M T W T F S S

Date: WARDAK 786

Introduction To Nervous System

Nervous System

- C.N.S (Central Nervous System)
  - Brain
  - Spinal cord
  - → Functions:-
    - Collects the sensory information
    - Stores it.
    - compares it.
    - Integrates the recent & past experiences.
    - Then decides about motor response.
- P.N.S (peripheral Nervous System)
  - Sensory P.N.S
  - Motor P.N.S
  - Functions:-
    - Takes information to the CNS & then motor information from the CNS to the peripheral tissues.

⇒ Sensory P.N.S:

- Special Sensations
  - Generated from specific parts of body.
  - E.g :- Vision, olfaction, Taste, Hearing, Equilibrium or position (By ear).
- General Sensations
  - Generated from many parts of Body.
  - Somatic Sensations
  - Visceral Sensations

Scanned with CamScanner

M T W T F S S

Date:

Somatic Sensations

- Are from superficial parts of the body. & Also from locomotive system.

(Origin) i.e
- Skin
- Locomotive system (muscles, joints, ligaments, tendons).

Types:-
- pain, temp, proprioception, touch.

Visceral Sensations

- Are from deep parts of the body.
  - Dull pain
  - Distensions of viscera.

- propriception:-

All the sensations coming from the locomotive system. & going to C.N.S, so as a group, they are called proprioception.

Note:-

Cerebral cortex is concerned with the conciousness of all the sensory information. E.g if some information comes to C.N.S but that doesn't come to cerebral cortex, so we will not appreciate that sensation in concious way. E.g sensations of blood blood pressure, which are not coming to cerebral cortex that's why we are unaware of it.

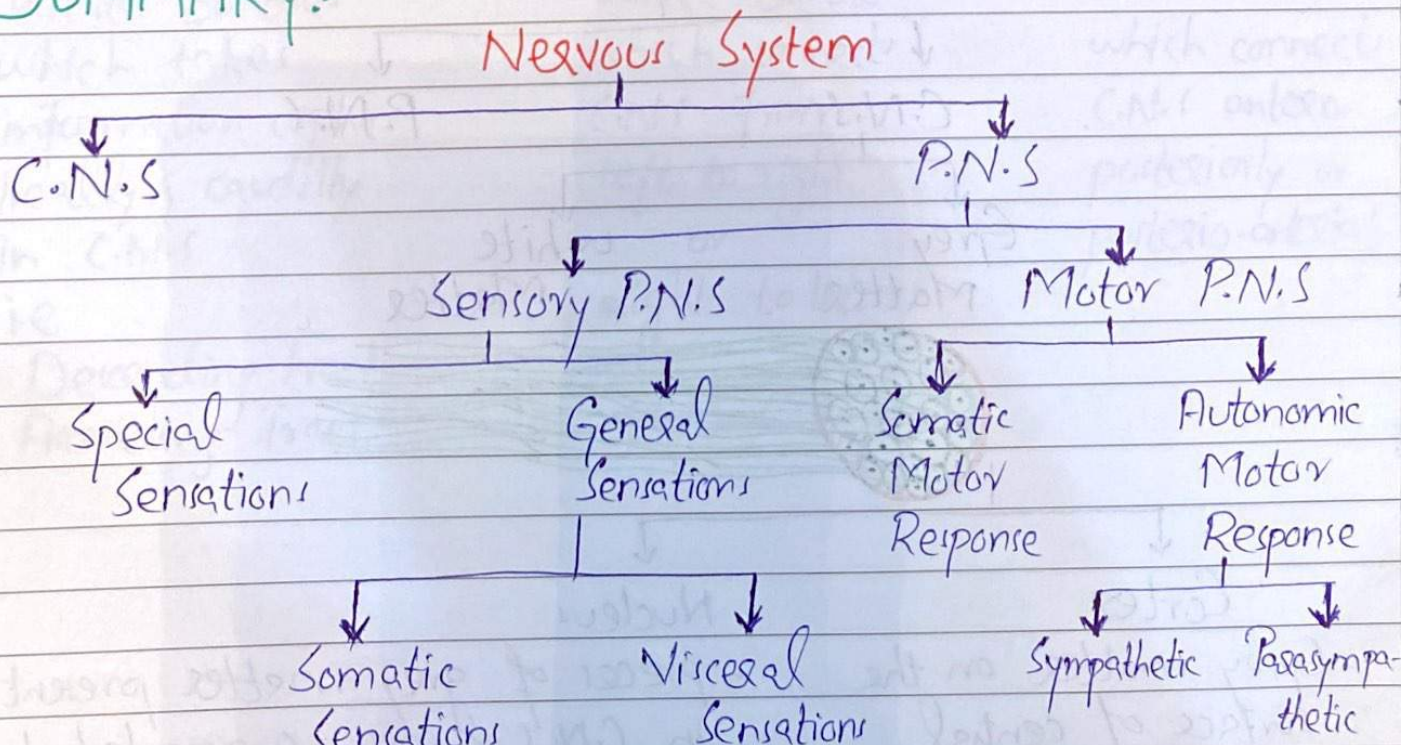
Scanned with CamScanner

M T W T F S S Date:

⇒ Motor P.N.S:

- **Somatic Motor Response**
  - Sensations that are under voluntary control
  - Examples:-
    - Moving body parts
    - Running.
- **Autonomic Motor Response**
  - Sensations that are not under voluntary control.
  - Examples:-
    - Secretions of glands.
    - Movement of smooth muscles.
    - Heart rate.
  - Sympathetic N.S
  - Parasympathetic

SUMMARY:-



Scanned with CamScanner

M T W T F S S

Date:

⇒ Central Nervous System is made up of two types of cells:-

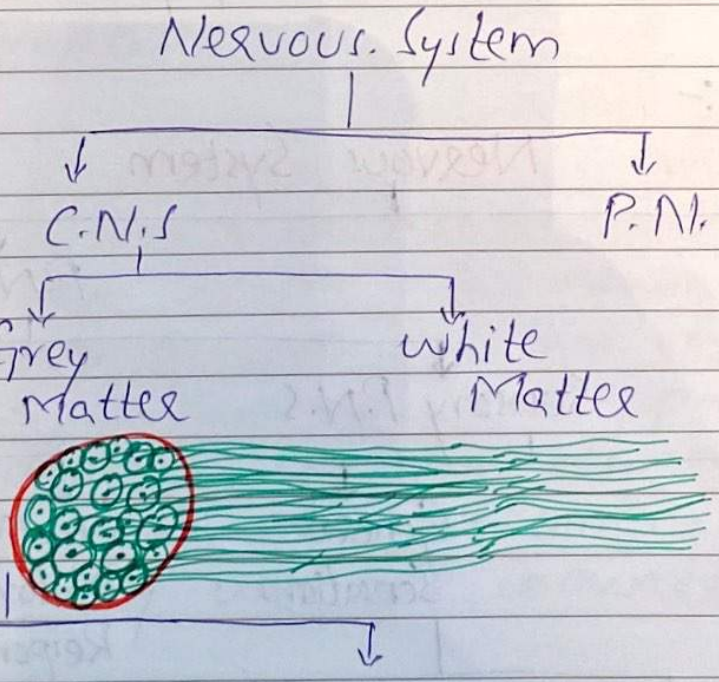
1) Neurons:- True functional cells of central Nervous system, which are generating & conducting action potentials.

Neuro-

2) Glial cells:- Supporting cells of Nervous System

→ Note:-

Collection of cell bodies in central nervous system is called grey matter while collection of axons in central nervous system is called white matter.

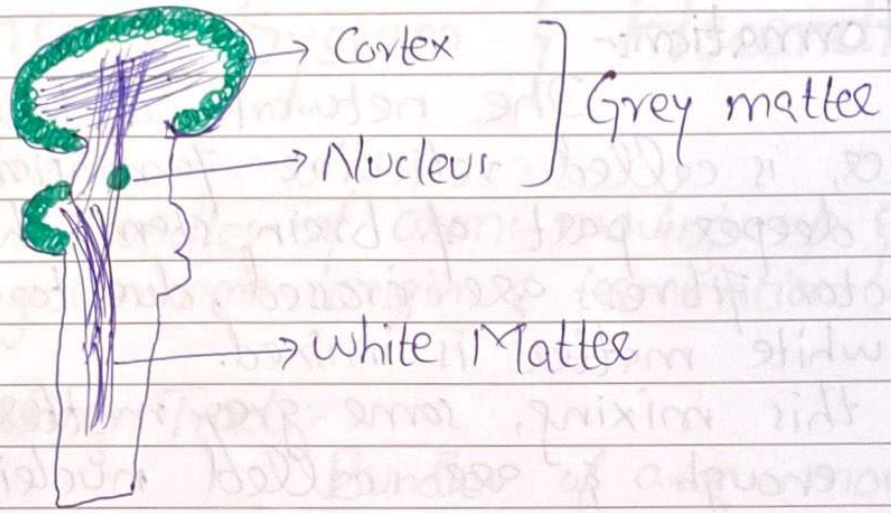


- Grey matter on the surface of central nervous system.

- pieces of grey matter present in C.N.S & are surrounded by white matter.

Scanned with CamScanner

M T W T F S S Date:



⇒ White Matter:

1) Tracts
- White Bundles which takes information cephalically & caudilly in C.N.S
i.e
- Descending Tract
- Ascending Tract

2) Commissural fibres
- White Bundles which connects C.N.S from left to right or right to left
e.g
- Corpus Callosum

3) Association fibres
- white bundles which connects C.N.S anteroposteriorly or posterioanteriorly

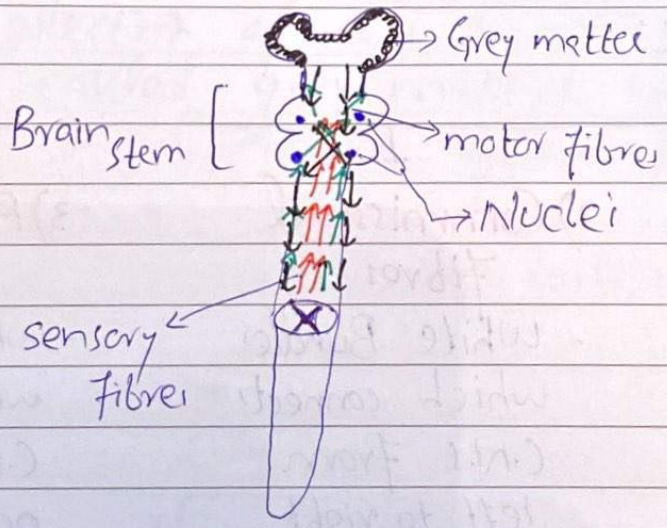
Scanned with CamScanner

M T W T F S S Date:

Reticular Formation:-

The network of both grey & white matter, is called reticular formation.

- In the deeper part of brain stem, the major sensory & motor fibres are crossed, due to which the grey & white matter is mixed.
- During this mixing, some grey matter pieces remains big enough & are called nuclei.



Difference between:-

Tracts	Nerves
- Bundles of axons inside C.N.S	- Bundles of axons outside C.N.S
- They have oligodendro-glia cells for insulation purpose	- They have schwann cells for insulation purpose

Scanned with CamScanner

M T W T F S S

Date:

Sensory System & Ascending Tracts:-

Tracts:-

Bundles of axons moving up & down in the C.N.S. having common origin & termination.

Ascending Tracts:-

Bundles of axons moving up in C.N.S.

Receptors:-

Receptors are transducers (certain apparatus which changes one type of energy into other type).

- Thus receptors are the apparatus which converts stimulus energy into electrochemical energy of action potential.

Note:-

- Roots of spinal cord are pure i.e anterior root is purely motor & posterior root is sensory.
- Trunks & Rami are mixed.

⇒ It means sensory information are coming from ventral & dorsal ramus but when it enters the trunk it segregates separately as a sensory input through posterior root.

Motor output is coming from the spinal cord through ventral root, but after the trunk, motor output enters, dorsal as well as ventral ramus.

Scanned with CamScanner

M T W T F S S Date:

White Matter of Spinal cord:-

- There are 3 columns / funiculus of white matter.
  - Dorsal
  - Lateral
  - Anterior

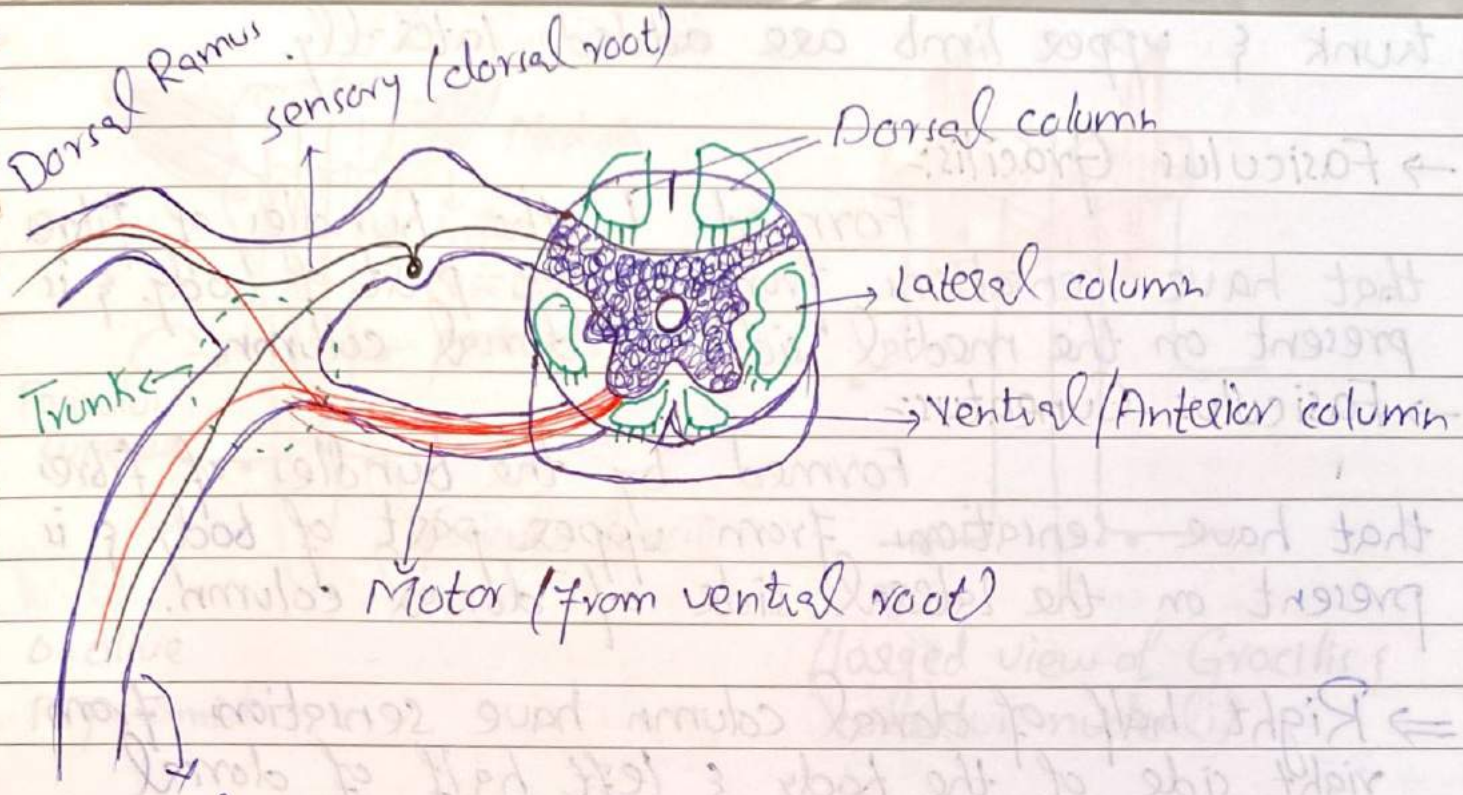
⇒ Dorsal column has only ascending Tracts. While lateral & ventral have both ascending & descending tract.

⇒ Dorsal column → Most modern tract system.
Antero-lateral → primitive tract system

Difference Between:-

Dorsal column	Antero-lateral column
- Modern	- Primitive
- purely sensory	- Mixed
- High velocity	- Low velocity
- Highly myelinated	- less myelinated
- Fine Touch	- Crude touch
- Specialized sensations: Proprioception, vibration, Two-point discrimination.	- Variety of sensations - Temp, pain.

Scanned with CamScanner



Dorsal Colum:-

- Receptors which takes the fine stimulus to the dorsal column are:-
  - Meissners Receptors
  - Pacinian Receptors
  - Muscle spindles
  - Golgi tendon organ
- These sensations goes to the CNS through the dorsal root.
- Sensations from the lower limb are added medially to the central canal of spinal cord. while those of

Scanned with CamScanner

trunk & upper limb are added laterally.

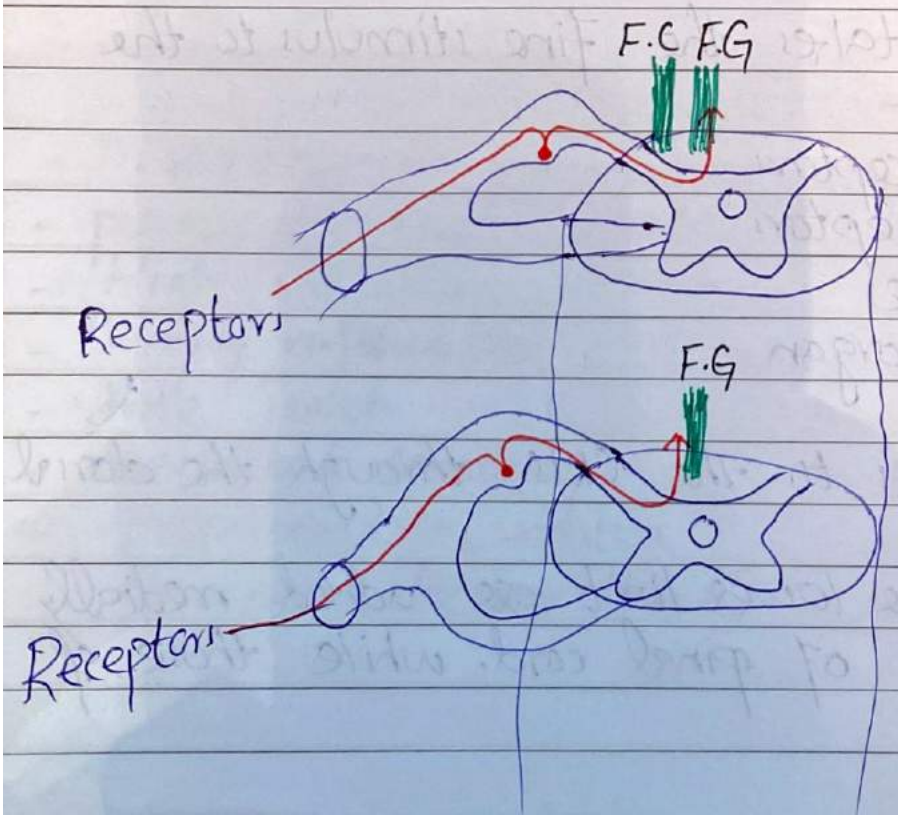
→ Fasiculus Gracilis:-

Formed by the bundles of fibres that have sensations from lower part of body. & is present on the medial side of dorsal column.

→ Fasiculus Cuneatus:-

Formed by the bundles of fibres that have sensations from upper part of body & is present on the lateral side of dorsal column.

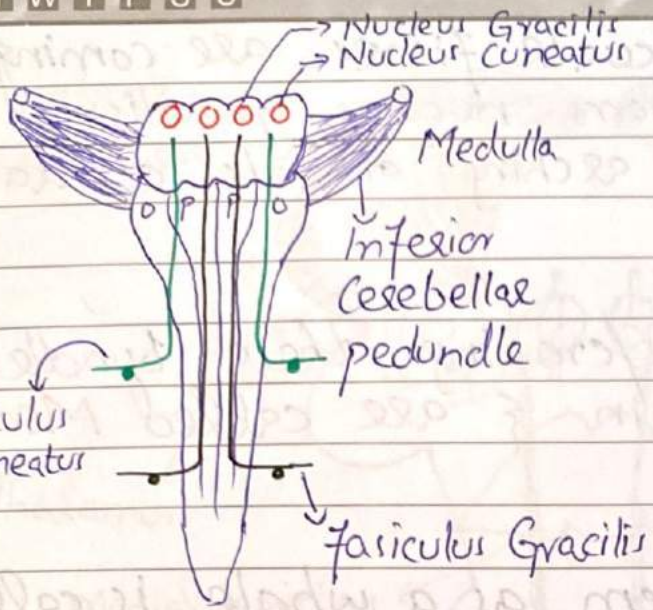
⇒ Right half of dorsal column have sensation from right side of the body & left half of dorsal column have sensations from left side of the body. i.e they are un-crossed or simply they move epsilaterally.



Scanned with CamScanner

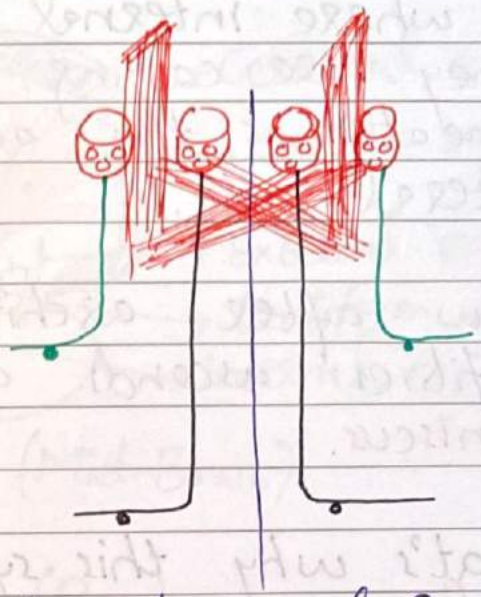
M T W T F S S

Date:



O = olive

P = pyramid



(lasged view of Gracilis & cuneatus nucleali)

⇒ Nucleaus Gracilis:-

Receives fibres from fasiculus gracilis.

⇒ Nucleus Cuneatus:-

Receives fibres from fasiculus cuneatus

⇒ The cell bodies of nucleus gracilis & cuneatus are 2nd order neuron, while 1st order neuron are present in dorsal root ganglion.

⇒ Then after reaching these nuclei, they (fibres) crosses the mid-line in the medulla & moves to the opposite i.e contra-lateral & then ascends again. Thus, these fibres are called internal arcuate fibres.

Scanned with CamScanner

M T W T F S S Date:

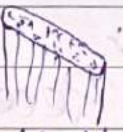
From where internal arcuate fibres are coming?
They are coming from nucleus gracilis & cuneatus & they are arching on the contra-lateral side.

⇒ Now after arching/crossing, these bundles of fibres ascends again & are called Medial lemniscus.

⇒ That's why this system as a whole is called Dorsal column Medial Lemniscus System.

⇒ Note:

Circular bundle
↓
Fasiculus

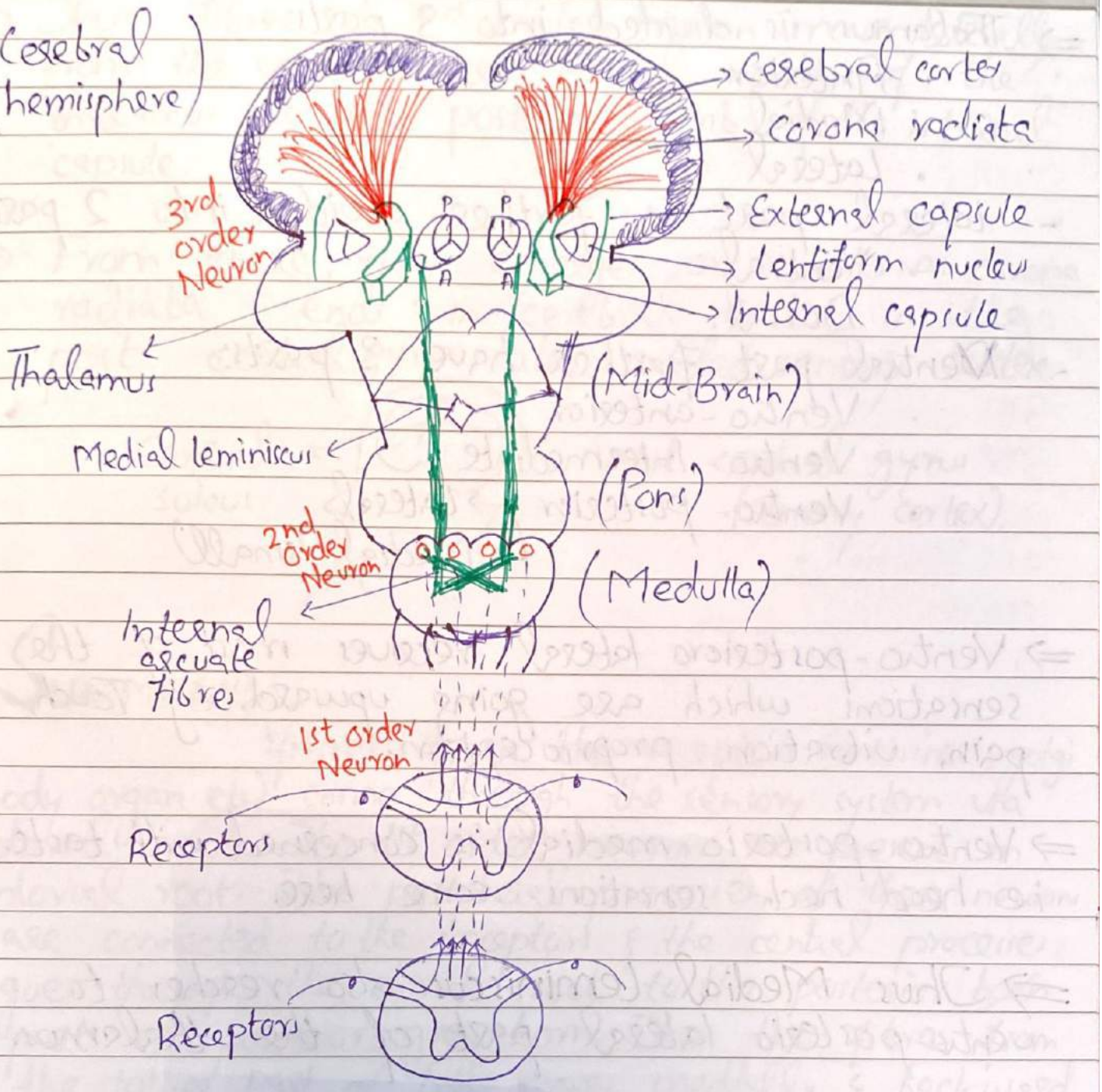


Flattened bundle
↓
Lemniscus

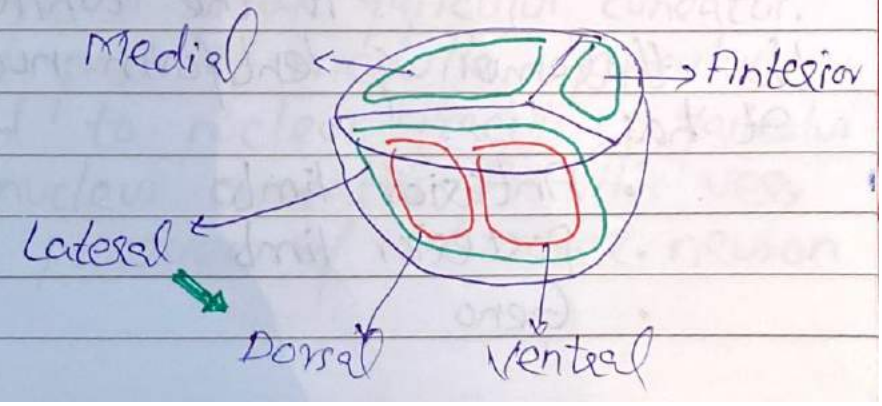
⇒ Then the medial lemniscus system will pass through the pons & mid-Brain.

⇒ Next station, where 2nd order neuron terminates is thalamus & from there the 3rd order neuron takes the signals.

Scanned with CamScanner



:Note:- Thalamus



Scanned with CamScanner

M T W T F S S Date:

⇒ Thalamus is divided into 3 parts:-
- Anterior
- Medial
- Lateral

- Lateral part is further divided into 2 parts:-
  - Ventral
  - Dorsal
- Ventral part further have 3 parts:-
  - Ventro-anterior
  - Ventro-Intermediate
  - Ventro-posterior → Lateral
    → Medial (small)

⇒ Ventro-posteriora lateral receives most of the sensations which are going upward. e.g Touch, pain, vibration, proprioception.

⇒ Ventro-posterio-medial is concerned with taste. i.e head neck sensations come here.

⇒ Thus Medial Leminiscus also reaches to ventro-posterio lateral part of the thalamus.

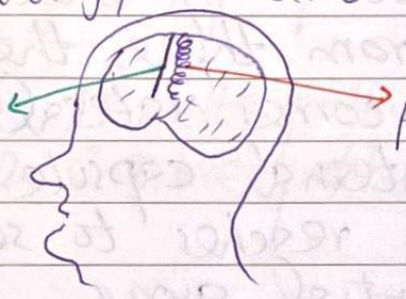
→ Internal capsule:-
is the white matter pressed between the thalamus & lentiform nucleus.
It has:-
- Anterior limb
- Posterior limb
- Geno

Scanned with CamScanner

M T W T F S S Date:

⇒ Thus fibres of 3rd order neuron move laterally from the ventro-posterio lateral nucleus of the thalamus to the posterior limb of the internal capsule.

⇒ From these, they emerges or radiates as corona radiata & ends in cerebral cortex. in the post central gyrus also called sensory cortex.



SUMMARY:-

Fibres from the receptors (meissners, golgi body organ etc) comes through the sensory system via dorsal root. The 1st order neuron are present in dorsal root. The peripheral processes of these neuron are connected to the receptors & the central processes goes through the dorsal root to the posterior horn past of posterior grey horn. Then the fibres from the lower part of body moves medially & backward & makes fasiculus gracilis & in the same way the upper part of the body's fibers make fasiculus cuneatus. And in the lower part of medulla, fasiculus gracilis is connected to nucleus gracilis & fasiculus cuneatus to the nucleus cuneatus. At this very point, the central processes of 1st order neuron

Scanned with CamScanner

M T W T F S S Date:

terminates & axons of 2nd order neuron stests. They again move forward & medially & crosses & this crossing is called internal arcuate fibres. After crossing these fibres moves/ascends as medial lemniscus & it passes the pons & mid-brain & eventually connects to the ventro-posterio lateral nucleus of the thalamus. Here axons of 2nd order neuron terminates & information is further taken by the 3rd order neuron. From these, the axons of 3rd order neurons comes laterally into the posterior limb of internal capsule & emerges out as corona radiata & reaches to sensory cerebral cortex ie post central gyrus.

Scanned with CamScanner

M T W T F S S Date:

Antero-Lateral Column:-

Pain & Temp Pathway:-

→ Receptors for pain are free nerve ending & for temp are thermal receptors.

- There are two pathways for the pain which goes to the C.N.S i.e
  1- A-delta pathway
  2- C fibres pathway

Note:-

Peripheral nerves are divided into 3 category, according to degree of myelination:-

1). A → more myelinated
2). B
3). C → Not myelinated

- Futher category 'A' are further, alpha, beta, gamma & delta. The A-delta which carries the fast pain are also less myelinated.

⇒ Then, there are two types of pain i.e fast & slow. fast is carried by A-delta & slow is carried by C-fibres.

⇒ Fast pain is received by the C.N.S in 0.1sec while slow pain is received in 1 or 2 hrs delay.

Scanned with CamScanner

M T W T F S S Date:

⇒ Fast & slow pain both can be produced by mechenical or theemal mechanism but slow pain can also be produced by chemical phenomenon e.g acids.

⇒ Potassium, Bradykinin, histamine, Acids, etc are the chemicals present at the site of pain free nerve endings.

⇒ Prostaglandins & substance P, also plays an indirect role in pain i.e they reduces the threshold level for above mentioned chemicals to cause pain.

⇒ Once the action potential goes to C.N.S, the 1st order neuron have their cell bodies in dorsal root ganglian, similar as that in dorsal column system.

⇒ The central processes of 1st order neuron teeminates in the area called substancia gelatinosa of the dorsal grey horn.

⇒ 2nd order Neuron cell bodies are present within the spinal cord in the anteo lateral system. at the point of entry into the grey horn.

⇒ Actually, the 1st order neuron at the point of teemination gives ascending & descending branches. And these branches within the spinal cord makes a local track which is called Dorsal lateral Track of Lissaure.

Scanned with CamScanner

M T W T F S S Date:

⇒ Now the 2nd order Neuron, moves to the opposite side i.e contralaterally.

⇒ The fibres then ascends upward & the new fibres of upper side are added medially.

⇒ Now this tract is going upto thalamus, so it is called spinothalamic tract & as it is present on the lateral side, so it is called Lateral spinothalamic tract.

→ So Lateral Spinothalamic Tract is concerned with pain & Temp.

⇒ The peripheral part of the tract has fibres from the lower part of the body & the medial part of the tract has fibres from the upper part of the body.

→ Note:-

The pathway for the crude touch is also similar upto some extend. But there is a difference i.e the 2nd order neuron moves to the anterior side, so it is called Anterior spino-thalamic Tract.

- There is another pathway which runs between the lateral & anterior part called spino-Tectal tract. (i.e between the spinal cord & the tectum). It is responsible for the spino visual reflex.

⇒ Now,

these 3 tracts ascends & fuses together in

Scanned with CamScanner

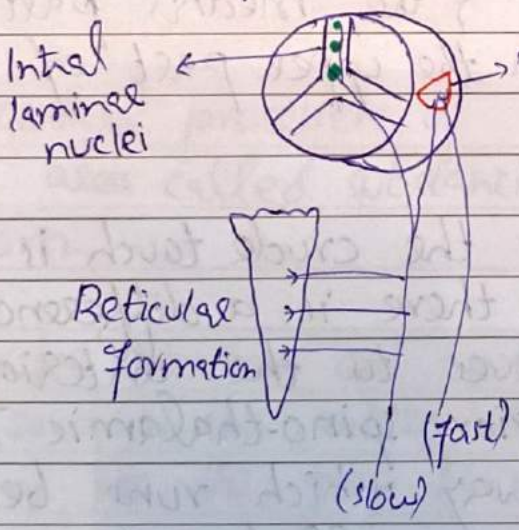
M T W T F S S Date:

the medulla & runs upward as a single bundle called spinal Leminiscus.

⇒ Then anterior & lateral spinothalamic fibres from the spinal Leminiscus bundle are connected to ventro posterio lateral nucleus of the thalamus. & the spino-tectal fibres from the spinal leminiscus bundle are connected to superior colliculus.

→ Note:-

The slow pain fibres also stimulates the reticular formation in its pathway & also reaches to the intra laminar nuclei of the thalami (present in white lamina of thalamus).

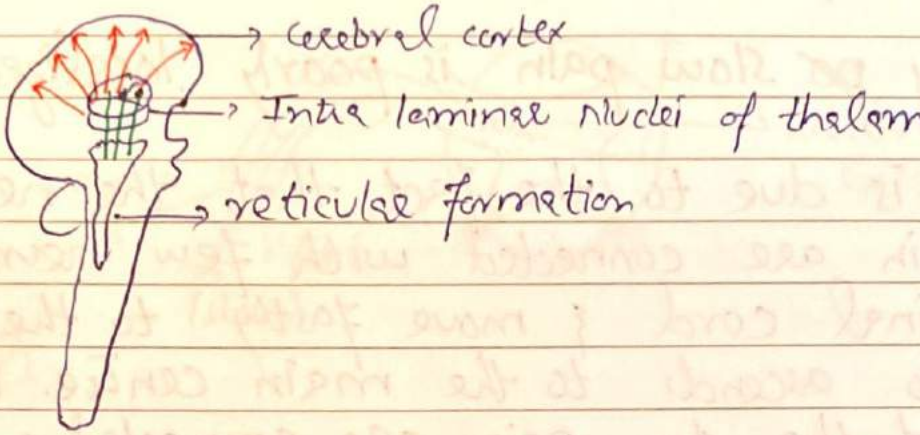


⇒ Reticular formation is the main switch for cerebral cortex. It is connected to intra laminar nuclei of thalamus. & through that it projects to the cerebral cortex.

Scanned with CamScanner

M T W T F S S Date:

→ All the ascending pathways moving upward have collateral connections with the reticular formation.



→ That's why during sleep, the pain stimuli specially slow pain stimulates the cerebral cortex through reticular formation.

⇒ Now,

Now the pain, temp & crude touch pathways after reaching ventro posterio lateral nuclei leaves to go to posterior limb of internal capsule & then radiates to cerebral cortex or to sensory cortex i.e post central gyrus.

→ Then in post central gyrus the analysis about the location & intensity of pain takes place.

→ The emotional component in the pain is due to its connection with cingulate gyrus (which is concerned with emotions).

→ The autonomic response during pain, is due to the connection of its fibres with insular cortex.

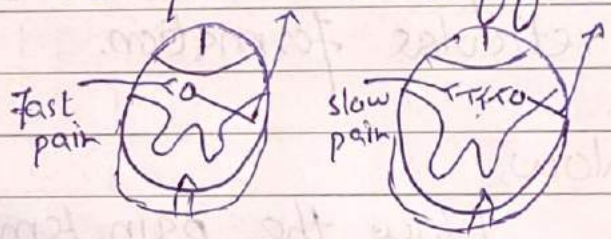
Scanned with CamScanner

M T W T F S S Date:

- The autonomic responses are sweating, nausea, tachycardia, fear etc.

Why pp slow pain is poorly localized?

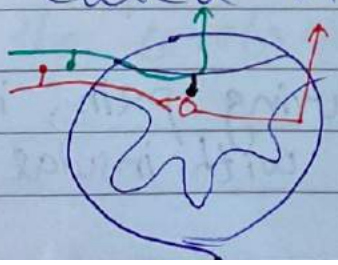
It is due to the fact, that the neurons of fast pain are connected with few neurons in the spinal cord & move fastly to the lateral side to ascend to the main centre. But the neurons of the slow pain are connected with many other neurons in the spinal cord before ascending to the main centre, thus it provides difficulty in its localization.

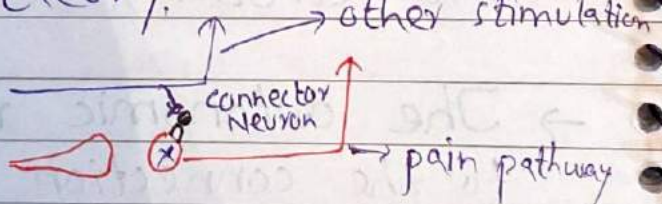


Gating Theory:-

When person has pain & we produce other stimulations which are not painful like massaging, may reduce the pain through that stimulation. The action potential coming through other stimulation may stimulate the connector neuron which may produce neuro-inhabitory substance, so that the pain pathways are inhibited.

→ Initially doctors were unaware of this & they thought that there might be some gates which may be closed during other stimulations, thus they called this gating theory.

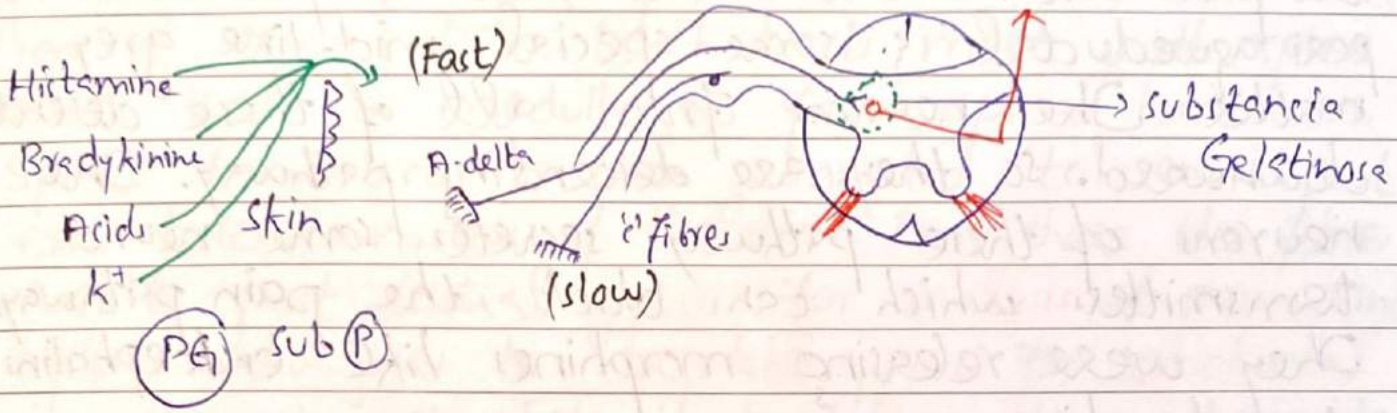




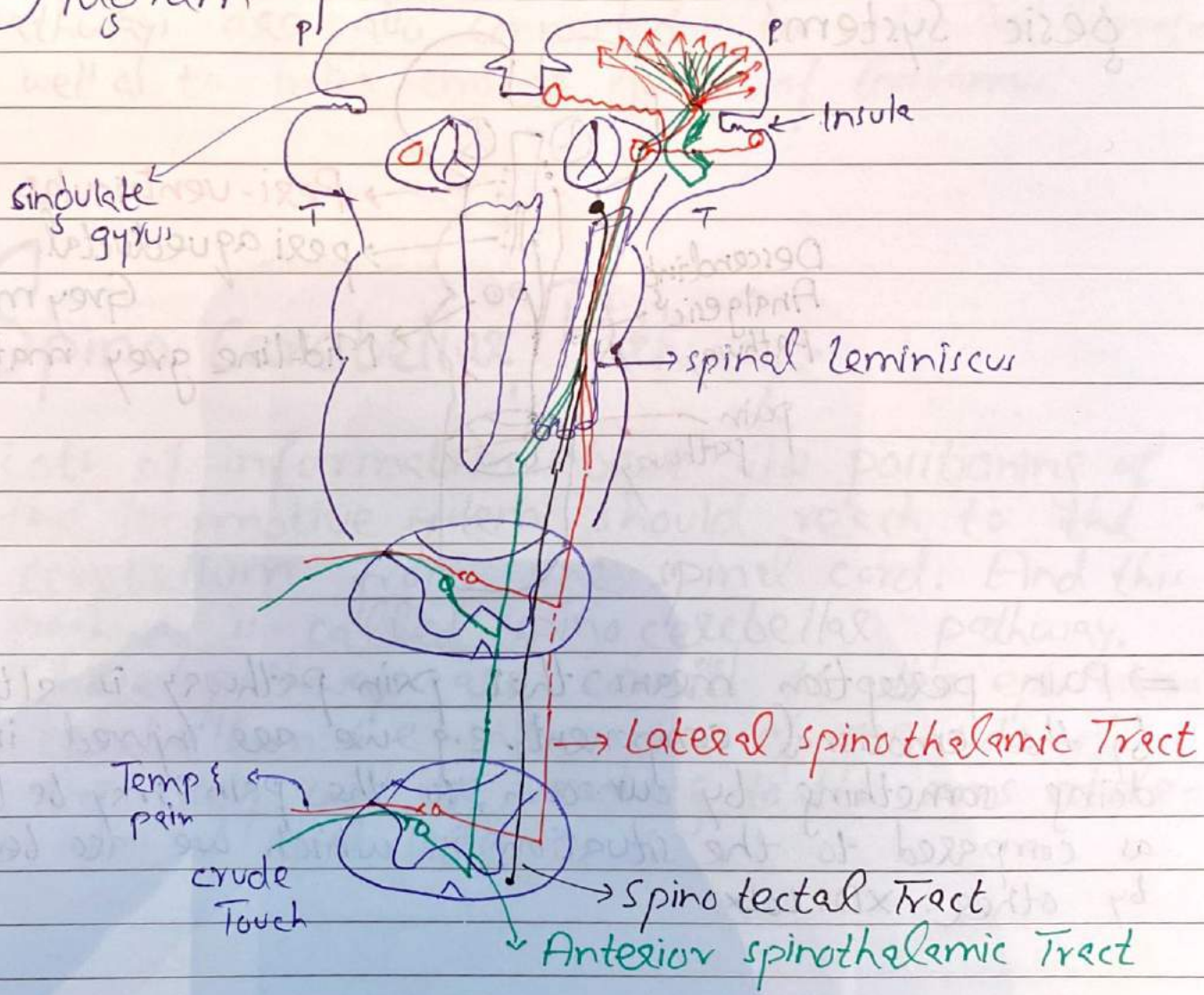
Scanned with CamScanner

M T W T F S S Date:

Diagram for slow & fast pain:-



⇒ Diagram for antero-lateral column:-



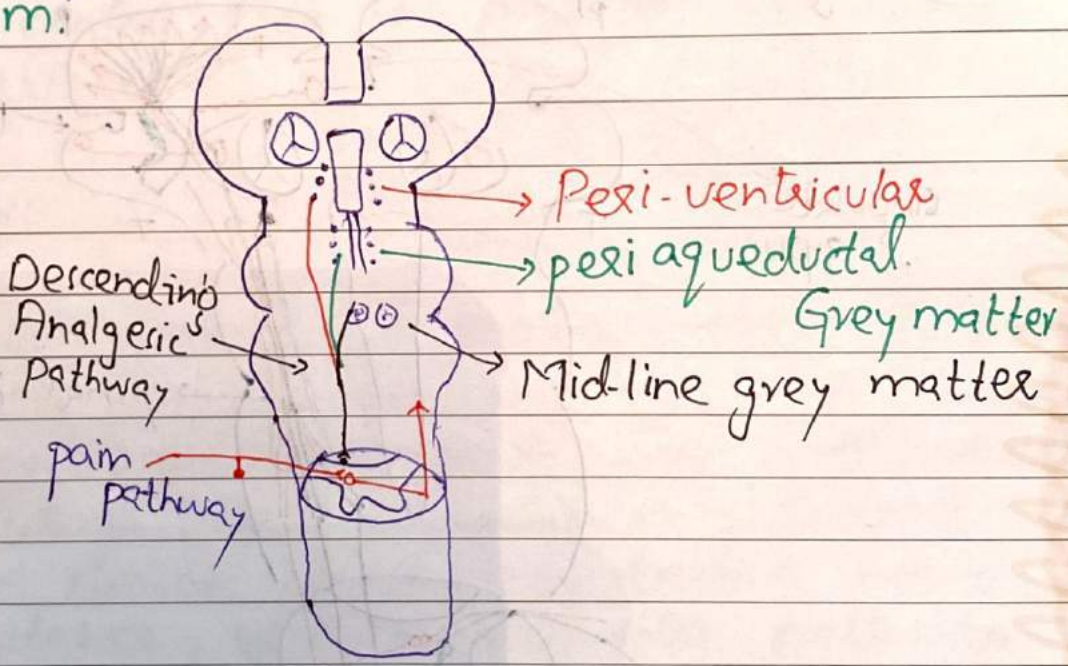
Scanned with CamScanner

M T W T F S S Date:

Pain Reduction:-

There is a mechanism to reduce the pain within the C.N.S. There are peri-ventricules, peri aqueductal & some special mid-line grey matter. The neurons from all of these descends downward. so they are descending pathway. The neurons of these pathway secrete some neuro-transmitter which can block the pain pathway. They were releasing morphines like endorphalins & endorphines.

