

# The Nervous System

## ¶ MAIN SENSORY AREAS OF THE CORTEX :

- the **somatic sensory area** is located in the parietal lobe posterior to the central sulcus
- **visual sensations** are received in the visual area in the posterior lobe
- **auditory sensations** are received in the temporal lobe close to the lateral sulcus
- **olfactory sensations** are received deep inside the temporal lobe

## ¶ REGIONS OF THE BRAIN ARE :

2 Cerebral hemispheres, Diencephalon, Cerebellum, Brain stem.

¶ **CEREBELLUM** has an outer cortex made from gray matter and an inner region of white matter .

¶ CSF is constantly produced by the choroid plexuses inside each ventricle.

¶ Medulla oblongata connects the brain with the spinal cord.

¶ the reticular formation is a column of gray matter extending the entire length of the brain stem, Reticular activating system (RAS) plays a role in consciousness and awake/sleep cycle. Damage to RAS area results in permanent coma.

## ¶ there are 4 ventricles:

- # the 2 lateral ventricles are in the brain hemispheres
- # the 3rd ventricle is in the diencephalon
- # the 4th ventricle is between the pons and the cerebellum
- # the cerebral aqueduct connects the 3rd to the 4th ventricle

¶ neuroglial cells are more numerous than nerve cells

¶ the diencephalon consist of 4 subdivisions in dorsoventral direction as they:

(epithalamus, thalamus, subthalamus & hypothalamus).

# CNS Development

- ☒ Nervous system is derived from embryonic ectoderm.
  
- ☒ Nerve cells that develop within the alar plate have predominantly sensory functions, while those in the basal plate are predominantly motor.
  
- ☒ The myelencephalon forms the medulla oblongata (medulla).
  
- ☒ **In the (4th ) week :**
  - The neural tube is completed and transformed into the adult CNS.
    - This growth is maximal at the rostral part which becomes the **brain**.
    - The caudal portion becomes the **spinal cord**.
  
- ☒ **In the 7th week :**
  - **Five** secondary brain vesicles appear.
  - The **Prosencephalon** is divided into :
    - **Telencephalon.**→ **Cerebral Hemispheres.**
    - **Diencephalon.**→ **mainly Thalamus.**
  - The **Rombencephalon** is divided into :
    - **Metencephalon** →**Pons and Cerebellum**
    - **Myelencephalon.**→ **The Medulla Oblongata and Brain Stem (Mid brain , Pons, Medulla)**
  - **The Mesencephalon** remains as it is.
  
- ☒ the neural crest form the sensory ganglia of spinal & cranial nerves also the autonomic ganglia
  
- ☒ at the 3<sup>rd</sup> week the dorsal midline ectoderm thickening to form the neural plate

## External features of spinal cord

- ☞ Termination of spinal cord in adult life: it narrows to form the conus medullaris which ends at the level of the disc between L1 & L2
- ☞ Prolapse is common in lumbar region leading to back pain radiating into the legs (sciatica).
- ☞ regeneration of nerves only found in peripheral nervous system because it has Schwann cell.
- ☞ **NEUROGLIA:** It supports, protects & insulates neurons and it can't transmit nerve impulses or divide.
- ☞ C1 to C5 SPINAL NERVES: leave above corresponding vertebrae
- ☞ until the third month of fetal life, the spinal cord occupies the **entire length** of vertebral canal.
- ☞ the subarachnoid space continues caudally to S2
- ☞ **LEVEL OF TERMINATION**
  - Adults :  
It terminates inferiorly at the lower border of the 1st lumbar vertebra.
  - Children :  
It is relatively longer and ends at the upper border of the third lumbar vertebra.
- ☞ **ARTERIAL SUPPLY**
  - Anterior spinal artery: it is a single artery that arises from the vertebral artery at the level of the medulla.
  - Posterior spinal arteries: two arteries that can arise from the vertebral or posterior inferior cerebellar arteries. .
  - Radicular arteries from: Ascending cervical Intercostal. Lumbar arteries.
  - Great radicular artery: Artery of **Adamkiewicz**. It may arise from an intercostal or a lumbar artery.
  - It supplies the lower half of the spinal cord. segments (T8 –L3)

## Internal features of spinal cord

**DORSAL HORN:** contains sensory neurones and **VENTRAL HORN:** contains motor neurones

- ☞ all nuclei of the dorsal horn contains only **second order neuron** , also all nuclei of the ventral horn contains only cell bodies
  
- ☞ the Cuneate tract of dorsal column tract: from T6 to C1 " **not from all level**
  
- ☞ **LATERAL HORN (T1-L3):** contains autonomic neurones
  
- ☞ at the spinal cord higher level contain greater amounts of **white matter.**
  
- ☞ in the ventral horn of the spinal cord, the neuron innervating the axial musculature tend to be **medially**, while those innervating limb muscles tend to be **laterally.**
  
- ☞ Alpha motor neurones innervate **extrafusal** muscle fibers. Gamma motor neurones innervate **intrafusal** muscle fibers.
  
- ☞ Tectospinal tract :
  - Site: ventral column.
  - Level: in **cervical region.**
  - Origin: superior colliculus of midbrain.
  - Function: mediates reflex movements in response to visual stimuli.

### ASCENDING TRACTS

They are long fibers that join the spinal cord with the brain.

(1) Spinothalamic tracts (Ventral & Lateral):

They carry impulses of pain, temperature, pressure and coarse touch (exteroceptive).

