

THE NERVOUS SYSTEM

Meninges

The brain and spinal cord are completely surrounded by 3 layers of (tissue) meninges (i.e; b/w the skull and the brain & " " vertebral " " s. cord) foramina

The 3 layers of meninges are:

Dura mater

Arachnoid "

Pia mater

* The space b/w Dura and arachnoid mater is called subdural space.

* The space b/w arachnoid and pia mater is called subarachnoid space

Dura mater

The cerebral dura mater consists of 2 layers

→ outer layer: covers the inner surface of the (perosteal) skull

→ inner layer: ^{acts as} _{protects} for the brain (meningeal)

~~There is only a potential space b/w the 2 layers~~

The meningeal layer of the dura mater also creates several dural folds that divides the cranial cavity into freely communicating spaces

The folds are

- i) falk cerebri - b/w cerebral hemisphere
- ii) falk cerebelli - " cerebellar "
- iii) tentorium cerebelli - b/w cerebrum and cerebellum.

Spiral duramater forms a loose sheath around the spinal cord, extending from foramen magnum to the 2nd sacral vertebral.

The space b/w the dura mater and the vertebral ~~mater~~ is called the epidural space, containing blood vessels and areolar connective tissue.

Arachnoid mater

Fibrous layer b/w dura and pia mater. It is separated from dura mater via subdural space and from pia mater via subarachnoid space.

- * The arachnoid mater passes over the convolutions of the brain along with the inner layer of the dura mater to form falk cerebri, falk cerebelli and tentorium cerebelli.
- * It continues downwards to envelop the spinal cord and ends by merging with dura mater at the level of the 2nd sacral vertebrae.

Pia mater

- * Connective tissue layer containing many minute blood vessels. It adheres to the brain covering the convolutions and dipping into each fissure.
- * It continues downwards surrounding the spinal cord. Beyond the end of the cord it continues as the filum terminale pierces the arachnoid tube and goes on, with the dura mater, to fuse with the periosteum of the coccyx.

FOURTH VENTRICLE - diamond shaped cavity situated below & behind 3rd ventricle, b/w cerebellum & pons. It's continuous below with the central canal of spinal cord.

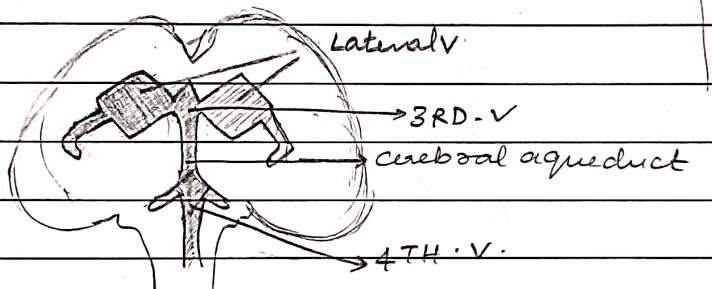
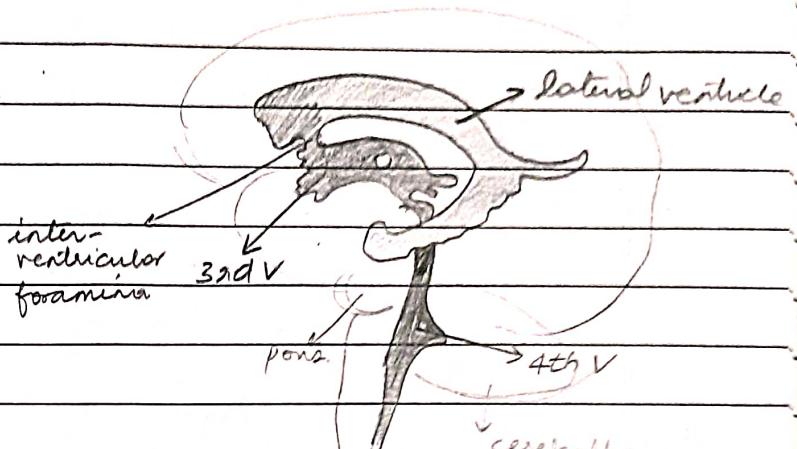
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Ventricles

The brain contains 4 irregular shaped cavities called as VENTRICLES. It ~~not~~ contains CSF.

