

NERVOUS SYSTEM

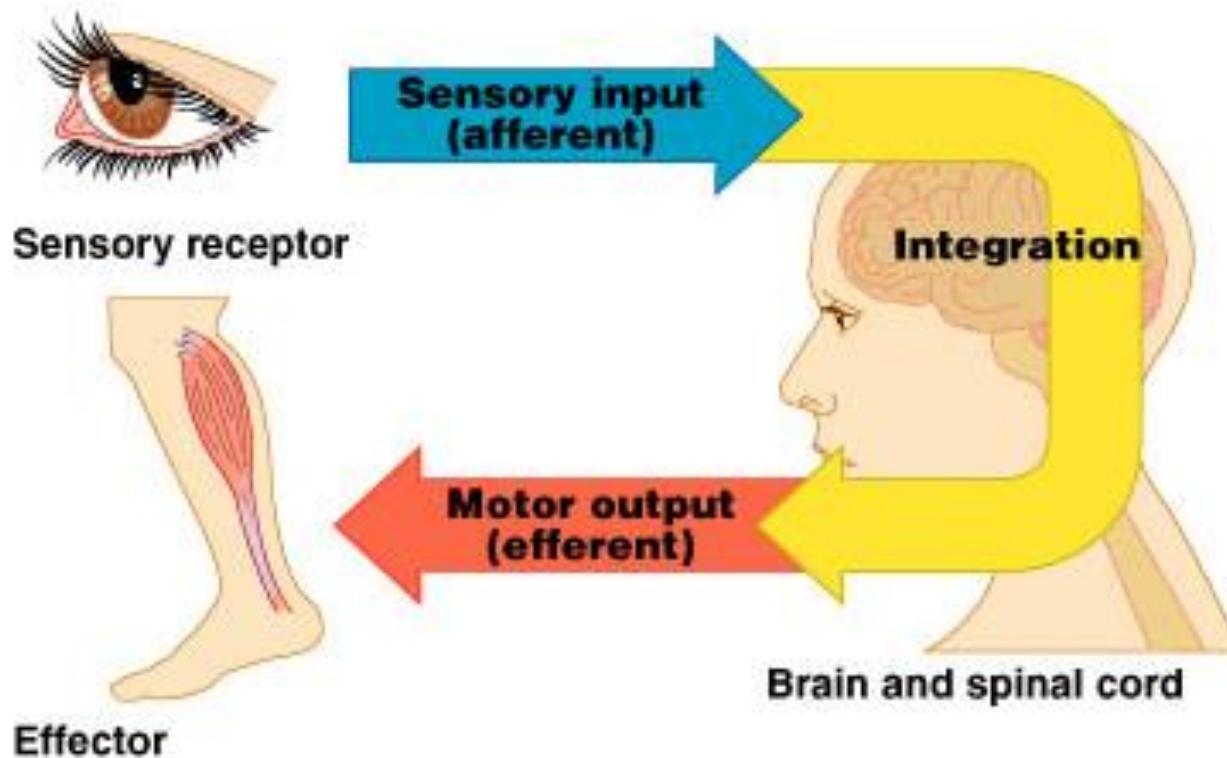
Dr. Aman Shakya

2080.02.30

Objectives

- To explain gross structure of meninges
- To explain gross structure of ventricles
- To discuss about Cerebro Spinal Fluid
- To explain gross structure of Cerebrum
- To explain gross structure of Mid brain
- To explain gross structure of Pons

Nervous system-Introduction



Nervous system-Components

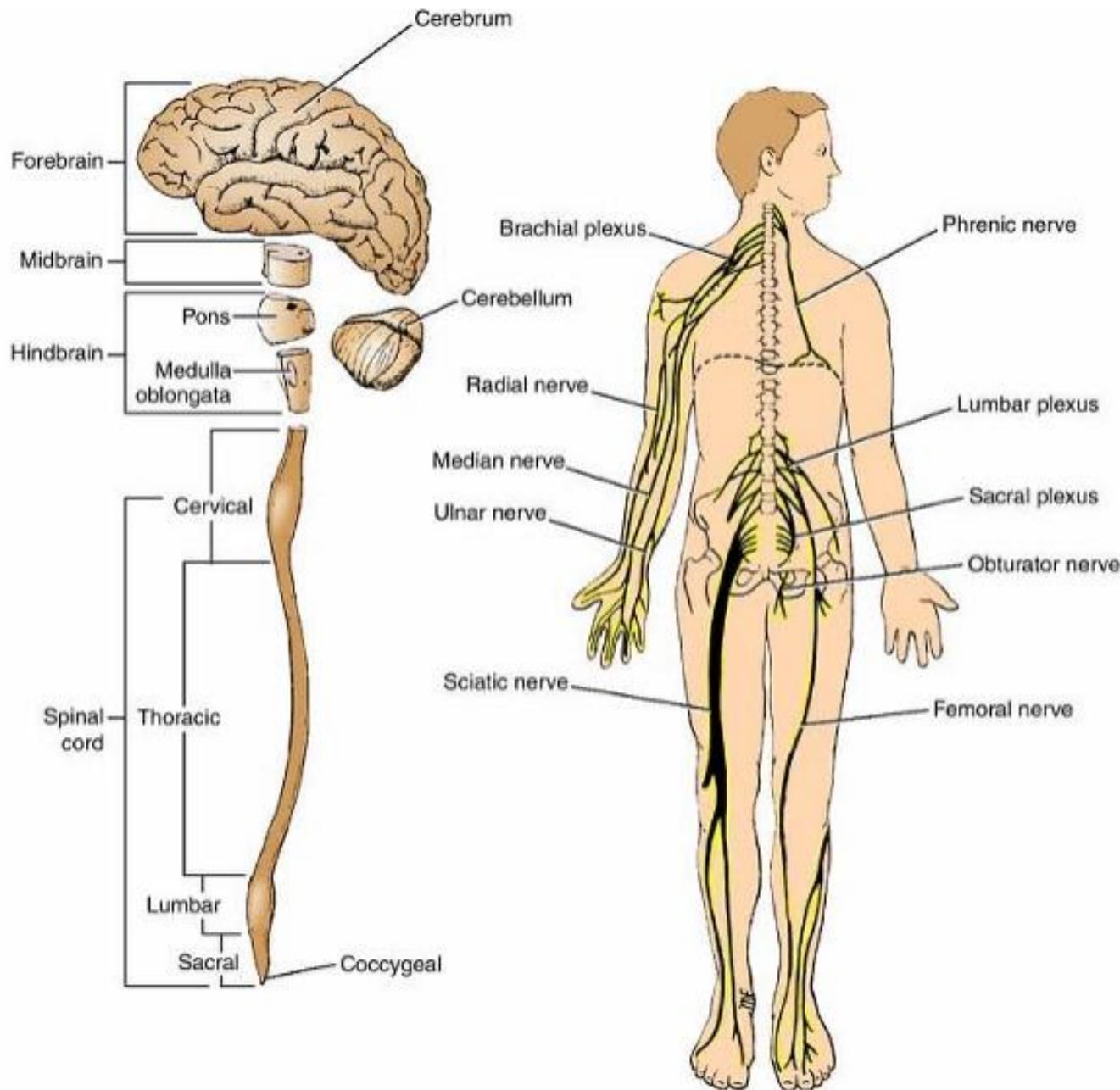
- For descriptive purposes it is grouped as:

➤ **Central nervous system (CNS)**

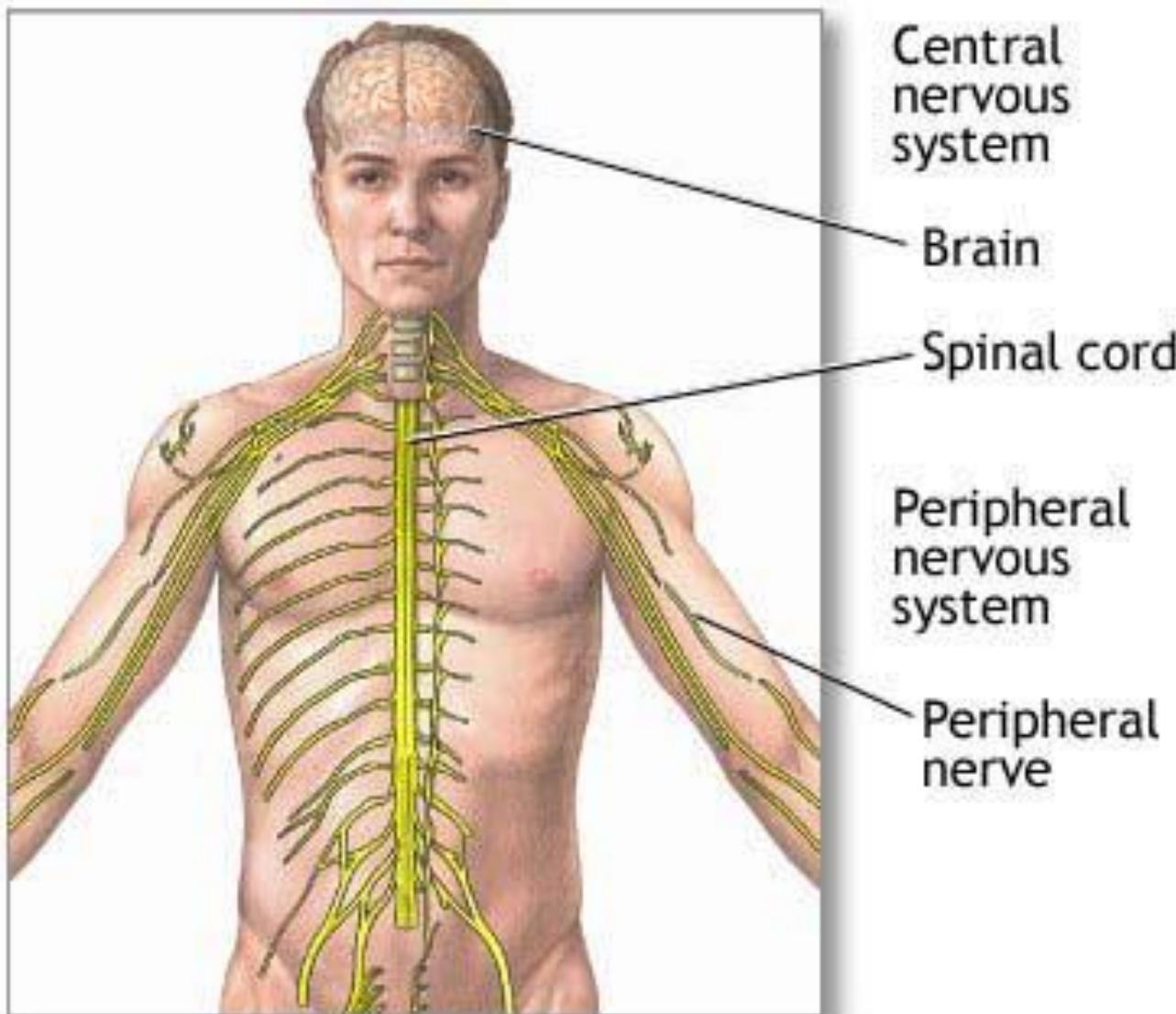
- Brain
- Spinal cord

➤ **Peripheral nervous system (PNS)**

- *Afferent division (Sensory input)*
- *Efferent division (Motor output)*



Nervous system-Components

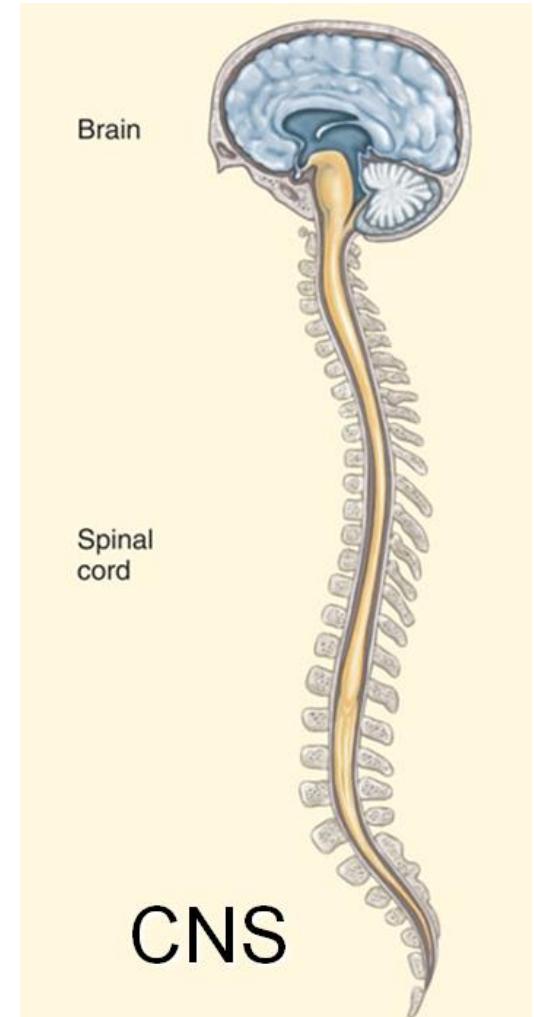


Nervous system-Components

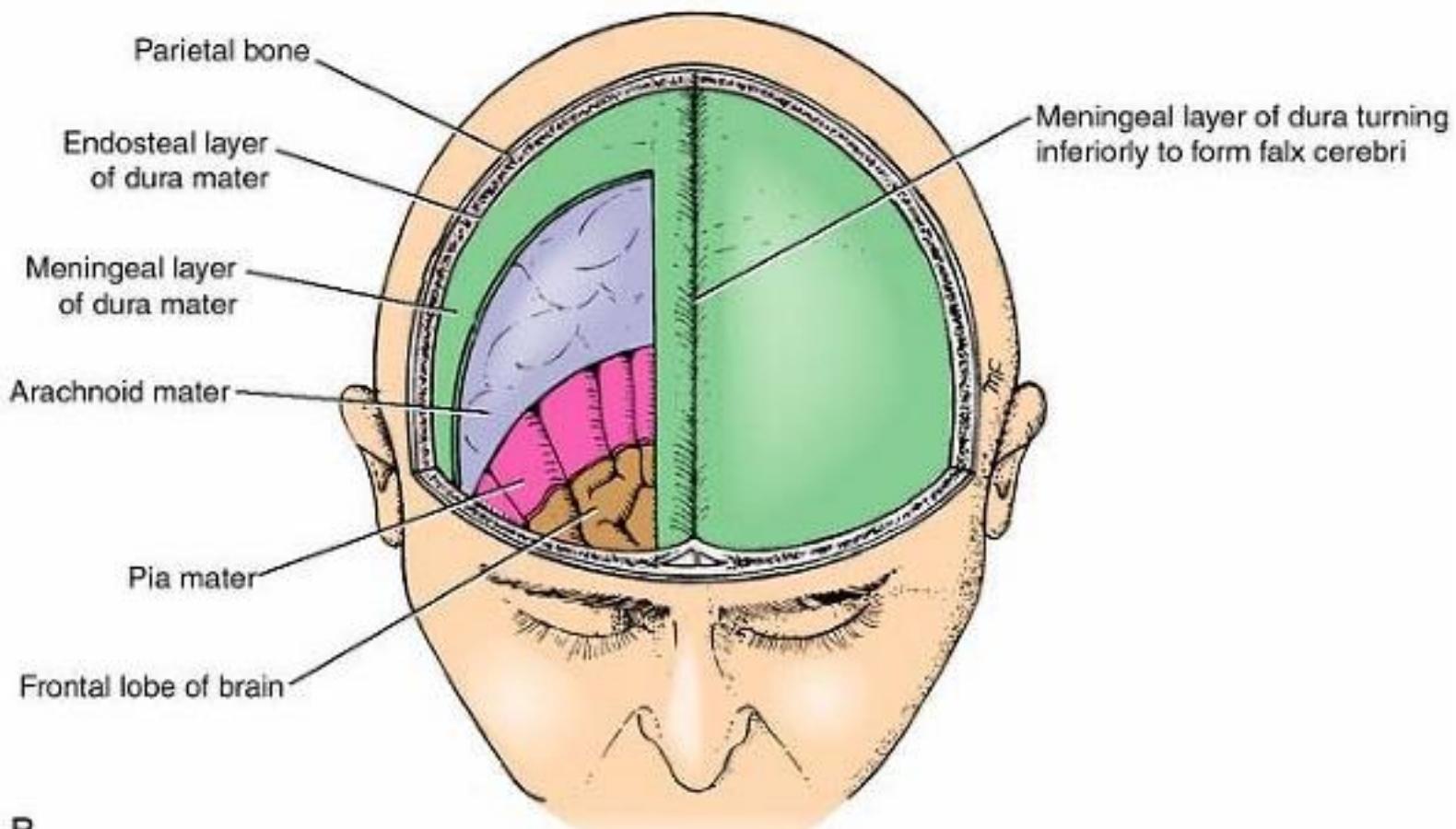


Membranes covering CNS (Meninges)

- Completely surrounded by 3 membranes, the *meninges*
- From outside inwards, they are:
 - Dura mater
 - Arachnoid mater
 - Pia mater
- *Subdural space*
- *Subarachnoid space*
{Cerebrospinal fluid (CSF)}



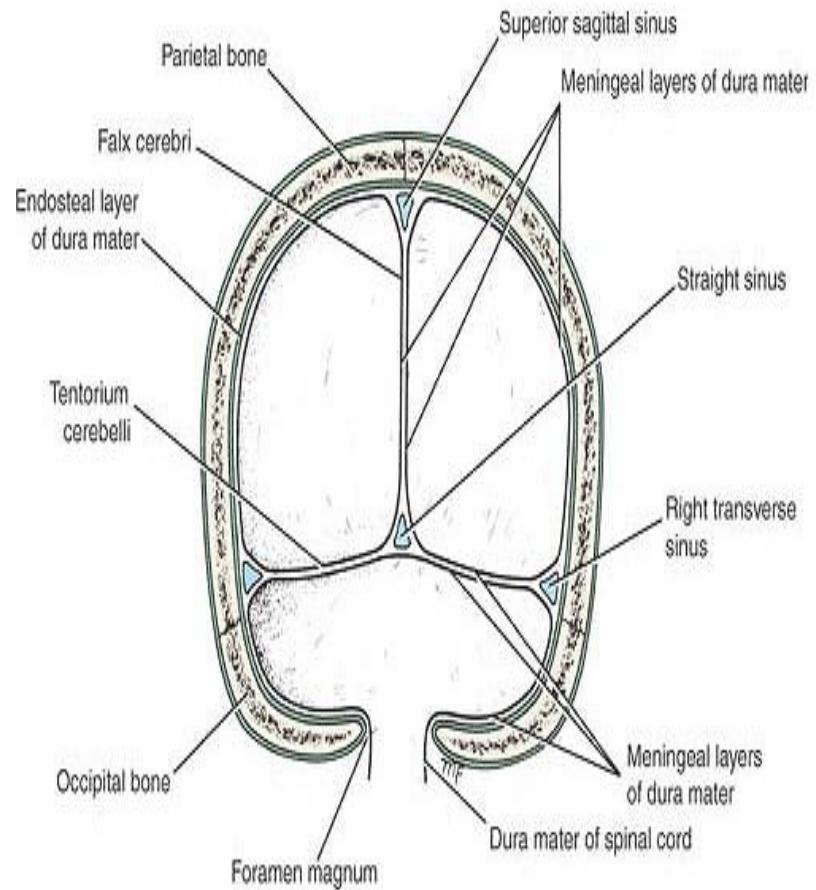
Meninges



Meninges

Cerebral Dura mater

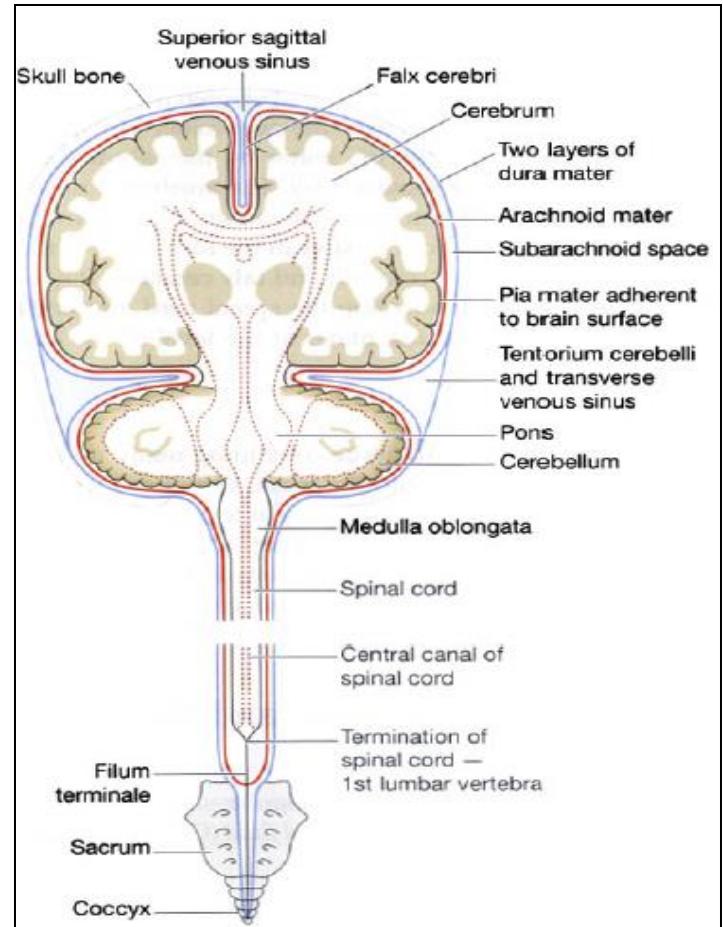
- 2 layers:
 - Outer layer
 - Inner layer
- Foldings of inner layer:
 - Falx cerebri
 - Falx cerebelli
 - Tentorium cerebelli
 - Diaphragma sellae
- Venous sinuses is present between the layers



Meninges

Spinal Dura mater

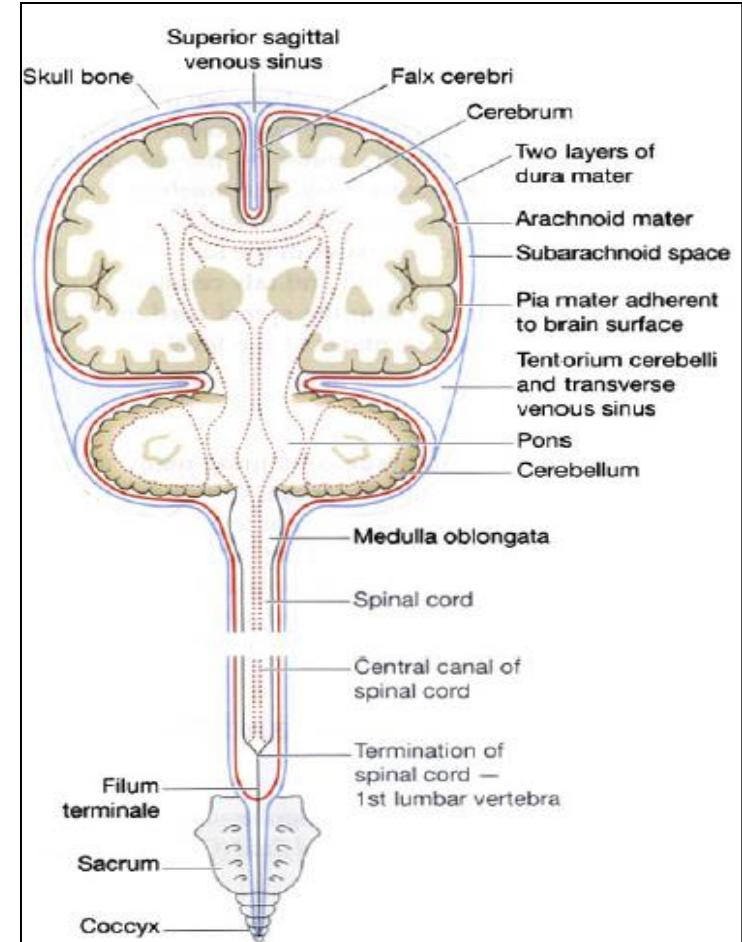
- Extension of inner layer
- Foramen magnum to S2
- Fuses with periosteum of coccyx
- Epidural/Extradural space



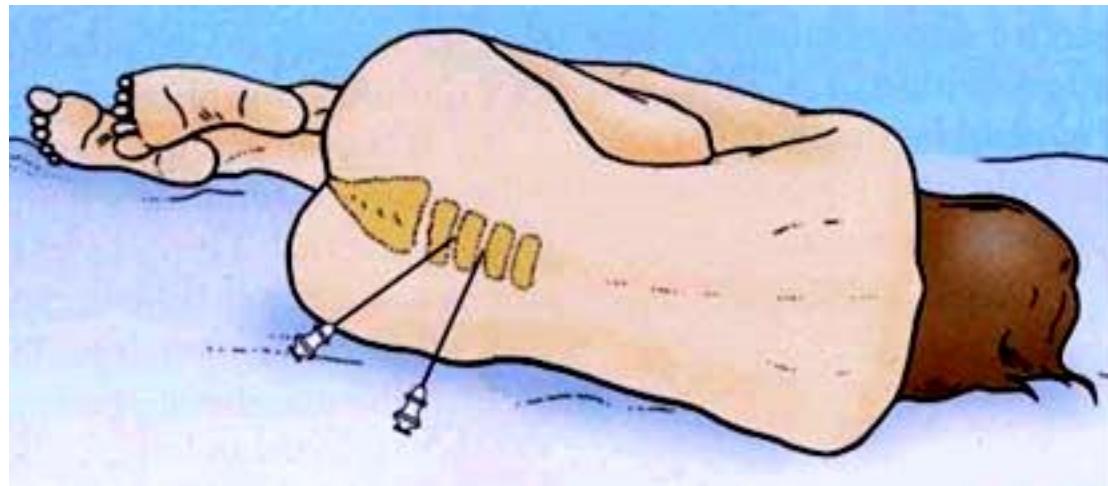
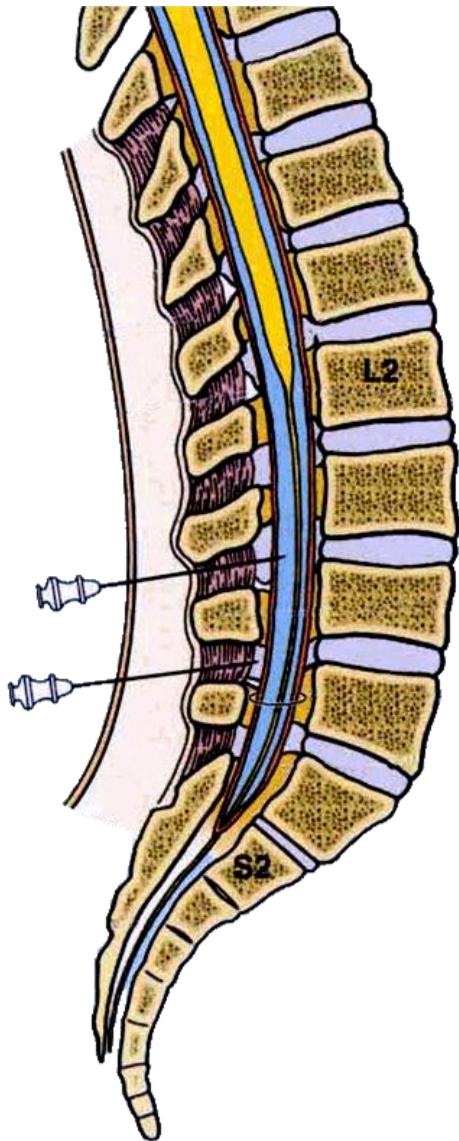
Meninges