→ And this system is called Descending Analgesic System.



⇒ Pain perception means that pain pathway is altered by the emotional component. e.g we are injured in doing something by our own, to the pain may be less as compared to the situation in which we are beaten by other. XD. LoLx.

Scanned with CamScanner

M T W T F S S Date: Wasdak

SUMMARY:-

Anterior spinothalamic tract takes sensations of crude touch. Lateral spinothalamic tract takes sensations of temp & pain. Both tracts meet with spinotectal tract in medulla to form spinal leminiscus. Spinal Leminiscus is then connected to ventro-posterio lateral nucleus of thalamus. From these the fibres goes to post central gyrus. For analysis of pain. And fibres also goes to cingulate gyrus for emotional reaction to pain. Fibres also goes to insular cortex for autonomic reaction with the pain. Slow pain pathways are also connected to reticular formation as well as to intra laminar nuclei of thalamus.

Spino Cerebellar Pathway:-

- Lots of information about the positioning of the locomotive system, should reach to the cerebellum from the spinal cord. And this pathway is called spino cerebellar pathway.
- These pathways are connected to the epsi-lateral cerebellum. i.e information of one side of the body will be reaching to the same cerebellum of that side.

Scanned with CamScanner

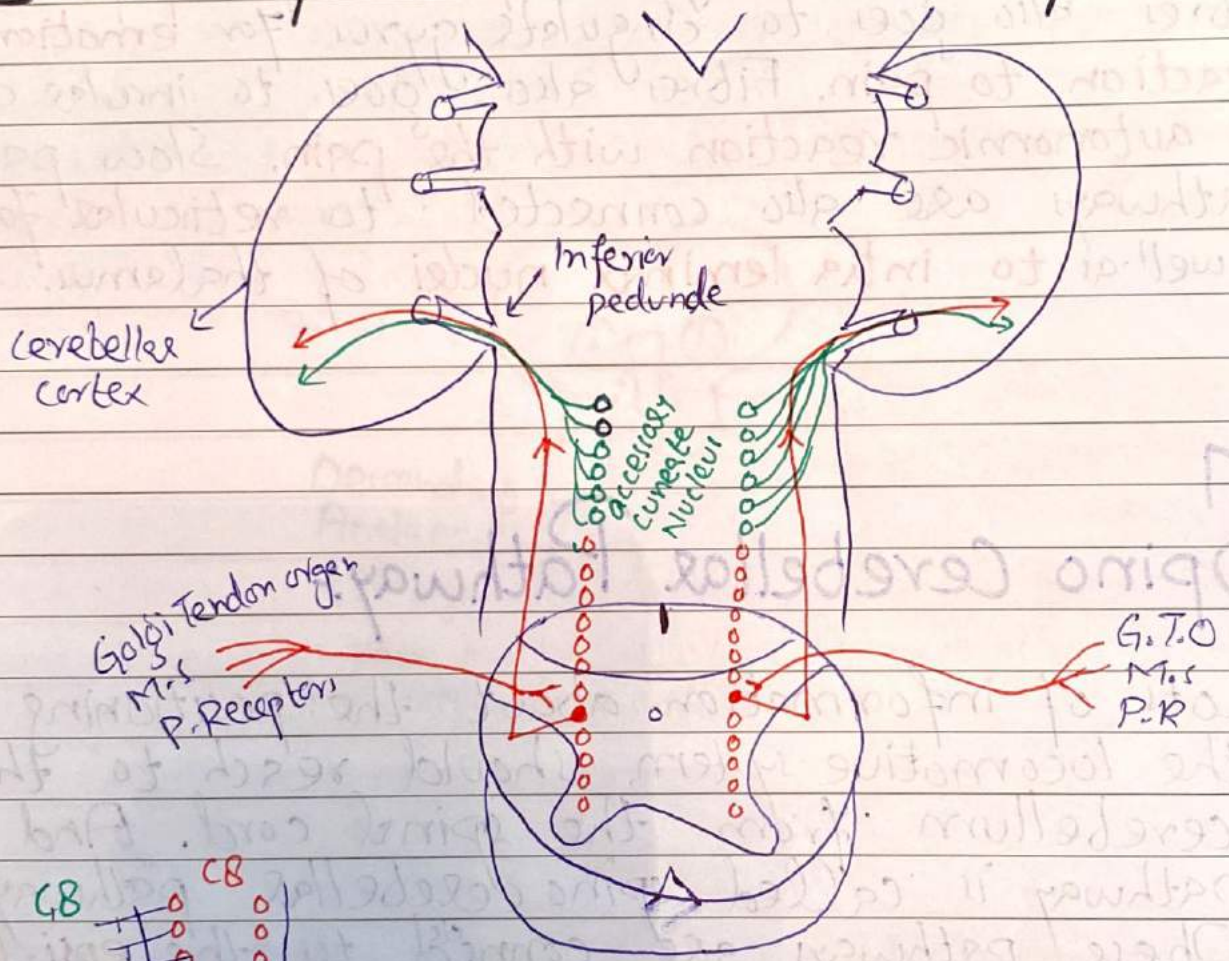
M T W T F S S Date:

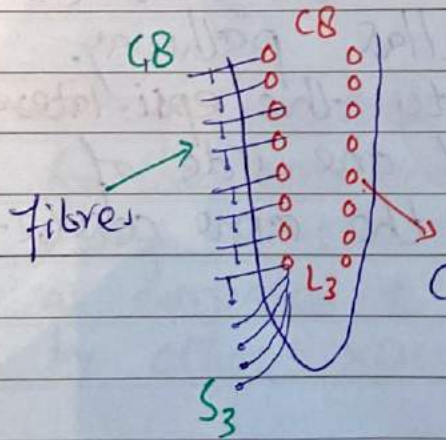
Note:-

Information through Dorsal column medial lemniscus system & anterior & lateral spinothalamic system reaches to the contralateral cerebrum.

⟹ There are two main spino-cerebellar pathways:-

1). Dorsal Spino-cerebellar Pathway:-





Scanned with CamScanner

M T W T F S S Date:

⇒ The information in this pathway comes from golgi tendon organ, muscle spindles, pressure receptors. The fibres goes to the dorsal grey horn & termi-nates these i.e the central process of 1st order neuron. terminates these.

- From these, 2nd order neuron move epsi-laterally on the right white column. (lateral column)
- From lateral column it ascends upward
- Same thing happens on the other side. i.e contra-lateral side.
- The cell bodies of 2nd order neuron is making a nucleus through out the spinal cord & is called Dorsalateral nucleus of clarke.

Note:-

Connection of cerebellum:
Cerebellum with Mid-Brain → superior peduncle
cerebellum with pons → middle peduncle
cerebellum with medulla → inferior peduncle

⇒ peduncles are bundles of white matter which connects cerebellum with mid brain, stem.

⇒ So the fibres from both side of spinal cord after descending enters the cerebellar cortex. through inferior cerebellar pedundes.

⇒ As it is present on the dorsal side of the lateral white matter, so it is called Dorsal spino cerebellar pathway.

Scanned with CamScanner

M T W T F S S Date:

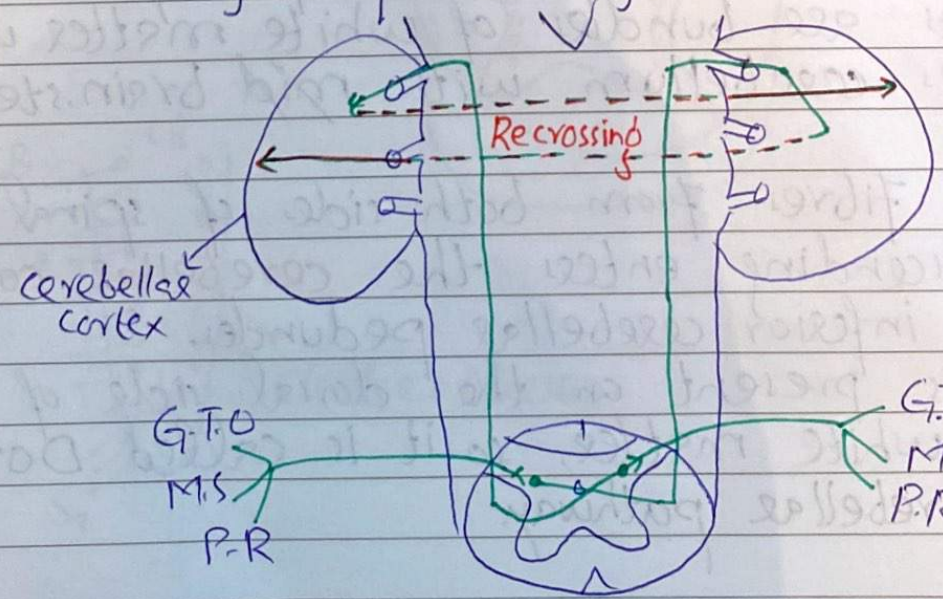
⇒ The fibres in this system can enters from C8 → S_3. But the clarke's nucleus extends from C8 → L_3. so the lower fibres which enters the system must ascends to reach clarke's nucleus. Thus fibres of or lower part of the body comes to the clarke's nucleus

⇒ Cuneocerebellar pathway:-

In this pathway, the fibres comes from upper limb or above to the accessory cuneate nucleus, instide going to clarke's nucleus. And then from accessary cuneate nucleus they ascend in the same way as that of dorsal spino-cerebellar pathway to reach cerebellum cortex.

2):- Ventro spino-cerebellar pathway:-

→ Same as dorsal pathway but there are some changes of crossing.



Scanned with CamScanner

M T W T F S S Date:

→ The information are received through same receptors. The cell bodies of 1st order neuron terminates in the spinal cord. The fibres of 2nd order neuron moves to the contra lateral side & ascends so much to reach superior cerebellar pedunde & enter there. But after that it recrosses to reach the other cerebellum. Thus the information of one side of body reaches at to the same side of cerebellum following the basic rule. (i.e the fibres will carry the information to same cerebellum.

→ It is called ventro spinal cerebellar pathway because it is present infront of dorsal pathway.

⇒ Spino-olivary pathway:-

The information is gathered through 1st order neuron present in the dorsal root ganglion & after its termination the 2nd order moves to the contra-lateral side & ascends to olives (grey mass present in medulla) & from there it enters the cerebellar cortex through inferior cerebellar peduncles. This pathway is concerned with proprioception, position of body, pressure etc which is not concerned with concious level.

⇒ Spino-reticular pathway:-

In this pathway, fibres after entering spinal cord directly ascends on the same side to the reticular formation. The purpose of this pathway is simply to increase the concious level.

Scanned with CamScanner

M T W T F S S

Date:

Tracts

- Ascending
  - Major Tracts
    - (For cerebrum)
      - Dorsal leminiscus System
      - Antiolateral System
    - (For cerebellum)
      - Dorsal spino cerebellar
      - cuneo cerebellar pathway
      - ventio-spino cerebellar
  - Minor Tracts
    - Spino-tectal
    - spino-olivary
    - spino-reticular
- Descending

Scanned with CamScanner

M T W T F S S Date:

Motor System & Descending Tracts:-

→ Descending Tracts are concerned with bringing motor response from higher level of C.N.S to lower level of C.N.S.

- These tracts can produce voluntary motor responses through skeleton muscles or through autonomic system which can or may modify the activity of glands, heart or smooth muscles.

Motor Cortex:-

In cerebral hemisphere (cortex), the central sulcus divides the motor & sensory cortex i.e anterior to central sulcus is motor & posterior to it, is sensory area.

⇒ Scientists learned about the activities of cerebral cortex through 2 tools:

1- Electrical stimulation through electrodes of different areas cerebrum.
2- Looking for neurological deficit produced through 'destructive' lesions.

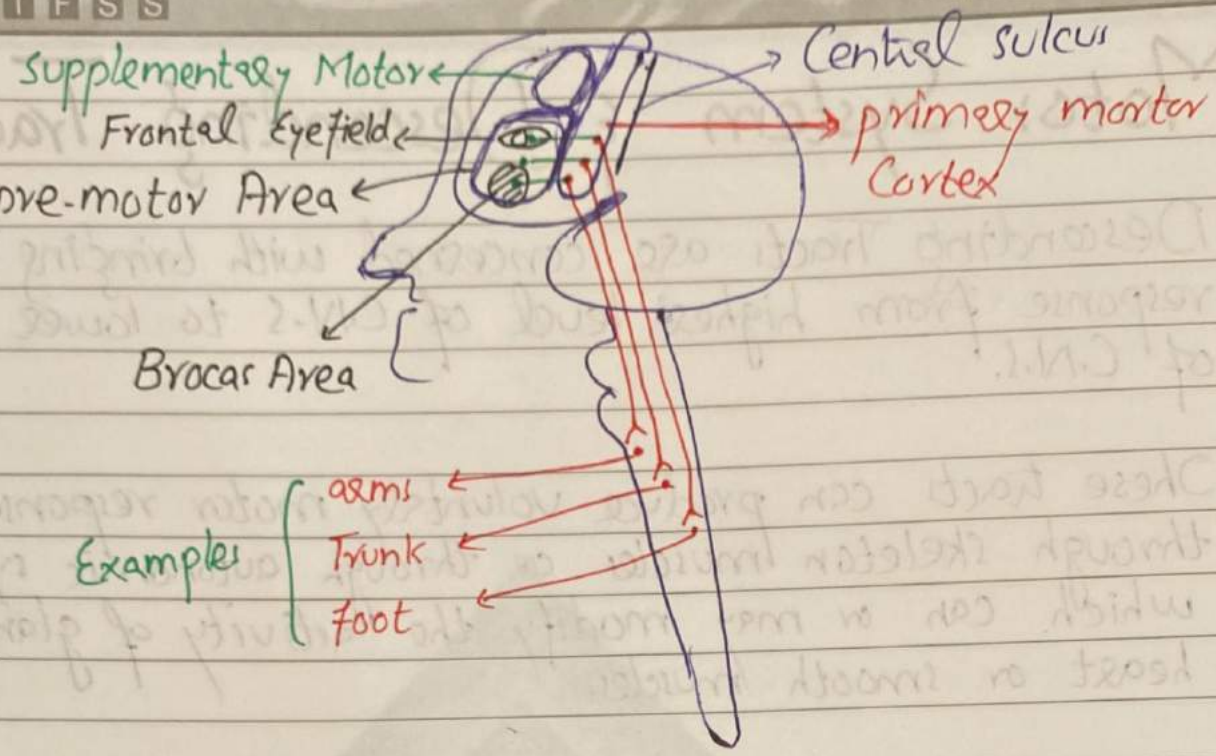
→ Actually,

There are 3 areas of the cortex which controls the motor system.

Scanned with CamScanner

M T W T F S S

Date:



1- PRIMARY MOTOR CORTEX:-

It consists of pre-central gyrus present on the supralateral surface, infront of the central sulcus. & it extends medially at its upper end. on the cerebral hemisphere.

2- PRE- MOTOR AREA:-

It is present infront of primary motor cortex. It is this very area which plans the motor response.

3- SUPPLIMENTARY MOTOR AREA:-

It is present at the top & medial side of pre-motor area. It is concerned with primitive movements e.g movement of trunk & hip. It moves

Scanned with CamScanner

M T W T F S S Date:

bilaterally after the stimulation.

Actually,

Motor programs are generated in pre-motor area. After their generation, they stimulates different groups of neurons in primary motor cortex. Then primary group neurons will come down & move the lower group of neurons which are connected with the muscles.

→ primary group of neuron can't plan the response they are directed by pre-motor area's neurons. But if there are some bilateral primitive movements, so primary motor cortex is directed by supplimentary group of neurons.

Note:-

Brocas Area:- Area present in the pre-motor cortex & is responsible for phonation i.e it directs the muscles of phonation (Larynx, pharynx, soft palate, muscles of facial expression, tongue) so that words can be produced in proper way.

. Frontal Eyefields:-

These are electrical push buttons of eyes present on both sides i.e if we electrically irritates it, so our eyes look to contralateral side.
→ And when we are looking straight, it means both are working.

Scanned with CamScanner

M T W T F S S Date:

HOMUNCULUS:-

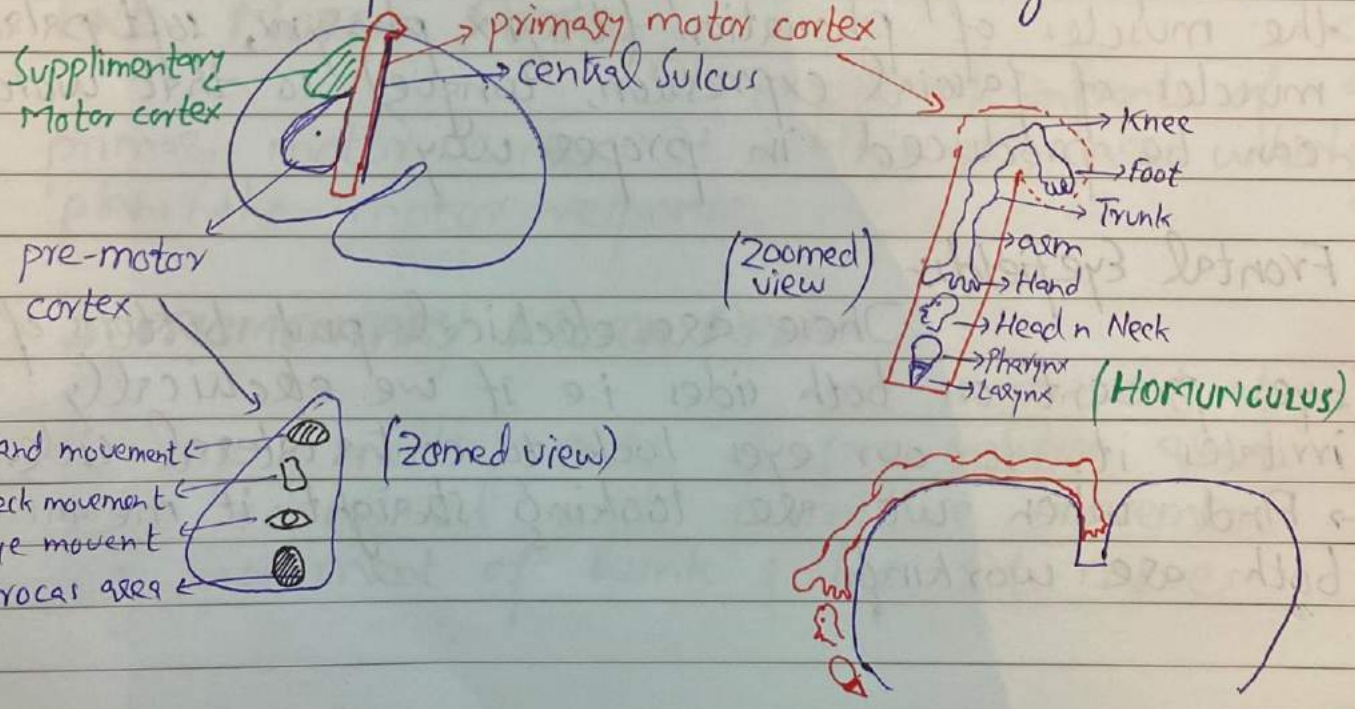
An imaginary map, dyr according to the area of primary motor cortex which is devoted to particular area of body's movement.

→ This map shows the different parts of the body, according to the proportional of cortex, which is controlling that part.

For example;

if biggee area is controlling hand's movement so hand area in the map is shown very big & vice versa.

⇒ There are 3 humunculus for every part of the body i.e in primary motor cortex, pre-motor cortex & supplementary motor cortex. & irritating it through any stimulus will cause the movement of hand, based on the irritation of cortex which is being irritated.

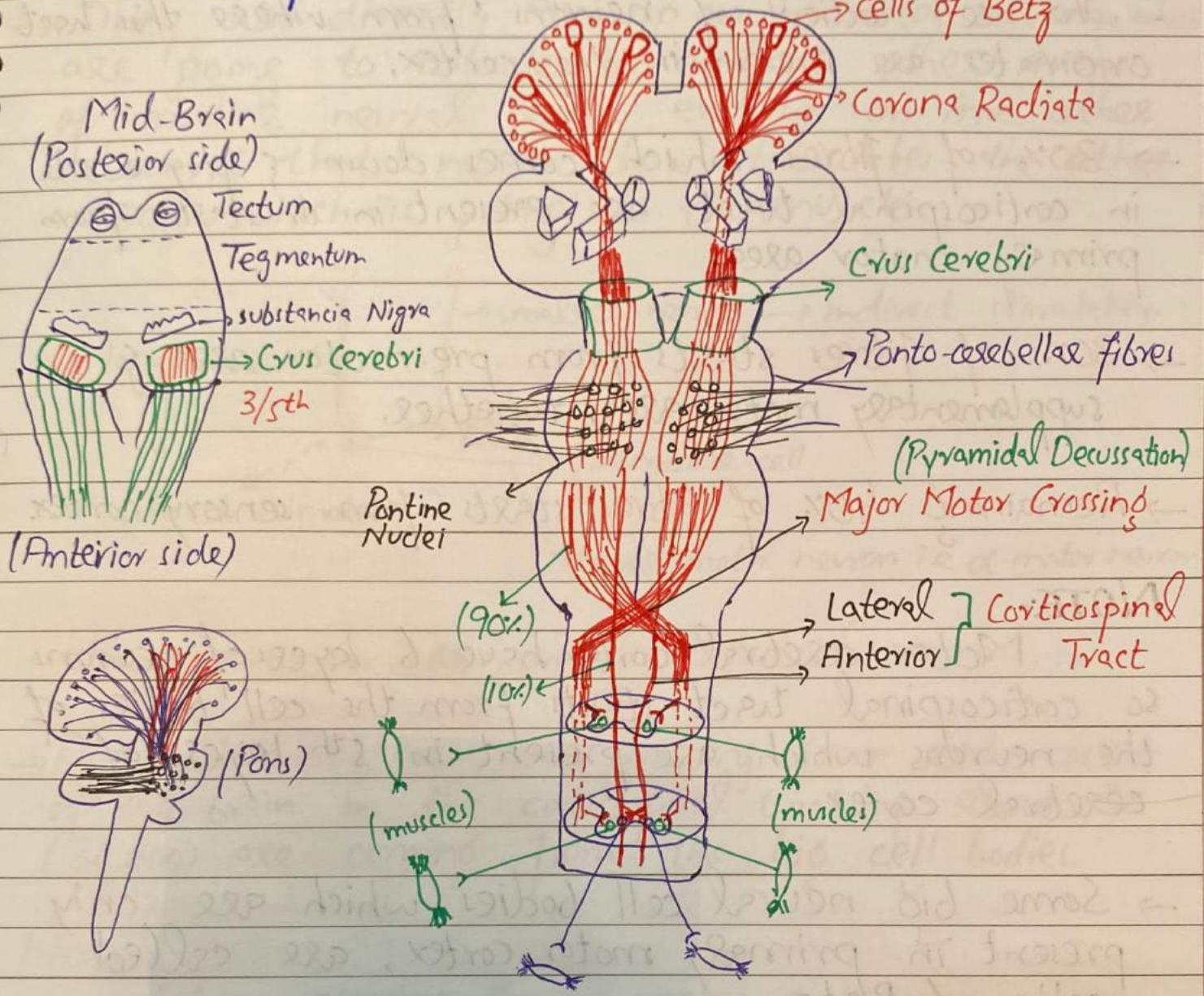


Scanned with CamScanner

M T W T F S S

Date:

Corticospinal Tract:-



Scanned with CamScanner

M T W T F S S Date:

→ As it name indicates, corticospinal tract starts in the cortex & goes to the spinal cord.
- The cell bodies of neurons from where this tract originates are present in the cortex.

→ 30% of fibres which comes down & play a role in corticospinal tract are present in or start from primary motor area.

→ 30% of fibres starts from pre-motor area & supplementary motor area. together.

→ Remaining 40% of fibres starts from sensory cortex.

NOTE:-
Motor cerebral cortex have 6 layers of neurons so corticospinal tract starts from the cell bodies of the neurons which are present in 5th layer of cerebral cortex.

→ Some bid neural cell bodies which are only present in primary motor cortex, are called cells of Betz.

→ These cells have size of 60 µm (about 8 times the size of one RBC.

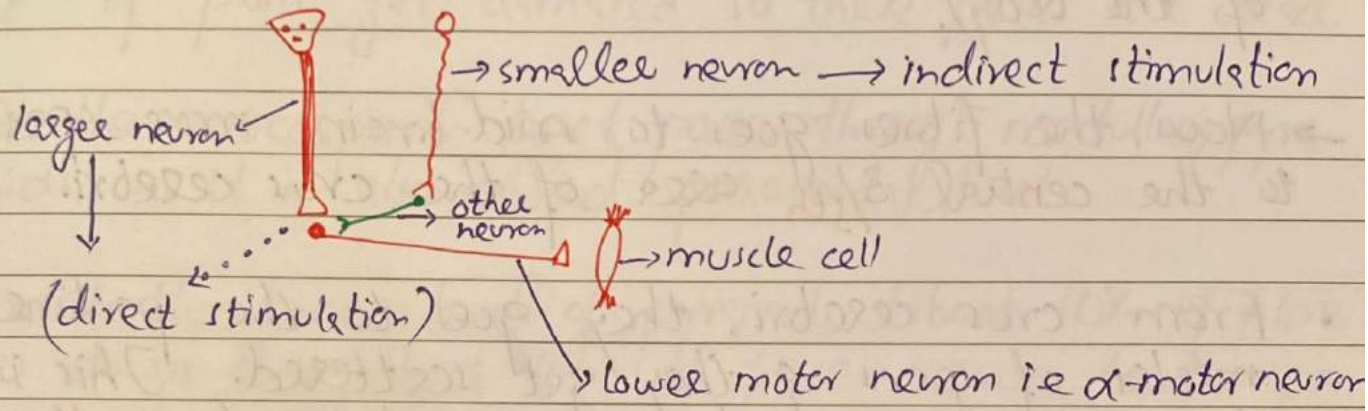
→ The axons coming from these cell bodies are only heavily myelinated & have size of 16 µm. considering the size of other axons which are

Scanned with CamScanner

M T W T F S S Date:

less then 4μm.

→ They also directly end up on α-motor neuron which are going to muscles, in contrast other axons of smaller neural bodies end up on some other neuron & that neuron then stimulates the other neuron which is going to the muscle



• other neuron = inter neuron (internuncial neuron)

→ About 1 million axons are coming from each cortex of the brain in the corticospinal tract & about 3% (30,000) are coming from the big cell bodies.

Now,

Fibres coming from motor & sensory cortex descends, & converge to the posterior limb of internal capsule, also forming corona radiata.

→ Now in this posterior limb, they are compacted so much i.e alots of fibres are going through small space.

Scanned with CamScanner

M T W T F S S Date:

→ It has some clinical importance, ie the artery supplying the posterior limb of internal capsule, if it's destroyed so it will cause damage to all the fibres of cerebral cortex passing through this posterior limb, thus we lose sensory sensations as well as motor control on the contra-lateral side of body.

- Thus it may cause hemeplegia (paralysis of half side of the body).

→ Now, the fibres goes to mid-brain, more specifically to the central 3/5th area of the crus cerebri.

- From crus cerebri, they goes to the pontine nuclei of pons & they get scattered. This is becoz in the pons there are alots of corti-pontine fibre, which after coming to the pontine nuclei, goes to the cerebellum, to inform it about the motor response which the mtor cortex is planning about. Thus due to so much corti-pontine fibre which are already present there, so when the corticospinal fibres come there, they get scattered. Actually, this is clinically so much importance, due to this scatteredness, if any lesion occur in this area, so due to this scatteredness, only small damage occurs to the motor system.

Scanned with CamScanner

M T W T F S S Date:

→ After these fibres goes to the medulla to form pyramids ie pyramids of medulla are having fibres of corticospinal tract.

Note:-
So if the medial part of medulla gets damaged so these fibres are dead. & in case of pons if the anterior part of pons get damaged so these fibres are dead.

→ As the corticospinal tract passes through medullary pyramids, so it is also called paramidal tract.

- Now at the lower level of pyramids, About 10% of fibres goes down straightly & 90% of fibres crosses to the opposite side, called major motor crossing. or pyramidal decussation.

→ Importance of these pyramidal decussation, is that if there are some lesions above these decussations so it will produce contra-lateral motor dysfunction. & if these lesions are below these decussations, so they produce epsilateral motor dysfunction.

→ Those 10% of fibres are making anterior corticospinal tract fibres becoz they are moving through anterior white column & 90% of fibres are moving through lateral white column thus making lateral corticospinal tract.

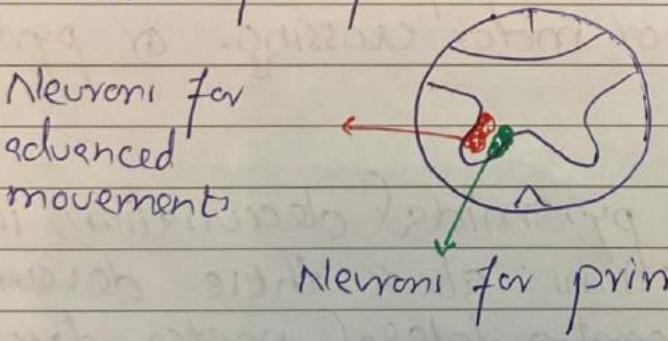
Scanned with CamScanner

M T W T F S S Date:

→ The neuronal cell bodies for primitive body movements are present in medial side of anterior grey horn & for advanced body movements, they are present in lateral side of anterior grey horn.

→ Minor motor crossing also occurs in the anterior corticospinal tract fibres at the point of connection with other fibres.

→ Thus the Lateral corticospinal tract fibres are connected to the neurons which are responsible for advanced movements. & Anterior corticospinal fibres are connected to neurons which are responsible for primitive or axial movement.



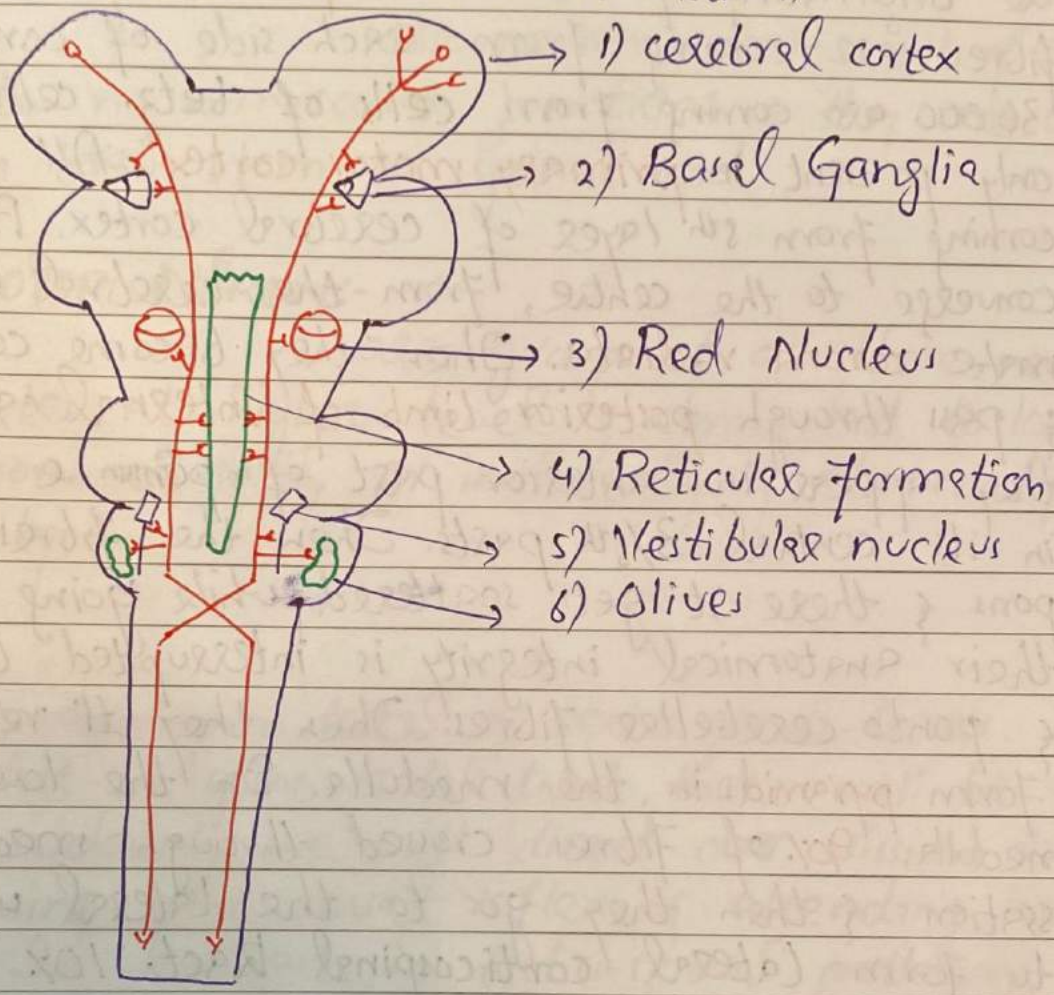
→ During their movements, the fibres of corticospinal tract make collateral connections. (1st) they make collateral connection with (cerebral cortex), to tell them about what will they do. (2nd) they make connections with (basal ganglia) (3rd) they make connections with (red nucleus), which will set the background pathway for the action e.g muscle tone of the wrist for fine movements. (4th) they make connections with (reticular formation) which will alert the cerebral cortex

Scanned with CamScanner

M T W T F S S Date:

(5th) they also make connections with (vestibular nucleus) which will provide proper tone for anti gravitational muscles.

(6th) they make connections with (olives of medulla) & due to its connection with cerebellum, the olives also inform the cerebellum about the action.



Scanned with CamScanner

M T W T F S S Date:

SUMMARY:-

Corticospinal tract starts in cerebral cortex & ends in motor neurons of spinal cord. Its fibres are originating from motor & sensory cortex. 1 millions fibres are coming from each side of cortex & about 30,000 are coming from cells of betz. cells of betz are only present in primary motor cortex. All the fibres are coming from 5th layer of cerebral cortex. As these fibres converge to the centre, from the cerebral cortex they make corona radiata. Then they become compacted bundle & pass through posterior limb of internal capsule. And then they appear in anterior part of mid Brain i.e crus cerebri. in its central 3/5th parts. Then the fibres comes to the pons & there it gets scattered. while going down, because their anatomical integrity is interrupted by pontine nuclei & ponto-cerebellar fibres. Then they re-compact & form pyramids in the medulla. In the lower part of medulla, 90% of fibres crossed through medullary decussation & then they go to the lateral white column to form Lateral corticospinal tract. 10% of fibres descend down such that without crossing & go to anterior white column to form Anterior corticospinal tract. Lateral corticospinal tract fibres are responsible for skilled movements or fine movements. by making connections with motor neurons of grey matter. Anterior corticospinal tract fibres makes connection with lower motor neuron & are responsible for axial movements. & they make crossing at the levels, where they are making connections with the final lower motor neuron. Any lesion above the pyramidal

Scanned with CamScanner

M T W T F S S Date:

decussation will produce contra-lateral weakness. & lesions below the pyramidal decussation will produce epsi-lateral weakness.

LOWER MOTOR NEURON:-

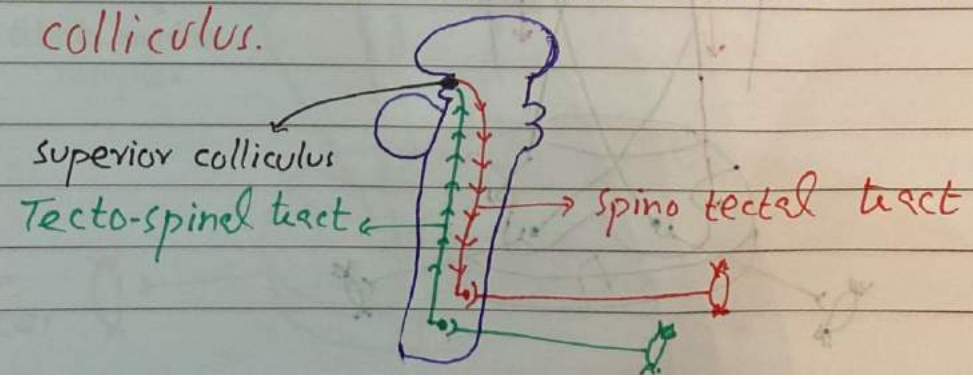
are neurons coming out of C.N.S & connected to neuro-muscular junctions. & they may be coming from brain stem or spinal cord.

UUPPER MOTOR NEURON:-

are groups of all those neurons which orginates at higher level & connected to lower motor neurons directly or indirectly & also modifying their activity.

NOTE:-

These are spino-tectal & tecto-spinal tracts. The difference is that in spino-tectal tract, there will be a stimulus & suddenly we will direct our vission towards it thus causing spino-visual reflex. & ascending tract is involved. In contrast, in tecto-spinal pathway, we must first see a visual stimuli & then we change our posture reflexely, thus causing visuo-spinal reflex. & descending tract is involved. The centre which controls both these tracts is superior colliculus.



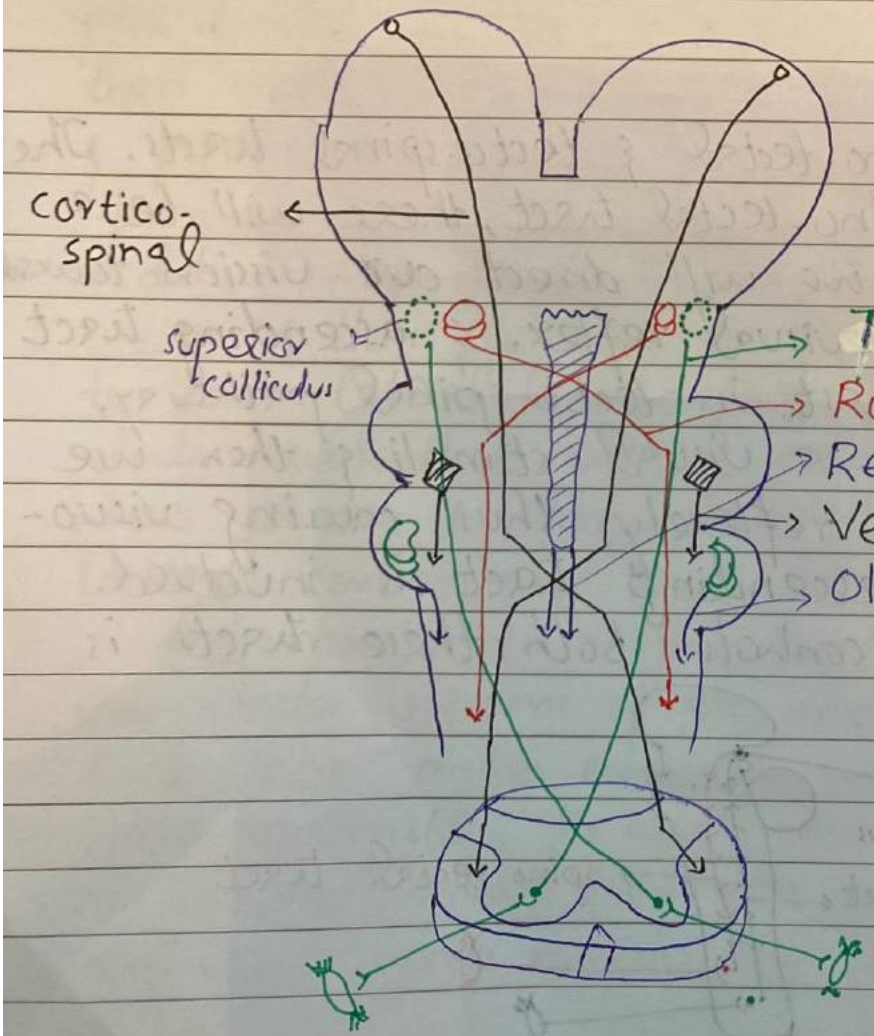
Scanned with CamScanner

M T W T F S S

Date:

MOTOR NEURON

- Upper Motor Neuron
  - Cortical origin (Pyramidal tracts)
    - Cortio spinal Tract
    - cortico nuclear Tract
  - Sub-cortical origin (Extra-pyramidal tracts)
    - → Tecto-spinal tract
    - → Rubro-spinal tract
    - → Retico-spinal tract
    - → vestibulo-spinal tract
    - → olivo-spinal tract
- Lower motor Neuron



Scanned with CamScanner

M T W T F S S Date:

TYPES:-

There are 2 types of descending tracts:-

1) PYRAMIDAL TRACTS:-

Those descending tracts which pass through pyramids of medulla.

