



NPTEL ONLINE CERTIFICATION COURSES

Basics of Mental Health & Clinical Psychiatry

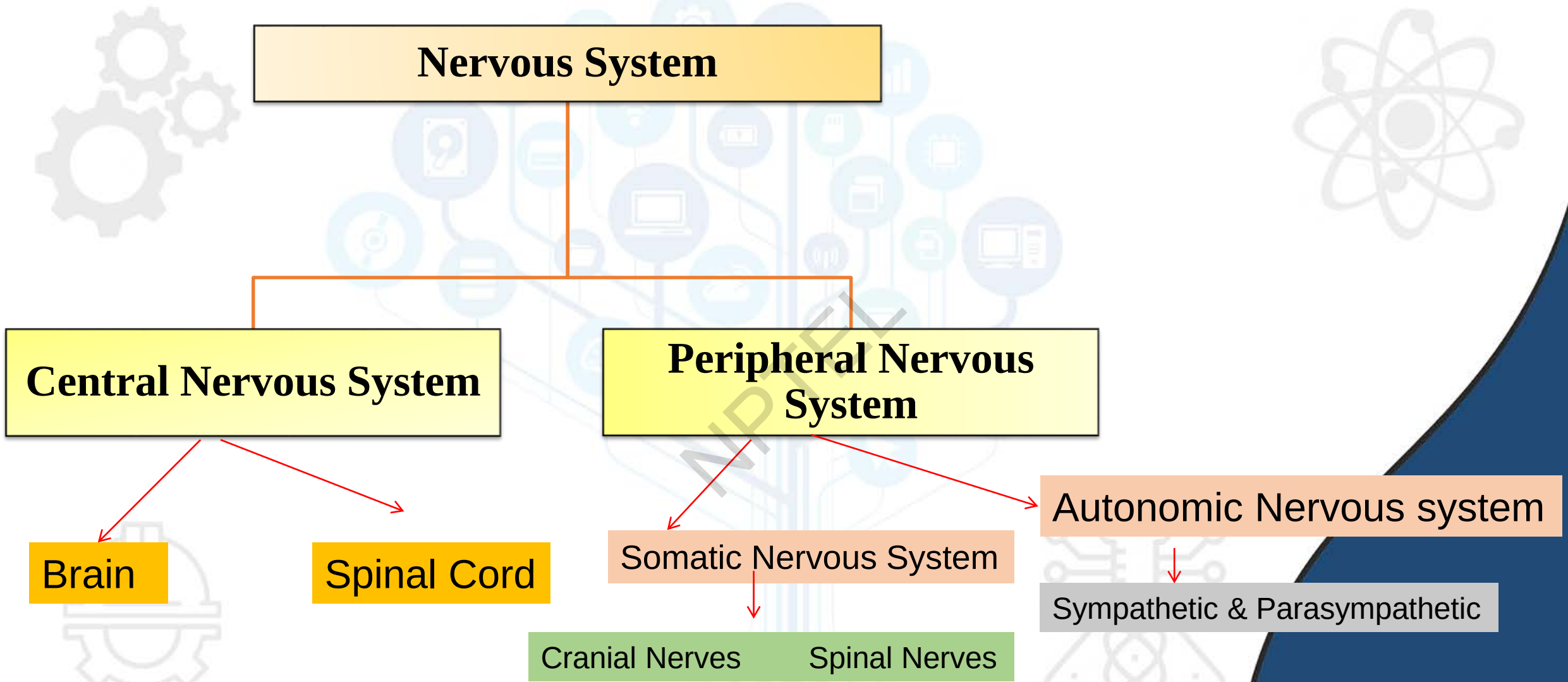
Dr. Arijita Banerjee

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IIT KHARAGPUR**

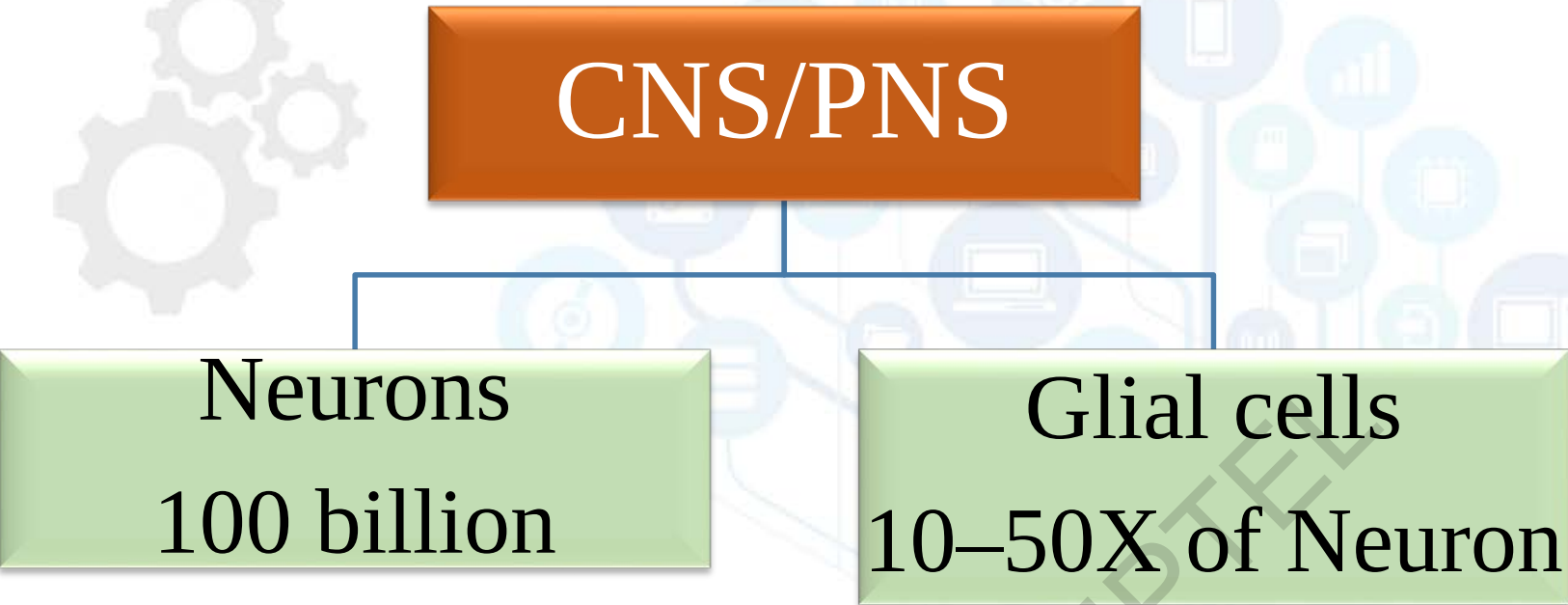
Lecture 1 : Introduction to Neuroanatomy

CONCEPTS COVERED

- Divisions of Nervous system
- Neuron-structure
- Types of neuron
- Axonal Transport
- Supporting cells
- Parts of Brain and regional specifications of functions
- Blood supply of Brain



CNS/PNS



Neurons

100 billion

Glial cells

10–50X of Neuron

Types of glial cells

- ❖ **Microglia-** scavenger cell
- ❖ **Macroglia:-**
 - Astrocytes
 - Schwann cells
 - Oligodendrocyte

Glial cells have role in communication within the CNS along with neurons.

Unlike neurons, glial cells continue to undergo cell division, particularly noticeable after brain injury

Astrocytes

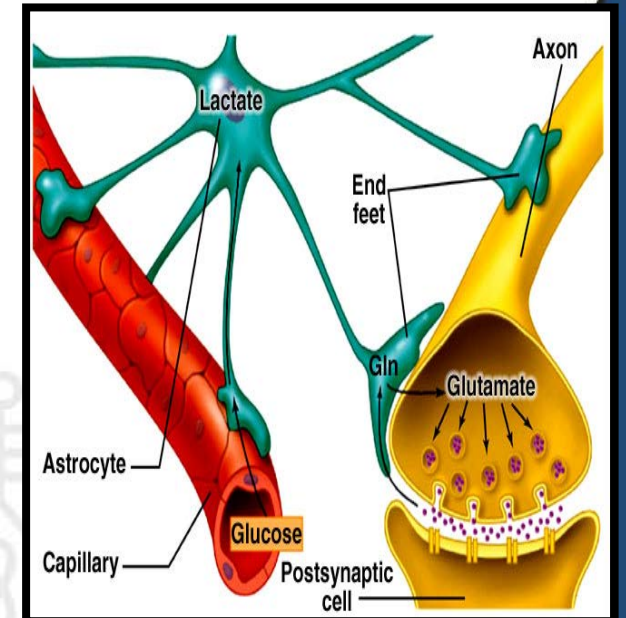
- Largest glial cell in CNS
- Starlike shape.

Fibrous Astrocytes

- Found primarily in white matter.

Protoplasmic Astrocytes

- Found in gray matter and have a granular cytoplasm.
- Blood–Brain barrier
- It send processes to blood vessels, where they induce capillaries to form the tight junctions
- Maintain the appropriate concentration of ions and neurotransmitters in brain
- Take up K^+ and glutamate and GABA



Oligodendrocytes and Schwann cells

- **Oligodendrocytes:** Myelin formation around axons in the CNS.
- Oligodendrocytes are small with relatively few processes.
- **Schwann cells:** Myelin formation around axons in PNS.

Neuron

Structural & Functional Unit Of Nervous System.

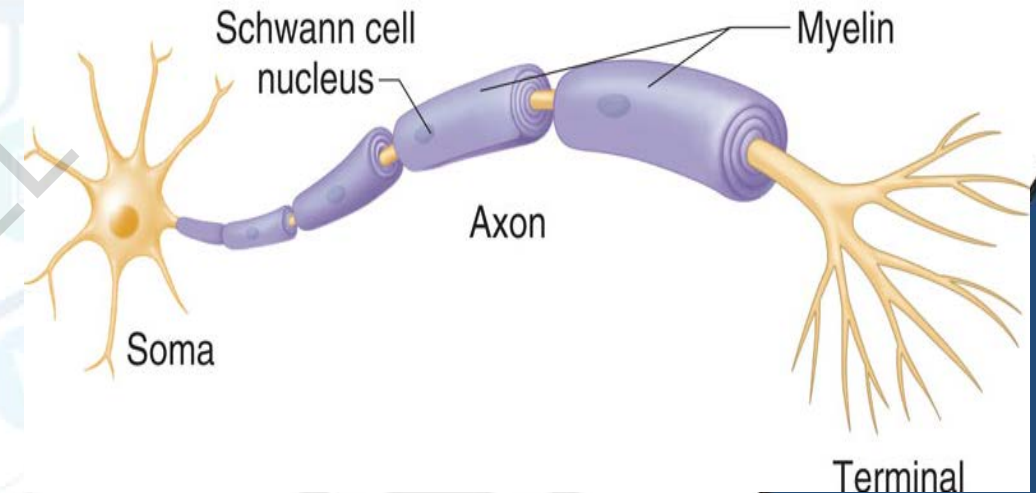
Excitable cell: Respond to stimuli by generating electrical signal.

Structure:

- Nerve Cell Body/Soma.
- Dendrites.
- Axons.
- Synaptic Knobs /Terminal Button.

Nerve cell body/Soma

- Major metabolic centre of the neuron as it contain nucleus.
- Principle constituents are similar to a general cell.



Nissl's granules:

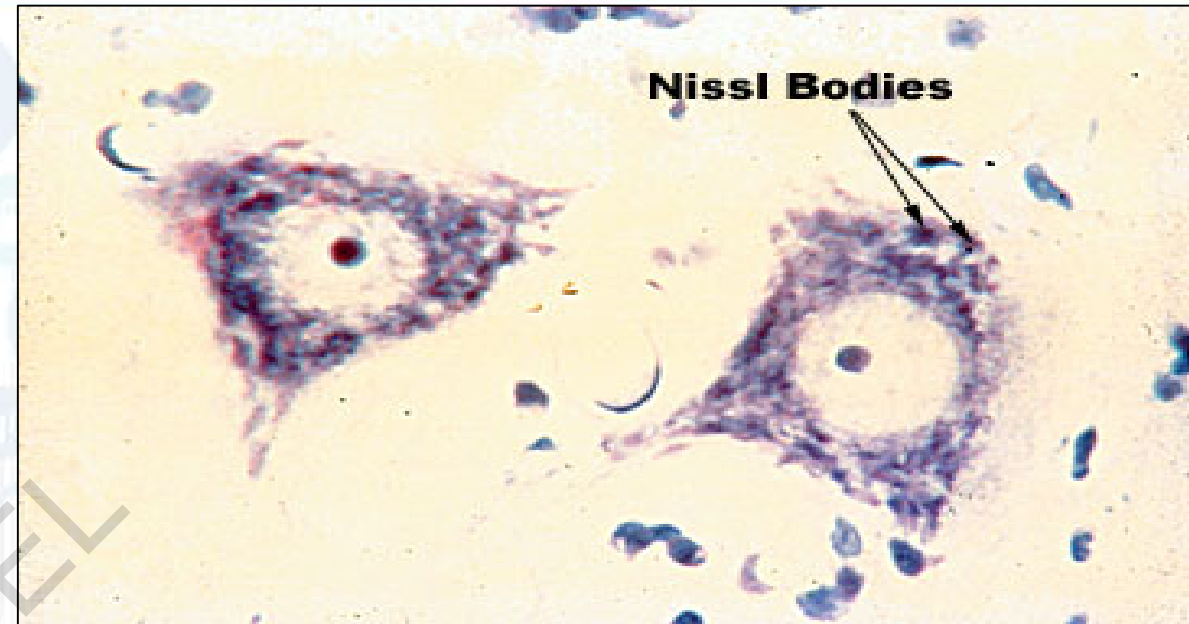
- Membrane bounded cavity covered by ribose nucleoprotein.
- Stain deeply with basic dyes, such as methylene blue.
- Involved in the synthesis of neurotransmitters such as Ach

Chromatolysis:

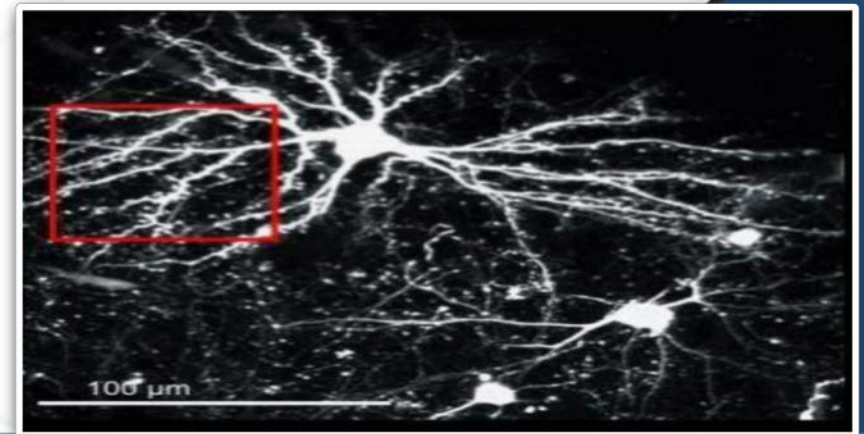
- Its disintegration into fine dust.
- Happens in condition of fatigue ,poisoning or sectioning of axon.

Dendrites:

- Extensions that carry impulses toward the cell body.
- Effectively increase the surface area of a neuron to increase its ability to communicate with other neurons.



Sections of motor neuron spinal cord showing Nissl bodies on methylene blue



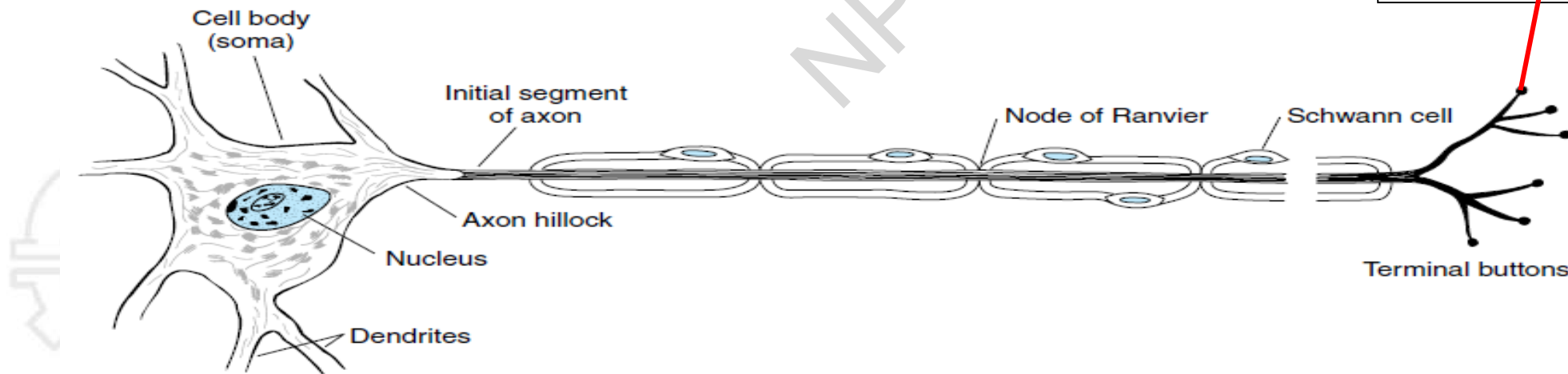
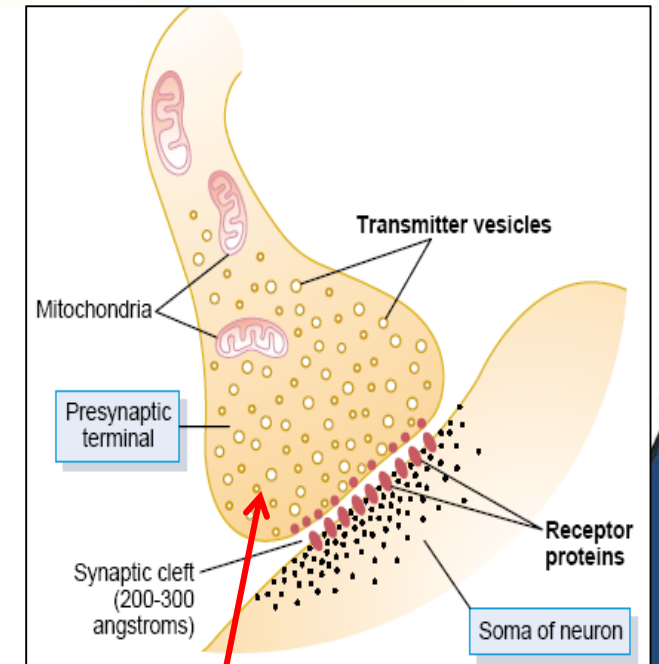
Axon: Single elongated protoplasmic extension from nerve cell body

Axon Hillock: Thickened portion of cell body from where the axon arises.