The 4 cavities are

- (1) * lateral ventricles
- (2) * left ventricle
- (3) * right " "
- (4) * 3rd ventricle
- (5) * 4th " "



LATERAL VENTRICLES

- * lateral ventricles lie within the cerebral hemisphere, one on each side of median plane below corpus callosum.
- * They are separated from each other by a thin membrane, the septum lucidum.
- * They communicate with each other via interventricular foramina.

THIRD VENTRICLE

- * It is situated below lateral ventricles b/w 2 parts of thalamus.
- * It communicates with each 4th V via cerebral aqueduct (its)

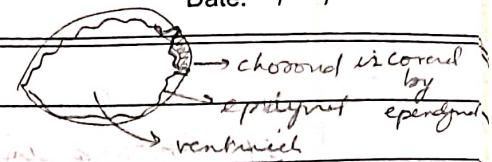
Ependymal cells - forms the epithelial lining of ventricle of brain & central canal of S. cord.

Those cells that form the choroid plexus of the ventricles secrete CSF

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Cerebrospinal Fluid (CSF)



* Cerebrospinal fluid is secreted into each ventricle of the brain by choroid plexuses.

* Choroid plexuses - a tuft of capillaries projecting in the cavities of ventricle, which is covered by cubical epithelium of ependyma

* CSF passes back to the blood via arachnoid villi into the venous sinuses.

* movement of CSF depends on the difference in pressure on each side of the walls of the arachnoid villi, which acts as one side ~~as~~ valve

when CSF pressure is greater than venous pressure, CSF is pushed into the blood



When the venous pressure is higher than CSF pressure, the arachnoid villi collapse, preventing the passage of blood constituents into the CSF.

Functions

* CSF supports and protects the brain and spinal cord by maintaining uniform pressure around these vital structures.

* It acts as a cushion or shock absorber b/w brain & the skull

* It keeps the brain & spinal cord moist

* ~~It exchanges~~, nutrients and waste products ~~takes place~~ takes place b/w CSF and interstitial fluid of the brain

- * CSF is involved in regulation of breathing as it bathes the surface of the medulla where central respiratory chemoreceptors are located

CSF - composition

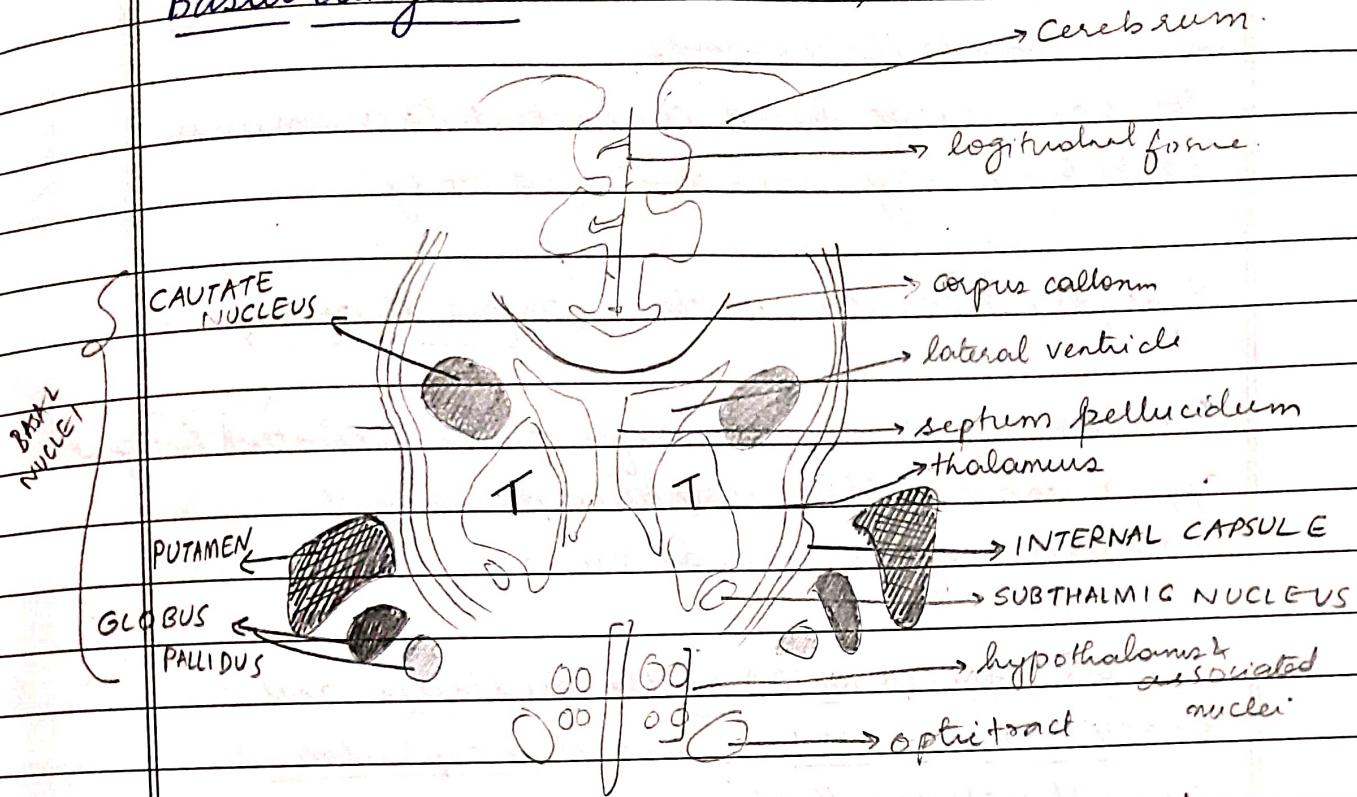
CSF is secreted at the rate of 0.5 ml/min ,
 $= 720 \text{ ml/day}$