Arachnoid mater

- Between dura and pia mater
- Merges with dura mater at level of S2



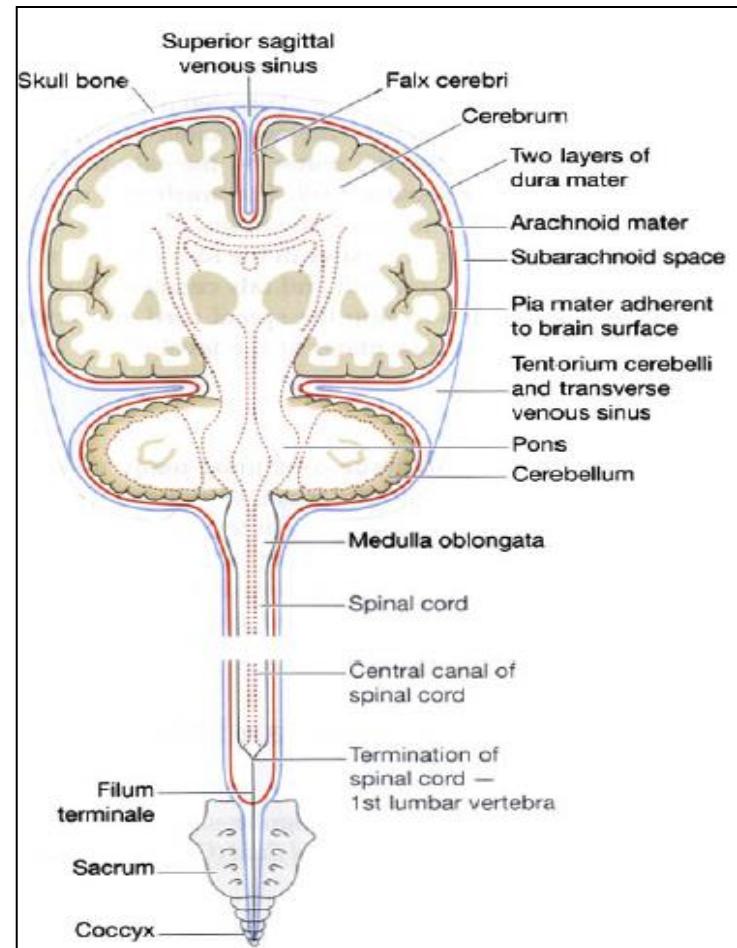
Meninges



Meninges

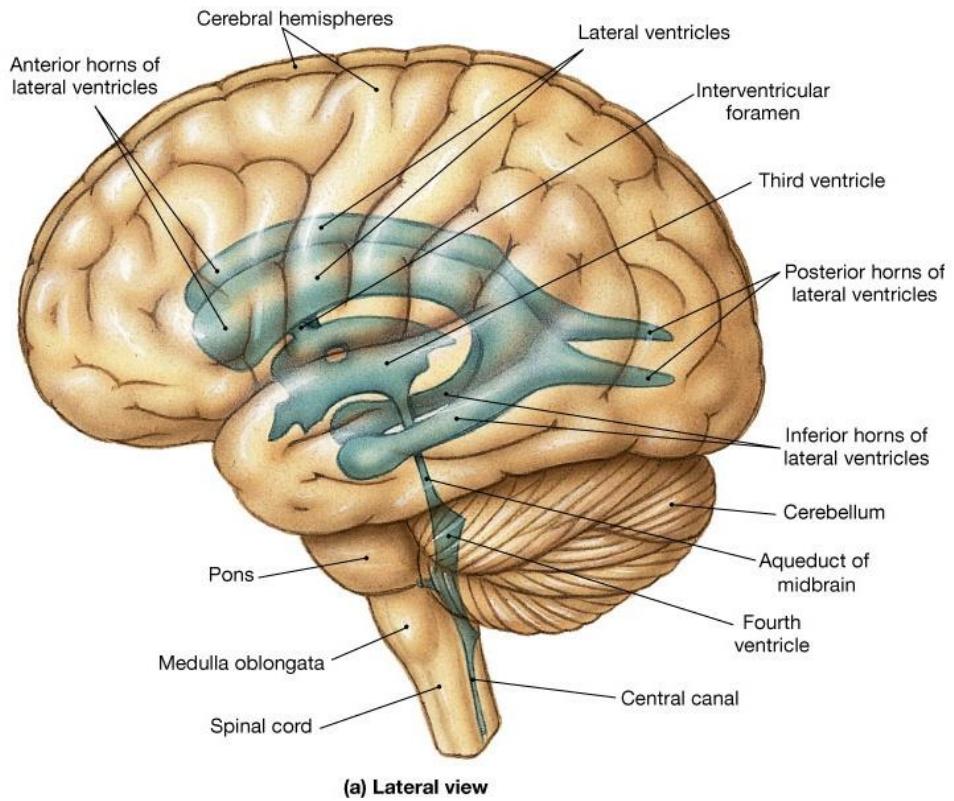
Pia mater

- Innermost layer
- Closely invests the brain and spinal cord
- Filum terminale

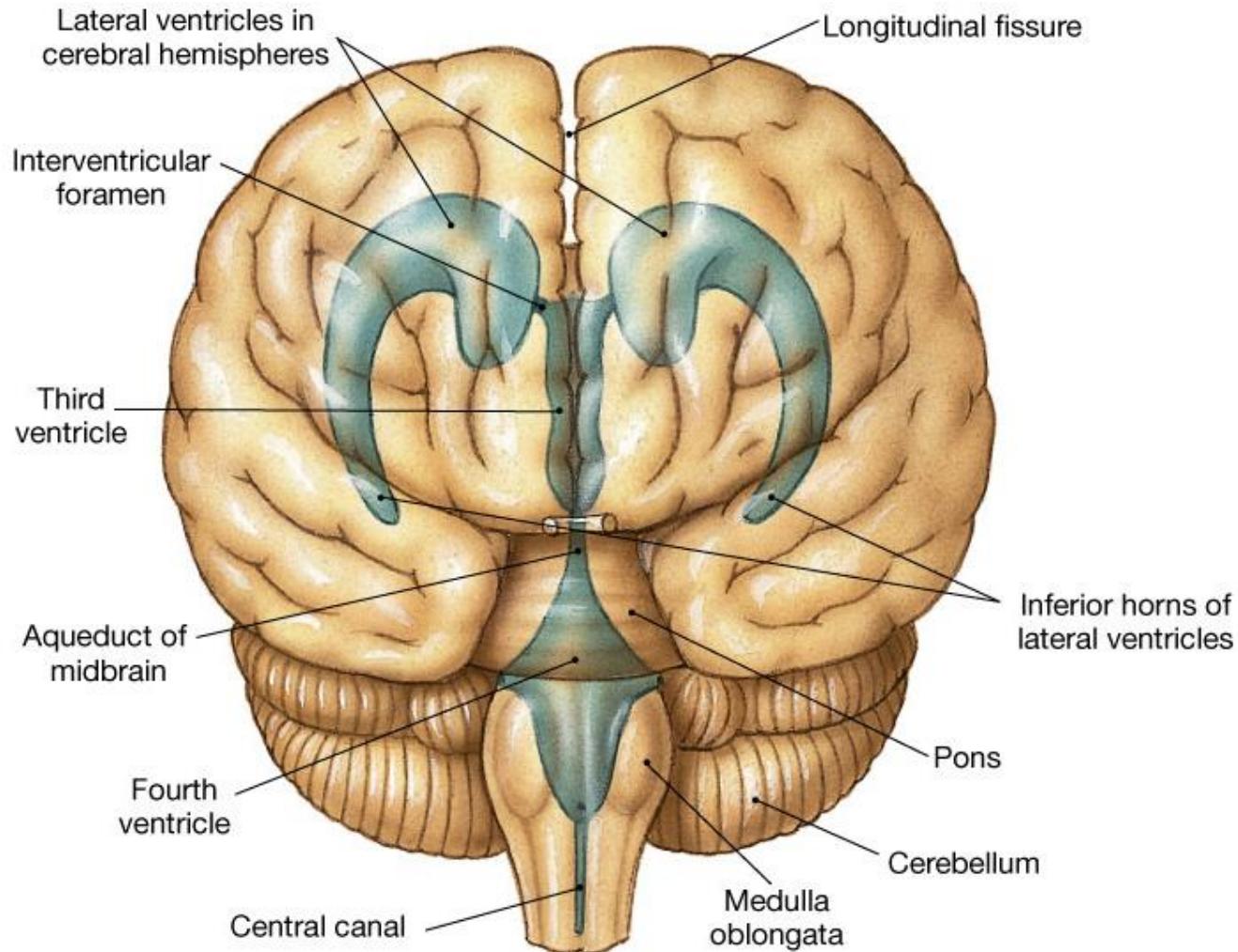


Ventricles of brain

- 4 irregular-shaped cavities, or ventricles :
 - Right and left lateral ventricles
 - Third ventricle
 - Fourth ventricle
 - CSF
 - Foramen of Monro
 - Aqueduct of Sylvius
- Luska and Magendie



Ventricles of brain



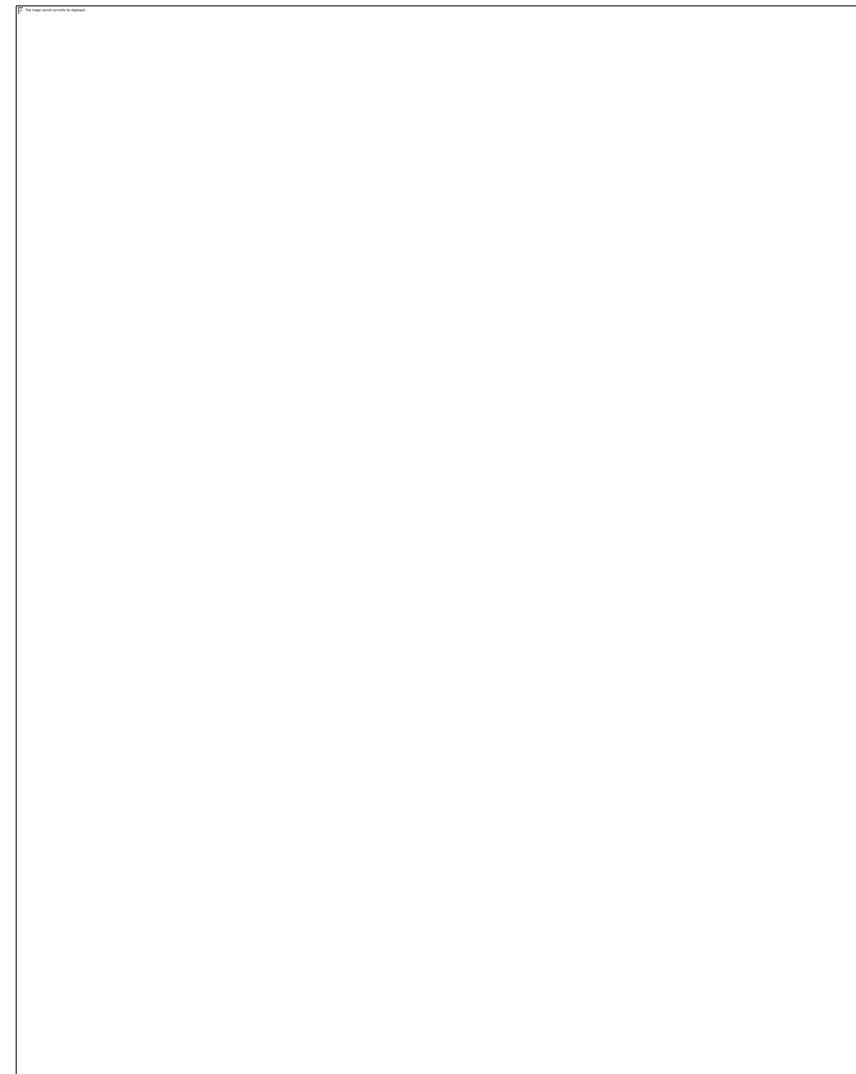
(c) Anterior view

Cerebrospinal Fluid (CSF)

It is secreted into each ventricle of the brain by *choroid plexuses* (are vascular areas surrounded by ependymal cells in the lining of ventricle walls).

CSF passes back into the blood through tiny projections of arachnoid mater, called *arachnoid villi* (arachnoid granulations), that project into the venous sinuses.

CSF passes from the choroid plexus in ventricles to subarachnoid space through foramen of Magendie and Lushka and then to the dural venous sinuses.

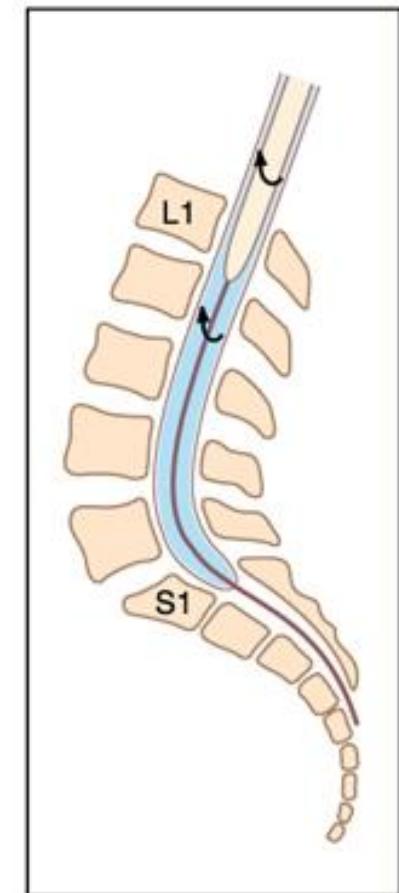
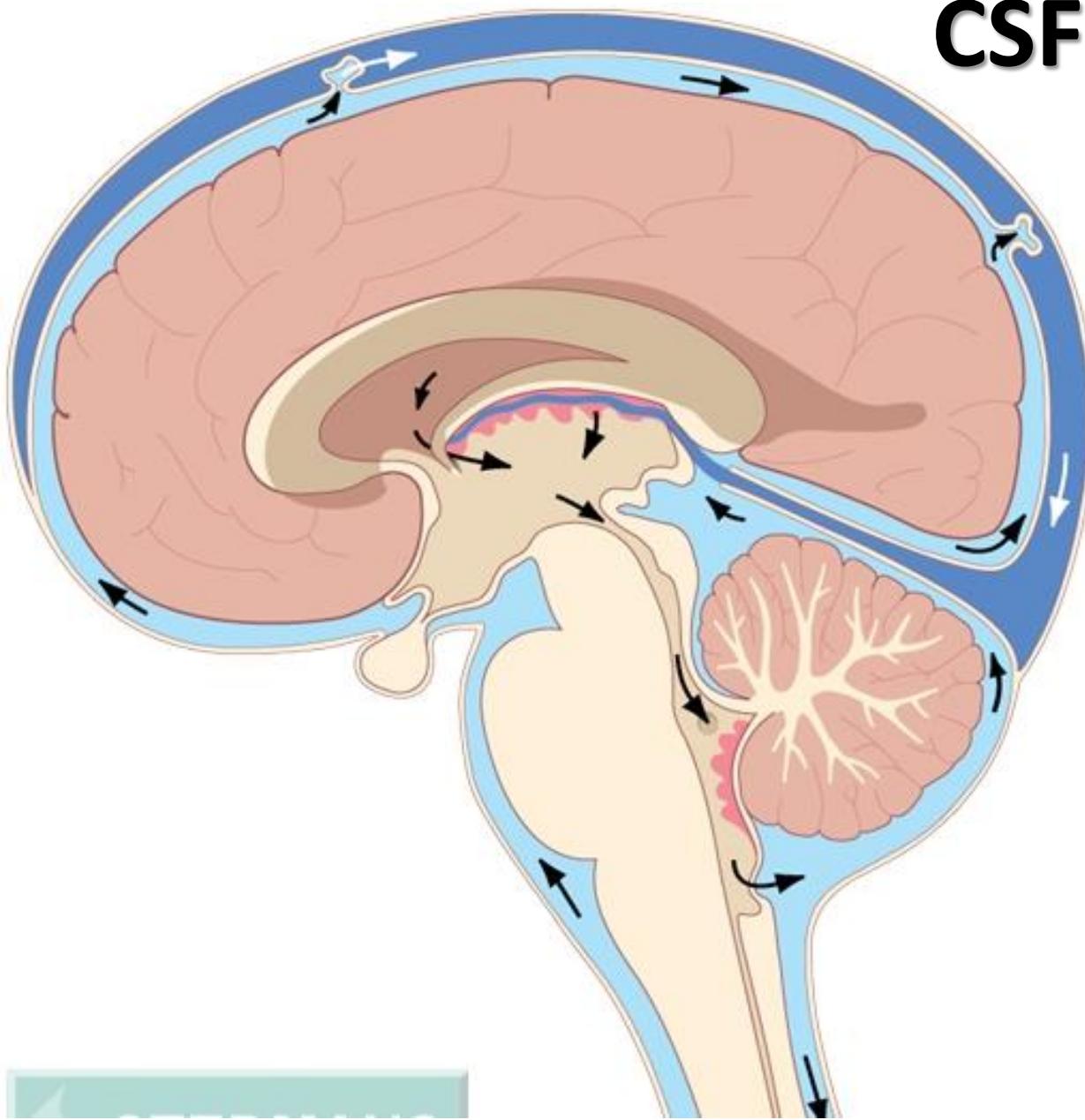


- It is secreted continuously at a rate of about 0.5 ml/min. The amount around the brain and spinal cord remains fairly constant at about 120 ml.

The Physical Characteristics and Composition of the Cerebrospinal Fluid

- Appearance: Clear and colorless
- Volume: approx. 150 mL
- Rate of production: 0.5 mL/minute
- Pressure (spinal tap with patient in lateral recumbent position): 60–150 mm of water
- Composition:
 - Protein 15–45 mg/100 mL
 - Glucose 50–85 mg/100 mL
 - Chloride 720–750 mg/100 mL
 - Number of cells 0–3 lymphocytes/cu mm

CSF Circulation

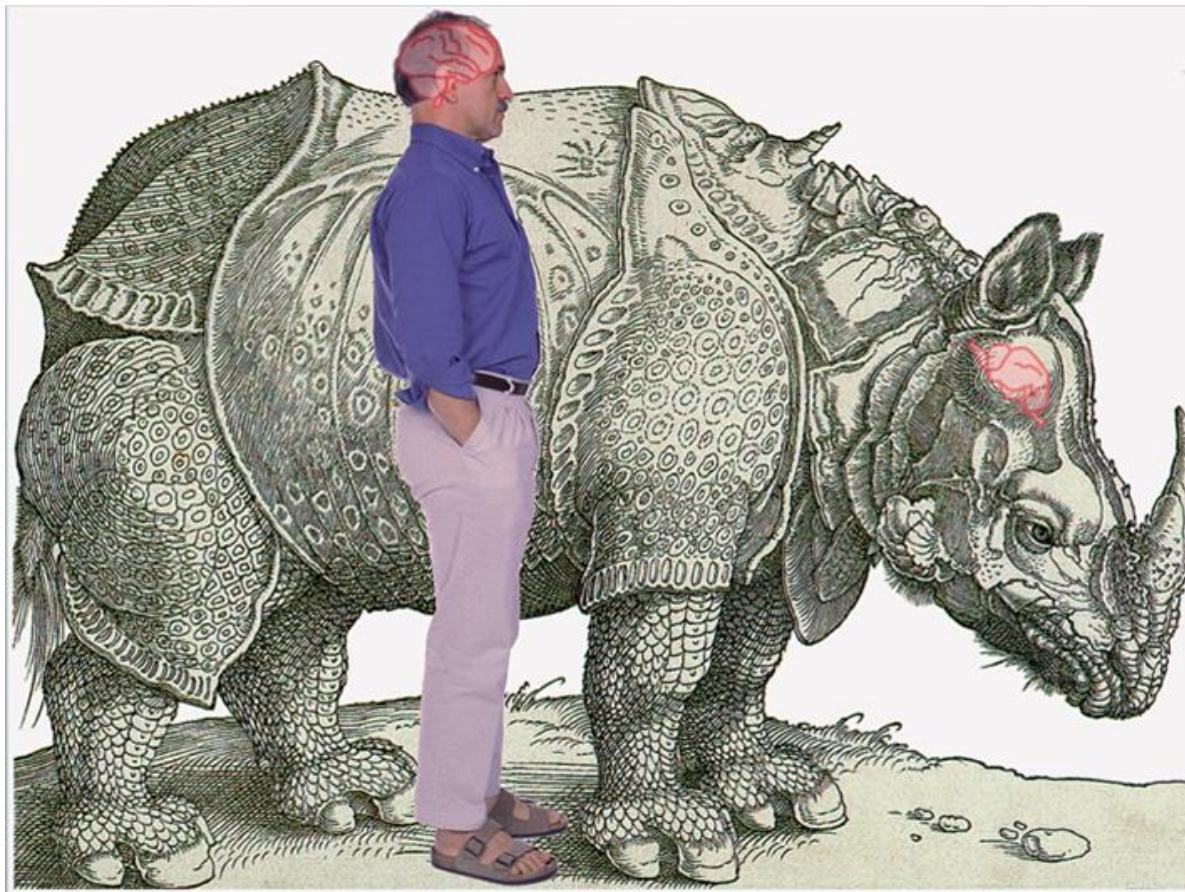


CSF-Functions

- Acts as a cushion and shock absorber between the brain and the cranial bones
- Interchange of substances between CSF and nerve cells, such as nutrients, waste products and gases

Brain

- About 1/50th of the body weight

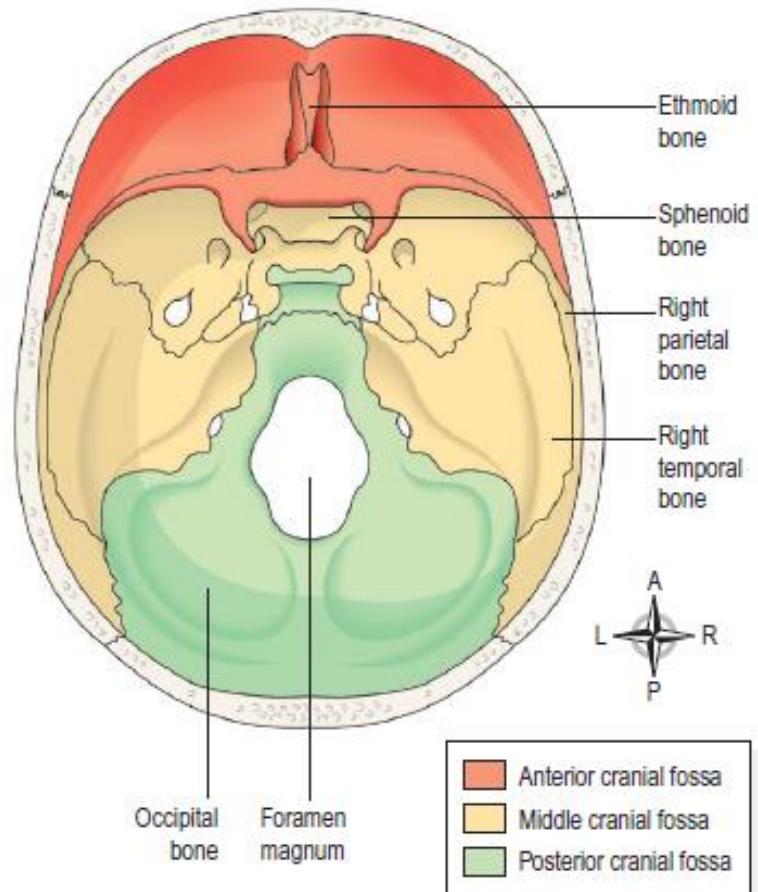


Brain

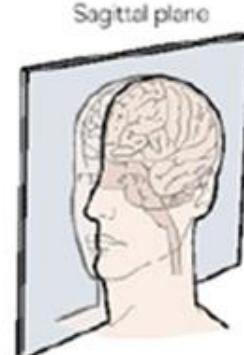
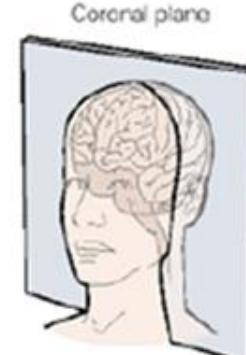
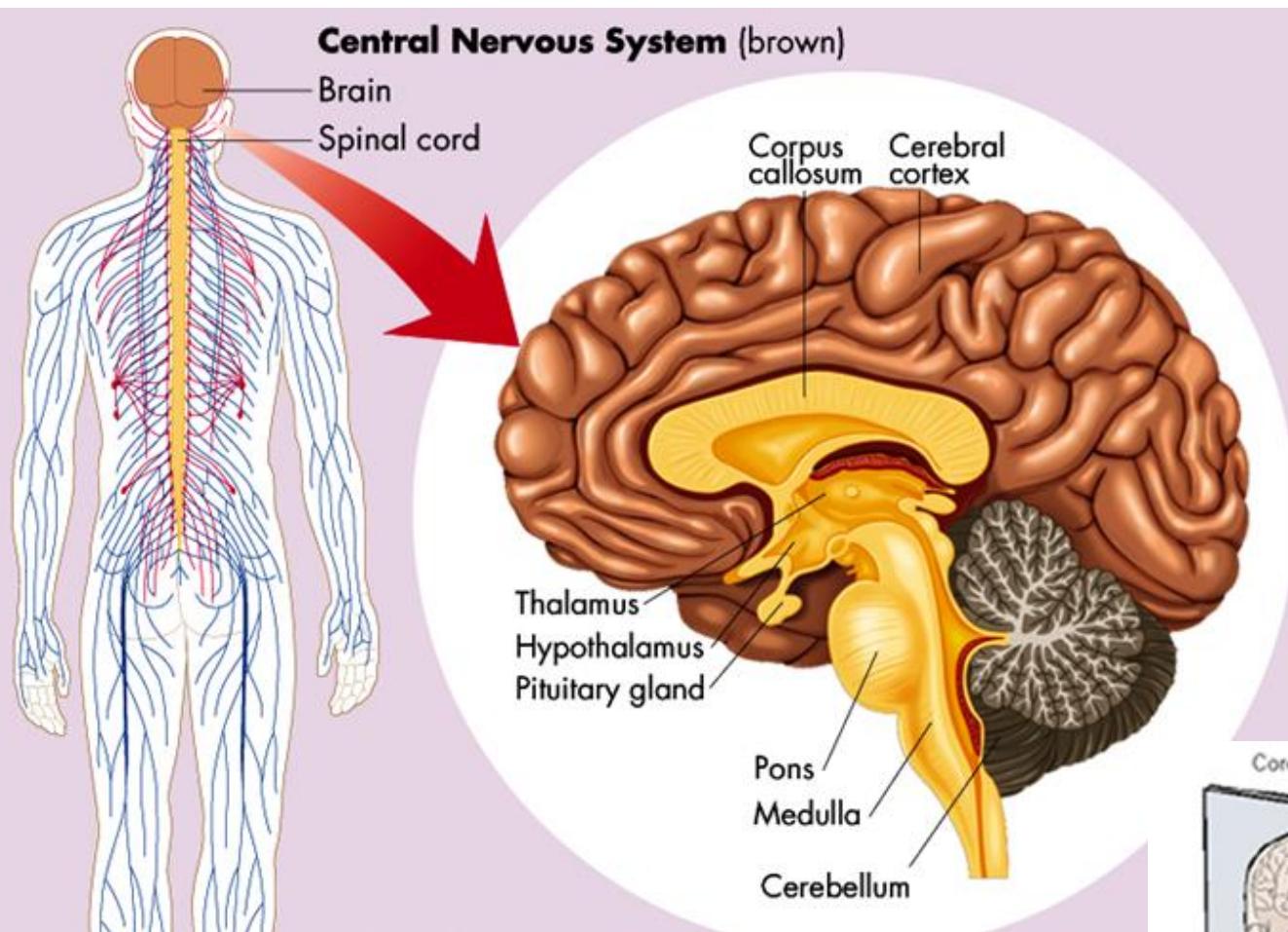
- Lies within cranial cavity

- Parts are:

- Cerebrum
- Brain stem
 - Midbrain
 - Pons
 - Medulla oblongata
- Cerebellum

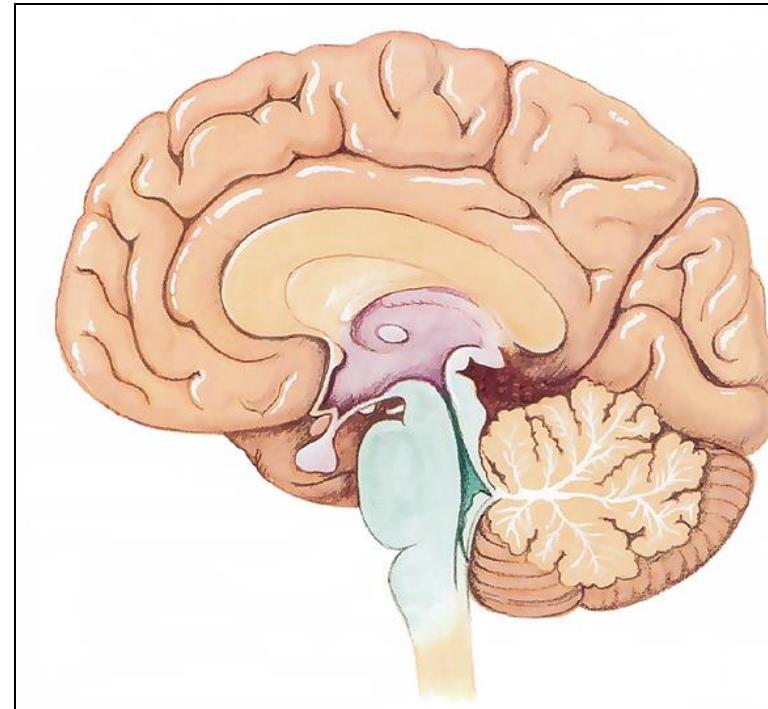


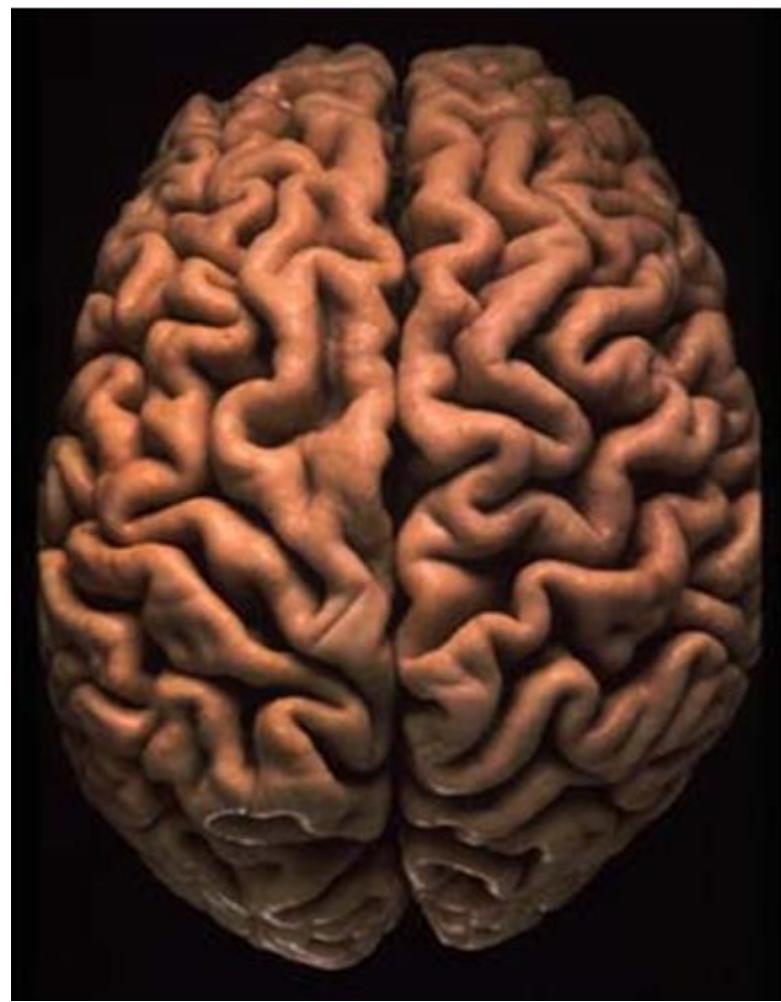
Brain



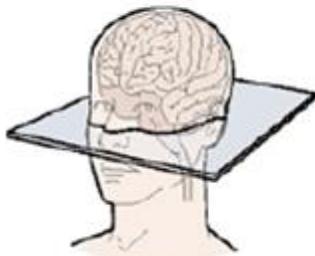
Cerebrum

- Largest part
- Cerebral cortex is highly folded
- Sulci & gyri.
- Right and left cerebral hemispheres by median longitudinal fissure.
- Corpus callosum joins 2 hemisphere
- Superficially grey matter, forming the cerebral cortex.
- Lateral ventricles present.