(2) Spinocerebellar tracts (Dorsal & Ventral) :

They carry information from muscle, joint and ligaments for the control of posture and coordination of movement .

### (3) DORSAL COLUMNS

- Fasciculus Gracilis :

It is present throughout the length of the spinal cord .

It has ascending fibers from the sacral, lumbar and lower thoracic regions.

- Fasciculus Cuneatus

it is situated laterally in the upper thoracic and cervical segments of the spinal cord.

The fasciculi are concerned with proprioceptive information (awareness of posture and discriminative touch).

### DESCENDING TRACTS

They originate from the cerebral cortex and brain stem. They are :

1. **Corticospinal tracts.** They control voluntary, discrete and skilled movements.
2. **Tectospinal tract** .It can mediate reflex movements in response to visual stimuli.
3. **Rubrospinal tract** It has a control over the tone of limb flexor muscles
4. **Vestibulospinal tracts.** They have an influence upon extensor motor neurones.
5. **Reticulospinal tracts** They influence voluntary movement, reflex activity and muscle tone.

## Brainstem

- The caudal two-thirds of the medulla contains the rostral continuation of the central canal of the spinal cord and is, therefore, sometimes referred to as the '**closed**' portion of the medulla.
- In the rostral pons, the walls converge until, at the **pontomesencephalic** junction, the fourth ventricle becomes continuous with a small channel, the **cerebral aqueduct**, which passes throughout the length of the midbrain.
- The ventral surface of the midbrain consists, on either side, of a massive column of descending fibres, the crus cerebri or basis pedunculi
- In the caudal part of the medulla, the dorsal columns ( fasciculi gracilis and cuneatus, containing first-order sensory neurones ) continue rostrally from the spinal cord
- ten pairs of cranial nerves from ( 3 to 12 ) are attach to the surface of the brain stem
- the superior & inferior cerebellar peduncles are connecting the brain stem with the cerebellum & form the lateral wall of the rostral part of the fourth ventricle .
- The transition from medulla to Pons is clearly delineated on the ventral surface of the brain stem in contrast to the dorsal surface .
- on the dorsal aspect of the brain stem can be seen the dorsal columns , the floor of the fourth ventricle , and the superior & inferior colliculi
- the trochlear nerve (4) emerges immediately caudal to the inferior colliculus ( in the dorsal brain stem)
- the pontocerebellar fibers pass through the contralateral middle cerebellar peduncle to cerebellar hemisphere

### Four cranial nerves are attached to its anterior surface

- Trigeminal (5th) nerve: it is attached to the side of the pons near its upper border by two roots , a large sensory and a small motor root. The motor root is located antero medial to the sensory root.
- Abducent (6th) nerve : it is located in the groove between the lower border of the pons and the pyramid.
- Facial (7th) nerve :it is found between the lower border of the pons and the inferior cerebellar peduncle.
- Vestibulo cochlear (8th) nerve : it is lateral to the facial . The vestibular nerve is anterior and the cochlear nerve is posterior.

## Medulla

- ☞ The dorsolateral part of the rostral medulla is dominated by the **inferior cerebellar peduncle**, or restiform body. This consists of fibres passing between the medulla and the cerebellum.
- ☞ In Caudal Medulla, The dorsal horn of spinal cord is replaced by the caudal part of the trigeminal sensory nucleus (nucleus of the spinal tract of the trigeminal nerve).
- ☞ TRIGEMINAL SENSORY NUCLEUS is a large nucleus that extends the whole length of the brain stem and into the upper segments of the spinal cord .
- ☞ The dorsal columns consist of first-order sensory neurons which the cell bodies of these neurons lie in the dorsal root ganglia of spinal nerves .
- ☞ INFERIOR OLIVARY NUCLEUS is concerned with the control of movement and receives afferents from the motor and sensory cortices of the cerebral hemisphere and from the red nucleus of the midbrain & Its main efferent connection is to the cerebellum via the inferior cerebellar peduncle .
- ☞ The most caudal aspect of the ventricular floor is known as the area postrema At this point the blood-brain barrier is absent .
- ☞ Lateral to the hypoglossal nucleus lies the dorsal (motor) nucleus of the vagus, containing preganglionic parasympathetic neurones that run in the vagus nerve
- ☞ On the ventral surface of the mid medulla the pyramids are prominent, above their decussation
- ☞ the (12<sup>th</sup> -hypoglossal, 11<sup>th</sup> -accessory, 10<sup>th</sup> -vagus & 9<sup>th</sup> -glossopharyngeal nerves) all emerges from medulla oblongata
- ☞ from the rostral medulla the 2<sup>nd</sup> order sensory fibers ascend and end in the ventral posterior thalamus

## **PYRAMIDAL DECUSSATION (MOTOR DECUSSATION)**

- is found in the caudal medulla
- pyramidal fibers ( cortico spinal) cross to the opposite side and descend in the lateral white column of the spinal cord as the lateral corticospinal tract

## **SENSORY DECUSSATION**

- is found in the mid medulla
- These axons (Internal Arcuate fibers) cross the median plane forming with the opposite side the Sensory Decussation.

## **OLIVARYNUCLEAR COMPLEX**

- It is the distinguishing feature of the open (rostral) medulla .
- It is formed of the large Inferior Olivary nucleus and the smaller dorsal and medial olivary nuclei.

لقد سارت ركائبنا لتعلو هامة النجم ..... نردد في ضمير الكون ليس السفح كالقمم  
نصوغ بكل معجزة خلود المجد والقيم ..... بحول الله موعدنا صباح ماطر الديم

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