Initial Segment: First portion of the axon.

Axoplasm: Cytoplasm within the axon of a neuron.

Axolemma: Cell membrane surrounding an axon.
Responsible for maintaining the membrane potential by ion channels it contains ion.



Axoplasmic Flow

Site of Protein synthesis & release located at opposite ends



Axoplasmic Flow

Orthograde transport

Cell body → Axon terminals

Occurs along microtubules with two molecular motors: (Dynein and kinesin)

Fast axonal transport: Occur at 400 mm/day.

Slow axonal transport: Occurs at 0.5 to 10 mm/day.

Retrograde transport

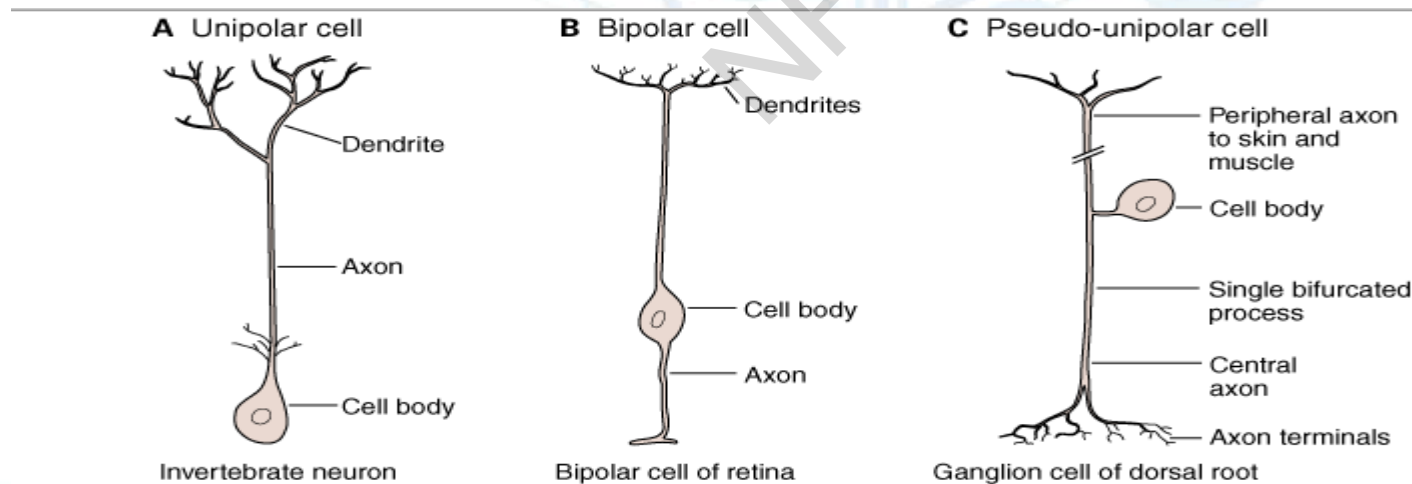
Axon terminals → Cell body

Occurs along microtubules at about 200 mm/day

Types of Neurons

Based On Polarity

- **Unipolar** : Type of neuron in which only one protoplasmic process extends from the cell body. **Eg:** Found mostly in invertebrate
- **Pseudounipolar**: Contains an axon that has split into two branches. **Eg:** Neurons in dorsal root of spinal cord.
- **Bipolar**: An axon and a single dendrite on opposite ends of the soma. **Eg:** Neurons in retina



Multipolar:

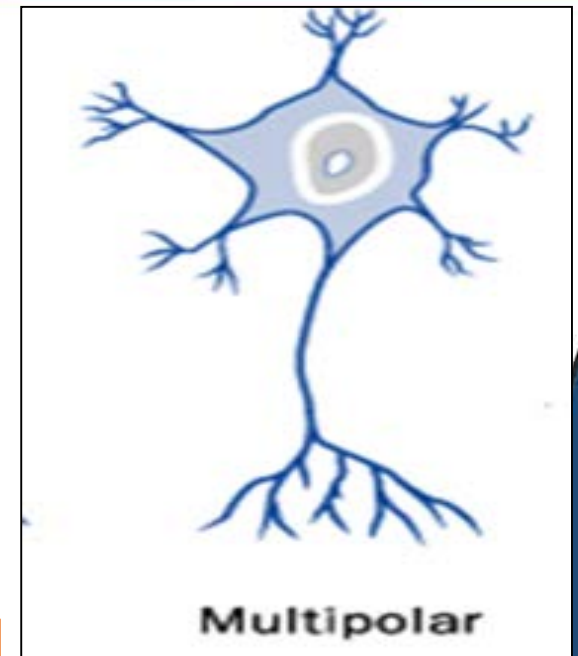
- An Axon along with many dendrites.
- Constitute the majority of neurons in the brain.

Eg:

- Motor neurons of spinal cord.
- Hippocampal cell.
- Pyramidal cells
- Cerebellar purkinje cells

Functional Classification

- **Sensory/Afferent neurons:** From sensory receptor to CNS.
- **Motor/ Efferent neurons:** From CNS to effector organ.



Myelination

- **Myelinated Nerve:** A sheath of myelin (protein–lipid complex) that is wrapped around the axon.

In CNS: Oligodendrocytes.

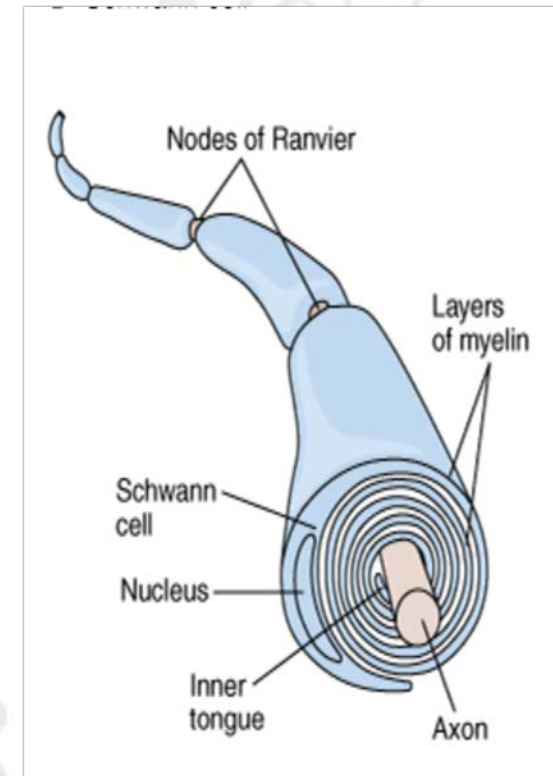
- White matter: Myelinated axons, Gray matter: Cell bodies & dendrites.

In PNS: Schwann Cell

- Schwann cell wraps its membrane made of protein lipid complex around an axon up to 100 times.
- Myelin have high insulating property.
- Prevent the leakage of K^+ ion.
- Increase the speed of conduction of nervous impulses (50 to 100 times).

Nodes of Ranvier:

- Periodic 1- μ m constricted non myelinated area $\sim$ 1 to 2 mm apart.



Pathophysiology of Multiple Sclerosis-

- In MS, antibodies and white blood cells attack myelin, causing injury to the sheath and nerves .
- Loss of myelin leads to leakage of K^+ , leading to hyperpolarization, and failure to conduct action potentials.

Nerve:

Neurons collectively form a nerve.

Endoneurim:

Axon is covered by fine connective tissue.

Perineurium:

Many neurons collectively forms fascicles.
Each fascicle is encased by perineurium.

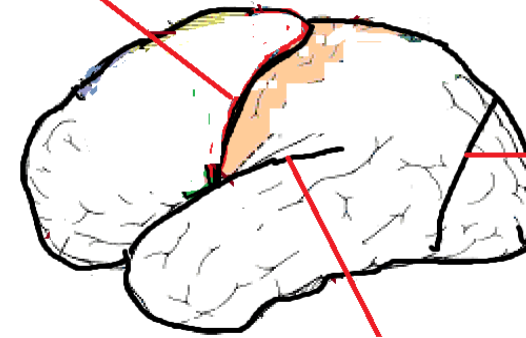
Epineurium:

Many fascicle are wrapped together by epineurium.

Parts of Brain

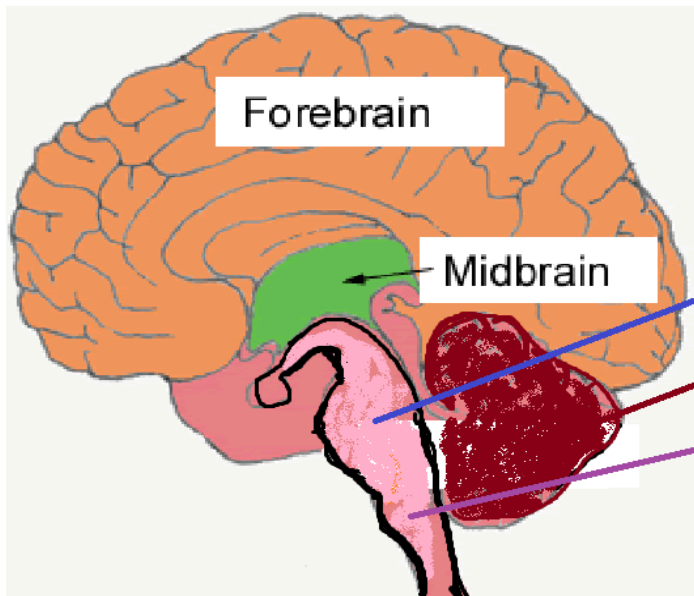
1. Forebrain or Prosencephalon
2. Midbrain or Mesencephalon
3. Hindbrain or Rhombencephalon

Central sulcus of Rolando



Occipito-parietal sulcus

Lateral sulcus of Sylvius



Forebrain

Midbrain

Pons

Cerebellum

Medulla

Hindbrain

(Brainstem : MB + Pons + Medulla)

Brain

Forebrain

Midbrain

Hindbrain

Telencephalon

Diencephalon

Upper Reticular formation, eye movements

Cerebellum
Pons
Medulla

Cortex
Basal Ganglia
Limbic system

Thalamus
Hypothalamus

Relay centre, memory
Attention, speech, emotion

Coordination,
tone, equilibrium

Respiration, taste,
arousal

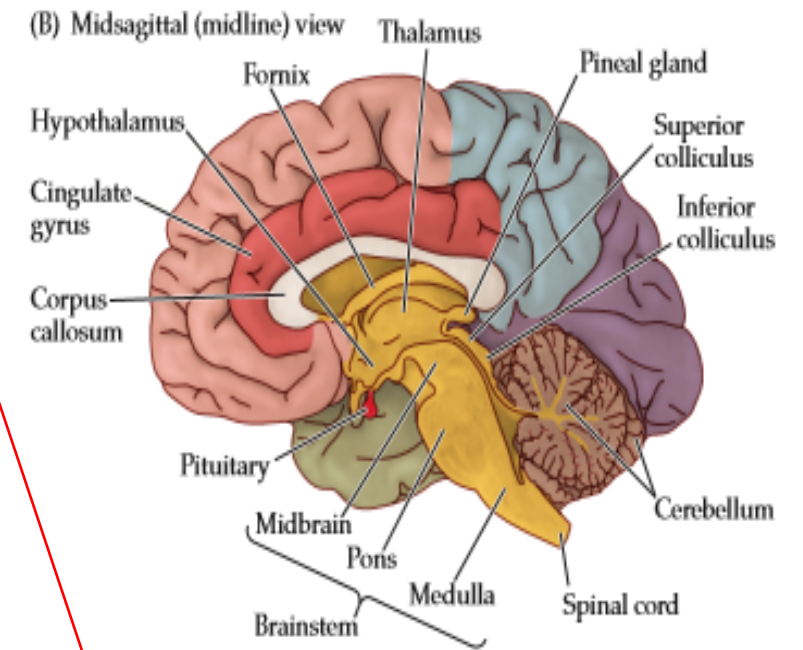
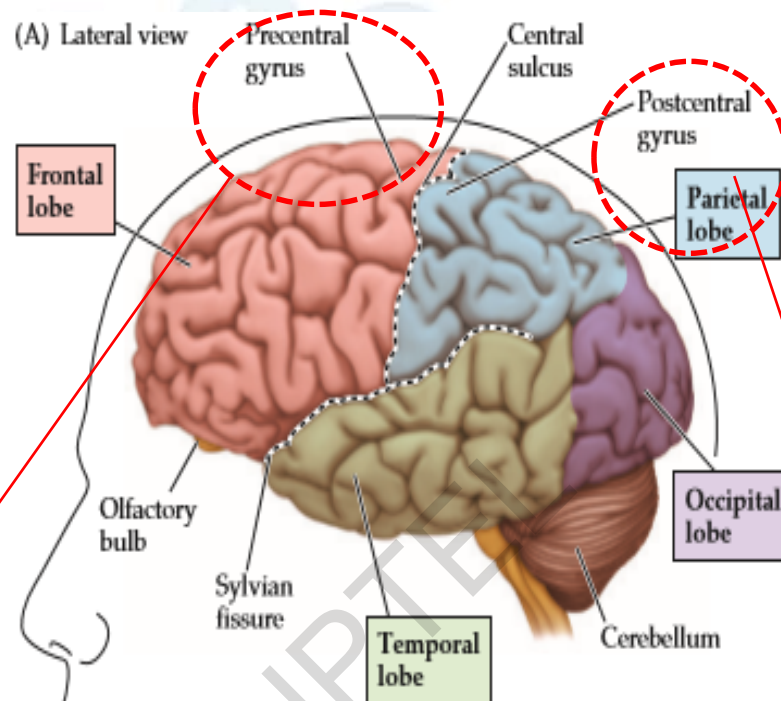
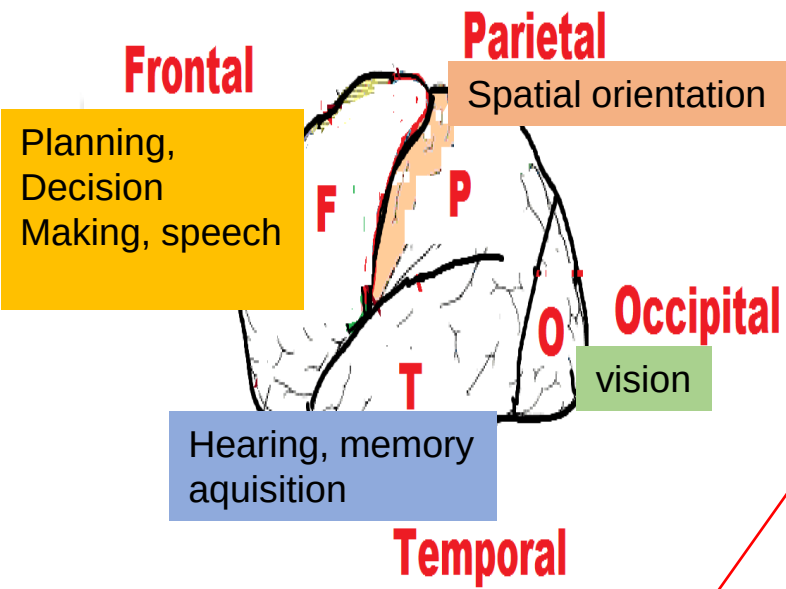
Controls motor system