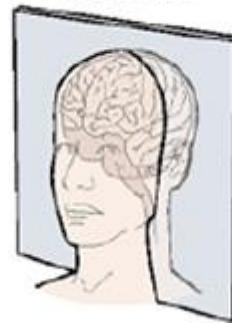




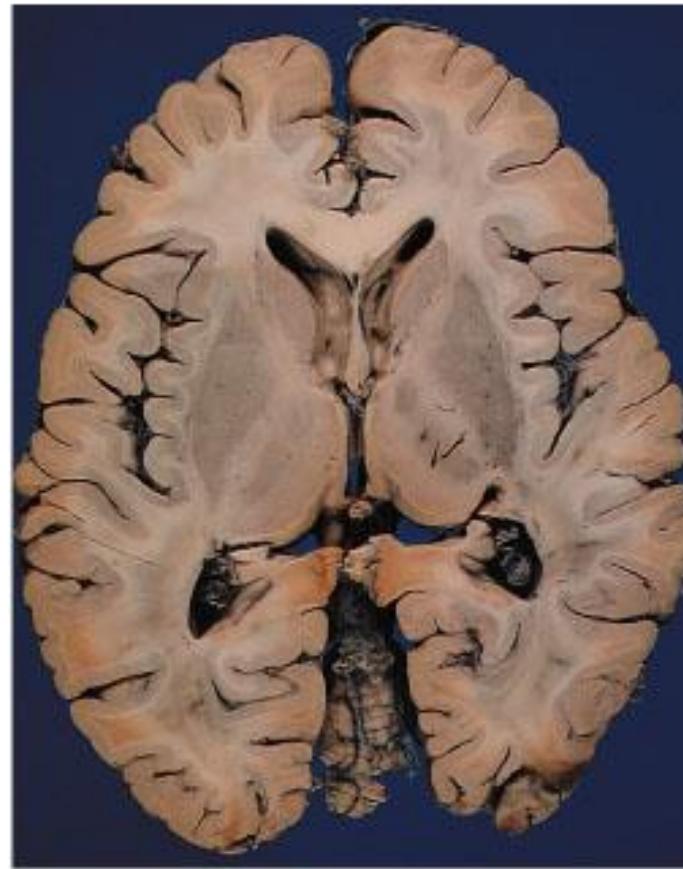
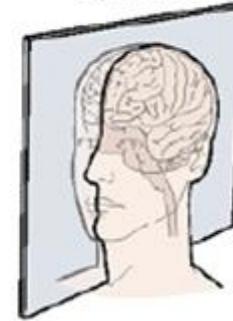
Horizontal plane



Coronal plane

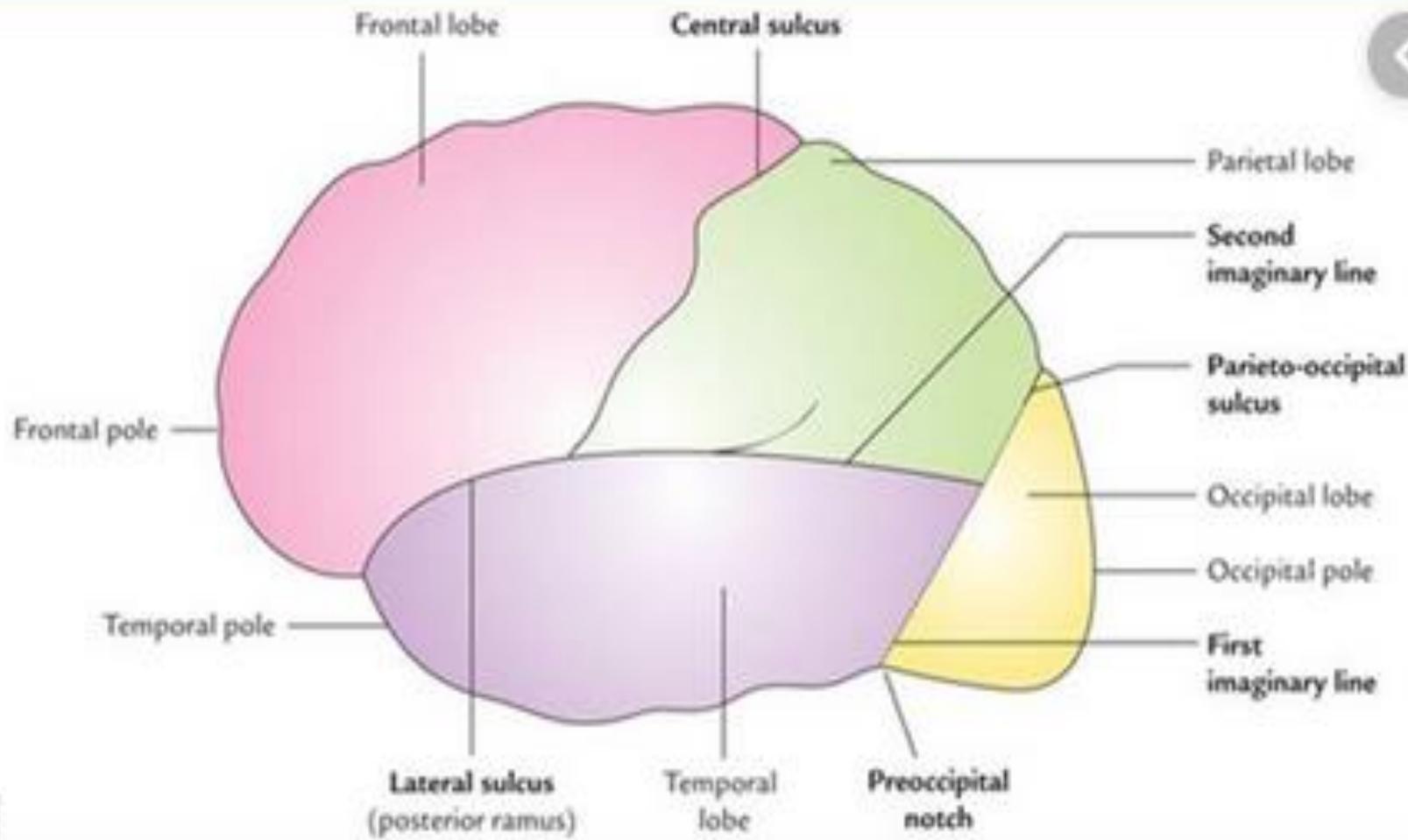


Sagittal plane



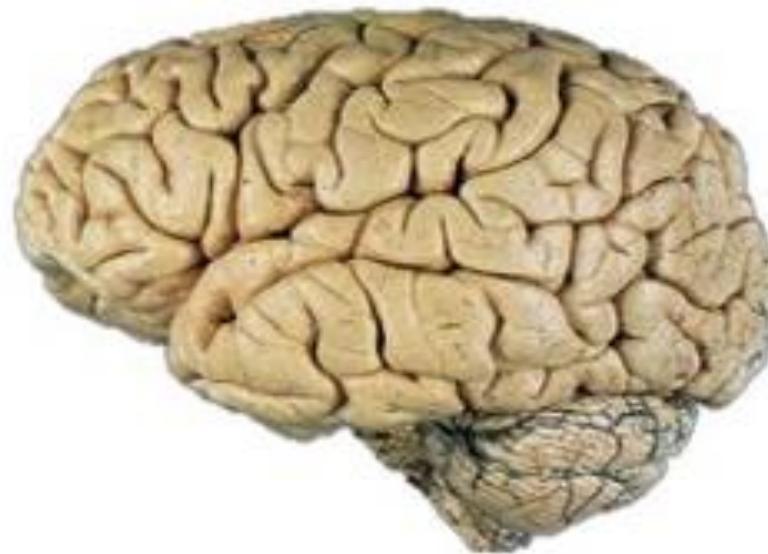
External features

- 3 poles → Frontal, Temporal, Occipital



3 borders:

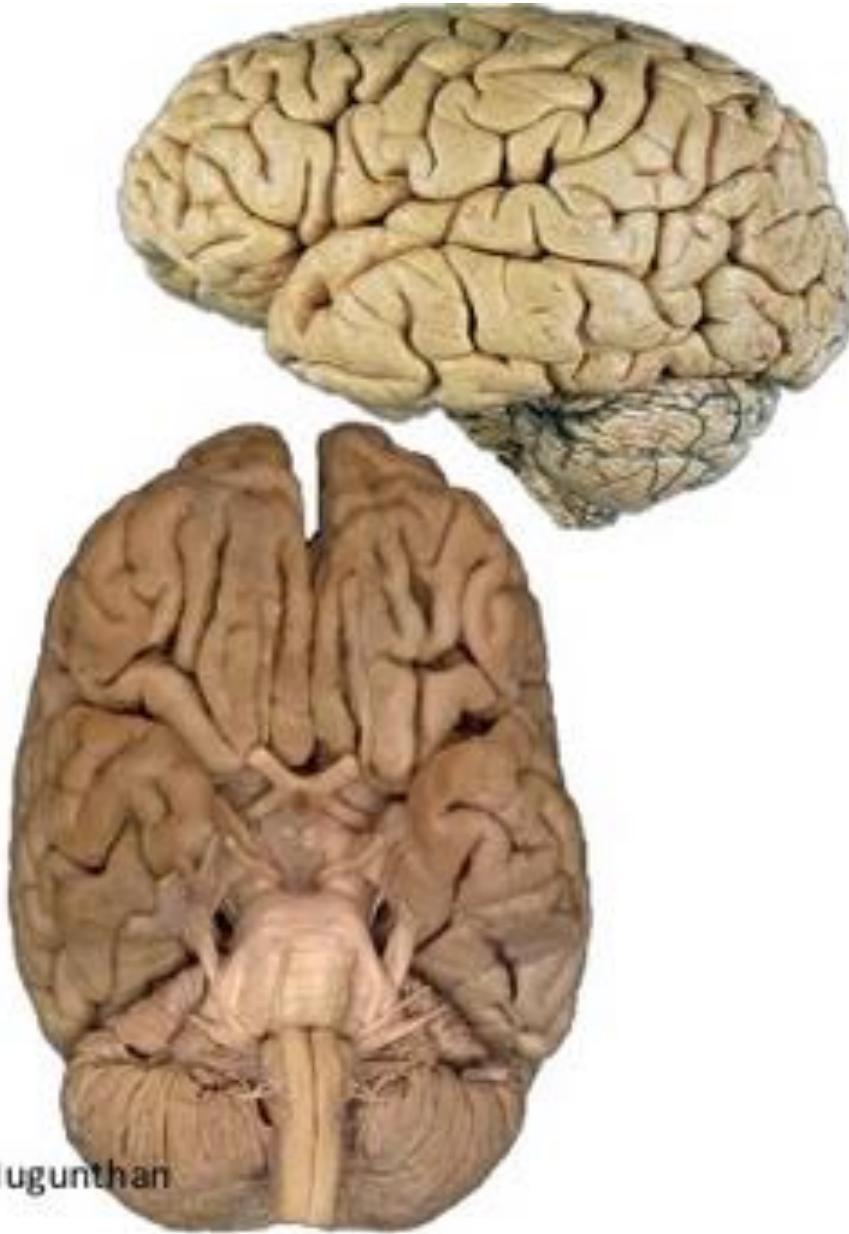
1. Superomedial border
2. Inferolateral border (ant.1/3 - superciliary border)
3. Inferomedial border
(ant.1/3-medial orbital border, middle 1/3 - hippocampal border, post 1/3 – medial occipital border)



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3 surfaces:

1. Superolateral surface
2. Medial surface
3. Inferior surface
 - a) Orbital surface
 - b) Tentorial surface

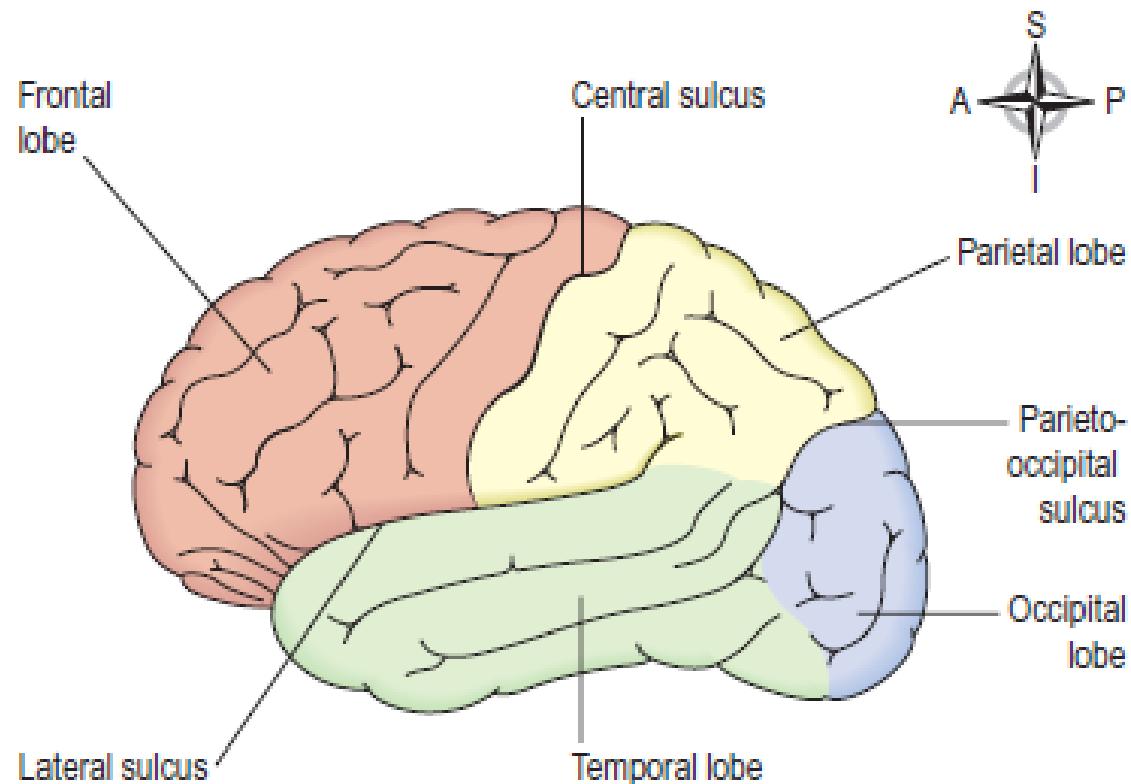


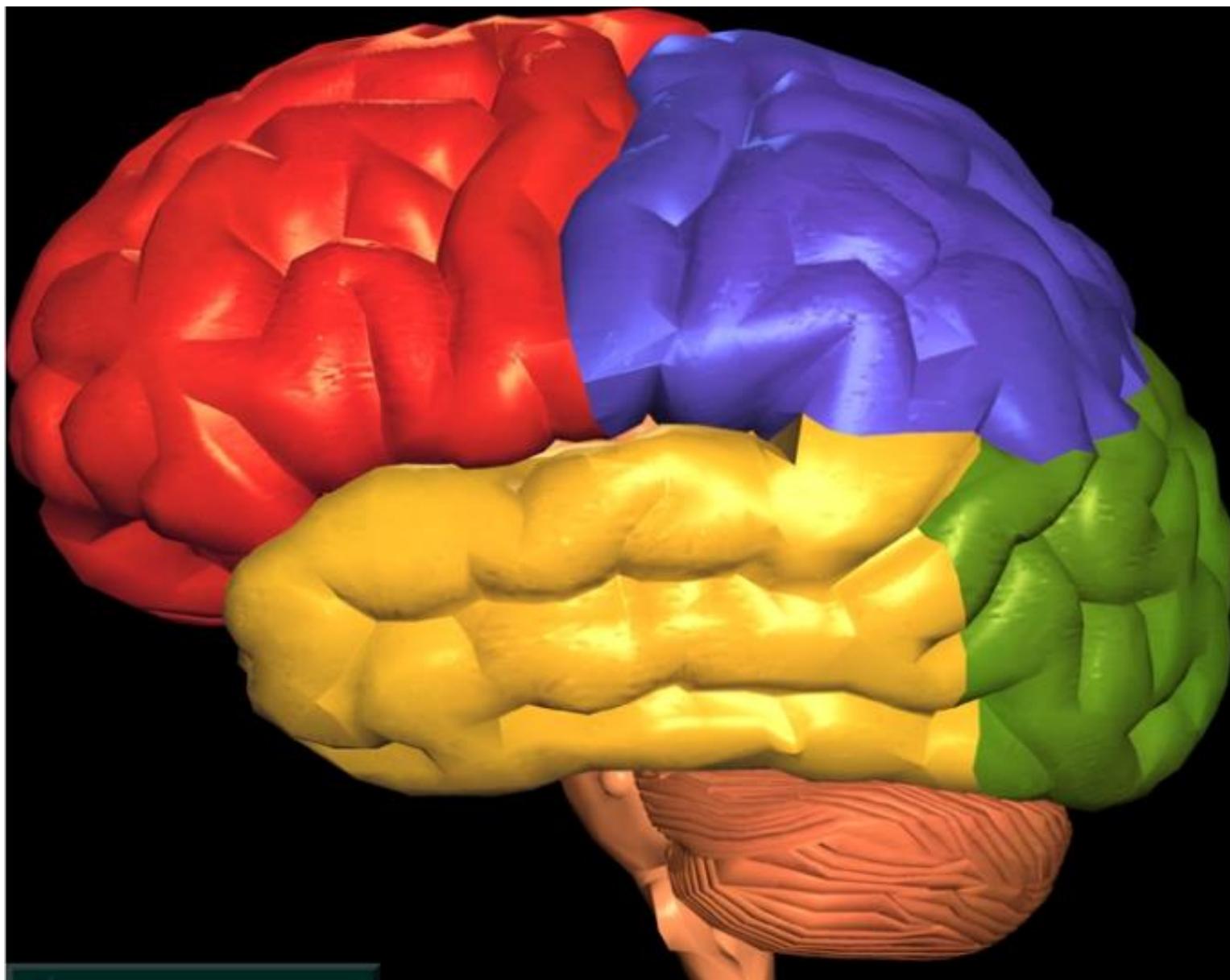
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Cerebrum

- Lobes:

- Frontal
- Parietal
- Temporal
- Occipital





Cerebrum-Blood supply

- Circle of Willis (Circulus arteriosus)
- Superficial veins drain the superficial areas of head → External jugular vein
- Dural venous sinuses → Internal jugular vein

Cerebrum-Functions

- 3 main types of activities:
 - Mental activities which includes intellectual and emotional processing
 - Sensory perception (Localization and interpretation)
 - Initiation and control of skeletal (**voluntary**) muscle activity

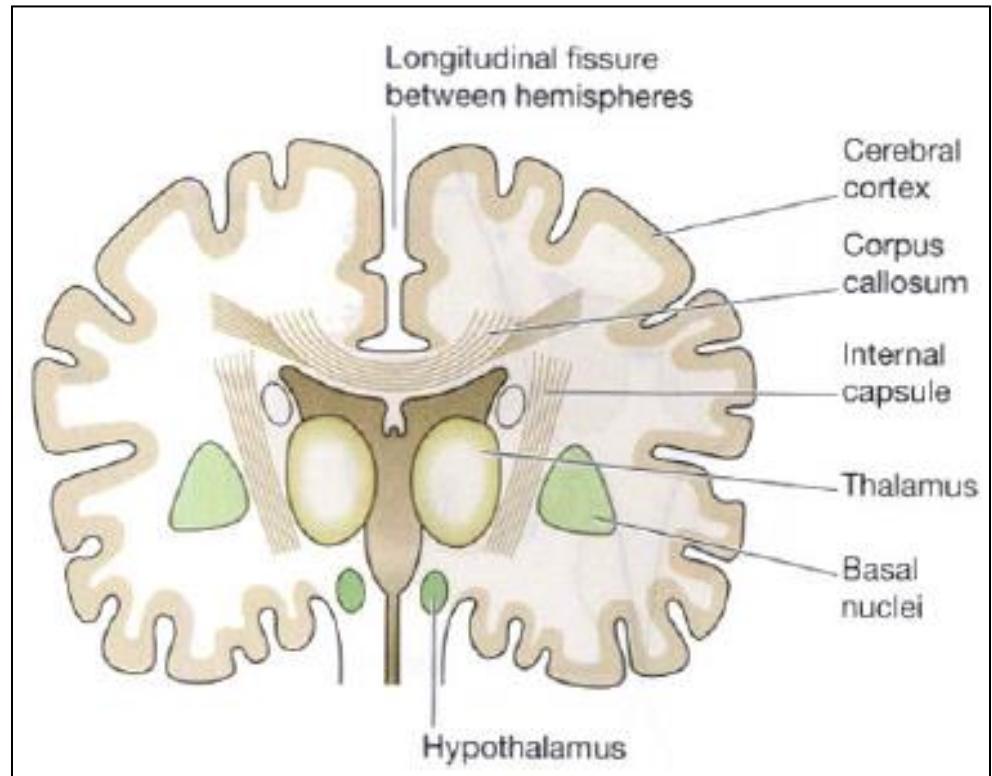
Functional areas of Cerebral cortex

- **Motor Areas:-** 1) Primary motor area
2) Motor homunculus
3) Premotor area
4) Frontal eye field
5) Prefrontal cortex
- **Motor speech areas of Broca**
- **Sensory Areas:-** 1) Primary sensory areas
2) Sensory association area
3) Sensory speech areas of wernicke

- 4) Primary & Secondary visual area
- 5) Primary & Secondary acoustic area
- 6) Entorhinal area
- **Cortical speech areas:-** 1) Motor speech area
2) Sensory speech area

Brain

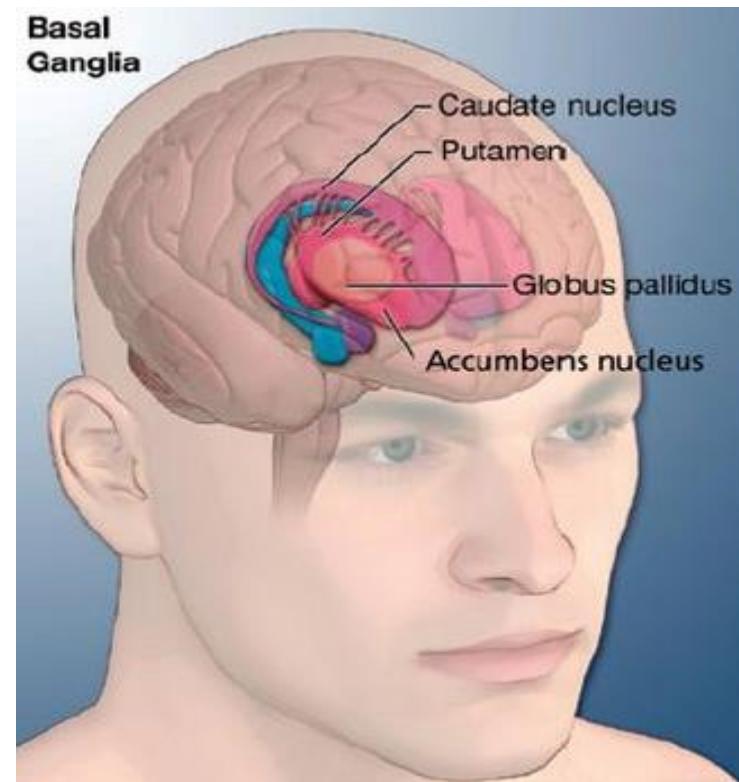
- Nuclei
- Important masses of grey matter include:
 - Basal nuclei
 - Thalamus
 - Hypothalamus



Brain

Basal nuclei

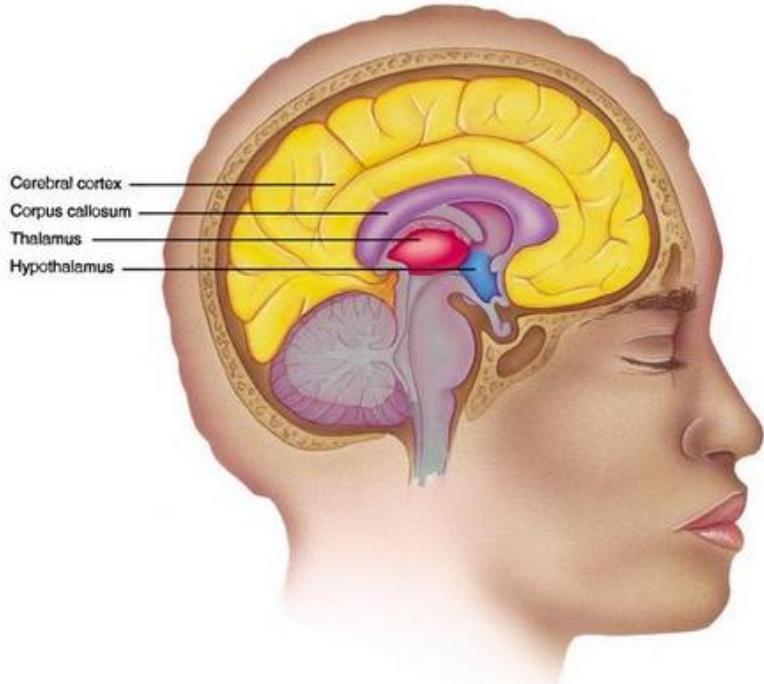
- Collections of grey matter
- Component :-
 - 1) Caudate nucleus
 - 2) Lentiform nucleus
 - 3) Claustrum
 - 4) Amygdaloid nucleus
 - 5) Subthalamic nucleus
- Involved in initiating skeletal muscle tone in slow and coordinated activities