2). EXTRA-PYRAMIDAL TRACTS:-

Those descending tracts which don't pass through pramids of medulla.

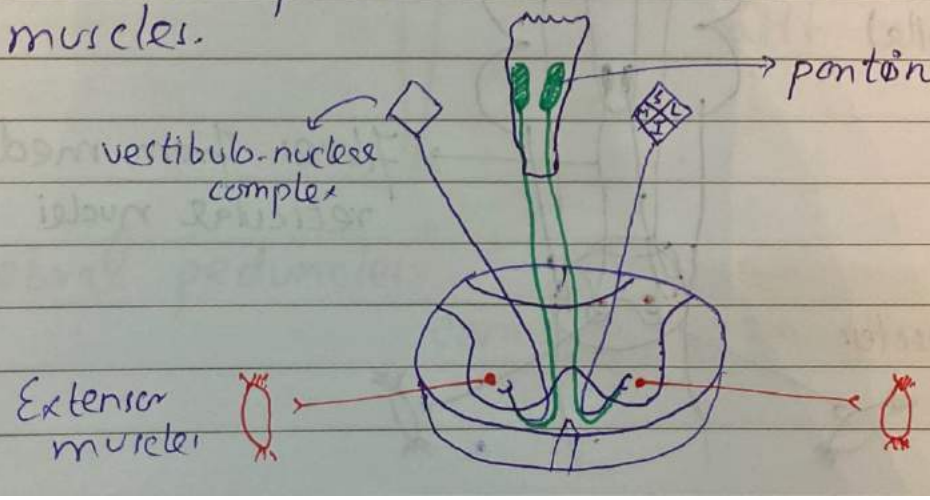
FUNCTIONS:-

1) VESTIBULO-SPINAL TRACT:-

From vestibular-nuclear complex, the fibres comes down to anterior white column, they increase the tone of extensor muscles. Thus helping us to stand-up or anti-gravity system.

2). RETICO-SPINAL TRACT:-

Fibres from pontine-reticular nucleus of reticular formation comes down & assists the vestibulo-spinal tract to increase the tone of extensor muscles.



Scanned with CamScanner

M T W T F S S Date:

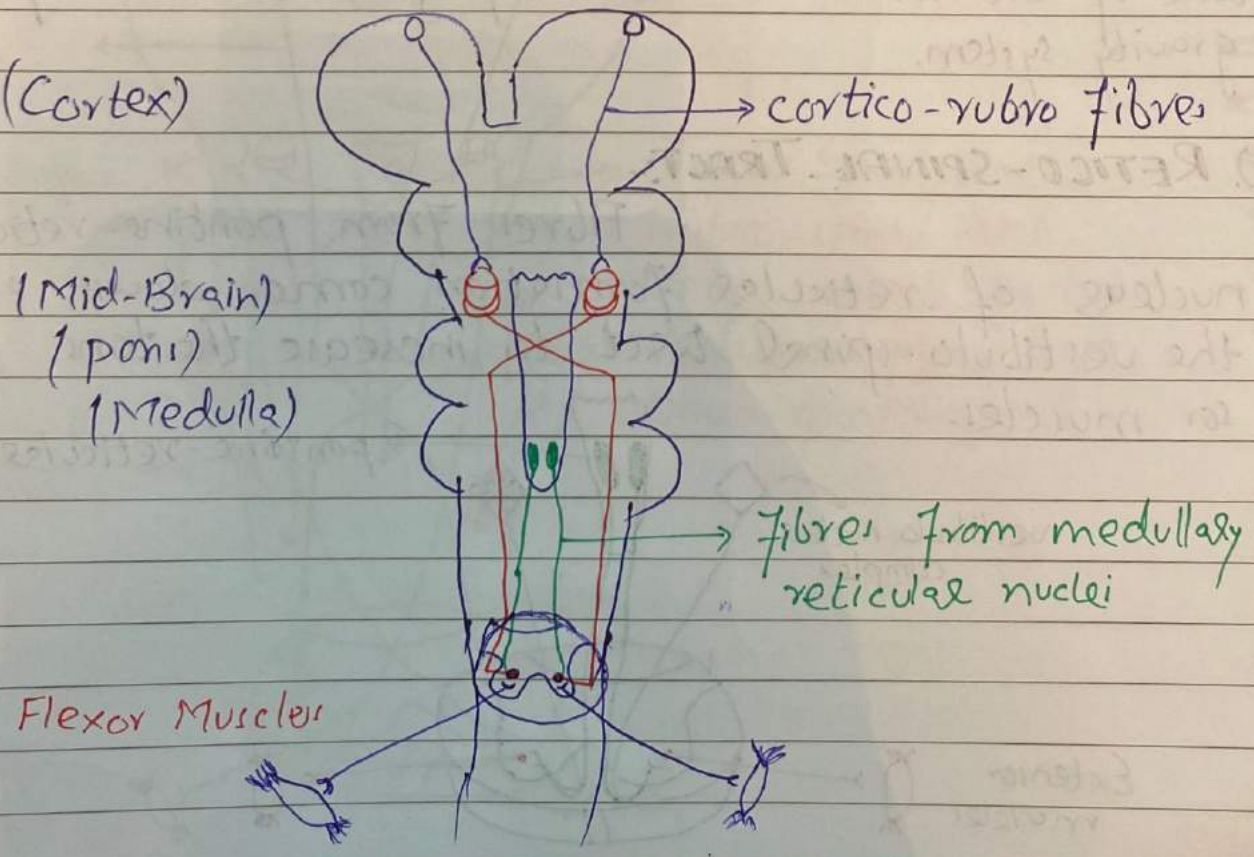
⇒ ViP makes you stand up.
V → vestibulo-spinal
P → pontine - reticulo-spinal

3). RUBRO-SPINAL TRACT:-

From red nucleus, the fibres descends to the lateral white column & there fibres are also crossed above & they enhance the tone of flexor muscles. & thus help us to sit down.

→ This tract has also connection with cortex through cortico-rubro fibres which enhances the voluntary movements.

⇒ Moreover, fibres from medullary reticolar nuclei of reticular system, descends down to flexor muscles.



Scanned with CamScanner

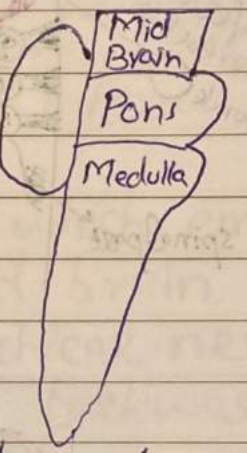
M T W T F S S Date:

⇒ Sit on Rubber Mat
R → rubrospinal tract
M → medullary reticular nuclei

BRAIN STEM:- (Basic Concept)

3 parts:-

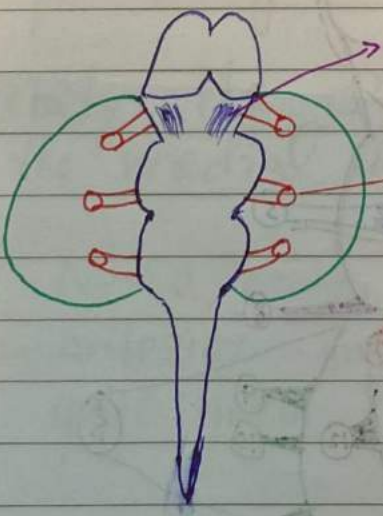
- Mid Brain
- Pons
- Medulla



(anterior view)

⇒ 1st & 2nd cranial nerves are not directly related to the brain stem but nuclei of 3→12 cranial nerves are present in brain stem.

• Peduncle:-
Bundles of white matter



→ cerebral peduncles

→ cerebellar peduncles

↓

connects brain stem with cerebellum

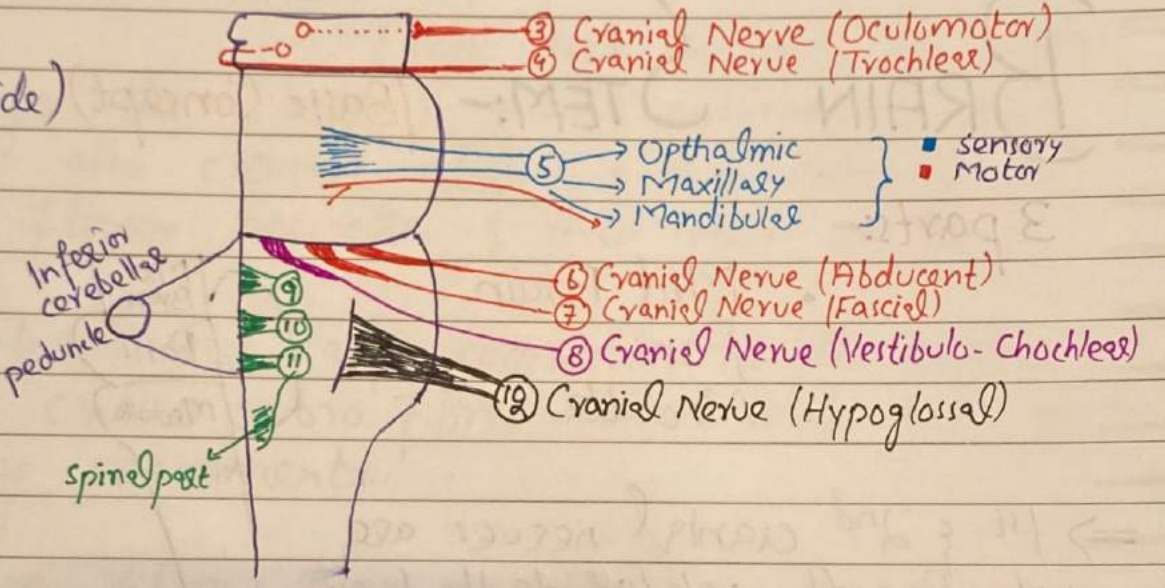
Cerebral peduncles:-
connects brain stem with fore-brain

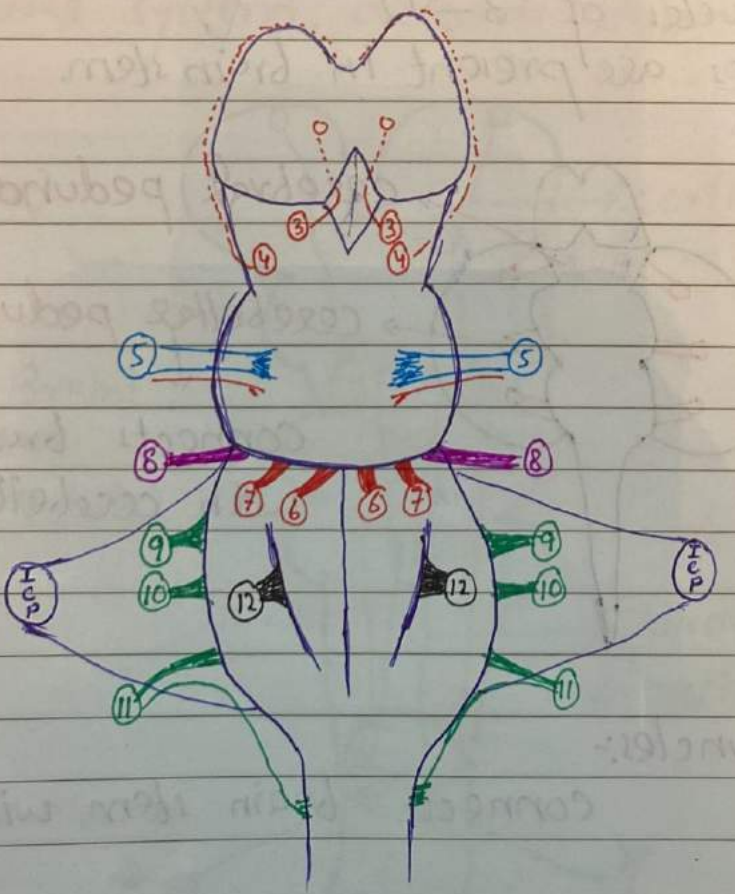
Scanned with CamScanner

M T W T F S S Date:

Brain stem connections:-

Superiorly → Fore-Brain
Inferiorly → Spinal cord
Posteriorly → cerebellum





(Mid Brain)

(Pons)

(Medulla)

Scanned with CamScanner

M T W T F S S Date:

→ On the back of Mid-Brain, there are 2 swellings called,
- Superior colliculus → Visual reflex
- Inferior colliculus → Auditory reflex

- 3RD Cranial Nerve exits from the anterior side of mid-brain at the level of superior colliculus. (3rd cranial Nerve → oculomotor nerve)

- 4th Cranial Nerve emerges out from the back of mid-brain at the level of inferior colliculus.

NOTE:-
It is the only nerve which, emerges out from the back of mid-brain.
(4th cranial nerve → Trochlear nerve)
- when it emerges out from backward, then it goes forward. The backward movement, may be due to pineal gland.

⇒ More precisely, the 3rd cranial nerve exist mid brain on the medial side of inter peduncular fossa.

- 5th Cranial Nerve, comes from mid-pon & on its lateral side, to its anterior. The fibres of this nerve after coming out split into 3 parts (Divisions)
  - Opthalamic
  - Maxillary
  - Mandibular
- That's why it is called as Trigeminal Nerve.

Scanned with CamScanner

M T W T F S S Date:

→ All these divisions carries sensory fibres. But in addition motor fibres also goes to the mandibular division.

→ The exact connection of these nerves (cranial) gives us the information of lesions in Brain stem, if they occurs. i.e the connection of these nerves with CNS.

6th, 7th & 8th Cranial Nerves; These nerves exit at ponto-medullary junction from medial side to lateral side in numerical sequence.
And the 7th nerve join the 8th after coming out.

6th → Abducent Nerve
7th → Fascial Nerve
8th → Vestibulo Chochlear Nerve

9th, 10th & 11th Cranial Nerves; These nerves exit at olivary-cerebellar junction (sulcus) in medulla from superiorly to inferiorly in numerical sequence.

9th → Glossopharyngeal Nerve
10th → Vagus Nerve
11th → Accessory Nerve (cranial & spinal part)

12th Cranial Nerve; comes from the junction b/w pyramids & olives in the medulla.

12th → Hypoglossal Nerve

Scanned with CamScanner

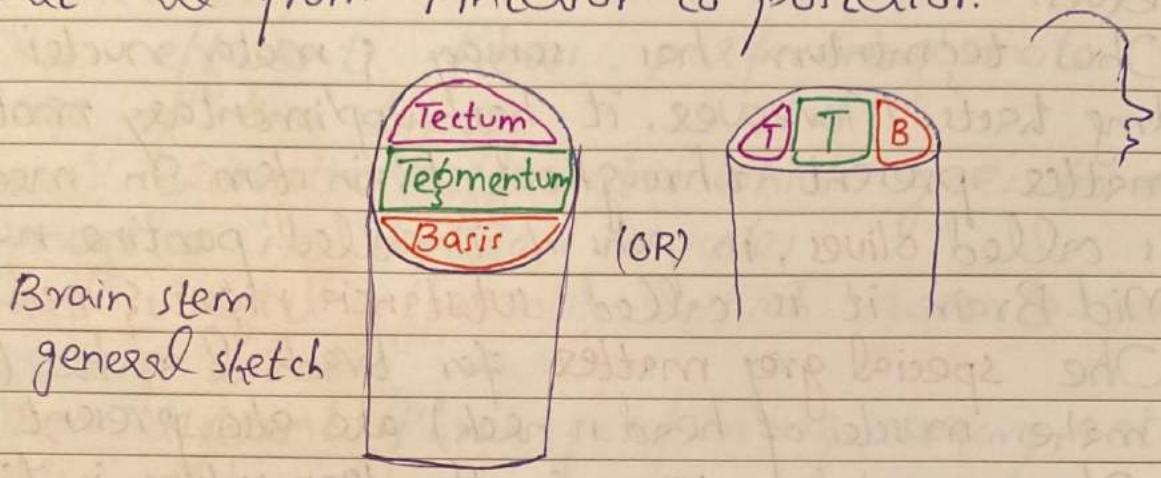
M T W T F S S Date:

Generally,

Brain stem has 3 anatomical parts:

- Basis
- Tegmentum
- Tectum

These parts are from Anterior to posterior.



Brain stem general sketch

In Brain stem, usually we study about,

1- upgoing system (Ascending tracts)
2- Down going system (Descending tracts)
3- Posto-lateral system (cerebellar system)
4- Antero-lateral system (cranial nerve system)

MAKING OF BRAINSTEM FROM SPINAL CORD:-

As in the spinal cord the motor grey matter is in the anterior column & sensory grey matter is in the posterior column. So when spinal cord is moving upward, spinal canal opens up & make the 4th ventricle, so motor grey matter comes to the centre & sensory grey matter goes to the sides. In Basis part of spinal cord, we have descending tracts.

Scanned with CamScanner

M T W T F S S

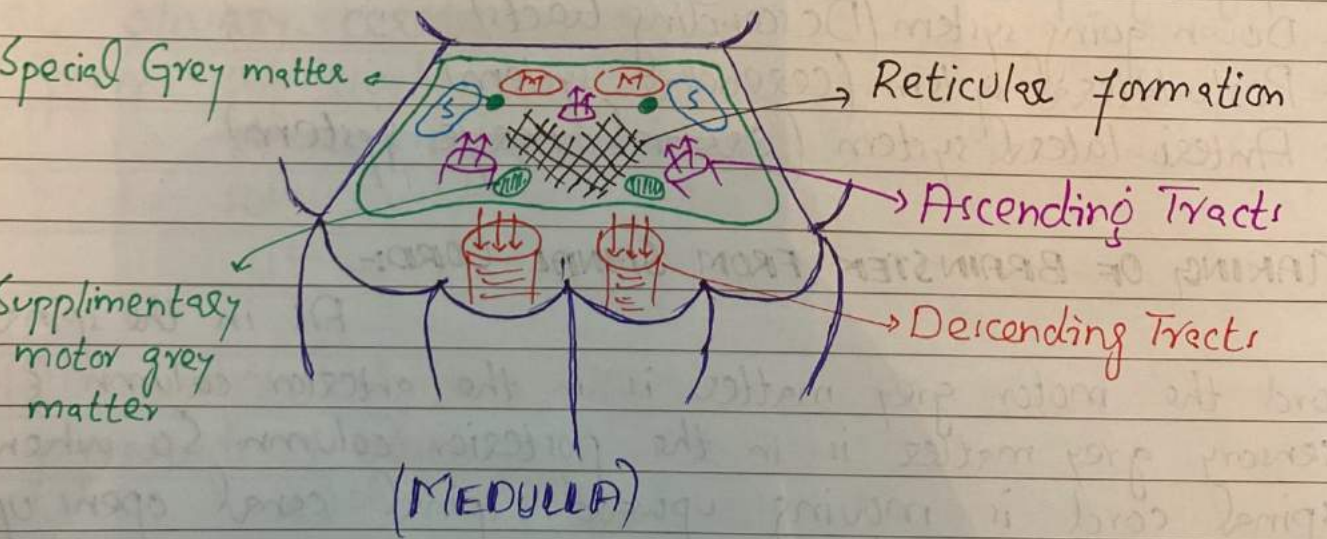
Date:

Tegmentum has continuation of spinal cord upward. As the motor grey matter comes to the centre & the spl sensory grey matter goes to the sides, thus due to major crossing of ascending & descending tracts in the medulla, these grey matter doesn't remains in the form of columns but they are broken into pieces called nuclei. of cranial nerves.

→ Thus tegmentum has sensory & motor nuclei plus ascending tracts. Moreover, it has supplimentary motor grey matter present throughout brain stem. In medulla, it is called olives, in pons it is called pontine nuclei & in Mid. Brain it is called substancia nigra & red nuclei.

→ The special grey matter for brachial arches (which makes muscle of head n neck) are also present here.

→ The remaining space in the tegmentum is filled by the Reticular formation (mixture of grey & white matter).



Scanned with CamScanner

M T W T F S S Date:

Basic Concept : part 2:-

The anterior grey horn of spinal cord contains motor neurons & posterior area/horn contains sensory neurons & lateral grey horn contains both motor & sensory neurons & are concerned with visceral activies.

→ The efferent fibres, performing motor activities are of two types:-

1) General somatic efferents:- which goes to skeleton muscles. i.e skeleton muscles

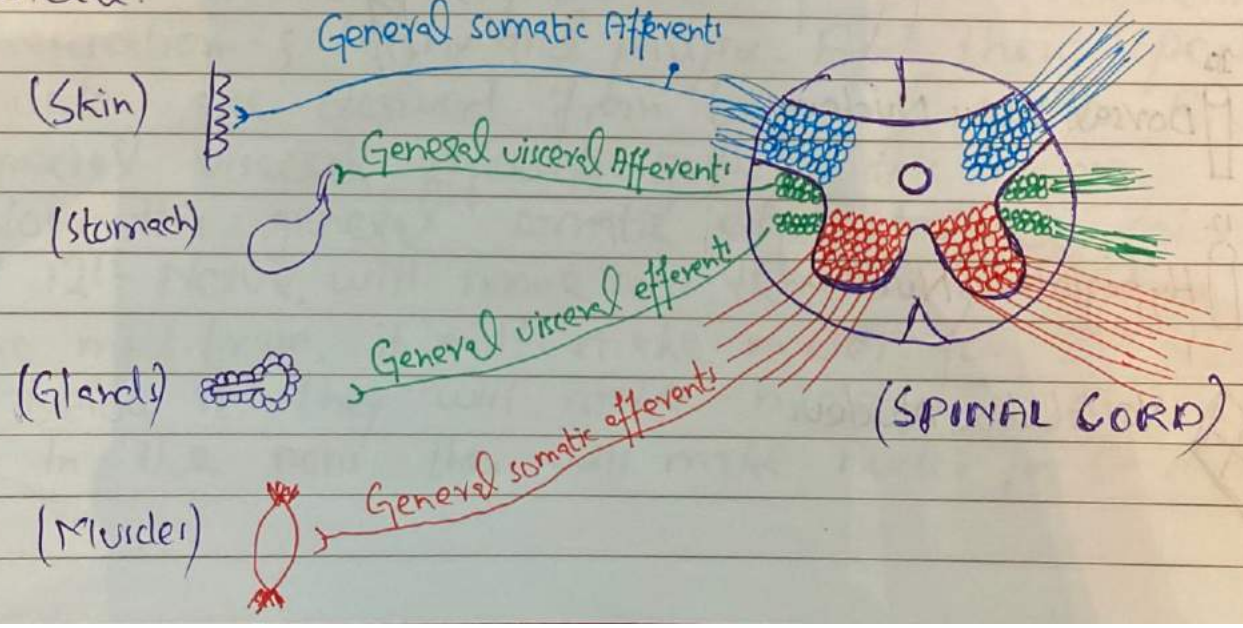
2). General visceral efferents:- which goes to general viscera e.g smooth muscles.

→ The afferent fibres, performing sensory activities are also of two types:-

1) General somatic afferents:- which take sensations from general body parts to the posterior grey horn.

2). General visceral efferents:- which take sensations from general viscera (GIT) to the lateral horn.

⇒ Thus, In spinal cord both output & input system is general.

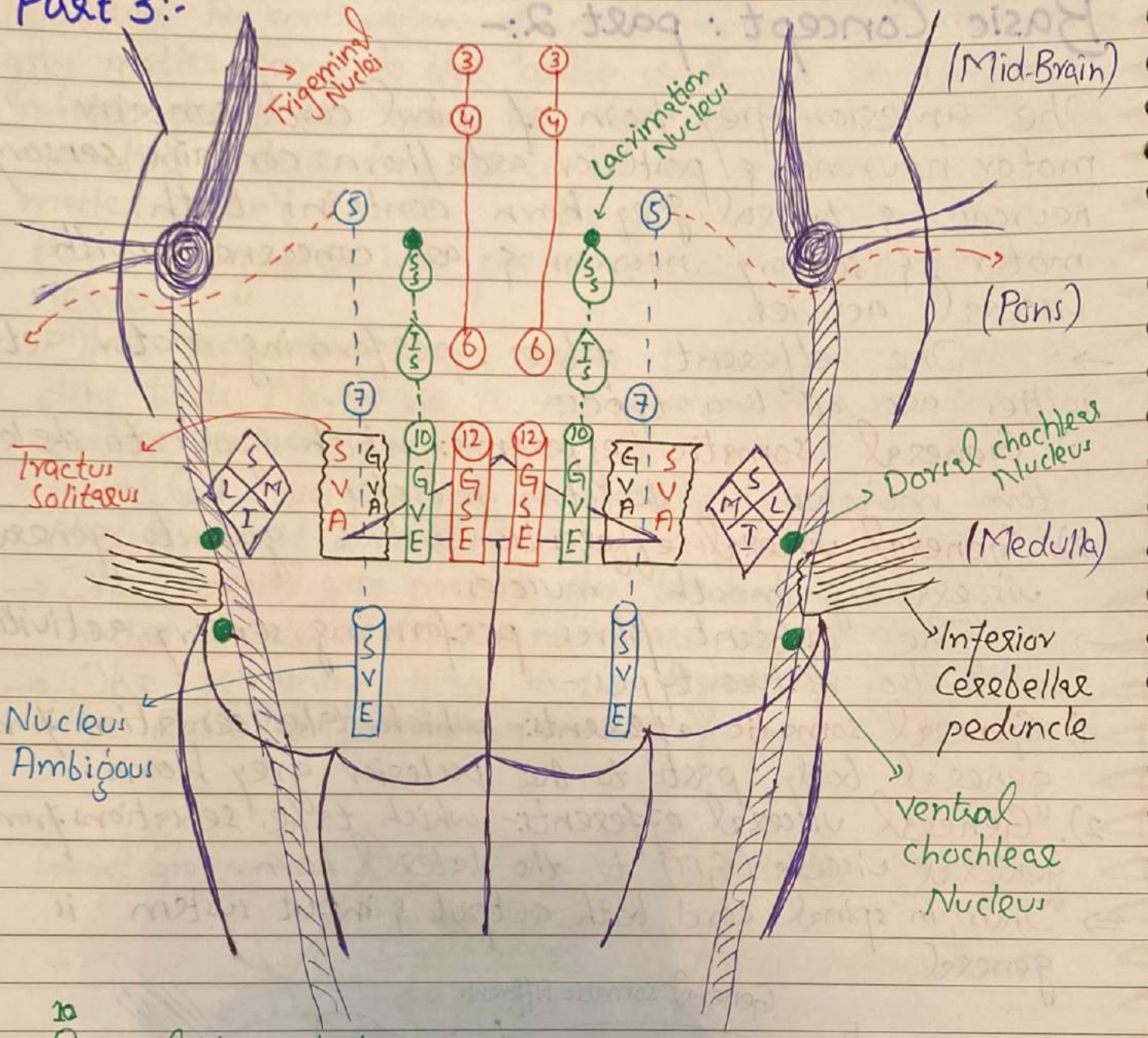


Scanned with CamScanner

M T W T F S S

Date:

Part 3:-



Scanned with CamScanner

M T W T F S S Date:

- As we know, that in making of brain stem from spinal cord, the motor neurons move to medial side & sensory neurons move to lateral side after opening of spinal canal & the visceral neurons remains between them.
- Thus, in the posterior side of medulla, there is a pair of nuclei (motor nuclei) for the 12th Nerve. & is concerned with skeleton muscles of tongue. Thus these nuclei are called hypoglossal nuclei & general somatic efferents are going through it.
- Little bit lateral to these nuclei on each side of medulla, are the motor nuclei for the 10th Nerve, which gives general visceral efferents to the general viscera (larynx, pharynx, GIT, cardiac muscles) & thus these are called Dorsal Vagus nuclei. They also supply the glands.
- Now anterolaterally to these motor nuclei, there is another pair of special motor nuclei, called the Nucleus Ambigous (so called due to its ambigous location) & is concerned with special musculature of head n neck e.g muscles of facial expression, mastication & larynx and pharynx. And these special muscles are derived from branchial arches. And special visceral efferents goes to this nucleus.
- Now this general somatic efferent fibers column of 12th Nerve, will move into the pons & mid-brain. In the mid-brain, it will make nuclei for 3rd Nerve & below it, they will make nuclei for 4th Nerve. & In the pons, they will make nuclei for 6th Nerve.

Scanned with CamScanner

M T W T F S S Date:

- These nuclei of 3rd, 4th, 6th & 12th Nerve have fibres which are going to skeleton muscles, & they make a column or a whole on the medial side, which is called General Somatic Efferent Column.
- Now above the dorsal vagus nuclei, there are 2 pair of nuclei on both side, in the pons. One is called inferior salivatory nuclei & the other is the superior salivatory nuclei. And the upper part of this superior salivatory nucleus gives fibres for Lacrimation.
- Thus, the dorsal vagus nuclei, salivatory nuclei & Lacrimal nuclei, will make a column, called General visceral efferent column.
- The nucleus ambiguus lies in the medulla & on the same line in the pons, the nuclei for the 5th & 7th nerves lies.

NOTE:-

The nuclei ambiguus also give fibres to 9th, 10th & 11th nerve (cranial part). Thus it means that a single nuclei can give fibres to many nerves & also a single nerve can also be connected to many nuclei. e.g vagus nerve is connected to both vagus nucleus & nucleus ambiguus.

Scanned with CamScanner

M T W T F S S Date:

Sensory Nuclei:-

- Lateral to the dorsal vagus nuclei, there is a nuclei on each side of medulla, called Tractus solitarus, which has two parts; The medial part is concerned with General visceral afferents & lateral most is concerned with Special visceral afferents.
- General visceral afferents takes sensory info from the general viscera e.g GIT to the tractus solitarus & Special visceral afferents takes sensory info from special viscera like tongue to tractus solitarus.
- The Taste sensations are carried by 3 nerves i.e 7th, 9th & 10th to tractus solitarus.
  - → Anterior 2/3 fibres are carried by 7th Nerve
  - → Posterior 1/3 fibres are carried by 9th Nerve
  - → Posterior most by the 10th Nerve.
- Now the Special somatic afferents e.g sense of balance & hearing goes to the vestibular nucles & chochlear nuclei respectively
- The vestibular nucleus is present lateral to the tractus solitarus. Moreover, there are 2 chochlear nuclei i.e ventral chochlear nuclei → ventral to inferior cerebellar peduncle & dorsal chochlear nuclei → dorsal to inferior cerebellar peduncle.
- And most lateral to these, there is an area for General somatic afferents i.e touch, temp, pain sensation. & nuclei for these sensation is called Trigeminal nucleus.

Scanned with CamScanner

M T W T F S S Date:

⇒ General & special visceral afferent have no column in the pons & above in mid-brain, and also the special somatic afferents have no column.

• But the general somatic afferents have a column there.

→ The Trigeminal System contains:-

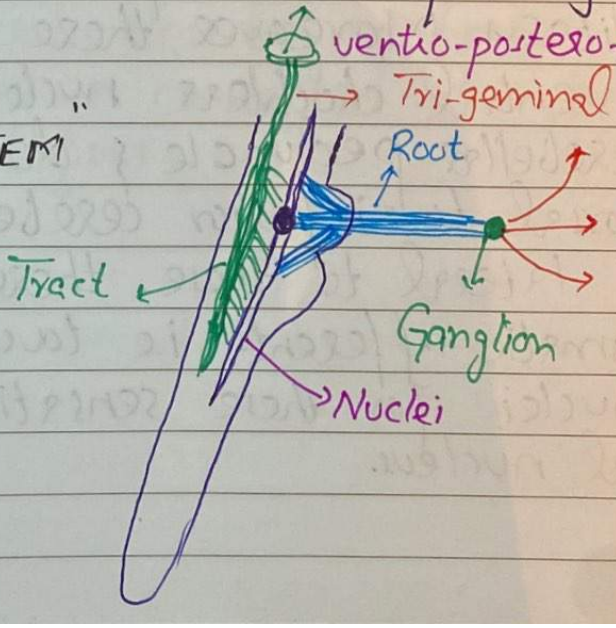
1- principle pontine Nucleus in the pons, fine touch sensations come here.

2- Mesencephalic Nucleus in the mid-brain, proprio-ception sensation come here.

3- Spinal Nucleus which extends upto the cervical part of spinal cord, the pain & temp sensation goes to this area.

⇒ Thus, sensations (touch, temp, pain, proprioception) from the opthalmic, maxillary & mandibular divisions goes to the trigeminal Ganglion & from there to the trigeminal root & into the trigeminal nuclei. And from the sensations are carried to thalamus by 2nd order neurons & then by the 3rd order neurons to the cortex, thus forming trigeminal tract.

"TRIGEMINAL SYSTEM"



Scanned with CamScanner

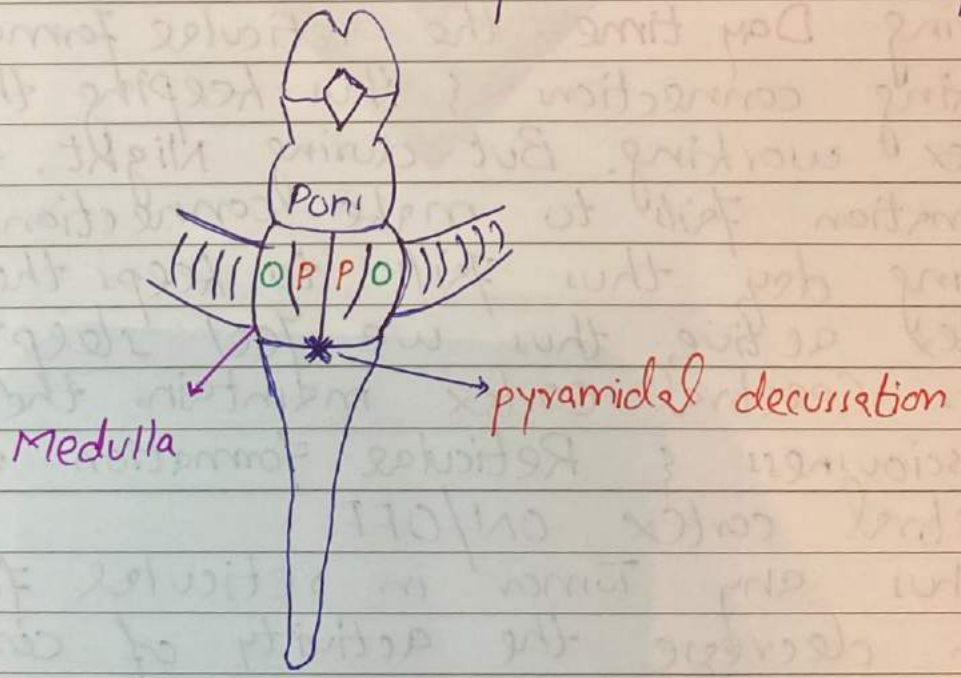
M T W T F S S Date:

MEDULLA OBLONGATA:-

- Lower part of Brain stem.
- Belongs to rhombencephalon (Hind Brain)
- Medulla extends from ponto-medullary sulcus (superiorly) upto pyramidal decussation.

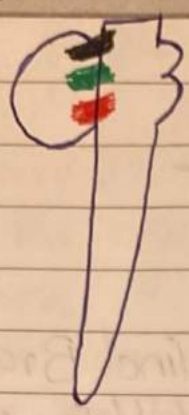
Frontal view:-

It has a central sulcus, medially it has pyramidal swellings on both sides & laterally it has olivary swellings on both sides. And more laterally to the olives, these are inferior cerebellar peduncles



- Brainstem is connected with cerebellum through 6 peduncles ✓
  - 2 superior cerebellar peduncles
  - 2 middle cerebellar peduncles
  - 2 inferior cerebellar peduncles

Scanned with CamScanner



- Reticular formation is situated deep in the centre of brainstem & acts as a ON/OFF switch for the cerebral cortex. & thus maintaining the concious level. i.e ascending fibres from the reticular formation comes to the intra-laminar nuclei of thalamus & from there the fibres goes to the cerebral cortex to activate it. During Day time, the reticular formation is making connections & thus keeping the cerebral cortex working. But during Night, the reticular formation fails to make connections as it do during day thus fails to keeps the cerebral cortex active, thus we feel sleepy.
- Thus Cerebral cortex maintain the states of consciousness & Reticular formation makes the cerebral cortex ON/OFF.
- Thus any Tumor in reticular formation can decrease the activity of conciousness in cerebral cortex

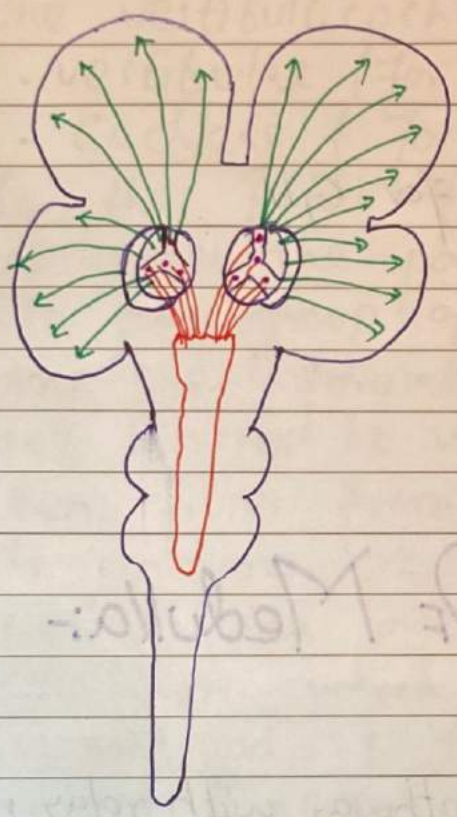
NOTE:-

Medulla is important part of C.N.S because

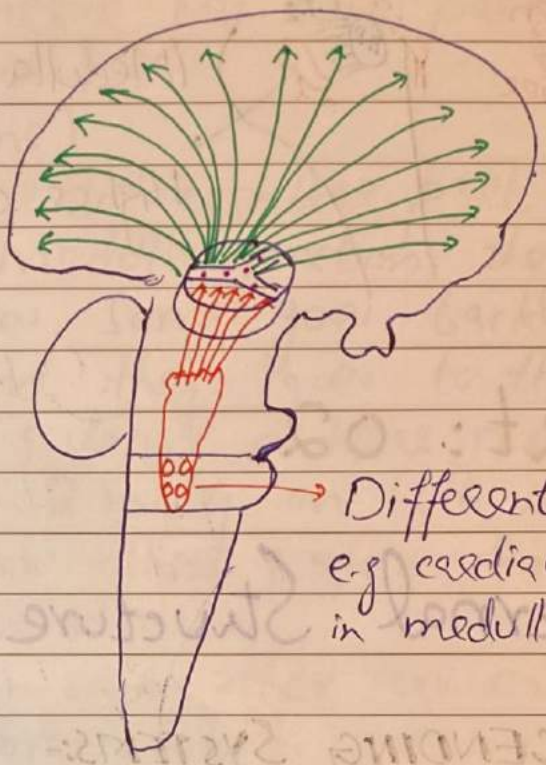
Scanned with CamScanner

M T W T F S S Date:

in its reticular formation, it has cardiac centers, vasomotor centers, respiratory centers, & gastro intestinal centers.



(Frontal view)



(side view)

AREA POSTREMA:-

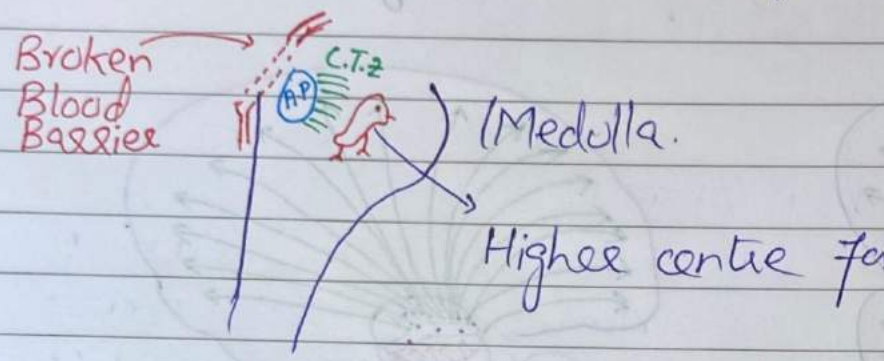
Present in the posterior side of medulla oblongata. Just under it, there is chemo-trigger zone & below which there is autonomic centre for GIT.

- Area postrema has a broken blood barrier. Thus the chemical substance in blood can influence the neurons present in the area postrema. Thus if any toxic substance comes in the blood, so it stimulates the neurons of Area postrema which again stimulates the chemo-trigger zone & thus it stimulates

Scanned with CamScanner

M T W T F S S Date:

autonomic contol of GIT. & thus it causes reverse paristalsis & thus causes the feeling of nausea



Part: 02

Internal Structure Of Medulla:-

1) ASCENDING SYSTEMS:-

(Sensory pathway with relay nuclei)

1) Dorsal Column:-
   1) Fasiculas Gracilis
   2) Fasciculus Cuneatus
   3). Nucleus Gracilis
   4). Nucleus Cuneatus
   5). Internal Arcuate fibres
   6). Medial Leminiscus

2) Antero-Lateral column:-
   1). Lateral spinothalamic tract (pain & temp)
   2). Anterior spinothalamic tract (crude touch)
   3). Spinotectal tract (spino-visual & spino-auditory reflex)
   4) Spinal Leminiscus

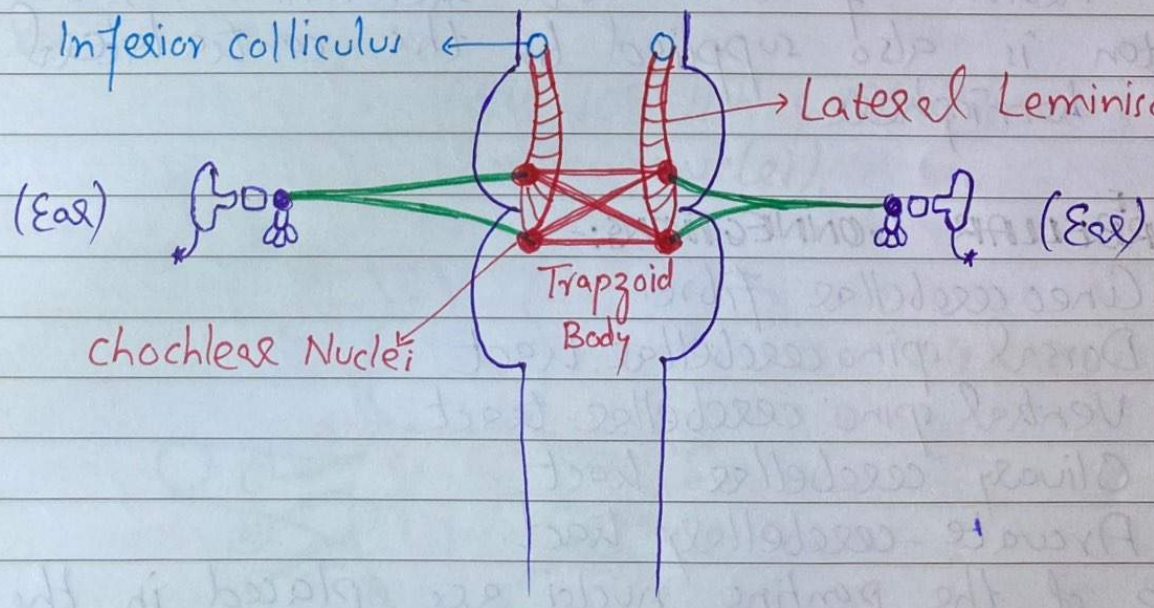
Scanned with CamScanner

M T W T F S S Date:

NOTE:-

What is Lateral Leminiscus?

