

# NEURO- ANATOMY

## CHAPTER 4

In adults, spinal cord terminates at level of lower border of first lumbar vertebra. In young children, it is relatively longer & usually ends at upper border of L3. Filum terminal is extension of pia mater (last part of spinal cord).

Anterior Grey Column of spinal cord has:

- ① **Medial group** ⇒ innervates neck muscles, trunk muscles & muscles of lower limb & perineum.
- ② **Central group** ⇒ ~~innervates~~ Has 2 nuclei:
  - ① **Phrenic nucleus** ⇒ innervates diaphragm.
  - ② **Accessory nucleus** ⇒ its axons form spinal part of accessory nerve ⇒ innervates Sternocleidomastoid & Trapezius muscles.
- ③ **Lateral group** ⇒ innervates skeletal muscles of limbs (more specifically UPPER LIMBS).

Posterior Gray Column of spinal cord has:

- ① **Substantia gelatinosa** ⇒ Composed of Golgi Type II neurons & receive afferent fibers concerned with Pain, Temp. & Touch (PTT) from the posterior root.
- ② **Nucleus proprius** ⇒ (Receives fibers from posterior white column associated with proprioception, two-point discrimination & vibration).
- ③ **Nucleus dorsalis (Clarke column)** ⇒ Most of the cells are comparatively large & are associated with proprioceptive endings (neuromuscular spindles & tendon spindles).
- ④ **Visceral afferent nucleus** ⇒ Associated with receiving visceral afferent information.

Ant. spinothalamic T ⇒ POSTERIOR LIMB OF INTERNAL CAPSULE

Lat. spinothalamic T ⇒ "

Post. white column ⇒ "

Corticospinal T ⇒ "



| Region            | White Matter                                    | Ant. Gray Column                    | Post. Gray Column                                      |
|-------------------|---|-------------------------------------|--|
| Cervical<br>(MCL) | F. Cuneatus &<br>F. Gracilis present            | Medial, Central<br>& Lateral groups | Substantia Gelatinosa<br>& Nucleus Proprius<br>present |
| Thoracic<br>(M)   | F. Cuneatus (T1-T6)<br>& F. Gracilis<br>present | Medial group                        | SG, NP &<br>VAN present                                |
| Lumbar<br>(MC)    | F. Gracilis<br>present                          | Medial &<br>Central groups          | SG, NP, ND<br>& VAN present                            |
| Sacral<br>(M)     | F. Gracilis<br>present<br>(small amount)        | Medial group                        | SG & NP<br>present                                     |

Ant. spinothalamic T ⇒ Crude touch & Pressure  
 Lateral " " ⇒ Pain & Temp.

Post. white column ⇒ Discriminative touch, vibratory sensations, some proprioception.  
*Fasciculus Gracilis & Cuneatus*

Ant. & Post. Spinocerebellar T ⇒ Unconscious info. from muscles, joints, skin & SC Tissue (Proprioception).  
 + Cuneocerebellar T

Spinotectal T ⇒ Passes Pain, Touch & Temp. sensations to sup. colliculus of midbrain for spinovisual reflexes.

Spinoreticular T ⇒ Provides pathway from muscles, joints & skin to the reticular formation.

Spinoolivary T ⇒ Provides an indirect pathway for further afferent info. to reach the cerebellum.

Pain fibers [ Aδ (Fast) ⇒ Glutamate & Substance P  
 [ C (Slow) ⇒ Substance P

Pain receptors have little or no adaptation

Periventricular areas of diencephalon, periaqueductal gray matter of midbrain & nuclei of brainstem ⇒ Sites for action of

ANALGESIA SYSTEM of brain



# NEUROANATOMY (2)

As the Ant. Spinothalamic T ascends through medulla, it accompanies lateral ST Tract & Spinotectal T  $\Rightarrow$  Together form SPINAL LEMNISCUS

Posterior White Column tract:

$\rightarrow$  Ascends **IPSILATERALLY** till terminating by synapsing with 2<sup>nd</sup> order neurons of nucleus gracilis & cuneatus of medulla oblongata.

$\rightarrow$  It then decussates to the opposite side forming **INTERNAL ARCUATE FIBERS**.

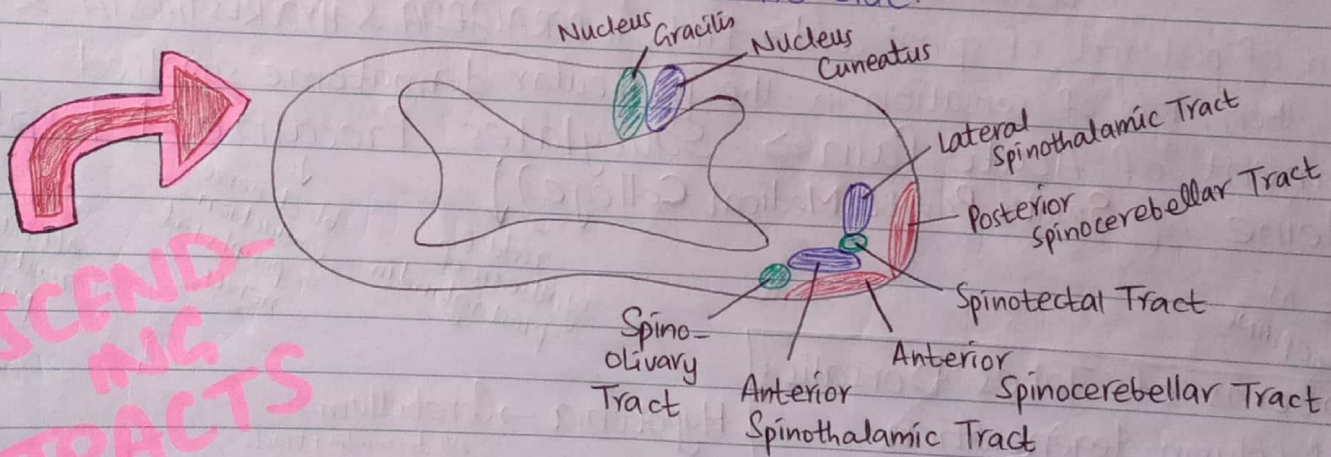
$\rightarrow$  Fibers then ascend further as **MEDIAL LEMNISCUS**.

(NOTE  $\Rightarrow$  Some fibers of Fasciculus Cuneatus (UPPER CERVICAL & FIRST SIX THORACIC) relay the axons of 2<sup>nd</sup> order neurons to cerebellum as **POSTERIOR EXTERNAL ARCUATE FIBERS** via **CUNEOCEREBELLAR TRACT**  $\Rightarrow$  Convey proprioception).

Spinocerebellar tract:

$\rightarrow$  ~~Ant.~~ <sup>Post</sup> SCT  $\Rightarrow$  does not cross at all.

$\rightarrow$  Ant. SCT  $\Rightarrow$  most of the fibers cross but they cross back in the cerebellum so, come to the **IPSILATERAL** side.



## DESCENDING TRACTS:

<sup>Cross</sup> Corticospinal T  $\Rightarrow$  Voluntary, discrete, skilled movements, especially those of the distal parts of the limbs.



- Reticulospinal T  $\Rightarrow$  Facilitate or inhibit voluntary movement or reflex activity
- Tectospinal T  $\Rightarrow$  Reflex postural movements concerning sight.
- Rubrospinal T  $\Rightarrow$  Facilitates  $\rightarrow$  Flexors      Inhibits  $\rightarrow$  Extensors
- Vestibulospinal T  $\Rightarrow$  Facilitates  $\rightarrow$  Extensors      Inhibits  $\rightarrow$  Flexors + Maintain balance
- Olivospinal T  $\Rightarrow$  Play a role in muscular activity.
- Descending autonomic fibers  $\Rightarrow$  Control of visceral activity.

THAT'S ODD!

**CORTICOSPINAL T:** (Fibers are myelinated but slow conducting)  
 $\rightarrow$   $2/3^{rd}$  fibers originate from precentral gyrus &  $1/3^{rd}$  from postcentral gyrus.

- $\rightarrow$  At the junction of medulla & spinal cord, most of the fibers cross the midline at the decussation of pyramids & enter lateral white column to form the lateral corticospinal tract.
- $\rightarrow$  Some of the fibers do not cross & are called ant. corticospinal tract. (they eventually cross at ant. gray column of spinal cord).

CLINICALS

- Lumbar puncture  $\approx$  below L2
- Lesion of ant. root of spinal cord  $\approx$  Paralysis of muscle
- Lesion of post. root of spinal cord  $\approx$  First, HYPERALGESIA & HYPERESTHESIA & then, loss of sensation in the particular dermatome supplied.

