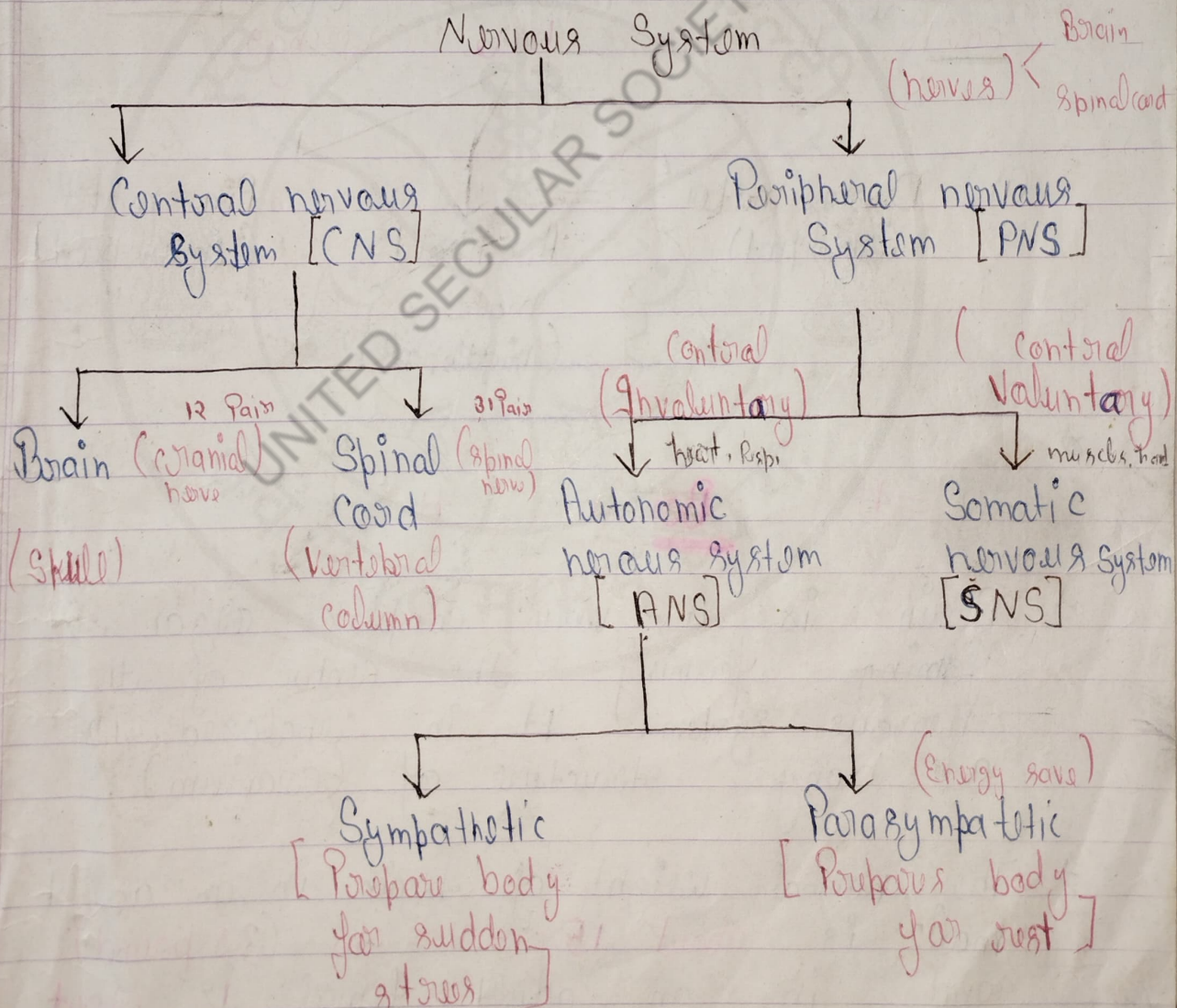


## Nervous System

The nervous system is a complex network of nerves <sup>call that carry</sup> & messages to and from the brain & spinal cord to various part of the body. Nervous system consists of a network of specialised cells called ~~ner~~ neurones (nerve cells) which coordinates all the body function and transmit signals b/w different parts of its body. Classification



## [CNS] Central nervous System

Central nervous system (CNS) consists of the brain and the spinal cord (vertebral column). It is safely contained within the skull and vertebral canal of the spine.

