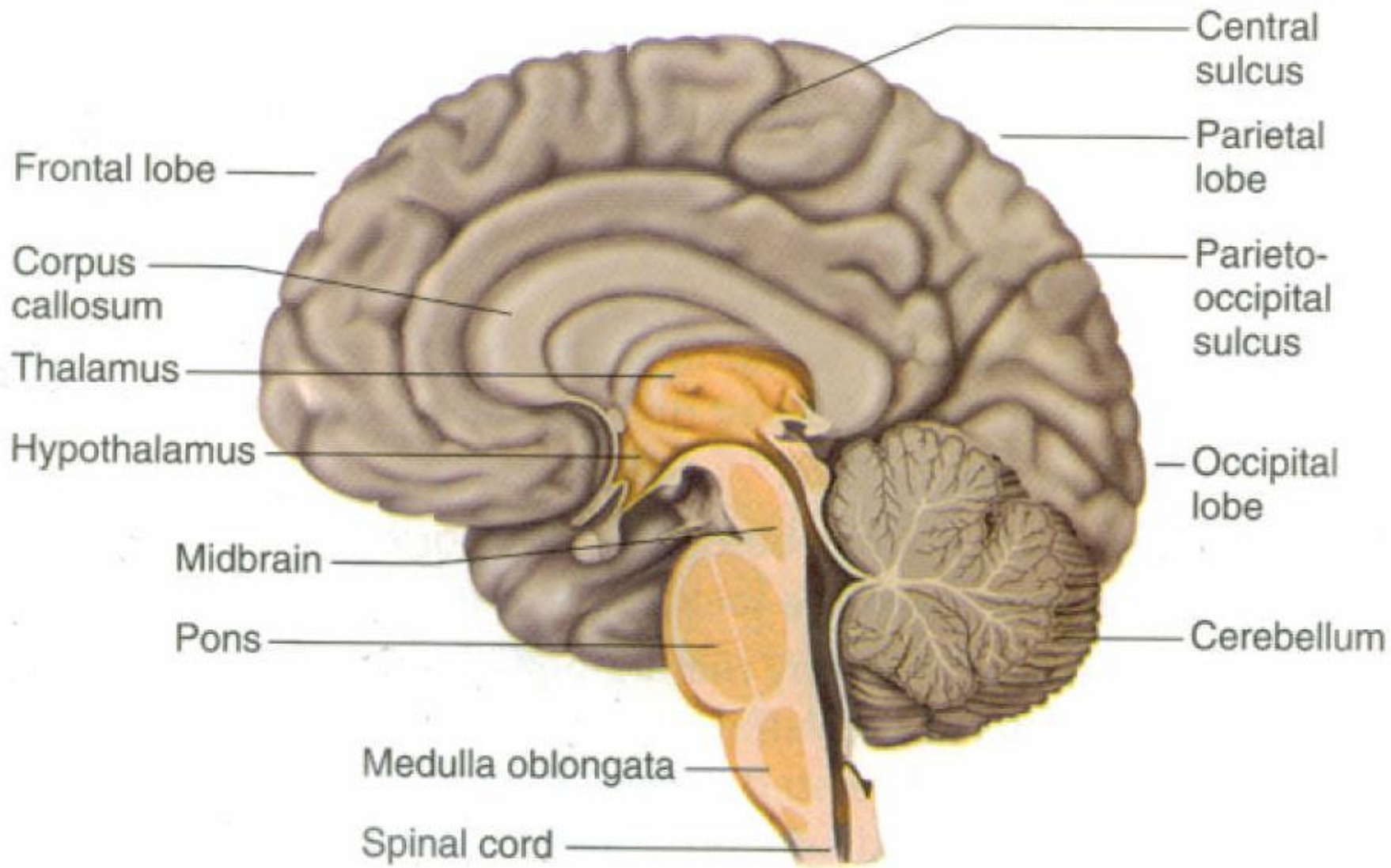
# Cerebellum

## ○ Location

- Inferior to the occipital lobes of the cerebrum
- Posterior to the pons and medulla oblongata

## ○ Coordinates

- Complex skeletal muscle contractions that are needed for body movements
- Control balance and equilibrium