Treatment of Acute Pain  $\Rightarrow$  Salicylates, Procaine, Morphine,

Codeine (Swat's Private Medical College)

SAME AS MORPHINE

- reduce synthesis of prostaglandin
- block nerve conduction in peripheral nerves
- reduce the affective reaction to pain

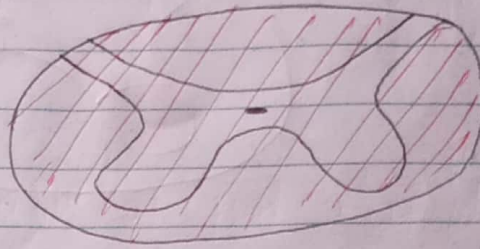
Symptoms of Tabes Dorsalis:

- Dorsal column degeneration
- Orthopedic pain
- Reflexes decreased
- Shooting pain
- Argyll-Robertson pupils
- Locomotor ataxia
- Impaired proprioception
- Syphilis

- Hypotonia  $\rightarrow$  Cerebellum
- Hypertonia  $\rightarrow$  All descending tracts but not corticospinal
- Tremors  $\rightarrow$  Parkinson, Thyrotoxicosis, Cerebellum
- Spasms  $\rightarrow$  All descending tracts but not corticospinal
- Athetosis  $\rightarrow$  Corpus striatum
- Chorea  $\rightarrow$  Corpus striatum
- Dystonia  $\rightarrow$  Lentiform nucleus
- Myoclonus  $\rightarrow$  Reticular formation & Cerebellum
- Hemiballismus  $\rightarrow$  Opposite subthalamic nuclei

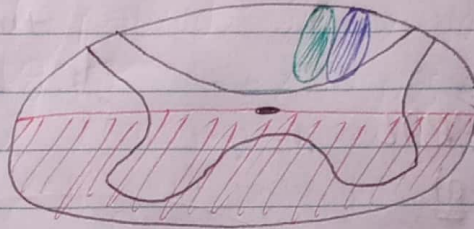


COMPLETE CORD  
 TRANSECTION SYNDROME:



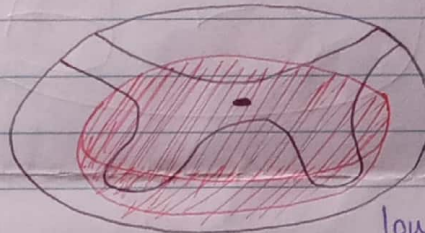
Everything you  
 can think of  
 is LOST!

ANTERIOR CORD  
 SYNDROME:



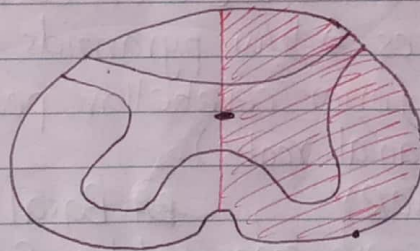
Everything is lost  
 EXCEPT Two-point  
 discrimination, vibration  
 & proprioception (b/c  
 nucleus cuneatus & gracilis  
 are not affected)

CENTRAL CORD  
 SYNDROME:



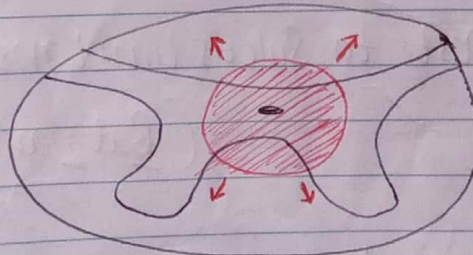
Everything is lost EXCEPT  
 there is a greater loss  
 in UPPER LIMBS as compared to  
 lower limbs, b/c fibers of Lower  
 Limbs are Lateral to those of upper limb &  
 so, some are saved + Sacral region is spared.

BROWN-SÉQUARD  
 SYNDROME:



All the sensations are lost  
~~CONTRALATERALLY~~<sup>IPSI</sup> EXCEPT  
 those of Ant. & Lateral  
 Spinothalamic Tracts  
 (i.e. Pain, Touch, <sup>Crude</sup>Temp.)

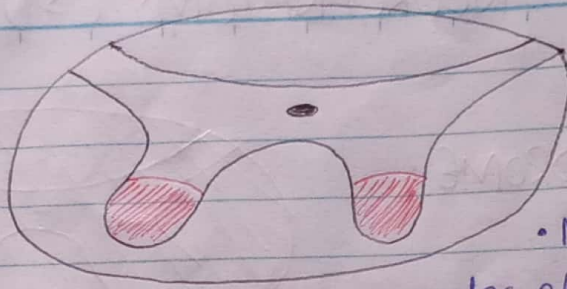
SYRINGOMYELIA:



<sup>CONTRALATERAL</sup>  
 Pain & Temp. are lost on  
 both sides of upper limbs  
 in a shawl-like fashion  
 (پیشے چادر کی طرح) + Horner's Syndrome  
 (miosis, ptosis & anhidrosis)



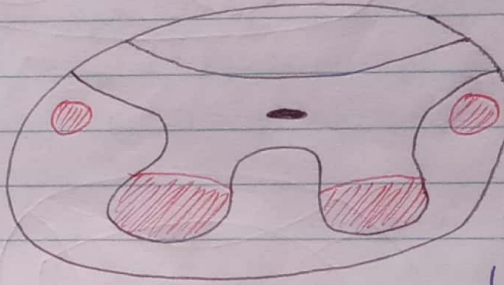
**POLIOMYELITIS:**



Viral infection of nucleus of ant. gray column + cranial nerve nuclei.

- Mostly affected are muscles of LOWER LIMB.
- Paralysis of intercostals & diaphragm + muscles of face, pharynx, larynx & tongue.

**AMYOTROPHIC LATERAL SCLEROSIS (ALS) or LOU GEHRIG DISEASE**



Affects ant. gray column + corticospinal tracts

- Symptoms of both mixed UMNL & LMNL.

**CHAPTER 5**

**Medulla Oblongata:**

Ant.  $\Rightarrow$  Ant. median fissure  $\Rightarrow$  on each side has pyramids  $\Rightarrow$  on each side has olives  $\Rightarrow$  b/w pyramids & olives, CN XII emerge.  $\rightarrow$  Post. to olives are inferior cerebellar peduncles  $\Rightarrow$  site of origin of CN 9, 10, 11 (only cranial roots).

NOTE  $\rightarrow$  Alar plate  $\rightarrow$  SENSORY, Basal plate  $\rightarrow$  MOTOR  
 Alar & basal plates are separated by SULCUS LIMITANS.

In spinal cord,

Alar plate is post. to Sulcus limitans & Basal plate is ant.

(Batman's ASS)

In medulla oblongata,

Alar plate is lateral to Sulcus limitans & Basal plate is medial. (Motor is Medial)



# NEUROANATOMY (4)

Olivary Nuclear Complex: (DIM)

Inferior olivary N, Dorsal & Medial accessory olivary nuclei

Vestibulocochlear Nuclear Complex: (SLIM) (AP)

Superior, Lateral, Inferior & Medial Vestibular Nuclei

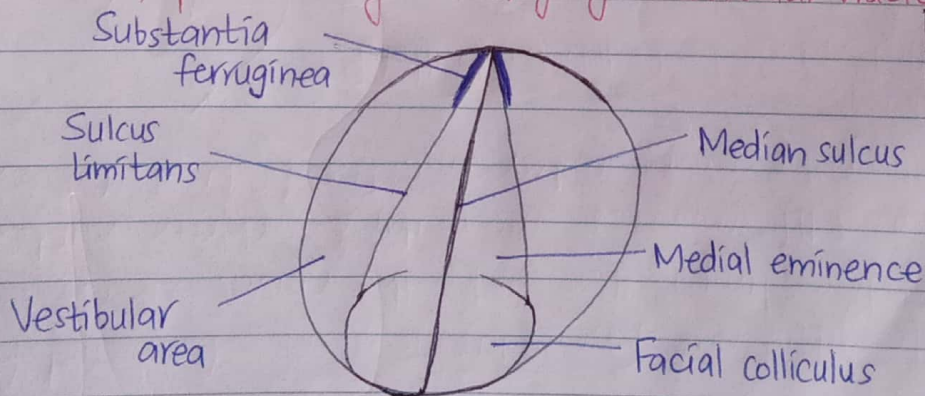
Anterior & Posterior Cochlear Nuclei

## PONS:

→ Basilar groove in the middle for the Basilar Artery.

- On the anterolateral surface of pons, CN 5 emerges on each side having motor part on its medial & large sensory root on its lateral
- In the groove b/w pons & medulla, from medial to lateral are CN 6, 7 & 8.