### Brain

Brain is the major part of the (CNS). It is located within the cranial cavity. It has three coverings

(1) Dura mater (outer part)

Arachnoid mater (middle part)

Pia mater (inner part)

### Brain

Brain is a very complex organ, forming the centre of the nervous system. It is enclosed in a bony structure of (cranium).

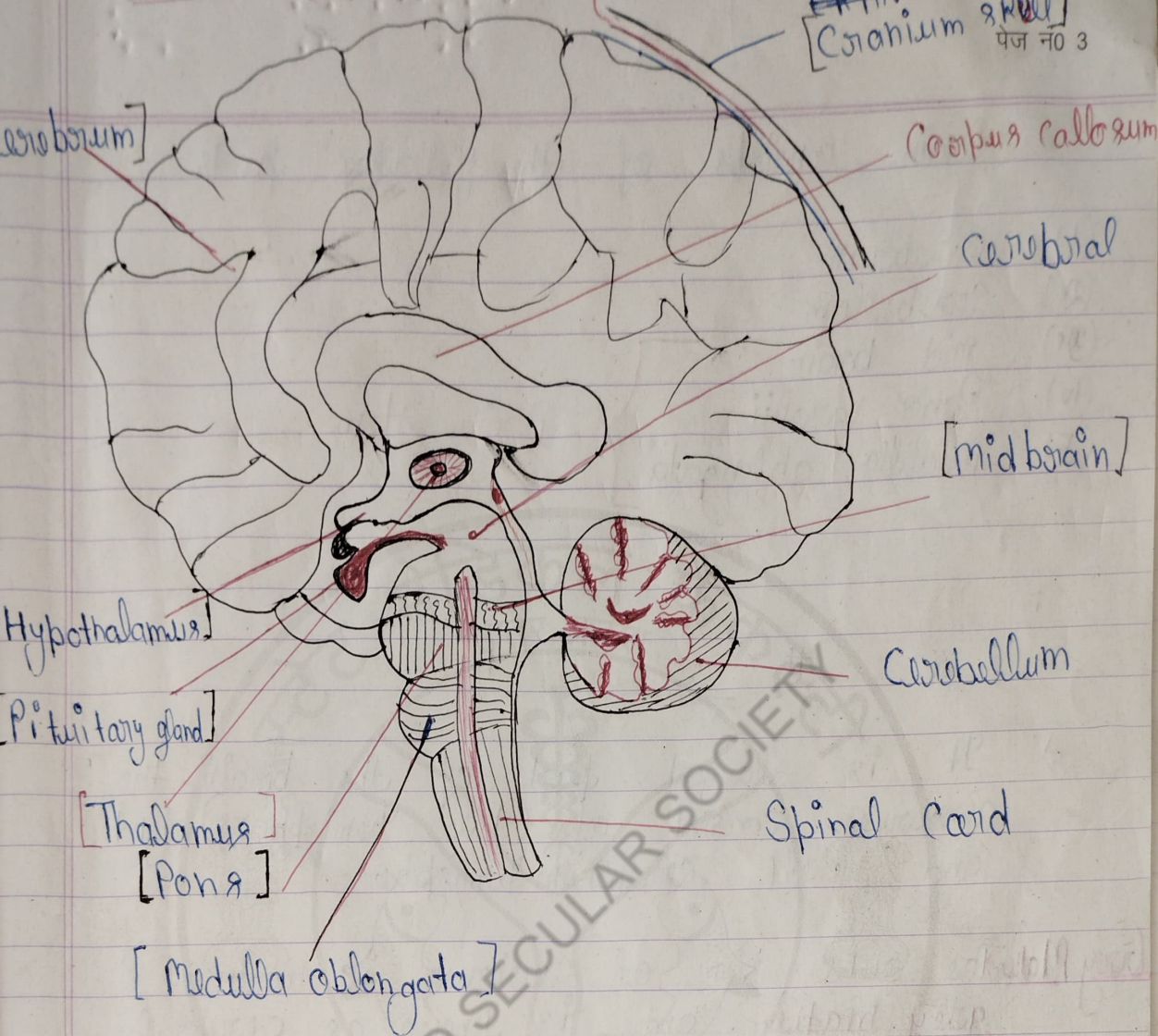
The normal weight of brain in an adult male is about 1500 - 1600 gm (3.5 pound) and in an adult female is about 1450 gm.