Hormonal, autonomic control

Breathing, BP
Heart rate

cognition

Emotion & memory



Somatosensory

Motor control

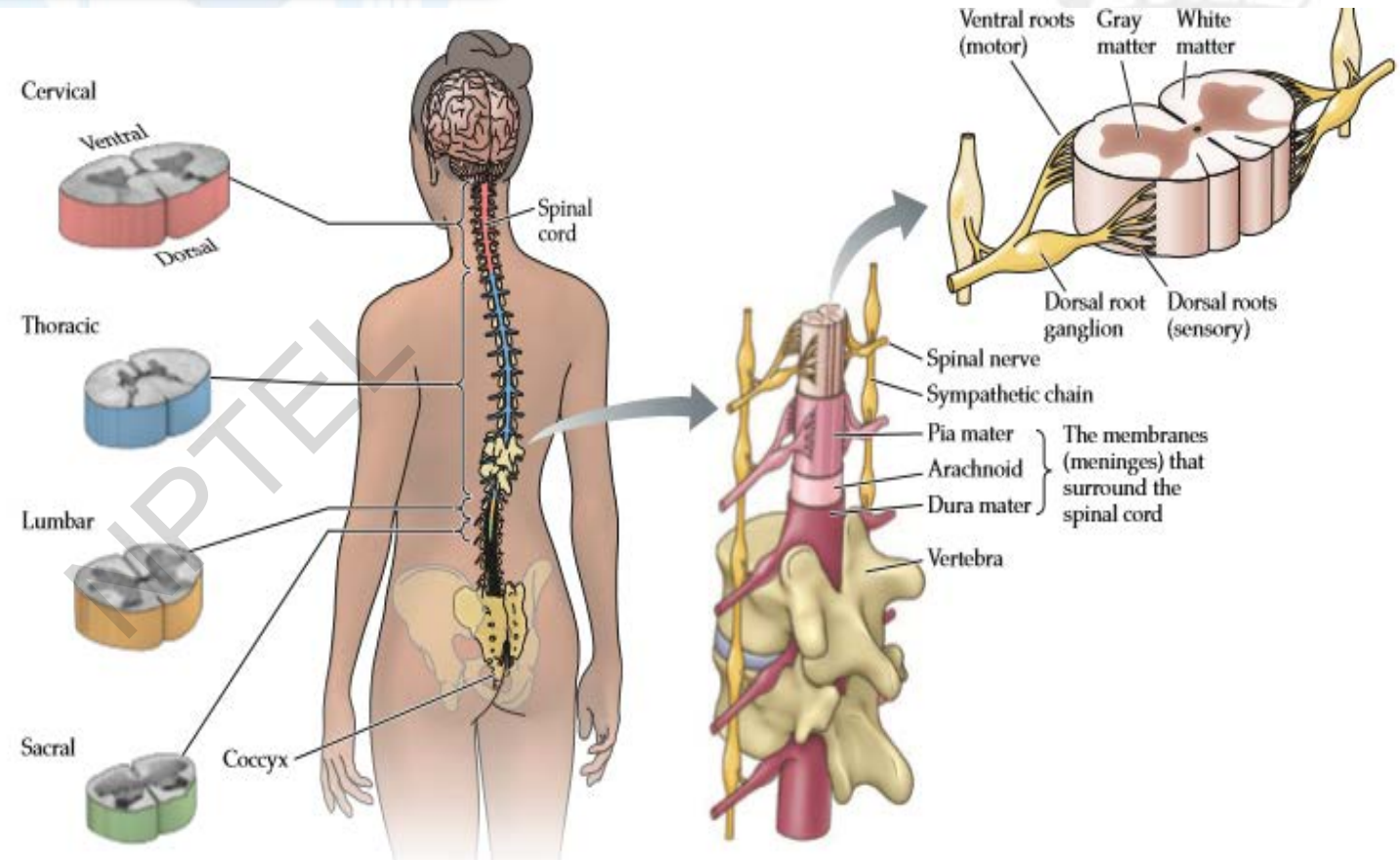
Parts of Brain

Spinal Cord

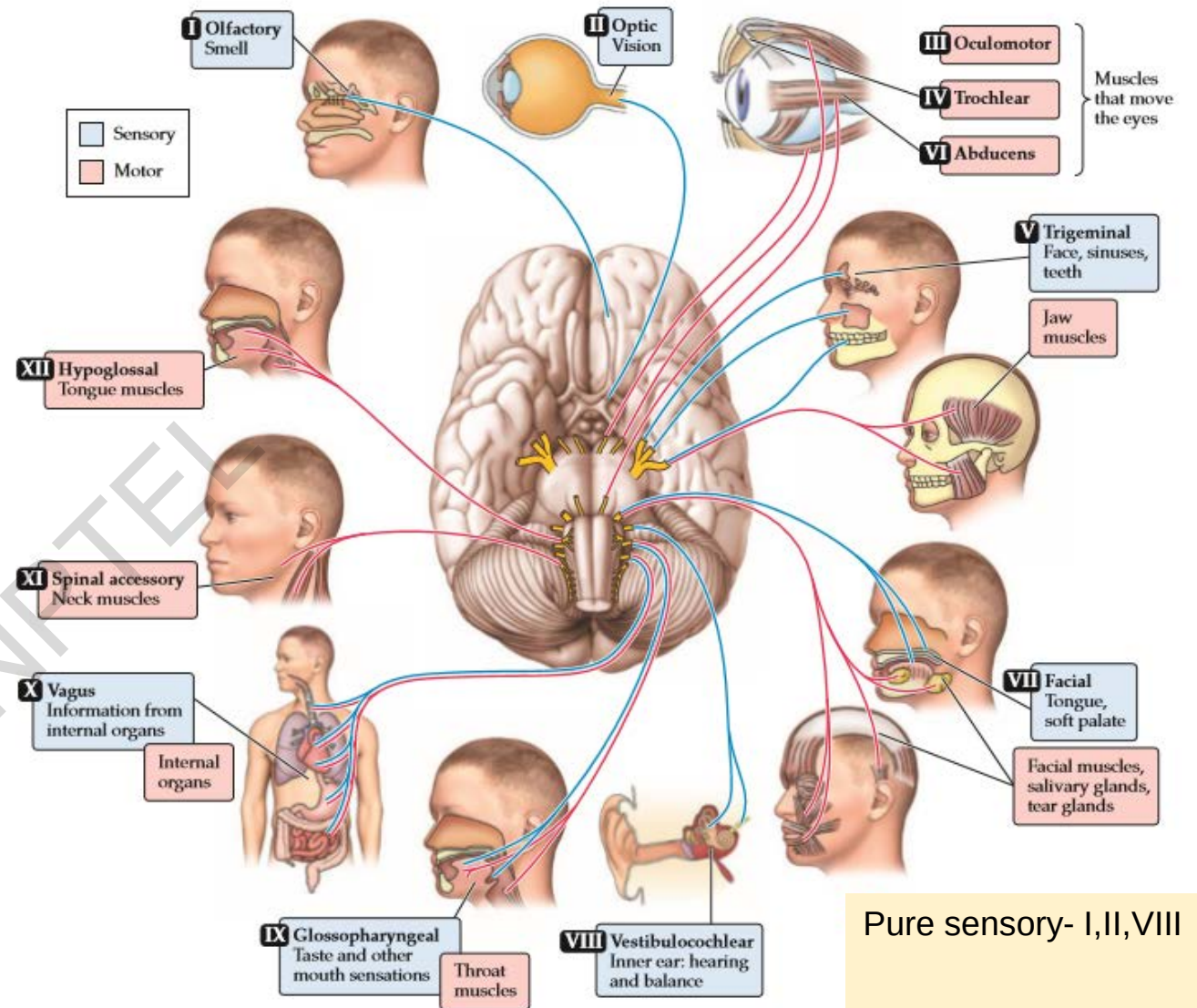
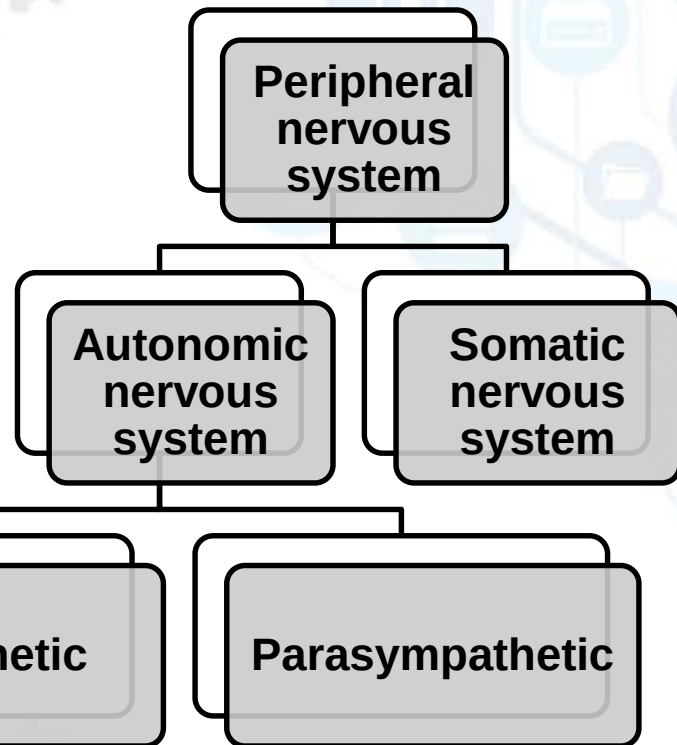
- From base of skull to coccyx
- Contains all the ascending and descending tracts.

Function

- Receive sensory inputs from peripheral structures and transmit them to brain.
- Convey motor signals from the brain to target structures.



Peripheral Nervous System

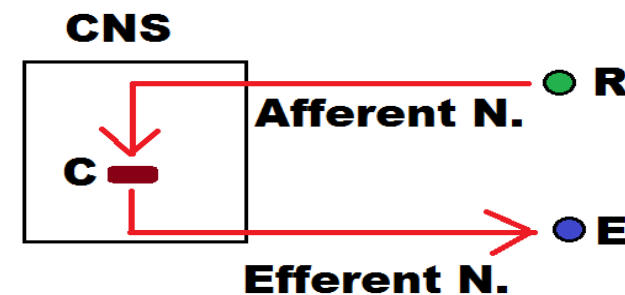


Pure sensory- I,II,VIII

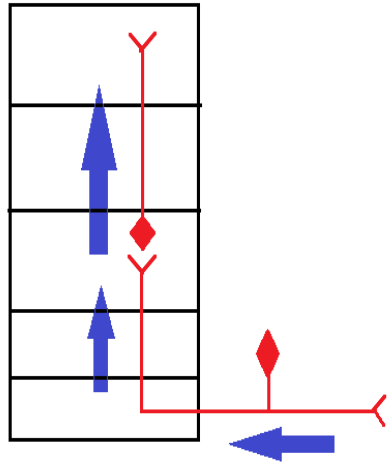
Somatosensory system

- Special Senses-vision, auditory, olfaction, taste, vestibular
- General senses- pain, touch, vibration, proprioception, 2 point discrimination

Sensory information → Receptors → Action potentials via afferent fibres (dorsal root ganglia/cranial nerves) → brainstem nuclei → thalamus → somatosensory cortex

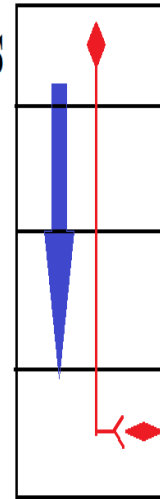


CNS



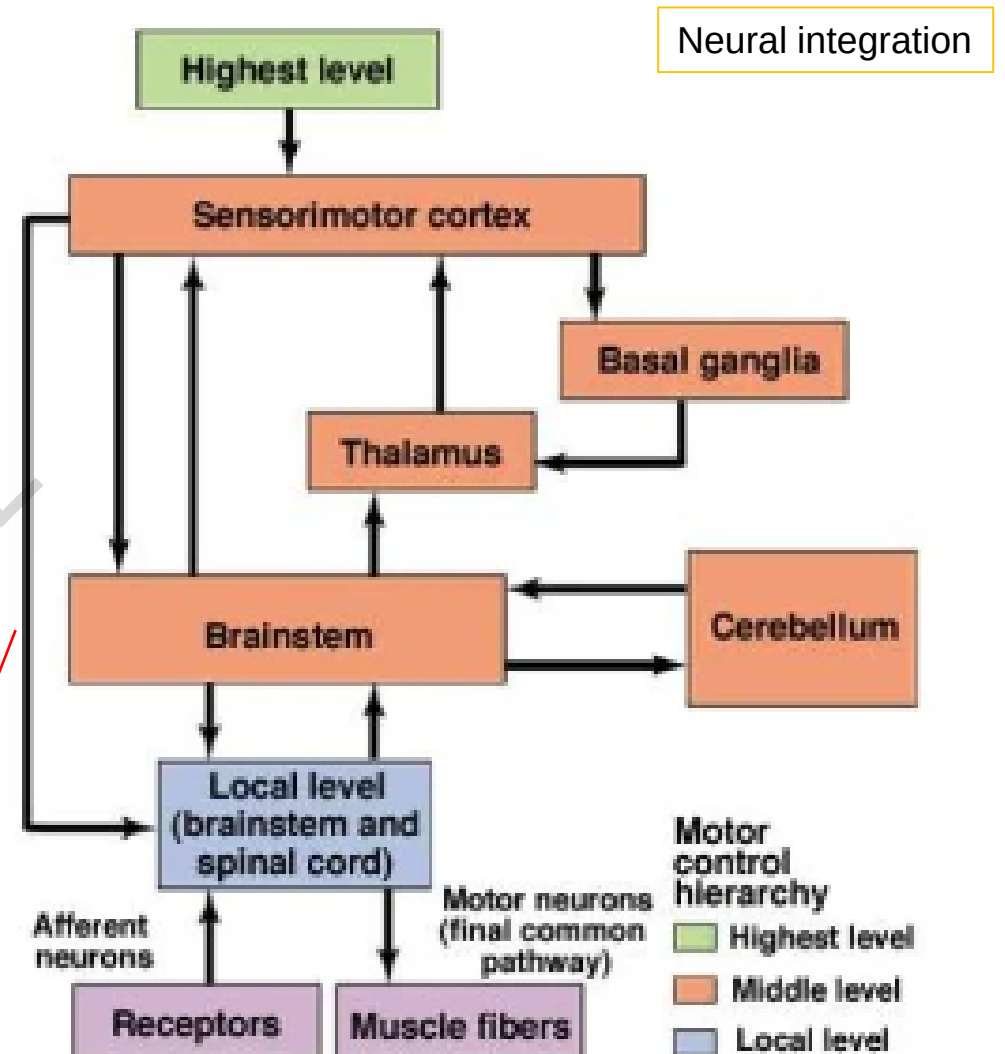
Sensory Neurons

CNS



Motor Neurons

Muscle



Motor tracts

Blood supply to brain

Aneurysm m/c

A hemorrhagic stroke occurs when a rupture in an artery allows blood to leak into the brain.

Rupture

Anterior cerebral artery

Middle cerebral artery

Internal carotid artery

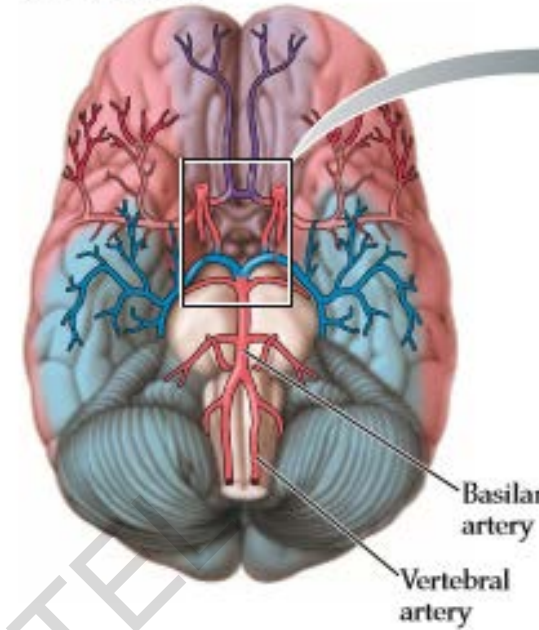
MCA m/c

In ischemic stroke, clots or other debris prevent blood from reaching a region of the brain, causing it to die.

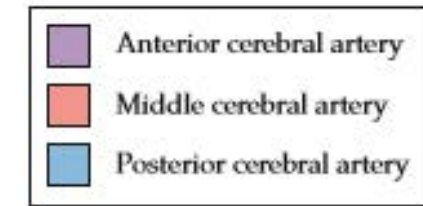
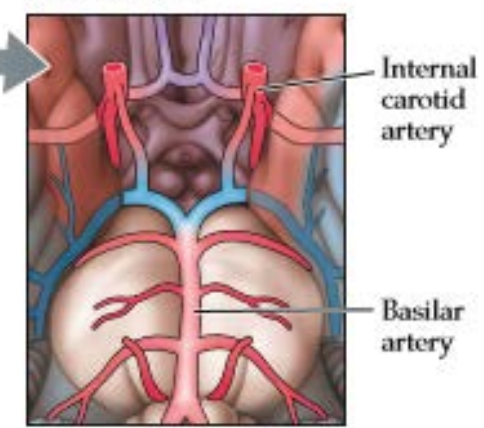
Blockage

ACA, MCA, PCA- main blood supply

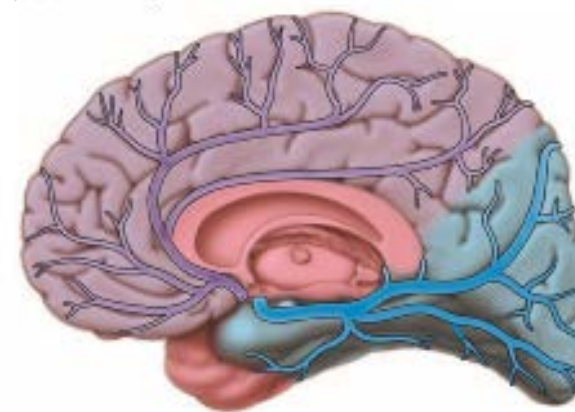
(A) Basal view



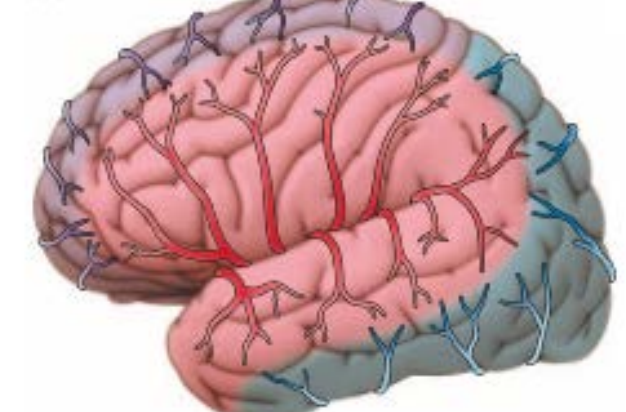
Circle of Willis



(B) Midsagittal view



(C) Lateral view



KEY POINTS

- At the microscopic level, neurons are the basic information-processing units of the nervous system.
- The typical neuron has four main parts: (1) the cell body, which contains the nucleus; (2) dendrites, which receive information; (3) an axon, which conducts information, in the form of electrical potentials, away from the cell body; and (4) axon terminals, which transmit the neuron's activity to other cells.
- Neurons make functional contacts with other neurons, or with muscles or glands, at specialized junctions called synapses.
- Glial cells serve many functions, including the breakdown of transmitters, the production of myelin sheaths around axons, the exchange of nutrients.
- The central nervous system (CNS) consists of the brain and spinal cord.
- The peripheral nervous system includes the cranial nerves, spinal nerves, and autonomic nervous system.
- The human brain is dominated by the cerebral hemispheres, which include the cerebral cortex.
- Other neural systems include the basal ganglia, which regulate movement; the limbic system, which controls emotional behaviors; and the cerebellum, which aids motor control.

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1. Review of Medical Physiology, William F Ganong, 23e
2. Kaplan & Saddock's Comprehensive Textbook of Psychiatry, 9e
3. Biological Psychology by Breedlove, et al. 6e
4. Guyton and Hall Textbook of Medical Physiology, John E. Hall, 13e
5. Mai, J. K., Majtanik, M., and Paxinos, G. (2016). The Human Brain (4th ed.). San Diego, CA: Academic Press.