On its posterior side, it forms upper half of floor of 4<sup>th</sup> ventricle. Limited laterally by sup. cerebellar peduncle ⇒ in the middle is the MEDIAN SULCUS, lateral to which is medial eminence, which is bounded laterally by SULCUS LIMITANS. Inferior end of medial eminence is slightly expanded to form FACIAL COLLICULUS (produced by facial N). The floor of the superior part of sulcus limitans is bluish-gray in colour & is called SUBSTANTIA FERRUGINEA, it is b/c of color to the group of deeply pigmented nerve cells. Lateral to the sulcus limitans is the AREA VESTIBULI, produced by underlying Vestibular nuclei.



Trapezoid body is made of fibers from COCHLEAR NUCLEI & NUCLEI OF TRAPEZOID BODY.

Pons is divided into Ant. → Basal part & Post. → Tegmentum

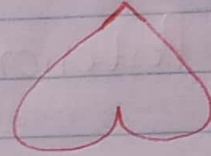


by transversely running fibers i.e. Trapezoid body.

NOTE \* Medial Longitudinal Fasciculus is a set of crossed fibers (ascending & descending) that links the nerves which control eye movements i.e. MLF connects vestibular & cochlear nuclei with the nuclei controlling the extra ocular muscles (C.N. 3, 4 & 6).

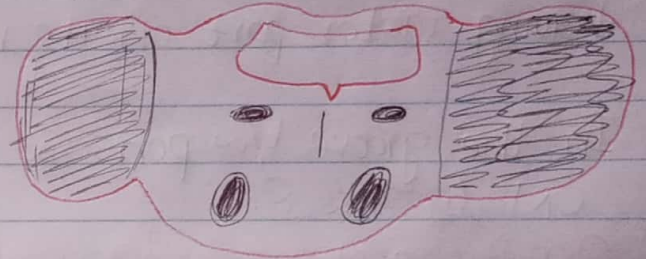
DESI TIPS

• Mid brain look INVERTED HEART



• Pons look like

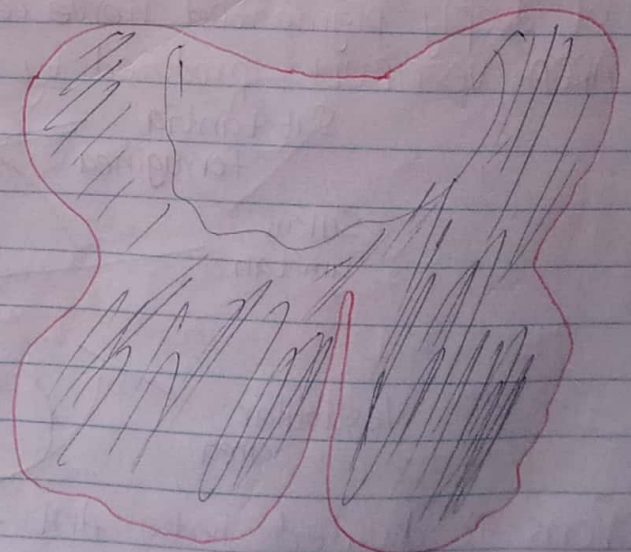
↳ At upper section as ~~an~~ ELEPHANT WITHOUT TRUNK (at level of trigeminal nuclei)



↳ At lower section as a scrotum



• Medulla Oblongata look like a BUTTERFLY





# NEUROANATOMY (5)

Mid brain:

→ Tegmentum

On post. surface → 4 colliculi (CORPORA QUADRIGEMINA)

Sup. colliculus ⇒ Visual reflexes

Inf. colliculus ⇒ Auditory centers

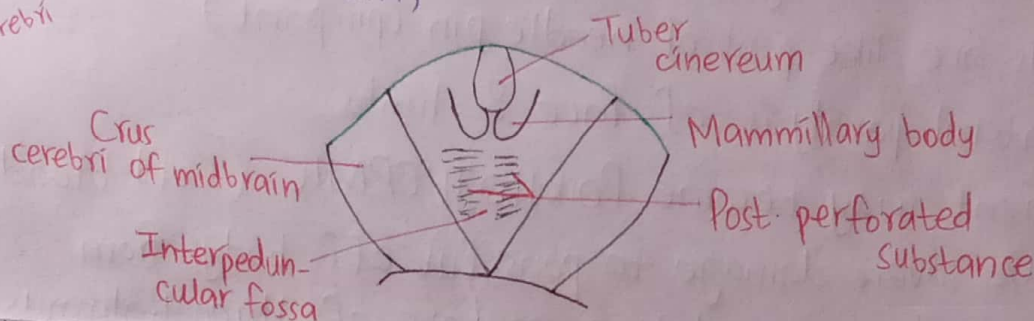
In the midline below inf. colliculi, CN 4 emerges (the only CN that emerges POSTERIORLY).

On the lateral aspect are Sup. & Inf. brachium.

(Sup. brachium connects sup. colliculus → lateral geniculate body + optic tract)  
(Inf. brachium connects inf. colliculus → medial geniculate body)

Ant. portion of Midbrain,

← Crus cerebri



Substantia nigra is a large motor nucleus b/w tegmentum & crus cerebri of midbrain. It possess inclusion granules of melanin pigment.

Red nucleus is a rounded mass of gray matter situated b/w the cerebral aqueduct & the substantia nigra. Its reddish hue is due to vascularity & presence of iron-containing pigment in the cytoplasm of many of its neurons.

## CLINICALS

ARNOLD - CHIARI MALFORMATION ⇒ Herniation of the tonsils of the cerebellum & the medulla through the foramen magnum into the vertebral canal.

Results in ⇒

- Blockage of exits in the roof of 4<sup>th</sup> ventricle to CSF.
- Causes internal hydrocephalus.



NOTE → ASTROCYTOMA of the pons occurring in childhood  
most common tumor of the brain stem.

## HEMORRHAGE:

Pons is supplied by Basilar A & the ant., inf. & sup. cerebellar arteries.

① If H occurs from one of those arteries & is unilateral:

- Facial paralysis on side of lesion
- Paralysis of limbs on the opposite side
- Paralysis of conjugate ocular deviation

② If H occurs bilaterally & is extensive:

- Pupils are like point of needle pin (pinpoint)
- Bilateral paralysis of face & limbs
- Patient may become POIKIOTHERMIC (Cold-blooded)  
(b/c severe damage to pons cut off body from heat regulating centers of Hypothalamus)

## WEBER SYNDROME:

- Occurs b/c of occlusion of branch of Post. Cerebral A <sup>→ supplies Midbrain</sup>
- Results in the necrosis of brain tissue involving the CN. 3 & crus cerebri

↓  
ant. portion  
of midbrain

## BENEDIKT SYNDROME:

- Similar to Weber Syndrome, EXCEPT that the necrosis involves Medial lemniscus & Red nucleus.

————— X ————— X —————



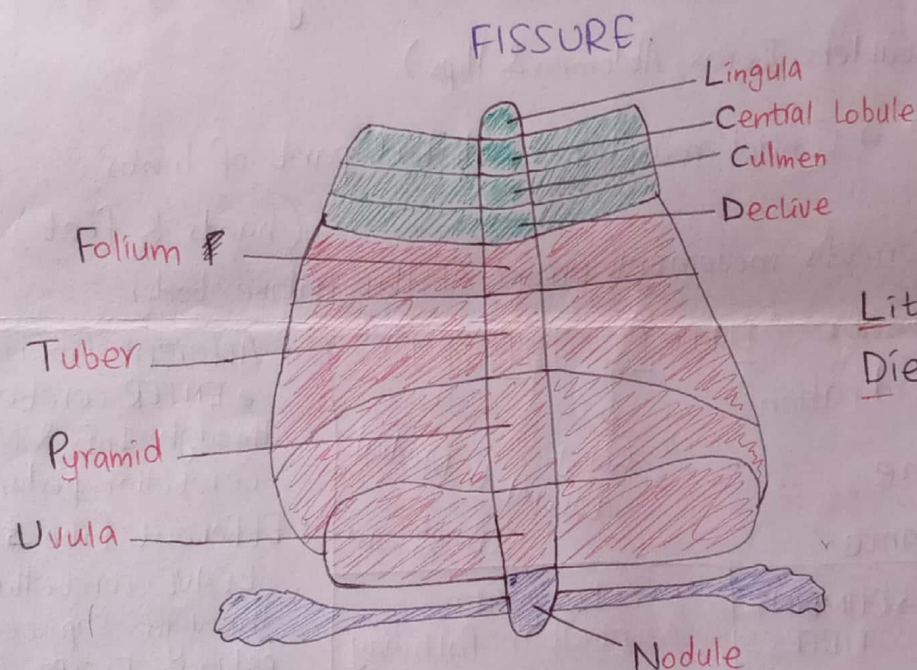
# NEUROANATOMY (6)