Brain

Thalamus

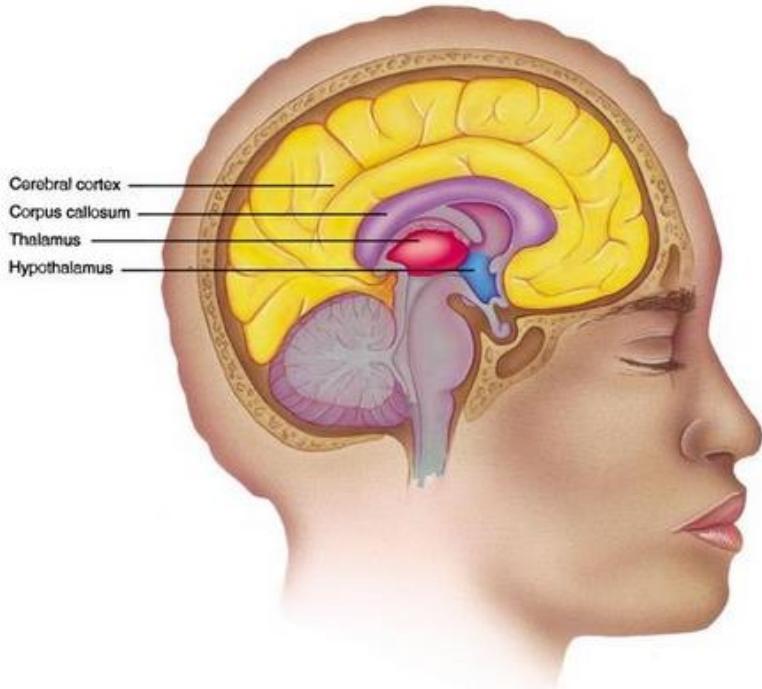
- Located on top of brainstem
- Relay centre



Brain

Hypothalamus

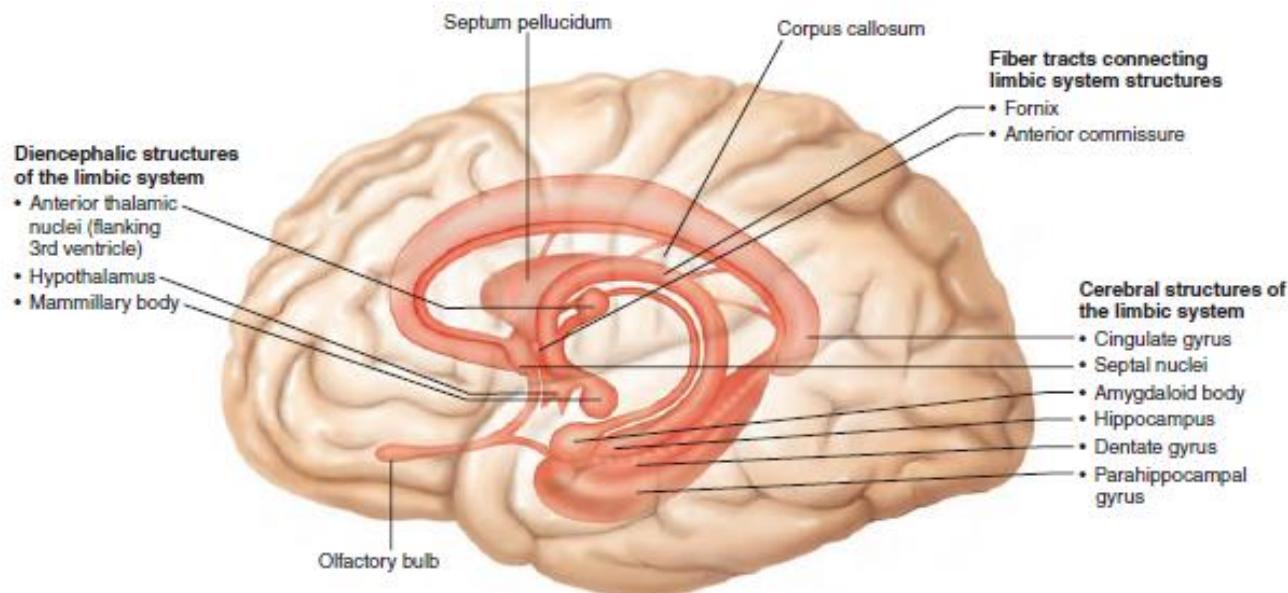
- Chief integration center of ANS
- Regulates body temp, food intake, water balance, thirst and biological rhythms and drives



Brain

Limbic System

- Includes various structures of cerebrum and diencephalon
- Mediates **emotional response**
- Component:- 1) cortical grey matter 2) subcortical grey matter 3) Interconnecting fiber tracts



NERVOUS SYSTEM

Dr. Aman Shakya

2080.02.31

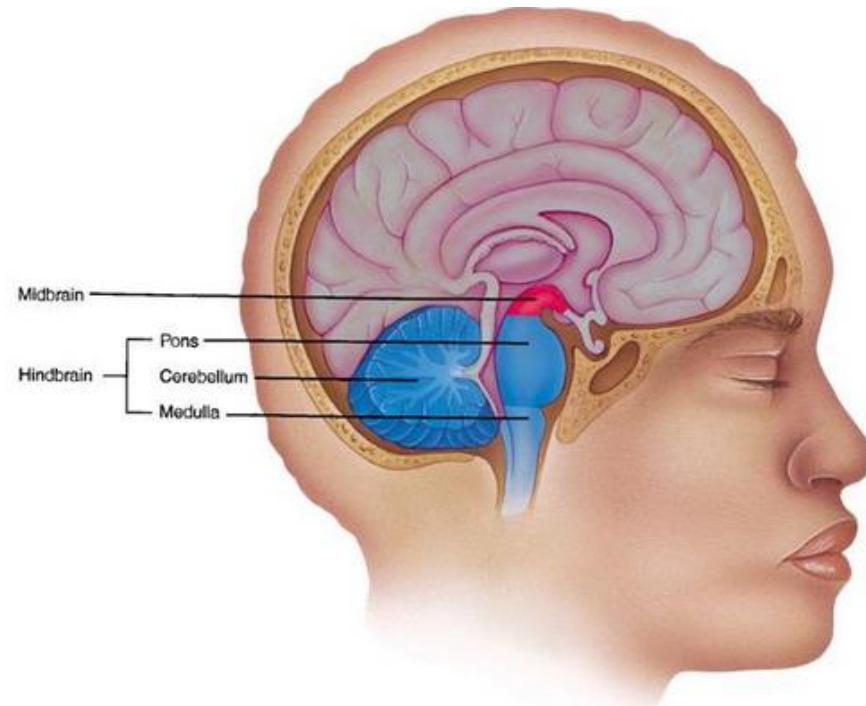
Objectives

- To explain gross structure of Mid brain
- To explain gross structure of Pons
- To explain gross structure of Cerebellum
- To discuss about cranial nerves
- To explain gross structure of white mater and grey mater
- To explain gross structure of spinal cord

Brainstem

Midbrain

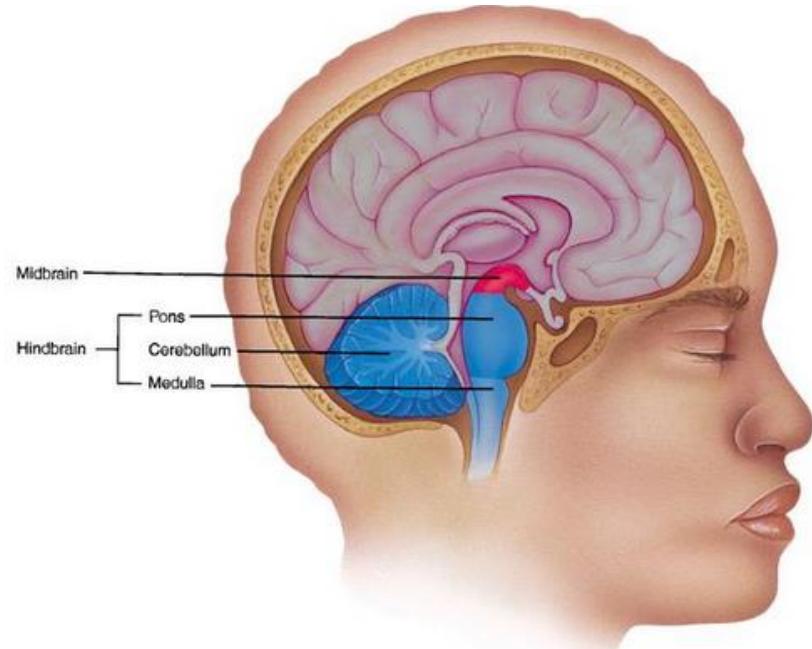
- Between cerebrum and pons
- Connects cerebrum with lower parts of brain and with the spinal cord
- Contains:
 - ❖ Visual and auditory reflex centers
 - ❖ Subcortical motor centers (Substantia nigra and red nuclei)
 - ❖ CN III and IV nuclei



Brainstem

Pons

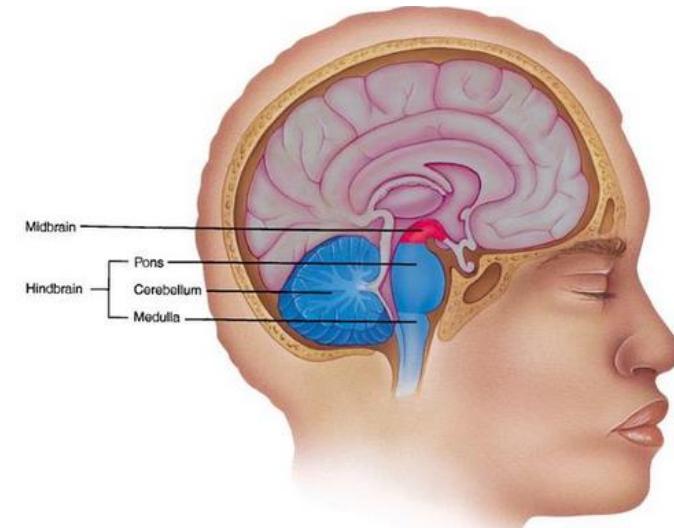
- In front of cerebellum, below midbrain and above medulla oblongata
- CN V-VII nuclei
- Cooperates with medullary respiratory centers to control respiration



Brainstem

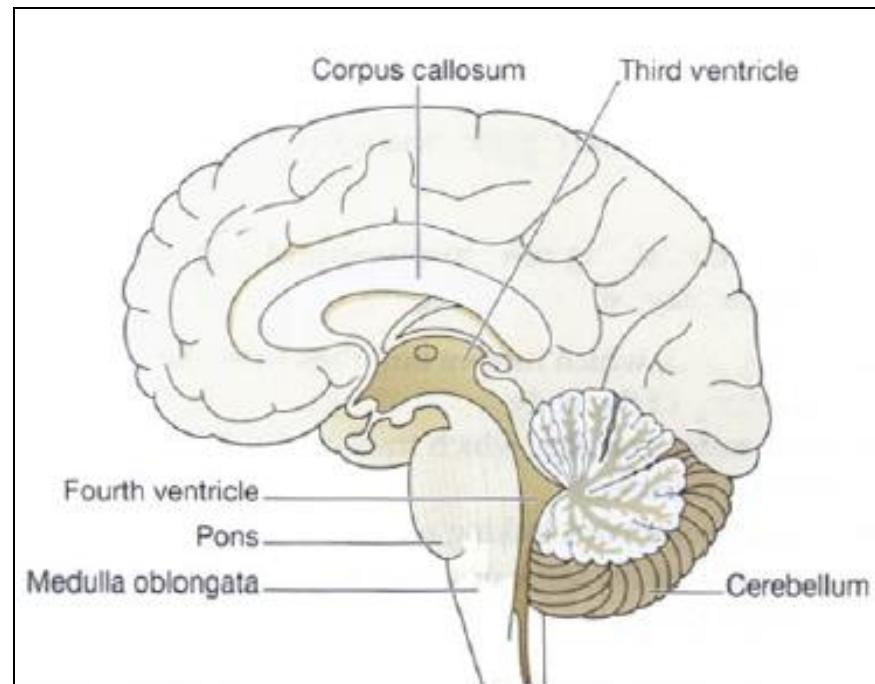
Medulla oblongata

- Situated below pons
- Continuous with spinal cord
- Vital centres {Cardiac centre, Respiratory centre, and Reflex centres of vomiting, coughing, sneezing and swallowing}
- CN VIII-XII nuclei
- Site of decussation of pyramidal fibers

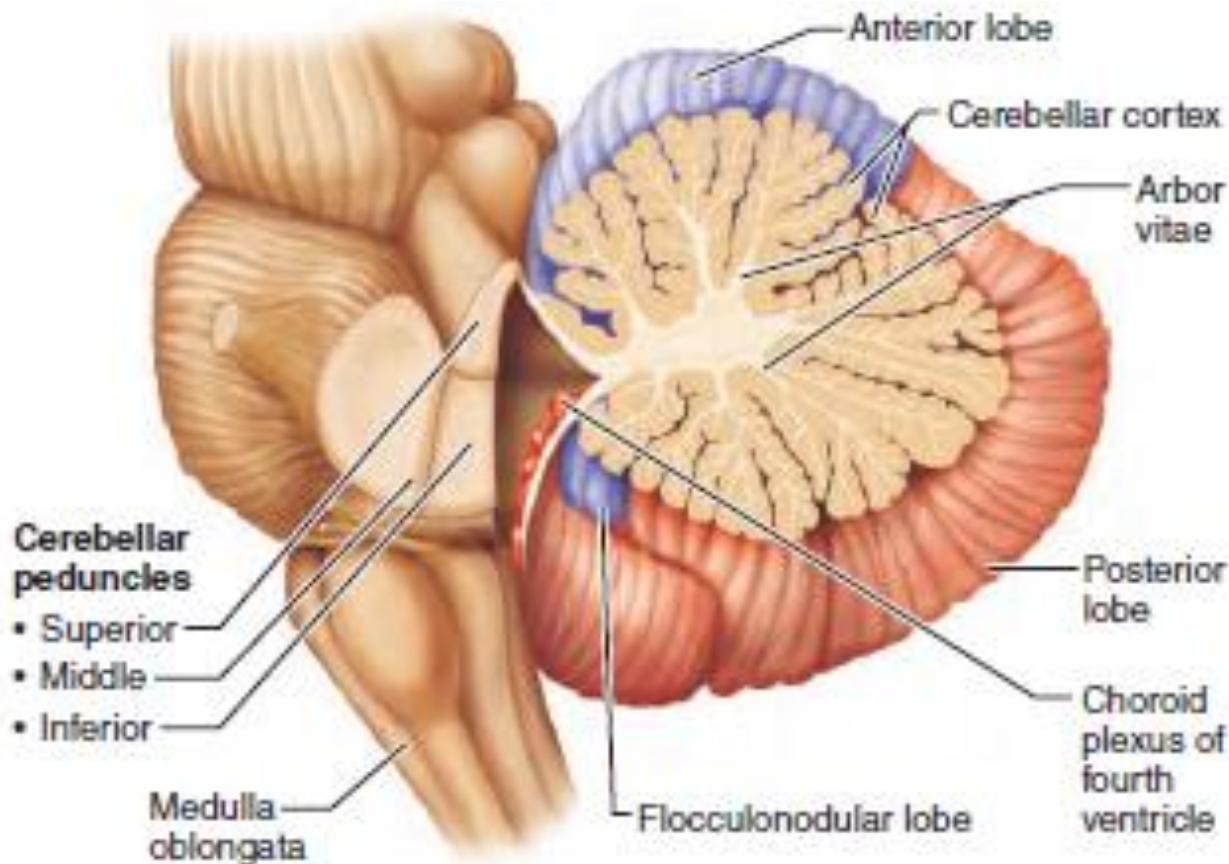


Cerebellum

- Situated behind pons and immediately below posterior portion of cerebrum
- Occupy posterior cranial fossa
- 2 hemispheres separated by Vermis
- Folia
- Grey matter is superficial, White matter lies deeply

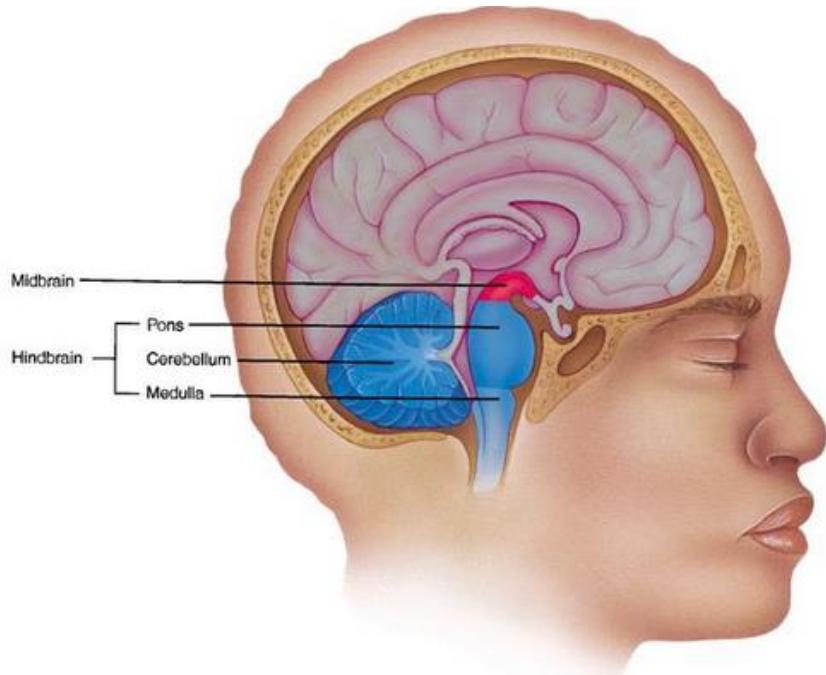


Cerebellum



Cerebellum-Functions

- Coordination of voluntary muscular movement, posture and balance ensuring smooth and precise actions
- Maintains balance and equilibrium
- Damage - Staggering gait and inability to carry out smooth, steady, precise movements



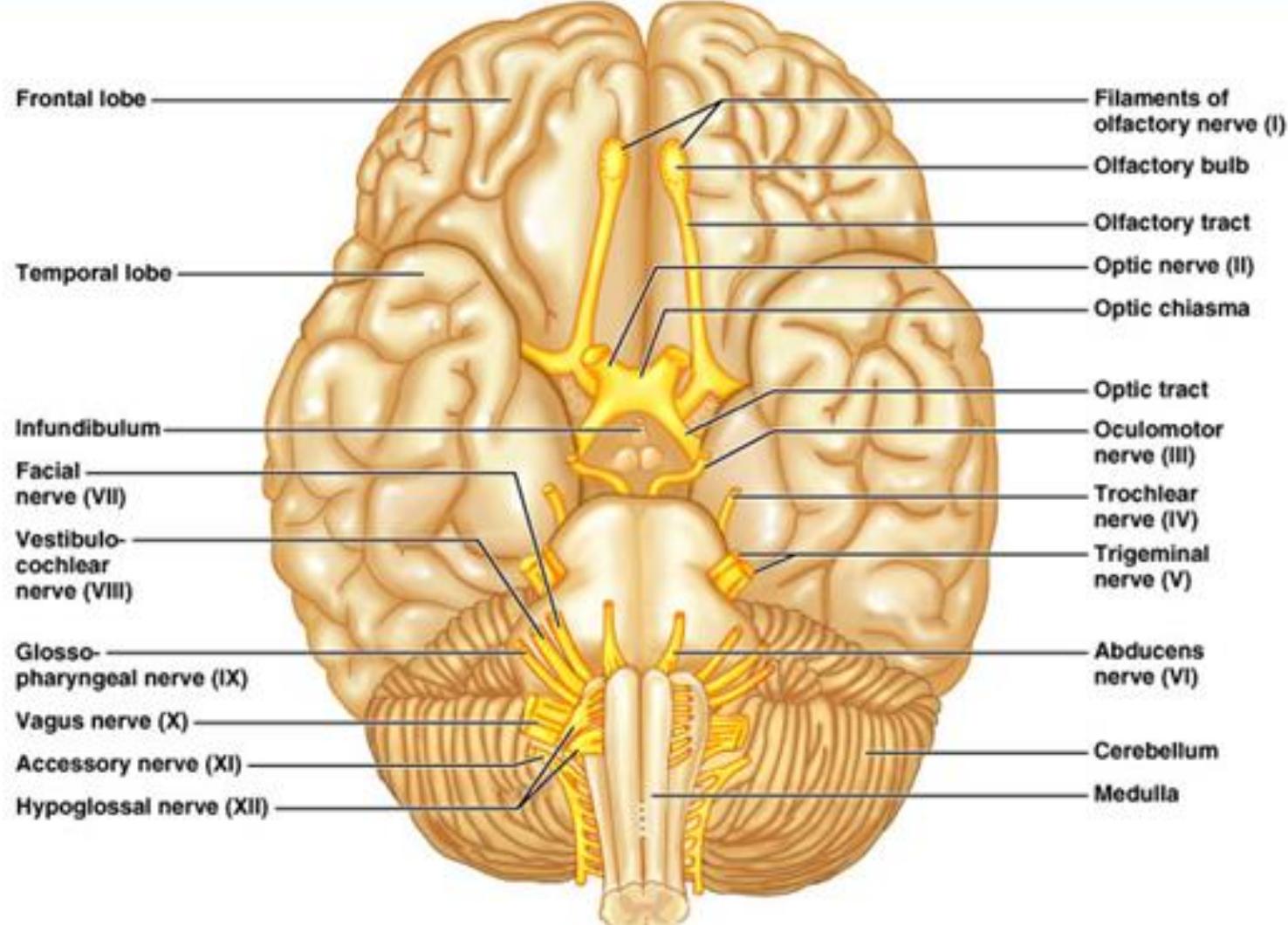
Cranial nerves

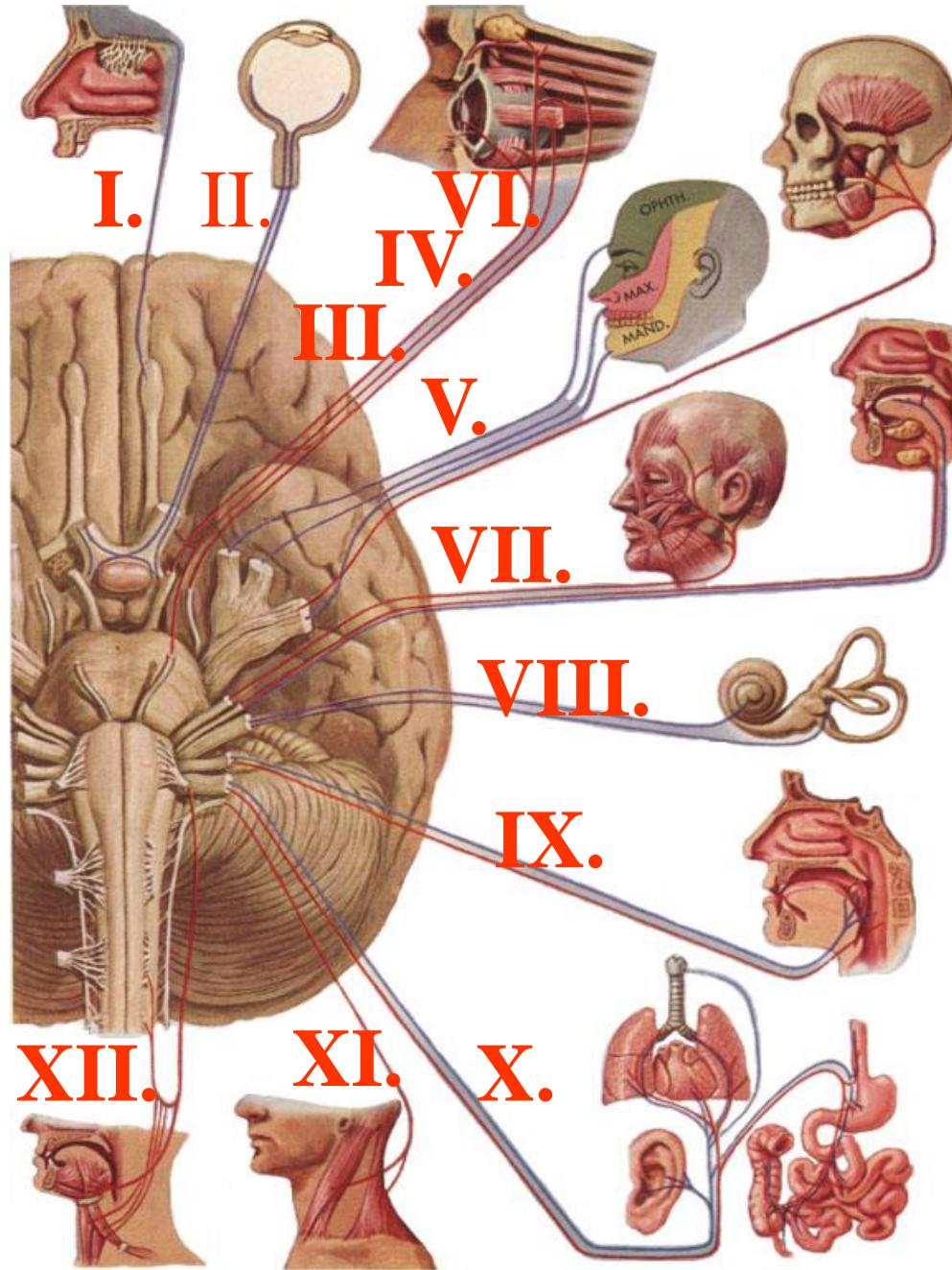
- 12 pairs, Roman numerals I-XII
- Some sensory, some motor and some mixed
 - Serve mainly head and neck
 - Vagus – into thoracic and abdominal cavities
 - All but first 2 arise from brain stem

Cranial nerves

- I. Olfactory: sensory
- II. Optic: sensory
- III. Oculomotor: motor
- IV. Trochlear: motor
- V. Trigeminal: mixed
- VI. Abducent: motor
- VII. Facial: mixed
- VIII. Vestibulocochlear (auditory): sensory
- IX. Glossopharyngeal: mixed
- X. Vagus: mixed
- XI. Accessory: motor
- XII. Hypoglossal: motor

Cranial nerves





Cranial nerves

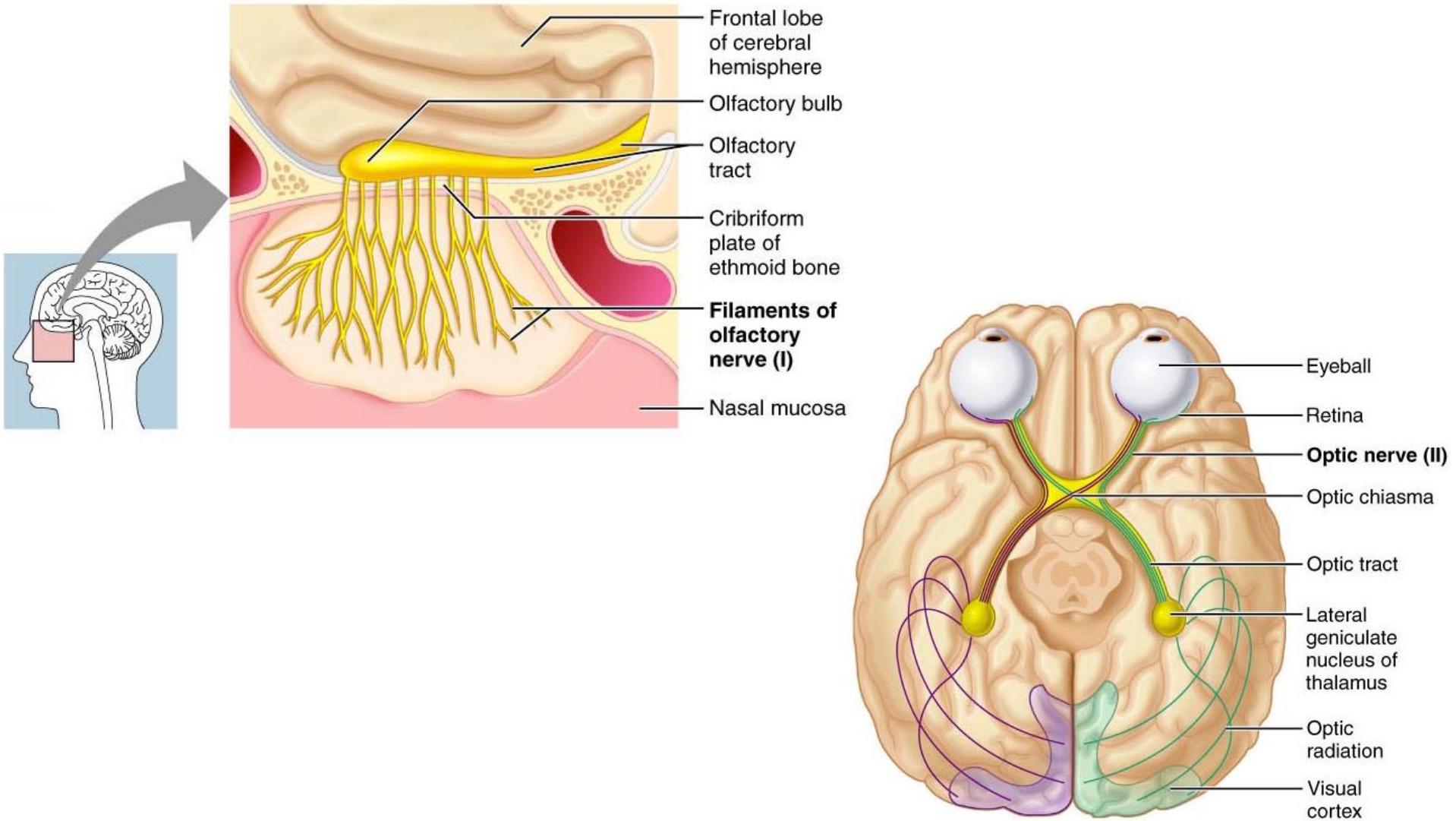
I. Olfactory nerves (sensory)