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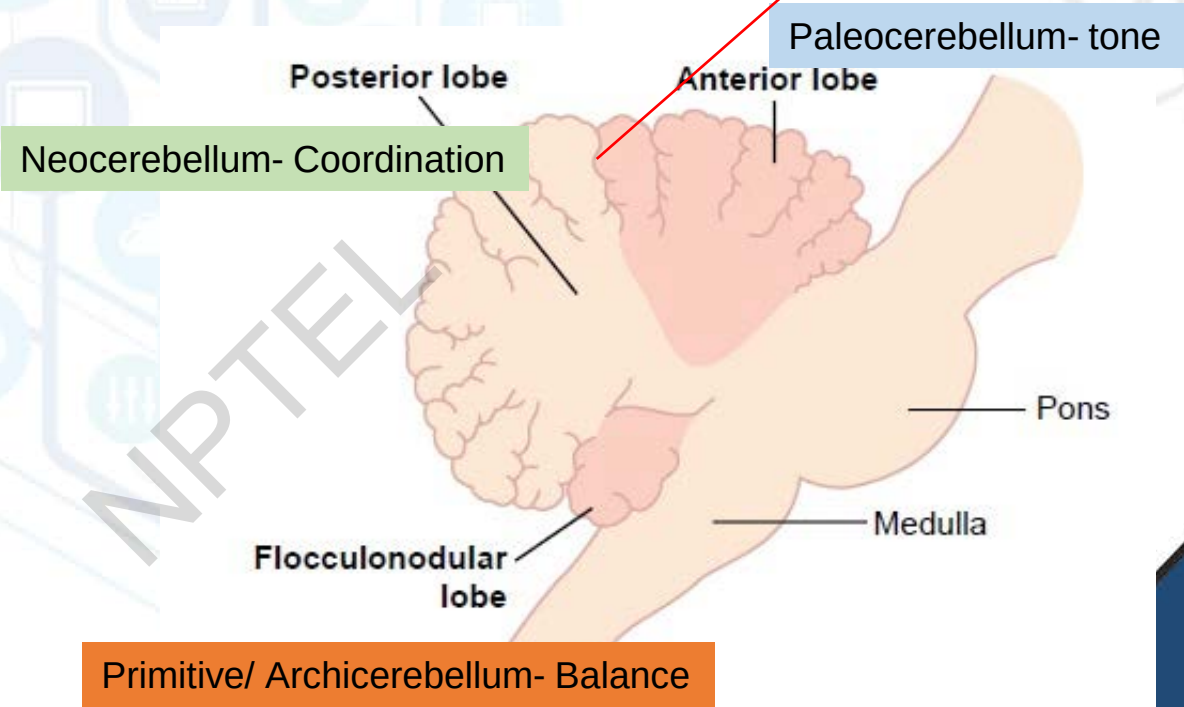
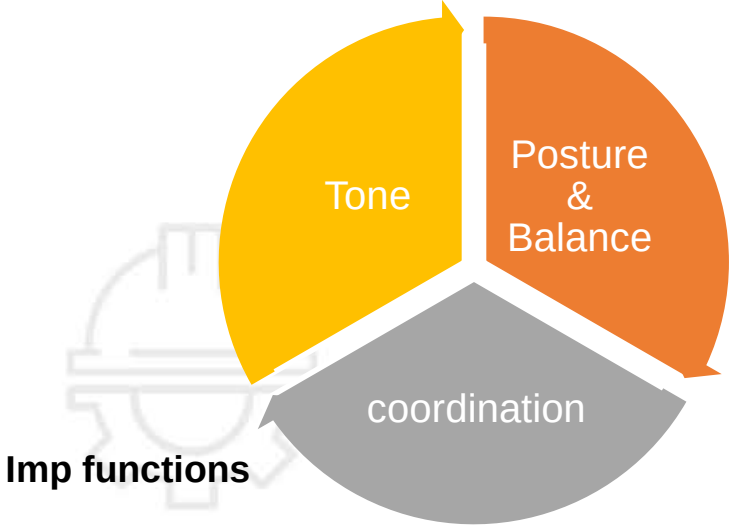
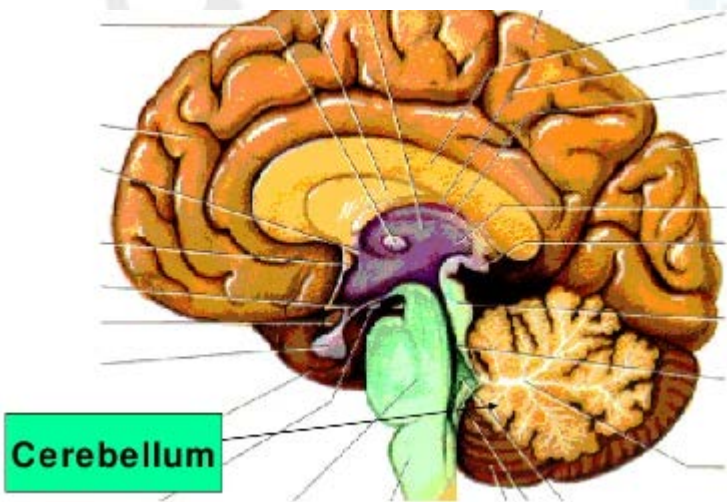
Lecture 2 : Cerebellum

CONCEPTS COVERED

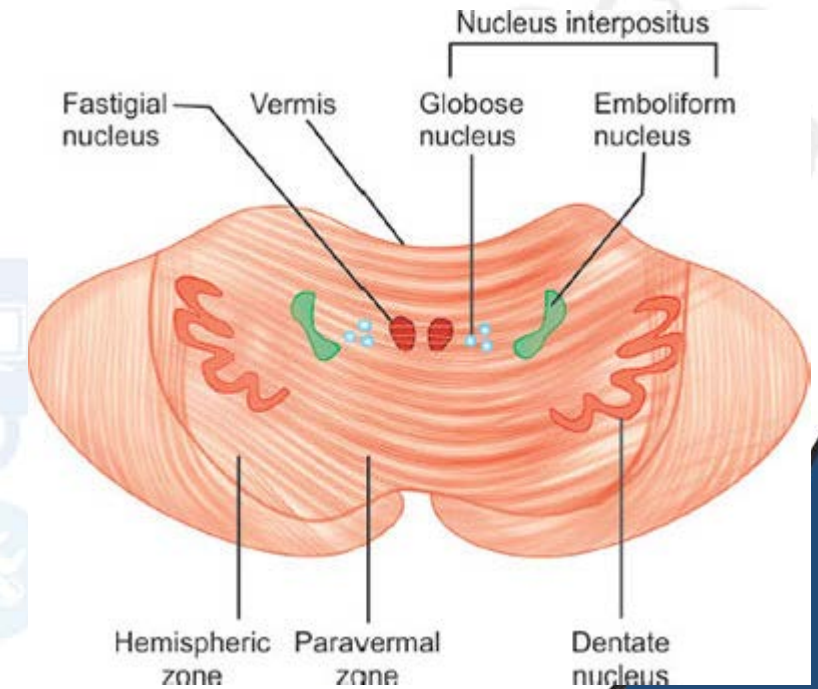
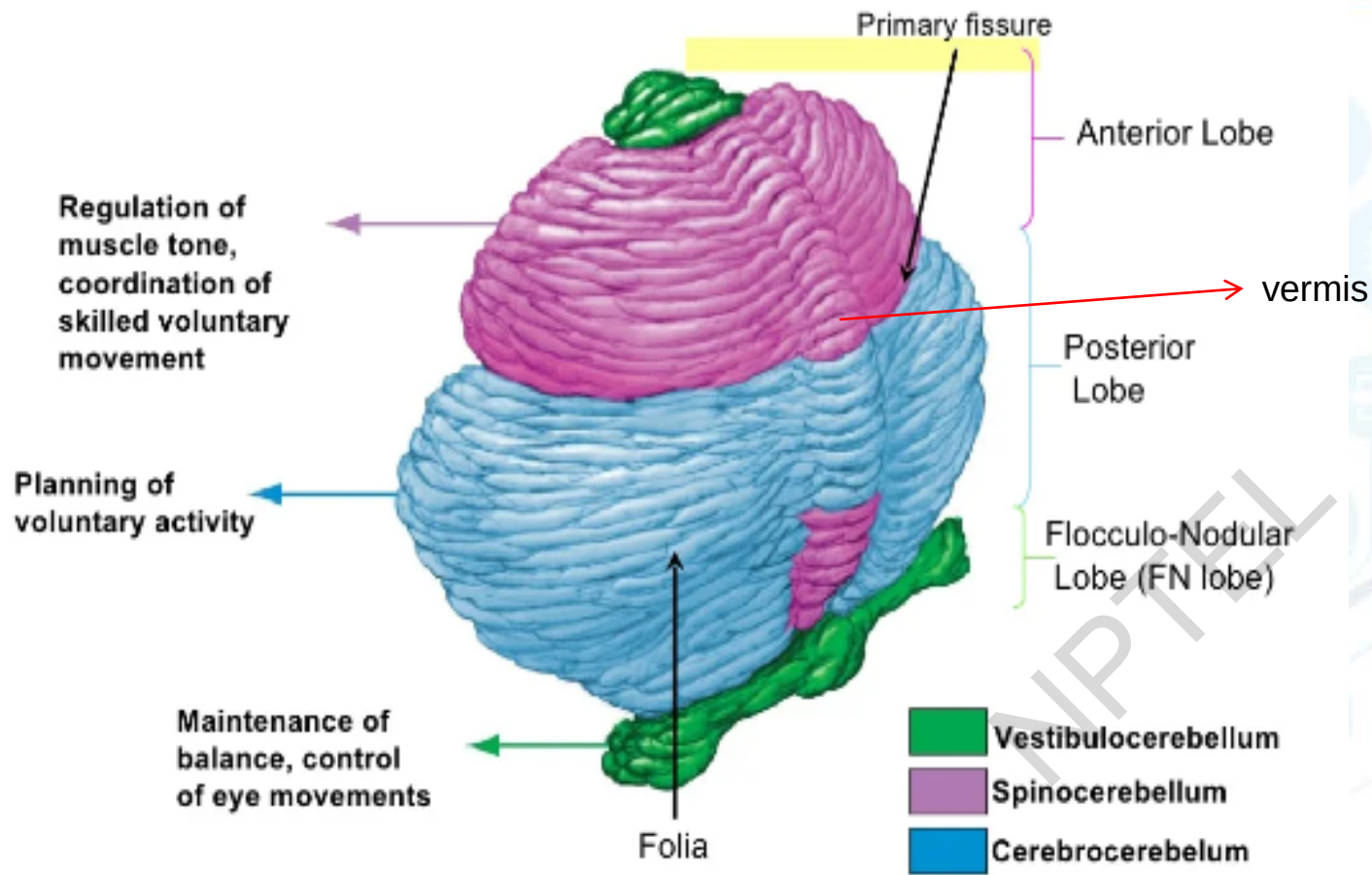
- **Functional Anatomy of Cerebellum**
- **Homunculus**
- **Internal circuitry**
- **Inputs and outputs**
- **Functions**
- **Applied aspects**

Cerebellum- develops from metencephalon of Rhombencephalon

Located dorsal to the pons & medulla

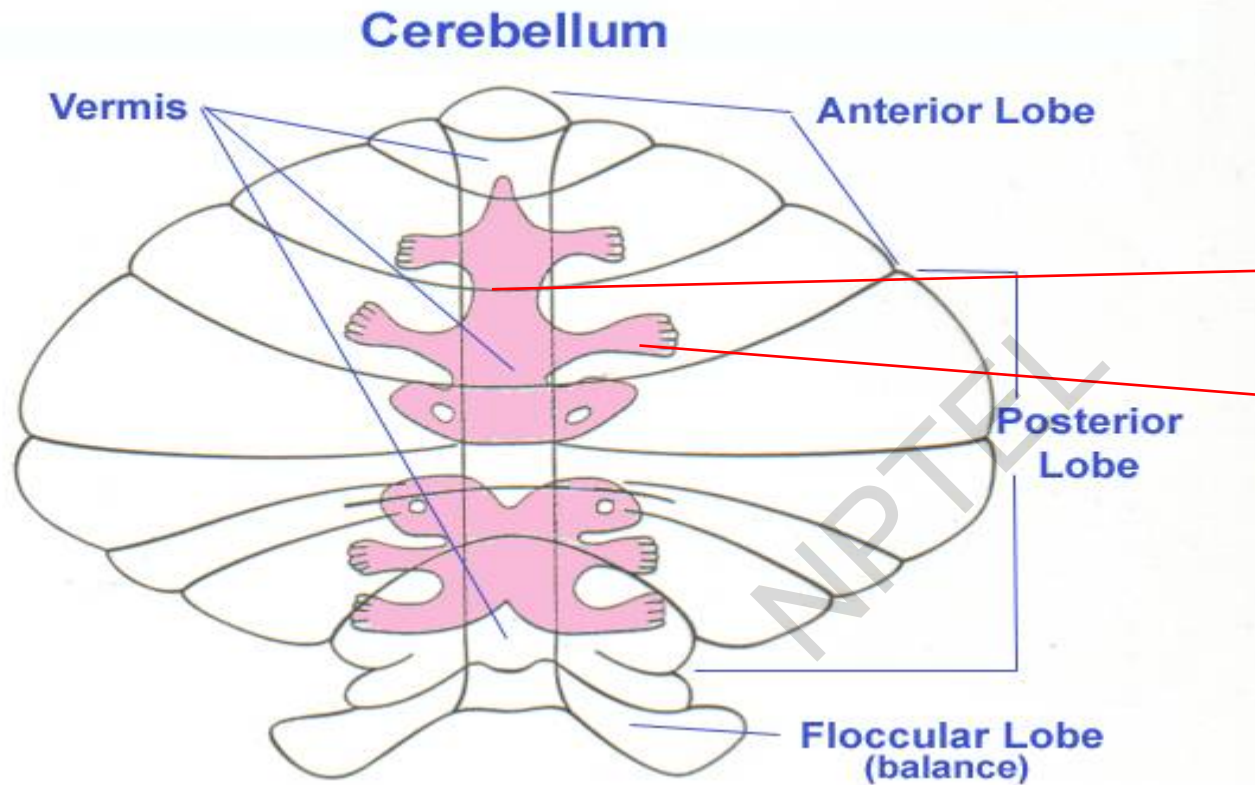


Anatomical & Phylogenetical divisions



Dentate nucleus- neocerebellum
 Nucleus interpositus- spinocerebellum
 Fastigial nucleus- vestibulocerebellum