The part of body inside it is the centre for all thought, memory, judgement and emotion.

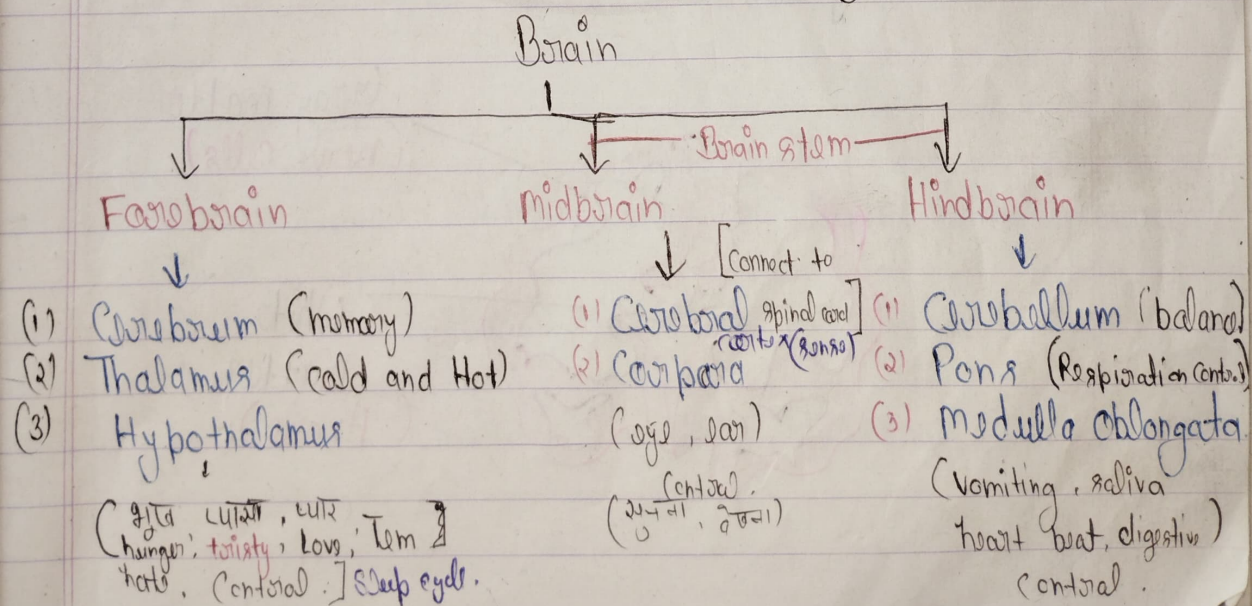
## Structure of brain #

CSF Purson

~~PPA~~  
[Cranium 8 will]  
पेज नं० 3



⇒ Each part of the brain is responsible for controlling different body functions, such as temperature regulation and breathing.