- Nerves of the *sense of smell*
- Originate in upper part of mucous membrane of nasal cavity

II. Optic nerves (sensory)

- Nerves of the *sense of sight*
- Originate in retina of the eyes
- occipital lobe → sight is perceived
- Cerebellum → maintenance of balance, posture, orientation of head in space

Cranial nerves



Cranial nerves

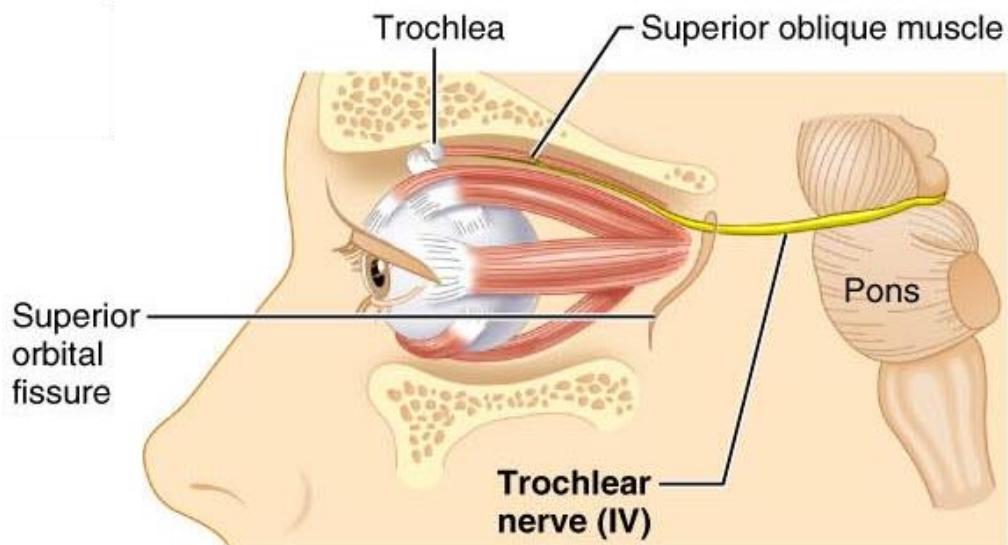
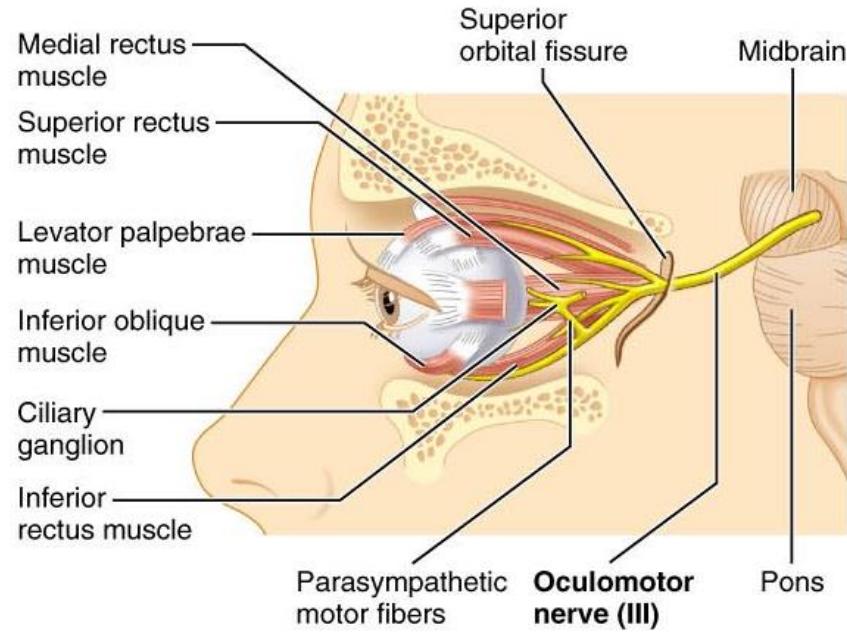
III. Oculomotor nerves (motor)

- From mid brain
- Supply:
 - 4 extraocular muscles (move the eyeball)
 - Intraocular muscles:
 - *Ciliary muscles*
 - *Circular muscles of the iris*
 - *Levator palpebrae* muscle

IV. Trochlear nerves (motor)

- From midbrain
- Supply the *superior oblique muscles* of the eyes

Cranial nerves



Cranial nerves

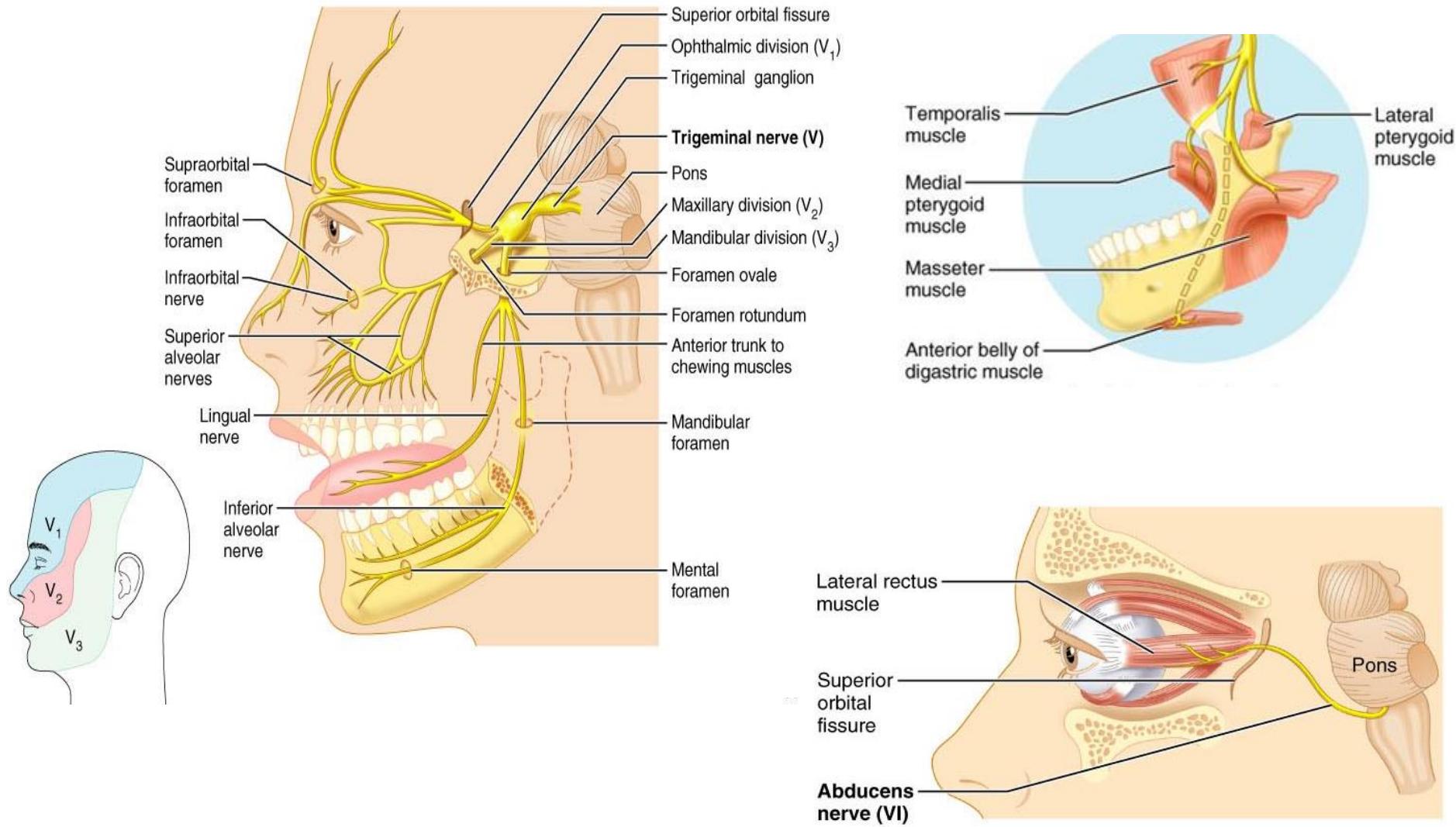
V. Trigeminal nerves (mixed)

- Largest
- S-face and head
- M-muscles of mastication
- V1-Ophthalmic, V2-Maxillary, V3-Mandibular

VI. Abducens nerves (motor)

- From the pons
- Supply the *lateral rectus muscles* of the eyeballs

Cranial nerves



Cranial nerves

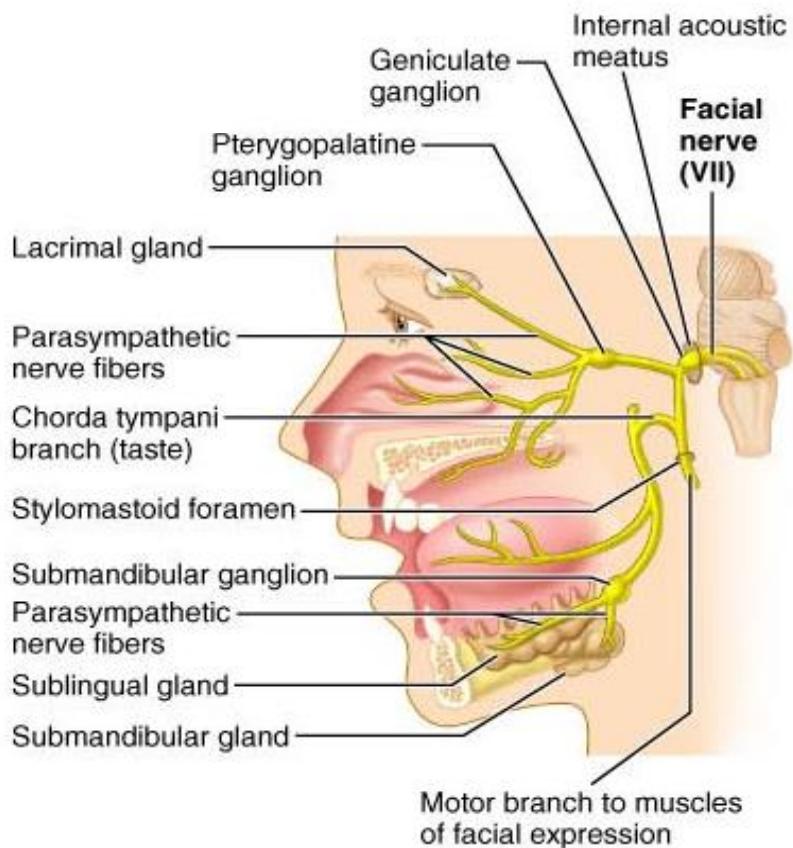
VII. Facial nerves (mixed)

- From lower part of the pons
- M- muscles of facial expression, salivary and lacrimal glands
- S-taste buds in anterior two-thirds of the tongue

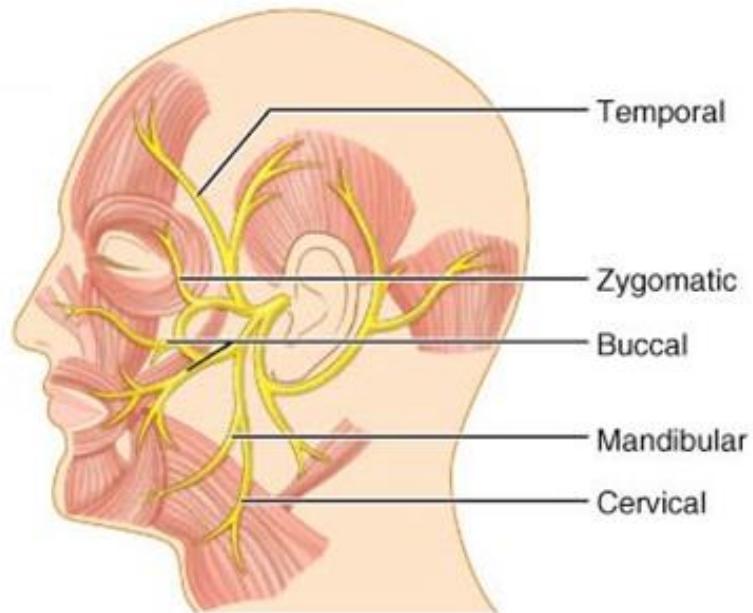
VIII. Vestibulocochlear nerves (sensory)

- Composed of vestibular and cochlear nerves
- *Vestibular nerves* - Equilibrium
- *Cochlear nerves* - Hearing

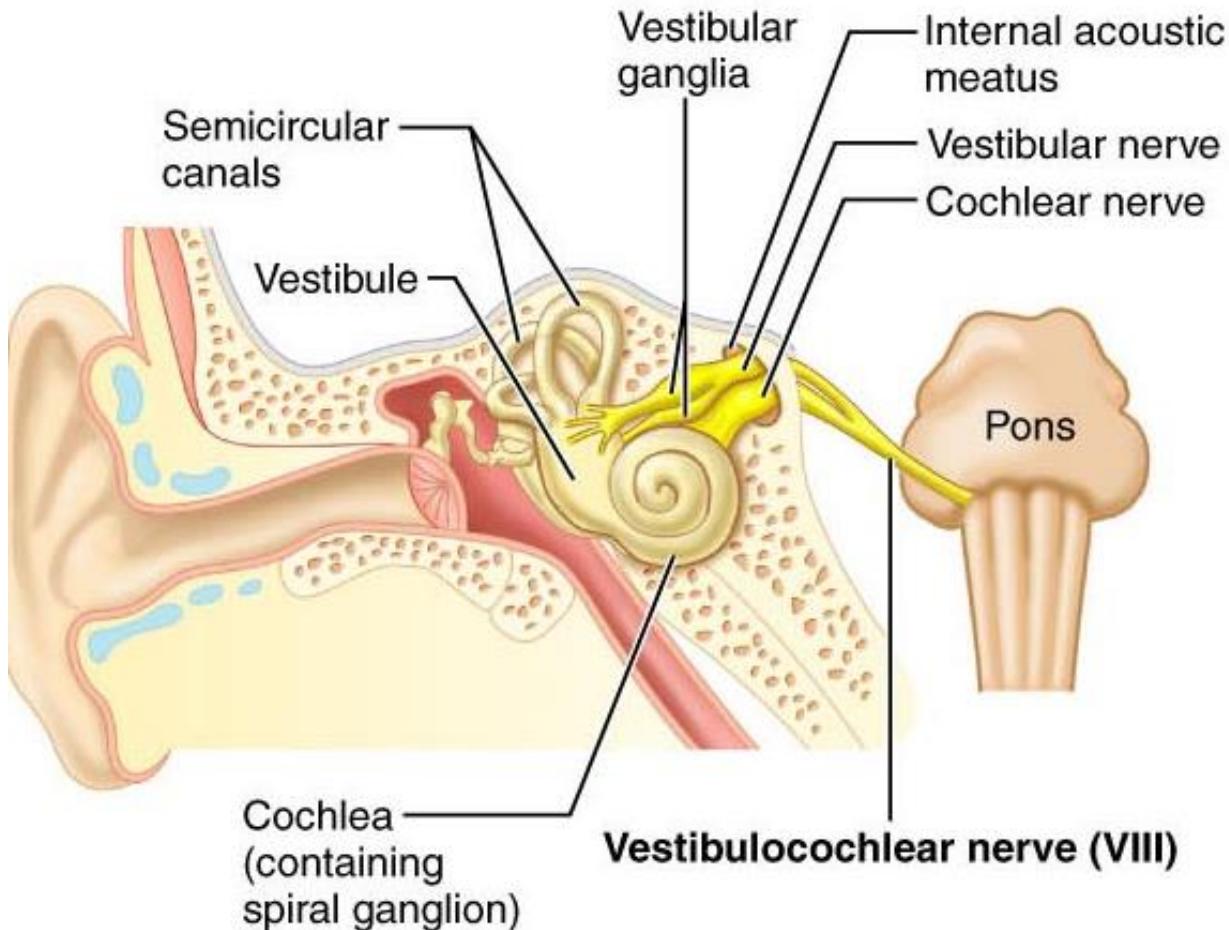
Cranial nerves



(c) Parasympathetic efferents
and sensory afferents



Cranial nerves



Cranial nerves

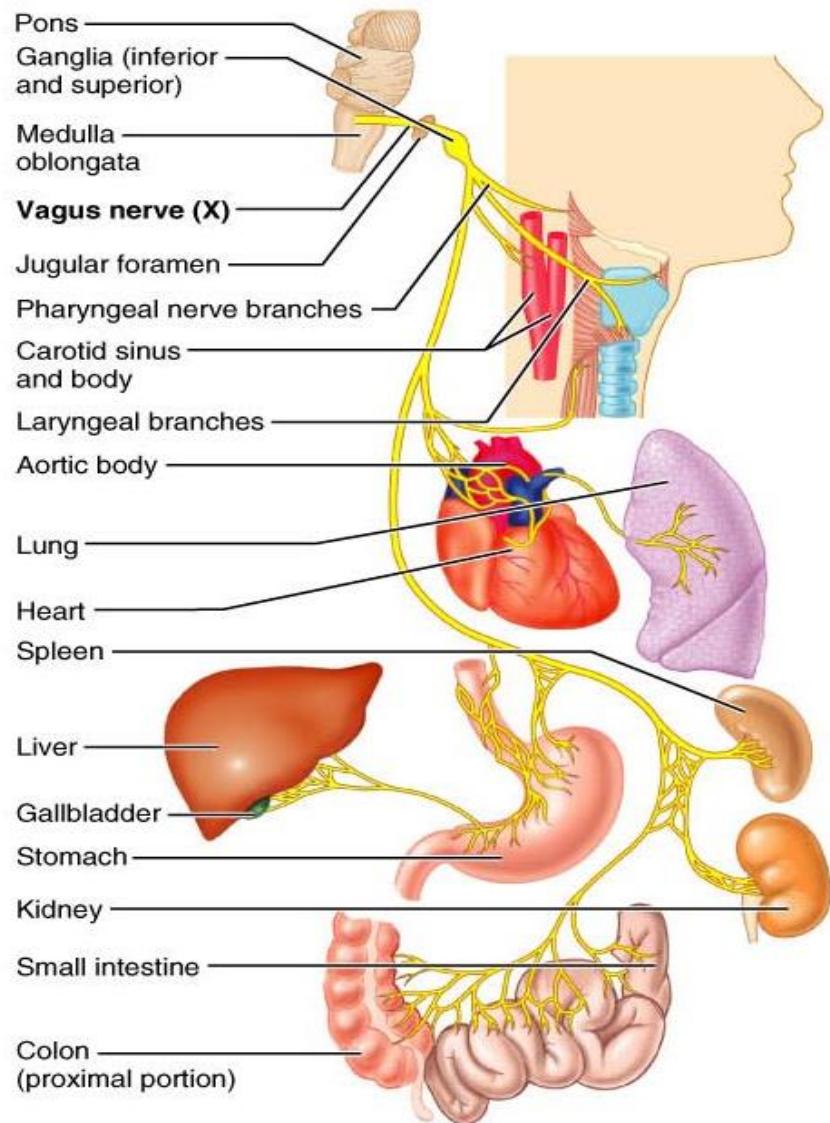
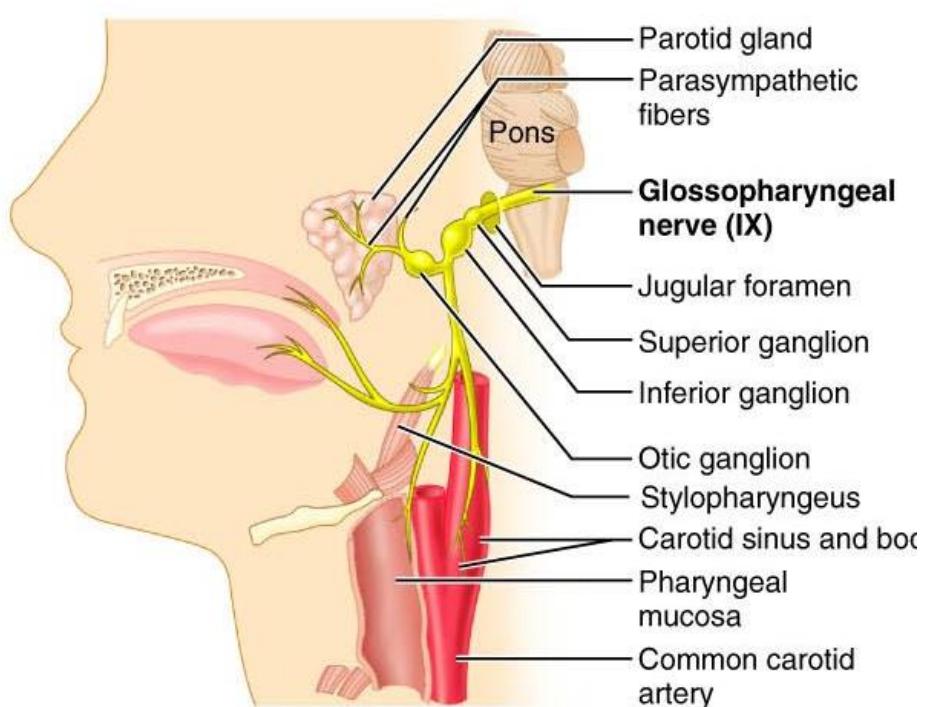
IX. Glossopharyngeal nerves (mixed)

- From medulla oblongata
- M - stylopharyngeus and parotid glands
- S - posterior third of the tongue, tonsils and pharynx
- Essential for the swallowing and gag reflexes

X. Vagus nerves (mixed)

- Pass down through the neck into the thorax and the abdomen
- M - smooth muscles and secretory glands of the GIT, larynx, heart, extrahepatic biliary system, kidneys, ureter and blood vessels in the thoracic and abdominal cavities
- S - lining membranes of the same structures

Cranial nerves



Cranial nerves

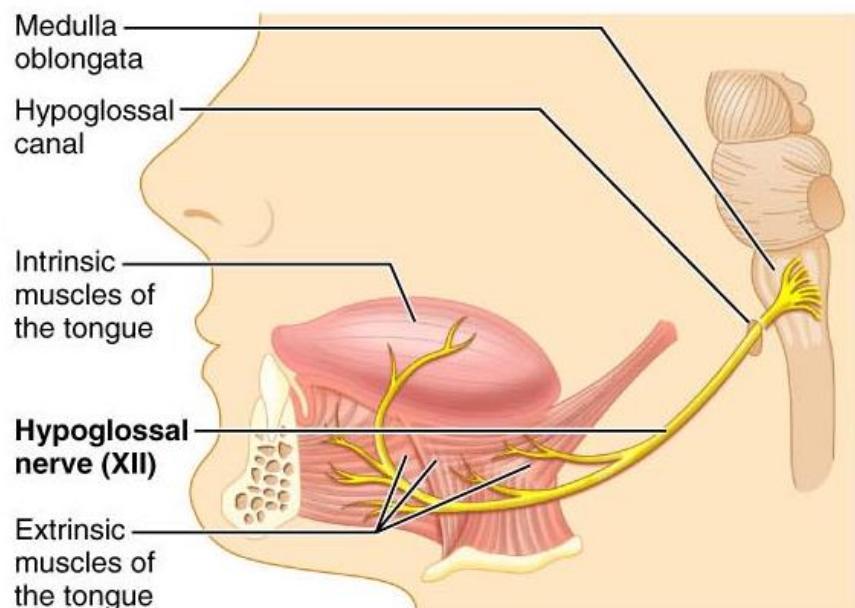
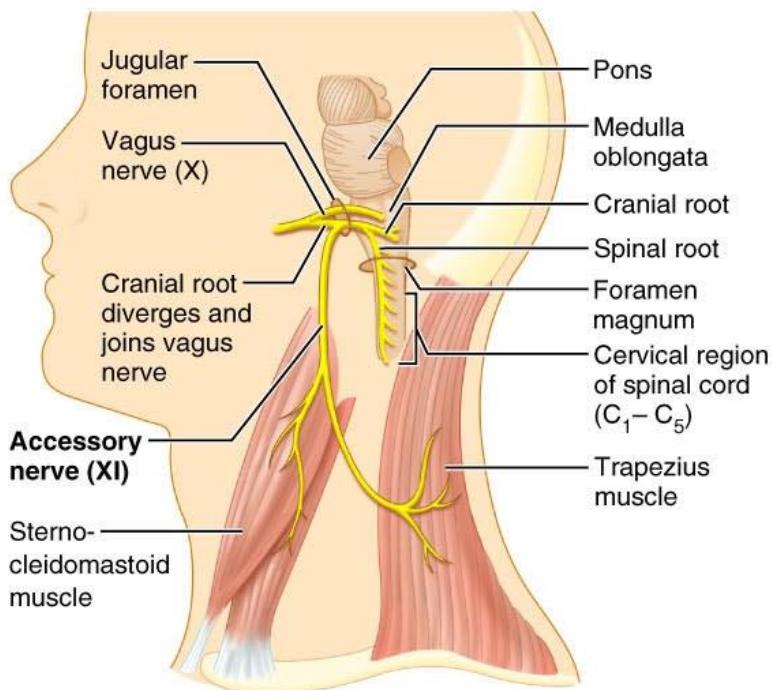
XI. Accessory nerves (motor)

- Supply the *sternocleidomastoid* and *trapezius muscles*

XII. Hypoglossal nerves (motor)

- From medulla oblongata
- Supply the muscles of the tongue and muscles surrounding the hyoid bone and contribute to swallowing and speech

Cranial nerves



Nervous System

Dr. Aman Shakya

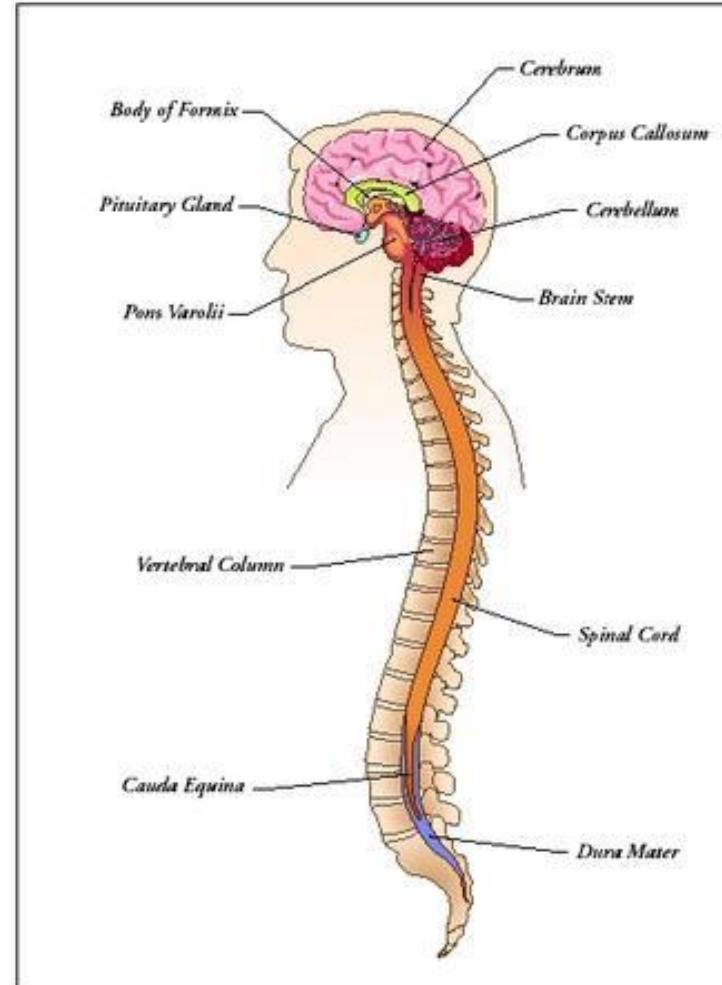
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Objectives