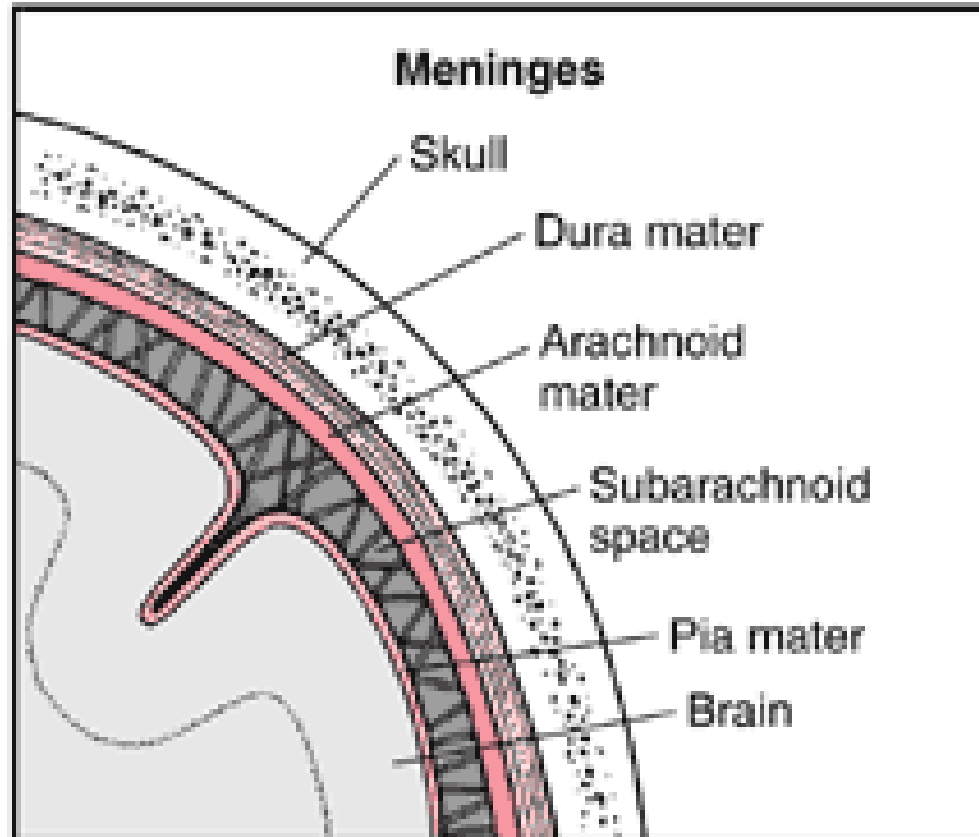
# Protection of the CNS

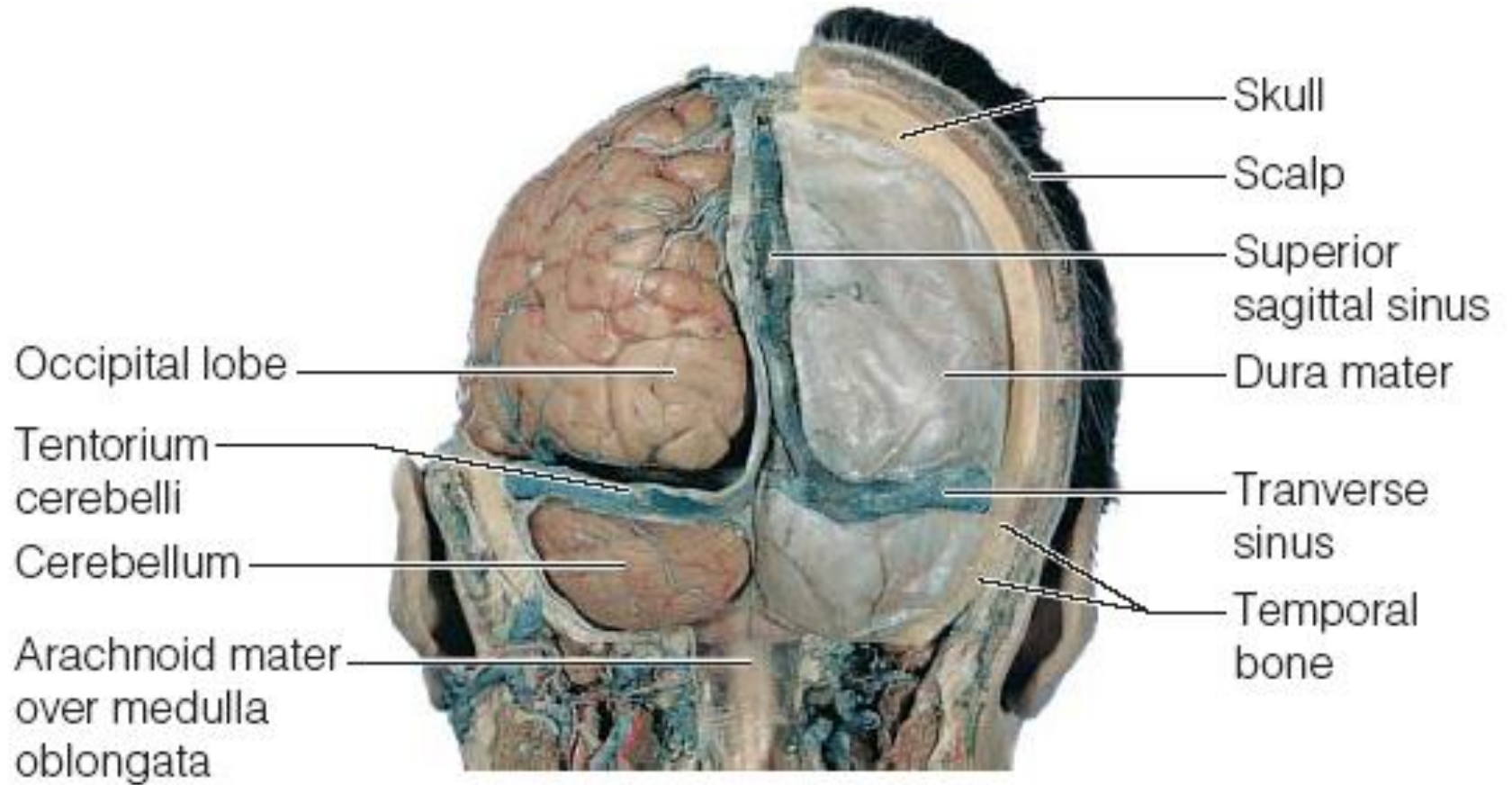
- Bones (skull and vertebral column)
- Membranes (meninges)
- CSF
- BBB (blood brain barrier)