Homunculus



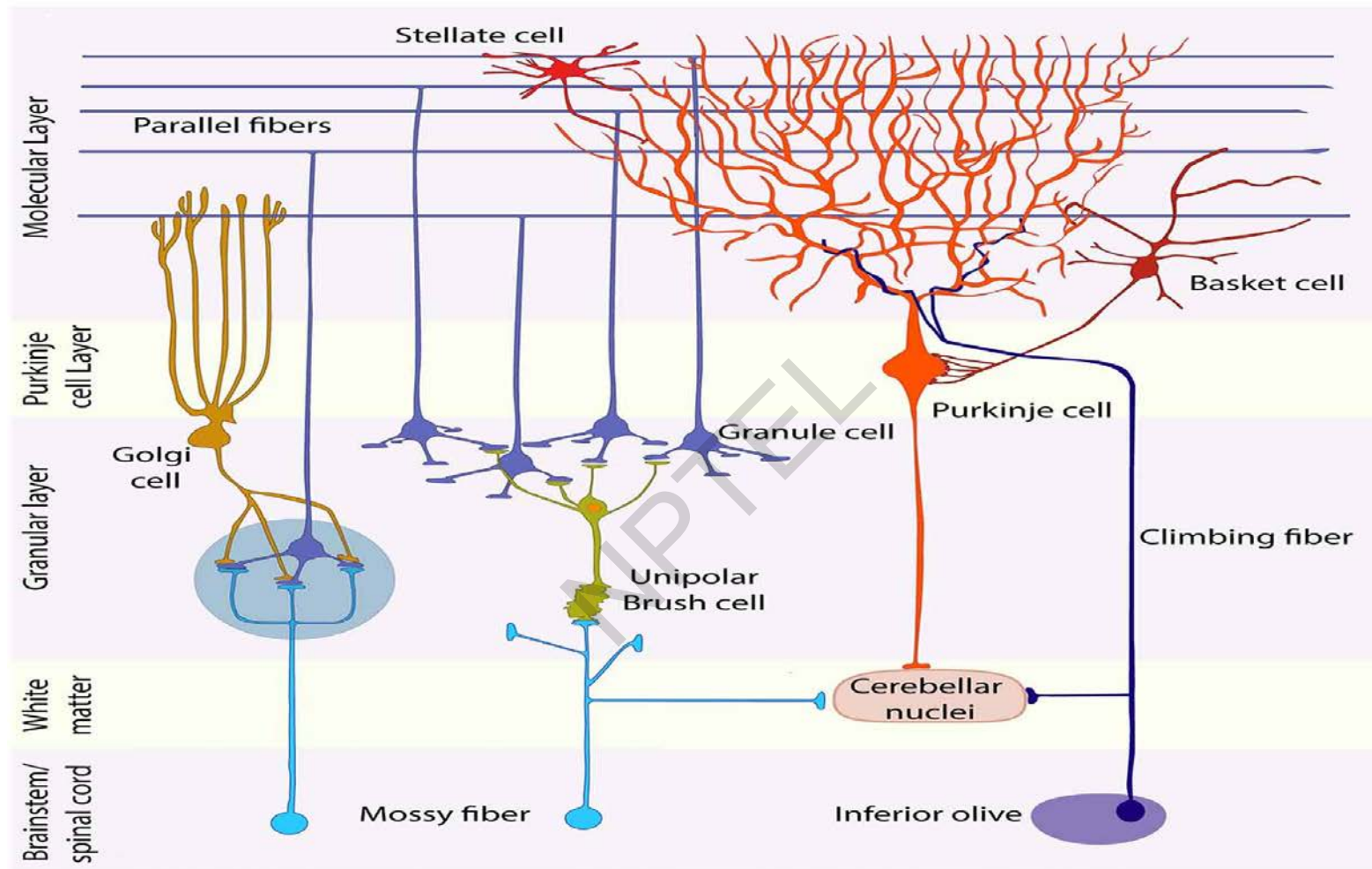
Cerebellum control is ipsilateral

Trunk/ Axial musculature
-vermis

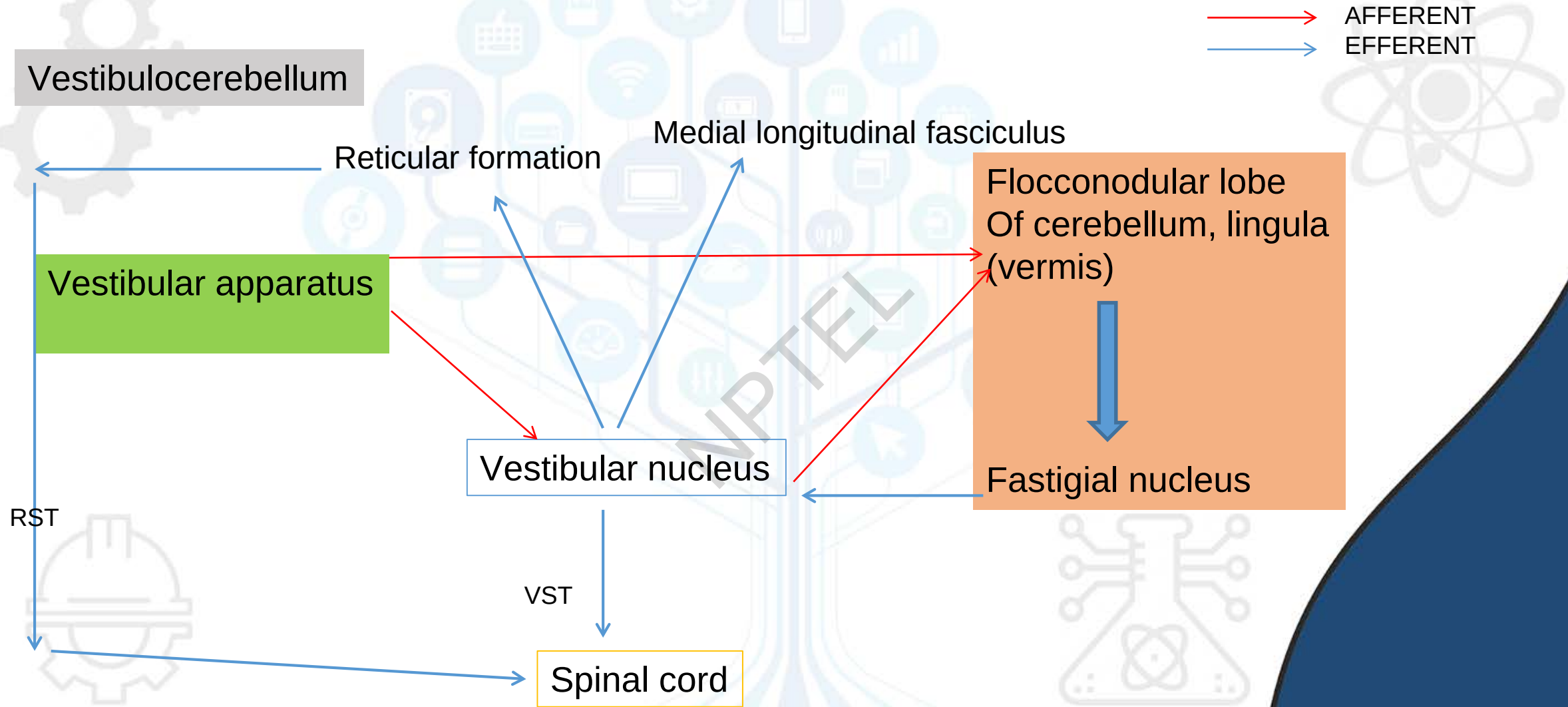
Limbs- paravermal area/intermediate
zone

Internal circuitry of cerebellar cortex

Mossy- granule-PC= Feedforward inhibition



Main connections of cerebellum



Spinocerebellum

→ AFFERENT
→ EFFERENT

Cortex

Thalamus

Red nucleus

Nucleus interpositus

CST

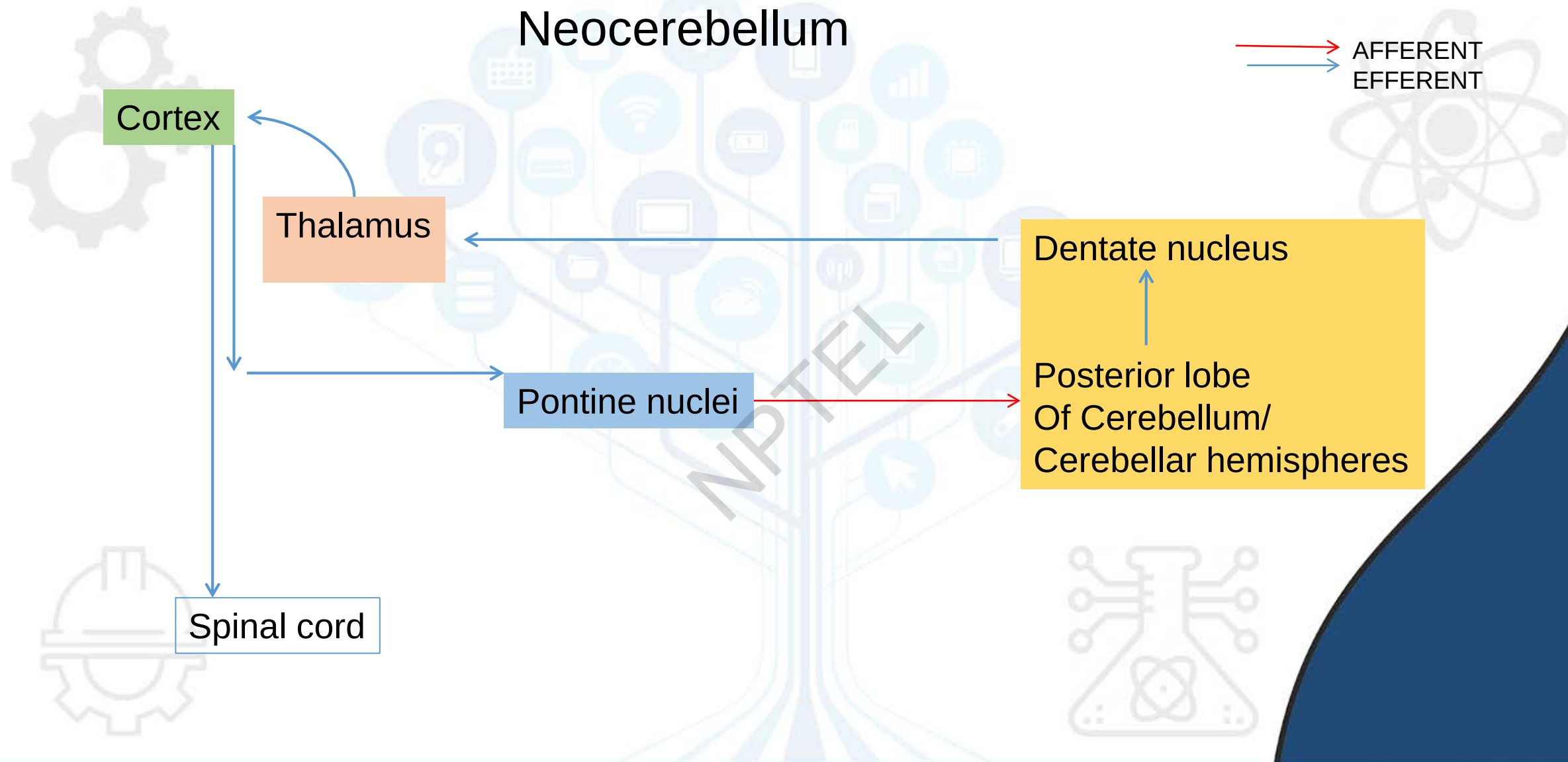
Inferior olivary nucleus

Anterior lobe &
Paravermal area of
cerebellum

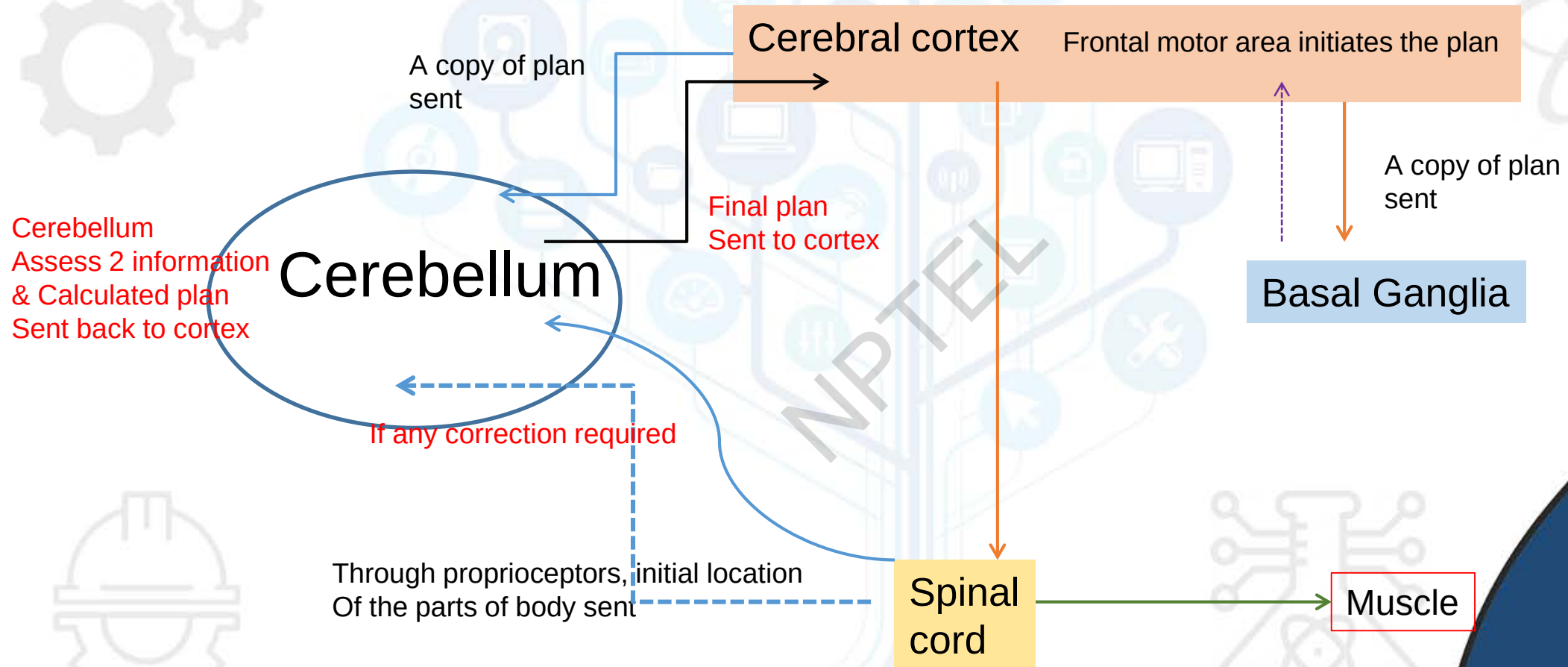
Rubrospinal tract

Spinal cord

Neocerebellum



Functions of Cerebellum- Comparator of a servo-mechanism



Applied aspects- clinical considerations

- Ataxia- incoordination of movements, gait ataxia
- Dysarthria- difficulty in articulation of speech
- Dysdiadochokinesia – clumsiness of alternate movements
- Dysmetria –overshooting/undershooting
- Nystagmus – to and fro movements of eye ball
- Bradykinesia- slow movements
- Hypotonia-reduced muscle tone
- Intention tremor-accessory movements while doing task
- Rebounding- inability to predict movement

- Impaired motor learning- inability to execute what is learned
- Romberg's test-

Patient stand with heels together
Or walk in a straight line
With eyes open followed by
Eyes closed

swaying of body to either side

eyes closed

sensory ataxia

eyes open

cerebellar ataxia

KEY POINTS

- The supplementary cortex, basal ganglia, and cerebellum participate in the planning of skilled movements.
- The cerebellar cortex contains five types of neurons: Purkinje, granule, basket, stellate, and Golgi cells.
- The two main inputs to the cerebellar cortex are climbing fibers and mossy fibers.
- Purkinje cells are the only output from the cerebellar cortex, and they generally project to the deep nuclei.
- Damage to the cerebellum leads to several characteristic abnormalities, including hypotonia, ataxia, and intention tremor.

REFERENCES

1. Guyton and Hall Textbook of Medical Physiology, John E. Hall, 13e
2. Mai, J. K., Majtanik, M., and Paxinos, G. (2016). The Human Brain (4th ed.). San Diego, CA: Academic Press.
3. Review of Medical Physiology, William F Ganong, 23e
4. Best & Taylor's Physiological Basis of Medical Practice, O.P. Tandon, 13/e



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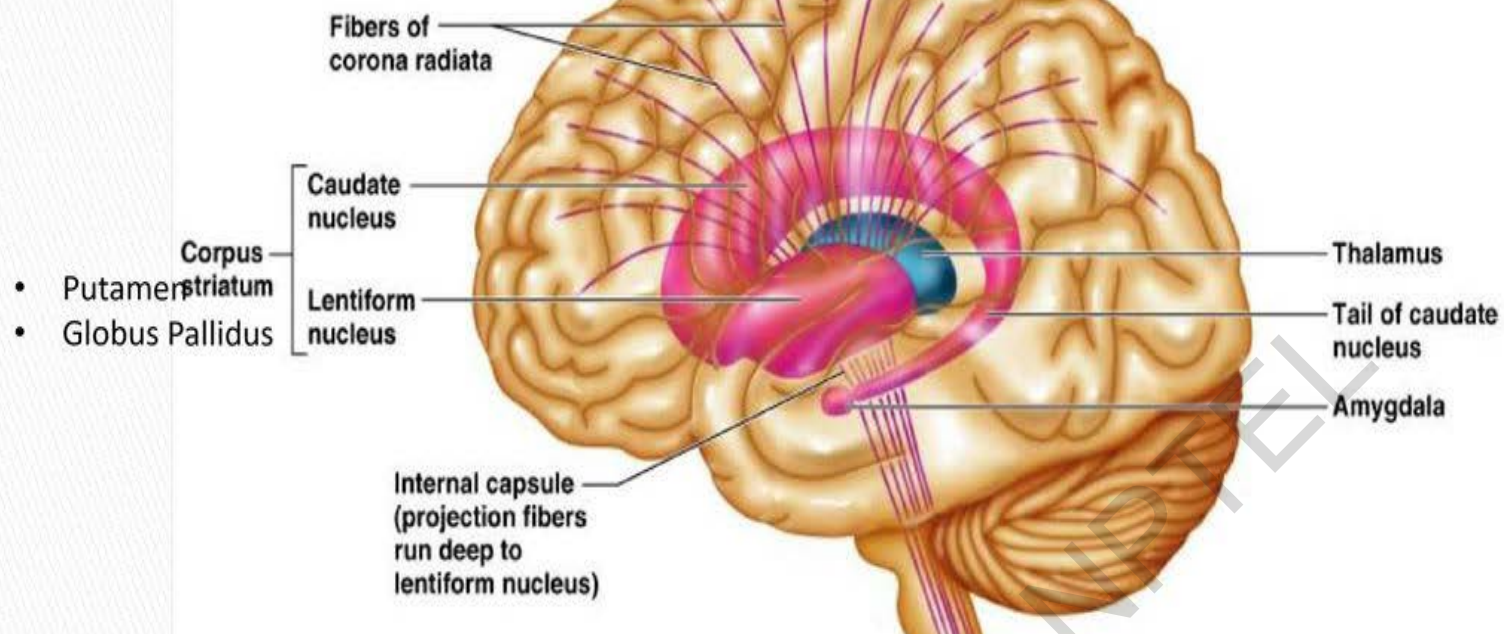
Lecture 3 : Basal Ganglia

CONCEPTS COVERED

- **Components of Basal Ganglia**
- **Nuclei of Basal Ganglia**
- **Connections of Basal Ganglia**
- **Functions of Basal Ganglia**
- **Applied aspects**

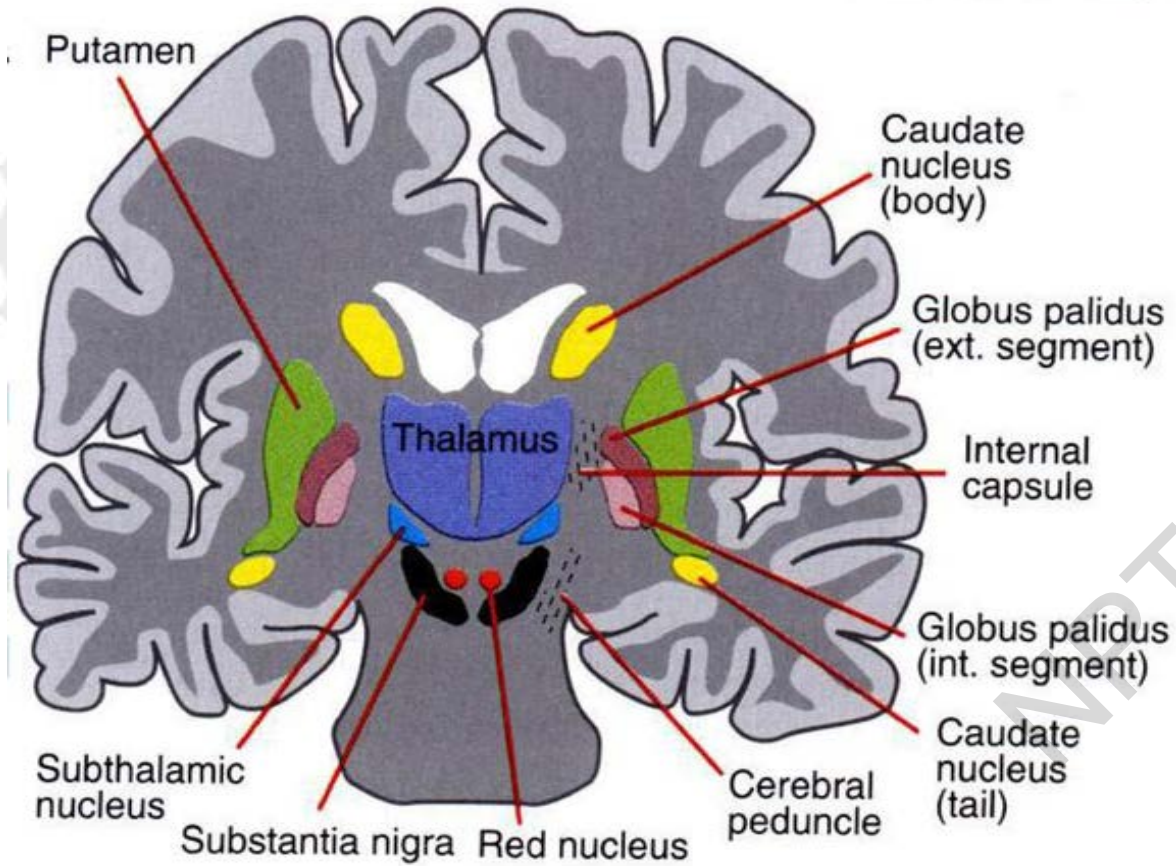
Basal Ganglia-components & nuclei

- Basal ganglia are a group of deep subcortical nuclei located at the base of forebrain.
- They are primarily involved in control of posture and movement.
- They receive inputs mainly from cortex and project to the cortex via thalamus.
- Basal ganglia via their cortical connections project principally to brainstem areas that give rise to all extrapyramidal tracts.