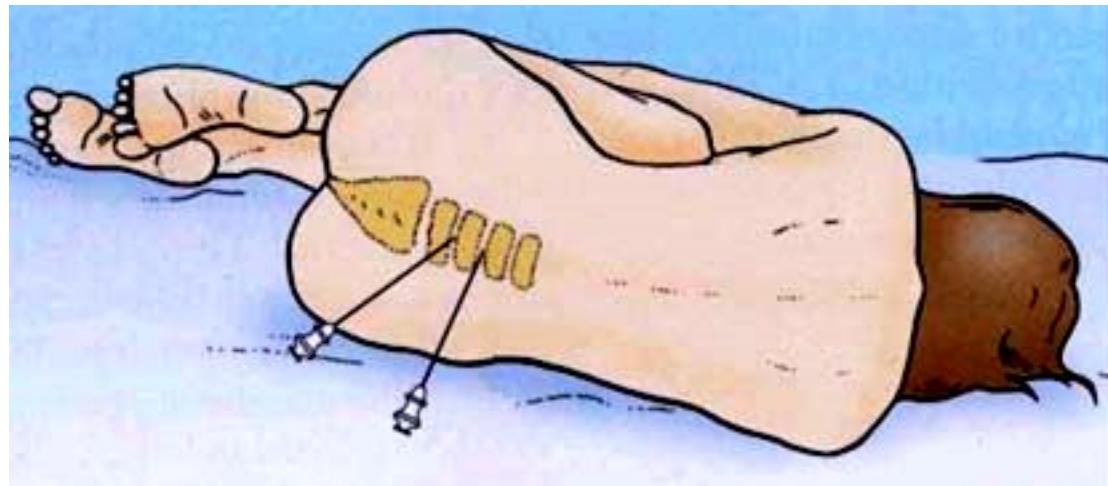
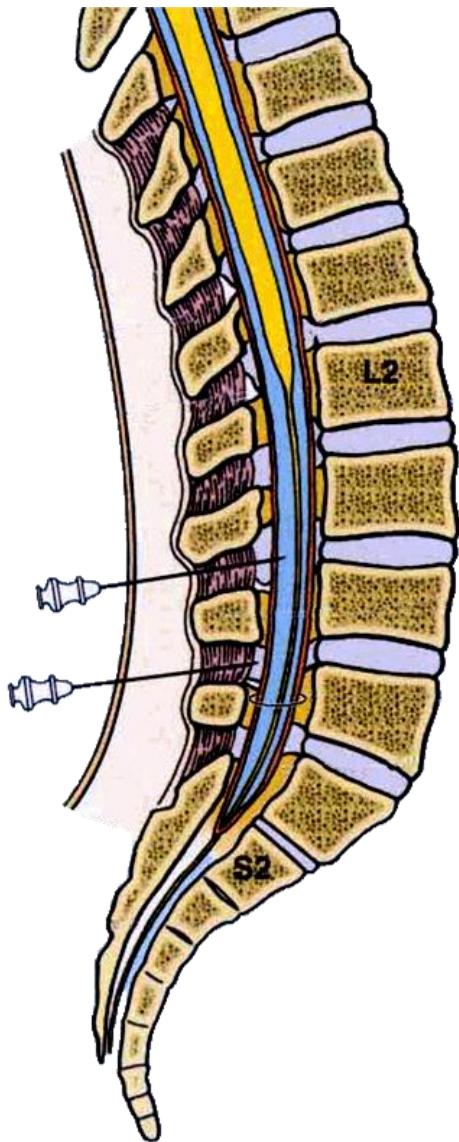
- To explain gross structure of spinal cord
- To explain gross structure of white mater and grey mater
- To discuss about autonomic nervous system
- To discuss structure of nerve cell

Spinal cord

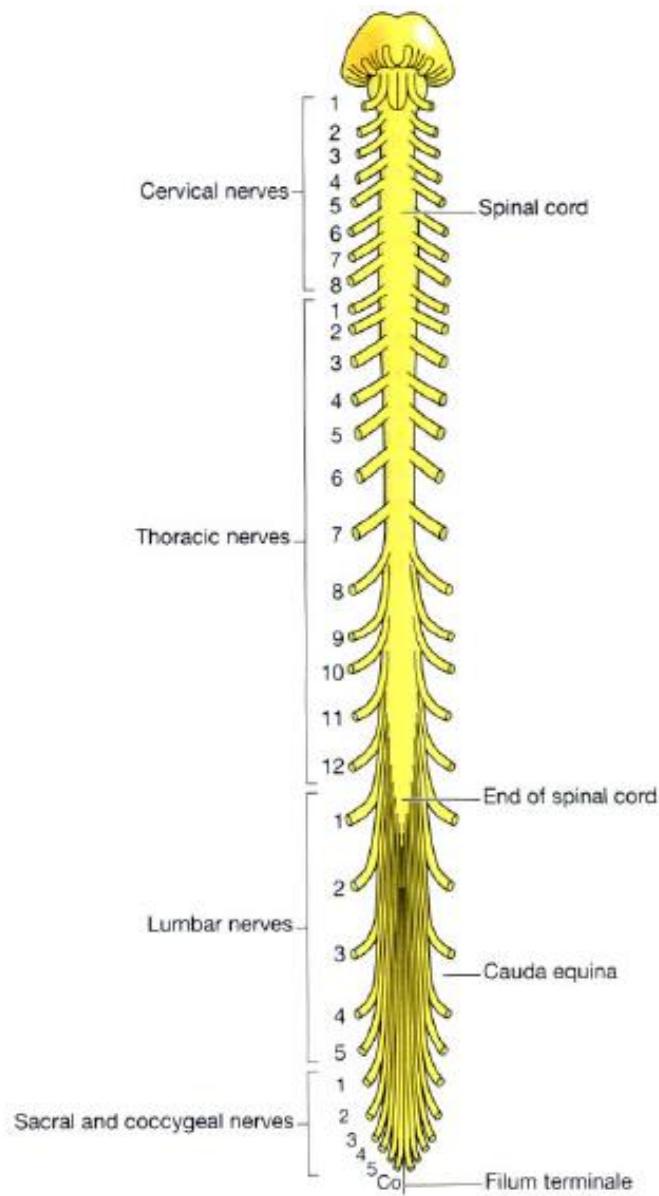
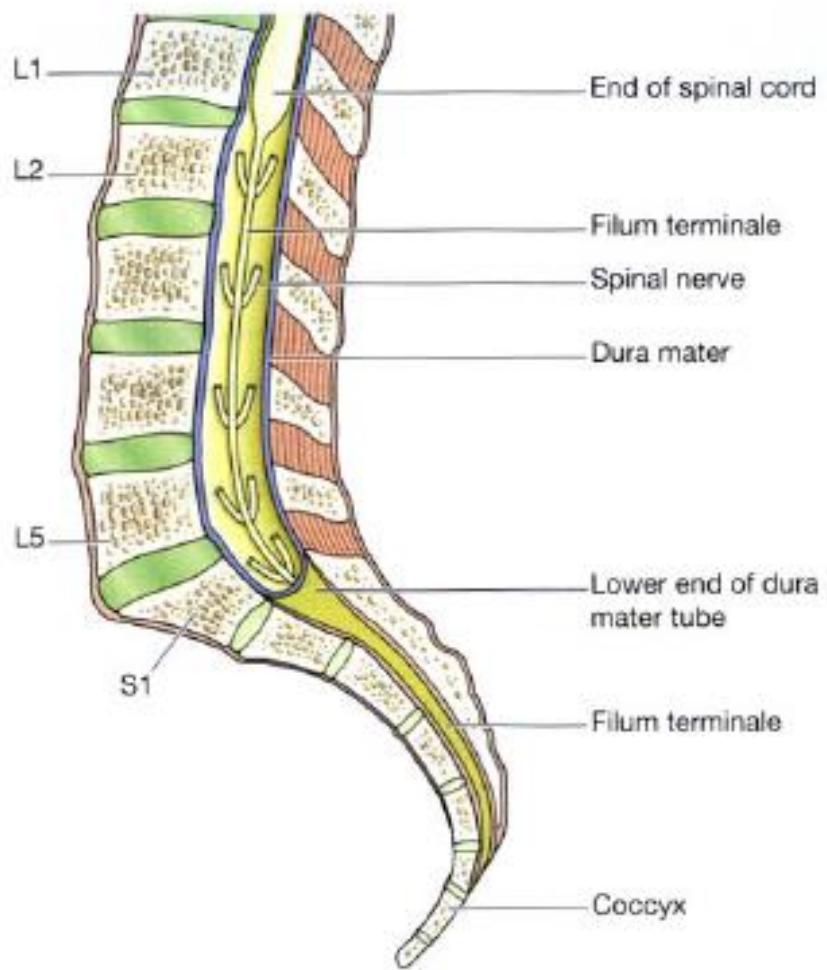
- Elongated (45 cm)
- Almost cylindrical part of CNS
- Suspended in vertebral canal surrounded by meninges and CSF
- Continuous above with medulla oblongata and extends from *upper border of atlas (C1)* to lower border of L1/upper border of L2
- Lumbar puncture



Spinal cord



Spinal cord

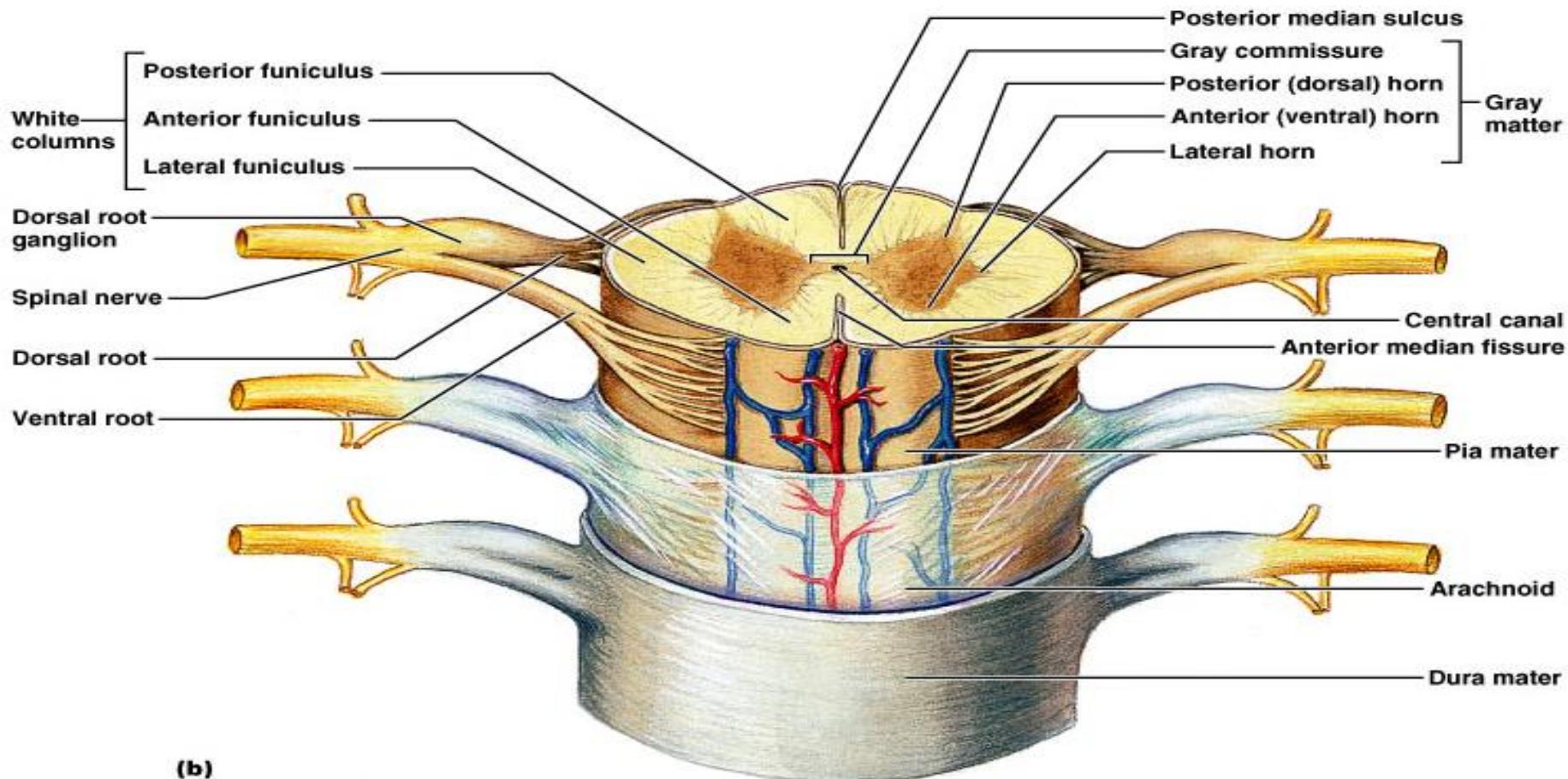


Spinal cord

- Nerves from brain descend through spinal cord
- Similarly, sensory nerves enter and pass upwards in spinal cord to brain
- 31 pairs of spinal nerves (Exit through intervertebral foramen)
- Grey matter in centre surrounded by white matter (TS)

Spinal cord-TS

- Grey matter resembles letter H
- Have 2 *posterior*, 2 *anterior* and 2 *lateral pillars*
- Central canal

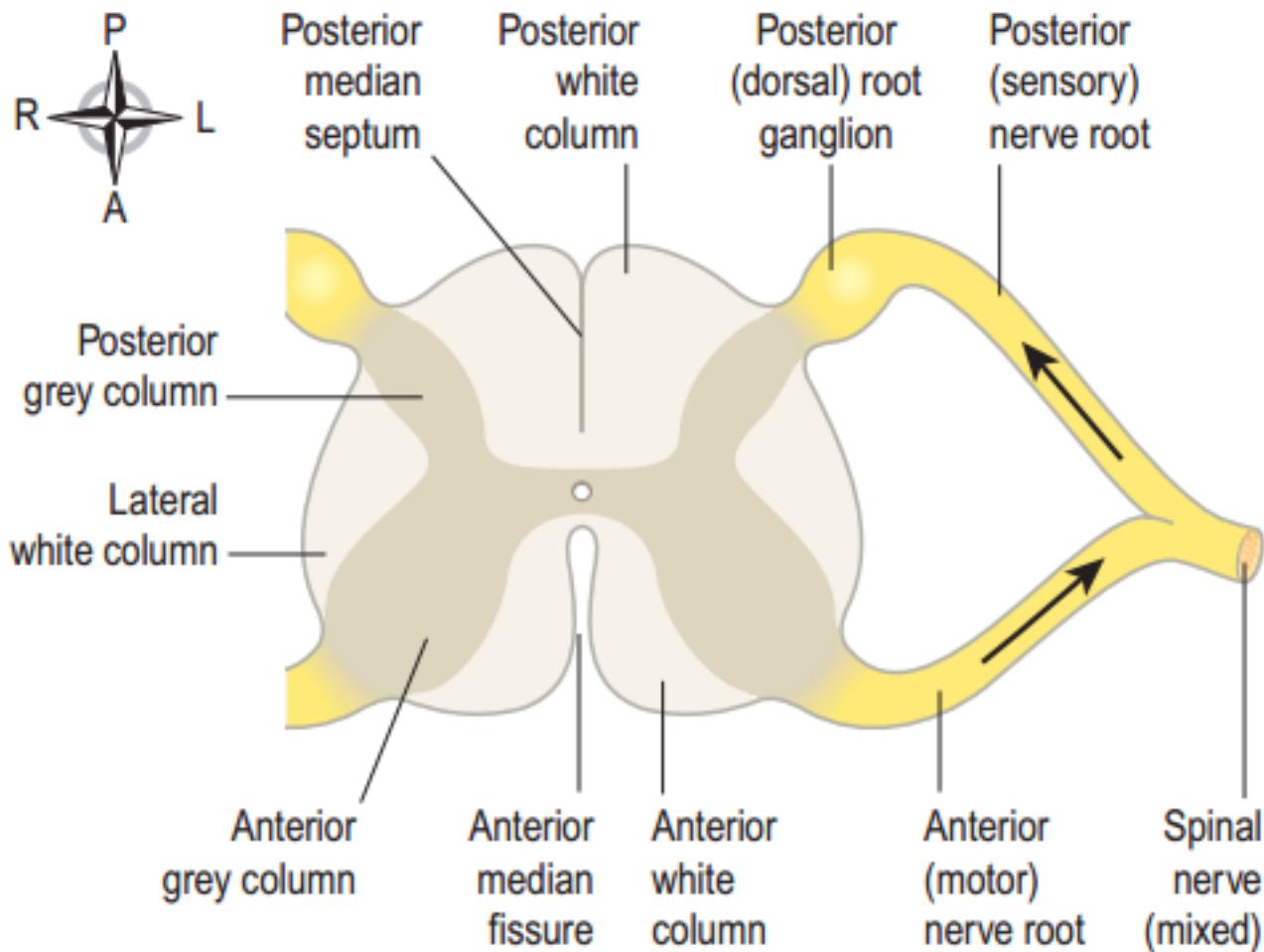


(b)

Spinal cord-TS

- The cell bodies may be:
 - Sensory cells - receive impulses
 - Lower motor neurones - transmit impulses to skeletal muscles
 - Connector neurons - link sensory and motor neurons to form reflex arc

Spinal cord-TS



Spinal cord-TS

- White matter is arranged in 3 *columns or tracts*; anterior (M), posterior(S) and lateral
- Formed by *motor nerve fibres* descending from the brain, *sensory nerve fibres* ascending to the brain, and fibres of *connector neurones*
- The white matter possess spinal tracts. Spinal tracts may be ascending , descending or.
- Tracts are named according to their points of origin and, e.g. spinothalamic, corticospinal

Ascending tracts

Dorsal white column
Fasciculus gracilis
Fasciculus cuneatus

Dorsal spinocerebellar tract

Ventral spinocerebellar tract

Lateral spinothalamic tract

Ventral spinothalamic tract

Descending tracts

Ventral white commissure

Lateral reticulospinal tract

Lateral corticospinal tract

Rubrospinal tract

Medial reticulospinal tract

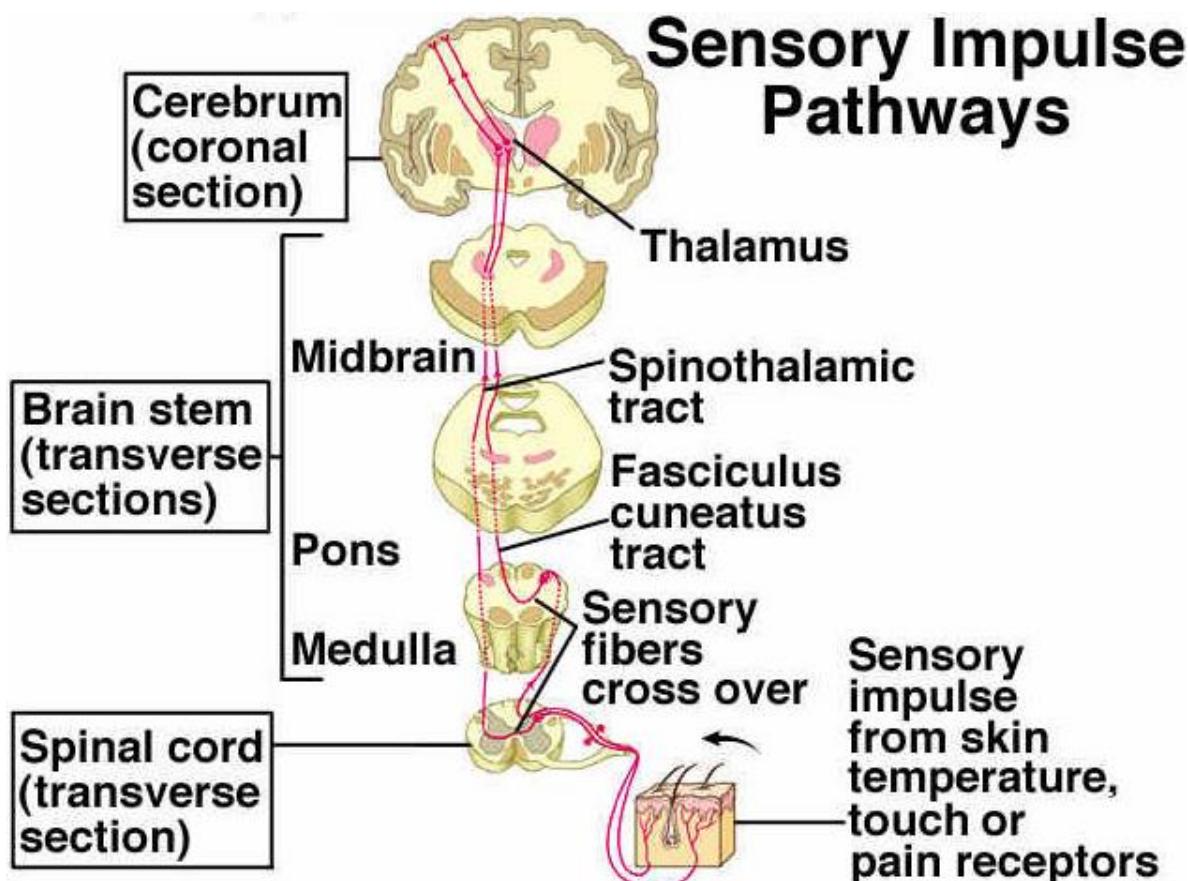
Ventral corticospinal tract

Vestibulospinal tract
Tectospinal tract

Spinal cord

Sensory/ Ascending tracts

- Spinothalamic tracts (pain, touch, temperature)
- Spinocerebellar tracts (vibration)



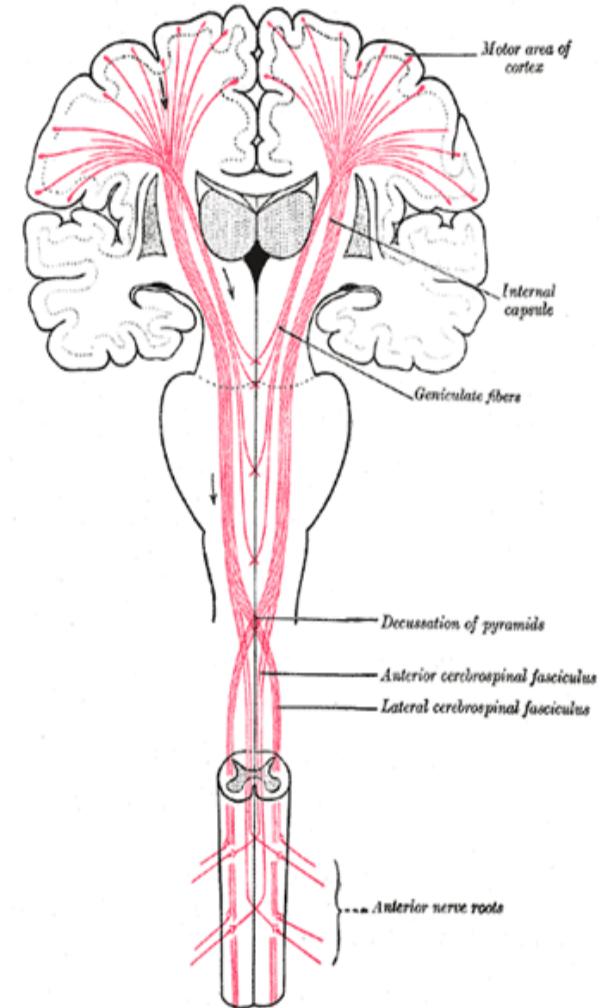
Spinal cord

Motor/ Descending tracts

Pyramidal/ Corticospinal tracts:-

The motor fibres that form the pyramidal tracts travel through the internal capsule and are the main pathway for impulses to voluntary (skeletal) muscles : Lateral and anterior corticospinal tract

Extrapyramidal tracts:-Those motor fibres that don't pass through the internal capsule form the extrapyramidal tracts & have connections with many parts of the brain including the basal nuclei and thalamus.



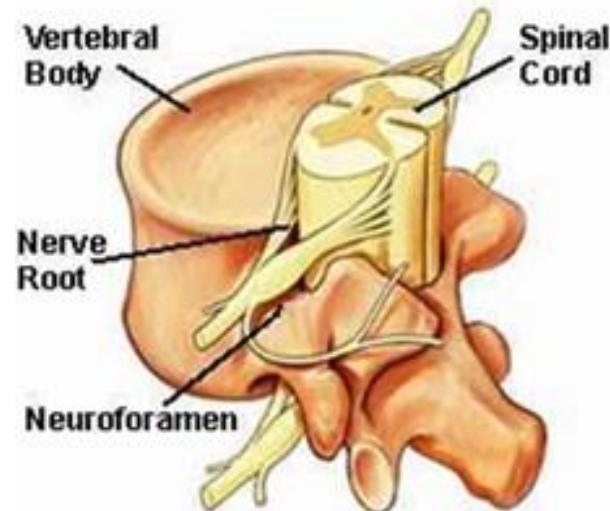
UMN and LMN

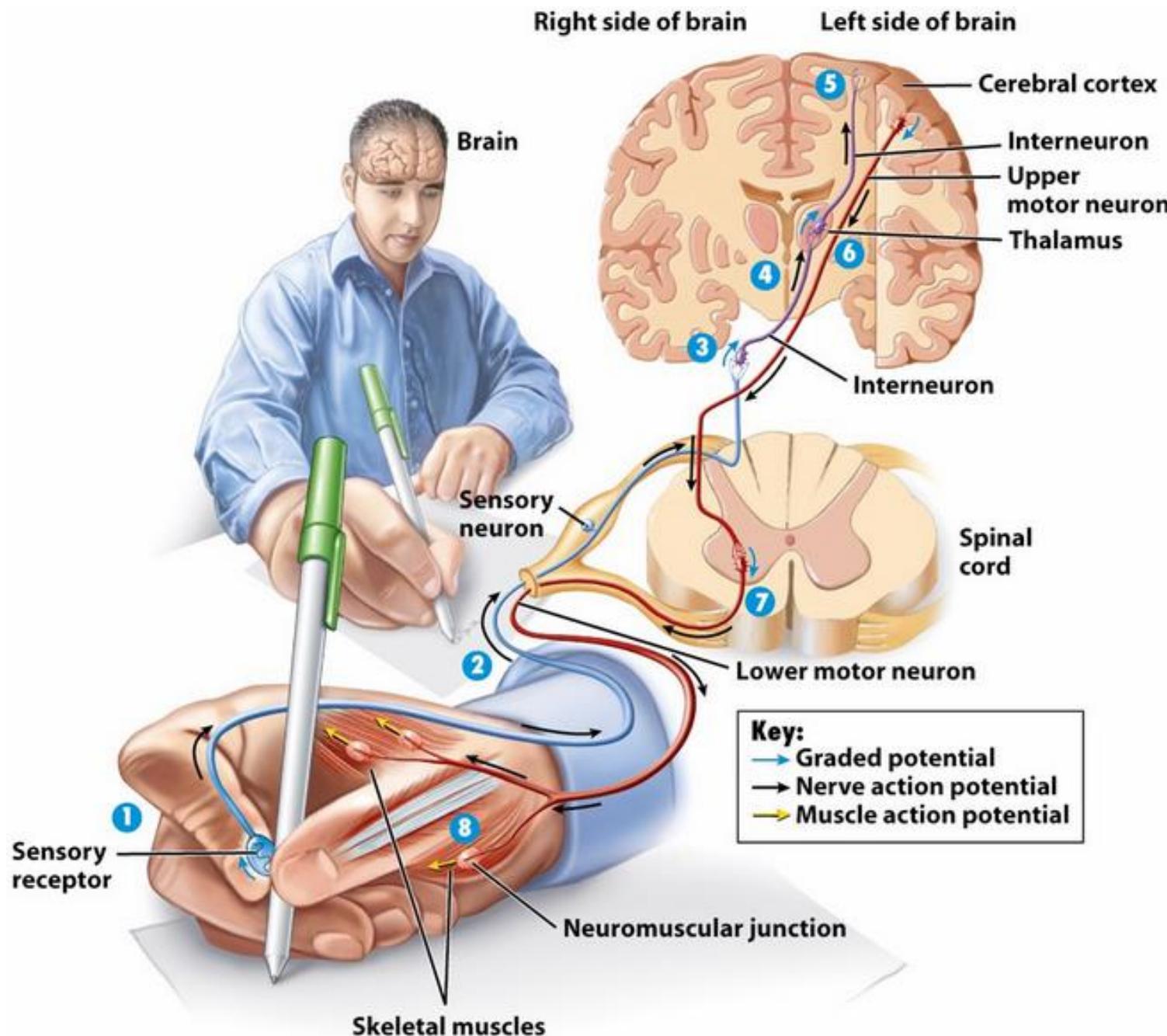
Upper motor neuron

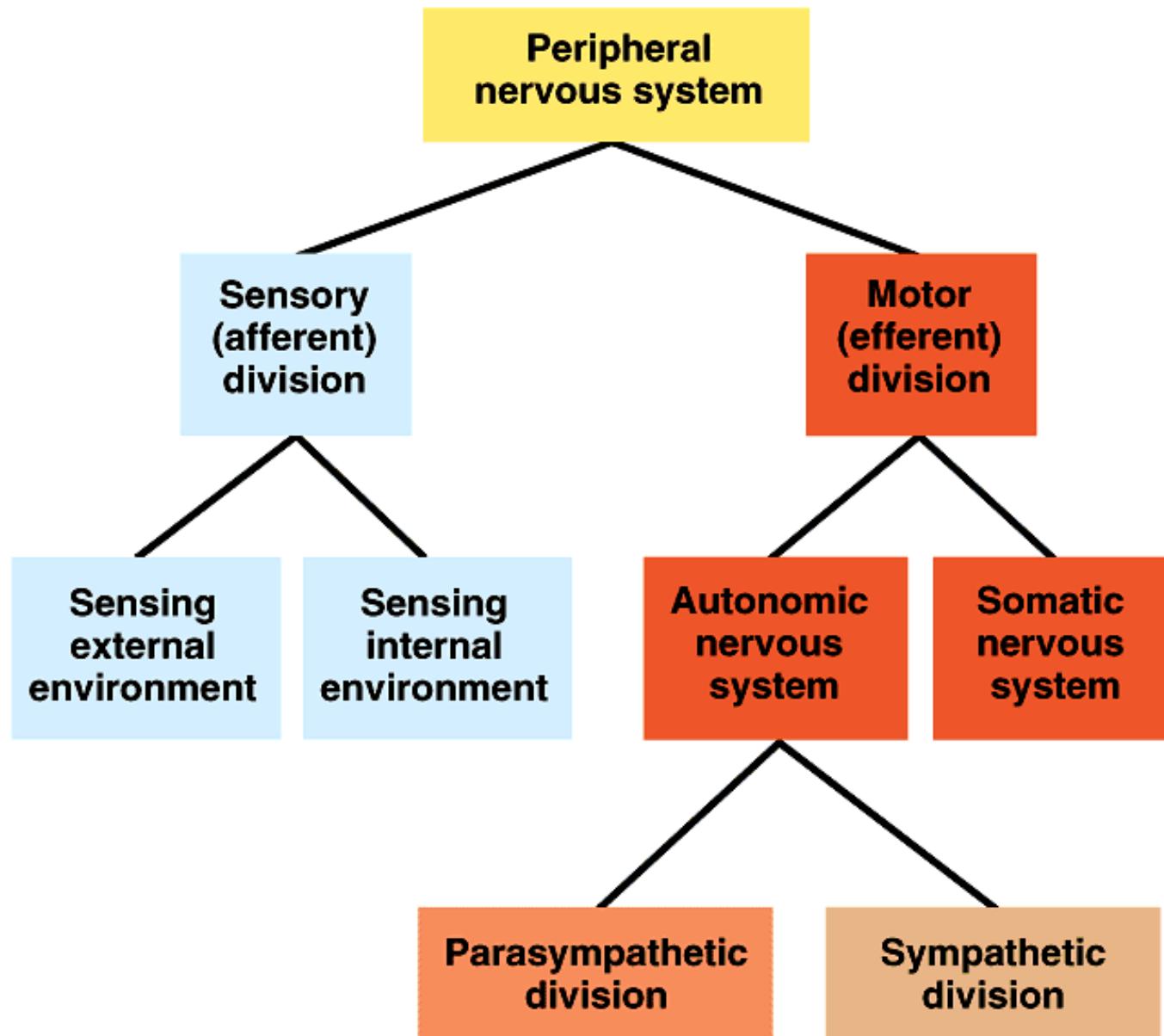
- Cell body in the motor area of the cerebrum
- Axons pass through the internal capsule, pons and medulla, forming the corticospinal tracts