- The vestibulocochlear nerve has two parts i.e
  - vestibular (for balance:)
  - Cochlear (for hearing)
- So, the fibres from the cochlear part, as they approaches the pons & medulla junction, they divide into two group of fibres. Some goes backward & some goes forward. And they goes to the cochlear nuclei. i.e ventral & dorsal cochlear nuclei.
- Then, fibres from these 2 nuclei on both sides of the junction crosses each other & after that they goes to the inferior colliculus.
- The fibres which crosses each other are called Trapzoid body & the fibres which goes up are called Lateral Leminiscus.



Scanned with CamScanner

M T W T F S S Date:

→ Thus, lateral lemniscus is not present in any portion of medulla. It is only present in pons & lower part of mid-Brain.

2) DESCENDING SYSTEM:-

(Motor pathways)

1) Cortico-spinal fibres
2) medullary pyramids (anterior swelling)
3) lateral cortico-spinal tract (crossed fibres - 90%)
4) Anterior cortico-spinal tract (uncrossed fibres - 10%)

- Lateral cortico-spinal tract decussation occurs in the lower part of medulla & they supplies the limbs through lower motor neurons. Thus Each limb is supplied by contralateral cerebral hemisphere.
- Anterior cortico-spinal tract decussation occurs just in the spinal cord before they supplies the lower motor neurons of the axial skeleton. Thus, the axial skeleton is also supplied by the contralateral cerebral hemisphere.

3). CERBELLAR CONNECTIONS:-

1) Cuneo cerebellar fibres
2) Dorsal spino cerebellar tract
3) Ventral spino cerebellar tract
4) Olivary cerebellar tract
5) Arcuate-cerebellary tract.

- Some of the pontine nuclei are placed in the medulla infront of pyramids & are called

Scanned with CamScanner

M T W T F S S Date:

arcuate nuclei & they make arcuate-cerebellar tract.

6). Reticular-cerebellar pathway

CENTRAL TEGMENTAL PATHWAY:-

→ Following pathways or fibres passes through central tegmental pathway:-

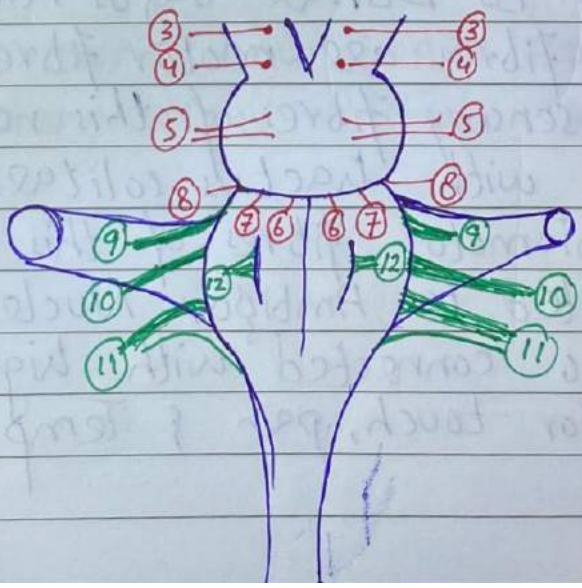
i- Rubro-olivary pathway

ii- Reticulo-thalamic fibres

iii- Tracto-solitario-thalamic pathway (Taste pathway) when fibres from Tongue through 7th, 9th & 10th nerve comes to the Tractus solitarius nucleus then they move through central tegmental pathway to the medial part of ventro-posterior nuclei or simply ventro-posterio medial nucleus of the thalamus.

4- CRANIAL NERVES:-

(9th, 10th, 11th & 12th Nerve & their relay nuclei).

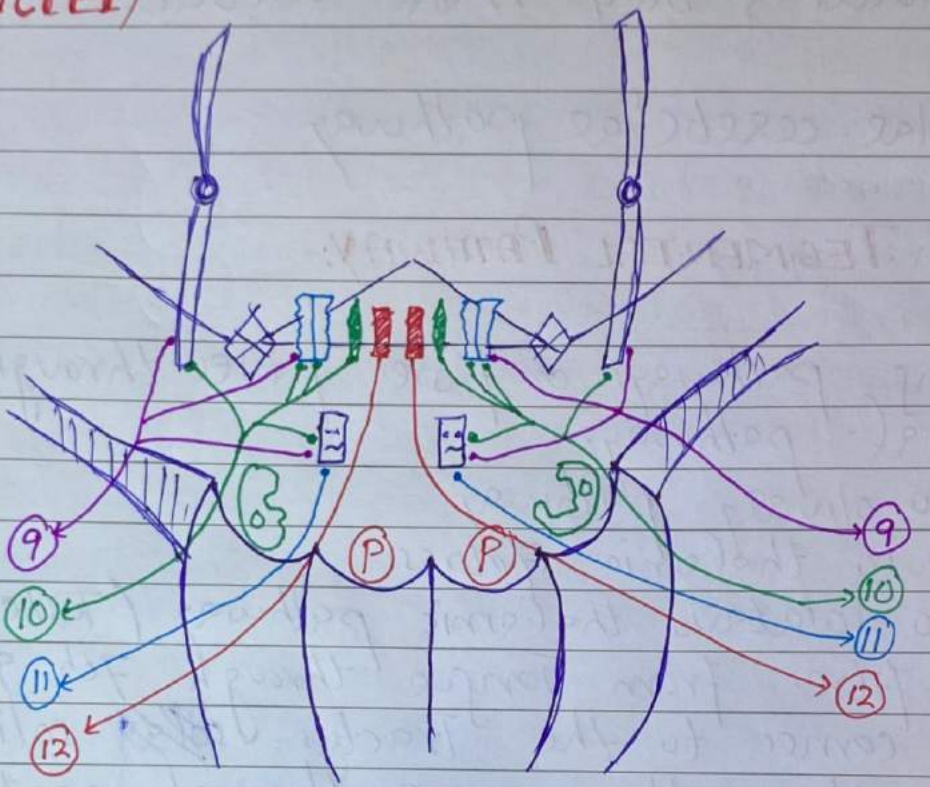


(NERVES)

Scanned with CamScanner

M T W T F S S Date:

(NUCLEI)



12 TH Nerve:- connected to hypoglossal nucleus.

10th Nerve:-
- parasympathetic fibres of this nerve is connected to Dorsal vagus Nerve. i.e these fibres are motor fibres.
- And the sensory fibres of this nerve is connected with tractus solitarius nucleus.
- The branchiomotor fibres of this nerve is connected to Ambigous Nucleus.
- It is also connected with trigeminal system for touch, pain & Temp.

Scanned with CamScanner

M T W T F S S Date:

So,
10th Nerve is connected with:
1) Dorsal Vagus Nucleus
2) Tractus solitaeus Nucleus
3) Ambigous Nucleus
4) Trigeminal System/Nuclei

- 9t (Vagus Nerve) is also connected with External Ear.

9TH Nerve:-

- Brachiomotor fibres of this nerve is connected with nucleus ambigous.
- Touch, pain, temperature fibres are connected with nucleus system of Trigeminal.
- This Nerve also brings taste fibres from posterior 1/3rd to nucleus Tractus solitarius.

11th Nerve:-

- Cranial part of 11th Nerve is also connected to nucleus ambigous.

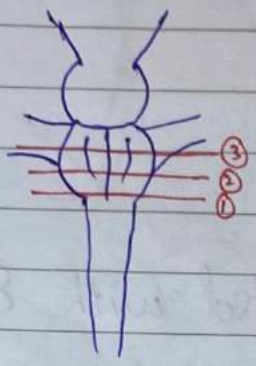
NOTE:-

The cranial nuclei are connected to each other through Medial Longitudnal Fasiculus in the Brainstem.

Scanned with CamScanner

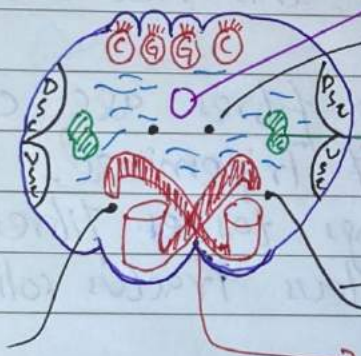
M T W T F S S Date:

Sections of Medulla:-



1. Level at motor decussation
2. Level at sensory decussation
3. Mid-olivary level.

1. Section



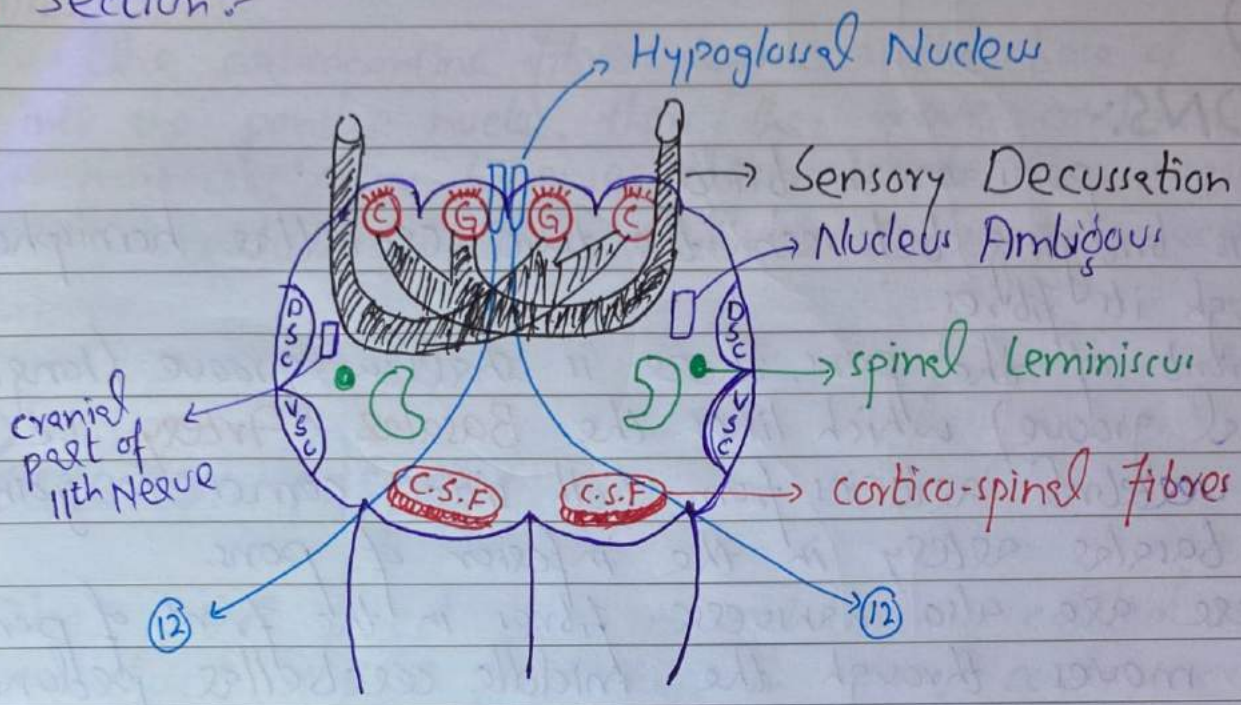
- DSC :- Dorsal spinal cerebellar tract
  VSC :- Ventral spinal cerebellar tract.
  ≈≈≈ :- shows reticular formation.

- In lower part of medulla, central canal is closed but in upper part, it open into 4th ventricle.

Scanned with CamScanner

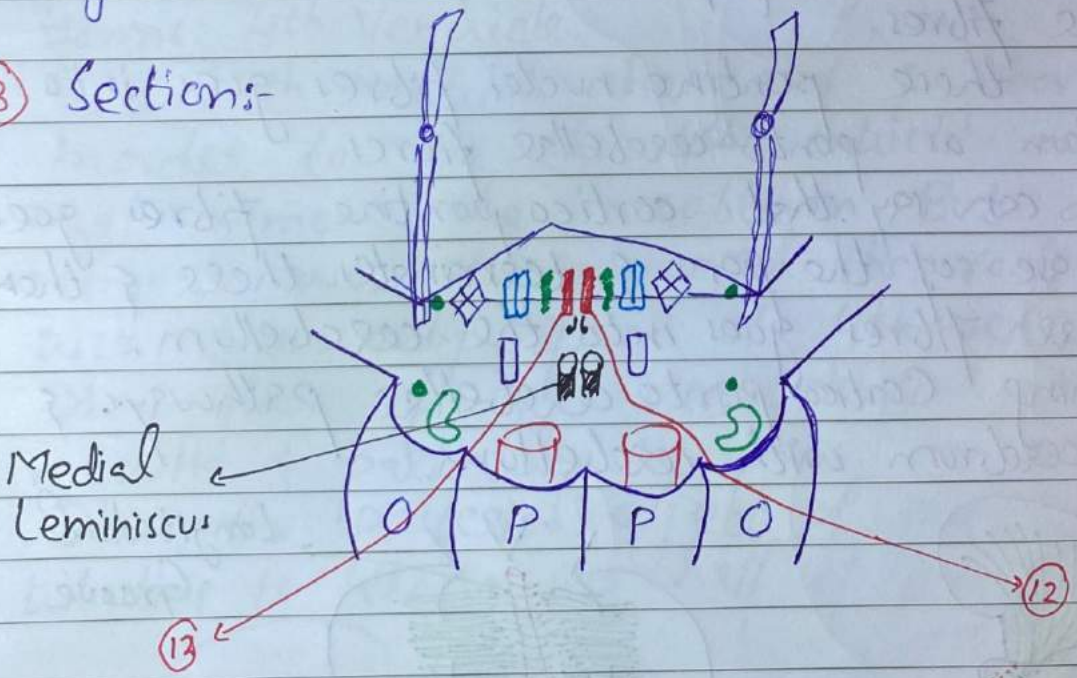
M T W T F S S Date:

(2) Section:-



- Other fibres from nucleus ambiguus will come out at higher level.

(3) Section:-



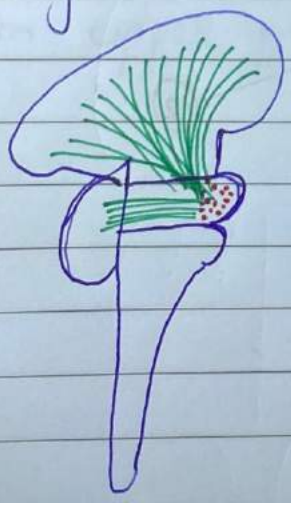
Scanned with CamScanner

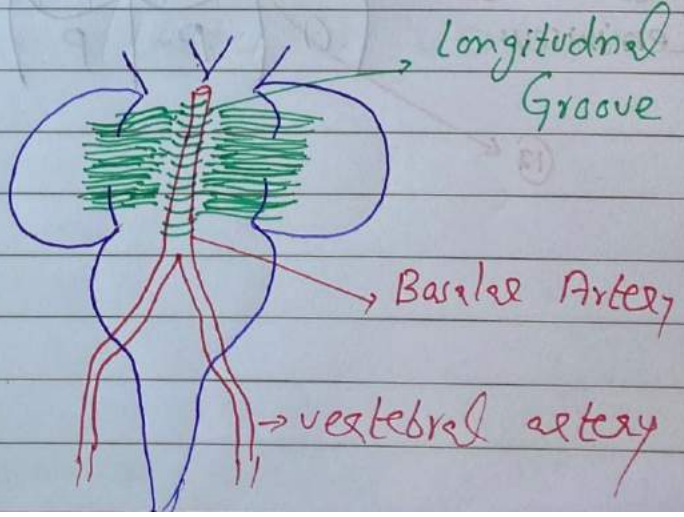
M T W T F S S Date:

PONS:-

pons mean bridge

- It is bridging between the two cerebellar hemispheres through its fibres.
- In front of the pons, there is shallow groove (longitudinal groove) which lines the Basalar Artery. i.e the vertebral arteries from both sides come to join the basalar artery in the inferior of pons.
- There are also transverse fibres in the front of pons which moves through the middle cerebellar peduncle into the cerebellum.
- Actually, lots of fibres are coming from the cerebrum into the pontine nuclei of pons & they are called cortico-pontine fibres.
- And from these pontine-nuclei fibres goes into the cerebellam as ponto-cerebellar fibres.
- Simply, we can say that cortico pontine fibres goes into the base of the pons & terminates there & then ponto cerebellar fibres goes into the cerebellum.
- Thus forming Cortico-ponto cerebellar pathways & connecting cerebrum with cerebellum.





Scanned with CamScanner

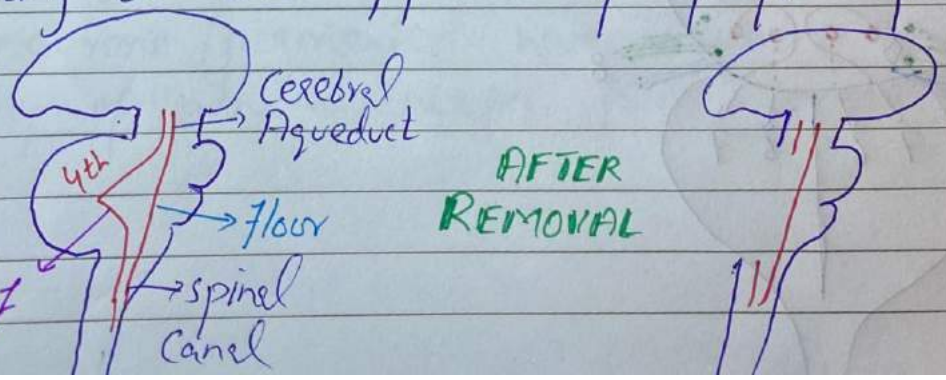
M T W T F S S Date:

NOTE:-

The corticopontine fibres come to the base of pons & into the pontine nuclei, then they move contralaterally as pontocerebellar (Transverse fibres) into the cerebellum through middle cerebellar peduncle. & thus pons acts as a bridge.

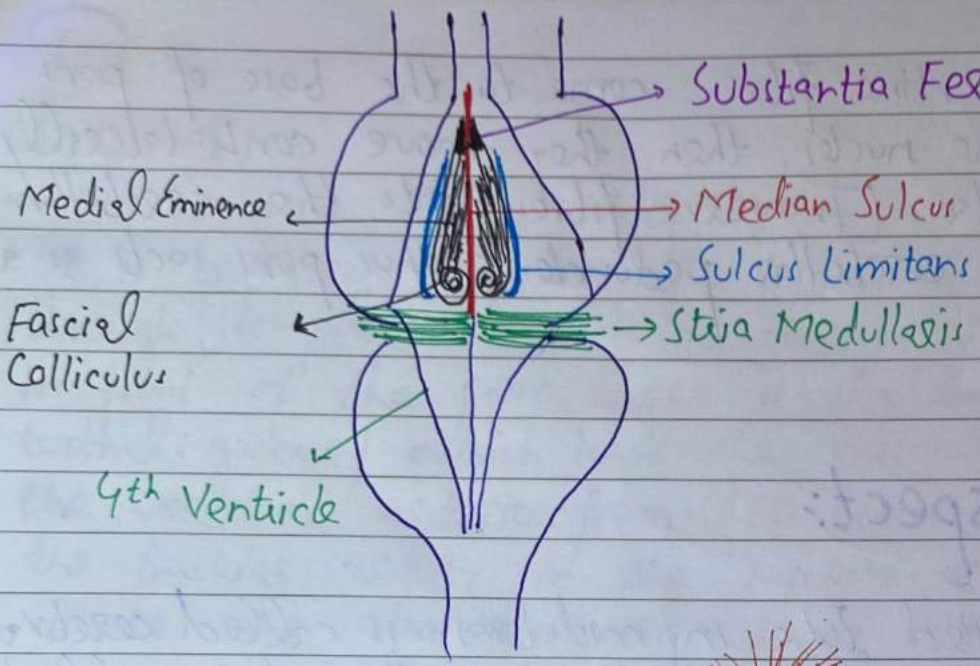
Posterior Aspect:

- The C.S.F filled tube in mid-brain is called cerebral aqueduct & C.S.F filled tube in spinal cord is called spinal canal.
- But below the cerebral aqueduct & above the spinal canal the tube is expended backward & forms 4th Ventricle.
- The 4th ventricle has roof & floor.
- In order to see the 4th ventricle or pons, we must remove the cerebellum. But during its removal we also removed the roof of 4th ventricle thus only floor of 4th ventricle is left
- The floor of 4th ventricle is partially in medulla & partially in pons.
- Thus, the posterior aspect of pons is actually contributing to the upper half of floor of 4th ventricle.

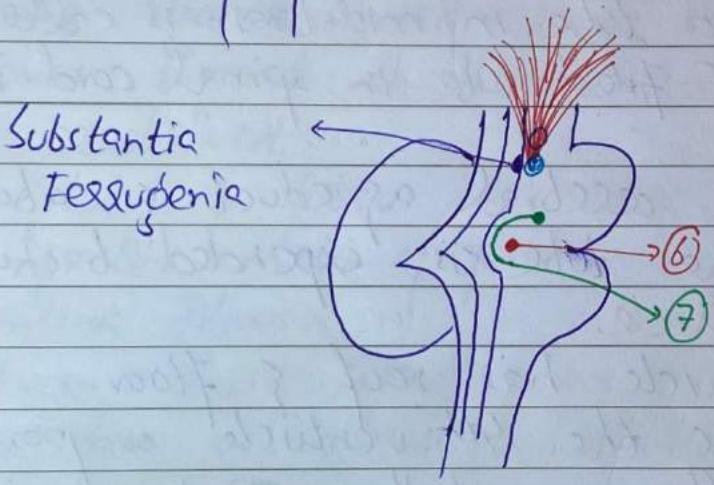


Scanned with CamScanner

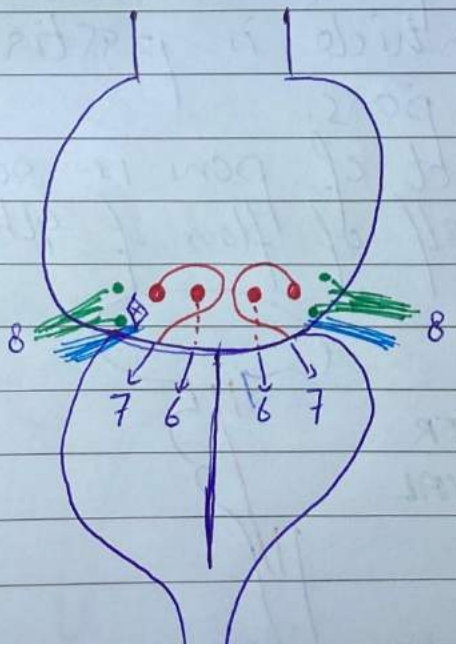
M T W T F S S Date:



(BACK VIEW)



(SIDE VIEW)



(FRONT VIEW)

Scanned with CamScanner

M T W T F S S Date:

- In the floor of 4th ventricle, there is longitudnel depression, called Median Sulcus.
- Above, the Stria medullaris the floor of 4th ventricle is contributed by the pons.
- There are longitudnel elevation on both sides of the median sulcus & it becomes swollen when it comes down.
- These swollen part is actually form by the internal geno (turn) of 7th (Fascial) Nerve i.e The 7th nerve while encircling the 6th Nerve nucleus, produces elevation in the floor of 4th ventricle.
- So this swelling is called Fascial colliculus.
- On the lateral side of these elevations & swelling, there is another sulcus called Sulcus limitans.
- Actually, these longitudnel elevation, lateral to the median sulcus, are called Medial eminence. & when this medial eminence comes down, the form fascial colliculus.
- And more laterally, there is vestibular area for vestibular nuclei.
- The very superior part of sulcus limitans & median sulcus is very bluish green & is called Substantia Ferruginia.
- Under the substantia Ferruginia, there is a group of neurons (pigmented neurons) which are the major supply of non-adrenergic fibres to the C.N.S.

Scanned with CamScanner

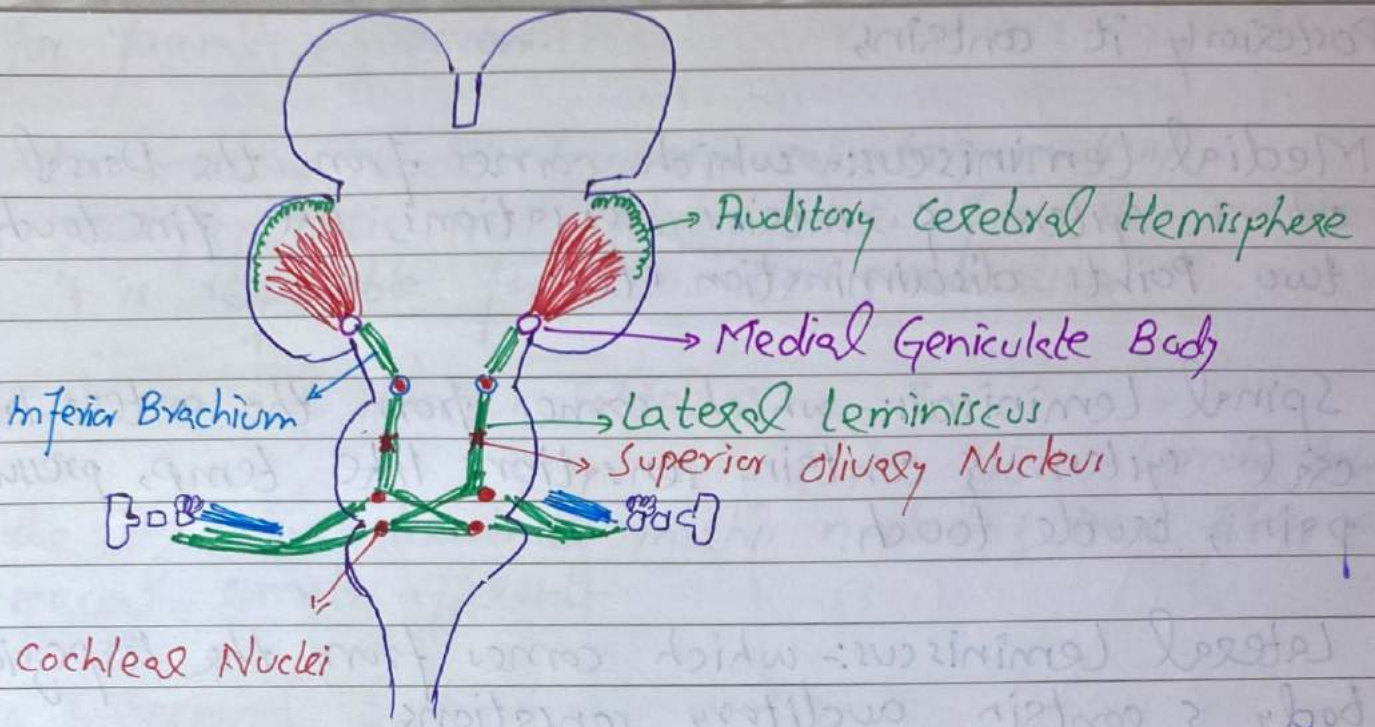
M T W T F S S Date:

Part 02:-

- Anterior to the trapezoid body, there is base & posterior to trapezoid body, there is tegmentum of the pons.
- Trapezoid body is mainly made up of contralaterally moving criss crossed fibres desived mainly from ventral cochlear nuclei.
- Then from trapezoid body, Lateral Leminiscus takes the information through the pons & terminate into the inferior collicoli of the mid-Brain.
- Then from inferior colliculi, next order neuron called the Inferior Brachium takes the info into the medial geniculate body.
- Then from the medial Geniculate body, it goes into auditory cortex in temporal lobe as auditory radiations.
- There are also some nuclei present in the trapzoid body, they are called nuclei of trapezoid body.
- There is also a nucleus present in the lateral leminiscus, called superior olivary nucleus. Some fibres terminate here & the next neuron order ascends from here.

• Cochlear Nuclei → Trapezoid Body → Lateral Leminiscus
↓
Inferior collicoli
↓ through Inferior Brachium
Medial Geniculate Body ← Auditory Cerebral Hemisphere

Scanned with CamScanner



BASE OF THE PONS:-

Anteriorly it contains,

1) Corticopontine fibres, which comes from the cortex to the pontine nuclei of the pons & the from these ponto-cerebellar fibres form the middle cerebellar peduncles.

2) Corticonuclear fibres, which comes from the cortex & move through the pontine nuclei & terminates into the motor nuclei in the brainstem.

3) Corticospinal fibres, which comes from the cortex & move to the spinal cord more specifically to it anterior horn.

Scanned with CamScanner

M T W T F S S Date:

- Posteriorly it contains,

1) Medial Leminiscus:- which comes from the Dorsal column system & contains sensations, like, fine touch, two Points discumination etc.

2) Spinal Leminiscus:- which comes from the anteso-lateral system & contains sensations like temp, pressure, pain, crude touch.

3) Lateral Leminiscus:- which comes from the tespezoid body & contain auditory sensations.

4). Ventral spinal cerebellar fibres:- which comes from the spinal cord into the superior cerebellar peduncles.

TEGMENTUM OF THE PONS:-

1) Abducen (6th) Nerve:- comes out from the abducen nuclei present in the back of pons & then exits anteriorly on the medial side of the pontomedullary junction.

2) Fascial (7th) Nerve:-

Fibres of this nerve is connected to so many nuclei for different sensory & motor functions:-

i- Brachiomotor Nuclei:- Special visceral effferent fibres comes from this nucleus. First, they move posteriorly around the 6th Nerve nucleus & then exits anteriorly just laterally to the 6th Nerve. They are responsible

Scanned with CamScanner

M T W T F S S Date:

for fascial expressions.

ii- Lacrimatory Nuclei:- (superior salivatory nucleus)
parasympathetic motor fibres comes from this nucleus & is responsible for lacrimation & salivation.

iii- Nucleus of Tractus Solitarius:-
Taste fibres coming through the 7th Nerve terminates in this nucleus. & these fibres are special somatic afferents.

iv. Trigeminal System:-
The touch, pain, temperature sensations coming from external ear goes to trigeminal system, more specifically to its spinal nucleus.

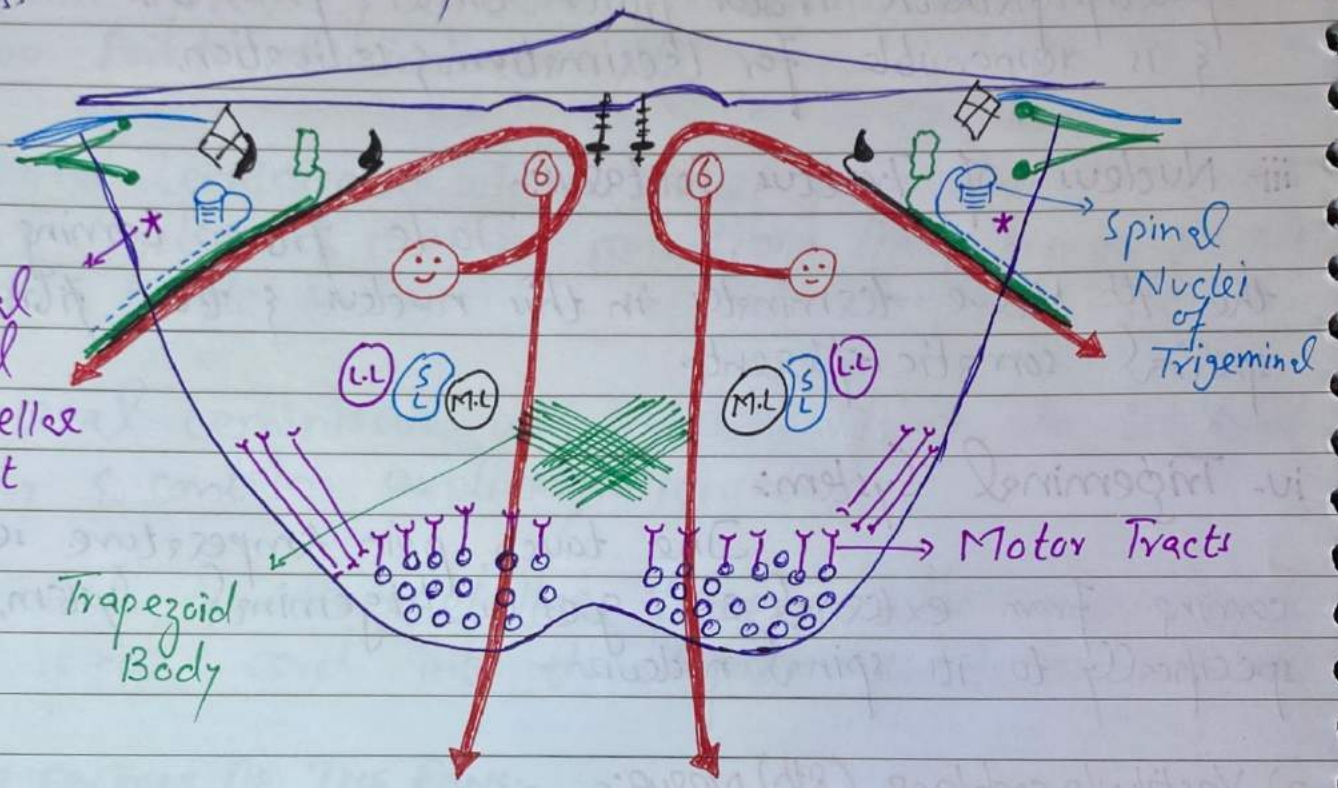
3). Vestibulocochlear (8th) Nerve:-
Fibres from the internal ear goes to the vestibular component of the vestibulocochlear system. And other sensations goes to the cochlear component This nuclei system is placed most laterally in the lower pontine area.

MEDIAL LONGITUDINAL FASICULUS:-
Many nuclei in the brainstem are connected for coordinative work / function, specially in the head n neck & this pathway is called medial Longitudnal fasiculus.
. For example, if someone looks to its left, so the left's eye muscle i.e lateral rectus is activated for its abduction.

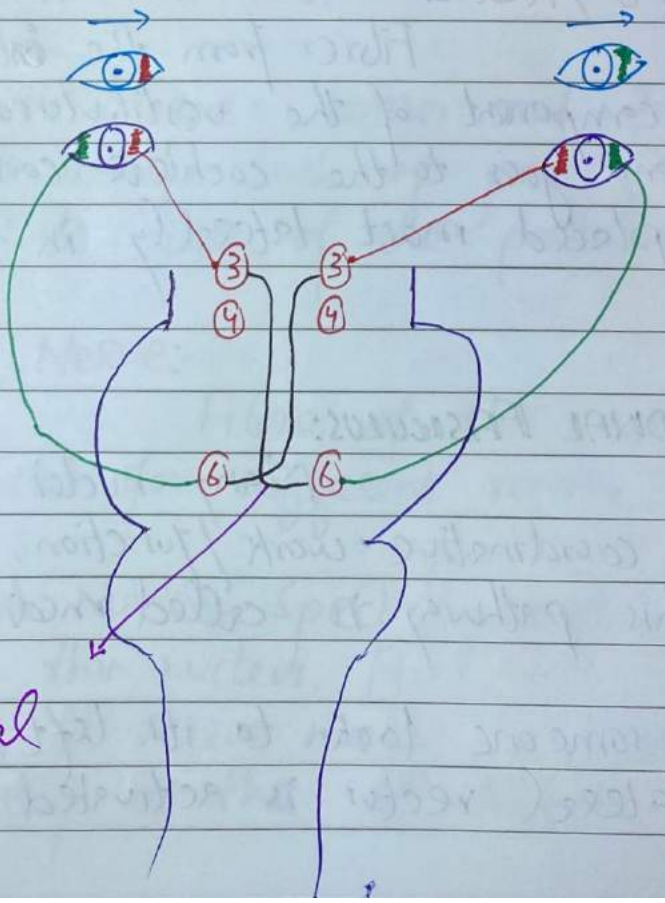
Scanned with CamScanner

M T W T F S S Date:

On the same time, medial rectus muscle of right eye is activated for its abduction. This whole cooperative work is done by the medial longitudnal fasiculus.



(B)



Scanned with CamScanner

M T W T F S S Date:

MID-BRAIN:-

Different terms related Mid-Brain;

- Crus Cerebri:- Longitudnal column present infront of the mid-brain are called crus cerebri & there is a depression between them called Interpeduncular Fossa.
- This crus cerebri also forms the Base of the mid Brain.

- Cerebral Aqueduct:- C.S.F filled cavity present in the back of the mid-brain.

- Tectum:- Structure posterior to the cerebral aqueduct is called tectum. It consists of the superior & inferior colliculi.

- Tegmentum:- Structure present between the cerebral aqueduct & the substancia nigera.

- Substantia Nigra:- Substance present in the mid-brain which separates tegmentum from the crus cerebri or the base.

NOTE:-

The Cerebral Aqueduct is inferiorly connected to 4th ventricle & superiorly connected to 3rd ventricle.

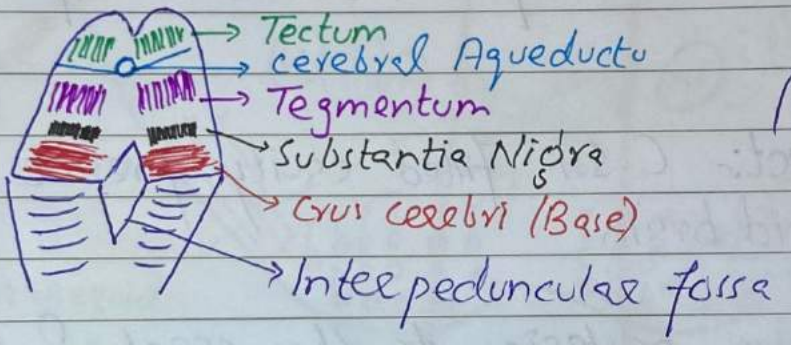
Scanned with CamScanner

M T W T F S S Date:

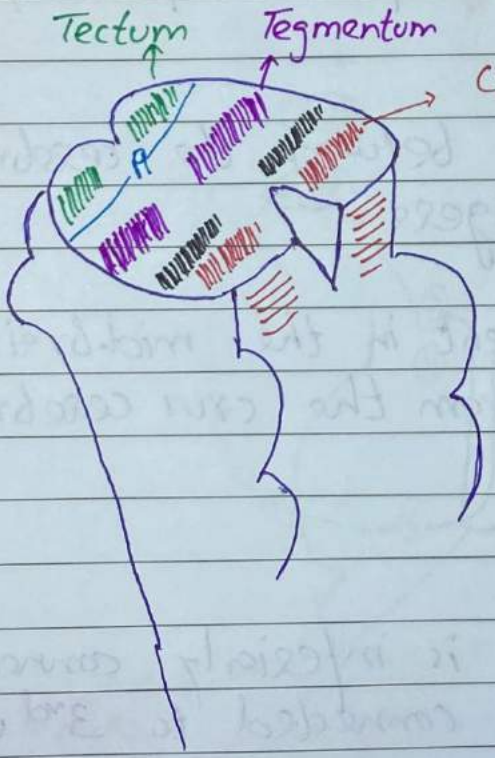
Cerebral Peduncles:- It connects the midbrain with the cerebral hemispheres. & there are right & left cerebral peduncles. Each cerebral peduncles is consists of the base, tegmentum & the tectum.

NOTE:

superior colliculi → visual reflex
inferior colliculi → hearing reflex



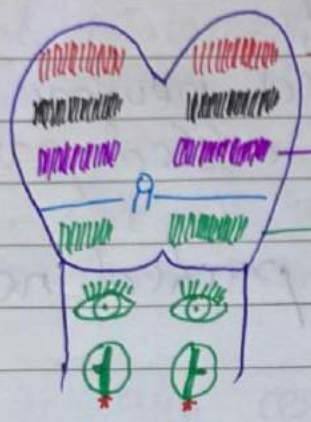
(FRONT VIEW)



(SIDE VIEW)

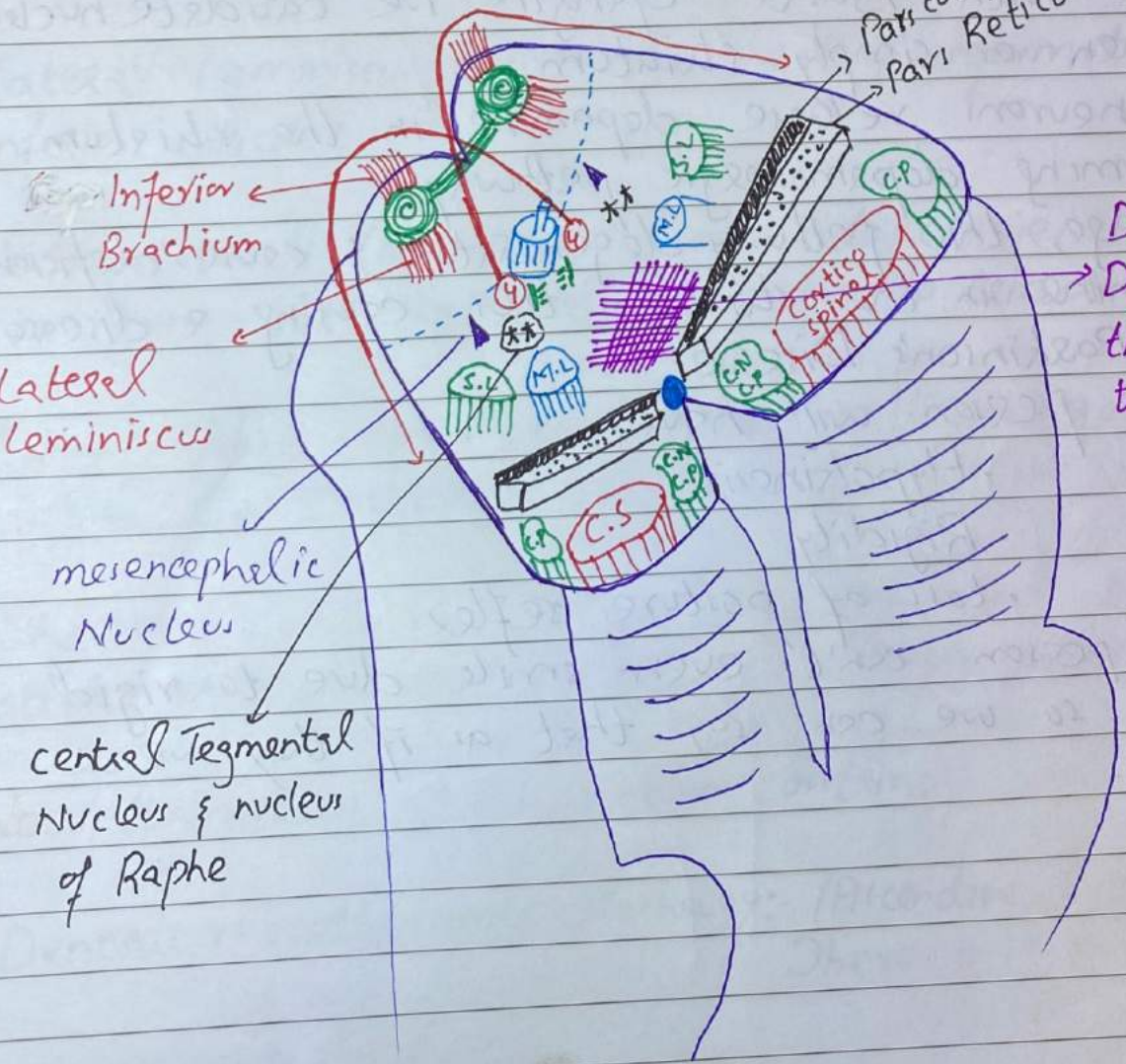
Scanned with CamScanner

M T W T F S S Date:



(Back View)

⇒ Now Section of Mid-Brain at the level of inferior colliculus:-



Scanned with CamScanner

M T W T F S S Date:

→ Substantia Nigra has two parts:-
- Posterior part had tightly packed neurons & is very dark area. & this area is called pars compacta.
- Anterior part has not tightly packed neurons & is called pars reticularis.

⇒ Substantia Nigra has concerned with important motor system, so if it is demaged, so it results in Parkinson's Disease.