Brain consists of the following parts

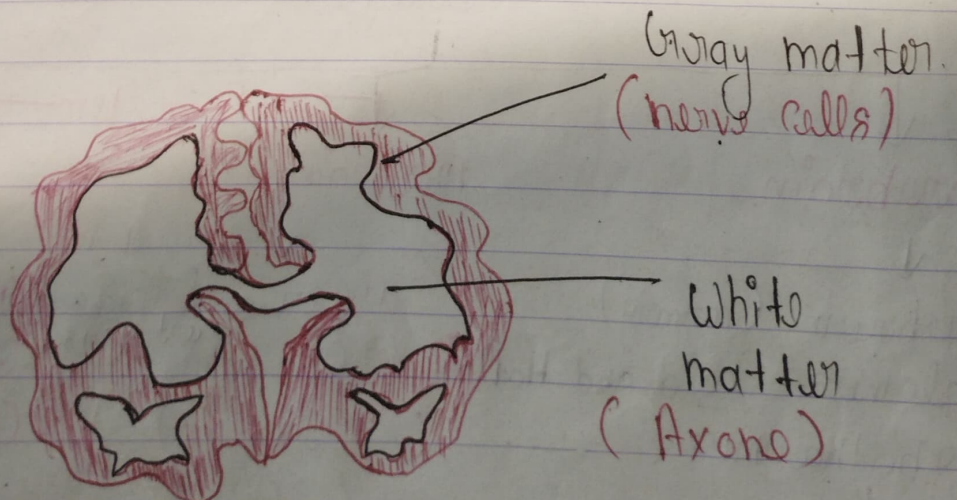
- (1) Cerebrum
  - (2) Cerebellum
  - (3) Mid brain
  - (4) Pons Varolii
  - (5) Medulla oblongata.
- } Brain stem

### (1) # Cerebrum #

⇒ It is largest part of the brain. The cerebrum consists of (two hemispheres) right and left cerebrum hemispheres.

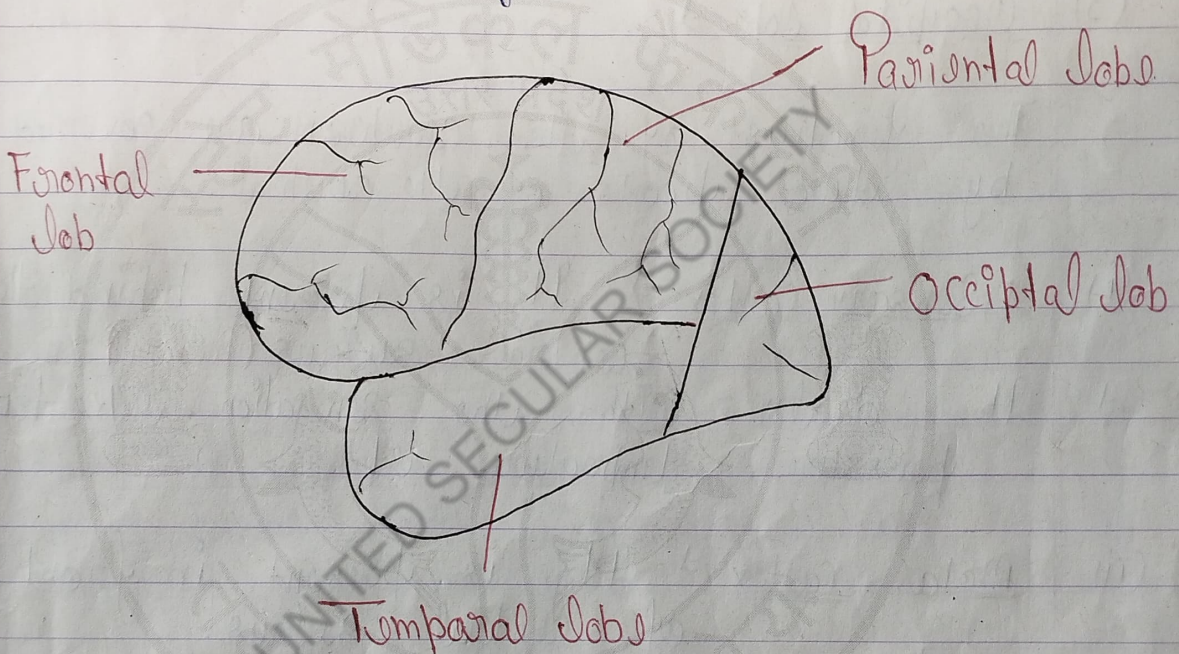
Grey Matter The outer rim of cerebrum is made of grey matter and is known as cerebral cortex and the ~~white matter~~ it consists of (nerve cells).