Lower motor neuron

- Cell body in the *anterior horn of grey matter* in the spinal cord
- Axon emerges from the spinal cord







Autonomic Nervous System

- Involuntary part
- Effects are rapid and essential for homeostasis
- Effector organs are:
 - Smooth muscle (bronchus, blood vessels, ciliary muscle, circular and radial muscle of iris)
 - Cardiac muscle
 - Glands

Autonomic Nervous System

- 2 divisions:
 - Sympathetic Nervous System (Thoracolumbar outflow)
 - Parasympathetic Nervous System (Craniosacral outflow)
- Normally work in an opposing manner

Parasympathetic

Eye

Salivary glands

Heart

Lungs

Stomach

Pancreas

Liver and gall-bladder

Bladder

Genitals

Sympathetic

Eye

Skin*

Salivary glands

Lungs

Heart

Stomach

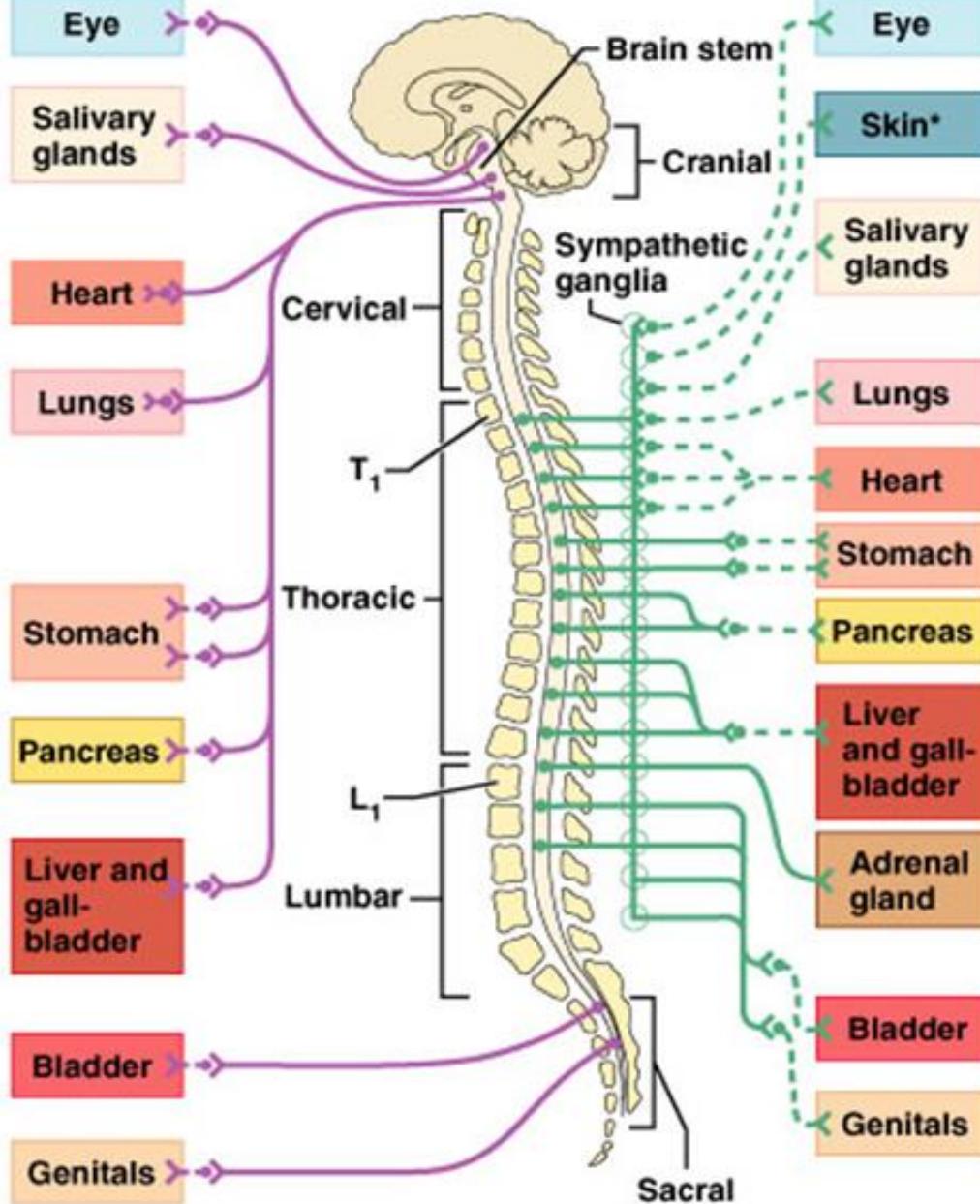
Pancreas

Liver and gall-bladder

Adrenal gland

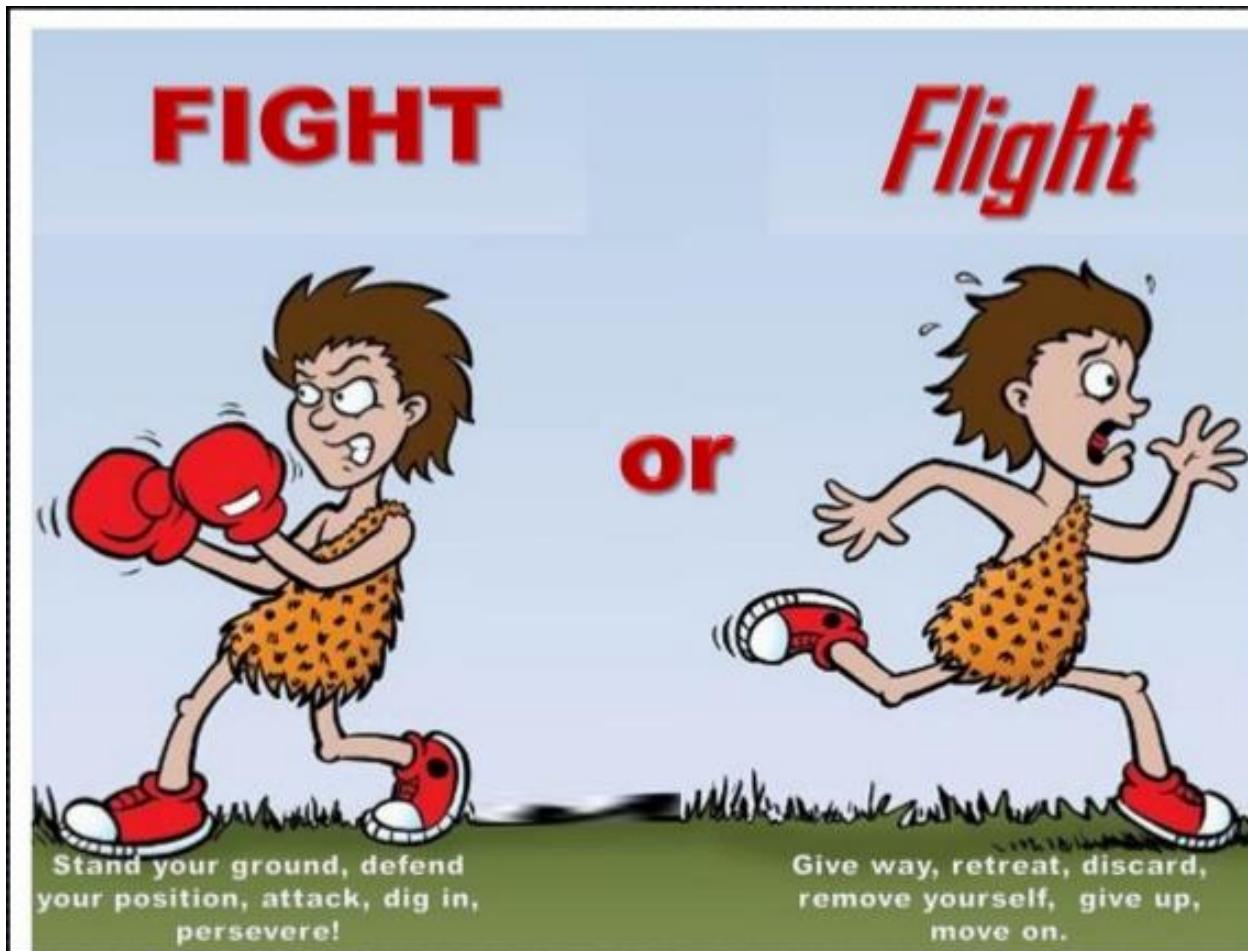
Bladder

Genitals



Autonomic Nervous System

- Sympathetic activity - stress
- Parasympathetic activity - during rest

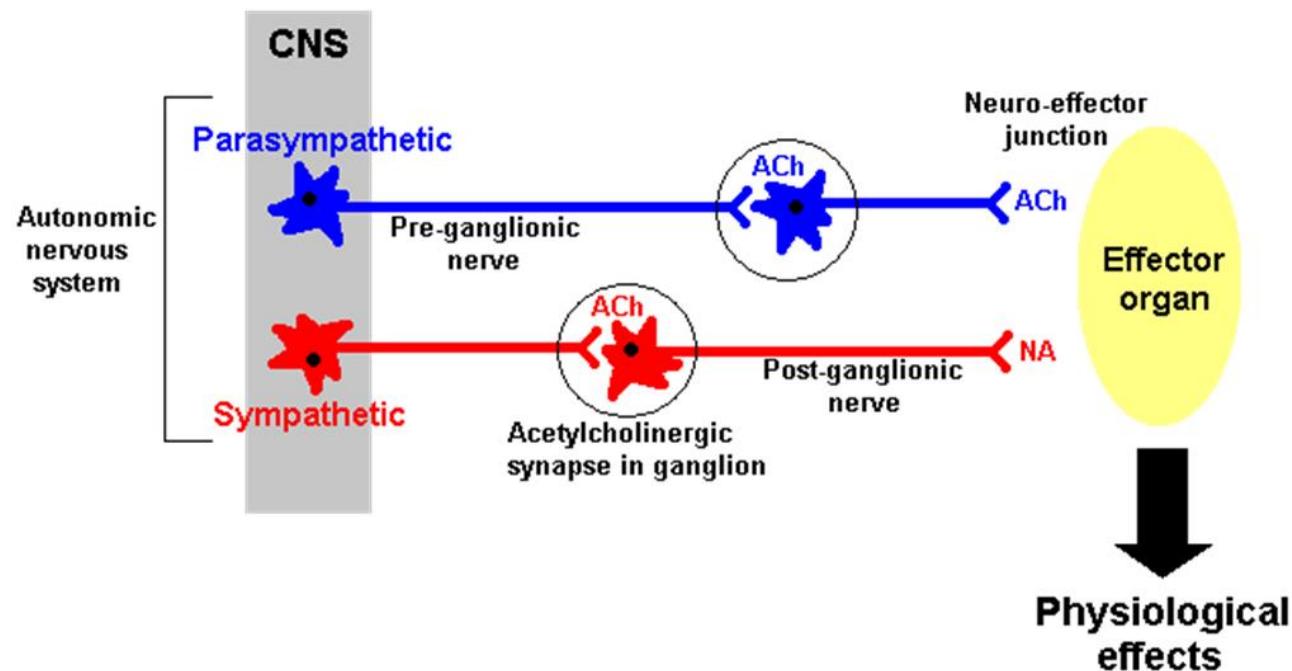


Autonomic Nervous System

- Have 2 neurons in their peripheral pathways which are:
 - Preganglionic neuron
 - Postganglionic neuron

Autonomic Nervous System

- Cell body of preganglionic neuron is in CNS
- Synapses with cell body of postganglionic neuron in an autonomic ganglion outside CNS
- Postganglionic neuron conducts impulses to effector organ



ANS vs Somatic NS

Somatic NS

Receptors

5 senses

Integration

Cortex

Effectors

Skeletal muscles

Autonomic NS

Receptors

Chemo-

Baro-

Receptors

Integration

Hypothalamus

Medulla oblongata

Effectors

Cardiac,

smooth

muscles,

Glands

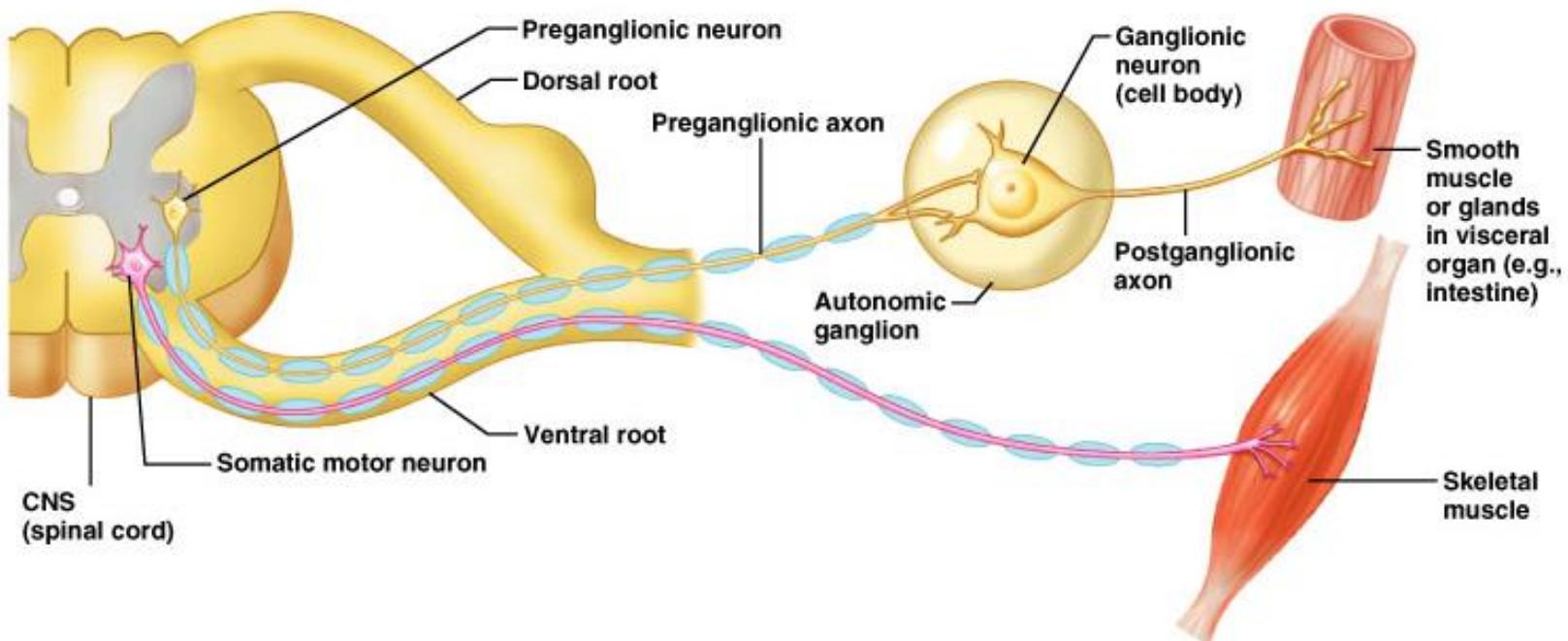
ANS vs Somatic NS

Cell bodies in central nervous system	Peripheral nervous system	Neurotransmitter at effector	Effector organs	Effect
SOMATIC NERVOUS SYSTEM	Single neuron from CNS to effector organs Heavily myelinated axon	ACh	Skeletal muscle	+ Stimulatory
AUTONOMIC NERVOUS SYSTEM	Two-neuron chain from CNS to effector organs Lightly myelinated preganglionic axons	NE	Stomach, Small intestine, Large intestine	+ - Stimulatory or inhibitory, depending on neurotransmitter and receptors on effector organs
	Ganglion Epinephrine and norepinephrine Adrenal medulla Blood vessel	ACh	Heart, Lungs, Smooth muscle (e.g., in gut), Glands, Cardiac muscle	
	Lightly myelinated preganglionic axon	ACh		

▲ Acetylcholine (ACh)

● Norepinephrine (NE)

ANS vs Somatic NS



Autonomic Nervous System

Sympathetic nervous system

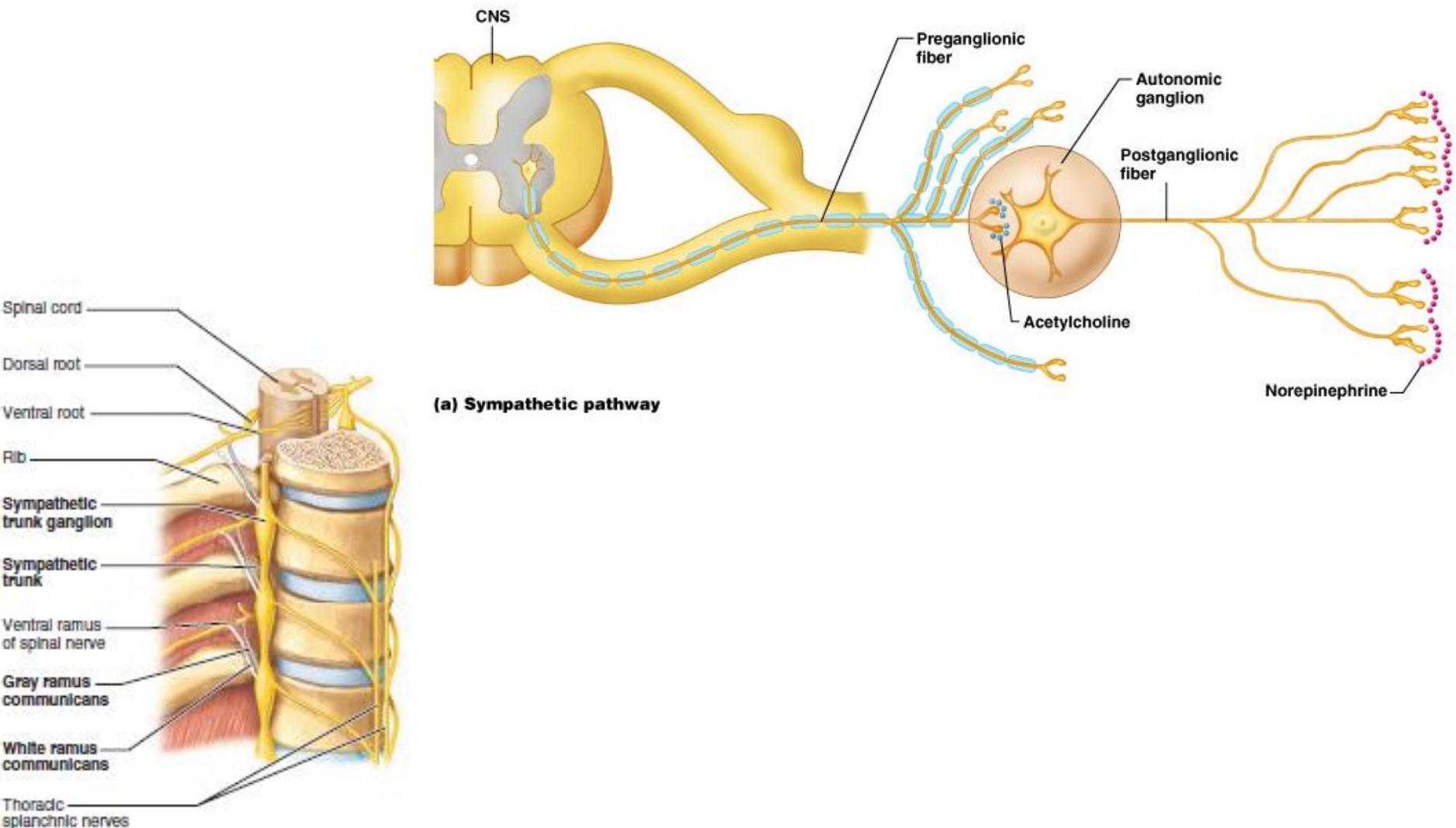
- **Preganglionic neuron**

- Cell body - *lateral column of grey matter*
- Nerve fibre terminates in the sympathetic ganglia
- Ach is the neurotransmitter

- **Postganglionic neuron**

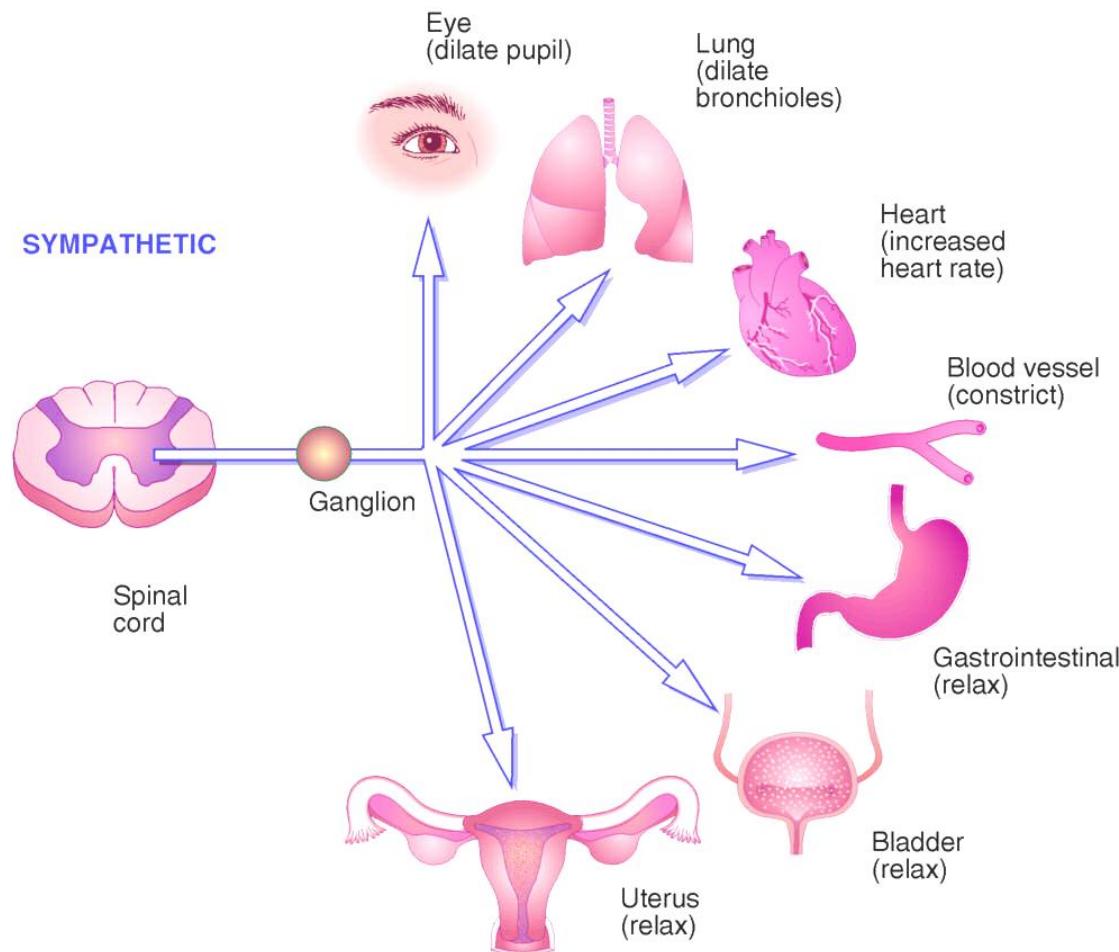
- Cell body - ganglion
- Nerve fibre terminates in the organ or tissue supplied
- Noradrenaline is usually the neurotransmitter

Autonomic Nervous System



Spinal cord	Lateral chain of ganglia	Structures	Effects of stimulation
	Superior cervical ganglion	Iris muscle	Pupil dilated
		Blood vessels in head	Slightly relaxed
		Salivary glands	Vasoconstriction
		Oral and nasal mucosa	Secretion inhibited
		Skeletal blood vessels	Mucus secretion inhibited
T1		Heart	Vasodilatation
	1	Coronary arteries	Rate and force of contraction increased
	2	Trachea and bronchi	Vasodilatation
	3	Stomach	Bronchodilation
	4	Intestines	Peristalsis reduced
	5	Liver	Sphincters closed
	6	Spleen	Peristalsis and tone decreased
	7	Adrenal medulla	Vasoconstriction
	8	Large and small intestine	Glycogen → glucose conversion increased
L1	9	Kidney	Contracted
L2	10	Bladder	Adrenaline and noradrenaline secreted into blood
L3	11		Peristalsis reduced
	12		Sphincters closed
	1		Urine secretion decreased
	2		
	3		
	Superior mesenteric ganglion	Sex organs and genitalia	Smooth muscle wall relaxed
	Inferior mesenteric ganglion		Sphincter closed
			Generally vasoconstriction