Traditional group

- *Caudate nucleus*
- *Lentiform nucleus*
- *Amygdaloid body*
- *Clastrum*



Clinical group of nuclei (connections)

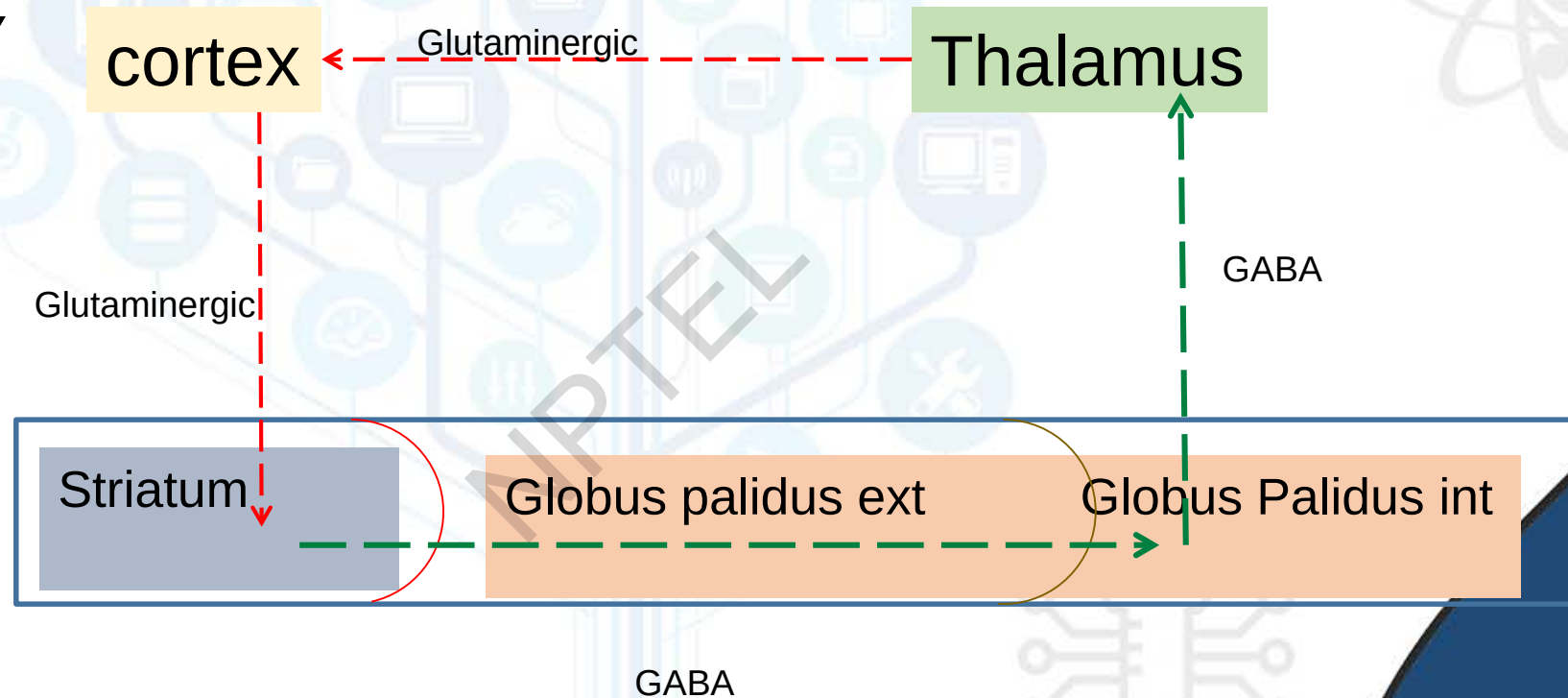
- *Lentiform nucleus*
- *Caudate nucleus*
- *Subthalamic nucleus*
- *Substantia nigra*

Caudate+ Putamen= Striatum

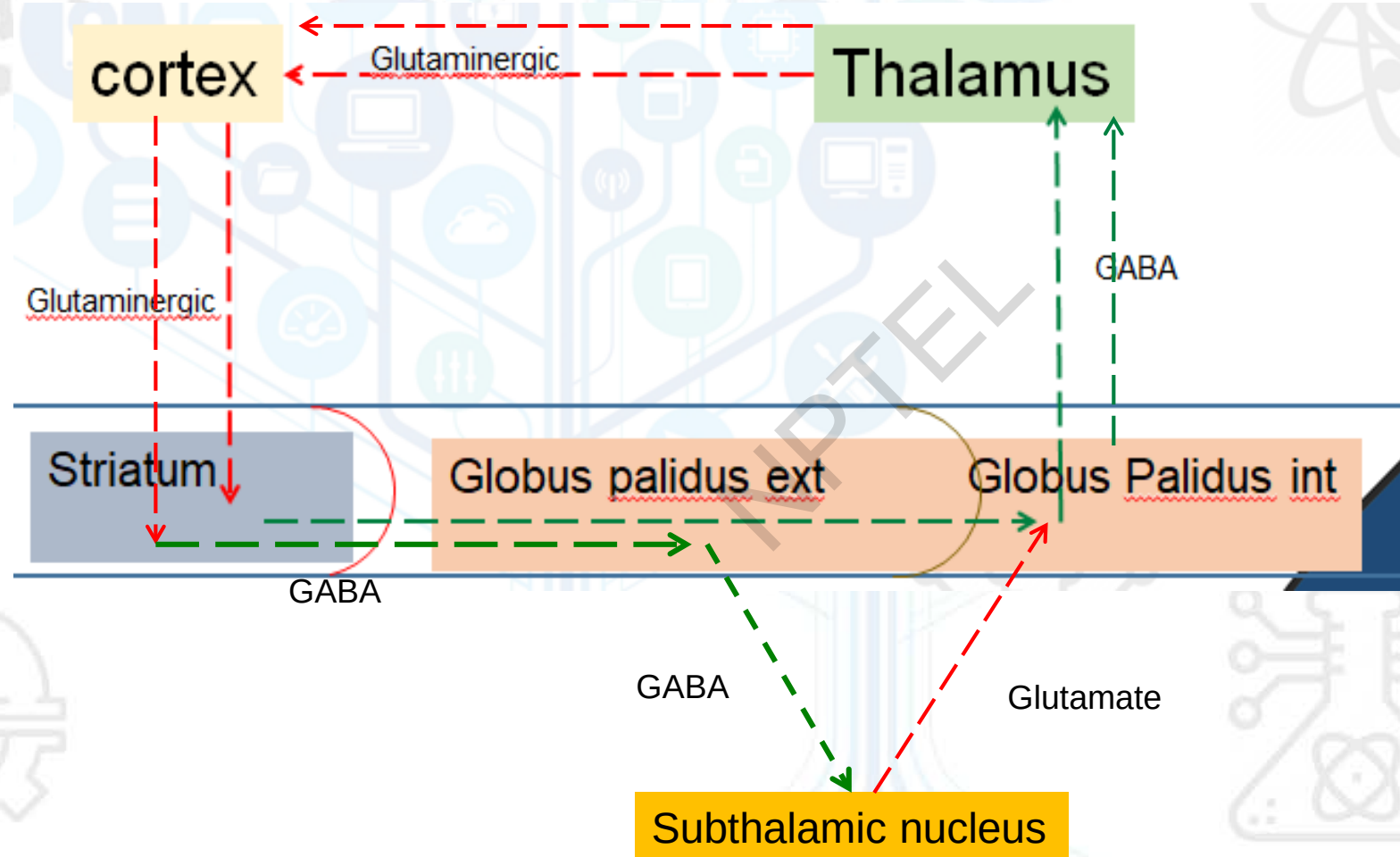
Caudate+ Globus pallidus+ Putamen=
Corpus striatum

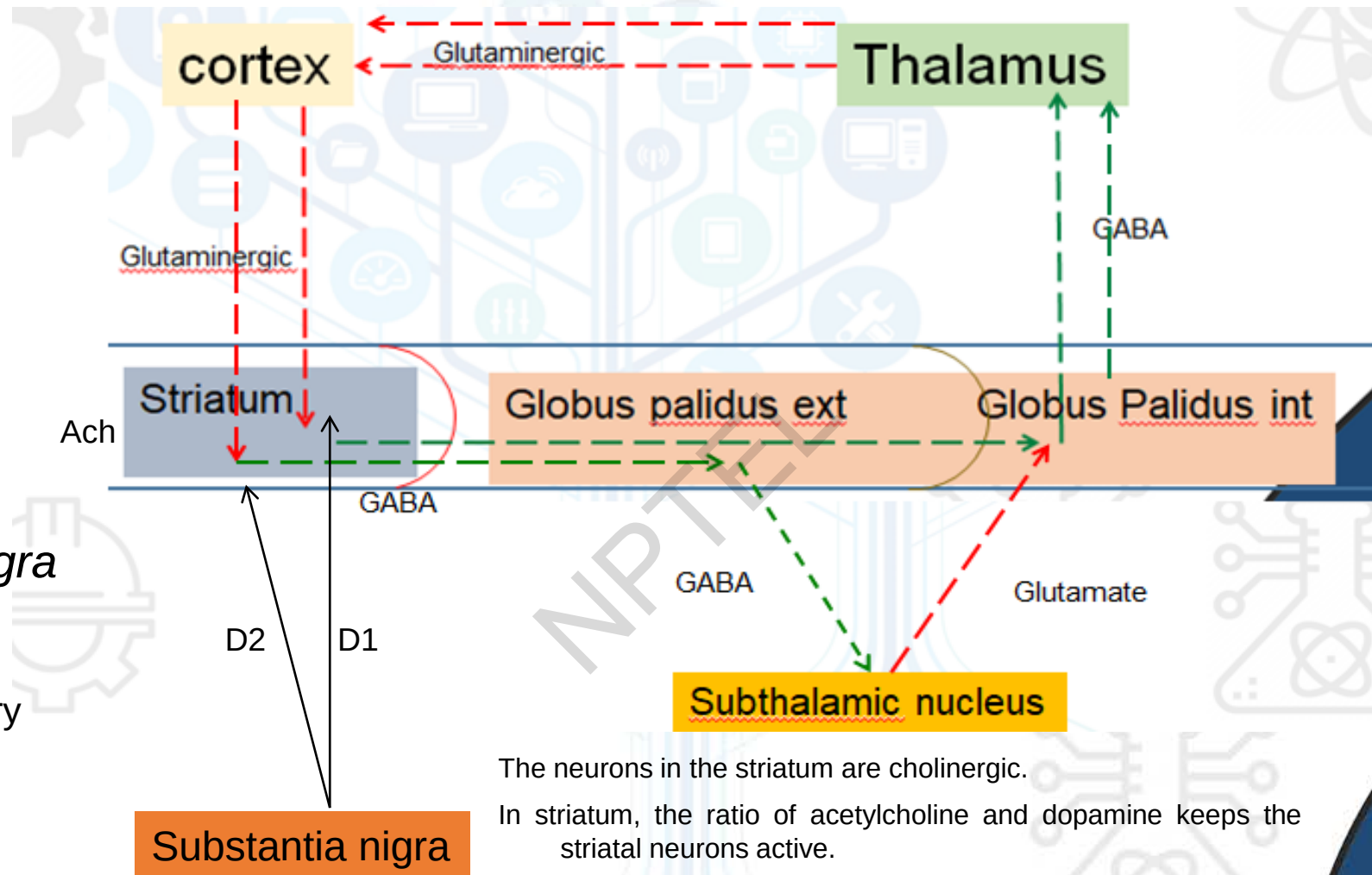
Connections of Basal ganglia

Direct pathway



Indirect pathway





*Overall pathway
With substantia nigra*

BOTH D1 & D2 –
Final pathway excitatory

The neurons in the striatum are cholinergic.

In striatum, the ratio of acetylcholine and dopamine keeps the striatal neurons active.

Alteration in this Ach-DA ratio results in abnormalities in motor activities.

FUNCTIONS OF BASAL GANGLIA

1. The neurons of basal ganglia are observed to discharge before the movement begins, involved in planning and programming of motor activities.
2. Basal ganglia control posture.
3. Basal ganglia inhibit stretch reflexes by stimulation of caudate nucleus. This is achieved by stimulation of inhibitory motor cortex through thalamocortical feedback pathway and by stimulation of inhibitory reticular formation-tone maintenance.
4. Basal ganglia also play a role in cognitive functions. This is especially performed by the caudate nucleus through its connections with the frontal portion of the neocortex. Lesion of caudate nucleus results in deficit in performance based on learning.
5. Substantia nigra is the center for coordination of impulses essential for skilled movements.

Lesions of Basal ganglia

Hypokinesia

Parkinson's Disease

degeneration of nigrostriatal dopaminergic neurons

Drugs: It occurs secondary to chronic use of many drugs like phenothiazine, D2 receptor blockers, etc.

MPP: Methylphenyl-pyridinium (MPP) concentration in the brain of parkinsonism is high.

MPP is formed from methyl-phenyltetrahydropyridinum (MPTP) by the action of monoamine oxidase B (MAO-B) enzyme.

Hyperkinesia

Chorea (striatum)

Athetosis (striatum)

Ballism (subthalamic nucleus)

Tardive dyskinesia

Features of Parkinsonism

1. Akinesia: Akinesia is defined as difficulty in initiating movements and decreased spontaneous movements.
2. Bradykinesia: Bradykinesia is defined as slowness of movement.
 - All activities are grossly reduced and slowed. Difficulty in tying shoelaces and buttoning is frequently observed.
3. Decreased associated movements: Examples of associated movements are swinging of the arms during walking or the facial expressions during speaking.
 - These associated movements are grossly diminished in parkinsonism.
 - The patient suffering from parkinsonism speaks without any emotional expression, which is called as expressionless face or mask face (facial immobility).

4. Serpentine stare: Frequency of spontaneous blinking of eyes decreases producing a serpentine stare.

Rigidity: Rigidity of parkinsonism is different from spasticity that occurs in UMN paralysis.

- In rigidity, the motor neuron discharge is increased in both agonists and antagonists.
- Therefore, the limbs offer resistance to passive bending throughout the movement (lead pipe rigidity).

5. Resting tremors

Huntington's disease

Autosomal dominant type that occurs due to a defective gene on the chromosome 4.

The gene codes for huntingtin, an abnormal protein that causes the disease. The abnormal gene has a many-times-repeating codon, CAG.

The disease occurs due to degeneration of GABAergic striatonigral pathway as well as Ach neurons.

Chorea: Chorea is defined as rapid involuntary and dancing movements. Loss of GABAergic neurons in the striatum removes its inhibitory influence on the globus pallidus, which reduces the activities in the thalamic nucleus that results in chorea.

Dementia: Dementia occurs due to simultaneous and progressive loss of cholinergic neurons in the cerebral cortex.

Slurring speech: Gradually, speech is slurred in Huntington disease.

KEY POINTS

- The supplementary cortex, basal ganglia, and cerebellum , participate in the planning of skilled movements.
- The basal ganglia include the caudate nucleus, putamen, globus pallidus, subthalamic nucleus, and substantia nigra.
- The connections between the parts of the basal ganglia include a dopaminergic nigrostriatal projection from the substantia nigra to the striatum and a GABAergic projection from the striatum to substantia nigra.
- Parkinson disease is due to degeneration of the nigrostriatal dopaminergic neurons and is characterized by akinesia, bradykinesia, rigidity, and tremor at rest.