⇒ White matter is present in the interior of the hemispheres. It contains (nerve fibers)



Lobes → There are four lobes namely

- (1) Frontal lobe
- (2) Parietal lobe
- (3) Occipital lobe
- (4) Temporal lobes → It is responsible for auditory (hearing) and olfactory (smell) function.   
 सुघ्रांशुगन्ध



~~(1) Frontal lobe~~  
Function of the Cerebrum →

(1) Frontal lobe →

- Frontal lobe stimulation of motor speech area causes speech.
- It is responsible for intelligence and memory of the person.
- It maintains the personality.

## (2) Parietal lobes ⇒

- (1) It is controls sensory function of the body such as touch, pain, ~~and test~~, heat and cold.
- (2) Appreciation <sup>(पुंरासा)</sup> of size, shape and weight of an object.

## (3) Occipital lobes ⇒

The functions of the cerebrum are governed by two parts of the cerebral.

- (i) Sensory Cortex ⇒ It is present behind the central sulcus (boundary).  
⇒ It deals with the sensation like touch, pressure, temperature etc.
- (ii) Motor Cortex ⇒ It is present in front of central sulcus.  
⇒ The motor cortex control voluntary movements of the body. The controlling areas are arranged from above downwards (feet, lower limbs, hip, trunk, arms and head in that order).

## # function of cerebrum ⇒

- ⇒ Controls other parts of the nervous system.
- ⇒ Seat of intelligence.
- ⇒ Controls of speech, judgment, thinking, emotion etc.

→ It receives all sensory stimuli and conveys most of them to consciousness

## (2) # Thalamus # (Diencephalon)

→ It is located above the brain stem and between cerebral cortex and midbrain

→ It carries sensory information from the body to cerebrum. and the ex (Cold, heat, pain)

⇒ Thalamus is a large egg shaped mass of gray matter.

## (3) # Hypothalamus # (gland) (Diencephalon)

→ It lies under the thalamus

→ It connects to the nervous system with the endocrine system via pituitary glands.

⇒ It has been described as the chief ganglion of autonomic nervous system because of its role in the control of many metabolic activities of the body.

→ It plays an important role in hormone production and helps to stimulate many important process in the body.

→ It is control of "body temperature, appetite and weight control, emotions, sleep cycles, childbirth, blood pressure and heart rate, secretion of digestive juices, balanced body fluid.

## # brain stem

Relays signals between the brain and spinal cord & manage basic involuntary function.

It consists of three parts.

- (1) Pons = breathing
- (2) Medulla = Respiration, circulation, digestion etc.
- (3) Midbrain = Vision, hearing, motor control.

(1) Pons :- The pons present between the midbrain and the medulla oblongata. It is connected to the cerebellum by the middle cerebellar peduncle.

# Function :- The pons contains nuclei that relay signals from the forebrain to the cerebrum.

It controls sleep.

The pons relays information about motor function, sensation, eye movement, hearing, taste etc.

(2) Medulla oblongata :- It is a part of brainstem and it is about (3cm in length). Simply, medulla is a long stem-like structure which makes up the lower part of the brainstem.

It is anterior and partially inferior to the cerebellum.

Group of cells related to autonomic reflex activity make up the vital centers.

are located ~~of cells~~ in the ~~deep~~ of the medulla oblongata

## Function →

- ⇒ The rate and force of cardiac contraction is controlled by the cardiovascular center within the medulla
- ⇒ The rate and depth of respiration is controlled by the respiratory center.
- ⇒ Diameter of the blood vessels is controlled by the vasomotor center.
- ⇒ The reflex actions of vomiting, and shivering are initiated in order to expel the irritants.