- Actually, the neurons of Substantia Nigra are connected with Basal Ganglia i.e caudate nucleus & putamen or simply striatum.
- These neurons release dopamine in the striatum thus forming dopamonergic pathway.
- In old age, this pathway degenerates & cause deficiency of dopamine in the striatum thus causing a disease called Parkinson's Disease.
- Thus the person will have;
  - Hypokinesia
  - Rigidity
  - Loss of posture reflex
- These person can't even smile due to rigid muscles, so we can say that as if they wear a mask.

Scanned with CamScanner

M T W T F S S Date:

- Different Motor fibres moves infront of the substantia nigra i.e in the cur cerebri & these fibres are:
  - Corticopontine fibres
  - Corticonuclear fibres
  - Corticospinal fibres

- There is also cerebral aqueduct around which grey matter is present called periaqueductal Grey matter.

- In this section, nucleus of inferior Colliculus will be present in the tectum of the Mid-Brain.

- Lateral Leminiscus brings the hearing information to the inferior collicolus.

NOTE:- Lateral Leminiscus of one side carries hearing info from both external ears due to cairs crossing of fibres.

- Then fibres from the inferior collicolus goes to the medial Geniculate body through the inferior brachium.

- The two inferior collicoli are connected to each other through commissure of inferior collicoli.

Now, tegmentum of this section contain;

1) Dentatorubrothalamic Pathway:- (Ascending System)
There is a nucleus present

Scanned with CamScanner

in the cerebellum called Dentate nucleus. Fibres from this nucleus goes into the red nucleus & then into the thalamus, thus forming this pathway.

- Crossing of these fibres occurs at the level of inferior colliculus. & these red nucleus is present at superior colliculus.

2) Medial Leminiscus:-

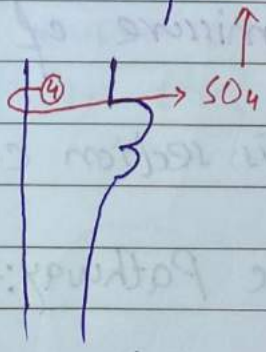
Also seen at this level, which comes from dorsal column of spinal cord.

3) Spinal Leminiscus:-

Also seen in this section, which comes from anterolateral column of the spinal cord.

4). 4th Cranial Nerve Nuclei:- (Trochlear Nerve)

- Nuclei for the 4th Nerve are present near the peri aqueductal grey matter area.
- Fibres from this nerve move posteriorly & then cross (decussate) to opposite side & then move laterally & the eventually move anteriorly in the mid-brain.
- This nerve supplies the superior oblique muscle.



Scanned with CamScanner

M T W T F S S Date:

NOTE:-

4th Nerve is the only nerve which exits at the Back of the C.N.S.

5). Medial Longitudnal Fasiculus:-

It is also present in this section.

6) Mesencephalic Nucleus of trigeminal System:-

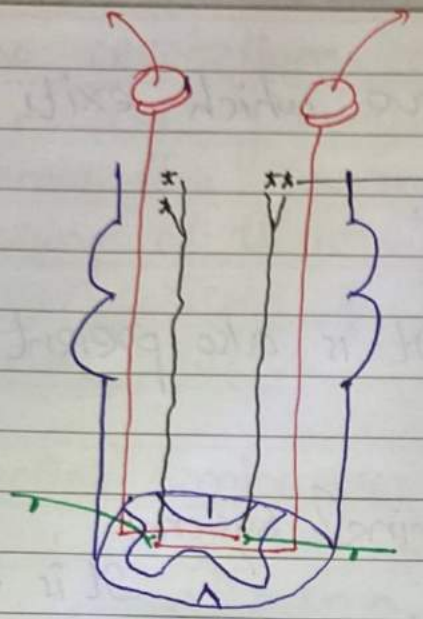
It is also present in this section of mid-brain.

7) Central Tegmentum Nuclei & Nucleus Raphae:-

Actually the pain comes in the lateral spinothalamic tract. But before this the first order neuron terminates in the lateral grey horn & from these 2nd order neuron takes the pain information & moves contralaterally & then ascends as lateral spinothalamic tract.

- So fibres from the central tegmental Nuclei & Nucleus raphe comes & terminates at the position at which the 1st order neuron of pain pathway enters the spinal cord (grey matter). So they can decrease the pain or simply modulate it.
- They Release morphine like substance here. & nucleus raphe releases serotonin.
- So these are the descending pathways, modulated the pain transmission.

Scanned with CamScanner



→ Nucleus Raphe & central tegmental nucleus

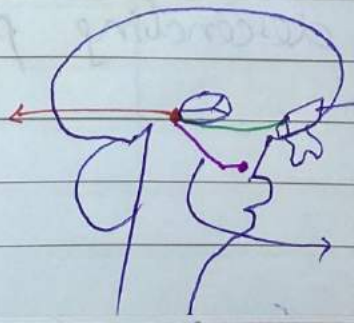
⇒ These nuclei & some other nuclei in the peri aqueductal grey matter, when they are activated, then pain can be modulated.

- Certain psychological factors activate these pathways so we feel less pain.

* Interpeduncular Nucleus:-

From Hypothalamus special connections comes to the habenular nucleus of the thalamus & from there other fibres comes to the interpeduncular Nucleus. & this connection b/w the thalamus (habenular nucleus) & interpeduncular nucleus is called habenulo interpeduncular tract or fasiculus retroflexus.

. This pathway controls the eating behaviour.



Scanned with CamScanner

M T W T F S S Date:

- Central Tegmental Tract:-

It is a bundle of fibres which are moving up & down.

- The upgoing fibres connects the reticular formation with the thalamus.
- The down going fibres connects the red nucleus with the olivary nucleus.

NOW, SECTION at the level of superior colliculus;

1) Base:-

Contains:-

- corticospinal fibres
- corticonuclear fibres
- corticopontine fibres

- Substantia Nigra is also present.

2) Tegmentum:-

contains:-

- Red nucleus
- Medial leminiscus
- Spinal leminiscus
- 3rd Nerve Nucleus
- Edinger Westphal Nucleus
- Central tegmental tract
- Mesencephalic nucleus of Trigeminal System

3). Tectum:-

contains:

- Superior colliculus

Scanned with CamScanner

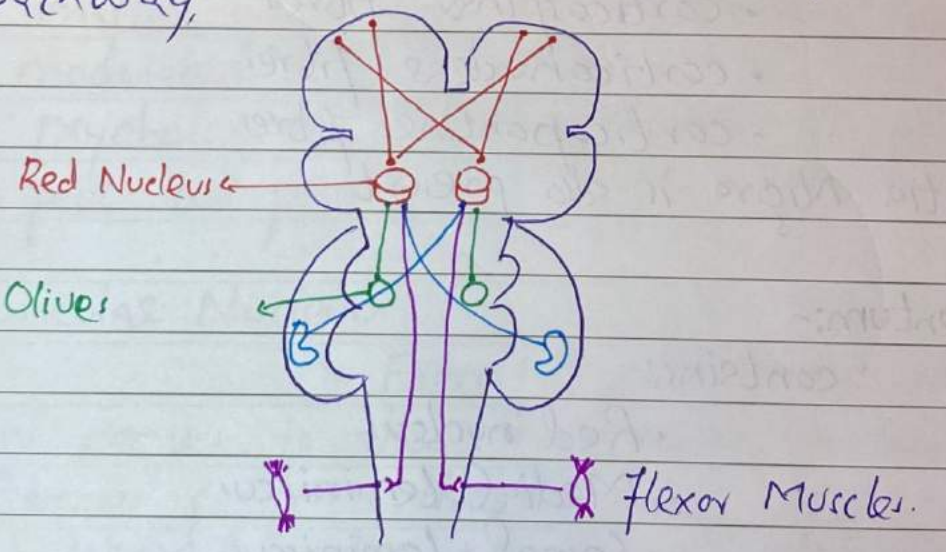
M T W T F S S Date:

- Superior Brachium
- pre-Tectal Nucleus
- Commissure b/w superior colliculi & posterior commissure b/w pre-tectal Nuclei.

• RED NUCLEUS:-

There is additional rubrospinal pathway from top to bottom & is concerned with flexion.

- It is epi-laterally & contralaterally connected with the cerebral hemisphere & only contralaterally connected with the cerebellum.
- It is also connected with olives to form rubro-olivary pathway.



3RD NERVE NUCLEUS:

- move forward cross the red nucleus & substantia nigra & exits at medial side of crus cerebri.

NOTE:-

All the extra ocular muscles are supplied by the

Scanned with CamScanner

M T W T F S S Date:

3rd Nerve except LR6 & SO4.
- Lateral rectus supplied by 6th Nerve
- Superior oblique supplied by 4th Nerve

Edingen Westphal Nucleus:-

parasympathetic pre-ganglionic fibres comes from this nucleus & goes with the 3rd Nerve & terminates in the ciliary ganglion & then from there goes into the eyeball & supplies the intra ocular muscles.

NOTE:-

Superior colliculus is connected through superior brachium with the lateral geniculate body & is concerned with visual spinal reflexes.

Pre-Tectal Nucleus:-

- concerned with pupillary constriction i.e when light is thrown into the eyes so both the pupil constrict.
- It is connected with each other & edingen westphal nuclei.
- There is connection between the two nuclei of pretectal & is called posterior comissure.

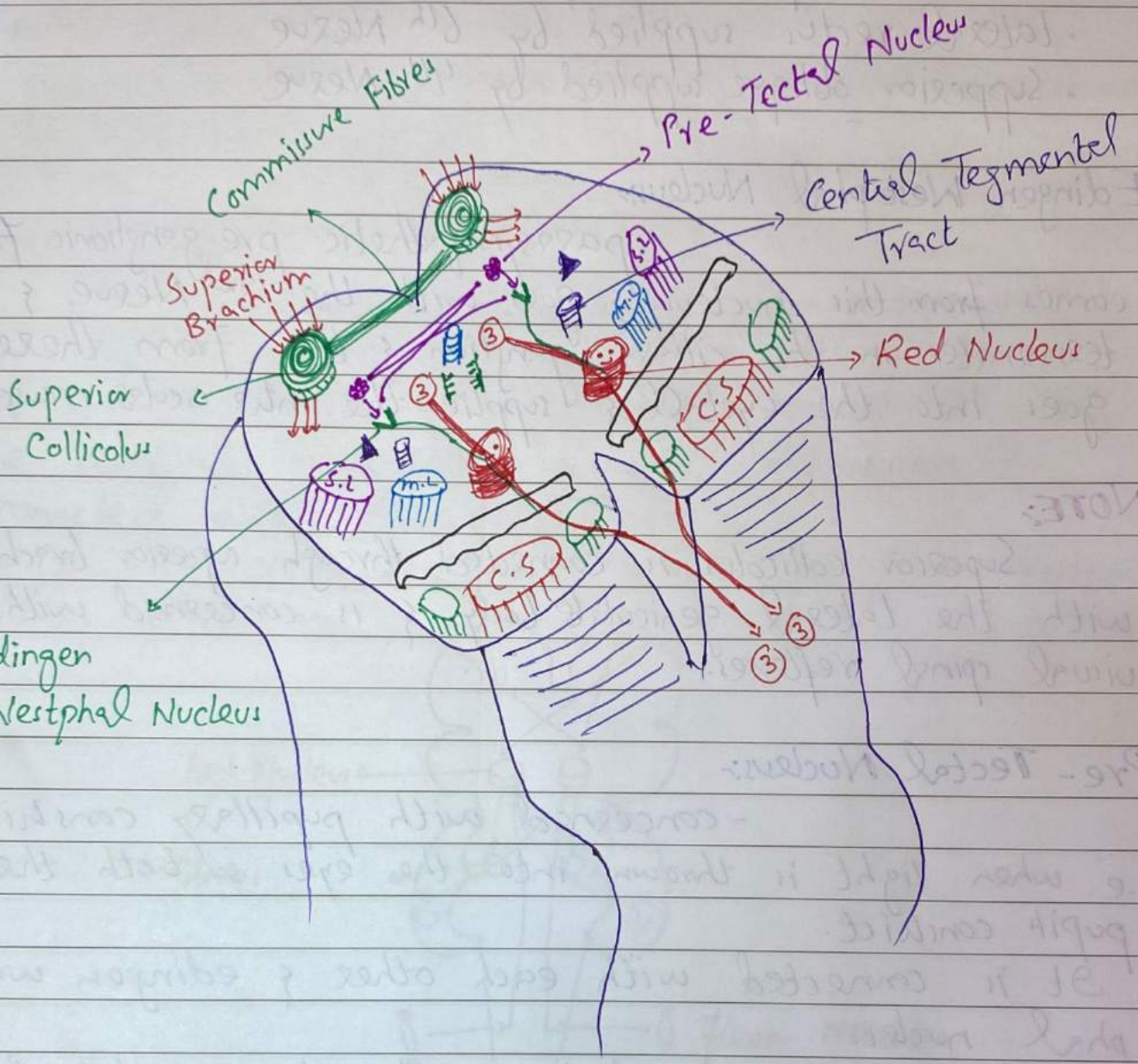
NOTE:-

Superior colliculus is connected with retina of the eye ball, frontal eye field & occipital eye field for coordinative function of searching, Tracking or visual spino reflex.

Scanned with CamScanner

M T W T F S S Date:

Section At Inferior Colliculus:-



Scanned with CamScanner

M T W T F S S Date:

CEREBELLUM:-

- Maintains the tone of the Muscles.
- Posture & Balance.
- Coordination of movements.

LOCATION:-

- Back of the Brainstem.

DEVELOPMENT:-

- It develops from metencephalon component of the rhombencephalon.

PARTS:-

1) Anterior Lobe:-

- Also called Paleocerebellum
- Concerned with Tone of muscles.

2). Posterior Lobe:-

- Also called Neocerebellum.
- Modern part.
- Concerned with Coordination of movements

3). Flocculonodular Lobe:-

- Also called Archicerebellum.
- Most primitive.
- Present even in Fishes.
- Concerned with Balance of the Body.

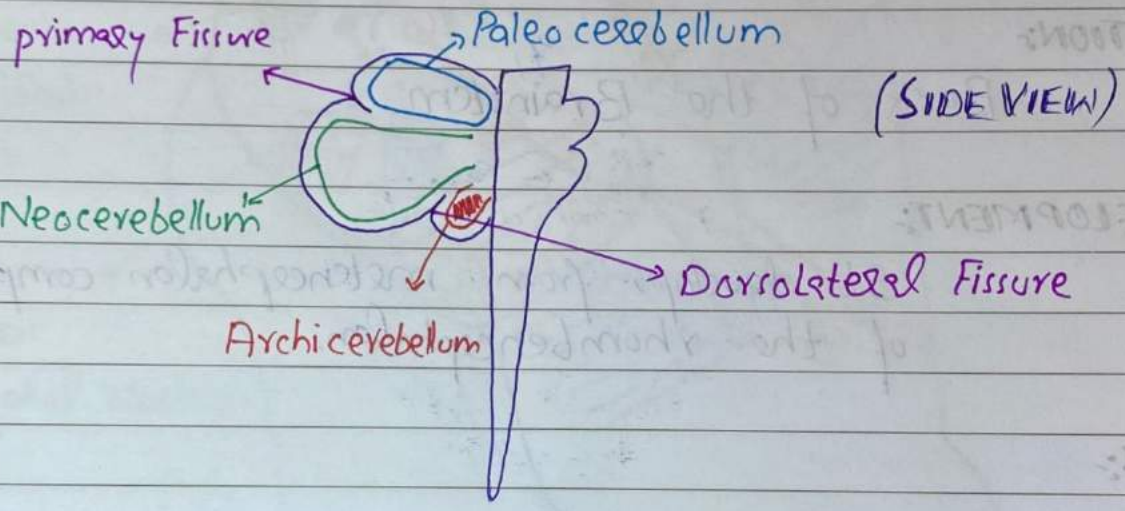
Scanned with CamScanner

M T W T F S S Date:

FISSURES:-

1) Primary Fissure:-
- Which divides the Anterior & Posterior Lobes

2). Dorsolateral Fissure:-
- Which divides the posterior & Flocculae Lobe.



⇒ NOW POSTERIOR ASPECT:-

1). Vermis:-
- Posteriorly, there is a longitudnal depression in the centre, & is called vermis.
- Lateral to Vermis on both side, the area are called cerebellar hemisphere.

NOTE:-
- Cerebellum controls the motor system epsi-laterally. So if one side the cerebellum is damaged so there will problems of motor system e.g (balance) on that same side.

Scanned with CamScanner

M T W T F S S Date:

2) Paravermal Area:-

- Present on both sides of the Vermis.
- Part of the cerebellar hemisphere.
- Also called intermediate zone.

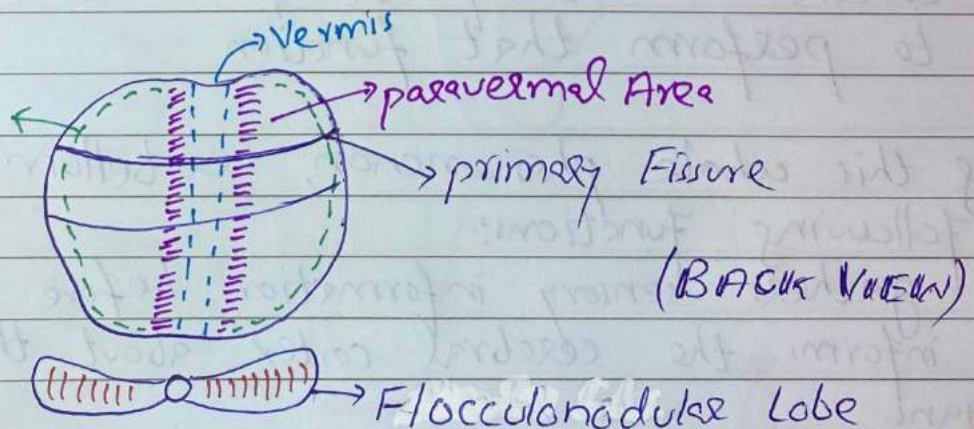
HUMUNCULUS OF CEREBELLUM:-

shows

- Vermal Area:-
  - Is concerned with motor function regarding axial skeleton. i.e shoulder girdle, hip girdle & Trunk.

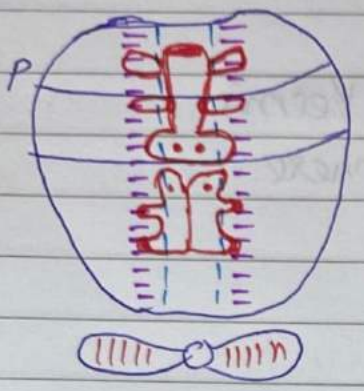
- Paravermal Area:-
  - Is concerned with motor function regarding hands & feet.

- A second humunculus is also present below this, which also shows the same functions.



Scanned with CamScanner

M T W T F S S Date:



⇒ Role of Cerebellum in Motor Function:-

- Basically when we think about any action. So in order to perform it, an idea is first generated in the pre-frontal lobe & from there it goes to the pre-motor area & supplementary motor area.
- Then from there it goes to the Basal ganglion.
- In the Basal Ganglia motor plan is generated which goes through the thalamus into the motor cortex & sensory cortex.
- And then at the end, motor fibres comes from these cortex as corticospinal fibres to the spinal cord to perform that function.

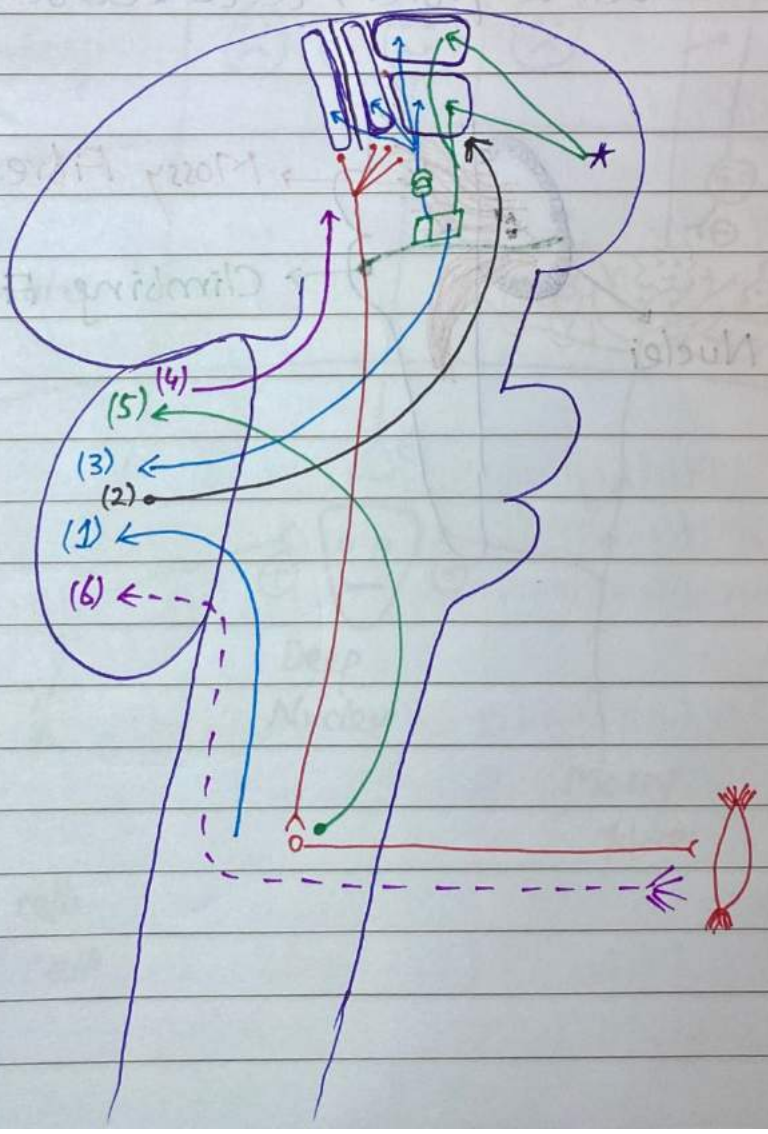
- During this whole phenomenon, cerebellum performs the following functions:-

1. It gathers sensory information before the action.
2. It informs the cerebral cortex about the locomotive organs.
3. A copy of motor plan is also sent to the cerebellum from the basal ganglia.

Scanned with CamScanner

M T W T F S S Date:

4. It also sent a copy of information to cerebrum i.e how to perform that particular action, because the cerebellum had already analyzed the motor plan with the already present sensory info.
5. Now whole process is done & central processes has been done & final motor order is sent to be performed. So at this very moment cerebellum once again receives the data i.e to check whether correct order is sent or not.
6. At last, cerebellum is also getting information from the locomotive organs, in order to check whether the action is going in right way/manner or not.



Scanned with CamScanner

M T W T F S S Date:

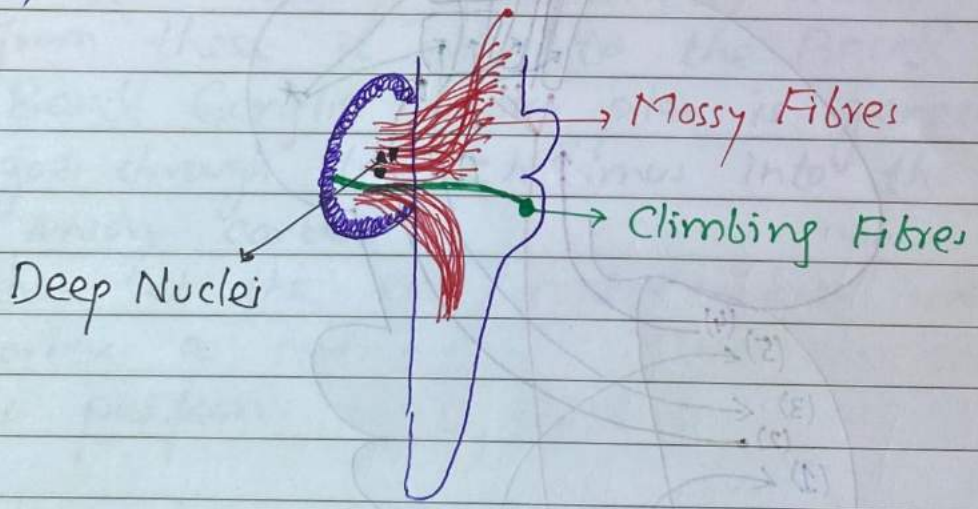
- External fibres coming from the C.N.S to the cerebellum are divided into two groups:-
  - Fibres coming from inferior olives.
  - All other fibres.

1) Climbing Fibres:-

- Fibres which come from inferior olives & climb to the outer surface of cerebellar cortex.

2) Mossy Fibres:-

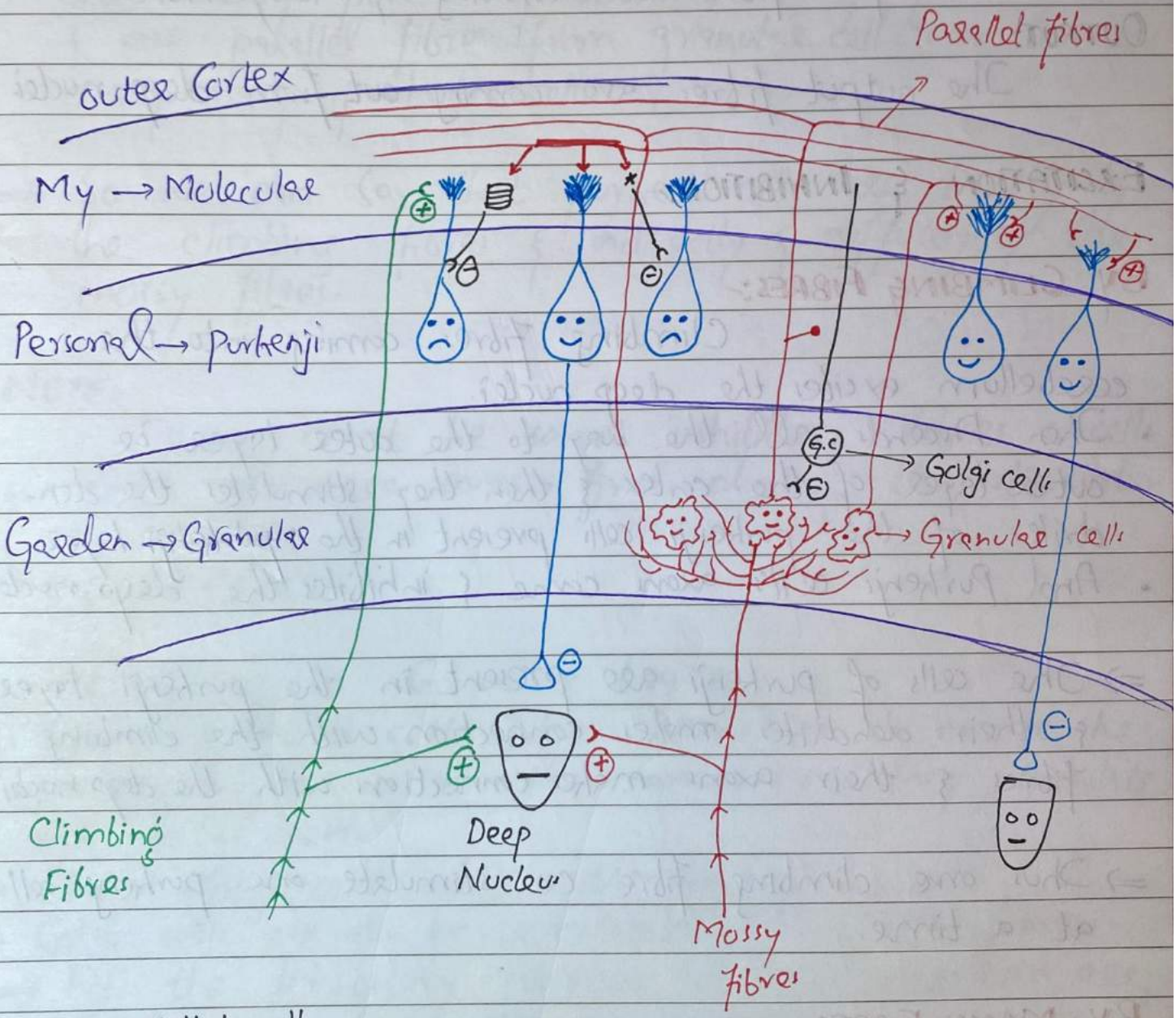
All other fibres except inferior olivary fibres are Mossy Fibres. eg ventro spino cerebellar fibres, ponto cerebellar fibres, tecto cerebellar, vestibulo-cerellar,



Scanned with CamScanner

M T W T F S S Date:

Cerebellar Cortex & Its Connections With Deep Nuclei:-



Scanned with CamScanner

M T W T F S S Date:

- Cerebellar Cortex is 3 cells thick layer;
  - Molecular
  - Purkenje
  - Granular

INPUT:-

The input fibres are climbing & Mossy Fibres.

OUTPUT:-

The output fibres are coming out from deep nuclei.

EXCITATION & INHIBITION:-

BY CLIMBING FIBRES:-

Climbing fibres coming into the cerebellum excites the deep nuclei.

- Then Ascends all the way to the outer layer i.e outer layer of the cortex & then they stimulates the dendrites of the purkenji cells present in the molecular layer.
- And Purkenji cell's axons come & inhibites the deep nuclei.

⇒ The cells of purkenji are present in the purkenji layer & their dendrites makes connection with the climbing fibres & their axons makes connections with the deep nuclei.

⇒ Thus one climbing fibre can stimulate one purkenji cell at a time.

BY MOSSY FIBRES:-

Mossy fibres also excites the deep nuclei after coming into the cerebellum.

Scanned with CamScanner

M T W T F S S Date:

- Then these fibres ascends & terminates in the granular layer of the cerebellar cortex.
- Then they make multiple connections with granular cells.
- Every granular cell gives axon which ascends to the outer layer of the cerebellar cortex & bifurcates into two division which runs parallel. & are called parallel fibres.
- One mossy fibre may stimulate many granular cells. & one parallel fibre from granular cell can stimulates many many purkenje cells.

⇒ So we can say, that purkenji cells are directly by the climbing fibres & indirectly & diffusely by the mossy fibres.

NOTE:

- These must be some inhibitory fibres or cells so that No area over fires during this stimulation.

1) GOLGI CELLS:-

- present in the Granular layer.
- When granular cells fibres stimulates to excite the purkenji cells so at the same time they stimulate the golgi cells.
- Thus golgi cells inhibits the granular cells.
- Golgi cells can also be stimulated by the mossy fibres.

⇒ All the Inhibitory neurons in the cerebellum are GABAergic (i.e releases gamma aminobutyric acid (GABA)

Scanned with CamScanner

M T W T F S S Date:

2) BASKET & STELLATE CELLS:-

- Granular cells fibres goes up & divide into parallel fibres
- Parallel fibres stimulates the purkenji cells.
- At the same time, they stimulate the basket & stellate cells.
- Then basket & stellate will inhibites the neighboring purkenji cells by releasing GABA.
- Thus only central purkenji cell is strongly stimulated by the parallel fibres & neighboring purkenji cells are inhibited by the stellate & basket cells.

FUNCTIONS OF DIFFERENT LOBES:-

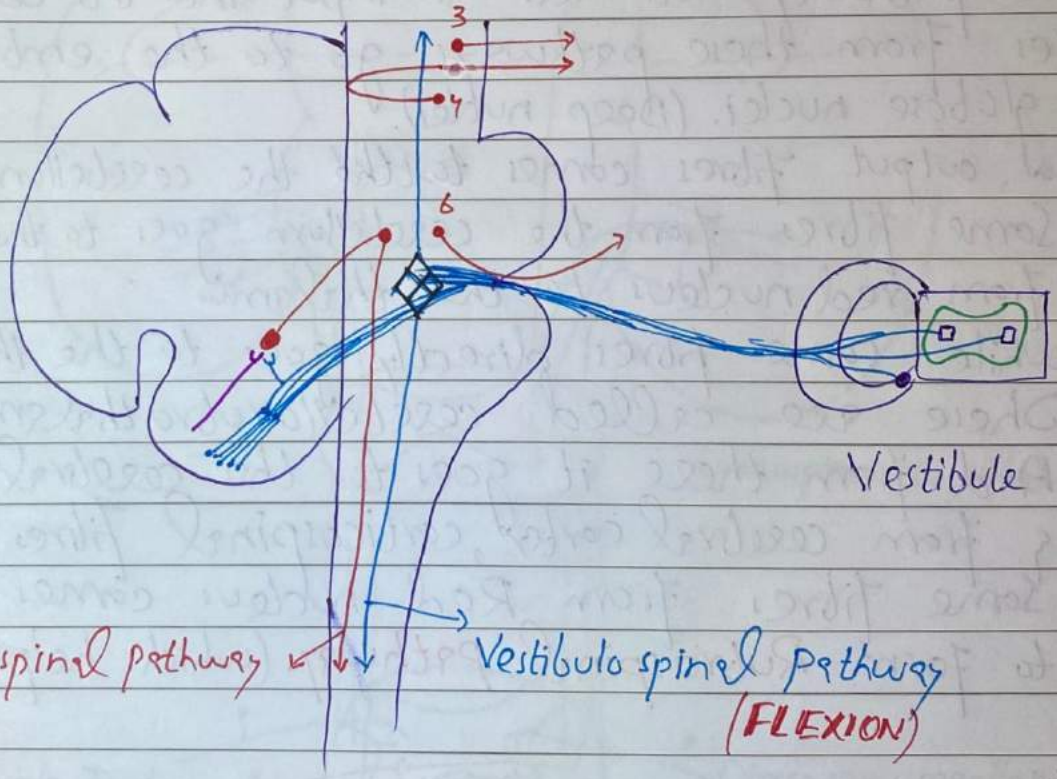
1) Archi cerebellum:-

- Also called vestibulocerebellum.
- Sensory information about the balance (motion or static) comes from the vestibules in the vestibular part of vestibulocochlear nerve.
- From these some fibres directly enters into the archicerebellum & some fibres terminates in the vestibular nucleus & then other fibres generates these & goes into the archicerebellum through inferior cerebellar peduncles.
- These are vestibulocerebellar fibres.
- These fibres on th way stimulates deep ~~fib~~ nucleus & then ascends into the cerebellar cortex & then eventually inhibits the deep nucleus through purkenji fibres.

Scanned with CamScanner

M T W T F S S Date:

- Then cerebellovestibular fibres come out into the vestibular nuclear complex & some goes to the reticular nuclear system.
- The vestibular nuclear complex fires up as well as down.
- During firing down, it forms vestibulo spinal pathway. which helps the extensor muscles to perform.
- The reticular nuclear system form recticulo spinal tract.
- The vestibular nuclear complex which goes upward stimulate, 3rd, 4th & 6th Nerves Nuclei, so that during head movement is adjusted.



Scanned with CamScanner

M T W T F S S Date:

2) Paleocerebellum:-

- Vermal & Paravermal area receives the sensory information from the spinal cord.
- Thus this part is also called spinocerebellum
- The sensory information from the spinal cord comes through;
  - Dorsal spinocerebellar pathway
  - Cuneo spinocerebellar pathway
  - Ventral spinocerebellar pathway

- These pathway acts acts as input into the cerebellum.
- Fibres from these pathways go to the emboliform & globose nuclei. (Deep nuclei).
- Thus, output fibres comes out of the cerebellum as;
  - Some fibres from the cerebellum goes to the red-nucleus & from red nucleus to the thalamus.
  - while some fibres directly goes to the thalamus.
  - These are called cerebello-rubro thalamic fibres.
  - And from there it goes to the cerebral cortex & from cerebral cortex, corticospinal fibres comes out.
  - Some fibres from Red nucleus comes down to form Rubrospinal pathway. (which helps in flexion).

NOTE:

From Lateral to medial, these nuclei are present in cerebellum

- Dentate
- Emboliform
- Globose
- Fastigial Nucleus

Scanned with CamScanner

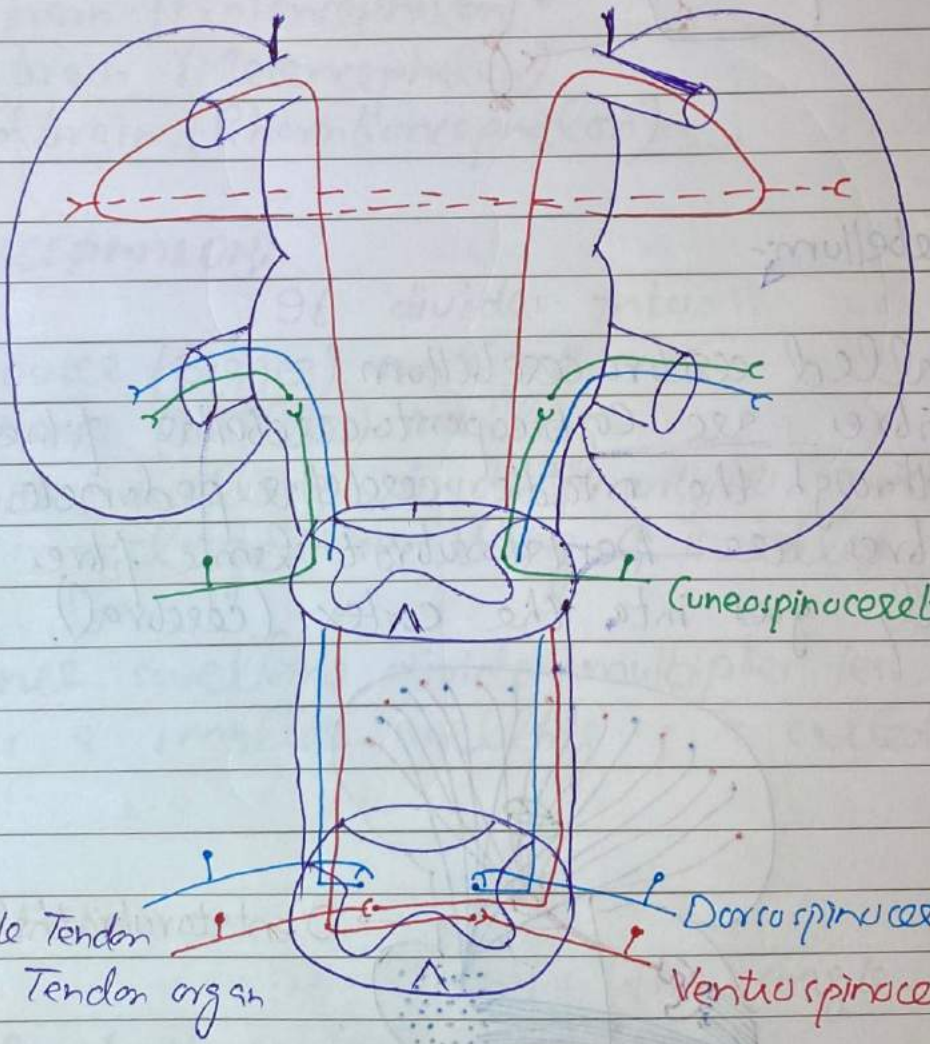
M T W T F S S Date:

- Together Emboliform & Globose are called Interposed Nuclei.
- Festigial Nucleus is associated with vestibulocerebellum.
- Emboliform & Globose are associated with spinocerebellum.
- Dentate is associated with cerebrocerebellum.

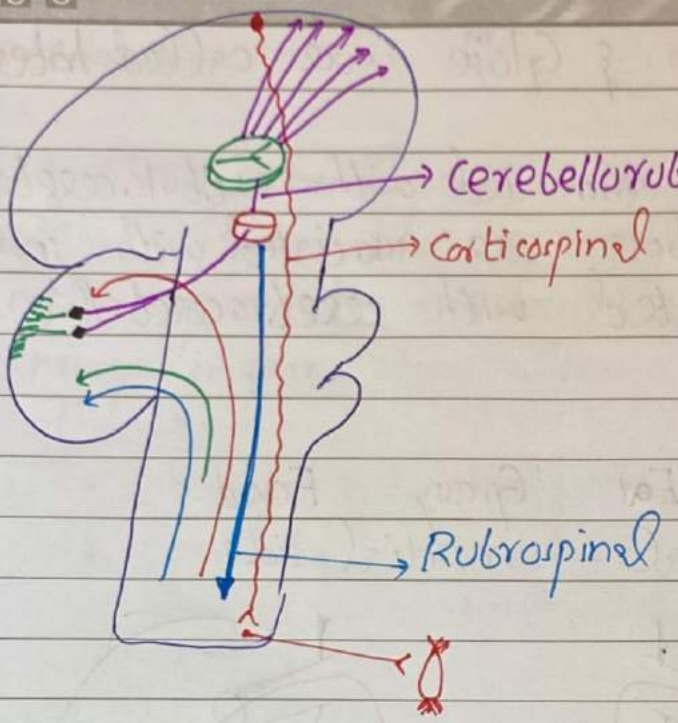
MNEMONIC:-

Dont Eat Grassy Food.

Lateral → medial side

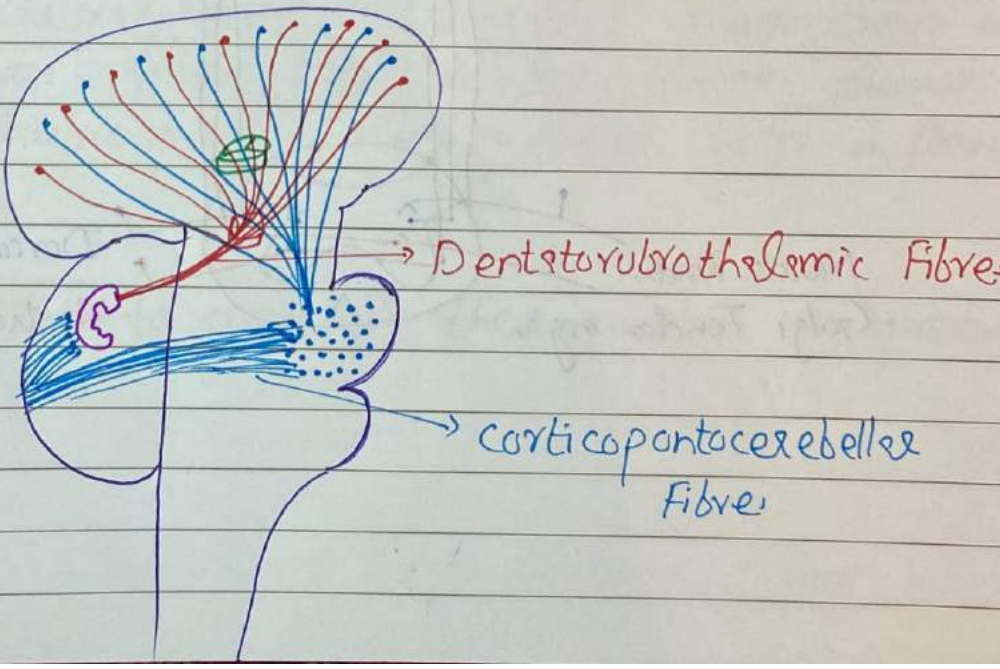


Scanned with CamScanner



3). Neocerebellum:-

- Also called cerebrocerebellum.
- Input fibres are Corticopontocerebellar fibres which comes through the middle cerebellar peduncle.
- output fibres are Dentatorubrothalamic fibres which eventually goes into the cortex. (cerebral).



Scanned with CamScanner

M T W T F S S Date:

Diencephalon:-

Development of CNS In Fetus:-

During development of CNS in fetus, the neural tube at its cranial side give three swellings:

- Forebrain (Prosencephalon)
- Midbrain (Mesencephalon)
- Hindbrain (Rhombencephalon)

1) **PROSENCEPHALON:-**

It divides into:

- outer (Bigger) swelling
- inner (smaller) swelling

- The outer swelling divides/multiplies quickly so it becomes a larger swelling & is called Telencephalon.
- The inner swelling divides/multiplies less, so it becomes a smaller swelling & is called Diencephalon.

2) **MESENCEPHALON:-**

It remains the single swelling as earlier & is called mid-brain.