- * CSF is clear, slightly alkaline fluid
- * specific gravity = 1.005

CSF consists of:

- * water
- * mineral salts
- * glucose
- * plasma proteins : small amounts of albumin & globulin
- * few leukocytes
- * Creatinine
- * Urea

Basal Ganglion (Basal nuclei)



BASAL NUCLEI

Deep within each cerebral hemisphere are 3 nuclei that are collectively termed the basal nuclei

GLOBUS PALLIDUS

2 of the basal nuclei lie side by side just lateral to the thalamus

PUTAMEN

closer to the cerebral cortex

globus pallidus + putamen = lentiform nucleus

CAUDATE NUCLEUS

The third of the basal ganglia nuclei is the caudate nucleus, present within each hemisphere of the brain

Caudate nuclei are located near the center of the brain sitting astride the thalamus.

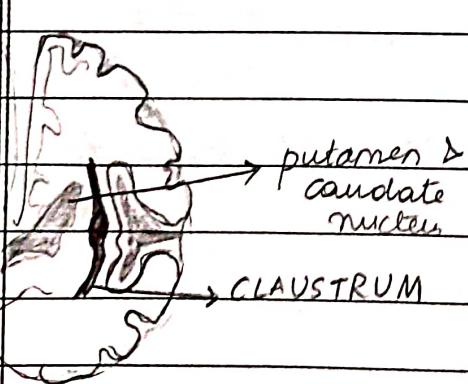
It has a large head connected to a smaller tail by a long comma shaped 'body'.

Lentiform + caudate nuclei = corpus striatum.

The term corpus striatum refers to the striated (striped) appearance of the internal capsule as it passes among the basal nuclei.

* SUBSTANTIA NIGRA of the midbrain and SUBTHALMIC NUCLEI of the diencephalon are structures that are linked functionally linked to the basal nuclei.

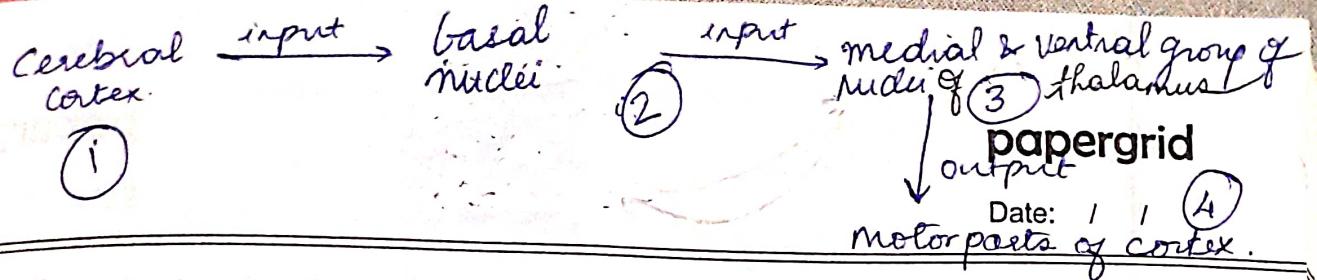
- * Axons from the substantia nigra terminate in the caudate nucleus and putamen.
- * Subthalamic nuclei - interconnect with globus pallidus.