## CHAPTER 6

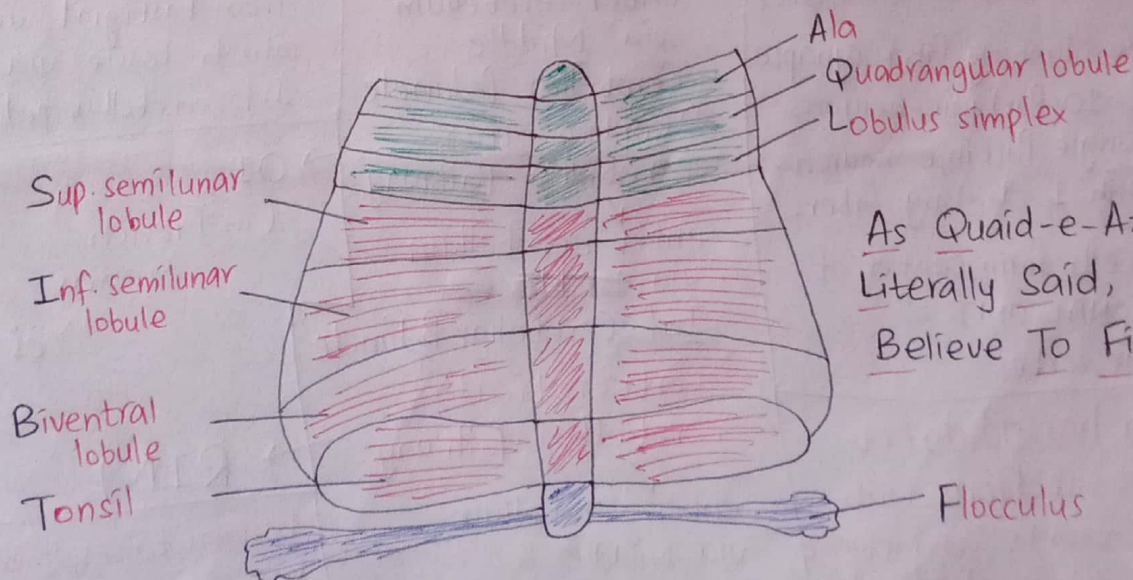
### Cerebellum :

Divided into 3 main lobes:

- ① Anterior lobe  $\Rightarrow$  On superior surface & is separated from middle lobe by a wide V-shaped fissure called PRIMARY FISSURE.
- ② Middle lobe  $\Rightarrow$  LARGEST PART. b/w PRIMARY & UVULONODULAR FISSURES.  
(Post. lobe)
- ③ Flocculonodular lobe  $\Rightarrow$  Situated posterior to the UVULONODULAR



Little Chuck Couldn't  
Die For The PUN



As Quaid-e-Azam  
Literally Said, "I  
Believe To Fight."



Cerebellar cortex (gray matter) is divided into 3 layers: (My Personal Gard. signs & Hypo)

① Molecular Layer:

(dendrites of all cells wanna come to this cool layer)  
Has 2 cells ⇒ Outer Stellate & inner basket cells.

② Purkinje Layer:

Have Purkinje cells (Golgi Type I neurons)

③ Granular Layer:

EXCITATORY

Have Granular cells.

Dendrites of Granular & Purkinje cells synapse in the molecular layer.

• 3 functional areas:

① Cortex of vermis ⇒ Influences movements of long axis of the body (Neck, Shoulders, Thorax, Abdomen & Hips).

② Intermediate zone ⇒ Control muscles of distal part of limbs

③ Lateral zone ⇒ Corrects movement errors of the entire body. (hands & feet)

• Intracerebellar Nuclei: (Dad's Ex Girlfriend)

- Dentate → Coordination
- Emboliform } Tone
- Globose }
- Fastigial → Balance

↓  
Going Lateral to Medial  
→ Prime Minister

• Afferent fibers  
• ENTER cerebellum through Inf. & Middle Cerebellar peduncles

• Efferent fibers  
LEAVE cerebellum through Sup. cerebellar peduncle EXCEPT fibers from Fastigial nucleus which leave via Inf. cerebellar peduncle

• Olivocerebellar tracts → CLIMBING FIBERS

• All other tracts → MOSSY FIBERS

NOTE ⇒ • One climbing fiber synapse with 1-10 Purkinje neurons while a single Purkinje neuron synapse with 1 climbing fiber.

• Purkinje cells form center of the FUNCTIONAL UNIT of cerebellar cortex

① Corticoponto-cerebellar Pathway  
↓  
enter cerebellum via Middle Cerebellar Peduncle

② Cortico-olivo-cerebellar Pathway  
↓  
enter cerebellum via ~~Middle~~ Inf. Cerebellar Peduncle

③ Corticoreticulo-cerebellar Pathway  
↓  
enter cerebellum via Middle & Inf. Cerebellar Peduncle

→ OI  
(in French, means "Yes")

→ RIM

Cerebellum has no direct neuronal connections with LMN but exerts its influence indirectly through cerebral cortex & brain stem.

Lesions to cerebellar hemispheres give rise to signs & symptoms IPSILATERALLY



# NEUROANATOMY (7a)

## Signs & Symptoms of Cerebellar Disease:

- Hypotonia • Postural changes + Alteration of gait • Dysdiadochokinesia
- Disturbances of voluntary movement (ATAXIA) • Disturbed reflexes
- Disturbed ocular movement (NYSTAGMUS) → if on right eye moves slowly & left eye moves fast, we say there's nystagmus in left eye.
- Disorders of speech (DYSARTHRIA)

If you can spell it, you're a COOL DUDE

## VERMIS SYNDROME:

- Caused by Medulloblastoma (brain tumor) of vermis.
- Muscle incoordination occurs in midline structures of the body i.e. Head & trunk (not the limbs).

ALCOHOL damages CEREBELLUM!

## NOTE

Cuneocerebellar fibers → Inf. cerebellar peduncle

Cerebellar reticular fibers → Inf. " "

Cerebellar rubral fibers → Sup. " "

upper (i.e. sup.)

## CHAPTER 7

Telencephalon → Cerebral Hemispheres

Diencephalon → 3<sup>rd</sup> ventricle & structures surrounding it (Thalamus, Subthalamus, Epithalamus & Hypothalamus)

\* DIAGRAMS ON PAGE 251 ARE HIGH YIELD \*

Diencephalon can be divided into 4 major parts:

① THALAMUS (read Chapter 12)

② SUBTHALAMUS

- Inferior to thalamus (i.e. b/w thalamus & tegmentum of midbrain)
- Its main components are RED NUCLEI & SUBSTANTIA NIGRA
- Subthalamic nucleus has important connections with corpus striatum thus, is involved in control of muscle activity (function of Basal Ganglia)

③ EPITHALAMUS

- Its main components are HABENULAR NUCLEI & PINEAL GLAND.

④ Habenular nucleus:

- Small group of neurons situated medial to the post.



surface of thalamus.

- Receive afferent fibers from amygdaloid nucleus via *S. Medullaris Thalami*.
- Center for integration of Olfactory, Visceral & Somat Afferent Pathways.

### ⑥ Pineal body (Gland):

- Microscopically, has 2 types of cells  $\Rightarrow$  PINEALOCYTES & GLIAL CELLS.
- Concretions of calcified material (BRAIN SAND) progressively accumulate within pineal gland with age.
- It possesses NO NERVE CELLS, but Adrenergic sympathetic fibers.
- Their actions are INHIBITORY, either directly inhibit production of hormones or indirectly inhibit releasing factors from Hypoth.
- PINEAL GLAND  $\rightarrow$  LACKS BBB.
- It also promotes Circadian Rhythm  $\rightarrow$  Most active during darkness
- Melatonin is present in high conc. in pineal gland. When it's released  $\rightarrow$  Gonadotrophic Hormones are INHIBITED.

(useful in pregnancy)

### ④ HYPOTHALAMUS (read chapter 13)

\* DIAGRAMS on page 255 & 256 are HIGH YIELD \*

NOTE  $\rightarrow$  The central sulcus indents the superior medial border of the hemisphere about 0.4" (1cm) behind midpoint.

#### LATERAL SULCUS

- $\rightarrow$  Ant Horizontal ramus
- $\rightarrow$  Post Horizontal ramus
- $\rightarrow$  Ascending ramus

#### CALCARINE SULCUS

- $\rightarrow$  Medial surface of hemisphere
- $\rightarrow$  Goes post. to end at occipital pole by joining with PARIETO-OCCIPITAL SULCUS.