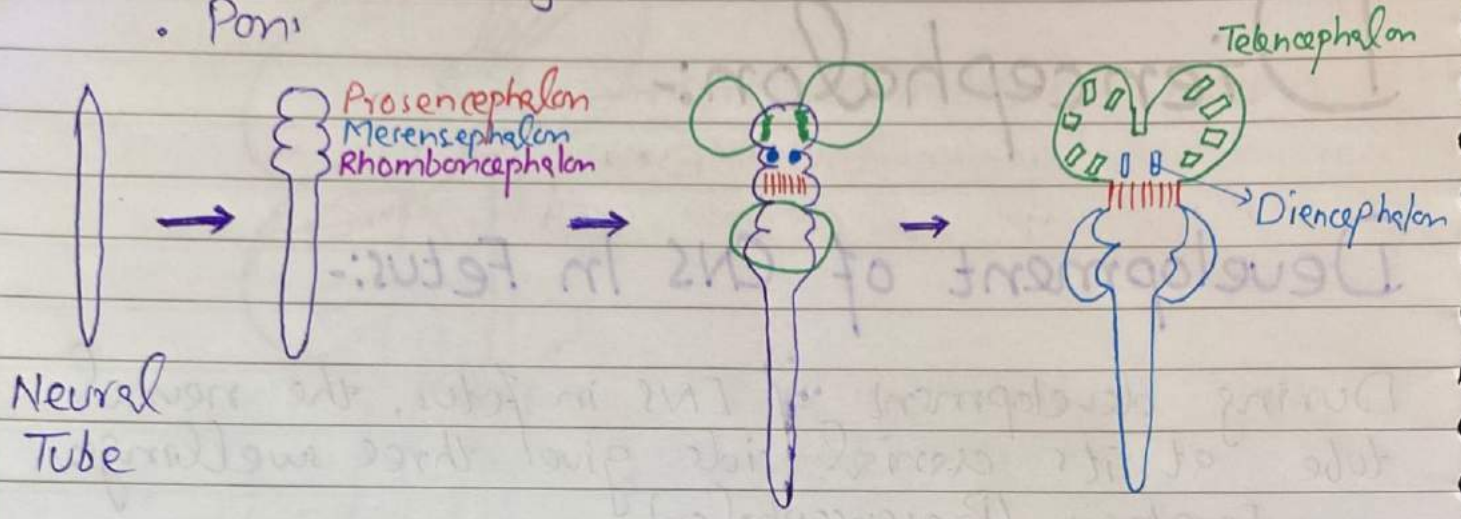
3) **RHOMBONCEPHALON:-**

It also divides into two swellings:

Scanned with CamScanner

M T W T F S S Date:

- Medulla Oblongata
- Pons
- Cerebellum



Structure Derived From Diencephalon:-

- **Thalami:-**

Two thalami are present just above the mid-brain.

- In Between the thalami, there is 3rd Ventricle. Actually the cerebral aqueduct of mid-brain, expands into 3rd ventricle above the mid-brain.
- Posteriorly, to the 3rd ventricle, there is Pineal Gland which expands centrally & backward & is present on median side.
- On the posterior corners, there are Habinular Nuclei, which are two in number.
- The Pineal Gland & these two habinular Nuclei are called Epithalamus.
  - one Median Pineal Body
  - Two Habinular Nuclei

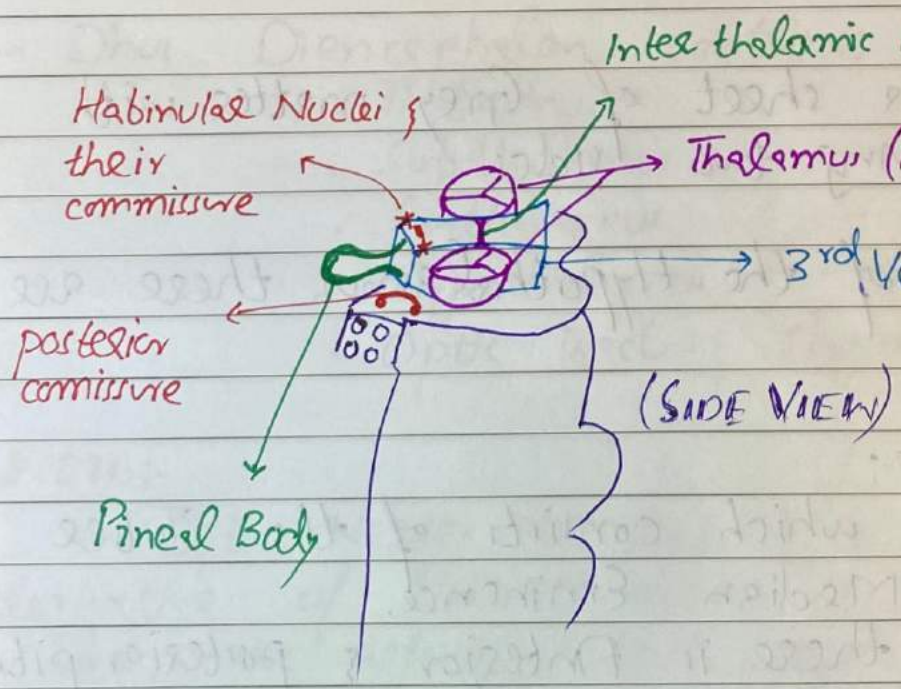
Scanned with CamScanner

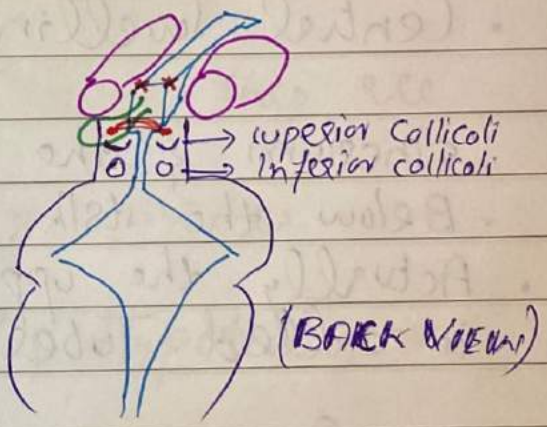
M T W T F S S Date:

- The two Habinulae Nuclei are connected through bundles of fibres, which also pass through stalk of the pineal Gland & are called Habinulae commissure.
- On the back of the thalami, little grey matter is touching each other & is called Inter Thalamic Grey matter Adhesion.

NOTE:-

- Anterior Comissure is present between the two temporal Lobes.
- Posterior Commissure is present between the two pre-tectal Nuclei of Midbrain.





Scanned with CamScanner

M T W T F S S Date:

Location of Hypothelamus & its relation with Thelamus:

- The Third Ventricle goes forward, unlike the mid-brain which terminates & also the thelami, they also terminates.

- Now the 3rd Ventricle has no thelami on the both sides & mid-brain below it.

- Thus, at its forward position, the 3rd Ventricle has Hypothelamus inferiorly. & also on the right & left position.

- Hypothelamus is a sheet of Grey matter with multiple nuclei, having two sides.

- On Inferior side of the Hypothelamus, there are few swelling:

  • Central Swelling:
    which consists of the Tubes cinerium & the Median Eminence.
  - Below the stalk, there is Anterior & posterior pituitary.
  • Actually the uppermost part of median eminence is called Tuber cinerum.

  • Dorsal Swelling:
    which are mamillary bodies & they are two in number.

Scanned with CamScanner

M T W T F S S Date:

- Thalamus has two more swellings called:
  - Lateral Geniculate Body (Seeing)
  - Medial Geniculate Body (Hearing)
- Structure present under the thalamus, is called Subthalamus.
- Optic Nerve comes from the eyes, forms the optic Chiasma & then optic tract & then terminates in the Lateral Geniculate Body.
- 3RD Ventricle, is the cavity of the Diencephalon, i.e 3rd Diencephalon is present around the 3rd ventricle.
- Thus Diencephalon contains;
  - Thalamus
  - Subthalamus
  - Epithalamus
  - Hypothalamus
  - Optic tract & Chiasma.

NOTE:-

Optic Nerves are not true nerves, they are derivative of Diencephalon.
- They are actually CNS tracts not nerves.

- The Junction b/w the thalamus & Hypothalamus, is called Hypothalmic Sulci.
- Superior to the hypothalmic sulci, there are foramen called Interventricular Foramen.

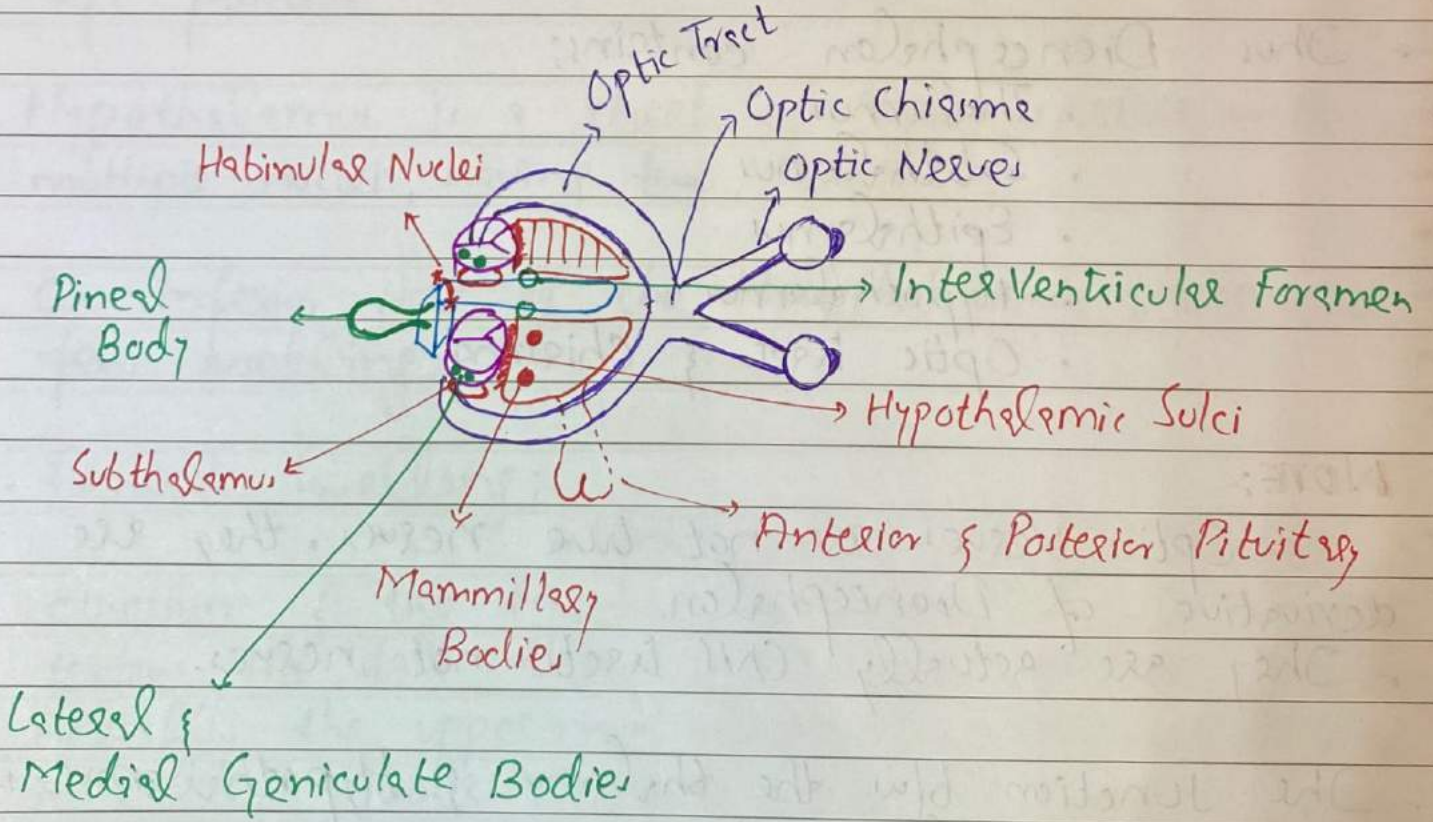
Scanned with CamScanner

M T W T F S S Date:

. These foramen connects the left & right Lateral Ventricles to the third Ventricle.

⇒ During Development of Anterior & Posterior pituitary, a swelling forms from the inferior of the hypothalamus, which is posterior pituitary. And From epithelium of Naso pharynx, a small pouch called Ruthke's pouch detatches & combines with posterior pituitary.

. Thus Anterior pituitary is derivative of Ruthke's pouch & posterior pituitary is derivative of Diencephalon.



Scanned with CamScanner

M T W T F S S Date:

THALAMUS:- (Dorsal Thalamus)

- Thalamus is a large grey matter mass i.e neuronal cell bodies mass.
- Within the Grey matter mass of the thalamus, there is internal Y-shaped white matter called Internal Medullary Lamina, which is formed by the axons.
- Internal Medullary Lamina divides the thalamus into;
  - Medial Thalamus
  - Anterior Thalamus
  - Lateral Thalamus
- Lateral Thalamus is further divided into;
  - Ventral area
  - Dorsal area
- Nuclei present in ventral area are called Ventral Tier Nuclei & that of Dorsal area are called Dorsal Tier Nuclei.
- Cover of white matter fibres present on the upper surface of thalamus is called Stratum Zonale.
- Cover of white matter fibres present on the lateral side of thalamus, is called External Medullary Lamina.

Scanned with CamScanner

M T W T F S S Date:

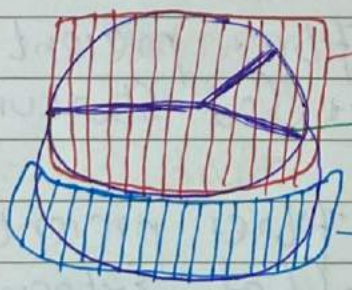
- Internal Medullary Lamina consists of those neuronal fibres which are produced as result of an interconnection of one nucleus group to another, within the thalamus.

- Within the internal medullary lamina, there is small groups of grey matter, called Internal Laminar Nuclei.

- Within the thalami, there is small grey matter connection, called Interthalamic Adhesion.

- On the Lateral Thalamus, posto-inferiorly, there is Lateral Geniculate Body connected with Visual System. & little bit medially, there is Medial Geniculate Body connected with Auditory System.

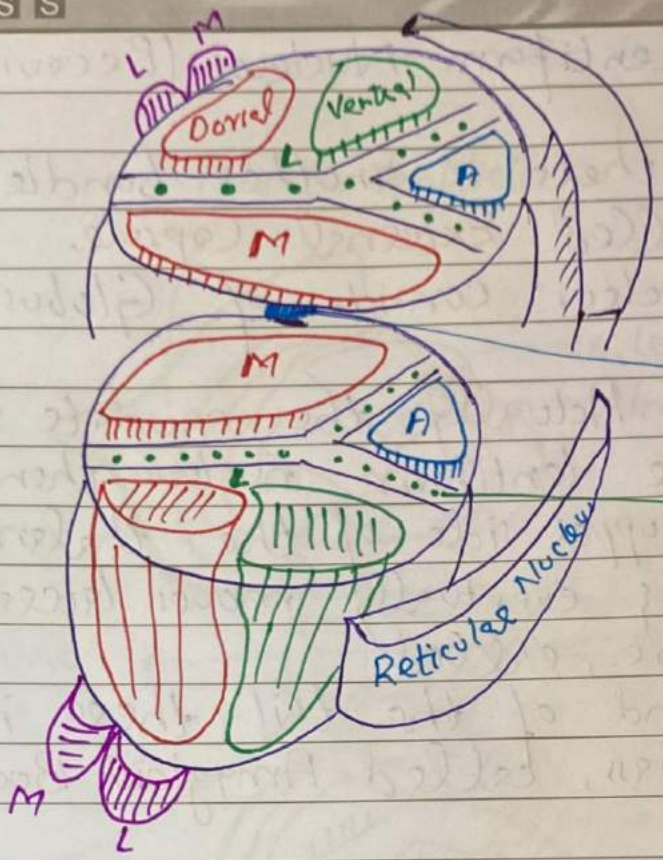
- outside to the external Medullary Lamina, there is another sheet of grey matter, which makes a nuclei on both the thalamus, called the Reticular Nucleus.



Scanned with CamScanner

M T W T F S S

Date:



Relation Of Other Parts to the Thalamus:-

- Lateral To the Thalami on both sides, there are bundles of white matter, formed by the ascending & descending Tracts fibres.
- In the centre of Both the Thalami, there is 3rd Ventricle.
- The white bundles fibres lateral to the thalami is actually called the Internal capsule.
- Then more laterally, there is mass of grey

Scanned with CamScanner

M T W T F S S Date:

matter called Lentiform Nucleus. (Because it looks like a lense).
- Most Laterally, there is another bundle of white matter fibres called External Capsule
- The lentiform nucleus consists of Globus pallidus & the putamen.
- Caudate Nucleus:- Actually the caudate nucleus starts infront & above the lentiform nucleus then moves medially to the upper side of the thalamus & then moves backward & eventually moves laterally & gives a tail like structure., ~~called~~
- Then at the end of the tail there is another grey matter mass, called Amygloid Body (concerned with anger).

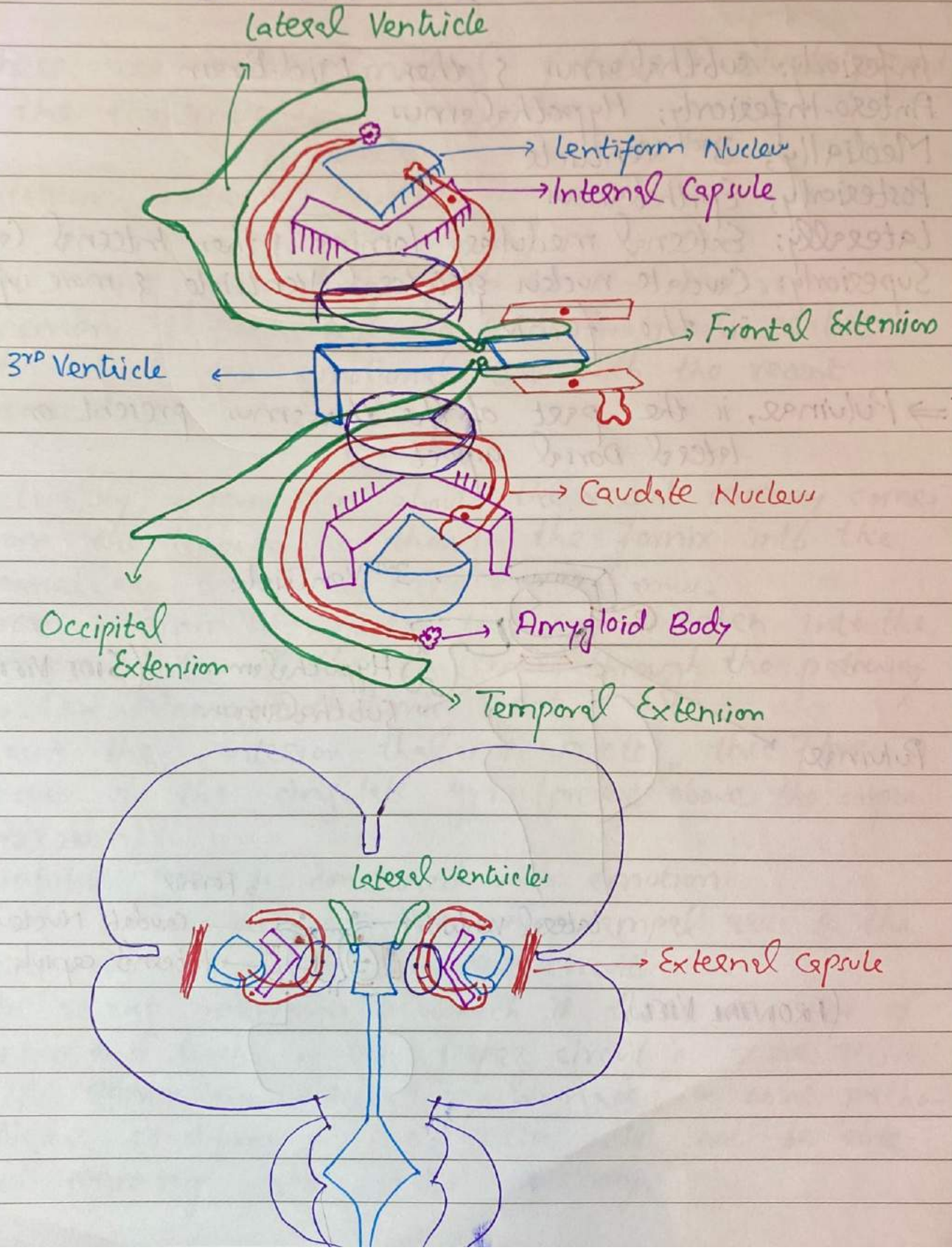
⇒
The Lateral ventricle, coming from interventricular foramen on both sides, gives its frontal extension anteriorly & occipital & temporal extensions, posteriorly & laterally.
- The lateral ventricle runs along the caudate nuclei above the thalamus.

⇒ In the Temporal lobe, there is another grey matter mass, called Hippocampal & parahippocampal area.
- From this Hippocampal & parahippocampal area alot of white fibres are going to the mamillary bodies of the hypothalamus & these white fibres are called Fornix.
- This Fornix moves above the lateral ventricle

Scanned with CamScanner

M T W T F S S

Date:



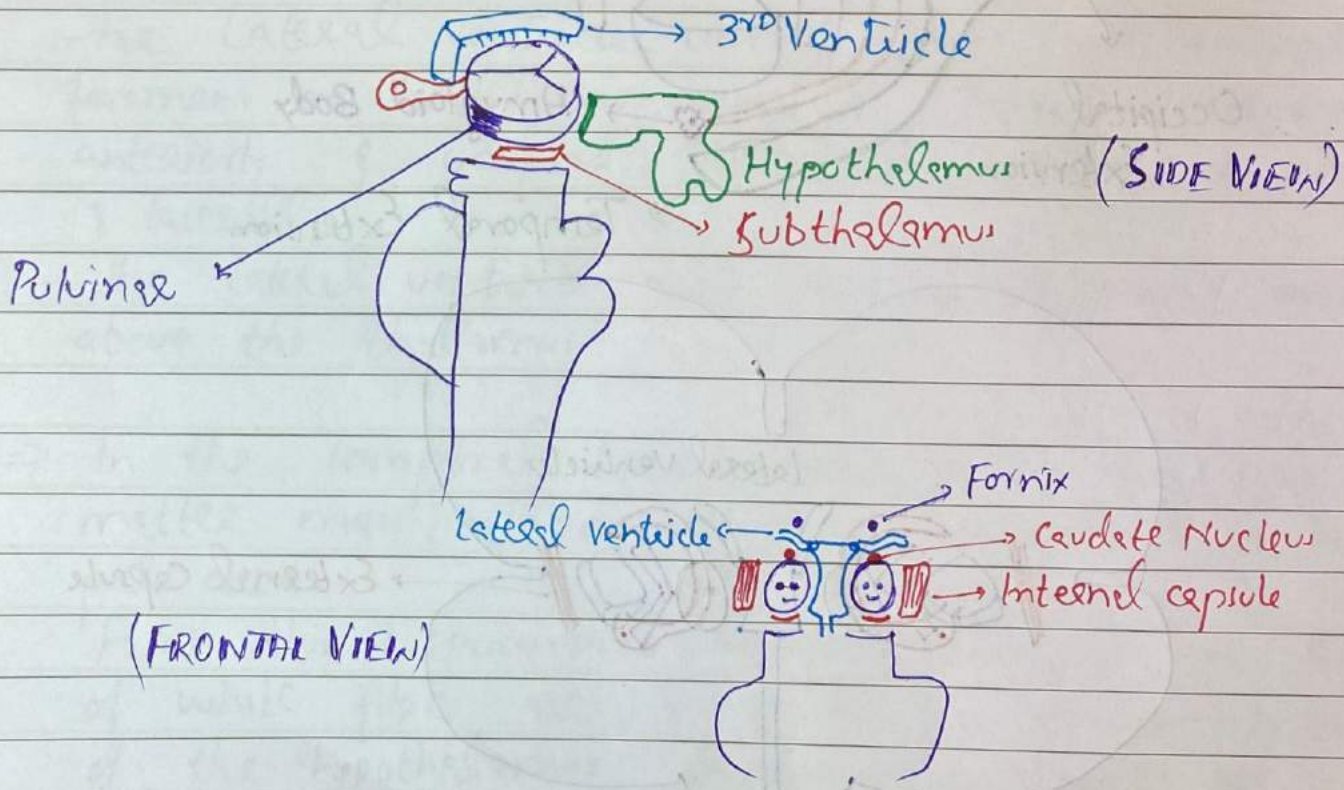
Scanned with CamScanner

M T W T F S S Date:

Boundaries Of The Thalamus:-

Inferiorly: subthalamus & then Mid-Brain
Antero-Inferiorly: Hypothalamus
Medially; 3rd Ventricle
Posteriorly; Epithalamus
Laterally; External medullary lamina & then Internal Capsule.
Superiorly; Caudate nucleus & Lateral Ventricle & more superiorly is the fornix.

⇒ Pulvinar, is the part of the thalamus present on the lateral Dorsal aspect



Scanned with CamScanner

M T W T F S S Date:

Thalamic Nuclei:-

- There are anterior, medial & lateral Nuclei present in the thalamus.

1). Anterior Thalamic Nuclei:-

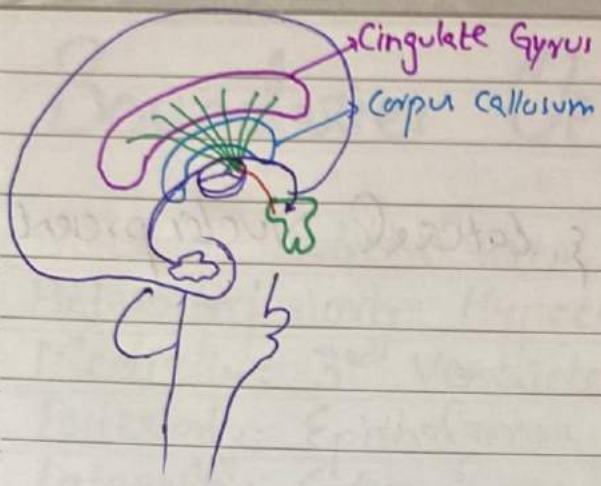
It is the part of the pathway for the recent memory & connected to the emotional centre to adjust the emotional tone with the recent experiences.

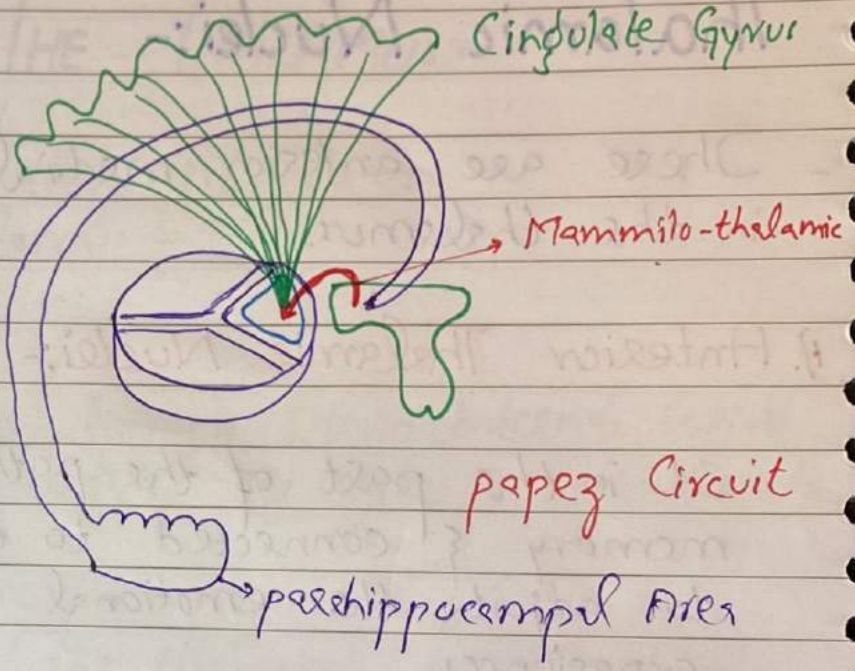
- Actually, information about the recent memory comes from the hippocampus through the fornix into the mimallary bodies of the hypothalamus.
From mammillary bodies the info is taken into the anterior nuclei of the thalamus, through the pathway called Mammillo-thalamic tract.
From the anterior thalamic nuclei, the fibre moves to the cingulate gyrus. (present above the corpus callosum)
- Cingulate gyrus is concerned with emotions.
- This whole pathway from hippocampal area to the cingulate is called Papez circuit.
- In recent memories, in which if there is alot of emotional touch, so this papez circuit is more active.

⇒ If Mammillary Bodies are damaged in some pathological conditions, so the person will not be able to memorize the recent memory.

Scanned with CamScanner

M T W T F S S Date:





2) Medial Thalamic Nuclei:-

- The Dorsal nuclei of this part is important, so it is also called Dorso-medial thalamus.
- The function of this part is to adjust our behaviour & psychological & physical state according to our mood. e.g if we are happy our body language is adjusted as such that is different then the state of sadness.
- This Dorso-medial nucleus is connected to the pre-frontal cerebral Cortex becoz this cerebral lobe is concerned with
  - Behaviour
  - Thoughts
  - Personality

Scanned with CamScanner

M T W T F S S Date:

NOTE:-

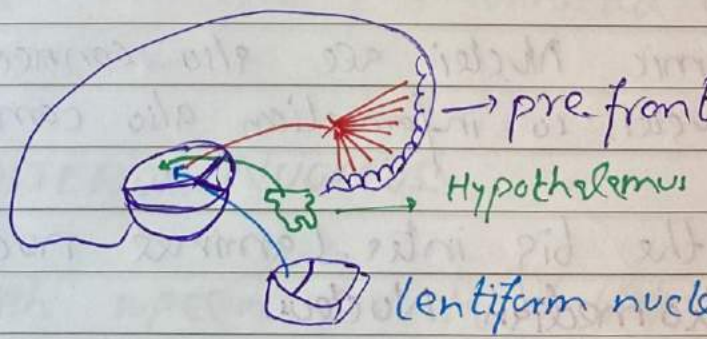
All sensory information input has to pass through the thalamus except the olfactory sensations.

- All the sensory information eg warmth, cold, pain etc are connected to Dorso-medial nuclei through other thalamic nuclei.

- Dorso-medial Nuclei are also connected with Globis pallidus of the Lentiform nuclei.

- Dorso-medial Nuclei are also connected to hypothalamus.

- As this Dorso-medial nucleus is concerned with behaviour & thoughts etc & it also guide our body's physical condition during happiness & saddness, so we can say that both Dorso-medial & Anterior nuclei are connected with Limbic System.



- Both Anterior & Medial Nuclei are damaged in a disease called, Wee Korsacof Wernikes Diseases

Scanned with CamScanner

M T W T F S S Date:

3). Intra-Laminar Nuclei:-

- Intra-laminar Nuclei of the thalamus is very important connection with the Reticular formation. (ascending fibres)
- It is also connected to pain pathways coming through;
  - Spinal thalamic pathway
  - Spinal Nucleus of the Trigeminal System

- Both these pathway may directly goes to the Intra-laminar nuclei or may be they first goes to the Reticular formation & from these into the intra-Laminar nuclei.

- Intra Laminar Nuclei then carries the info into the cerebral cortex.

- Ascending Reticular formation fibres are the main ON/OFF switch for the cerebral cortex.

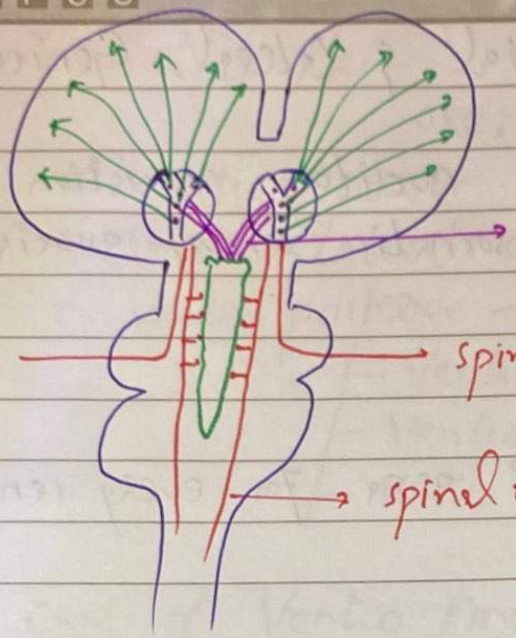
- Intra-thalamic Nuclei are also connected with other thalamic nuclei, so information also comes from these

- One of the big intra-Laminar nucleus, is called the Centromedian Nucleus.

- This centromedian Nucleus is connected with Motor cortex & Basal Ganglia. e.g if we imagin any motor activity before sleeping, so we can't sleep becoz the centromedian Nucleus is consistently activating the Motor Cortex.

Scanned with CamScanner

M T W T F S S Date:



4) Lateral Nuclei :-

i- Dorsal Tier Nuclei :-

a- DORSAL LATERAL NUCLEUS:- (Lateral Dorsal Nucleus)

- It is same as anteriorly placed nuclei. i.e it is also concerned with emotions & is connected with cingulate Gyrus & hypothalamus.

b- LATERAL POSTERIOR NUCLEUS:-

- connected with superior parietal Lobule (which is concerned with analysis alot of information.
- Also connected with other thalamic nuclei

c- PULVINAR:-

- Also connected with all thalamic nuclei.

Scanned with CamScanner

M T W T F S S Date:

- Also connected with medial & lateral Geniculate bodies.
- It is also connected with auditory association area, visual association area & somatic sensory association area.

NOTE:-

Actually there are 3 area for every sensation in the cerebral cortex;

- Primary
- Secondary
- Tertiary

- Secondary & Tertiary as a whole is also called association area.
- Primary area is the area where the input comes at very first.
- Secondary area, in the area the analysis of the input takes place.
- Tertiary area, in this area it is compared with the already stored information about any sensations.

- In case of visual sensation;

primary → Area 17
Secondary → Area 18
Tertiary → Area 19

- If the Pulvinar gets damaged, so we will be able to hear anything for example but we will not be able to understand it, This is called Sensory Aphasia.

Scanned with CamScanner

M T W T F S S Date:

ii- Ventral Tier Nuclei:-

are;

a- Ventro Anterior } Motor
b- Ventro Lateral or intermediate }
c- Ventro posterior → Sensory
- Ventral postero lateral
- Ventro postero medial
- Ventro postero inferior

⇒ In case of Ventro Anterior Nuclei, when we think of an action to be performed, 10 fibres from pre-frontal cortex comes to the Basal Ganglia & these fibres are called Cortico-striated fibres.

- Then it goes to the Globis pallidus in the Basal Ganglia & then into the Ventro Anterior Nuclei & from these the fibres goes back to the pre-motor cortex.
- This Nucleus is also connected Substantia Nigra.

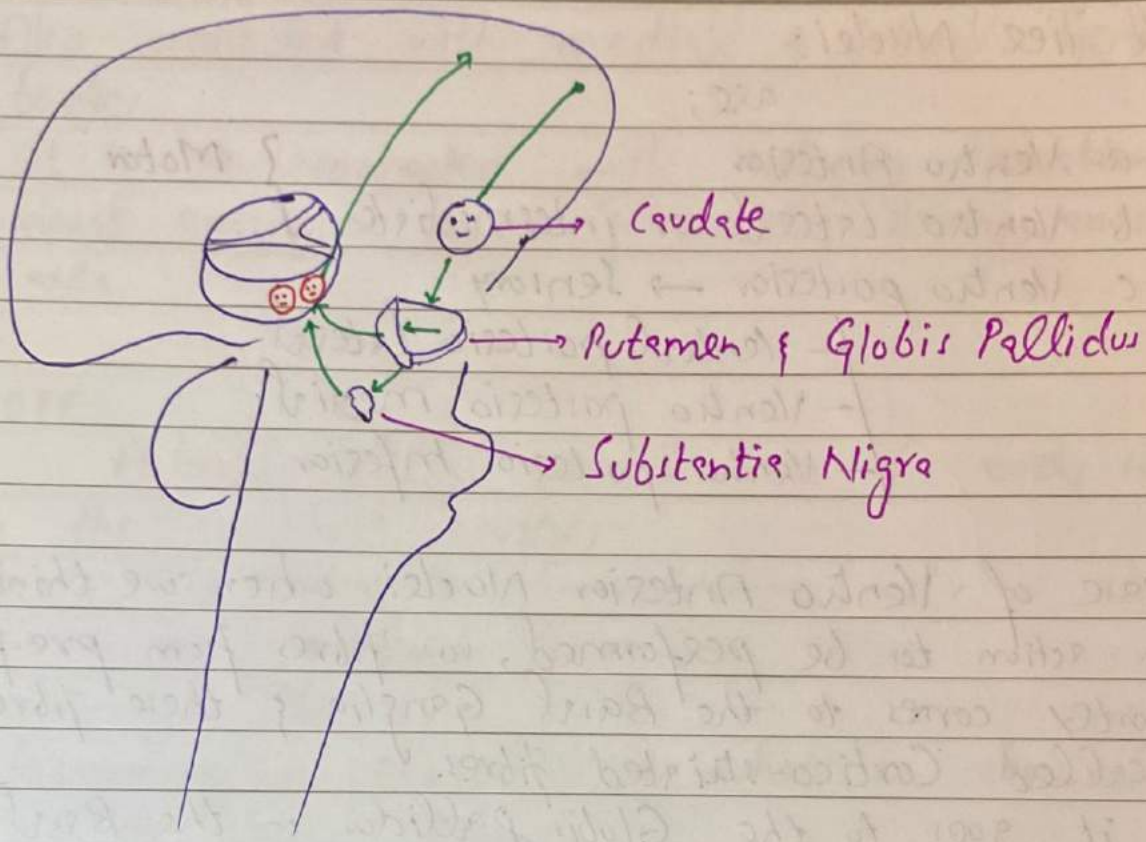
⇒ In case of Ventro Lateral Nuclei, The cortico-ponto cerebellar fibres which are in the cerebellum goes directly to the ventro lateral nuclei or indirectly through the red nucleus & into the ventro lateral Nucleus & from these they goes into the primary motor area & supplimentary motor area.

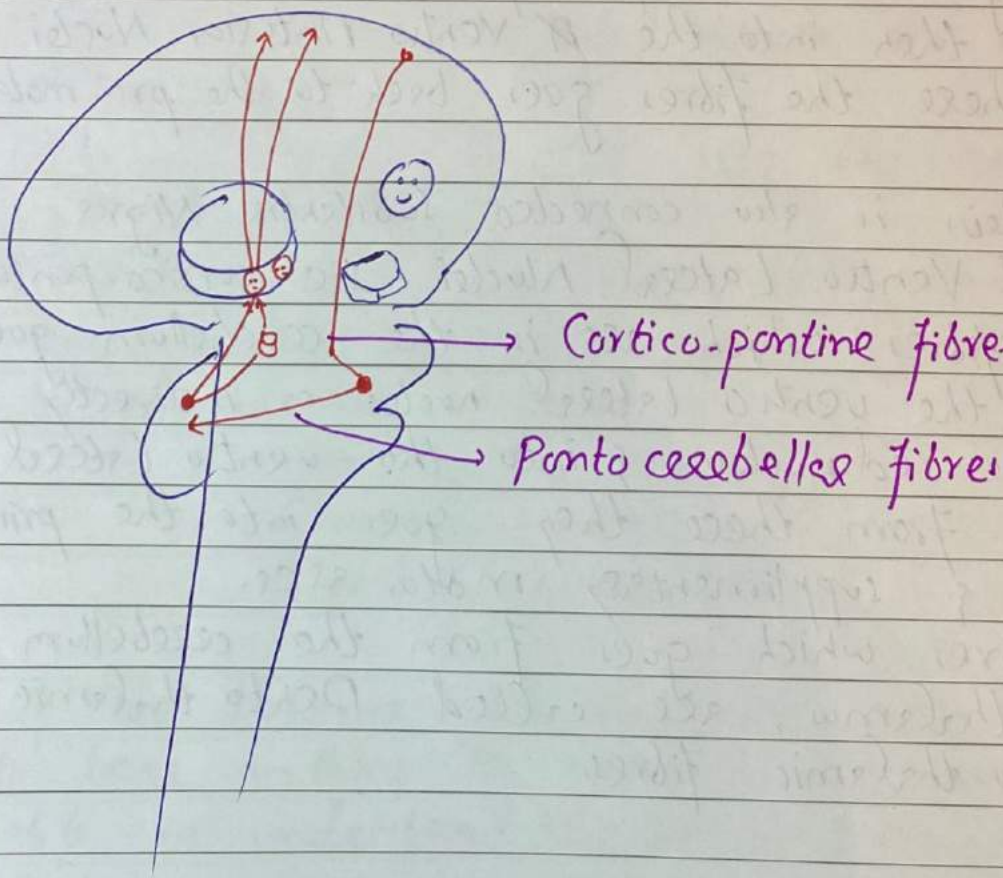
- These fibres which goes from the cerebellum into the thalamus, are called Dento thalamic or Dento-rubro-thalamic fibres.

Scanned with CamScanner

M T W T F S S

Date:





Scanned with CamScanner

M T W T F S S Date:

i- Ventio postro Lateral:-

Receives sensations from Dorsal column Medial lemiriscus System & Lateral spinothalamic pathway.

→ If it is damaged so;
- we looses sensations on contralateral side
- Severe burning pain (which may force the patient to suicide)
- Thalamic Hand development i.e Hand becomes pronated, then it becomes flexed & metacarpophalangeal joints become flexed & interphalangeal joints become extended.

ii- Ventio postio Medial:-

It receives sensations from the Head n Neck along the pain, temp, pressure & taste sensations & project them to the primary sensory cortex.

iii- Ventio postio Inferior:-

Receive the fibres from the vestibular nuclei i.e concerned with the balance.

Scanned with CamScanner

M T W T F S S Date:

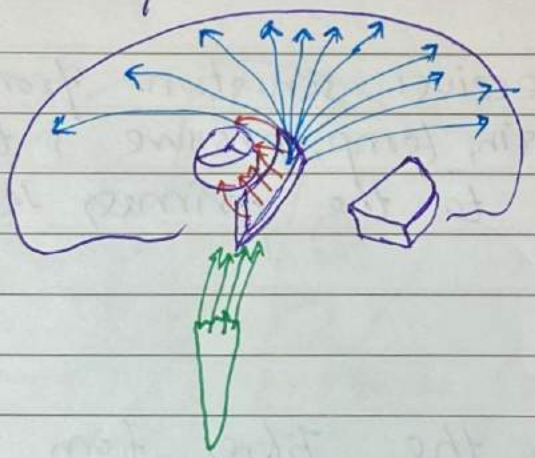
5) Medial & Lateral Geniculate Bodies:-

Medial Geniculate Body → Auditory System
Lateral Geniculate Body → Visual System

- Already explained earlier.

6). Reticular Nucleus:-

- Main regulator of thalamic activity
- Recieves information from all cerebral cortex
- Reticular formation is also connected to Reticular Nucleus
- Gives fibres to all the thalamic Nuclei.