CLAUSTRUM - is a thin sheet of gray matter situated to putamen.

Subdivision of basal nuclei.

Function: may be involved in visual attention.



Functions

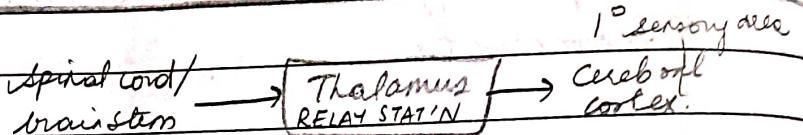
- * The basal nuclei receives input from the cerebral cortex and provide output to motor parts of the cortex via the medial and ventral group nuclei of the thalamus.
- * A major function of basal nuclei - ~~as~~ is to help regulate initiation and termination of movements.
- * Activity of neurons in the putamen precedes or anticipates body movement.
- * Activity of neurons in the caudate nucleus occurs prior to eye movements.
- * The globus pallidus helps regulate the muscle tone required for specific body movements.
- * The basal nuclei also control subconscious contraction of skeletal muscles.
 - Example : ~~the~~ automatic swinging of arms while walking

Diencephalon → Thalamus + hypothalamus + Epithalamus

THALAMUS

- * 3 cm in length, makes up to 80% of diencephalon
- * paired oval masses of gray matter organized into nuclei with interspersed tract of white matter

FUNCTION



- * Thalamus is major relay station for most sensory impulses that reach the primary sensory areas of cerebral cortex from the spinal cord and brainstem.
- * The thalamus contributes to motor functions by transmitting information from the cerebellum and basal nuclei to the primary motor area of cerebral cortex. A diagram shows the cerebellum and basal nuclei both pointing to the Thalamus, which then points to the cerebral cortex. The cerebral cortex is labeled as the 1st motor area.
- * The ~~tot~~ thalamus also relays nerve impulse b/w different areas of the cerebrum and plays a role in the maintenance of consciousness.
- * Because of the intimate connections b/w the thalamus and the frontal cortex and the hypothalamus, the thalamus is involved in the subjective feeling of personality & various emotions. Thalamus, ~~these may be regarded as a part of limbic system~~

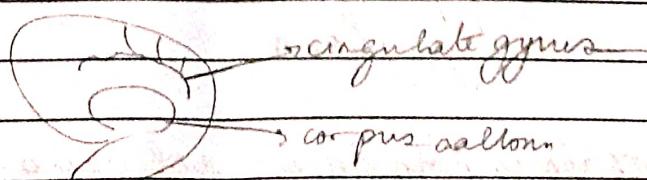
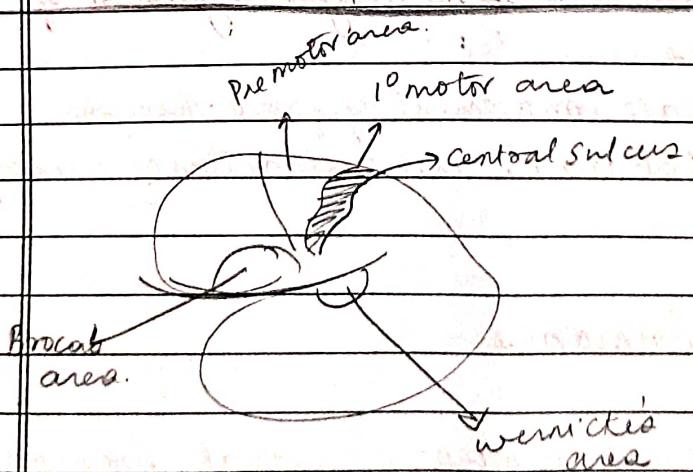
THALAMUS

There are 2 thalami, in b/w them lies the 3rd V.
Together with the hypothalamus, the
thalami constitute the bulk of diencephalon.

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- * Anterior end of each thalamus is narrow, while, the posterior end is broad and called the 'pulvinar'.
- * Each thalamus rests on the superior surface of the midbrain. The medial surface of the thalamus forms the lateral wall of the 3rd V.
- * The internal capsule stands in b/w the lateral surface of the thalamus and the lentiform nucleus. (globus pallidus + putamen)
- * A mass of gray matter, called the 'massa intermedia' connects the 2 thalami at their anterior parts.
- * Intermedullary lamina (Y shaped, sheet of white matter) divides Thalamus into 3 parts
 - anterior
 - medial
 - lateral parts.
 and each part contains a number of thalamic nuclei



HYPOTHALAMUS

H + T = D

3rd V

ME

i. caps.