REFERENCES

1. Guyton and Hall Textbook of Medical Physiology, John E. Hall, 13e
2. Mai, J. K., Majtanik, M., and Paxinos, G. (2016). The Human Brain (4th ed.). San Diego, CA: Academic Press.
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NPTEL ONLINE CERTIFICATION COURSES

Basics of Mental Health & Clinical Psychiatry

Dr. Arijita Banerjee

**Dr B.C. Roy Multi-speciality Medical Research Centre
IIT KHARAGPUR**

Lecture 4 : Thalamus & Hypothalamus

CONCEPTS COVERED

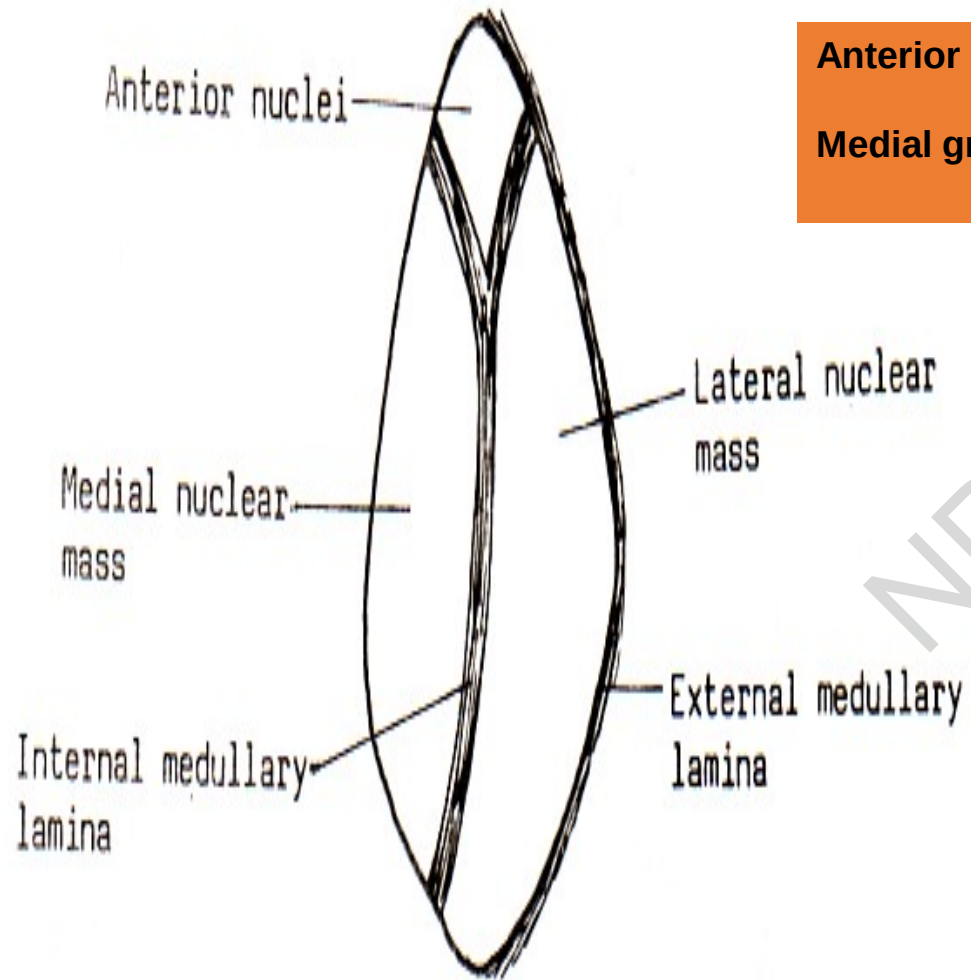
- **Functional anatomy of Thalamus & Hypothalamus**
- **Nuclei of Thalamus & Hypothalamus**
- **Connections of Thalamus & Hypothalamus**
- **Functions of Thalamus & Hypothalamus**
- **Applied aspects**

Thalamus

- Greek word means 'inner chamber'.
- The largest component of diencephalon.



Classification of thalamic nuclei



Anterior group- Anterior nucleus of thalamus

Medial group- Dorsomedial nucleus of thalamus

Small superior- Lateral dorsal, Lateral Posterior, Pulvinar

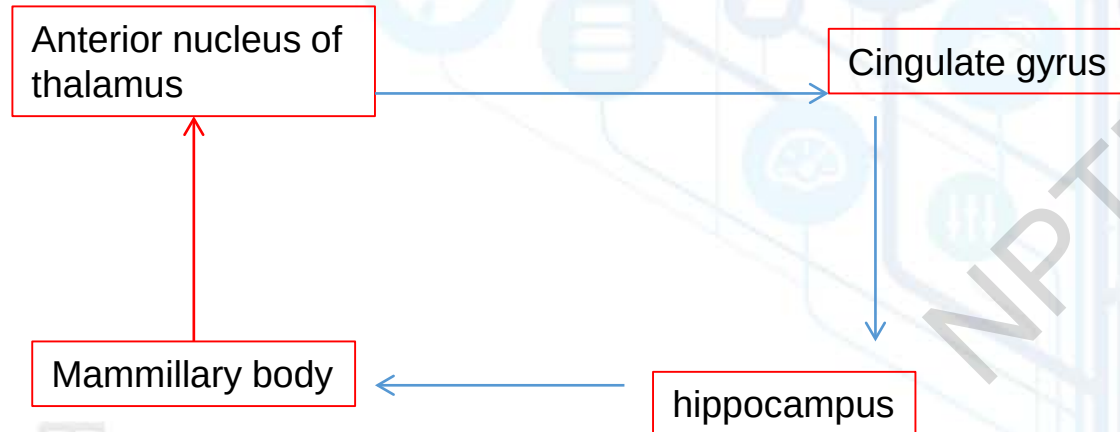
Ventral anterior, ventral posterior, ventral lateral, Medial geniculate, lateral geniculate

Specific in nature

Functions of nuclei-

Anterior nucleus of thalamus

*Plays an important role in
Learning, memory and emotion
behaviour*



Medial nucleus of thalamus

Cerebral cortex

Plays important role in affective behaviour, decision making, judgement, memory & integration of somatic and visceral activity.

Dorsomedial nucleus
Of Thalamus

Globus pallidus

Amygdala

Ventral group of nuclei

Cerebral cortex
Premotor area/supplementary motor area,
Area 4

*Motor thalamus-regulation of tone, movements,
coordination of voluntary activity (ventral lateral
& anterior)*

Ventral lateral nucleus of thalamus

Basal ganglia substantia nigra cerebellum

Ventral group of nuclei

Cerebral cortex Somatosensory area (3,2,1)

Ventral posterior nucleus of thalamus

Spinothalamic tracts, medial lemniscus

sensory thalamus- somatic sensations
Special senses-

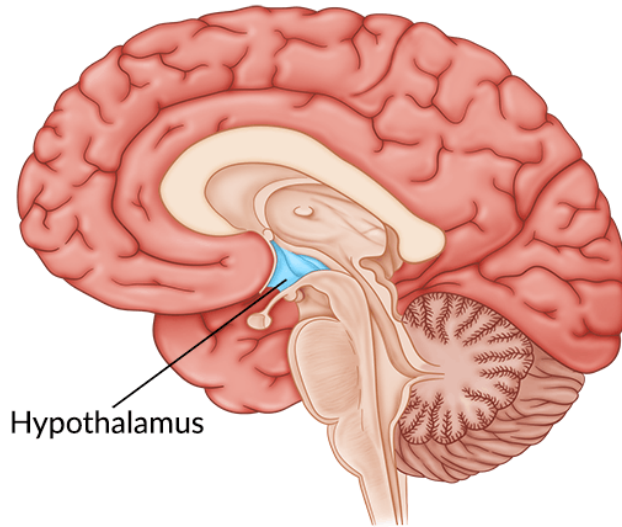
Medial Geniculate – auditory
Lateral Geniculate - vision

Clinical Aspects- Thalamic syndrome

- Cause- thrombosis of the geniculothalamic artery (branch of the posterior cerebral artery).
- Ventral posterior and ventral lateral group affected
- Persistent intolerable pain resistant to analgesics-thalamic pain
- Sensory disturbances
- Dyskinesia, reduced tone, ataxia
- Hemiparesis
- Language problem
- Thalamic hand-



Hypothalamus



Functional zones-

Anterior

Tuberal

Posterior

Medial & lateral zones

Nuclei

Anterior region

Nucleus	Functions
Supraoptic	ADH
Paraventricular	Oxytocin, TRH, CRH
Preoptic	Median-GnRH, Thermoregulation Ventrolateral- Sleep promoting area (GABA)
Anterior	Thermoregulation, sexual behaviour
Suprachiasmatic	Circadian rhythm
Lateral	Hunger (feeding)

Tuberal region

Ventromedial nucleus- satiety centre
Reward centre (Medial forebrain bundle)

Punishment centre- PAG

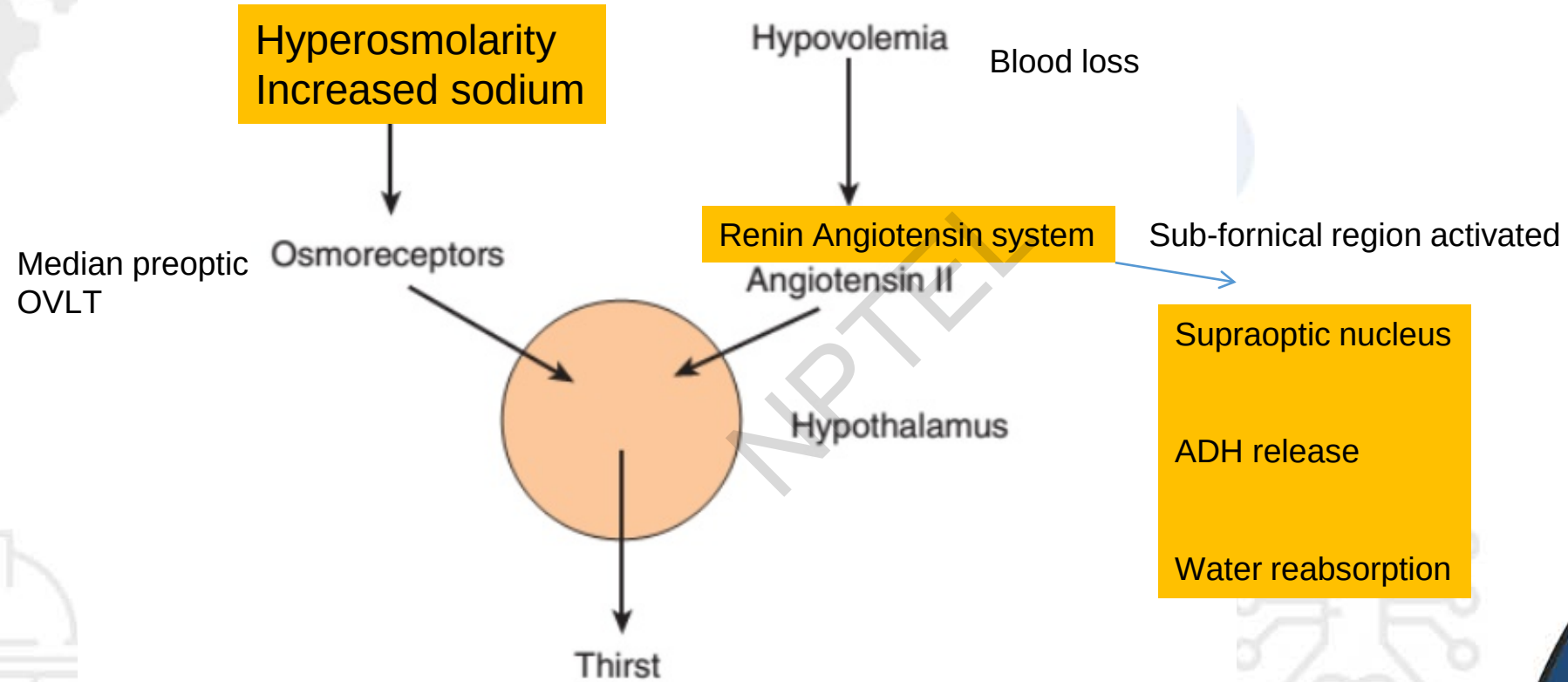
Rage

Posterior region

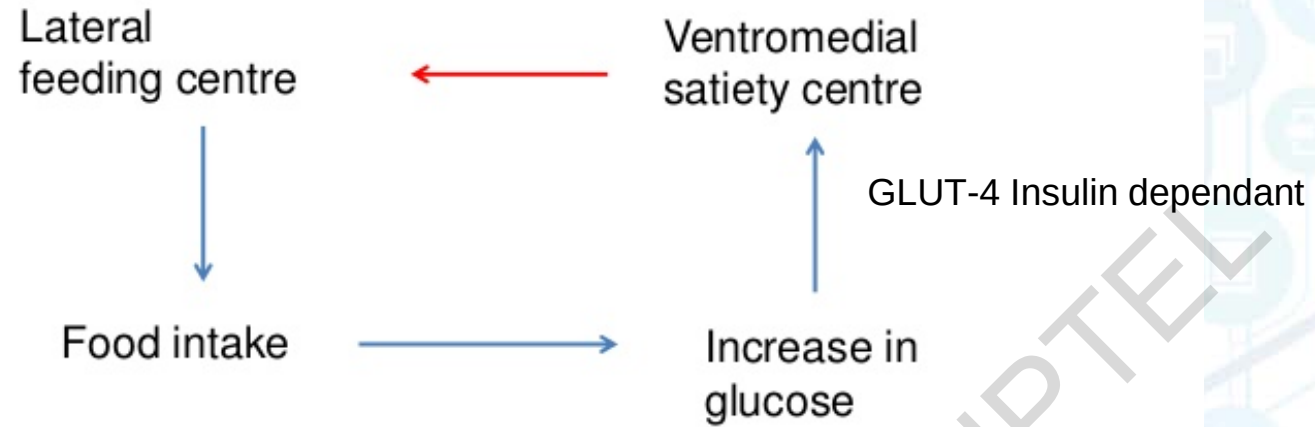
Mammillary – wake promoting area (histamine)
Posterior - Thermoregulation

When we remove the cortex- sham rage
Remove hypothalamus- placidity

Regulation of water balance



Regulation of food intake



**Diabetes mellitus- lack of insulin- no glucose uptake-satiety centre is not active
Feeding centre is active-polyphagia**

Food intake

Lateral hypothalamus-orexins
Responsible for feeding & arousal

NPY
INCREASES

Alpha-MSH
DECREASES

NPY/AgRP

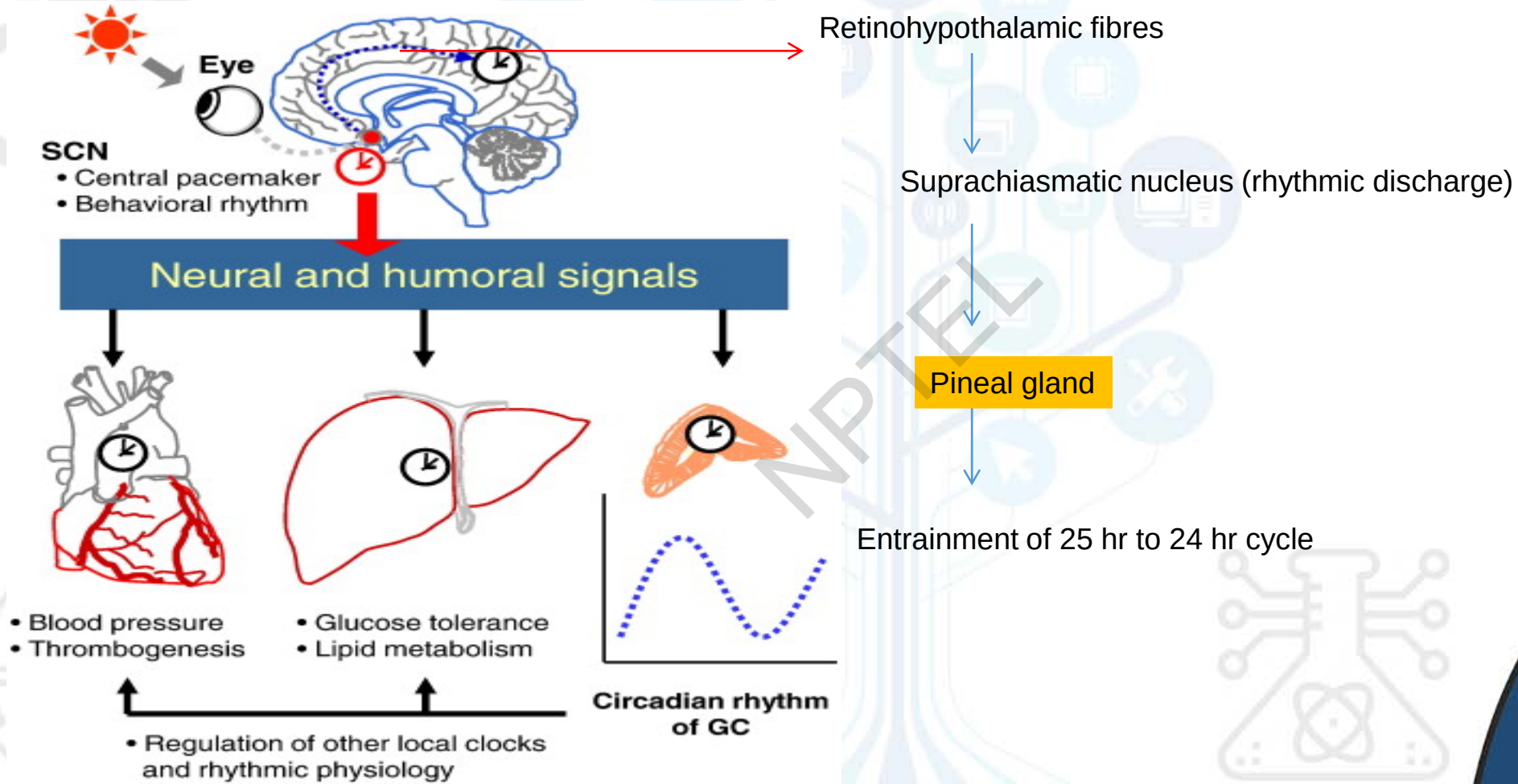
POMC

Arcuate nucleus

Ghrelin
CCK/GLP-1

Leptin
Insulin
Amylin
Dopamine

Circadian rhythm



KEY POINTS

- Thalamus is an integral part of motor loop of the brain, relay station for somatic sensations, special sensations, arousal, memory formation and language.
- When the thalamus is damaged, not only thalamic functions are lost, but also many cortical functions are affected, as the cortex is intimately connected with the thalamus.
- The hypothalamus is an essential component of regulation of many homeostatic functions, visceral functions, behavior, sleep-wakefulness, body rhythms (circadian and seasonal), feeding and reproductive functions.