# Meninges

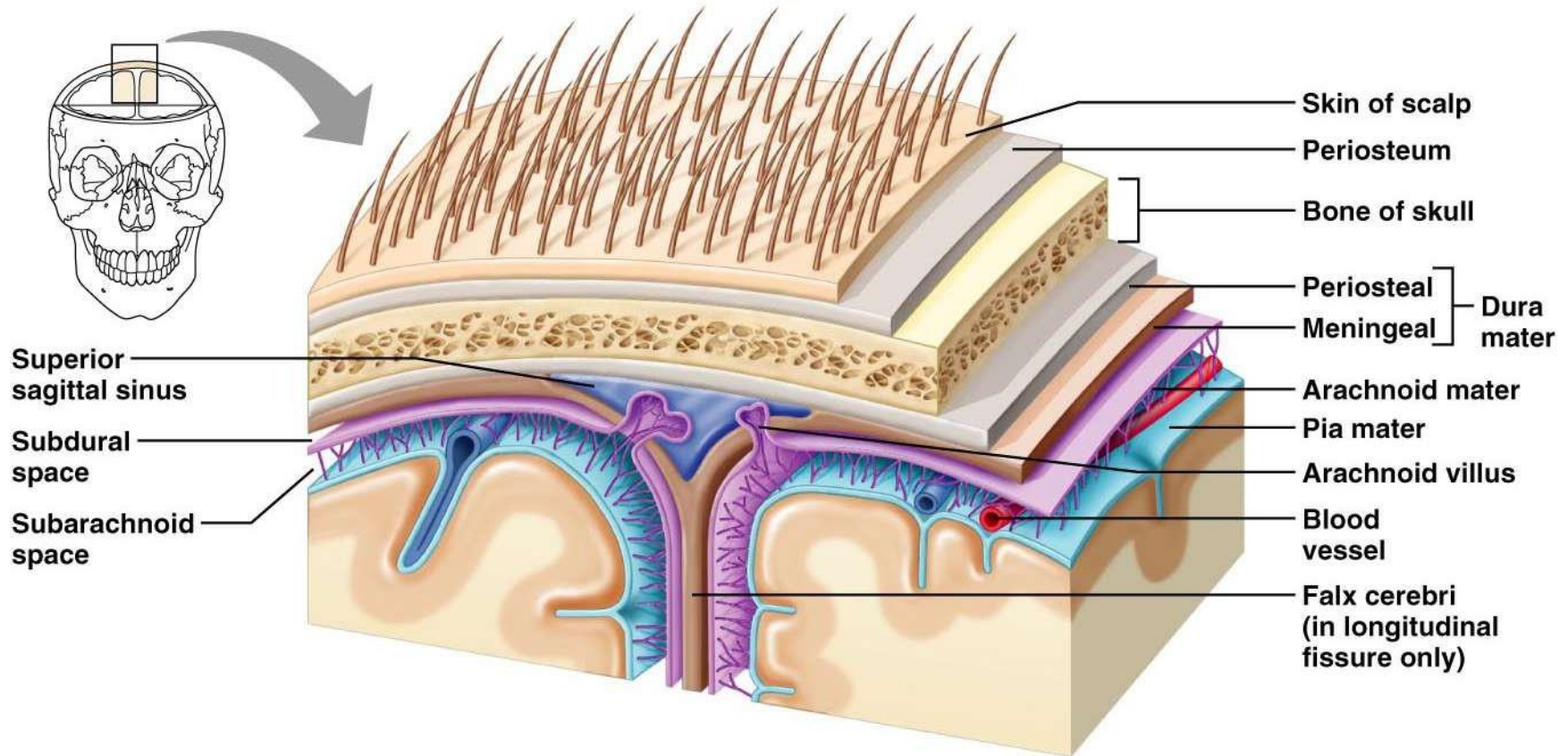
○ **Meninges** –protect brain and spinal cord

- Dura mater
  - Tough outer layer
- Arachnoid mater
  - Middle layer
- Pia mater
  - Innermost and most delicate





# Meninges

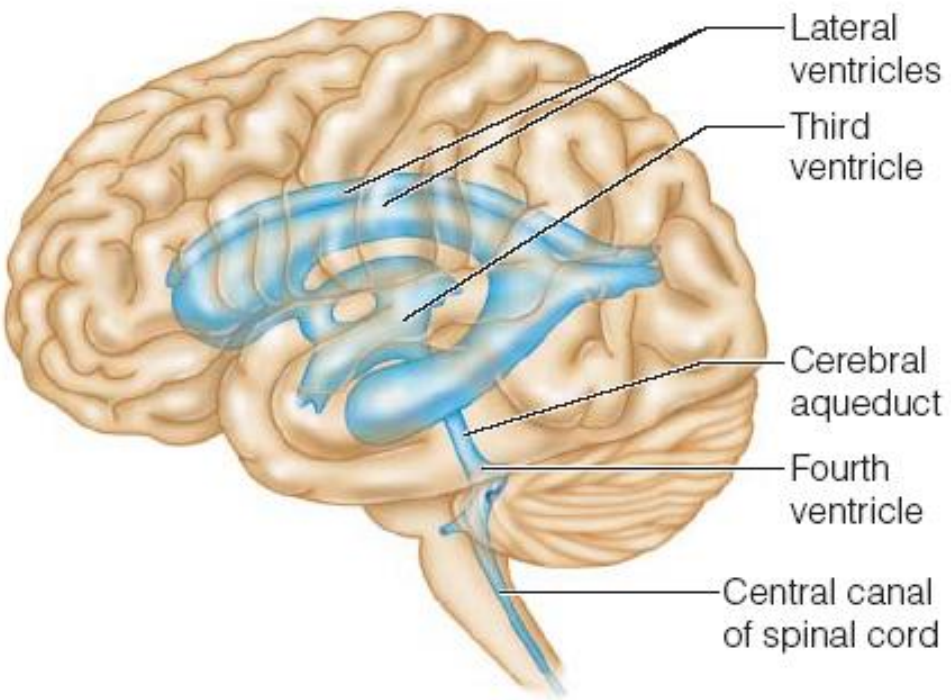


(a)