Hypothalamus (4gms) together with thalamus forms the diencephalon.

In the under surface of the brain, the hypothalamus extends from the region of optic chiasma to the caudal part of the mammillary bodies.

Laterally, the hypothalamus extends upto the internal capsule.

Hypothalamus forms the floor of the 3rd V.

FUNCTIONS

→ Control of the ANS:

* The hypothalamus controls and integrates activities of ANS, which regulates contraction of smooth muscle and cardiac muscle and secretion of many glands.

* Through hypothalamus is the major regulator of visceral activities

(regulation of heart rate, movement of food through gastrointestinal tract, and contraction of urinary bladder)

→ Production of hormones

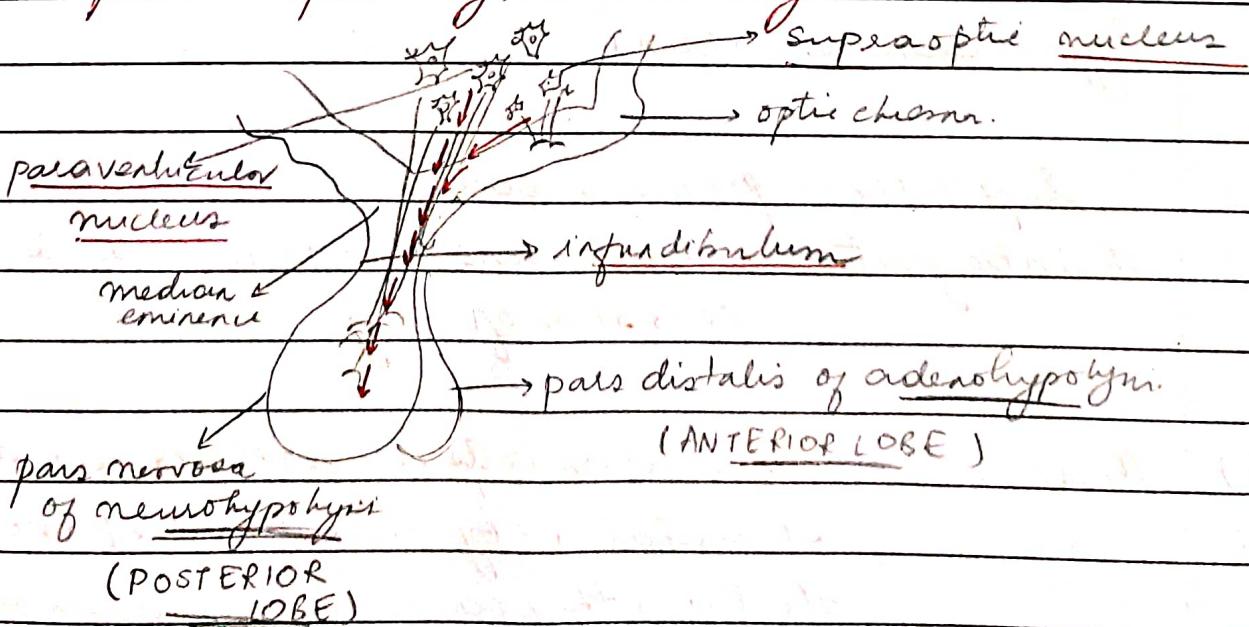
The hypothalamus produces several hormones and has 2 types of important connection with the pituitary gland.

i) hypothalamic hormones - releasing hormones & inhibiting hormones are released, blood stream

carries these hormones directly to the anterior
lobe of the pituitary, where they stimulate
or inhibit secretion of anterior pituitary hormones.

ii) Axons extend from the paraventricular & supraoptic nuclei through the infundibulum into the posterior lobe of the pituitary.

The cell bodies of these neurons make ~~one~~
one of the 2 hormones (Oxytocin or anti-diuretic
hormones). Their axons transport the hormones to
the posterior pituitary, where they are released.



Regulation of emotional and behavioral patterns

Together with the limbic system, the hypothalamus participates in expressions of rage, aggression, pain, and pleasure and the behavioral patterns related to sexual arousal.