# NEUROANATOMY (76)

White matter is composed of myelinated nerve fibers.  
They are classified into 3 groups:

## ① COMMISSURE FIBERS:

- Connect corresponding regions of 2 hemispheres.
- e.g. Corpus callosum, Ant. commissure, Post. commissure, Fornix, Habenular commissure

## a) Corpus Callosum (LARGEST COMMISSURE OF THE BRAIN)

has 4 parts ⇒

- Rostrum (Thin, anterior end)
- Genu (curved part)
- Body (arches posteriorly)
- Splenium (Thick, posterior end)

TELA CHOROIDEA is a two-layered fold of Pia mater, situated b/w Fornix Sup., Roof of 3<sup>rd</sup> ventricle, upper surfaces of the two thalami.

- Traced laterally, the fibers of GENU curve forward into frontal lobes & form the FORCEPS MINOR.
- Traced laterally, the fibers of SPLENIUM curve backward into occipital lobes & form the FORCEPS MAJOR.

b) Anterior Commissure ⇒ Small bundles of nerve fibers that crosses the midline in the LAMINA TERMINALIS.

c) Posterior Commissure ⇒ Bundles of nerve fibers that crosses the midline immediately above the opening of cerebral aqueduct into 3<sup>rd</sup> ventricle.



d) Fornix → Composed of myelinated nerve fibers & constitute the efferent system of hippocampus that passes to the mammillary bodies of the hypothalamus.

• The nerve fibers first form ALVEUS & then FIMBRIA

e) Habenular Commissure ⇒ Small bundle of nerve fibers that crosses the midline in the superior part of the root of the pineal stalk.

• Associated with HABENULAR NUCLEI.

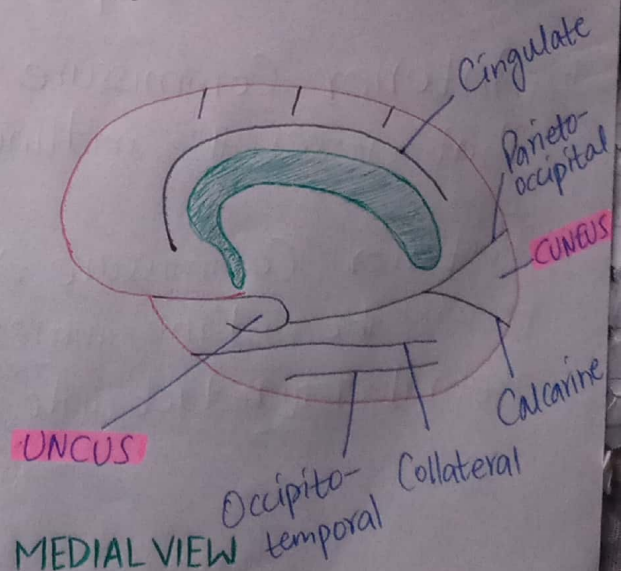
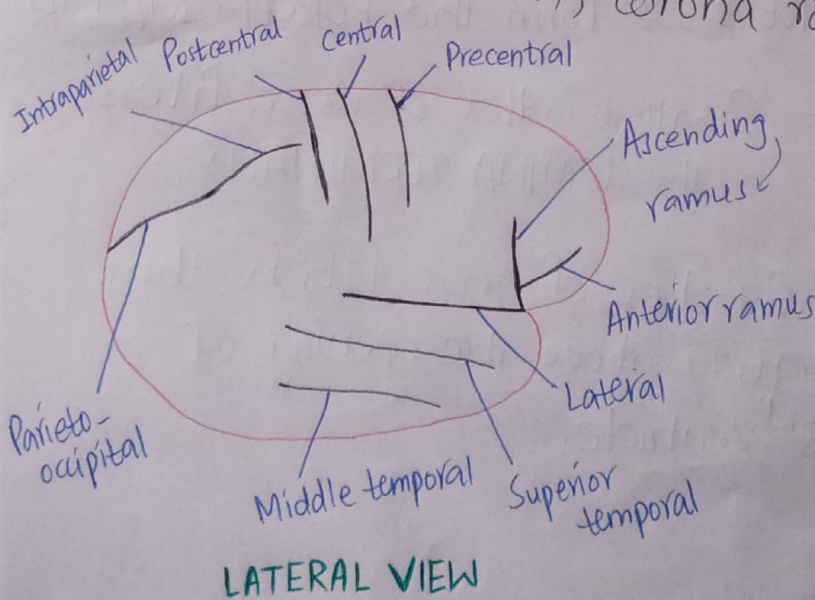
### ② ASSOCIATION FIBERS:

- Connect various cortical regions within the same hemisphere.
- e.g. Short & long association fibers, Uncinate fasciculus, cingulum, superior longitudinal fasciculus, inferior longitudinal fasciculus, fronto-occipital fasciculus.

### ③ PROJECTION FIBERS:

- These are large nuclear masses of gray matter within the cerebral hemisphere through which afferent & efferent nerve fibers pass to & from brainstem to cerebral cortex.

e.g. Optic radiation, corona radiata.