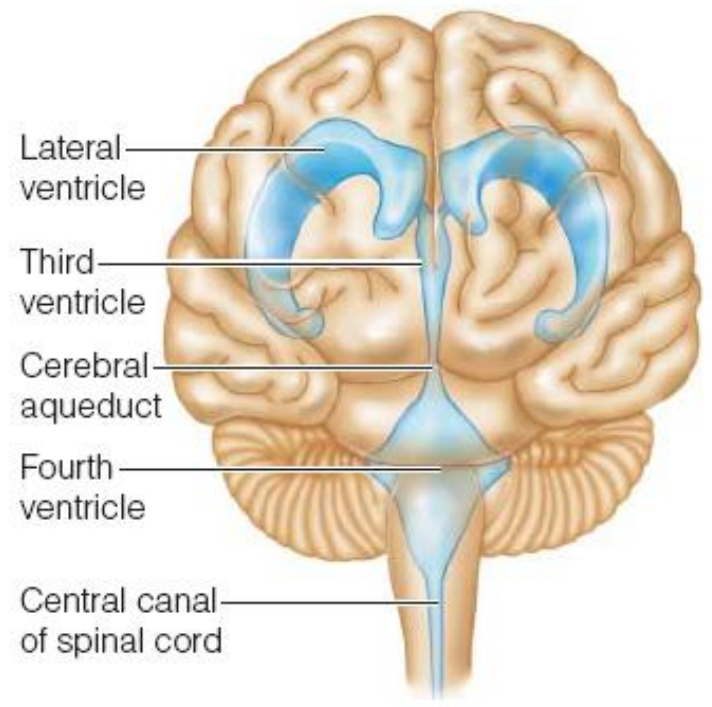


# Cerebrospinal Fluid (CSF)

- Made in choroid plexuses (roofs of ventricles)
- Cushions and nourishes brain
- Hydrocephalus: excessive accumulation



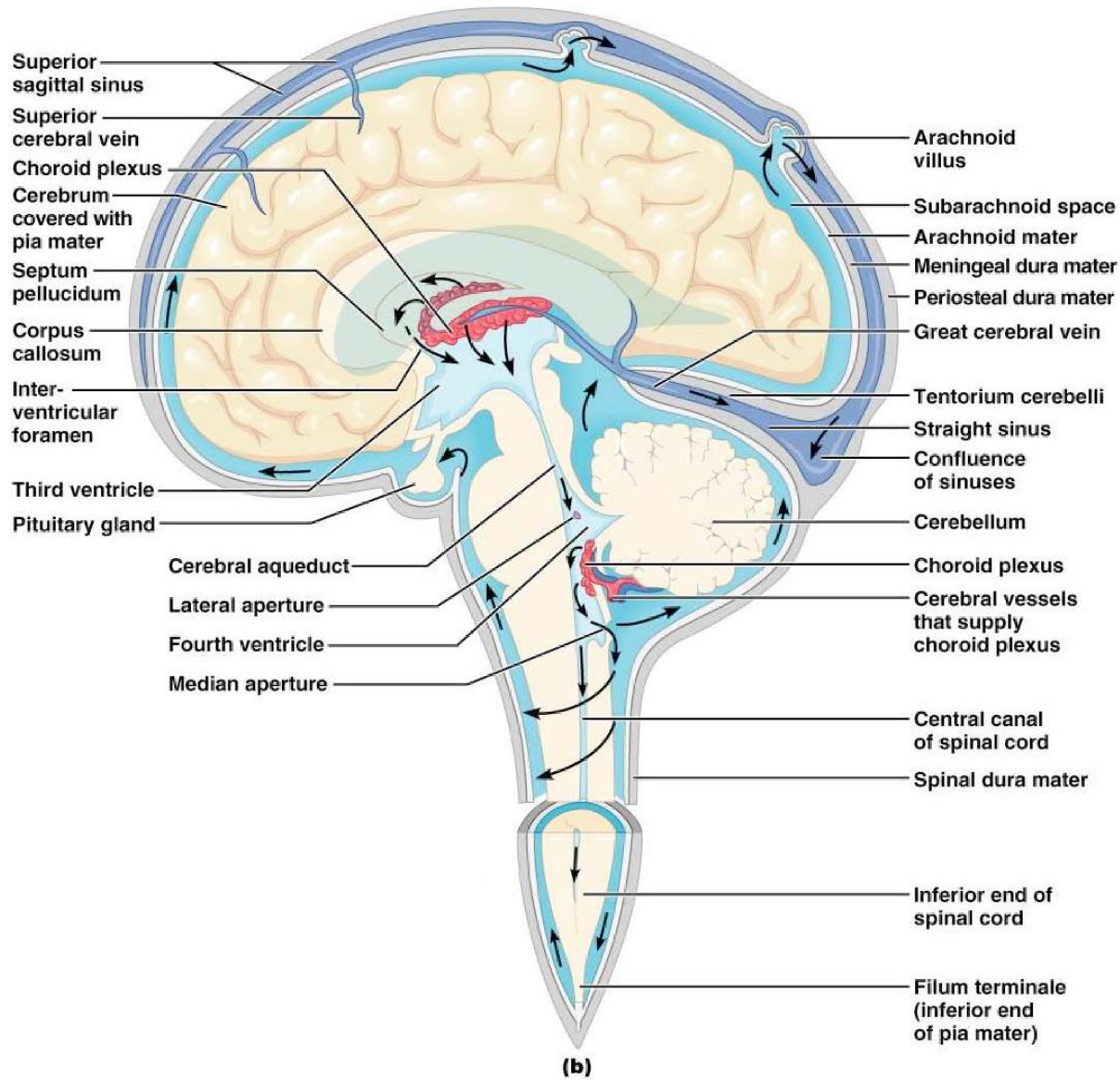
**(b) Left lateral view**



**(a) Anterior view**



# Circulation of CSF





# Hydrocephalus





# Blood Brain Barrier (BBB)

- Tight junctions between endothelial cells of brain capillaries
- Highly selective transport mechanisms (allows nutrients, O<sub>2</sub>, CO<sub>2</sub>)
- *Not* a barrier against uncharged and lipid soluble molecules; allows alcohol, nicotine, and some drugs including anesthetics

# Blood Brain Barrier (BBB)

Some molecules  
can pass through

While others  
simply bounce off

REFERENCE 1. Nature Reviews Drug Discovery. 2007 Aug;6(8):650-61.