Control of body temperature

The hypothalamus functions as the body's thermostat of the temp of blood flowing through hypothalamus is above normal -

- hypothalamus directs the ANS to stimulate activities that promote heat loss.

If the blood temp is below normal

- hypothalamus generates impulses that promote heat production and retention

Regulation of eating & drinking

hypothalamus contains

Feeding center - promotes eating

satiation center - causes sensation of fullness & cessation of eating

Thirst center - when certain cells in hypothalamus are stimulated by rising osmotic pressure of the ECF, they cause the sensation of thirst

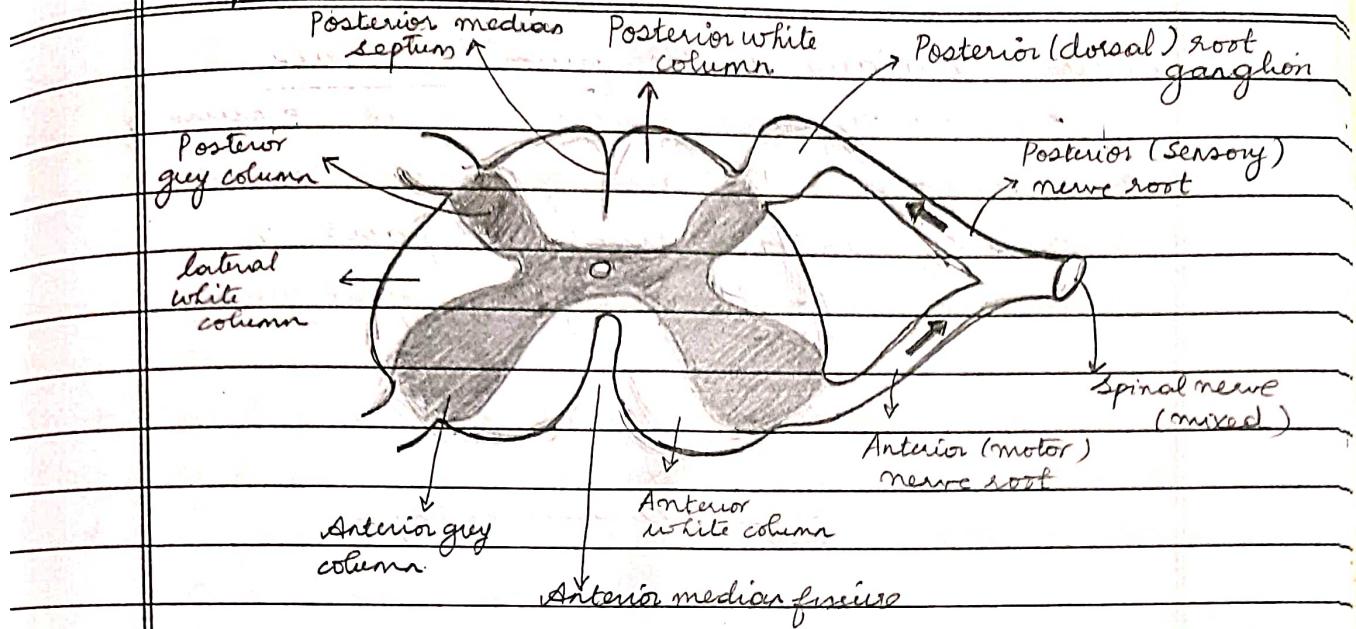
- The intake of water by drinking restores the osmotic pressure to normal, removing the stimulus & releasing the thirst

~~spinal cord~~ → int shoo

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Regulation of Circadian rhythms & state of consciousness

The supraoptic nucleus of the hypothalamus serves as the body's internal biological clock because it establishes circadian (daily) rhythms, patterns of biological activity (such as sleep-wake cycle) that occur on a circadian schedule (cycle of about 24 hours).
~~associated area~~ | - | nnnnn Axn ~~potent~~ neurotransmitter

Spinal cord.

TRANSVERSE SECTION OF
SPINAL CORD
SPINAL CORD

Spinal cord is the elongated, almost cylindrical part of the CNS, which is suspended in the vertebral canal surrounded by the meninges & CSF.

The spinal cord is ~~not~~ continuous above with the medulla oblongata and extends from the upper border of atlas (1st cervical vertebrae) to the lower border of the 1st lumbar vertebrae.