Autonomic Nervous System



Autonomic Nervous System

Parasympathetic nervous system

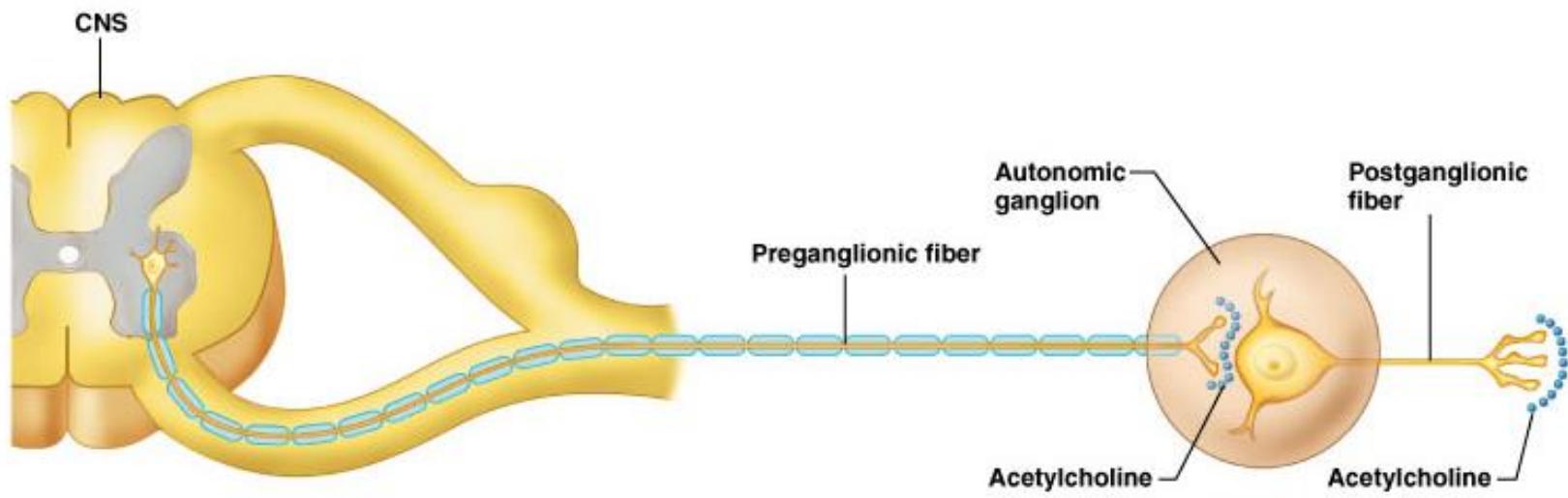
- **Preganglionic neuron**

- Cell body - brain (CN III, VII, IX and X) or spinal cord (lateral columns of S2,S3,S4)
- Nerve fibres synapse with postganglionic neurones in the walls of pelvic organs
- Ach

- **Postganglionic neuron**

- Cell body - ganglion or in the wall of the organ supplied
- Ach

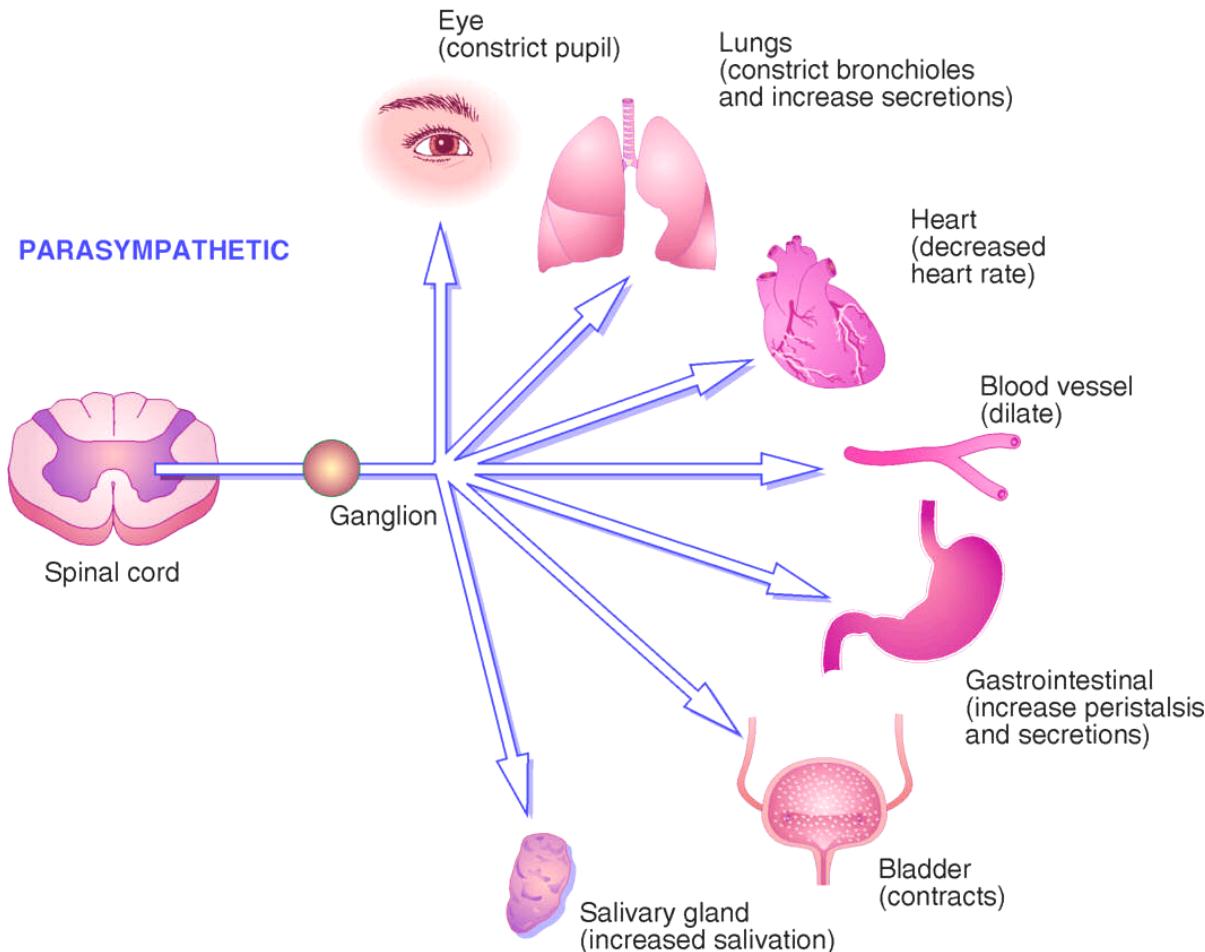
Autonomic Nervous System



(b) Parasympathetic pathway

Spinal cord	Cranial nerve numbers	Ganglia	Structures	Effects of stimulation
	III	Ciliary	Iris muscle	Pupil constricted Contracted
	VII	Pterygopalatine	Lacrimal gland	Tear secretion increased
	IX		Salivary glands: submandibular sublingual	Saliva secretion increased
	X	Submandibular	parotid gland	Saliva secretion increased
		Otic	Heart	Rate and force of contraction decreased
			Coronary arteries	Vasoconstriction
			Trachea and bronchi	Bronchoconstriction
			Stomach	Secretion of gastric juice and peristalsis increased
			Small intestine	Digestion and absorption increased
			Liver and gall bladder	Blood vessels dilated Secretion of bile increased
			Pancreas	Secretion of pancreatic juice increased
			Kidney	Urine secretion increased
			Small intestine	Secretion of intestinal juice and peristalsis increased
			Large intestine	Secretions and peristalsis increased Sphincter relaxed
			Bladder	Muscle of wall contracted Sphincters relaxed
			Sex organs and genitalia	Male: erection Female: variable; depending on stage in cycle

Autonomic Nervous System



Autonomic Nervous System

SNS

- Thoracolumbar outflow
- Doesn't involve cranial nerves
- Preganglionic neuron is shorter
- Main NT: Adrenaline/Nor adrenaline
- Active in “fright, fight and flight”
- Promote survival in crisis state

PNS

- Craniosacral outflow
- Main NT: Acetylcholine
- Active in “rest and digest”
- Promote survival in stable state

Autonomic Nervous System

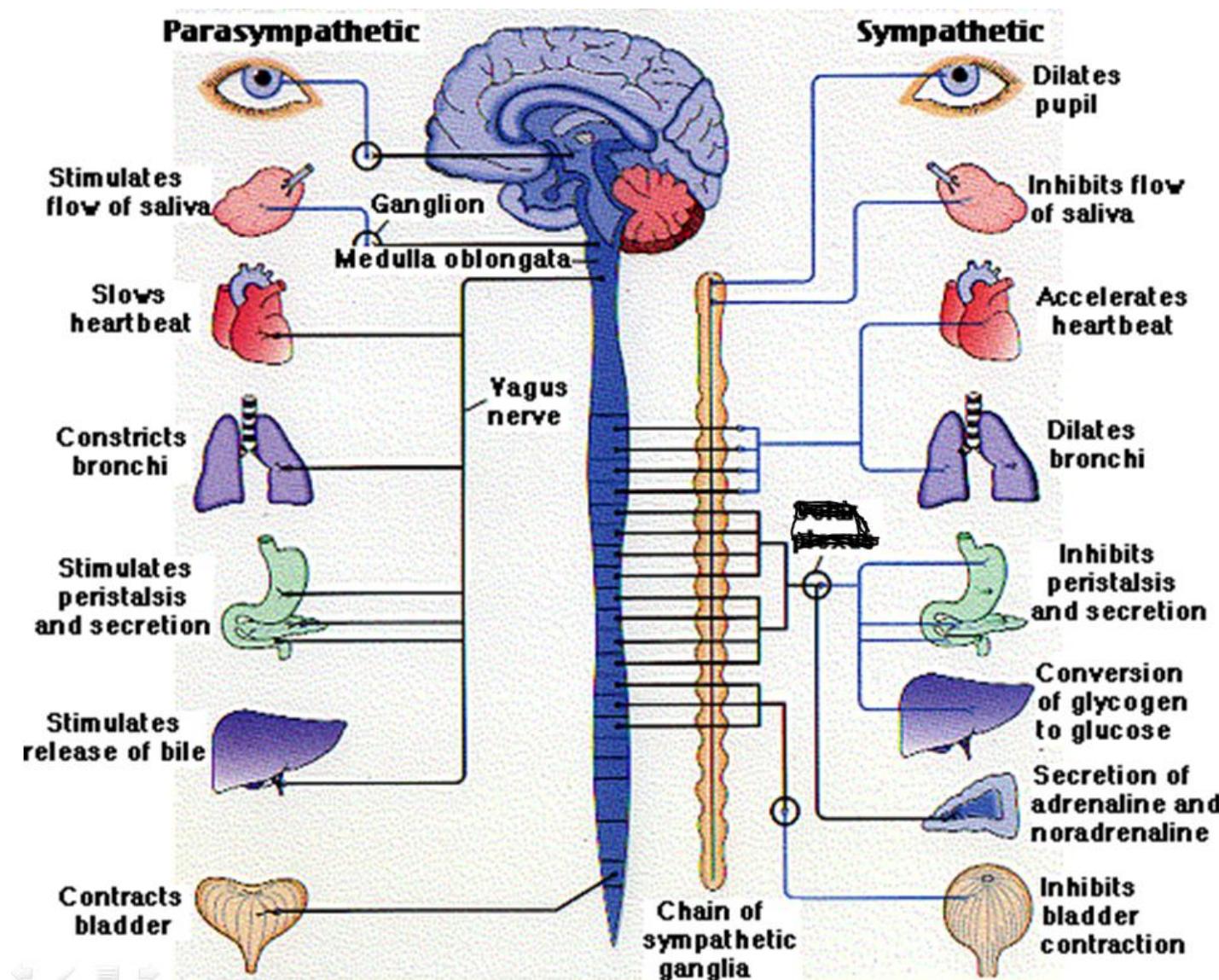
SNS



PNS



Autonomic Nervous System



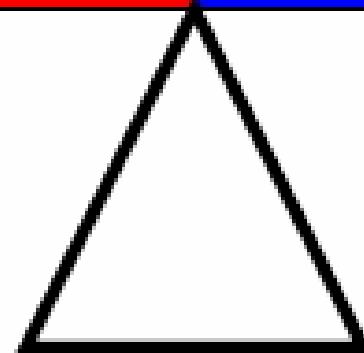
ANS-Functions

- Involved in a complex of reflex activities
- Sympathetic stimulation - exciting and stressful situations
- Parasympathetic stimulation - slows down body processes *except:*
 - Digestion and absorption of food
 - Functions of the genitourinary systems

ANS-Functions

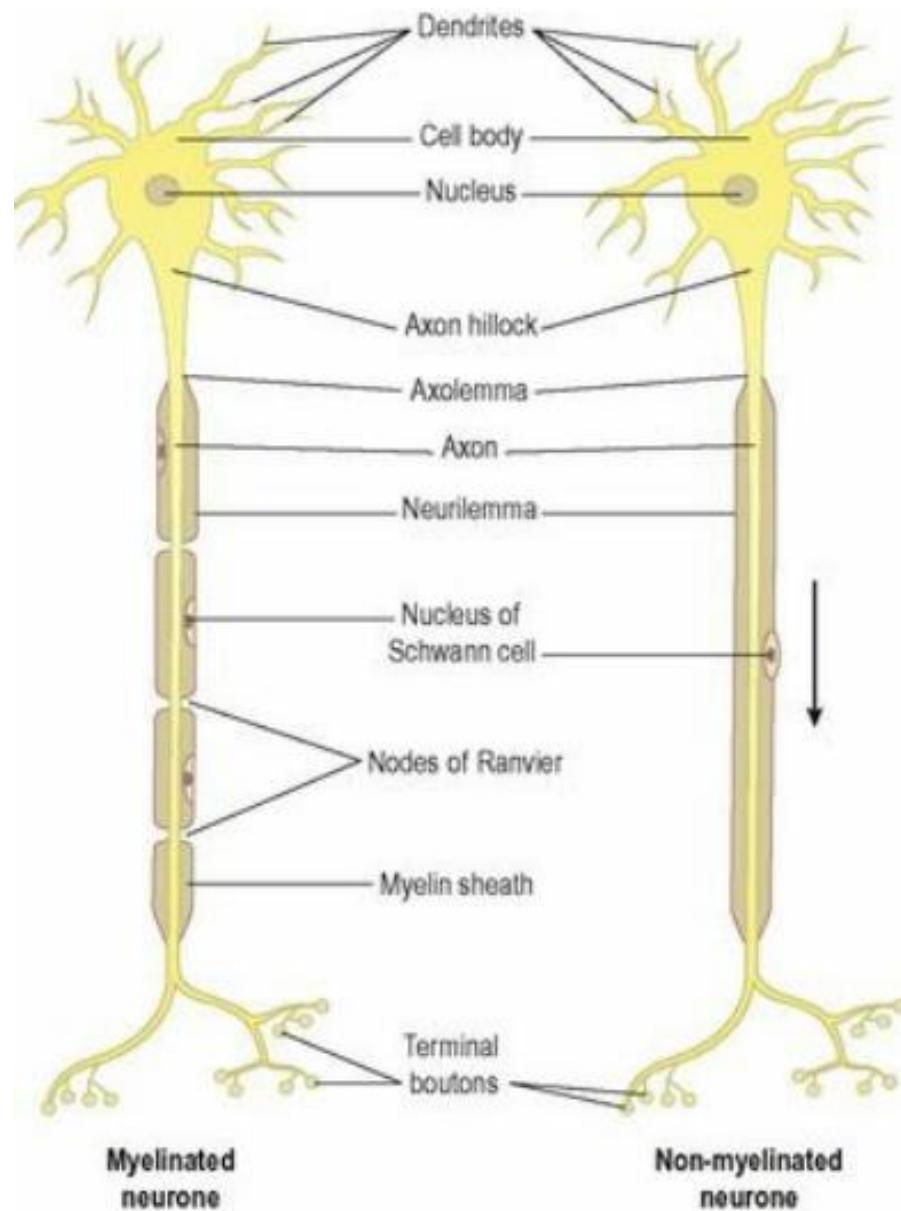
Sympathetic

Parasympathetic



- Effects of sympathetic and parasympathetic nerves are finely balanced ensuring optimum functioning of organs

Structure of Nerve Cell



Structure of Nerve Cell

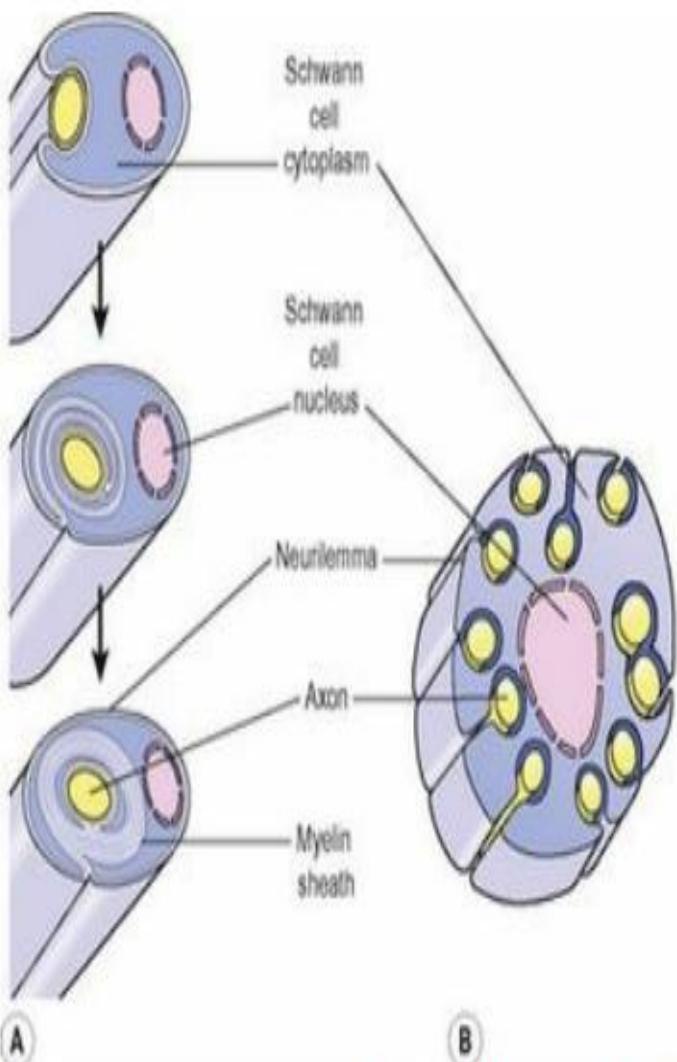
Cell Bodies

- Form grey matter
- Periphery of brain and center of spinal cord
- Group → nuclei in CNS
ganglia in PNS

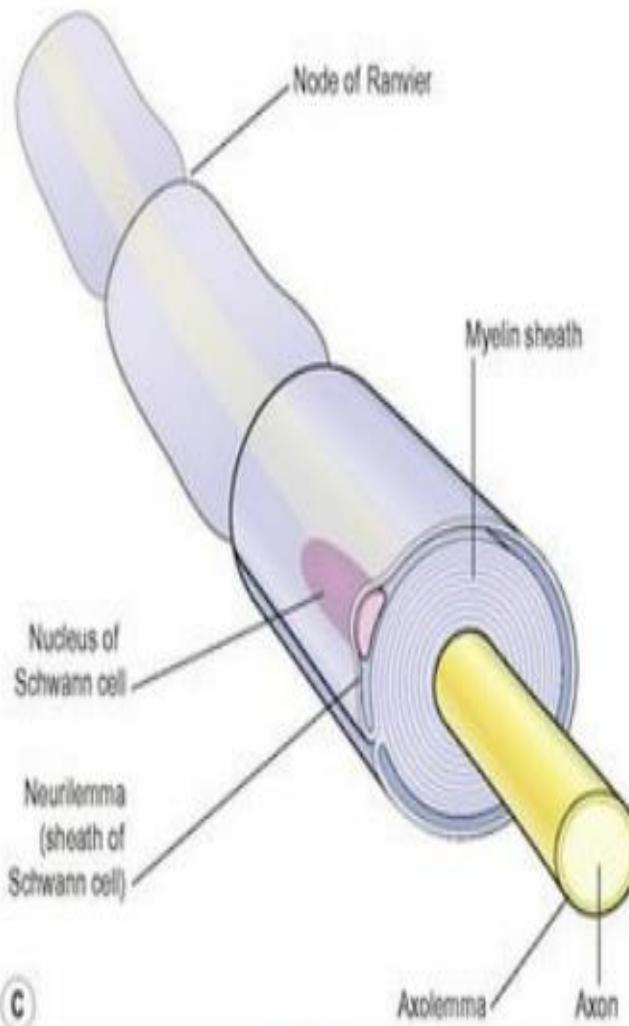
** Exception : Basal Ganglia

Structure of Nerve Cell

- Axon
- Found deep in brain and periphery in spinal cord
- Each nerve has one axon
- Axon hillock
- Can be as long as 100 cm
- Axolemma
- Neurilemma
- Node of Ranvier



(A)



(B)

(C)

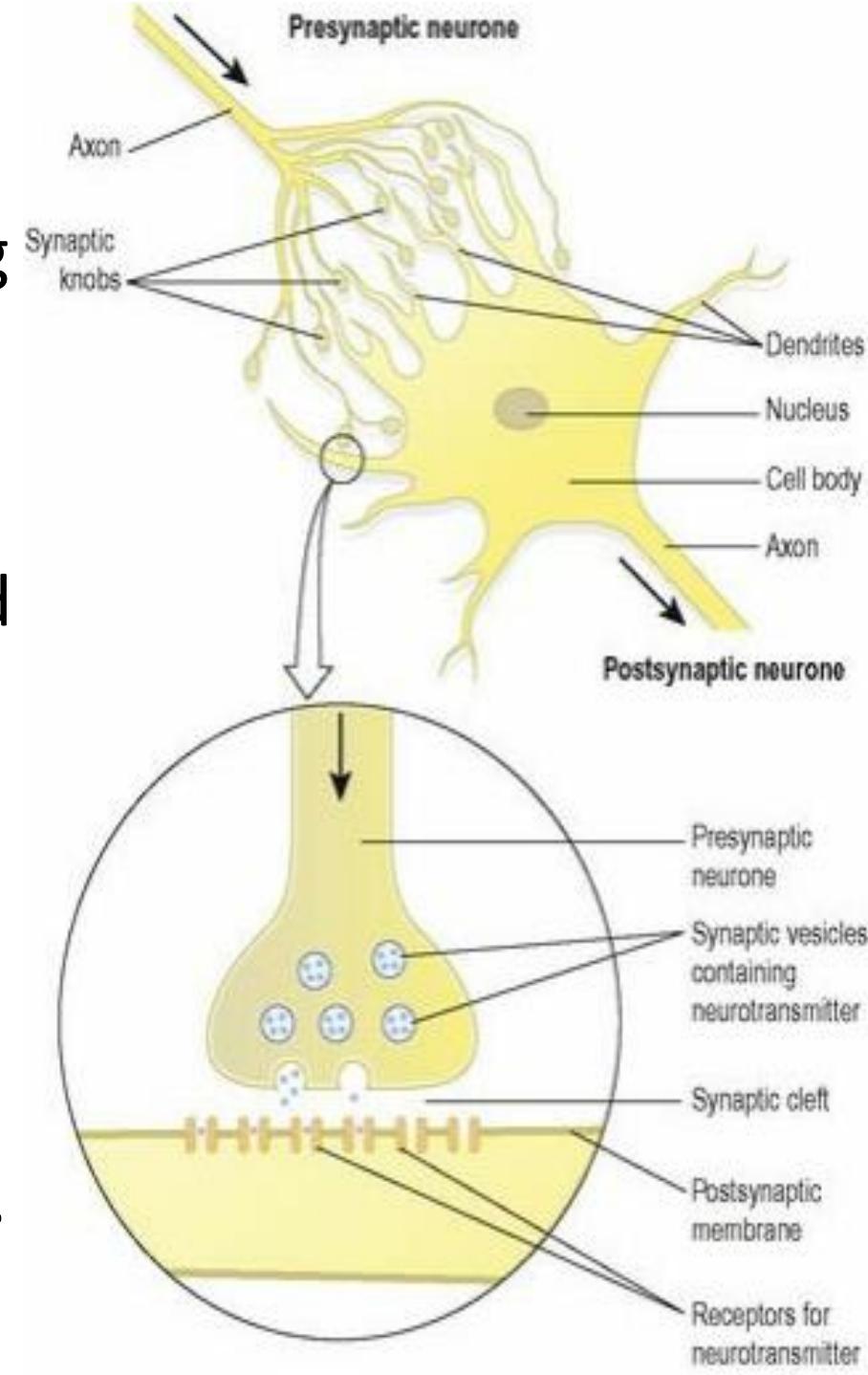
Figure 7.3 Arrangement of myelin. **A.** Myelinated neurone. **B.** Non-myelinated neurone. **C.** Length of myelinated axon.

Non Myelinated Neurone

- Postganglionic fibres and some small fibres in the central nervous system
- Axons are embedded in Schwann cell plasma membranes
- Adjacent Schwann cells are in close association and there is no exposed axolemma.
- Speed of transmission of nerve impulses is significantly slower in non-myelinated fibres.

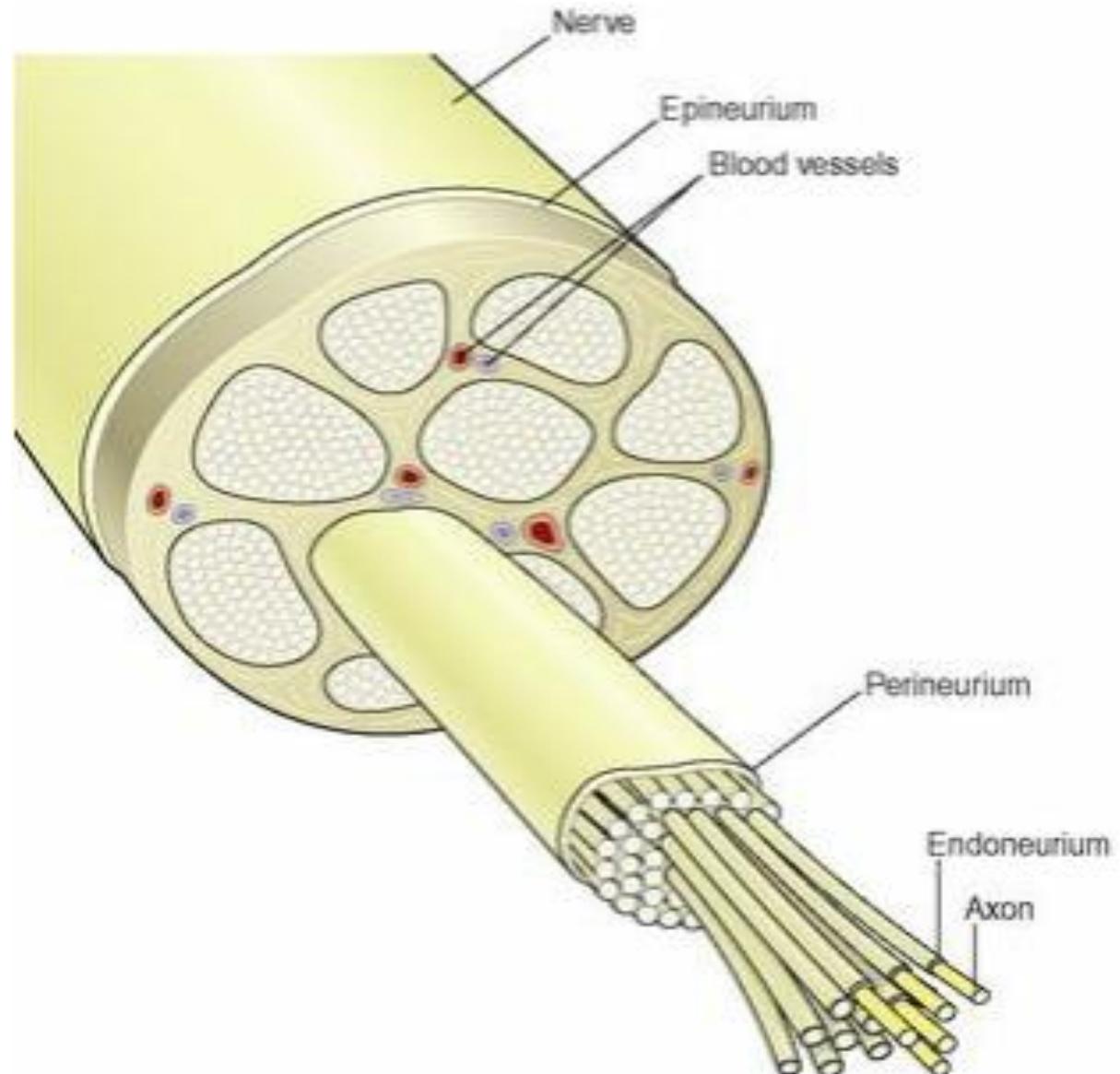
Dendrites

- Short processes that receive and carry incoming impulses towards cell bodies.
- Same structure as axons but are usually shorter and branching.
- In motor neurones dendrites form part of synapses and in sensory neurones they form the sensory receptors that respond to specific stimuli.



Nerve

- Numerous neurones collected into bundles
- Endoneurium
- Perineurium
- Epineurium



Sensory Nerve –

- carry information from body to the spinal cord.
- Impulses may pass to brain or to the connector neurons

Motor Nerve-

- Originate in brain, spinal cord and autonomic ganglia
- Transmit impulse to effector organ

Mixed Nerve:

- Sensory and motor nerve enclosed within same sheath of connective tissue

Thank You