# Cerebrovascular Accidents (Strokes)

- Caused when blood circulation to the brain is blocked and brain tissue dies
- Most commonly caused by blockage of a cerebral artery
- Other causes include compression of the brain by hemorrhage or edema, and atherosclerosis
- Transient ischemic attacks (TIAs) – temporary episodes of reversible cerebral ischemia
- Tissue plasminogen activator (TPA) is the only approved treatment for stroke

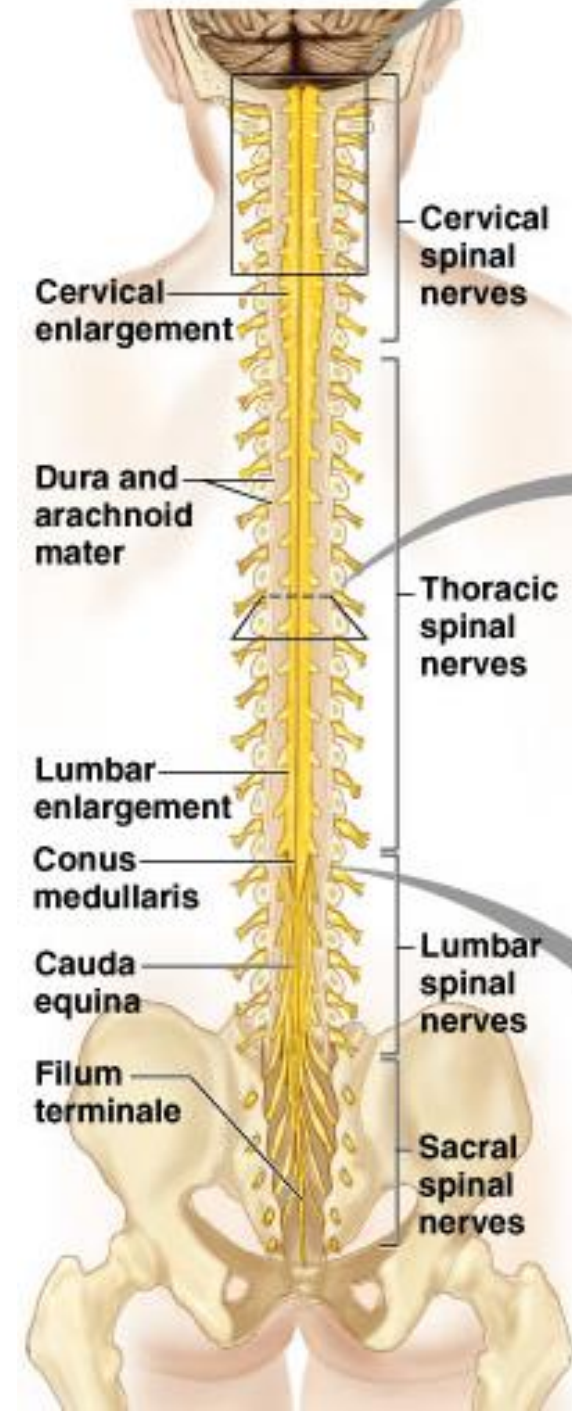


# Degenerative Brain Disorders

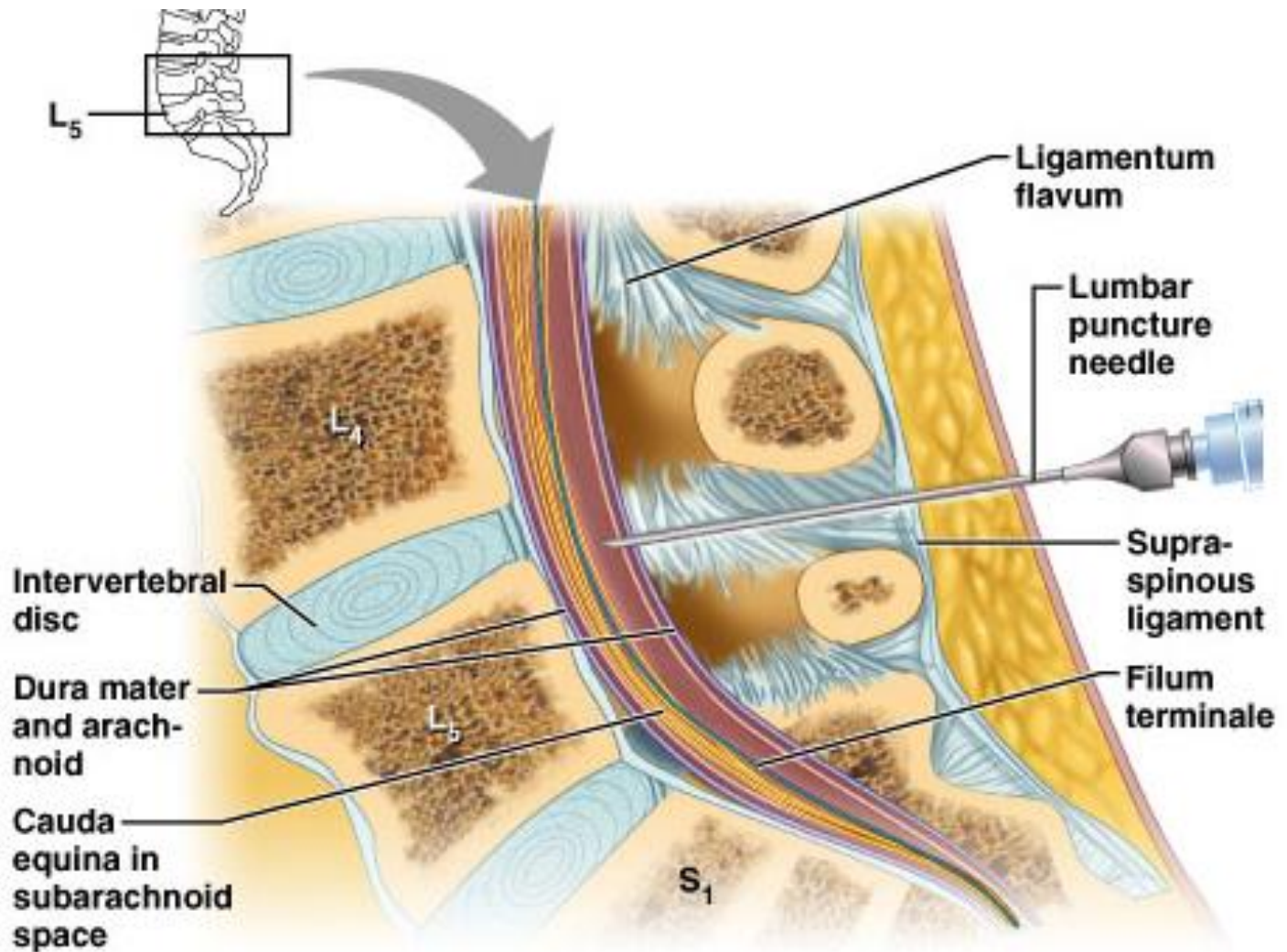
- **Alzheimer's disease** – a progressive degenerative disease of the brain that results in dementia
- **Parkinson's disease** – degeneration of the dopamine-releasing neurons of the substantia nigra
- **Huntington's disease** – a fatal hereditary disorder caused by accumulation of the protein huntingtin that leads to degeneration of the basal nuclei