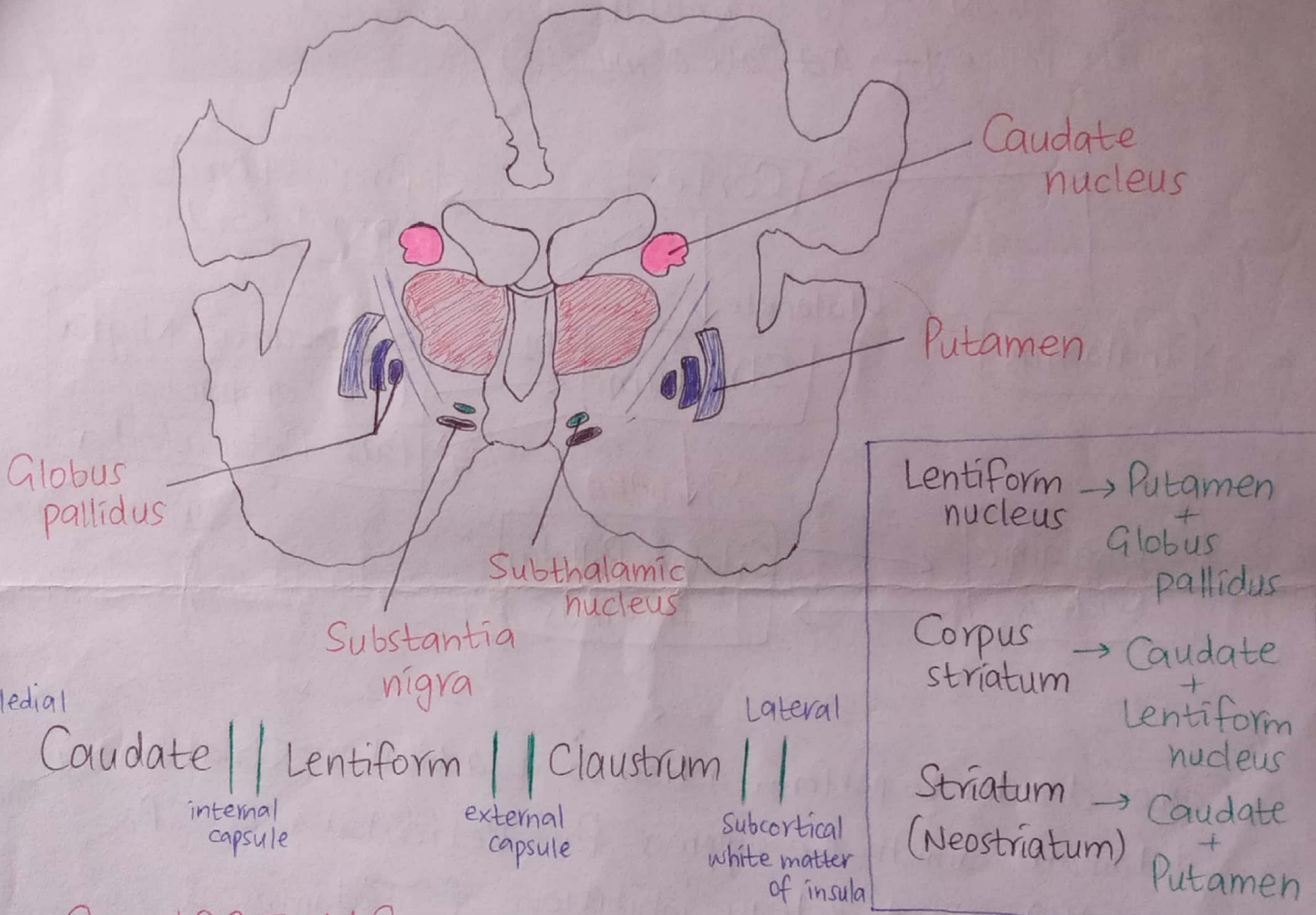


# NEUROANATOMY (8)

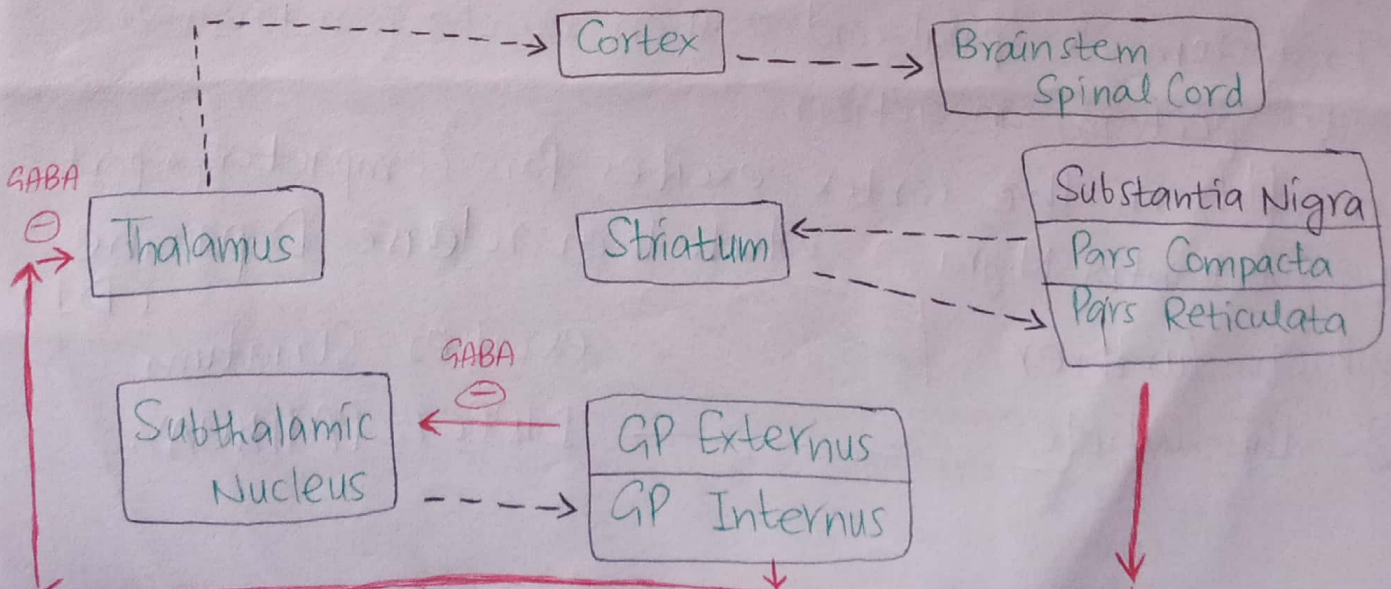
## CHAPTER 10

Components of Basal Ganglia are:

- Substantia Nigra
- Subthalamic Nucleus
- Putamen
- Globus Pallidus
- Caudate Nucleus



## CONNECTIONS (AT REST)

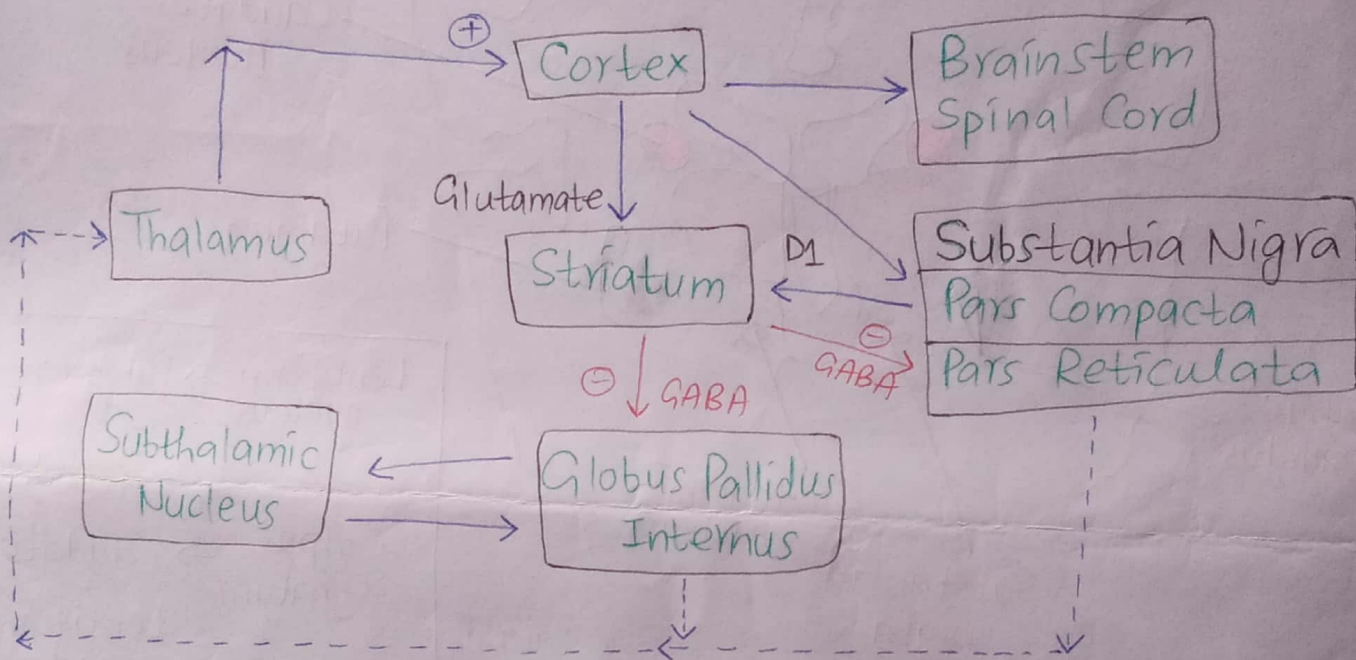




NOTE → From previous diagram, we can see that even at REST, the thalamus wants to excite Brainstem & Spinal Cord by giving continuous connections to the cortex BUT it does not happen b/c AT REST, GP Internus (GPI) & Pars Reticulata (part of Substantia Nigra) are continually suppressing thalamus by producing GABA.

## CONNECTIONS (To Stimulate Movement)

(Direct Pathway → Activate a muscle)



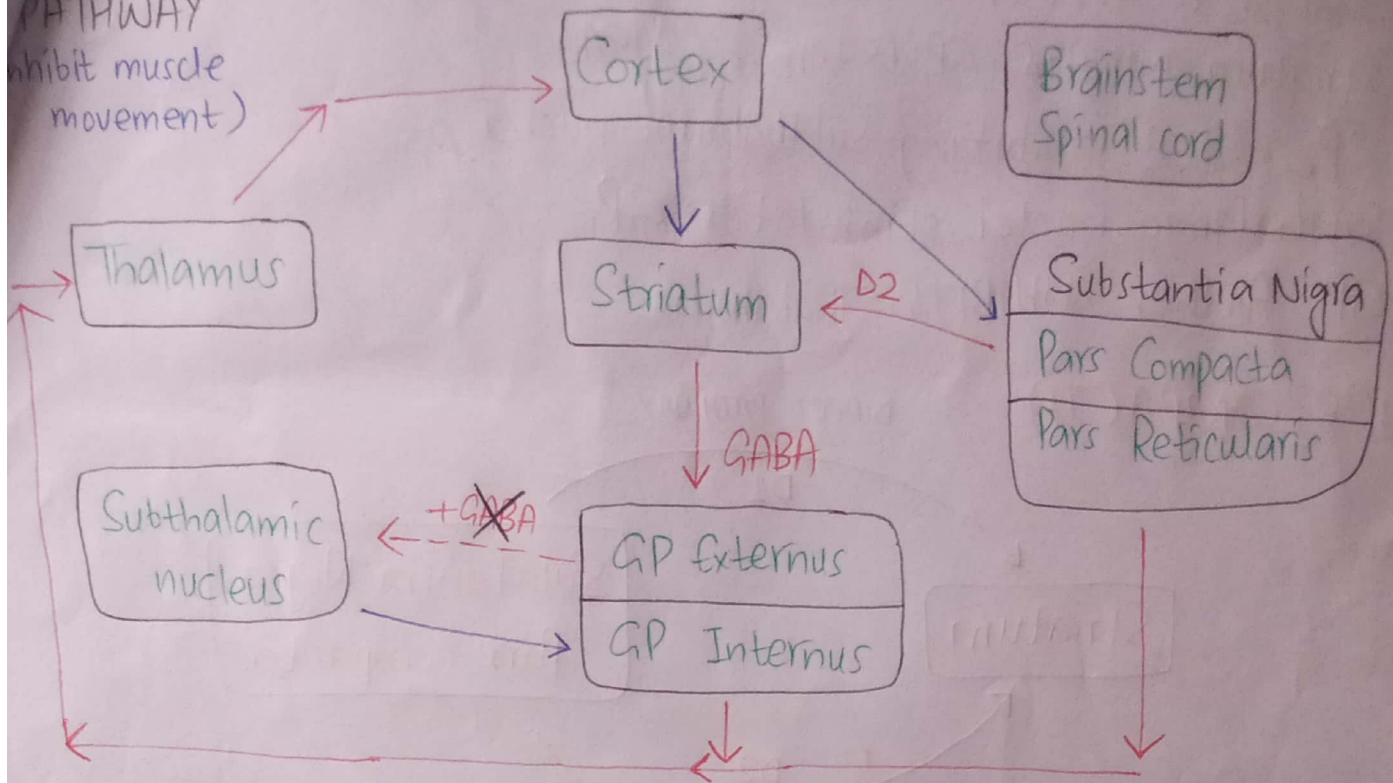
Cortex decides to perform action so it activates Striatum by Glutamate, which then suppress Pars Reticulata & GPI by GABA which release inhibition of Thalamus & now thalamus can excite cortex in order to excite brainstem & spinal cord so then muscle is activated to perform an action.