Scanned with CamScanner

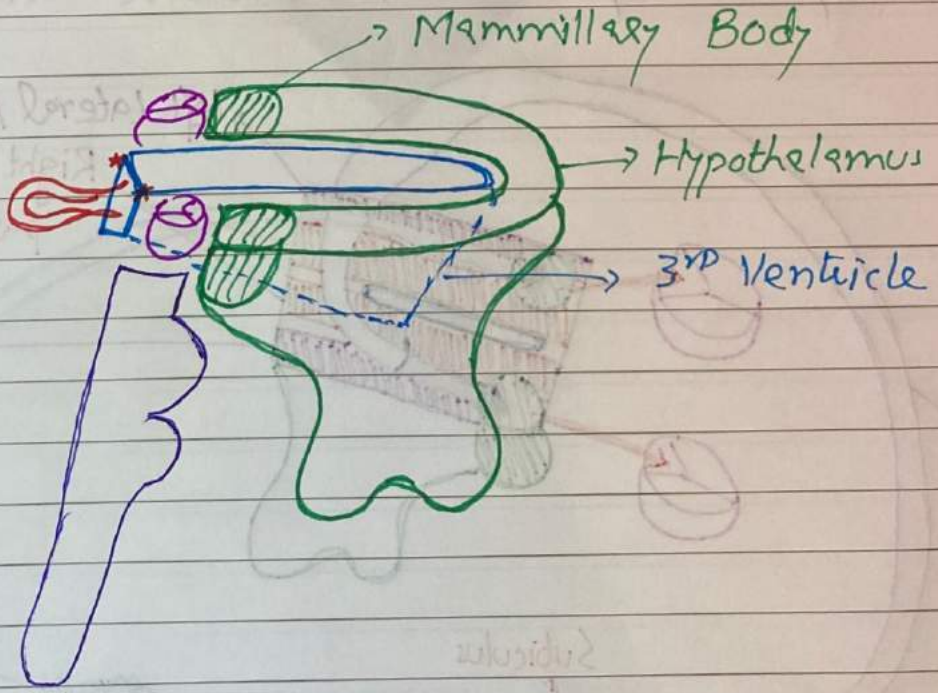
M T W T F S S Date:

HYPOTHALAMUS:-

- Part of Diencephelon.
- Part of Limbic System
- Role in Autonomic Nervous System.
- Have Endocrine Functions

LOCATION:-

Present in the lateral walls of 3rd Ventricle & on the floor of 3rd ventricle.

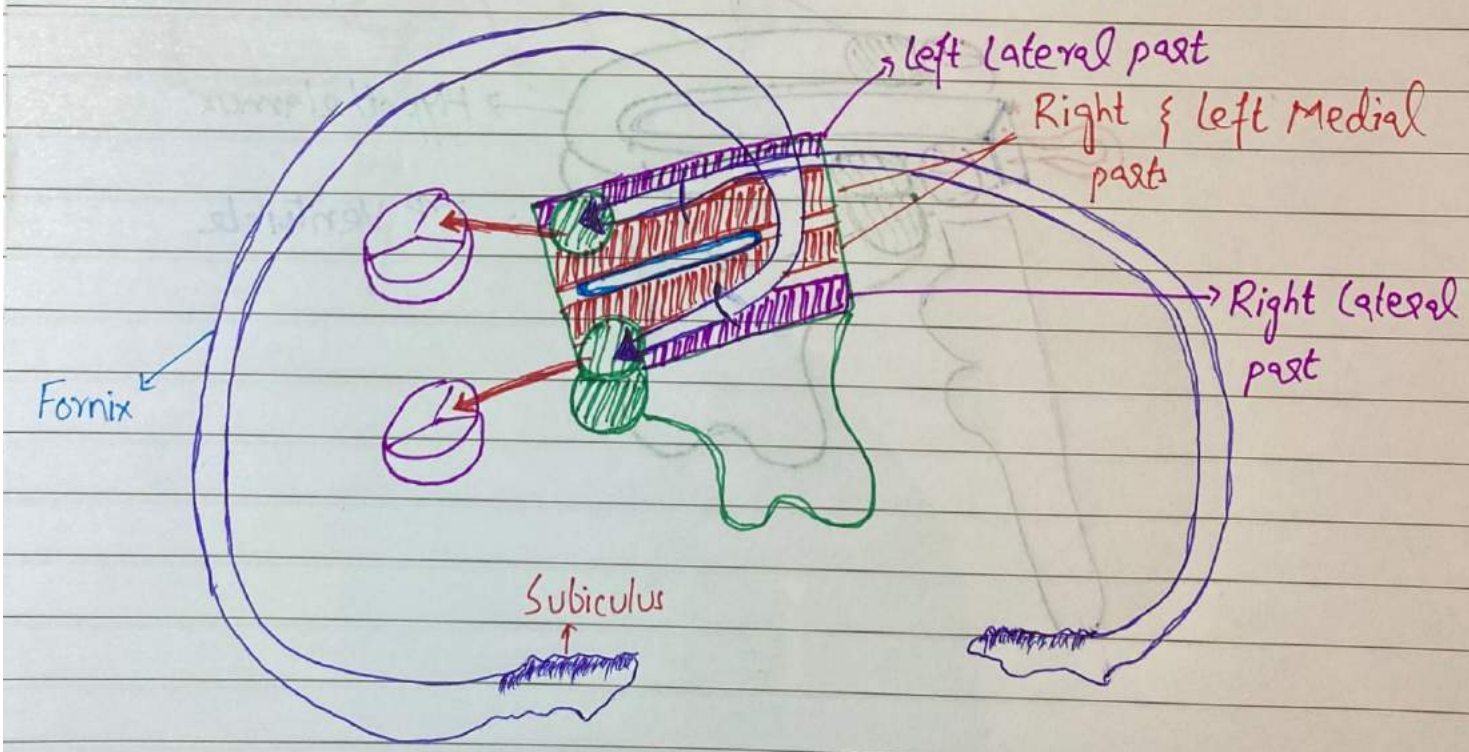


Scanned with CamScanner

M T W T F S S Date:

RIGHT & LEFT HYPOTHALAMUS:-

- The 3rd Ventricle divides the hypothalamus into right & left parts.
- Actually from Subiculus of Hippocampal & parahippocampal area, the information is taken through bundles of white fibres called Fornix into the hypothamus.
- Then within the hypothalamus they goes into the Mammillary Bodies
- And from mammillary bodies they goes into the anterior thalamus.
- Now Both left & right half of the hypothalamus is divided into medial & lateral parts the demarkation of imaginary plane formed by the entrance of fornix & exit of mammillothalamic tract.



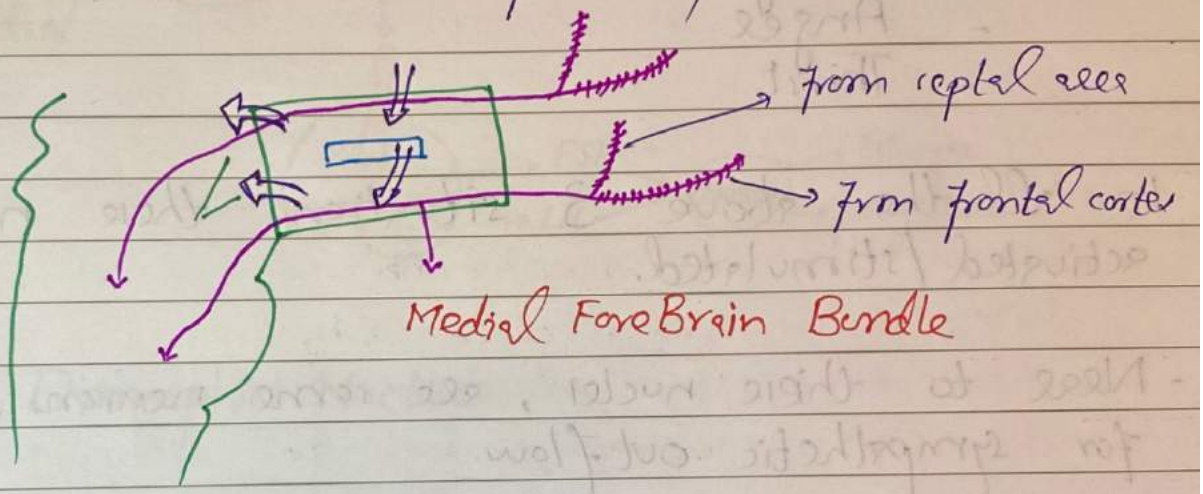
Scanned with CamScanner

M T W T F S S Date:

NOTE:-

Some fibres come from frontal cortex area & septal area & move through the lateral part of the hypothalamus & go to the brainstem area, These bundles of fibres are called Medial Forebrain Bundle.

- This bundle move anteroposteriorly.



HYPOTHALAMUS NUCLEI:-

Pre-Optic Nucleus:-

- present in both medial & lateral hypothalamus.
- Responsible for sexual activities.
- Releases GnRH GnTRFactors
- which goes to the medial eminence & from these through blood supply goes to the anterior pituitary.
- These in anterior pituitary these releasing substance will acts on specific cells which will release FSH & LH.

Scanned with CamScanner

M T W T F S S Date:

- FSH & LH will act on the ovaries.
- Ovaries will then release estrogen & progrestron.

Lateral hypothalamic Nuclei:-

Have the centre for;

- Hunger
- Anger
- Thirst

In all the above 3 situations these nuclei are activated / stimulated.

- Near to these nuclei, are some nerons, responsible for sympathetic out flow.
- In these nuclei there is also an area responsible for the checking of glucose level in the blood.
- So when glucose level becomes down, so due to close relation of the sympathetic outflow area, sympathetic system becomes active.

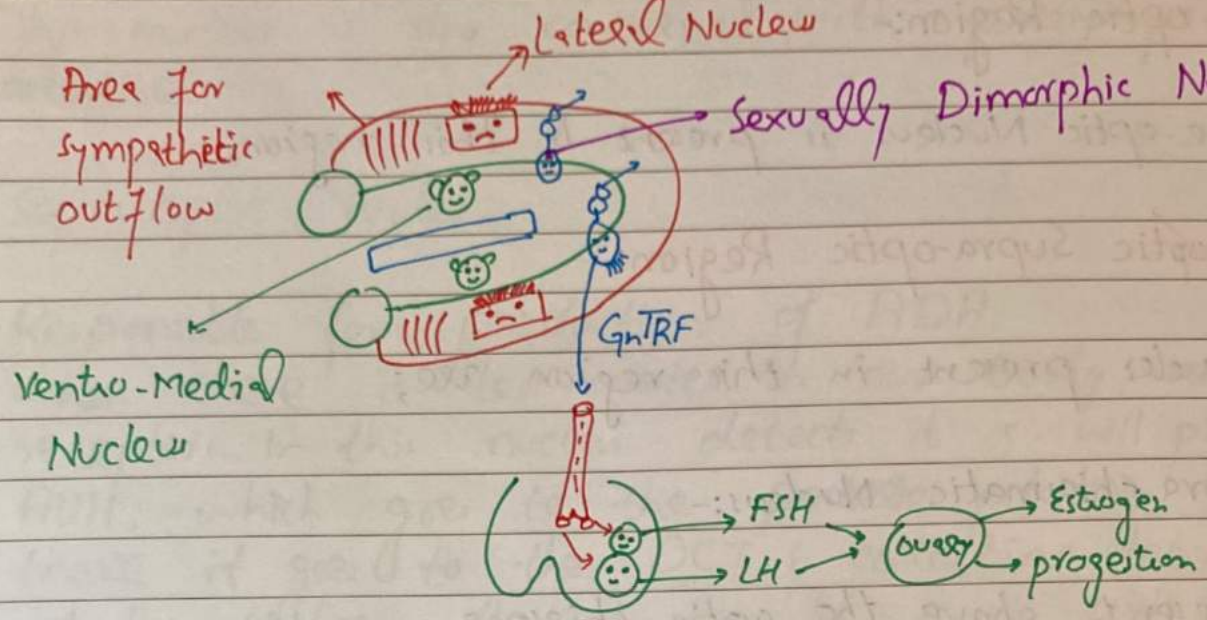
Ventro Medial Nuclei:-

Have the centre responsible

- fullness (after eating)
- Happiness.

Scanned with CamScanner

M T W T F S S Date:



- Sexually Dimorphic Nucleus:-

- present in pre-optic Area
- Responible for sexuall attractions
- Homo-sexuals have problems in the development of this nucleus during their development in the uterus.

Medial part:

- Medial part of hypothalamus is divided into 4 regions from anterior to posteriorly:
  - pre-optic Region
  - supra optic Region
  - Tubeal Region
  - Mammillary Region

Scanned with CamScanner

M T W T F S S Date:

1- Pre-optic Region:-

- Pre-optic Nucleus is present in this region.

2- Subpotic Supra-optic Region:-

- Nuclei present in this region are;

a- Supra chiasmatic Nucleus:-

- Present above the optic chiasme.
- Responsible for circadian rhythms.
- They do so, by calculating the light's ratio i.e the lights coming through the optic pathways goes to this nucleus through some fibres.
- This nucleus is also connected to pineal Gland & hibenulee nuclei.

b. Anteirior Hypothelamic Nucleus:-

- Responsible for keeping the temperature of the body low if the temp in the environment goes high.
→ Fibres from this nucleus go to the brainstem & then to the spinal cord & those fibres are connected to sweat glands, thus if the temp goes high, they produce sweating & lowee the temp.
→ Fibres from this nucleus also dilate the cutaneous blood vessels, thus more blood flow & more heat loss.

Scanned with CamScanner

M T W T F S S Date:

- This nucleus is also concerned with parasympathetic activities.

c. Supra-optic Nuclei:-

- Responsible for production of ADH.
- When there is less water in our body, so osmo-receptors in this nucleus detect it & will produce ADH, which goes to the posterior pituitary & from there it goes to the DCT & collecting tubules of the kidneys through the blood & will make them reabsorb more water.
- ADH has also some receptors on the blood vessels, so when it attaches on them, so it constricts them thus it is also called as Vasopressin.
- ADH comes to posterior pituitary along with a protein, called neurophysin.

d. Para-ventricular Nucleus:-

- Responsible for production of Oxytocin.
- Oxytocin produced in this nucleus go to the posterior pituitary along with a protein called neurophysin.
- It has two functions:
  - contraction of uterus during child birth
  - production of milk / release of milk.
- Actually, these are some cells around the area where milk is stored in the breasts of a female, so when baby sucks/press the nipples, sensory info. is sent to the nucleus, which produces oxytocin & oxytocin comes & attach to those cells which are around the milk's area, thus they press

Scanned with CamScanner

M T W T F S S Date:

that area & milk is released.
- This nucleus also release corticotropin releasing factor.

3- Tubeal Region:-

a- Arcuate Nucleus:-

- Produces release factors or release inhibitory factors.
- which goes into the primary capillaries present in the infundibulum.
Then these capillaries break into vein & then those veins again forms capillaries in the anterior pituitary.
- This is called Hypothalamic hypophysial portal System.
- The products (release factors or release inhibitory factors) comes through the portal system into the anterior pituitary, where they influence the cells of anterior pituitary to produce hormones according to product released by arcuate nucleus.

For example;

GHRF → produces → Growth Hormone
GHRIF → inhibits → GH & ∄
PRF → produces → prolactin
Dopamine → inhibits → prolactin
GnRF → produces → LH & FSH

- The products from the Arcuate nucleus coming through the fibres, which makes a tract, called Tuberohypophysial Tract.

Scanned with CamScanner

M T W T F S S Date:

b- Ventro-Medial:-

- Responsible for fullness after eating something enough
- Receptors for Glucose & hormones coming from GIT.
- Also centre for happiness.
- Thus after more eating, this nucleus inhibits Lateral hypothalamic nucleus.

c- Dorso-Medial Nucleus:-

- Responsible for anger & hunger.

4- Mamillary Regions:-

1- Responsible for controlling eating mechanisms.

2- Posterior hypothalamic Nucleus:-

- Responsible for keeping the temp normal, when the outside temp falls.
  It is done by;
  - Vasoconstriction
  - Shivering

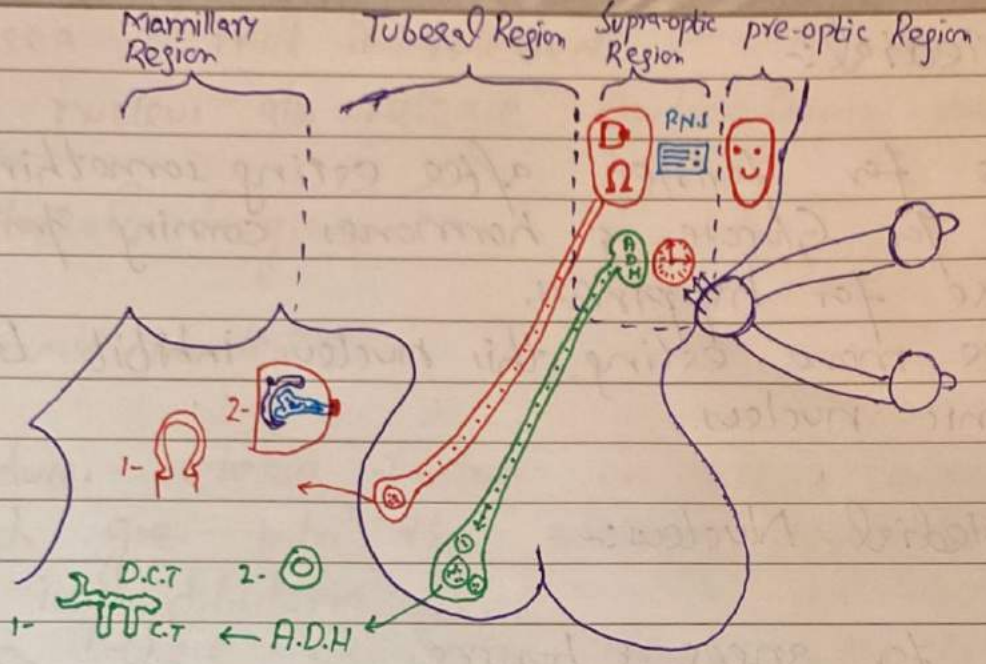
- These are also few neurons around this nucleus, which are responsible for sympathetic outflow.

Scanned with CamScanner

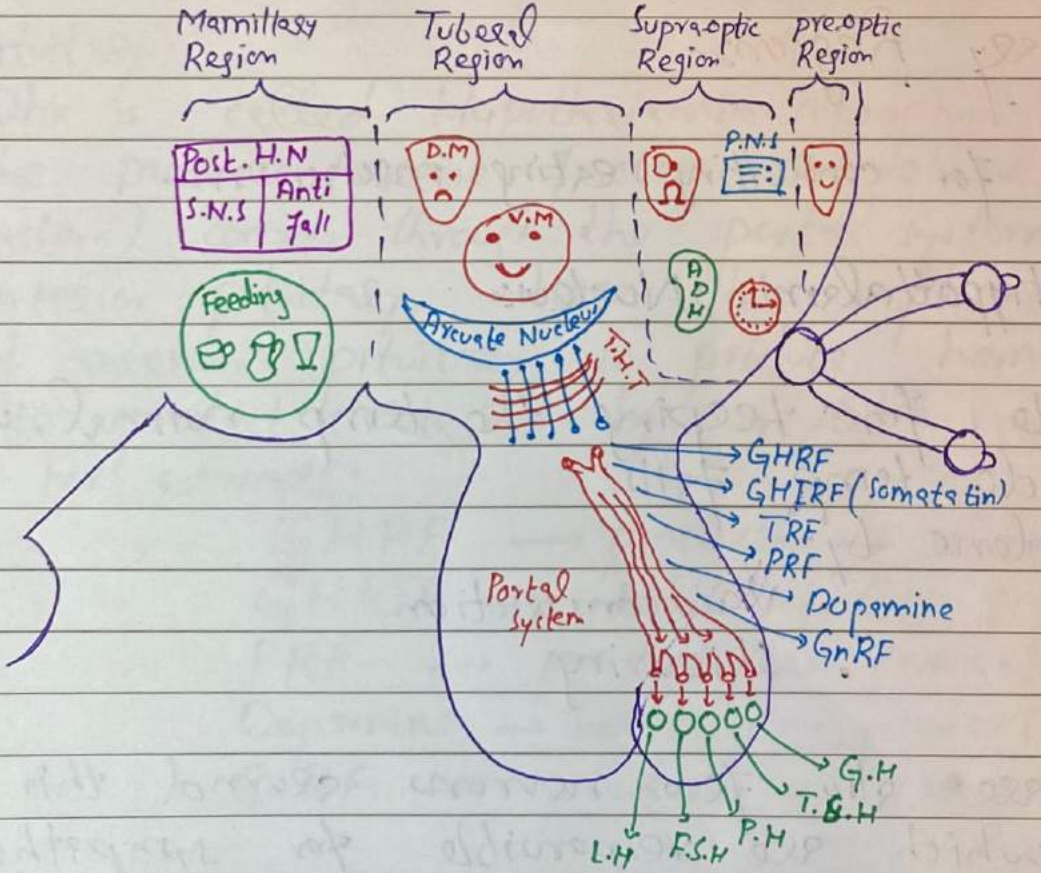
M T W T F S S

Date:

1-



2-



"MEDIAL VIEW" (1), (2)

Scanned with CamScanner

M T W T F S S Date:

Functions Of Hypothalamus:-

Autonomic Functions:-

- Anterior hypothalamus → Parasympathetic activity
  ↳ Anti-rise centre
- Posterior hypothalamus → Sympathetic activity
  ↳ Anti-fall centre
- Medial hypothalamus → Fullness after eating
- Lateral hypothalamus → Hunger & Anger
- Lower Area → Endocrine activities

Hypothalamus Connections:-

With Temporal Lobe:-

1- Parahippocampal area → hypothalamus
(connected through fornix)

Damaged to this connected develops "amnesia."

2- Amygloid body → hypothalamus
(connected through stria terminalis)

Scanned with CamScanner

M T W T F S S Date:

3- Amygdaloid body → hypothalamus
(connected through ventral Amygdaloid fugal pathway)

With pre-frontal Orbital cortex & septal area:-

- Medial forebrain Bundle comes through lateral hypothalamus from these areas & goes to the Brainstem.

With anterior & posterior pituitary:-

- Supra-optic hypophyseal tract
- Tuberal hypophyseal tract

With Thalamus:-

- Mammillo-thalamic Pathway (anterior thalamus)
- Inferior thalamic peduncle (Dorso medial thalamus)

With Tegmentum:-

- Ventral Tegmentum & Dorsal Tegmentum Nuclei & Nucleus raphe are connected to mamillary body through Mammillo tegmentum / tegmental tract
- Fibres from the mammillary body also come to the ventral & dorsal tegmental nuclei & nucleus raphe & is called "Mammillary peduncle".

Scanned with CamScanner

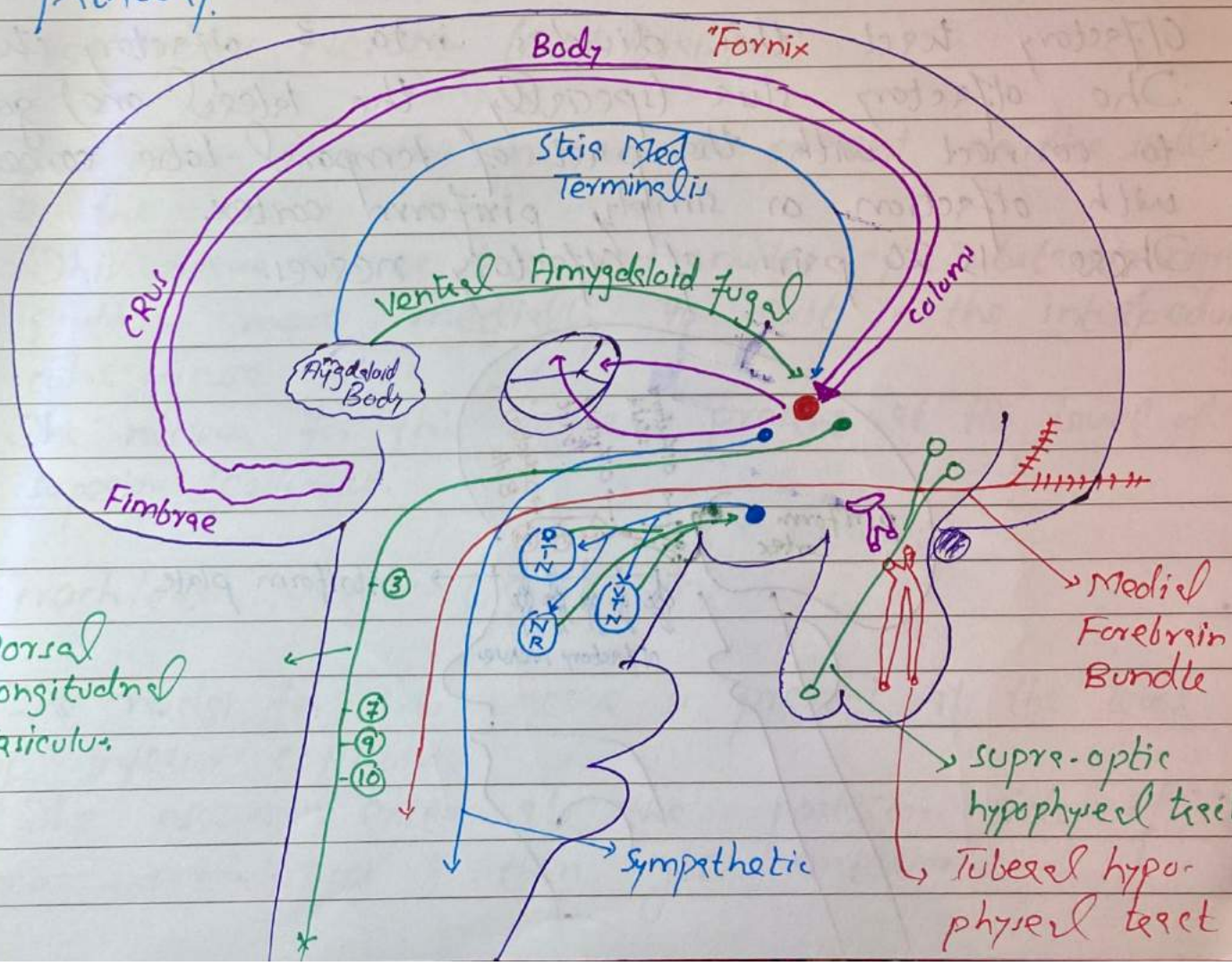
M T W T F S S Date:

Parasympathetic fibres:-

- comes from the anterior hypothalamus
- feeds 3rd, 7th 9th & 10th cranial nerves
- makes a pathway called Dorsal longitudnal fasiculus.

Sympathetic fibres:-

- comes from the posterior hypothalamus.
- these fibres stimulates the thoraco-lumbar spinal cord i.e their sympathetic outflow.
- These fibres are called hypothalamo spinal pathway.



Scanned with CamScanner

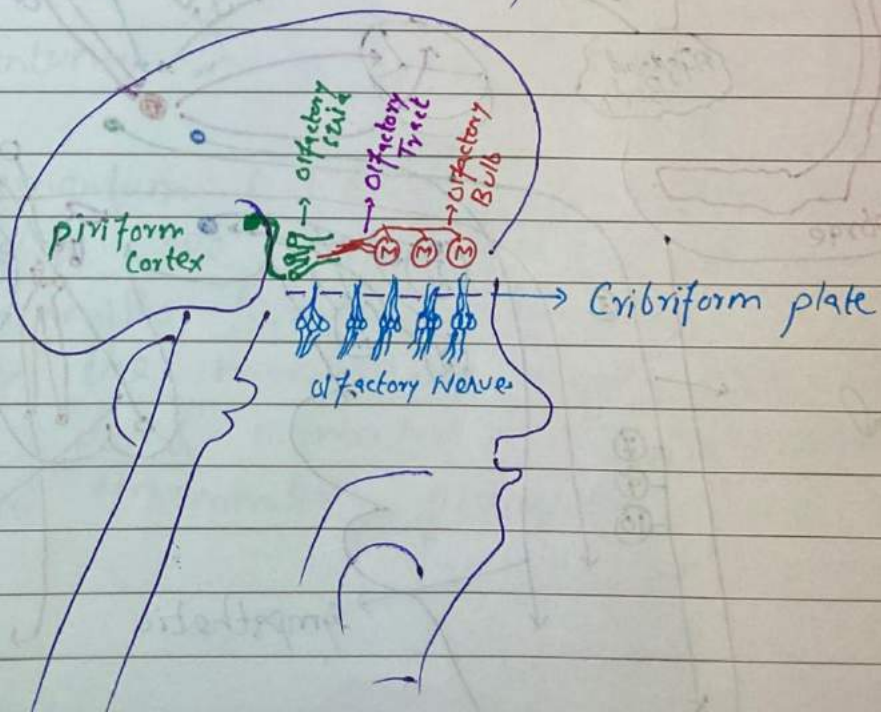
M T W T F S S Date:

Cranial Nerves :- (Basic Concepts:-)

- Attachement of of Cranial Nerves with C.N.S.

1- Olfactory Nerve:- (Telencephelon)

- Centeral processes of multipolar neurons of olfactory Nerve crosses the cribriform plate & goes to the mitral cells of olfactory bulb.
- These extends from the upper part of nasal mucosa.
- From these mitral cells go centrally to form olfactory bulb & olfactory bulb then makes olfactory tract
- Olfactory tract then divides into 3 olfactory stria
- The olfactory stria (specially the lateral one) goes to connect with the part of temporal lobe concerned with olfaction, or simply piriform cortex.
- These 15-20 pairs of olfactory nerves.

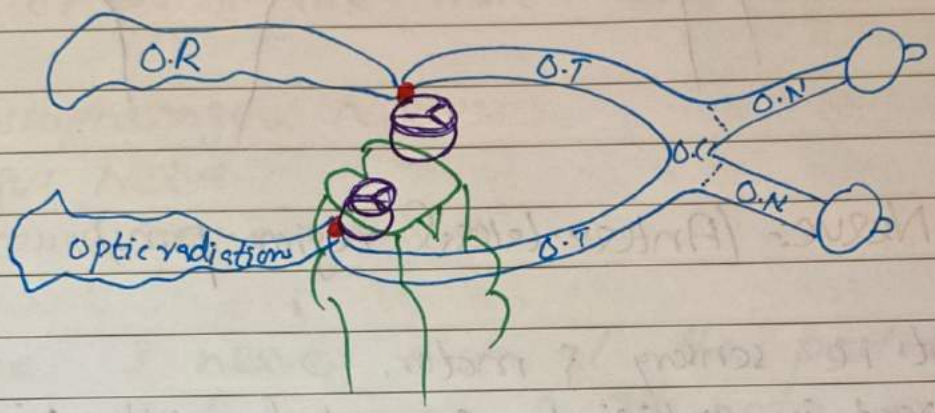


Scanned with CamScanner

M T W T F S S Date:

2- Optic Nerve :- (Diencephalon)

- Not true Nerves
- They are central tracts
- prolongation of Diencephalon
- Optic Nerve → optic chiasma → optic tract → Lateral Geniculate Body



3- Oculomotor Nerve :- (Mid-Brain)

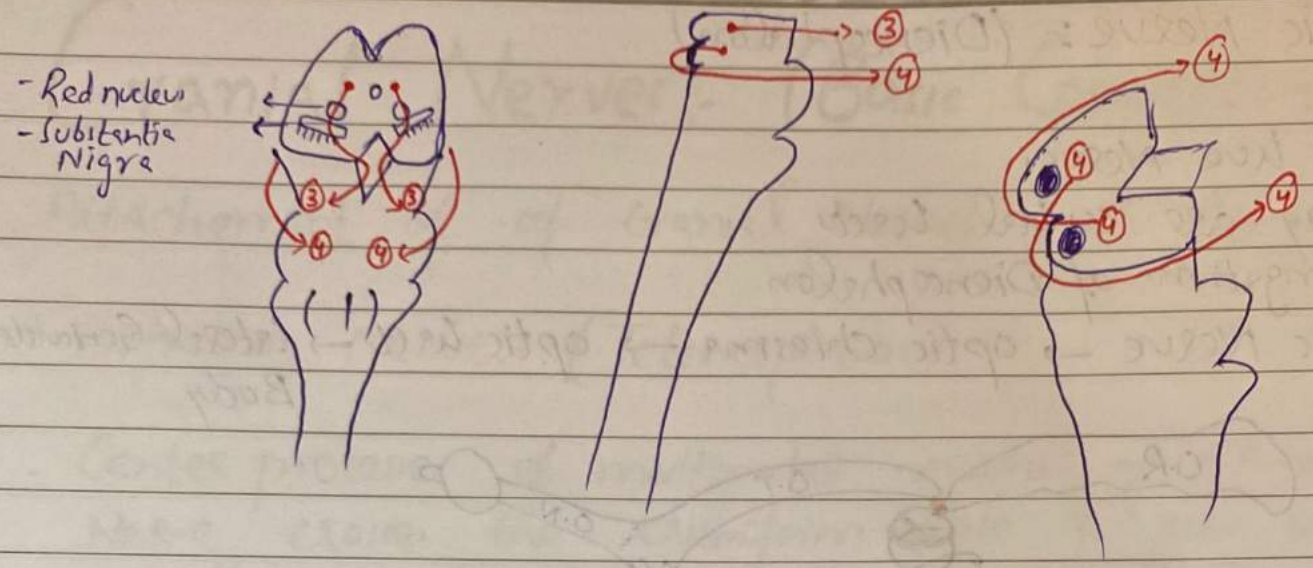
- The nuclei for this nerve are present on the sides of the peri-aqueductal area.
- This nerve crosse the red nucleus & substantia nigra & then move medially to exit in the interpeduncular fossa.
- The nucleus for this nerve is present at the level of superior collicolus.

4- Trochlear Nerve :- (Mid-Brain)

- The nuclei for this nerve is present at the level of inferior collicolus.
- The nerve exits at the posterior side of the mid-brain & then goes anteriorly.

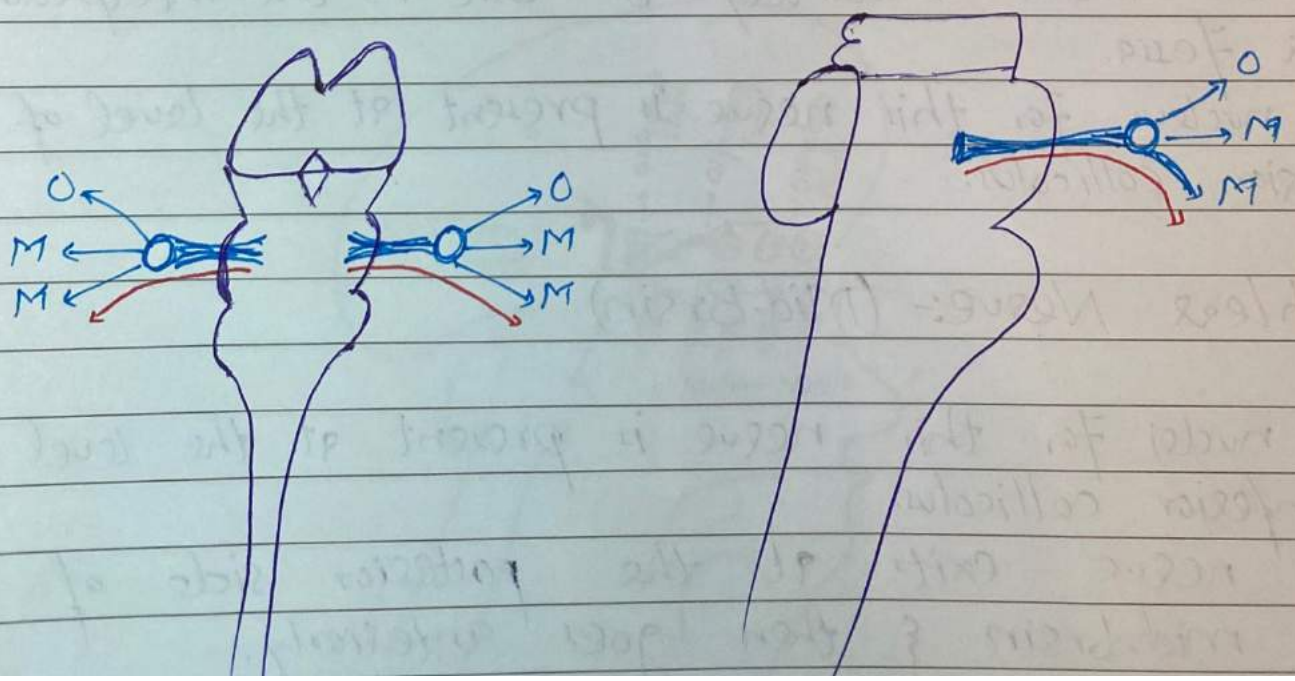
Scanned with CamScanner

M T W T F S S Date:



5- Trigeminal Nerve: (Antero-lateral region pons)

- Has two roots i.e sensory & motor.
- The sensory root is anteriorly connected with trigeminal ganglion which has 3 divisions
  - opthalmic
  - maxillary
  - mandibular
- Motor root, all fibre goes along the mandibular division.



Scanned with CamScanner

M T W T F S S Date:

6- Abducent Nerve:-

7- Facial Nerve:-

8. Vestibulocochlear Nerve:-

- These 3 nerves exit at ponto-medullary junction. From medial to lateral side & anteriorly. i.e 6th nerve is the most medial one.

9- Glossopharyngeal Nerve:-

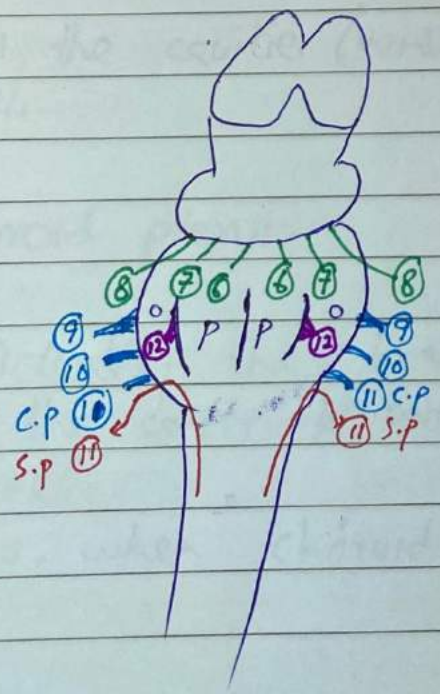
10- Vagus Nerve

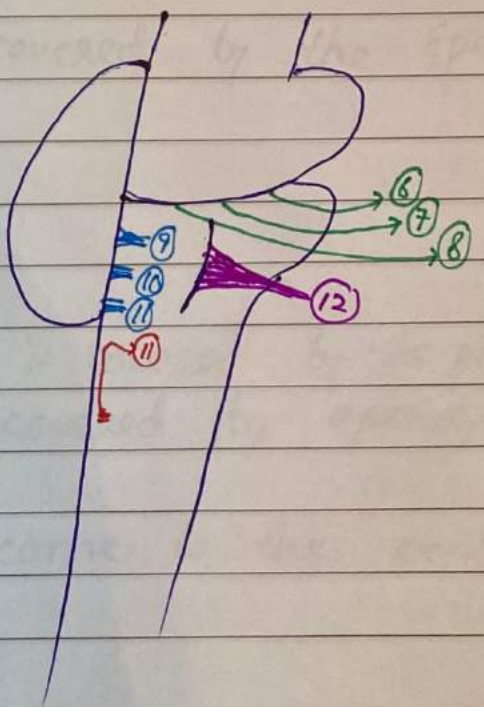
11- Accessory Nerve

- These 3 nerves exit at the post-olivary sulcus in a vertical manner & 9th nerve is the most superior one.

12- ∅ Hypoglossal Nerve:-

- This nerve exit at the pre-olivary sulcus.





Scanned with CamScanner

M T W T F S S Date:

NOTE:-

1- 1st Cranial Nerve come out through Cribriform plate.
2- 2nd Cranial Nerve come out through optic canal.
3- 3rd, 4th, opthelmic division of 5th & 6th cranial nerve come out through superior orbital fissure.
4- Maxillary division of 5th cranial nerve come out through foramen rotundum.
5- Mandibular division along with motor root of 5th nerve come out through foramen ovale.
6- 7th & 8th Nerve passes through auditory canal.
7- 9th, 10th & 11th Nerve exit through jogular foramen.
8- 12th Nerve exits through hypoglossal canal.

Scanned with CamScanner

M T W T F S S Date:

Cerebro Spinal Fluid (CSF):-

- present in the CNS & also around the CNS in the sub-arachnoid space.

→ Lateral ventricles are the cavities of Telencephelon.
→ 3rd ventricle is the cavity of Diencephelon.
→ 4th ventricle is the cavity of proximal pons & mid point of the medulla.

- The CSF runs in these cavities.

Foramen of Monro, is present b/w the 3rd & lateral ventricles of both sides.

- These are special structures present in 3rd, 4th & both lateral ventricles, called Coroid plexus where CSF is formed.

- All the cavities (ventricles) are covered by the Ependymal cells.

Choroid plexus:-

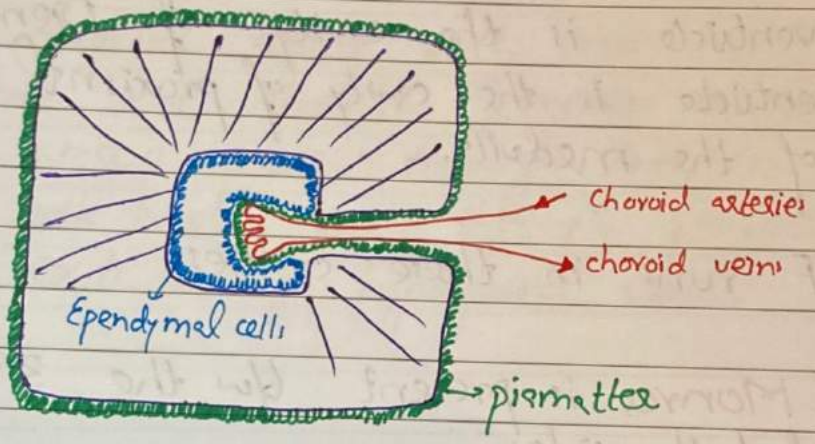
- Actually the brain substance is covered by the pia matter & the cavity it within it, is covered by ependymal cells.
- So, when choroid arteries come to the cavity, they

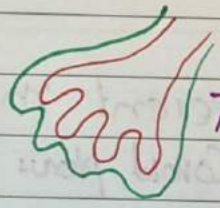
Scanned with CamScanner

M T W T F S S Date:

form capillaries. from which veins comes out of the cavity & out of the brain substance.

- Now, when the fold of these arteries, when covered by the pia matter, so it is called Telochoroide.
- And when Telochoroide is covered by the ependymal cell, it is called choroid Plexus.





Telochoroide :- Double folded layer of vessels with pia matter.

- So Telochoroid + Ependymal cells layer = Choroid Plexus

How CSF is formed?

- The epithelial cells of choroid plexus secrets Na^+.
- Due to increased Na^+, Cl^- ions are also passively secreted.
- These ions increases the osmotic pressure, which also cause, the movement of H_2O into it.
- These epithelial cells have glucose transporters, which transport glucose from the blood into the CSF. but they are less efficient.

Scanned with CamScanner

M T W T F S S Date:

- Thus the glucose level of CSF is less then that of blood glucose level and usually it is 2/3rd of blood glucose level.

- K^+ ions are transported from CSF into blood, so K^+ level is less in CSF then the blood.

NOTE:-

CSF is formed in these ventricles & it also move in these ventricles & sometime the lower end of the spinal canal is dilated due to CSF & it is called Terminal Ventricle.

How the CSF moves around the CNS?

Foramen Luschka:-

There are lateral foramen present in the roof of 4th ventricle on the lateral sides, which drains CSF from the ventricle into the sub-arachnoid space.

- There are cerebello pontine cisternae.

Foramen Magendie:-

present in the posterior aspect of the pon, & it also drain CSF out of the ventricles into the sub-arachnoid space

- present medially.

- This is cerebello-medullary cisternae / cisternae magna.