## Cerebellum

- ⇒ The cerebellum is the largest part of the hindbrain. It is butterfly-shaped. It is lies below the occipital lobe of cerebrum. from which it is separated by tentorium cerebelli (a fold of dura).
- ⇒ cerebellum has two hemispheres joined together by a worm-like portion, the vermis. Each hemisphere is divided into three lobes -
  - (1) Anterior lobe
  - (2) Posterior lobe
  - (3) flocculonodular lobe
- ⇒ It is situated in the posterior cranial fossa.

behinds the pons and medulla.

## # function x of cerebellum :-

- ⇒ Maintenance of posture (equilibrium) and balance of the body
- ⇒ Control the muscle tone. (सूत्र)
- ⇒ It is responsible for controlling and coordinating the movements of several group of muscles, resulting in smooth, even, and clear-cut action.

## # Mid x brain #

- ⇒ Mid brain is a short constricted segment of brain which forms a connection between cerebrum and other parts of brain mainly the pons. Mid brain is connected to the cerebellum by the superior cerebellar peduncle.

## # Function :-

- ⇒ Midbrain and hindbrain together form the brainstem.
- ⇒ Control reflex movements of head and trunk in response to visual and auditory stimuli.
- ⇒ It is also controls the reflex movements of the eye muscles, changes in pupil size and shape of the eye lens.

## # Basal ganglia #

The basal ganglia, or (basal nuclei), are a group of ~~subcortical~~ subcortical structures found deep within the white matter of the brain, located deep within each cerebral hemisphere.

⇒ Several nerve fibers connected the basal ganglia to each other. Caudate nucleus, putamen, globus pallidus, subthalamic nucleus and substantia nigra. These nuclei are grouped into broader clusters. (समूह)

## # Function ⇒

- ⇒ Control of voluntary motor activity
- ⇒ Control of reflex muscular activity
- ⇒ Control of muscle tone.
- ⇒ Role in arousal (जागरण) mechanism. (उत्तेजन)

## ★ Spinal cord = ★ B

⇒ Spinal cord is a long, thin tube like structure which is the part of central nervous system (CNS). There are 31 pair of spinal nerves.

⇒ It starts from the medulla oblongata in the brain stem and ~~ends~~ extends down at the Coccyx.

⇒ It is about 45 cm long [18 inch] in male and 43 cm long [18 inch] in female.

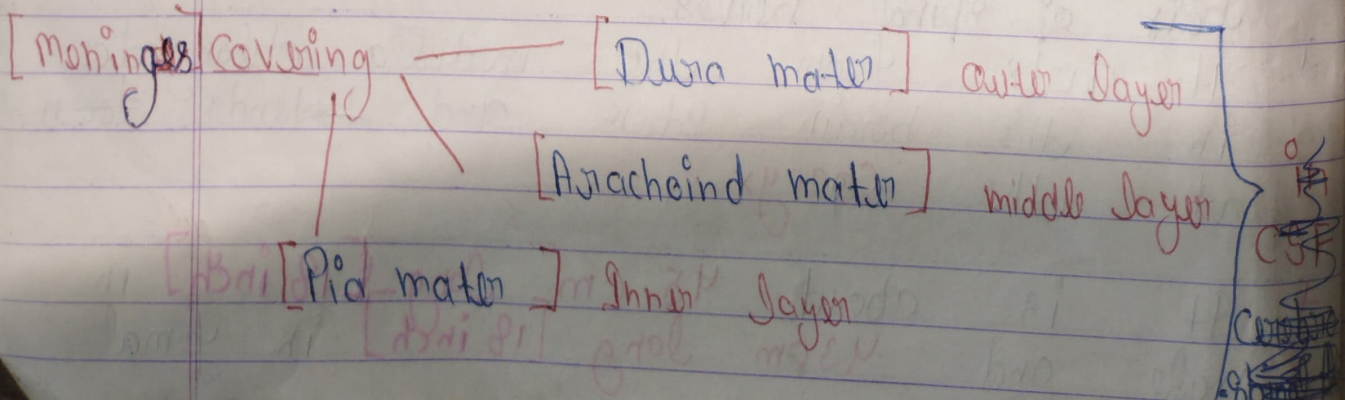
## Spinal Cord

⇒ It is located within the vertebral canal. It commences from the foramen magnum to the lower border of first lumbar vertebra.