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2. Kaplan & Sadock's Comprehensive Textbook of Psychiatry, 9e
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4. Medical Physiology, Walter F. Boron, 3e



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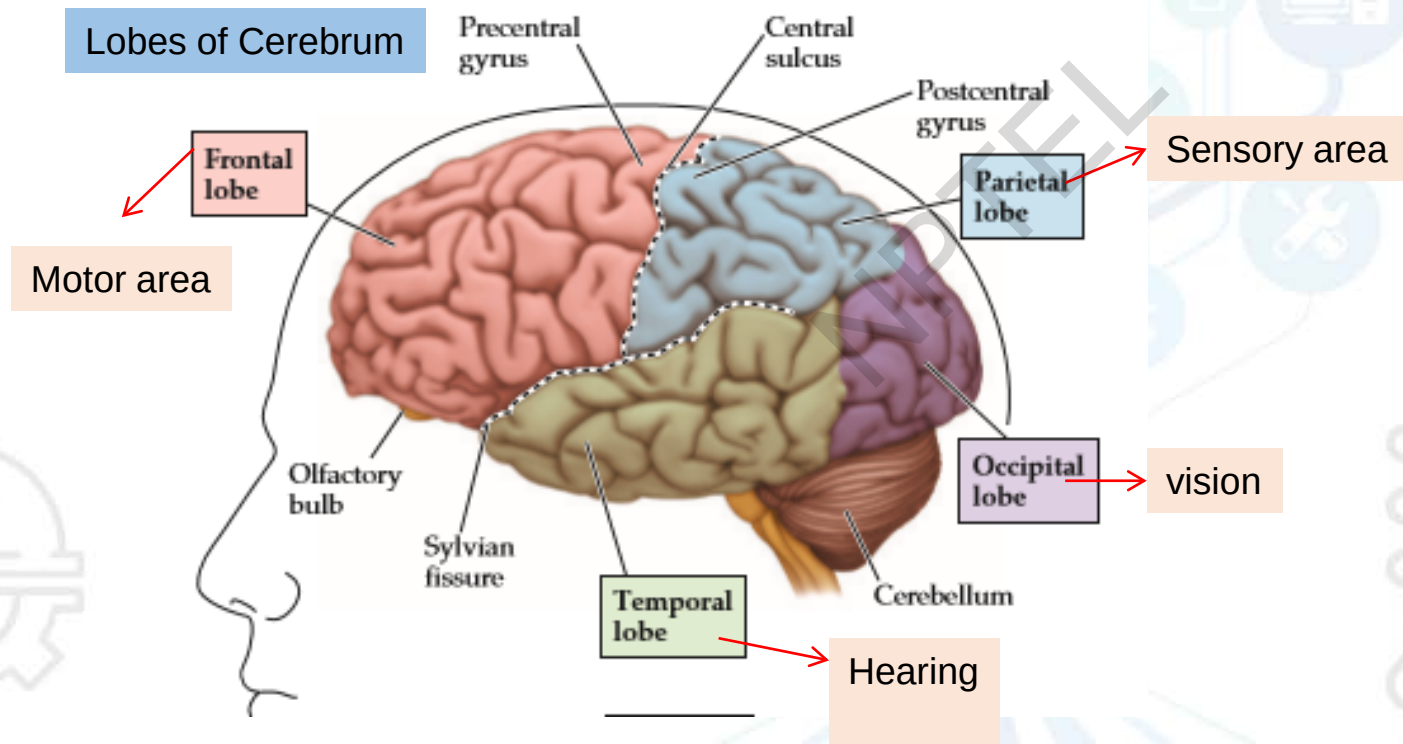
Lecture 5 : Cerebral Cortex

CONCEPTS COVERED

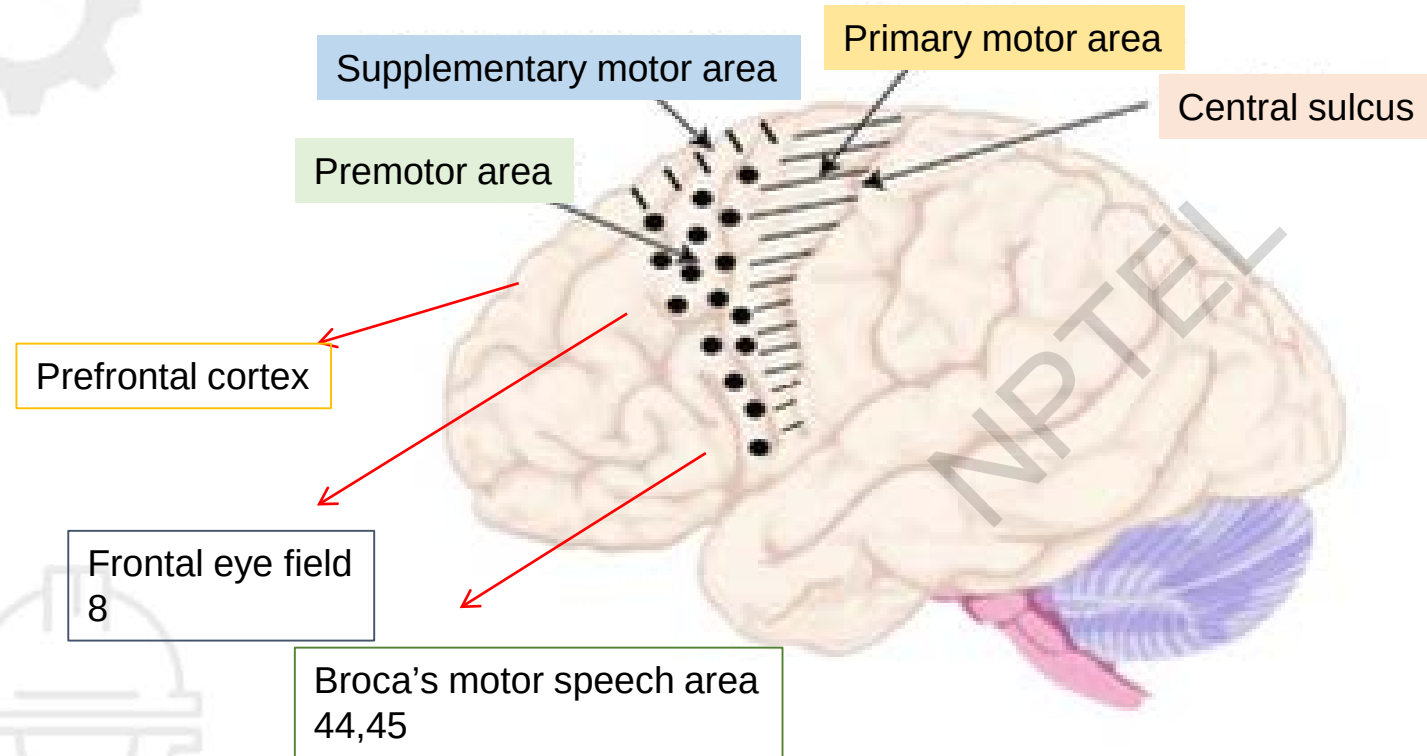
- Lobes of cerebrum
- Motor areas
- Sensory areas
- Homunculus
- Histology of cerebral cortex
- Applied aspects

Cerebral Cortex

- 2 cerebral hemispheres are connected by corpus callosum.
- Sulci & Gyri.



Motor areas



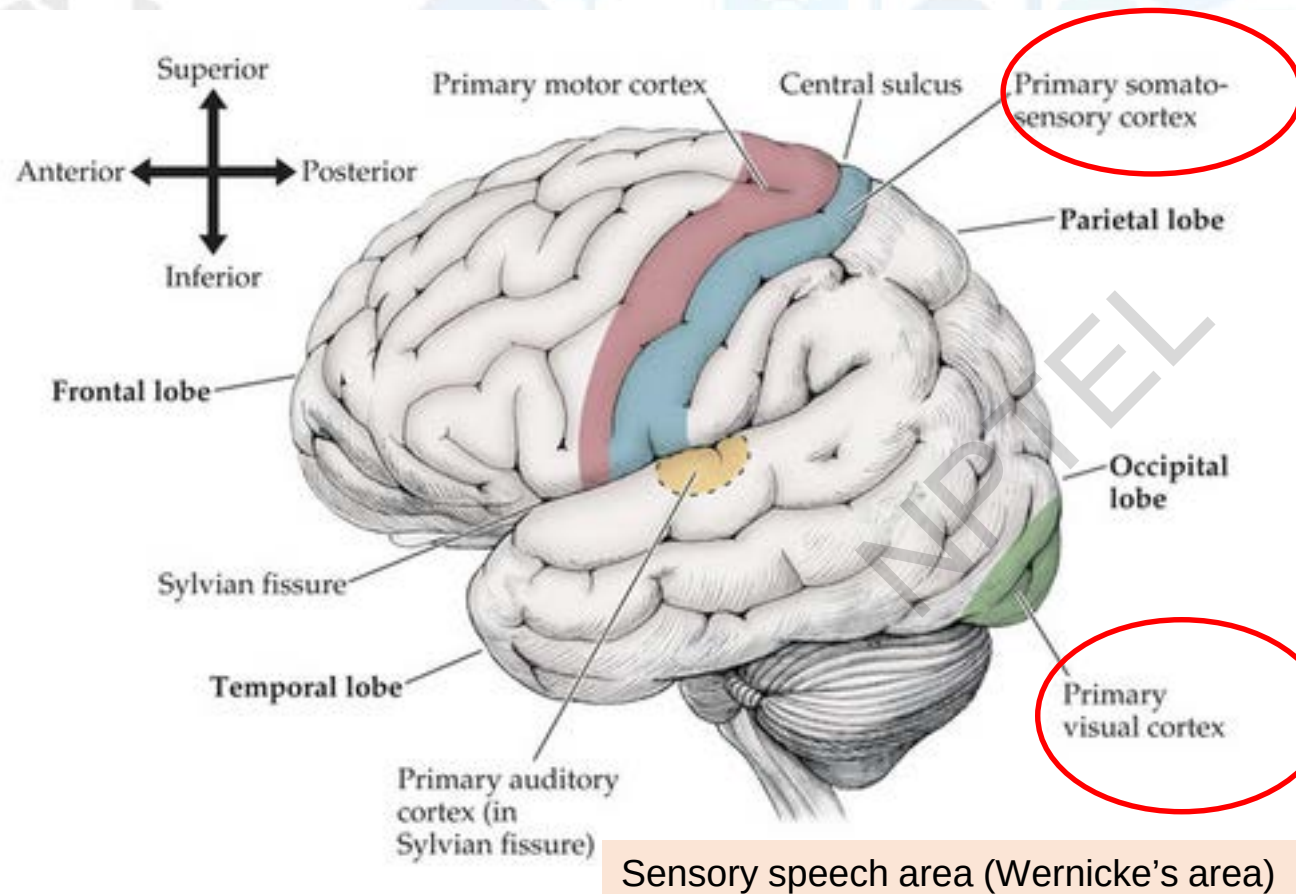


Motor areas	Functions
Primary motor area (4)	Initiation of voluntary activities of contralateral body Initiation of speech
Premotor area (6)	Coordinates the movements even before the actual action is started
Frontal eyefield (8)	Control of eye movements
Broca's motor speech area (44,45)	Articulation, movements of mouth, tongue during speech
Supplementary motor area	In association with premotor – movements of different parts of body, eyes, head
Prefrontal area	Centre for higher functions, intelligence, planning



Sensory areas

- Supplementary sensory areas
- Association areas

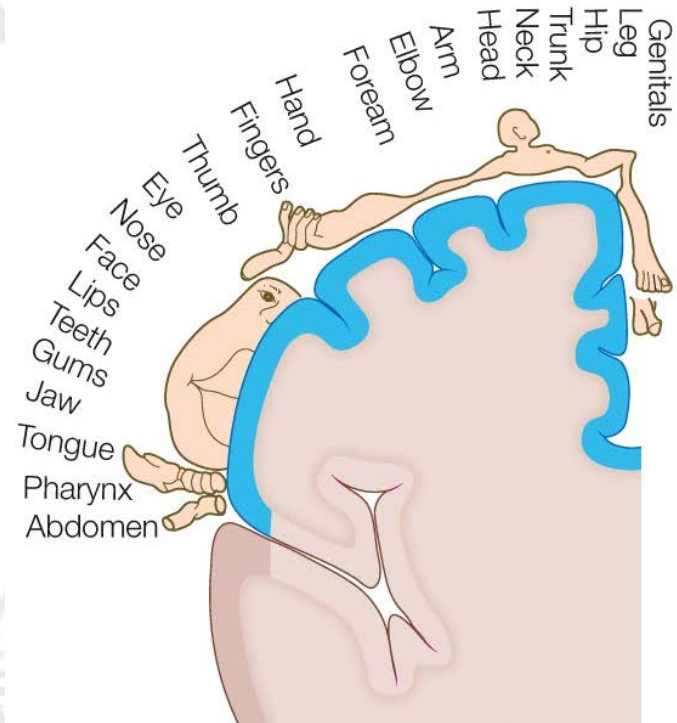


Sensory areas	Functions
Primary sensory area (3,1,2)	Receives sensory inputs from other half of cortex
Supplementary sensory areas	Receives inputs from thalamus
Sensory association areas (5,7)	Point to point representation for discrimination between stimuli
Inferior parietal lobule	Interpretation of sensory information in face, concerned with body image

Homunculus

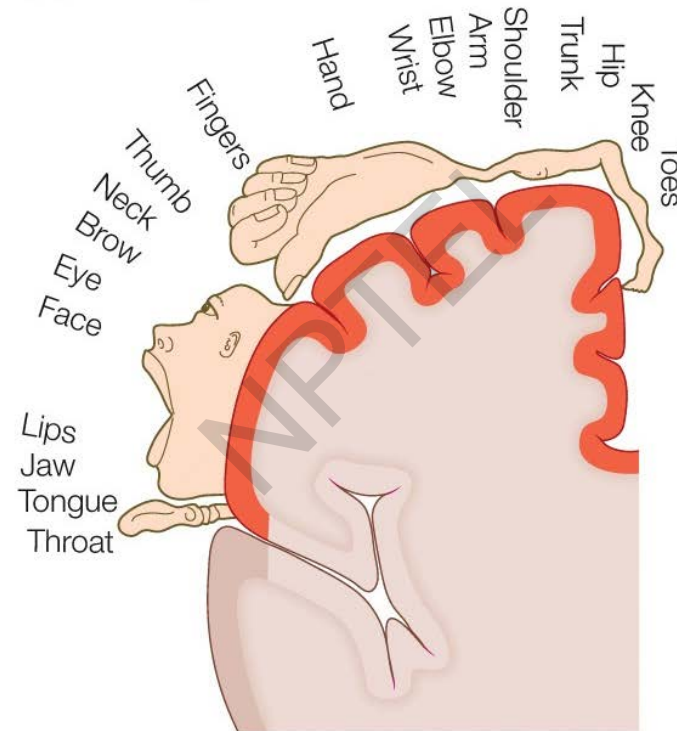
- Little man
- Image is distorted
- Proportionate to no. of receptors

(A) Primary somatosensory cortex



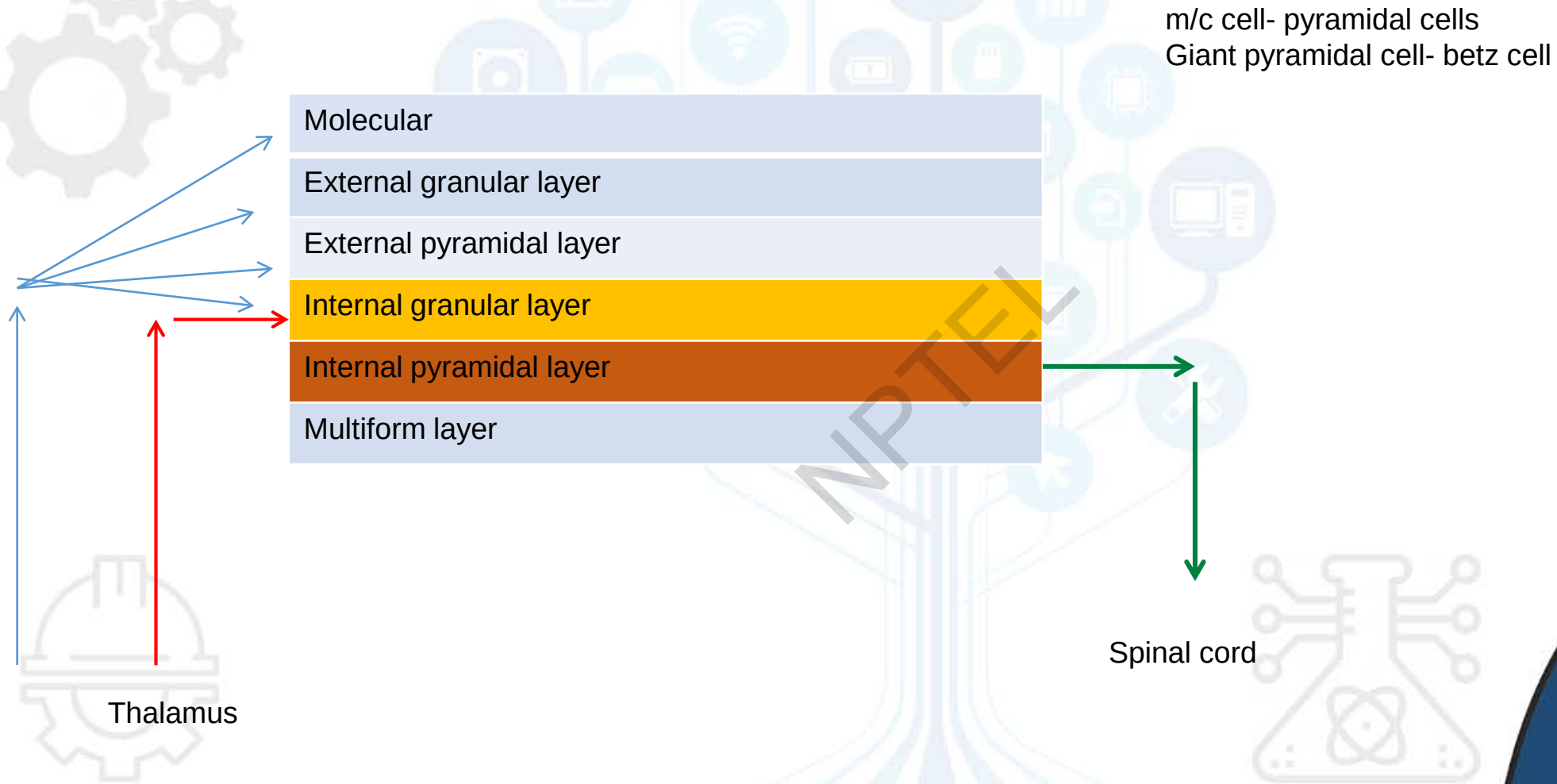
lips, face-max

(B) Primary motor cortex



muscles of articulation/speech-max

Cortex layers



KEY POINTS

- Motor area lies in front of central sulcus.
- Primary motor area is mainly for simple movements, for complex movements association motor cortex required.
- All somatosensations lost contralaterally if primary somatosensory area is destroyed.
- Graphaesthesia and stereognosis earliest to get lost.
- Internal pyramidal cell layer gives rise to corticospinal tract.

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1. Review of Medical Physiology, William F Ganong, 23e
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