# Spinal Cord

- Approximately 17 inches (42 cm) long
- Provides two-way pathway
- Extends from the foramen magnum and ends L1/L2 in adults
- Cauda equina

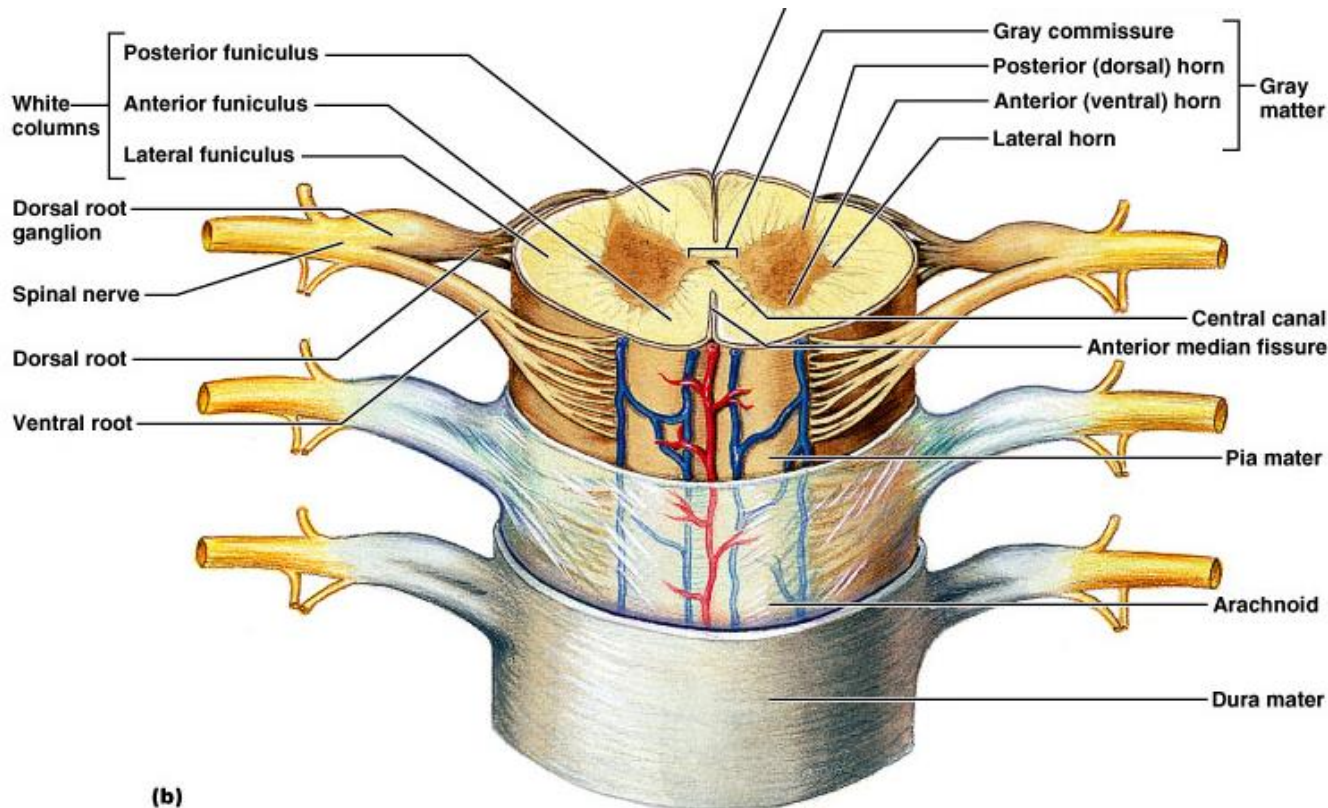
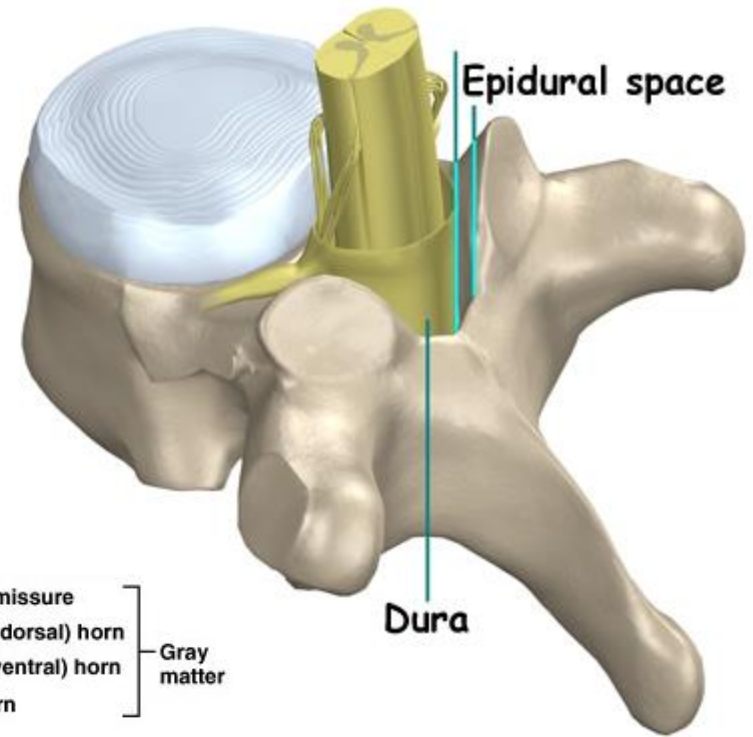