In addition, the cortex excites Pars Compacta (a part of Substantia Nigra) which then release Dopamine (D1) which further ~~excites~~ excites Striatum & this whole DIRECT PATHWAY.



# NEUROANATOMY (9)

DIRECT PATHWAY  
(inhibit muscle movement)



In order to perform movement, when one muscle is excited (by DIRECT PATHWAY), the antagonist is inhibited (by INDIRECT PATHWAY). It occurs as follows,

Cortex stimulate Striatum which INHIBITS GP EXTERNUS by GABA. (NOTE GP Externus normally suppresses Subthalamic nucleus by GABA) This results in activation of Subthalamic nucleus, which ACTIVATES GP Internus. GPi now release even more GABA than normal on Thalamus & suppress it even more than when it was At Rest.

As a side pathway, Cortex stimulates Pars Compacta, which releases Dopamine D2 (at D2 receptors) which lead to production of even more GABA to suppress GP Externus even more.

## KEY POINTS : DIRECT PATHWAY :

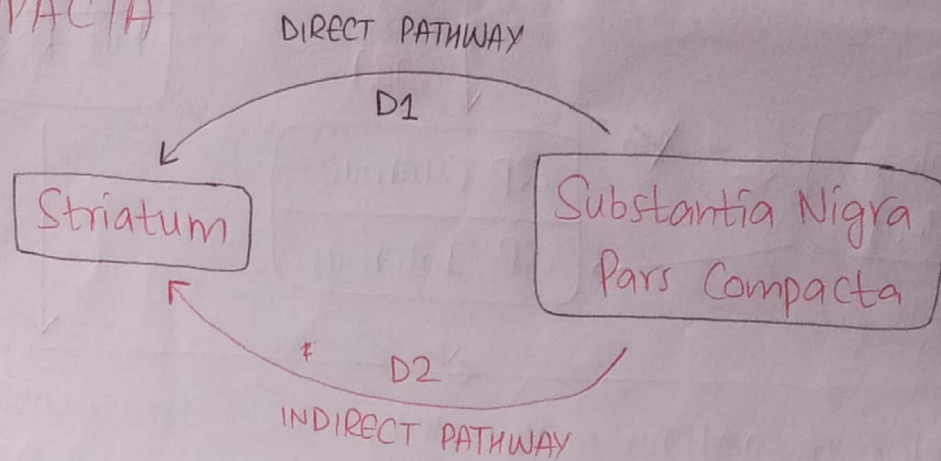
- Goal is to create movement
- Striatum INHIBITS (GABA) GPi & PR
- GPi & PR STOP inhibiting Thalamus
- Thalamus is free to activate cortex



## INDIRECT PATHWAY:

- Goal is to further inhibit movement
- Striatum INHIBITS GP externus (GABA)
- GPe STOP inhibiting Subthalamic nuclei
- Subthalamic nuclei stimulates GPi
- GPi further INHIBITS Thalamus

## PARS COMPACTA



① The above pathway is destroyed during PARKINSON'S DISEASE.

### NOTE

There are certain fibers (STRIATONIGRAL FIBERS) that go from Striatum to Substantia Nigra to suppress it (by GABA, Ach or Substance P).

② In HUNTINGTON'S DISEASE, the striatonigral fibers degenerate & Substantia Nigra is overly stimulated.

③ Sydenham Chorea (St. Vitus' Dance) occurs commonly during RHEUMATIC FEVER b/c the antigens of Streptococcal bacteria are similar to the antigens of striatal neurons. So, the antibodies are most likely to attack striatal neurons too while attacking Streptococcal bacteria.

④ Hemiballismus occurs on OPPOSITE side of the site of lesion ~~of~~ in subthalamic nucleus.



# NEUROANATOMY (10)

## CHAPTER 9

Main functions of Reticular Formation are:

- Control of skeletal muscle
- Control of muscles of facial expression
- Somatic & visceral sensations
- ANS
- Endocrine system
- Influence on biological clocks
- Reticular activating system.

### LIMBIC SYSTEM :

- Emotion
- Long-term memory
- Smell
- ANS function
- Behavior changes (modulation)

### Components :

- Cingulate gyrus
- Hippocampus
- Fornix
- Amygdala (Amygdaloid nucleus)
- Mammillary bodies
- Ant. thalamic nucleus

If limbic receptors to dopamine are blocked by a pharmacological agent, the greater symptoms of Schizophrenia are lessened.

### CLINICALS

- Lesions of HIPPOCAMPUS (concerned with converting recent memory to long-term) results in Anterograde amnesia (Aagay kuch yaad nahi rahe ga)
- Damage to Reticular Formation  $\Rightarrow$  loss of consciousness & coma.

- Bilateral removal of temporal lobes (or simply destruction of amygdaloid nucleus & para-amygdaloid area) causes **KLÜVER-BUCY SYNDROME**

↳ No fear or rage

↳ Unable to appreciate objects visually (APHASIA)

↳ Increased appetite & sexual activity.

→ vision is normal but its processing in Temporal lobe is affected



CHAPTER 12 :

*\* HIGH YIELD diagram on page 365 \**

- Ventral Posterolateral (VPL) nucleus receives Medial & Spinal lemnisci while Ventral Posteromedial (VPM) nucleus receives ascending trigeminal & gustatory pathways.
- Lateral Geniculate body forms part of VISUAL PATHWAY.
- Medial " " " " " " (LoVe) AUDITORY PATHWAY

NOTE -> Every thalamic nuclei send & receives axons to/from specific parts of cerebral cortex EXCEPT Reticular Nucleus

NUCLEI

FUNCTION

Anterior

Concerned with limbic system (Emotional tone, mechanisms of recent memory)

VA & VL

Influences activity of motor cortex

VPM

Relay station for Trigeminal lemniscus & Gustatory fibers

VPL

Relay station for Medial & Spinal lemnisci

Intralaminar

Concerned with reticular formation (Influences levels of consciousness & alertness)

Reticular

Cerebral cortex regulates thalamus

MSB

Hearing (from BOTH but mainly from OPP ear)

LGB

Visual information.



# NEUROANATOMY (11)

Vast amount of sensory information of all types converges on the thalamus EXCEPT smell.

NOTE

Inf. colliculus

↓ via Inf. brachium

AUDITORY PATHWAY ⇒ Medial geniculate body

VISUAL PATHWAY ⇒ Sup. colliculus

↓ via Superior brachium

Lateral geniculate body

## CHAPTER 13

| Hypothalamic regulatory hormone      | Presumed Nuclear Origin                               |
|--------------------------------------|---|
| GH-releasing Hormone                 | Infundibular or Arcuate Nucleus                       |
| GH-inhibiting Hormone (Somatostatin) | Suprachiasmatic Nucleus                               |
| Corticotropin-releasing Hormone      | Paraventricular Nuclei                                |
| Thyrotropin-releasing Hormone        | Paraventricular & Dorsomedial Nuclei + Adjacent areas |
| ☞ GnRH                               | Preoptic & Anterior nuclei                            |



## NOTE

Nuclear origin of Prolactin-releasing & inhibiting Hormones is UNKNOWN.

Supraoptic → Synthesize Vasopressin

Paraventricular → Synthesize Oxytocin

Preoptic & Ant. → Control Parasympathetic NS

Post. & Lateral → Control Sympathetic NS

Ant. → Regulate temp. (response to heat)

Post. → Regulate temp. (response to cold)

Lateral → Hunger & Thirst centers.

Medial → Satiety center.

Suprachiasmatic → Controls circadian rhythms.