It about 45 cm long in adult males.

When spinal cord is viewed externally 2 enlargements can be seen (i) cervical enlargement - ^{upper} ~~neck~~ ^{area} _{lumb}
(ii) lumbar enlargement - ^{lower} ~~lumb~~ _{area} ^{area} _{lumb}

Inferior to lumbar enlargement, spinal cord terminates as a tapering conical structure. Called Conus medullaris. Arising from

Posterior (dorsal) root → sensory
Anterior (ventral) root → motor

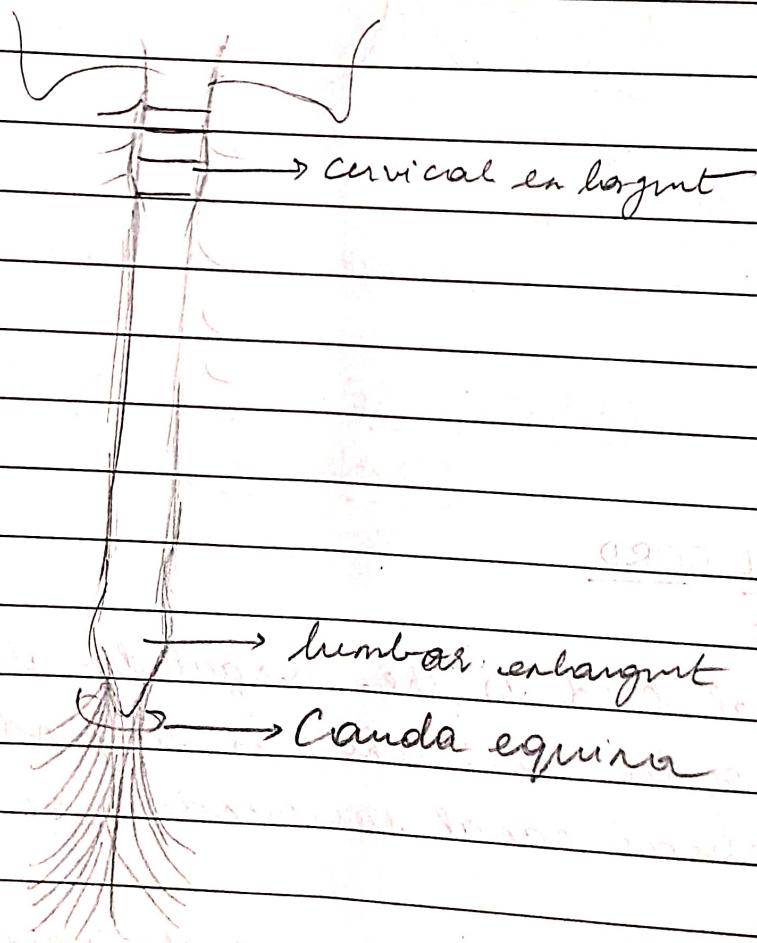
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Conus medullaris is the filum terminale

There are 31 pairs of spinal nerves, 8 pairs of cervical pairs, 12 pairs of thoracic nerves, 5 pairs of lumbar nerves, 5 pairs of sacral nerves & 1 pair of coccygeal nerves.



INTERNAL ANATOMY OF SPINAL CORD

spinal cord - white matter

- * (white matter) surrounds an inner core of grey matter.
- * white matter of spinal cord consists primarily of bundles of myelinated axons of neurons
- * 2 grooves penetrate the white matter of spinal cord - into left and right sides
 - Anterior median fissure - wide groove on anterior side
 - Posterior median sulcus - narrow furrow on posterior side
- * ~~stargate on top~~

- * The gray matter of spinal cord is shaped like the letter H or a butterfly
- * consists of dendrites and cell bodies of neurons, unmyelinated axons & neuroglia
- * The gray commissure forms the crossbar of the H.
- * In the center of " is a small space called the central canal; it extends the entire length of spinal cord and is filled with CSF.
- * The gray matter on each side of S.C. is subdivided into regions called horns
 - The posterior gray horns - cell bodies of ^(dorsal)sensory neurons
 - The anterior gray horns - " " " ^(ventral)motor neurons
- * B/w the posterior & anterior gray horns are the lateral gray horns - autonomic nuclei

* The anterior & posterior gray horns divide the white matter on each side into 3 broad areas.

1) anterior (ventral) white column

2) posterior (dorsal) " "

3) lateral " "