# LP (Lumbar Puncture)





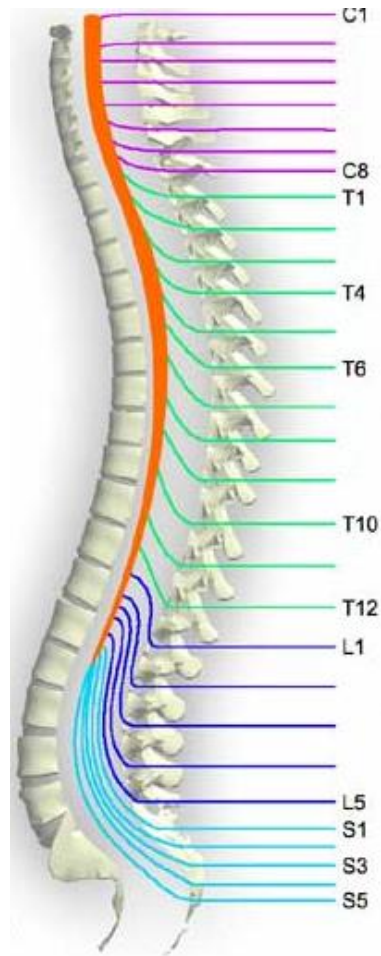
# Spinal cord coverings and spaces



(b)

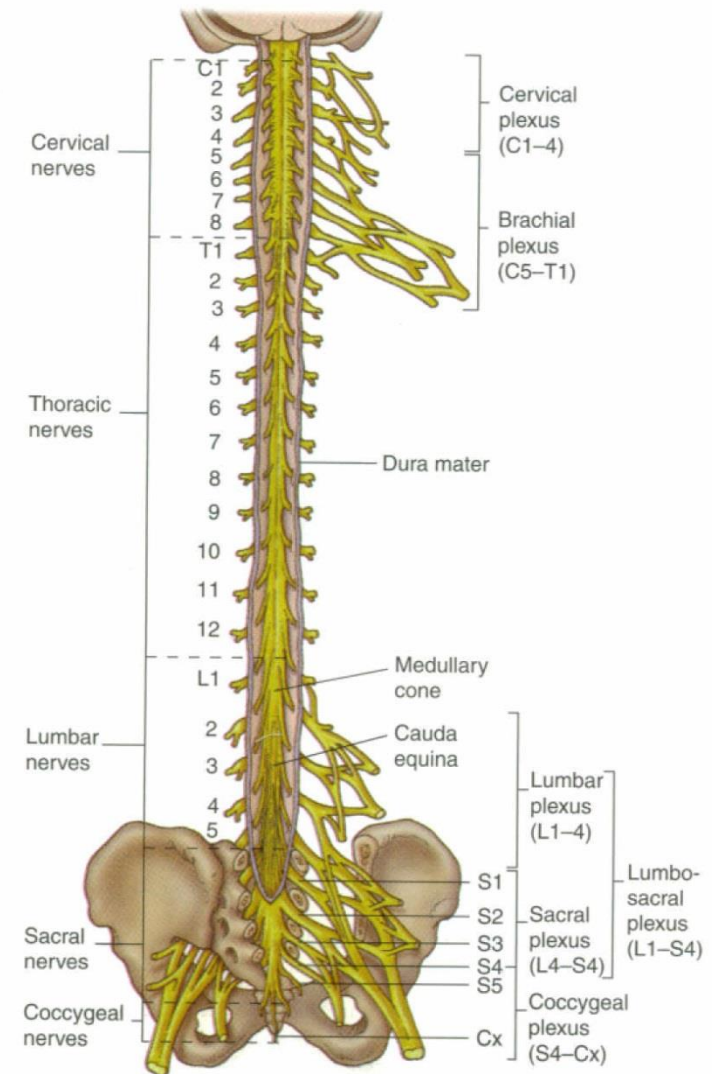


# PNS



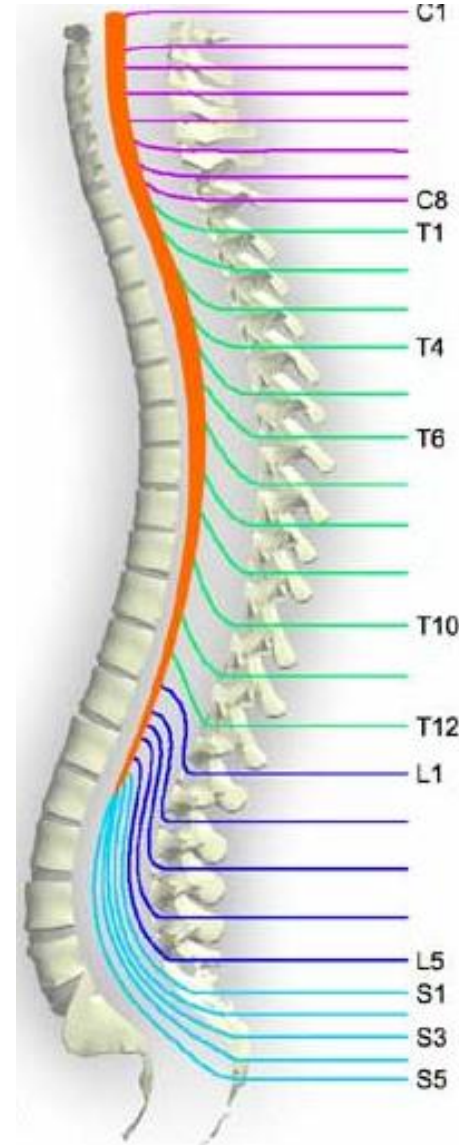
# Peripheral Nervous System (PNS)