## CHAPTER 16 CSF

Appearance → Clear & Colourless

Volume → 150 ml

Rate of prod. → 0.5 ml/min

Pressure → 60-150 mm H<sub>2</sub>O

Protein → 15-45 mg/100ml

Glucose → 50-85 mg/100ml

Chloride → 720-750 mg/100ml

No. of cells → 0-3 lymphocytes/mm<sup>3</sup>

## CLINICALS

- Cloudiness ⇒ presence of polymorpho nuclear leukocytes or ↑ protein.
- ↑ WBCs suggest inflammation of the meninges or encephalitis.
- ↑ proteins suggest change in vascular permeability, commonly seen in ~~TB~~ Tuberculous meningitis & poliomyelitis.
- In MS, gamma globulins are ↑.
- Moderate WBCs → viral infection.
- High WBCs → bacterial.
- Glucose ↓ → bacterial meningitis (but not in viral).



# NEUROANATOMY (12)

## CHAPTER 17

Brain is supplied with 2 internal carotid & 2 vertebral arteries.

→ lie within SUBARACHNOID SPACE.

### A Branches of ICA:

① Ophthalmic A

PCOMA

② Post. Communicating A.

③ Choroidal A.

④ Ant. Cerebral A. (cortical branches supply entire medial surface of cerebral cortex till Parieto-occipital sulcus)

⑤ Middle Cerebral A.

↓  
(Cortical branches supply lateral surface of the hemisphere throughout, EXCEPT the superior small area i.e. Leg area which is supplied by Ant. Cerebral A.)

### B Branches of Vertebral Artery:

① Meningeal branches

② Post. spinal A

③ Ant. spinal A

④ PICA

⑤ Medullary A

My Papa MPA

At lower border of Pons, the 2 vertebral A join to form the basilar A.

- Post. 1/3<sup>rd</sup> of spinal cord  
↳ Post. spinal A
- Ant. 2/3<sup>rd</sup> of spinal cord  
↳ Ant. spinal A



## ③ Branches of Basilar Artery:

① Pontine A

② Labyrinthine A (accompanies Facial & Vestibulocochlear N into Int. Acoustic Meatus to supply INNER EAR) **PALPS**

③ AICA

④ Sup. Cerebellar A

⑤ Post. Cerebral A

## ARTERIES TO SPECIFIC AREAS

CORPUS STRIATUM & INTERNAL CAPSULE ⇒ Ant. & Middle Cerebral A (CIMA قیمة)

THALAMUS ⇒ Post. communicating, Basilar & Post. Cerebral A (The People with Blood Pressure)

MIDBRAIN ⇒ Post. Cerebral, Sup. Cerebellar & Basilar A (My Personal Super Bike)

PONS ⇒ Basilar, AICA & Sup. Cerebellar A (Peer SAIB)

MEDULLA ⇒ Vertebral, Ant. spinal, Post. spinal, PICA & Basilar A (Must VAPe & Puke Bitches)

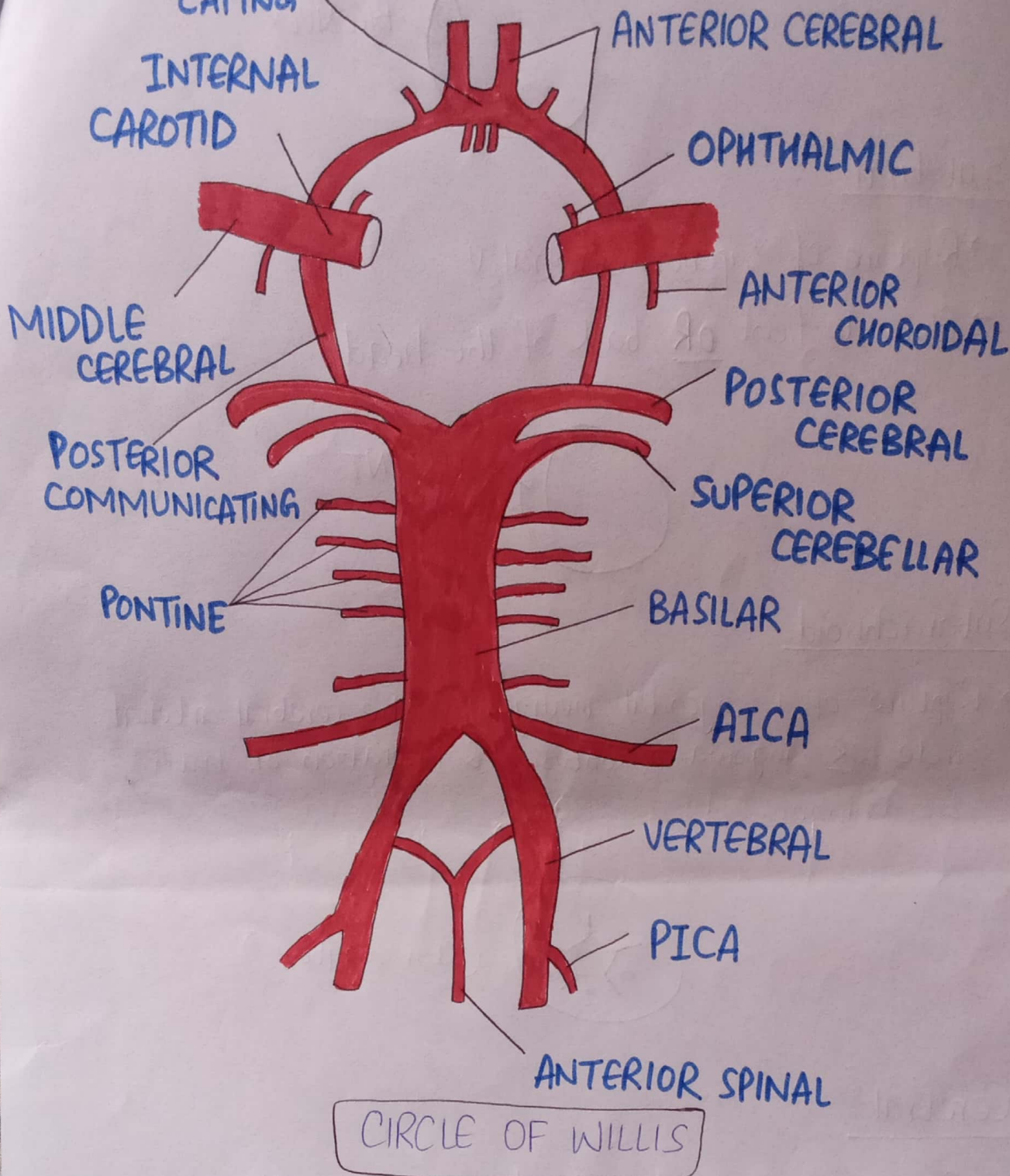
CEREBELLUM ⇒ Sup. Cerebellar, AICA & PICA (Chandler PASsed)

### NOTE

→ Brain receives 15% of the Total Cardiac Output.



# NEUROANATOMY (13)

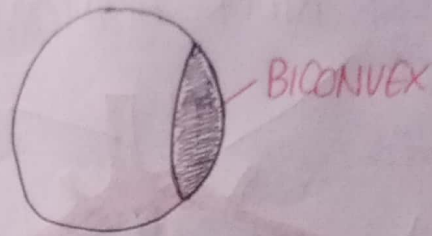


## Intracranial Hemorrhages:

### ① Epidural

- Rupture to meningeal A or V
- e.g. Blow to side of the head

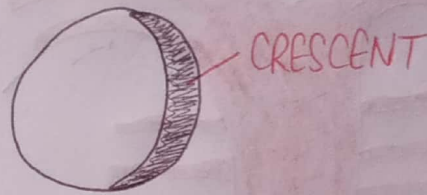




## ② Subdural

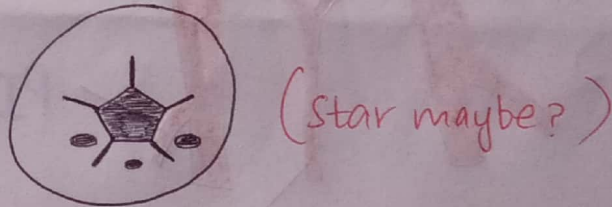
→ Rupture of Superior Cerebral V.

→ Blow to front OR back of the head



## ③ Subarachnoid

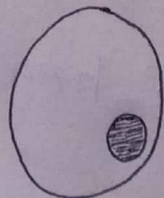
→ Rupture of a congenital aneurysm on the cerebral arterial circle OR angioma or contusion & laceration of brain & meninges.



## ④ Cerebral

→ Rupture of lenticulostriate A, branch of middle cerebral A.

→ Due to rupture of an atheromatous A & is most common in patients with hypertension.



(maybe an eye looking at its nose)