- Cisternae:-

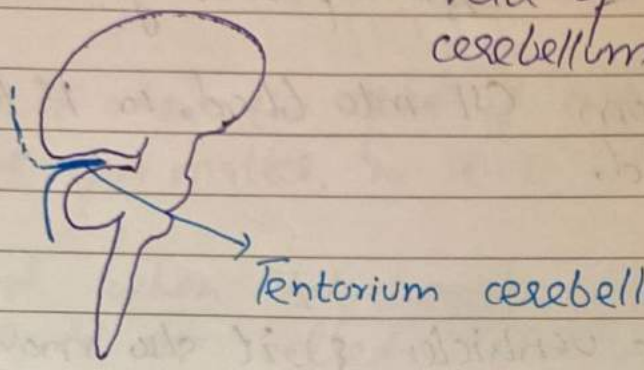
Dilated space where more CSF is present.

Scanned with CamScanner

M T W T F S S Date:

Tentorium Cerebelli:-

Fold of dura matter present above the cerebellum



⇒ There are two layers of Dura matter.

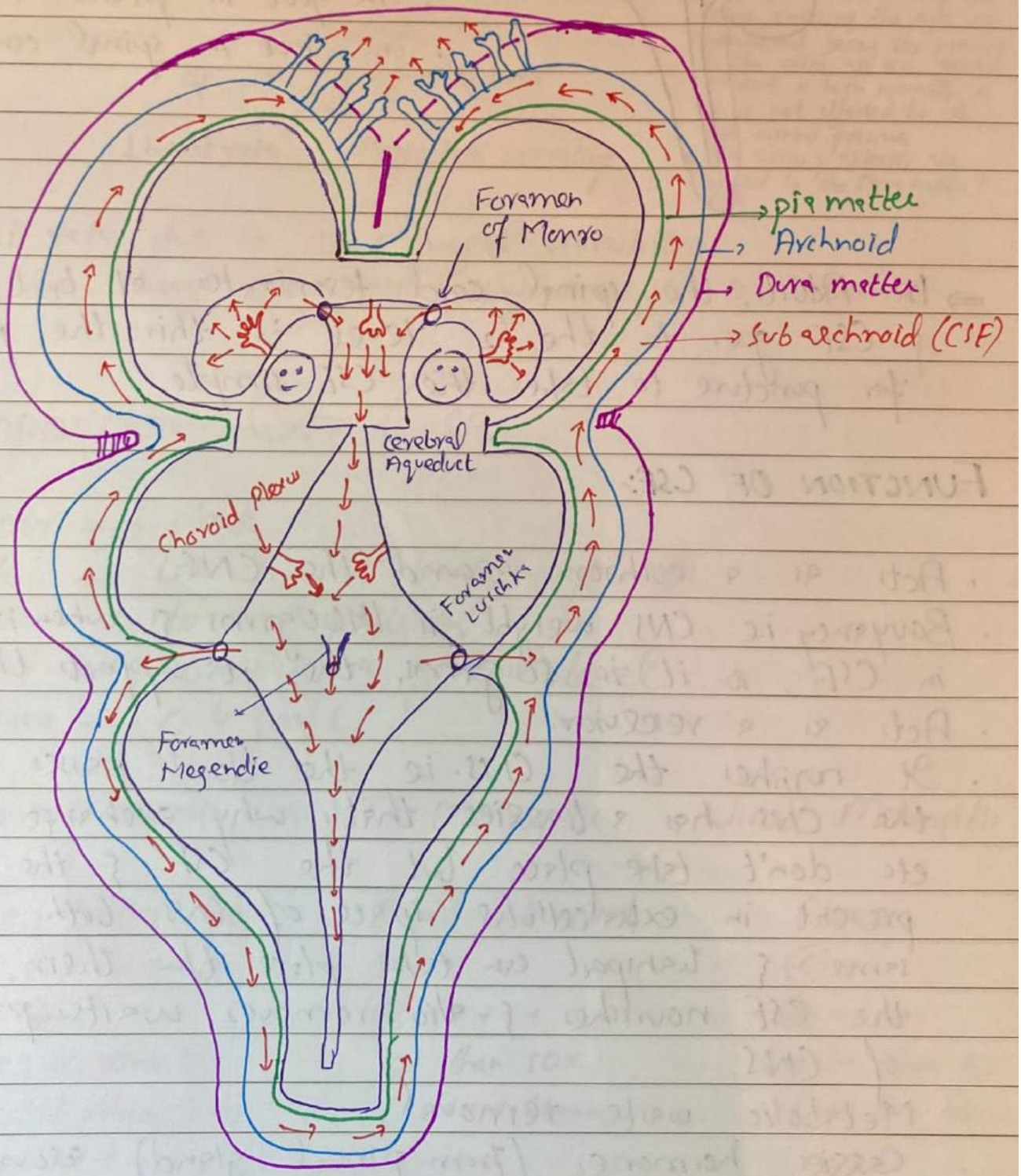
- At the top of the CNS, these two layers separate & make a triangular structure, called Superior sagittal Sinus. or Dural venous sinus.
- There are few holes in this triangular structure through which ~~sub~~ arachnoid matter passes & make finger like structure called arachnoid villi.
- These arachnoid villi as a group are called arachnoid granulation.
- So, from these archnoid granulation, CSF is drained into Dural venous sinus.
- These arachnoid granulations only allow one way movement of CSF i.e from sub arachnoid into the dural venous sinus.
- There are vesicles channels in the endothelial cells of arachnoid villi which allow movement of large molecules from subarachnoid into these sinus ie RBC, protein etc.

Scanned with CamScanner

M T W T F S S Date:

NOTE:-

- Every minute about 0.5 ml CSF is produced
- In 24hrs, 500ml CSF is produced.
- Total CSF, in the brain & around brain = 130ml



Scanned with CamScanner

M T W T F S S Date:

Example:-
person in 4th ventricle:
- Head in cerebral aqueduct
- Both hands in foramen Luschka
- one foot in foramen Megendie.
- one foot in spinal canal.

⇒ In Adults, the spinal cord terminate at L_1, L_2 & CSF goes to the S_2 level i.e this the point for puncture to take the CSF simple.

FUNCTION OF CSF:-

- Acts as a cushion around the CNS.
- Bouyancy i.e CNS weight is 1400grms & when it is in CSF, so it is 50 grms, they it supports the CSF.
- Acts as a reservior.
- It nurishes the CNS. i.e the blood passes through the CNS has a barriee that's why exchange of molecules etc don't take place. but the CSF & the fluid present in extracellular space of CNS, both are the same & transport can take place b/w them, thus the CSF nourishes & also removes waste product of CNS.
- Metabolic waste removal.
- Carries hormone (from pineal gland) around the CSF.

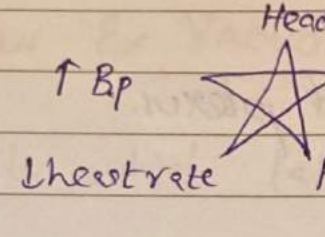
Scanned with CamScanner

M T W T F S S Date:

- CSF pressure → 60 – 160 mm of Hg

NOTE:-

Increased cranial pressure signs:-



*In papilledema only the veins entering the eye are constricted because the pressure in the veins are less, external pressure is high normally, so it is not affected by the high cranial pressure.
*Both veins & arteries are covered by the Dura matter & CSF.

↓ Heart rate due to strong vagal stimulation.
↑ B.p due strong sympathetic stimulation due to ischemia.

Composition Of CSF:-

- Colour → clear
- Cells → less than 5 Lymphocytes (L)
  No neutrophils. (N)
- Glucose → 66% plasma glucose level.
- proteins → 0.4 gm/L

	Pyogenic Meningitis	T.B Meningitis	Viral Meningitis
• Colour:	Yellow, Torbid	Torbid + Fibrin web	Clear
• cells:	(N) +++++	(N) +	(N) +
	(L) +	(L) +++++	(L) +++++
• Glucose:	less than 50% of plasma Glucose	less than 50% of plasma Glucose	Greater than 50% of plasma Glucose
• proteins:	+++	++++	+

Scanned with CamScanner

M T W T F S S Date:

Hydrocephelus:-

excess CSF builds up within the cranial cavities.

Due to;

1- ↑ Production:-

Tumor of choroid plexus.

2- Abnormal Circulation:-

Cyst formed in the 3rd ventricle blocks the foramen of Monro.
Thus CSF builds up in the lateral ventricle, so it compresses the brain substance.

- Assymetrical enlargement i.e one lateral ventricle enlarges.
- Blockage of cerebral aqueduct, which leads to symetrical enlargement of both lateral ventricles & 3rd ventricle.
- Blockage of foramen Luschka or megendie.
- Blockage in the sub-arachnoid space e.g due to T/ T.B meningitis,
- Blockage in the arachnoid granulation
- Thrombosis in the superior sagittal sinus.
- Blockage of internal jagular veins.

3- ↓ Drainage.

⇒ Hydrocephelous → communicating hydrocephelous
→ non-communicating hydrocephelous.

Scanned with CamScanner

M T W T F S S Date:

NOTE:-

CSF pressure is not increased by its production, but it is increased by the arachnoid villi which acts as valves & when they are closed, so it increases the CSF pressure.

Hydrocephalus Ex Vacuo:-

In some diseases, caudate nucleus shrinks, due to which lateral ventricle gets enlarge.-

→

- Blood Brain barrier is due to endothelial cells & tight junctions of the vessels itself
- Blood CSF barrier is due to epithelial cells & tight junctions of choroid plexus or simply choridal epithelial cells.
- CSF & extracellular fluid of brain have no barrier.

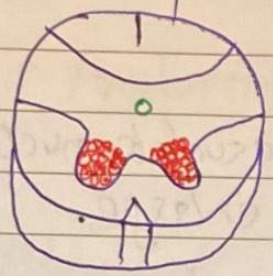
Scanned with CamScanner

M T W T F S S Date:

Spinal Cord Lesions:-

"MOTOR LESIONS"

1- Poliomyelitis

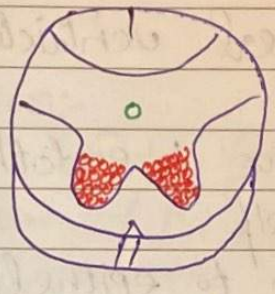


virus, polio

- Lower motor neurons, damaged
- purely motor
- Loss of mass
- Loss of power
- Hypotonia

2- Progressive Infantile muscular atrophy (OR)

- Werdnig Hoffman disorder

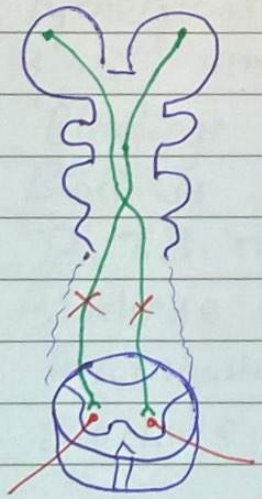


- Lower motor neurons, damaged
- Inherited

3- Juvenile hereditary lower motor neurons disease (OR)

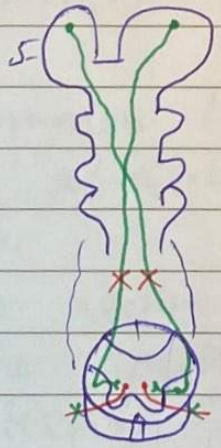
- Kugelberg welanda disease

4-



- upper motor neurons lesions
- Bilateral (on both sides)
- Hereditary Spastic paraplegia
- corticospinal tract lesion

5-



- Motor neuron Disease
- Amyotrophic Lateral Sclerosis
- Both upper & lower motor neuron lesions.

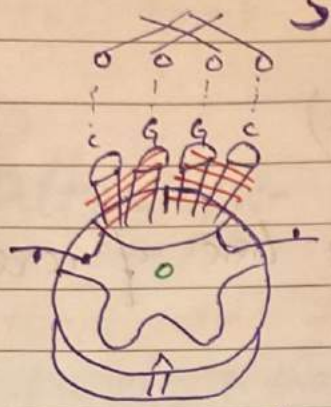
Scanned with CamScanner

M T W T F S S

Date:

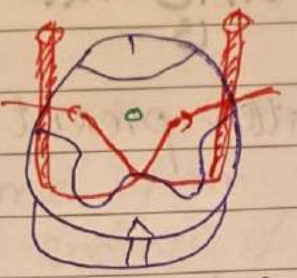
"SENSORY LESIONS"

1-



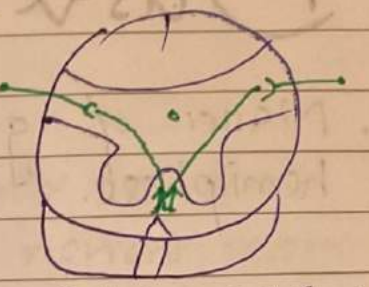
- If Bilateral dorsal column lesion then;
  - Problem with balance of the body after closing the eyes - Rhombegs's sign.
- Dorsal column syndrome
- Epilateral loss.
- Demylenation

2-



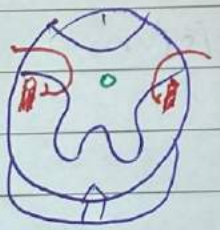
- Lateral spinothalamic tract lesion;
  - contralateral loss of pain, temp one segment below the lesion becos they cross obliquely i.e they don't cross horizontly so, one segment is spared & below that others are damaged.

3-



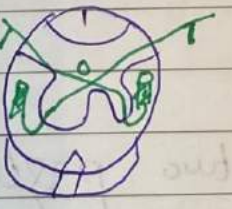
- Anterior spiothalamic tract lesion;
  - contralateral loss of crude touch, 4-5 segments below the lesion.

4-



- Dorsal spinocerebellar tract lesion
  - Epilateral loss of coordination movement of lowerlimb.

5-



- Ventral spinocerebellar tract lesion
  - Contralateral loss of coordination movement of lowerlimb.

Scanned with CamScanner

M T W T F S S Date:

Basal Ganglia:- (Nuclei)

- Masses of gray matter present at the base of cerebral hemispheres.

Traditional Classification	Clinical Group
- Caudate nucleus	- caudate nucleus
- lentiform nucleus	- lentiform nucleus
- Amygdaloid body	- Sub-thalami
- Claustrum	- Substantia Nigra

NOTE:-

Caudate + putamen + Globus pallidus = Corpus Striatum
Caudate + putamen = Neostriatum
Globus pallidus = Paleo striatum

- Globus pallidus has two parts:
  - Lateral or external
  - Medial or internal.

Importance:-

When we think of an action, so first the information about doing that certain action, comes to the Basal ganglia & then it goes back to the cerebral Cortex. through the thalamus &

Scanned with CamScanner

M T W T F S S Date:

then final circles comes through corticospinal fibres.

Pathways:-

Corticostriatal fibres comes from the cortex to the putamen. & the nerve endings of these neurons release Glutamate. (stimulatory)

Striatopallidal fibres goes to the internal globus pallidus from the putamen & the nerve ending of these neurons release GABA + substance P.

Pallidothalamic fibres, come from internal globus pallidus & goes to the thalamus & the nerve endings of these neurons release GABA

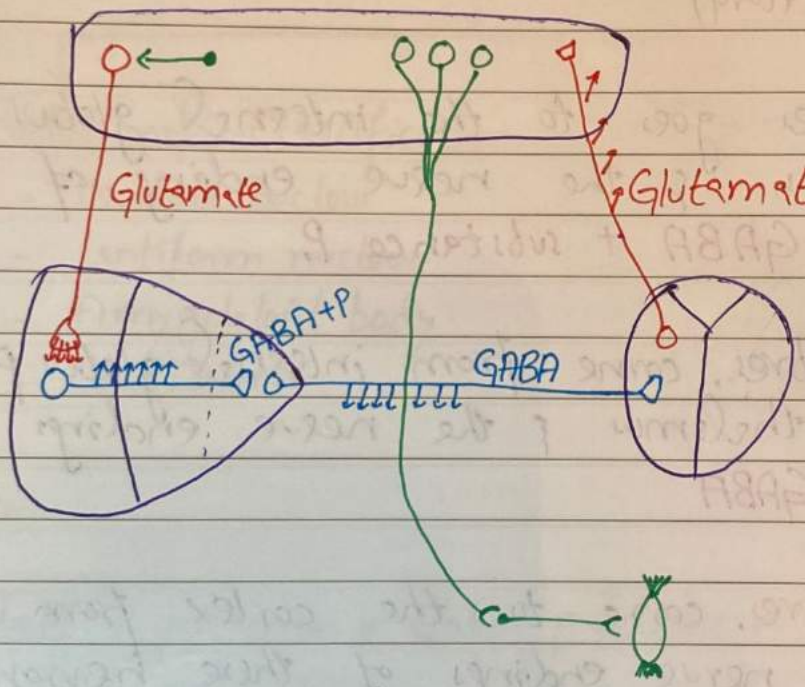
Thalamocortical fibres, come to the cortex from the thalamus & the nerve endings of these neurons release Glutamate

→ AT REST:-
When we are at rest, pallidothalamic fibres are constantly firing GABA & they keep thalamocortical fibres inhibited, thus the corticospinal fibres are not stimulated.

→ ACTION:- (Direct pathway)
When we think of an action, so the corticostriatal fibres are stimulated & they release glutamate to the

Scanned with CamScanner

striatopallidal fibres which are also stimulated & they release GABA to the pallidothalamic fibres, which are inhibited & thus less GABA released for the thalamocortical fibres, so they escape the inhibition (which were caused by pallidothalamic fibres) & Thus they start firing & mig goes to the upper motor neuron & eventually they stimulate lower motor neurons.



(During Action)
Direct pathway

(↑↑↑ excited)
(↓↓↓ inhibited)

Indirect pathway:-

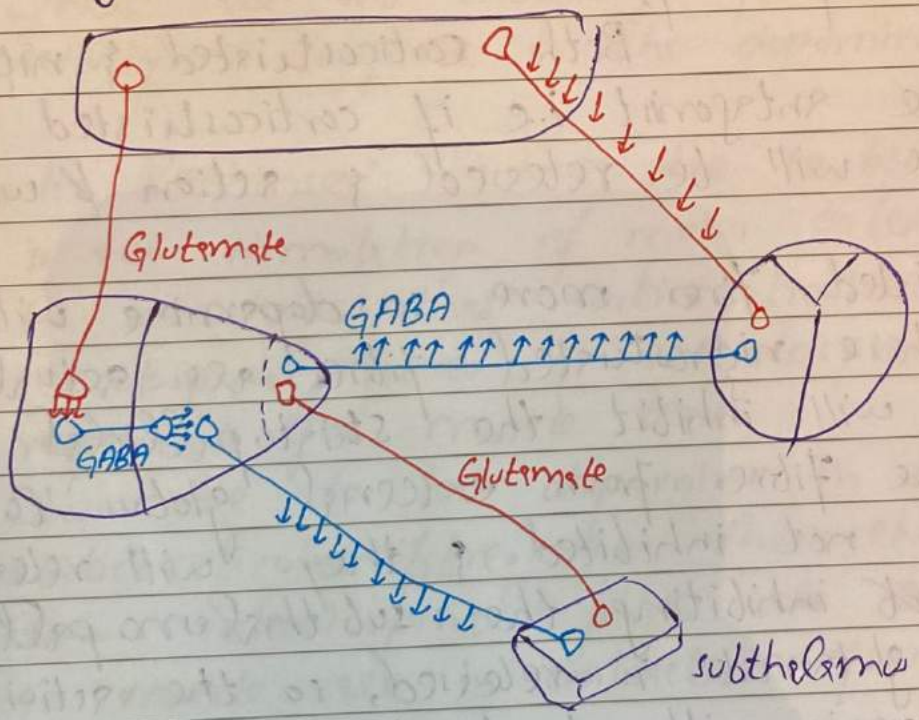
- In this pathway, the corticostriated fibres are stimulated which release Glutamate, then another fibres called striatopallidal are stimulated with will release the GABA but the difference is that in this pathway, these fibres just go to the external globus pallidus. From external globus fibres goe to the subthalamus which ~~also release GABA~~ are inhibited by GABA released by the striatopallidal fibres. Now the

Scanned with CamScanner

M T W T F S S Date:

sub-thalamopallidal which escaped the inhibition over fibres & they release Glutamate. & thus they stimulated pallidothalamic fibres & eventually they release GABA. & thus they keep the corticospinal thalamocortical fibres inhibited & corticospinal fibres are thus inhibited.

⇒ Actually, when we are doing something, for example writing something, so some of our muscle are flexed through direct pathway & some extensor are relaxed through indirect pathway.



Nigrostriatal Pathway:-

- This nigrostriatal pathway is connected with both the direct & indirect pathways.

Scanned with CamScanner

M T W T F S S Date:

- In case of direct pathway, Both corticostriated & nigrostriated stimulated the striatopallidal pathway by releasing Glutamate & Dopamine respectively, & then the striatopallidal after excitation will release GABA & will inhibit the pallidothalamic fibres, thus the thalamocortical fibres will escape the inhibition & action will be performed.
- Thus Nigrostriated fibres enhances the action.

- In case of indirect pathway, Both corticostriated & nigrostriated fibres are antagonist i.e if corticostriated fire so glutamate will be released & action will be inhibited.
But if nigrostriated fires more, so dopamine will be released. & these nigrostriated fibre are actually inhibitory. so they will inhibit the striatopallidal fibres & thus the fibres from external globus to subthalamus are not inhibited & they will release more GABA, inhibiting the subthalamopallidal fibres, & less glutamate is released, so the activity of pallidothalamic will also be less i.e they can't inhibit thalamocortical fibres & thus action is performed.

NOTE:-
D_1 receptors for dopamine in direct pathway
D_2 receptors for dopamine in indirect pathway.

Scanned with CamScanner

M T W T F S S Date:

- Pars reticulasic is a piece of grey matter functionally placed downward just under the globus pallidus.

- Dopamine has stimulatory action on direct pathway & inhibitory on indirect pathway.

⇒ Direct & Indirect pathways, both of these when loss dopaminergic activity, both of these leads to less stimulation of motor cortex.

- There are also cholenergic fibre in the striatum, whose activity is opposite to the dopamine.

⇒ In Parkinson's Disease: due to less dopamine, there is less stimulation of motor cortex.
- As we know that corticoreticular fibre inhibits the reticulospinal fibres & reticulospinal fibres are responsible for muscle tone.
- Thus due to less dopamine in this disease, the corticoreticular fibres are themselves inhibited, & thus reticulospinal fibres are escaped from inhibition. & muscle are in contracted form.

- Resting tremors in this disease is due to circular stimulation of neurons & thus causing flexion & extension to occur very quick & in hyper manner.

Scanned with CamScanner

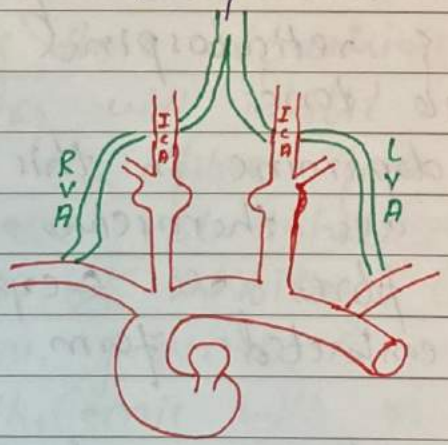
M T W T F S S Date:

Blood Supply To The Brain:-

- About 15% of cardiac output goes to the brain.
- Two system i.e carotid (internal carotid arteries) & vertebro basillar (vertebral arteries) supplies the brain.

Vertebral arteries arise from subclavian arteries, they move upward & medially & reaches the foramen present in the transverse processes of cervical vertebrae & then through foramen Magnum enters the cranial cavity.

- All the arteries are present in the Sub-arachnoidal space.



Basillar System:-

- Vertebral arteries are going up through transverse foramen of cervical vertebrae.
- Then they move medially & pass the dura matter & arachnoid & reaches sub arachnoid space.

Scanned with CamScanner

M T W T F S S Date:

- Then they move forward upward & medially & both arteries meet at ponto-medullary junction.
- They they move as a trunk called basillar arteries.
- Then just above the 3rd nerve, this basillar artery divided into two terminal arteries which moves backward;
  - posterior cerebral arteries (right & left)

Branches:-

1- From lower part of vertebral arteries branches come infront of medulla, unit & descends together in the anterior median fissure of spinal cord, called Anterior spinal artery.

2- Posterior inferior cerebellar arteries, also originate from the vertebral arteries on both sides. & it also supplies lateral part of the medulla.

Anterior Spinal Artery:-

- Anterior 2/3rd of spinal cord is supplied by the spinal artery.

Posterior Spinal Arteries:-

In some people, they originate from the vertebral arteries but in some they originates from posterior or inferior cerebellar arteries.

Scanned with CamScanner

M T W T F S S Date:

- And then they descend to spinal cord, just behind the posterior root.

- Segmental arteries present on both sides of the spinal cord enters the spinal cord & divides into
  - Anterior reticular arteries
  - posterior reticular arteries

- Both of these reinforce the flow of blood in anterior & spinal arteries.

NOTE:

There are two posterior spinal arteries & one anterior spinal artery.

- These segmental arteries may be;
  - Deep cervical arteries
  - Intercostal Arteries
  - Lumbar arteries

Great Medullary Artery of ADAM, is the most imp segmental artery for the spinal arteries i.e if this artery gets block so major area of the spinal cord may be infected.

- The area of anterior spinal artery which is very vulnerable to infection, if there is little blood supply, is present at the level of T4 & L1.

Scanned with CamScanner

M T W T F S S Date:

- And incase of posterior spinal arteries, it is T_1, T_2 & T_3.
- These areas in anterior & posterior spinal arteries have least blood flow due to the placement of segmental arteries, so if further blood decrease so they may be infarcted.

Anterior Inferior cerebellar Arteries:- (AICA)

- In some people, this branch comes from basillar artery but in some it might come from the vertebral arteries.
- It supplies the 3rd inferior surface of cerebellum lateral area of pons.

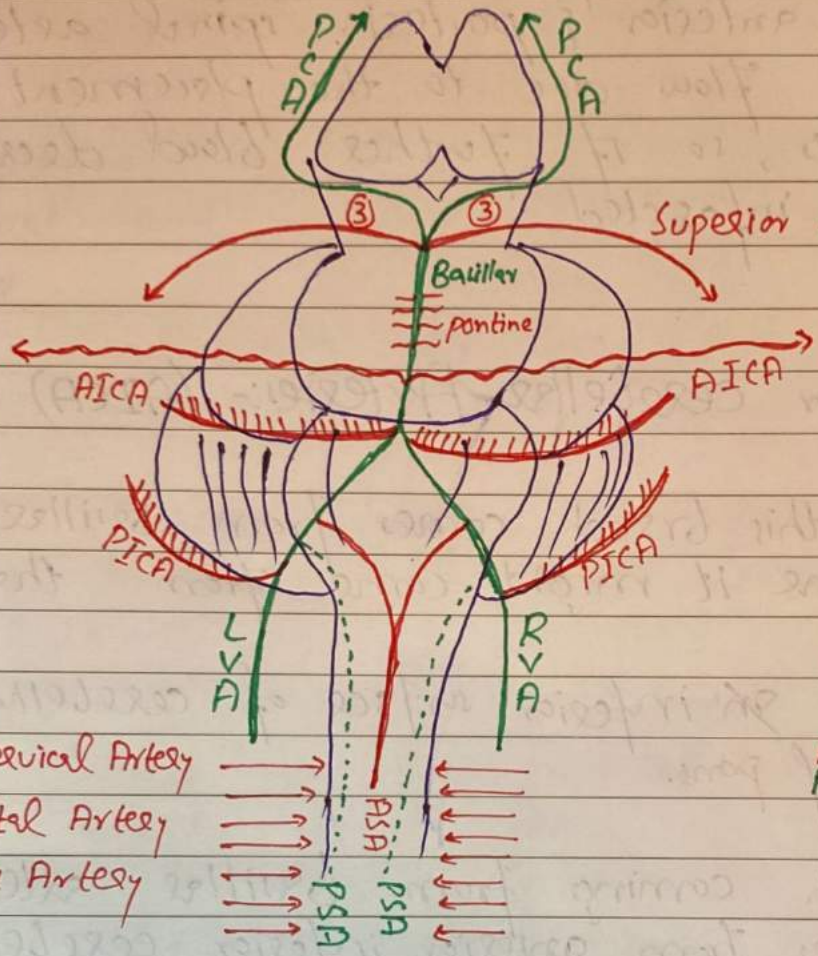
⇒ Another branch coming from basillar artery, occasionally comes from anterior inferior cerebellar artery & move with 7th & 8th nerve & supplies the internal ear, this branch is called Labyrinthine artery.

⇒ In Pons, this basillar artery gives small pontine arteries.

⇒ ## Superiorior Cerebellar Arteries:-

Just below the 3rd nerve, basillar artery give two superior cerebellar arteries to the cerebellum.

Scanned with CamScanner



RVA :- Right Vertebral Artery
LVA :- left Vertebral Artery

ASA :- Anterior Spinal Artery
PSA :- posterior Spinal Artery

Carotid System:-

. The Internal carotid artery enters the carotid canal. & from there it enters the foramen lacerum. & after entering this foramen it reaches middle cranial fossa.

. In the middle cranial fossa, it reaches cavernous sinus & in this sinus it move forward & upward. & medial to the clinoid process & ~~sk~~ turn up

Scanned with CamScanner

M T W T F S S Date:

sharply, facing the dura matter & arachnoid to appear in the sub-arachnoid space.
. These arteries are on the sides of the pituitary.

Branches:- (of internal carotid artery)

1- Opthalmic Artery:-
opthalmic artery, enters into orbital cavity through optic canal & gives an important branch called central retinal artery. to the artery.

* Clinical:- If some thrombus comes through this carotid system & it block this central retinal artery to the person will loss his/her vision.

2- Posterior communicating Artery;
Communicates between the carotid & basilar arteries.

3- Anterior Choroidal Arteries:-
move posteriorly & supplies the choroid plexus of lateral ventricles.

4- Terminal Branches:-
- Anterior cerebral Artery
- Middle cerebral Artery (move laterally)

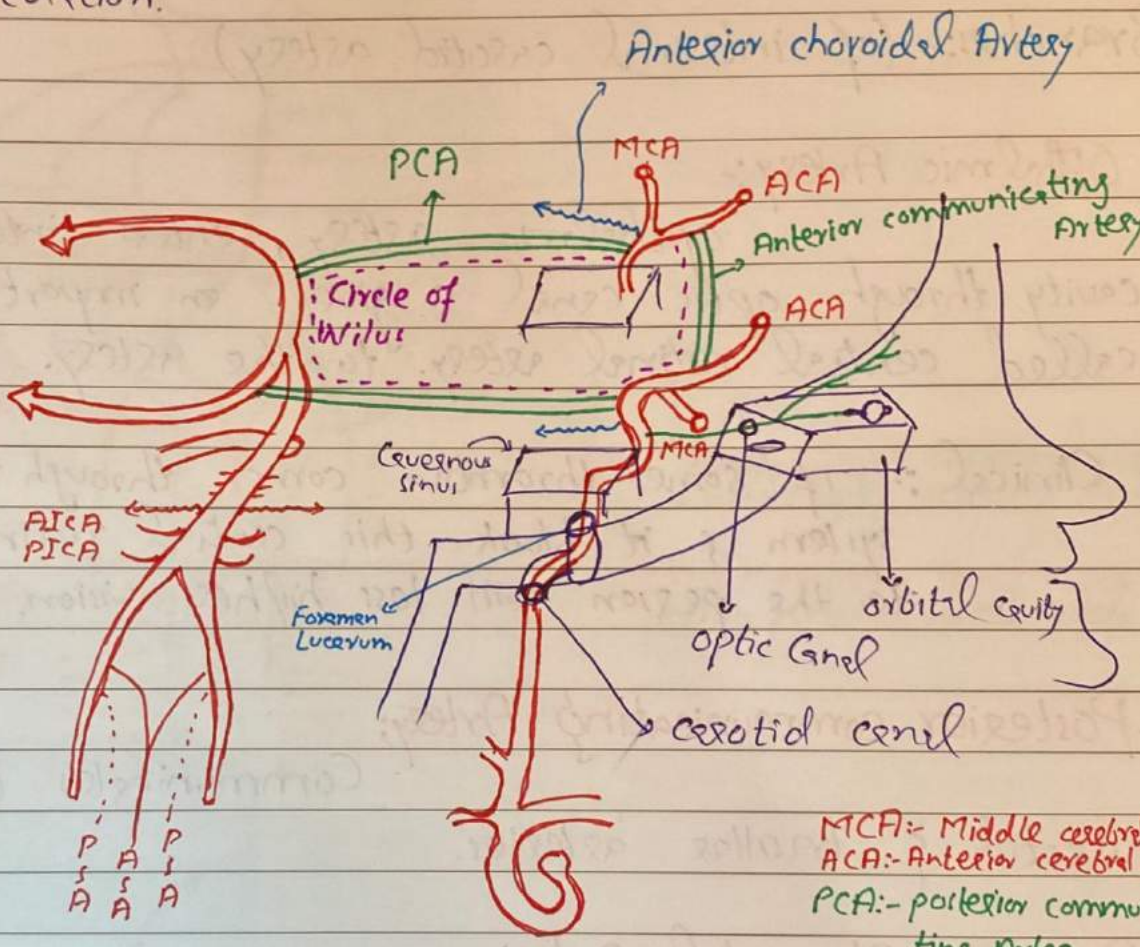
Anterior communicating Artery:-
which communicates b/w the right & left anterior cerebral arteries.

Scanned with CamScanner

M T W T F S S Date:

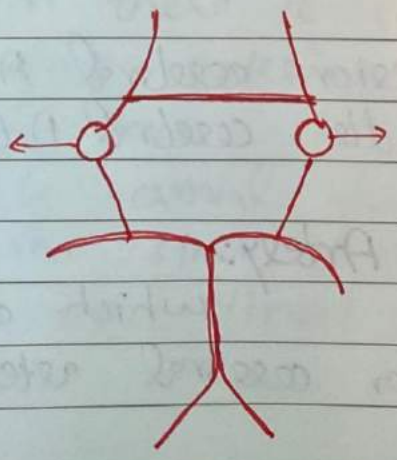
Circle of Willis:-

- Connects the right carotid with left carotid arteries & carotid (anterior) circulation with vertebro-basilar (posterior) circulation.



MCA:- Middle cerebral Artery
ACA:- Anterior cerebral Artery
PCA:- posterior communicating Artery

- Circle of Willis is present in the subarachnoid space under the base of the brain, infront of the mid-brain & under the cerebral hemisphere.



Scanned with CamScanner

M T W T F S S Date:

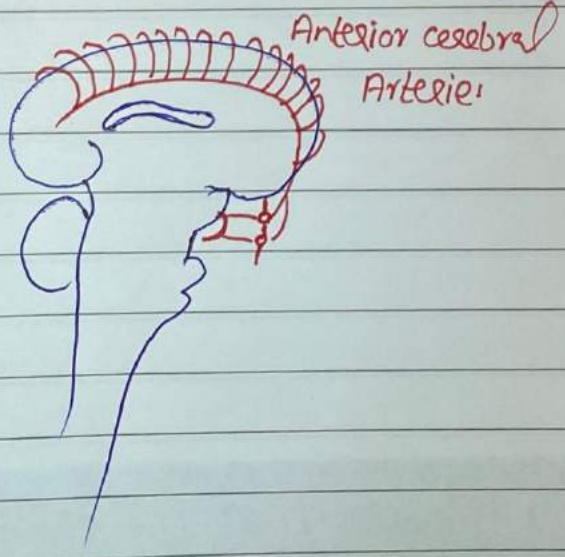
* Advantage of circle of Willis is that it provides collateral blood supplies incase of any blockage in anterior & posterior circulation.

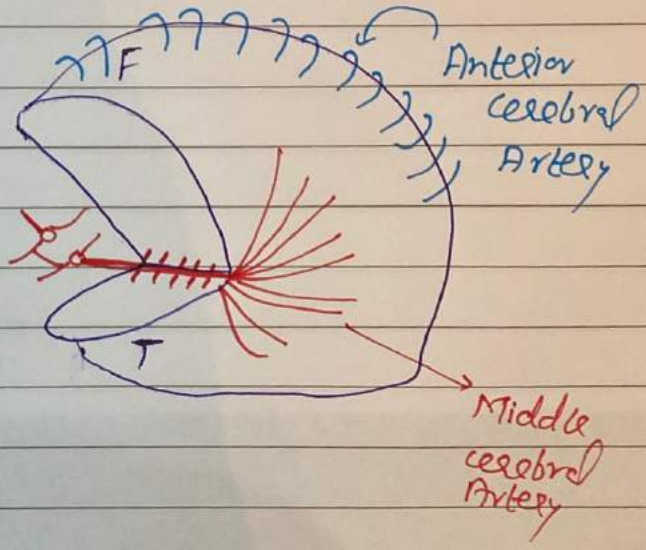
Anterior cerebral Artery:-

- It goes anteriorly then move upward & move above the corpus callosum & the goes back.
- Through out this course it gives branches (cortical branches) to the frontal & parietal lobes.

Middle cerebral Artery:-

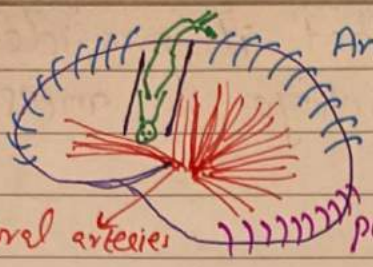
- It moves laterally on the stem of the lateral sulcus. till it appears on the superior lateral surface of cerebral hemisphere.
- It will give deep branches throughout this course, called central branches of middle cerebral Artery.
- These branches will supply the basal Ganglia, internal capsule.





Scanned with CamScanner

M T W T F S S Date:



- According to this homunculus, foot & leg areas are supplied by Anterior cerebral Arteries & arm, trunk & head n neck is supplid by Middle cerebral Arteries
- Thus blockage in any artery will cause damage to that area i.e according to the homunculus.

Posterior cerebral artery:-

- Supplies the mid-brain, inferior temporal lobe & occipital lobes.

Scanned with CamScanner

M T W T F S S Date:

Meninges:-

1- Pia matter:-

↓ ↓

Soft Mother

- thin layer of connective tissue
- Highly vascular
- Covers all CNS.

2- Arachnoid - matter:-

- outside pia mater.
- connective trabecular which connects it with pia matters

3- Dura - matter:-

- Strong n tough layer.

Clinicals:-

1- Epidural Hemorrhage:-

- Present in epidural space.:

⇒ Dura matter has two layers;

- peri-osteal layer
- Meningeal layer

- At some point, these two layers get separated

Scanned with CamScanner

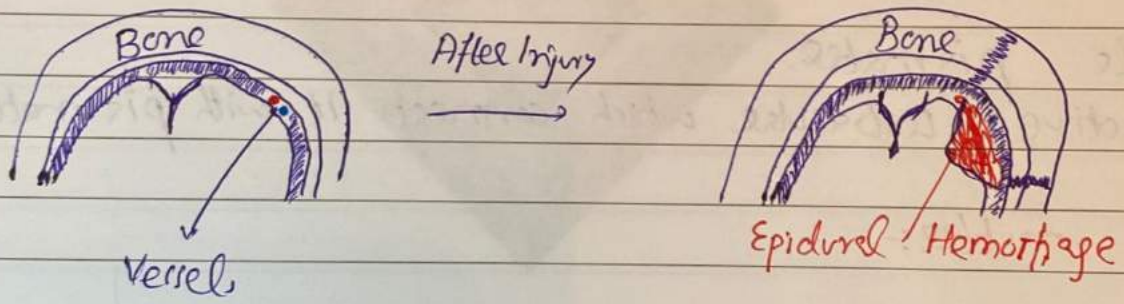
M T W T F S S Date:

to form Venous Dural Sinus. (which is covered by endothelial cells).

- Meningeal veins & Arteries run between these two layers. or more specifically anterior branch of middle meningeal artery runs through this space b/w these layers.

- Now if any injury / trauma occurs to the skull, these arteries get damaged & hemorrhage occurs.

- These hemorrhage are also called extra-dural hemorrhage.



- This hemorrhage may be biconvex lense.

⇒ After injury, at first he/she might be at conscious level but slowly n gradually they go to deep unconscious level, this time from conscious to being unconscious is called Lucid interval.

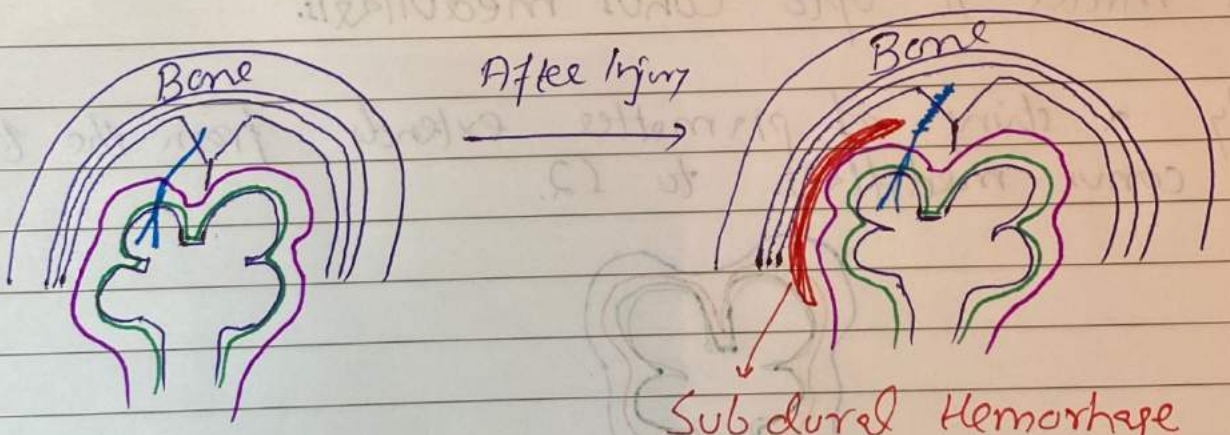
2- Sub dural Hemorrhage:-

- Cerebral veins drain blood from cerebrum into the venous dural sinus by piercing pia-mater, arachnoid & dura matter.

Scanned with CamScanner

M T W T F S S Date:

- Now due to deceleration injury, skull move anteriorly & then brain hit the skull very headly so due to this injury, these cerebral veins can be damaged.
- And in case of old age, the brain shrinks & became small than before, so more chances of injury.
- Thus when injury occurs, so blood come b/w the dura & arachnoid matter.
- This hemorhage may be of crescent shape.
- This hemorhage may be present in patient with unexplained fluctating level of conscious, specially with history of fall.



3- Sub-arachnoid Hemorhage:-

- Occurs throughout the sub-arachnoid space
- Occurs due to aneurysm (abnormal dilation of blood partly taking place in circle of willis)
- This hemorhage spread throughout the arachnoid space
- Causes:-
  Severe headache (as if someone hit his/her head.

Scanned with CamScanner

M T W T F S S Date:

4- Intra cerebral hemorrhage:-

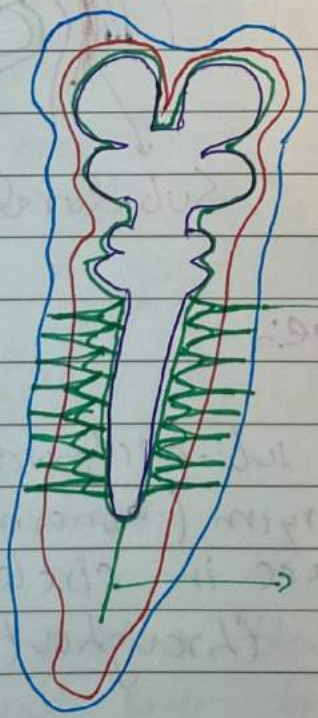
- Blood vessels going through cerebrum, if aneurysm occur in these ; then they get damaged & hemorrhage occurs called intra cerebral hemorrhage.

NOTE:-

- There 21 Denticulate ligaments on each side of the spinal cord, which connect Pia matter to the dura matter by passing the arachnoid matter.

- Pia matter is upto Conus medullaris.

- Only a string of pia matter extends from the tip of conus medullaris to S2.



Scanned with CamScanner