- Peripheral nerves
  - Two types:
    - Spinal nerves
    - Cranial nerves

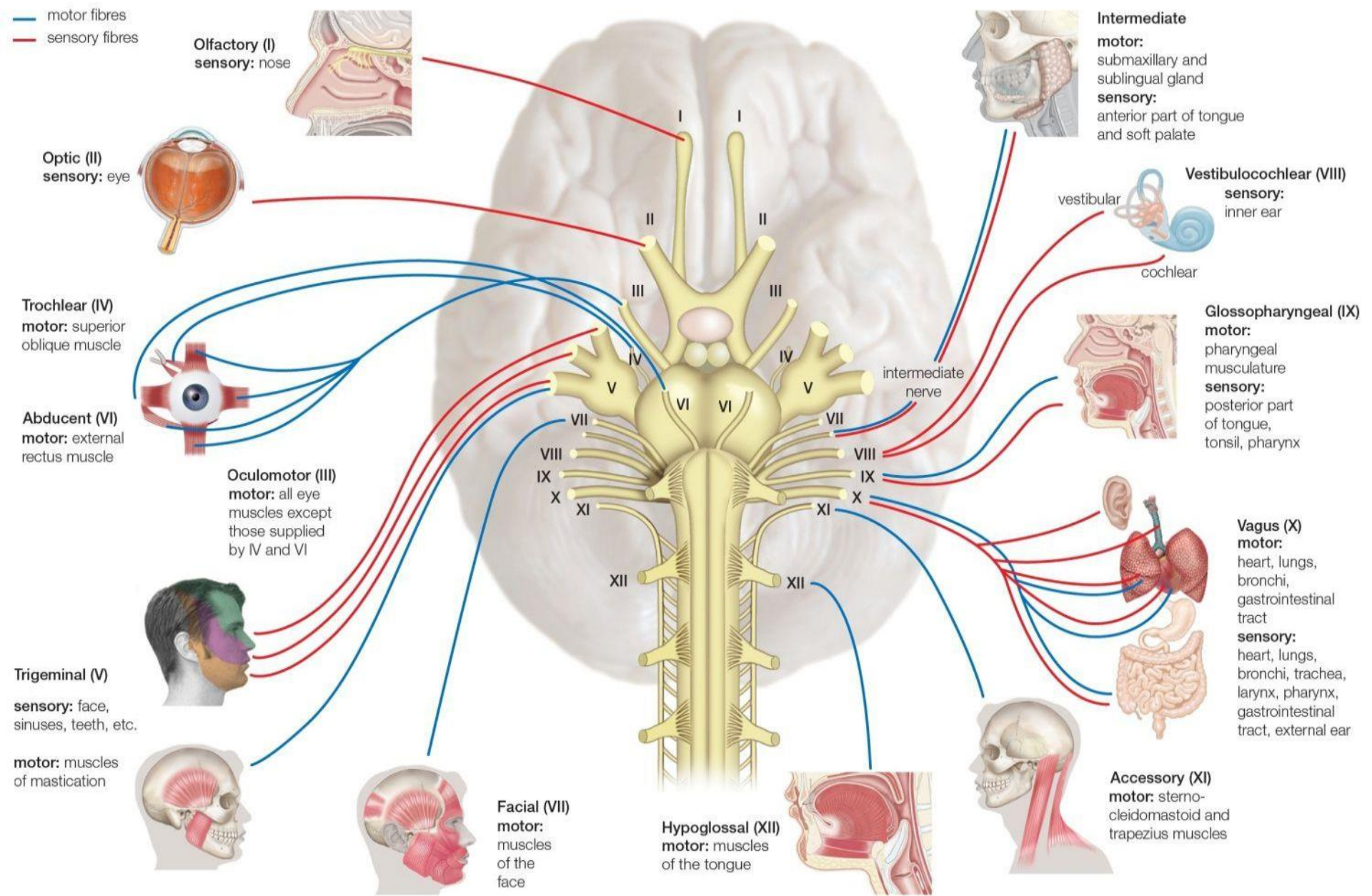


# PNS: Spinal nerves

- Peripheral nerves originating from the spinal cord
- 31 pairs
- Divided into:
  - 8 cervical
  - 12 thoracic
  - 5 lumbar
  - 5 sacral
  - 1 coccygeal









# PNS: Cranial Nerves

## I. **Olfactory** nerves

- smell

## II. **Optic** nerves

- vision

## III. **Oculomotor** nerves

- muscles that move the eyeball, eyelid, and iris

## IV. **Trochlear** nerves

- muscles that move the eyeball





## PNS: Cranial Nerves

### V. **Trigeminal** nerves

- Carry sensory information from the surface of the eye, the scalp, facial skin, the lining of the gums, and the palate
- Also found within the muscles needed for chewing

### VI. **Abducens** nerves

- muscles that move the eyeball



# PNS: Cranial Nerves

## VII. **Facial** nerves

- Found in the muscles of facial expression as well as in the salivary and tear glands
- Also carry sensory information from the tongue

## VIII. **Vestibulocochlear** nerves

- Carry hearing and equilibrium information from the inner ear to the brain



## PNS: Cranial Nerves

### IX. **Glossopharyngeal** nerves

- Carry sensory information from the throat and tongue
- Also act in the muscles of the throat

### X. **Vagus** nerves

- Carry sensory information from the thoracic and abdominal organs
- Also found within the muscles in the throat, stomach, intestines, and heart



# PNS: Cranial Nerves

## XI. **Accessory** nerves

- Found within the muscles of the throat, neck, back, and voice box

## XII. **Hypoglossal** nerves

- Found within the muscles of the tongue

# End of Part -1-