⇒ It is located within the vertebral canal. It commences from the foramen magnum to the lower border of first lumbar vertebra. The lower end of the spinal cord terminates in a bunch of nerves [tail like tail of a horse] called as "cauda equina" the longest of these nerves is called as "filum terminale" which ends at the cerebellum.

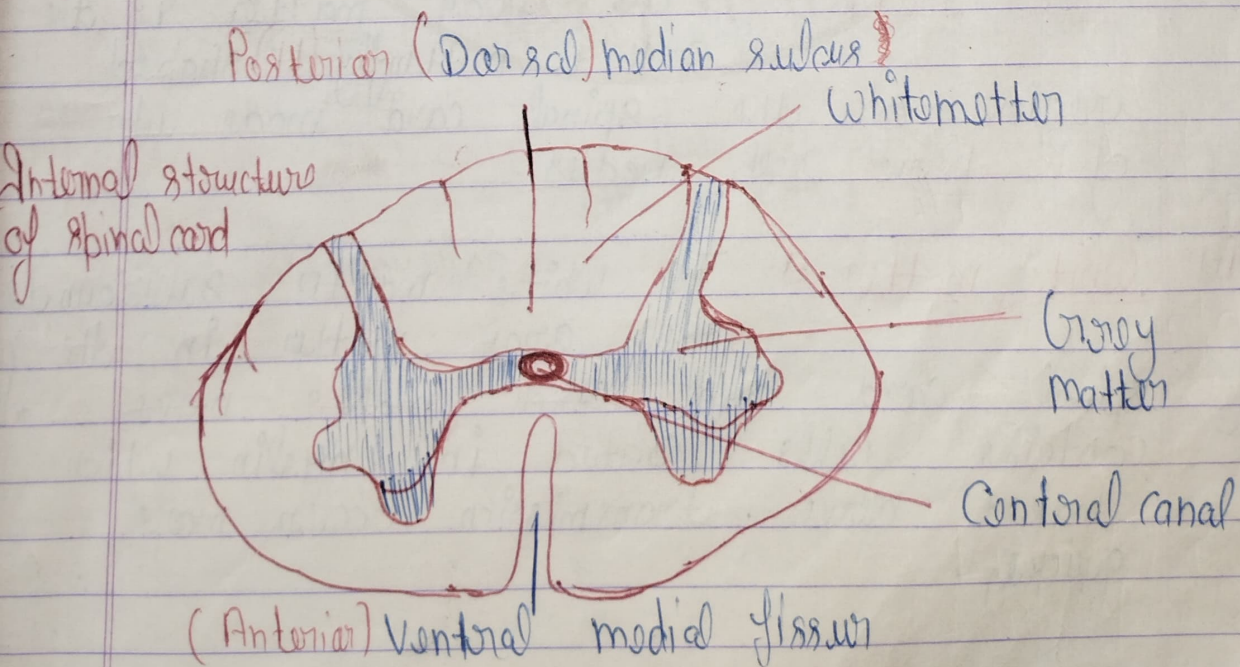
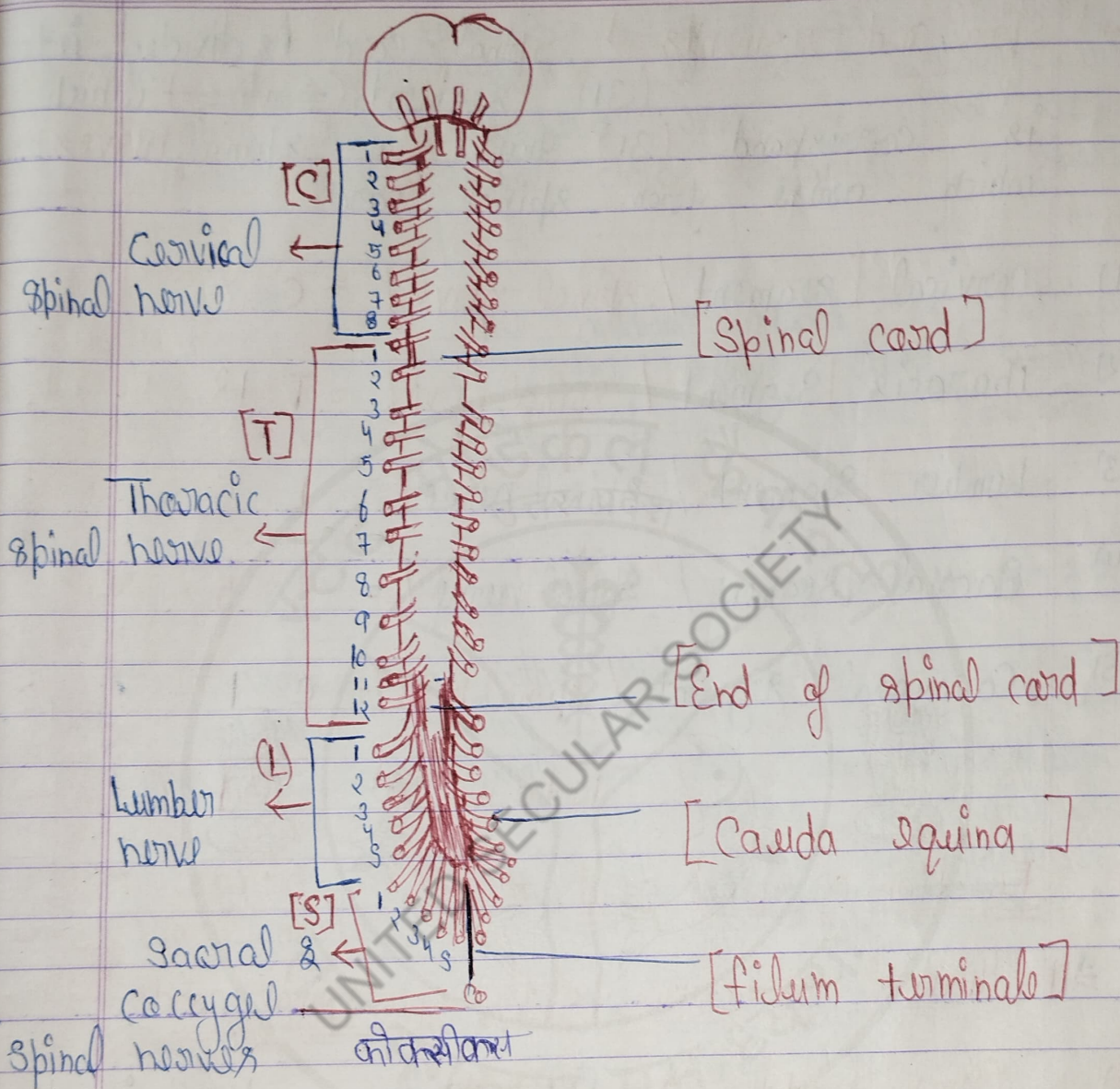
⇒ Spinal cord is a main pathway for information connecting the brain and the rest of body.

⇒ A total 31 pairs of spinal nerves (दिखा) arise from the spinal cord. Spinal cord and spinal nerves help in the maintenance of homeostasis reflexive responses to many stimuli.



# = Structure of the spinal cord and spinal nerves

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# Spinal cord segments  $\Rightarrow$  Spinal cord is divided into (31) segment, (~~cervical~~) which is correspond (31) pairs of spinal nerves which arise from spinal cord

(1) Cervical [segment / spinal nerve] = C 8

(2) Thoracic [segment / spinal nerve] = T 12

(3) Lumbar [segment / spinal nerve] = L 5

(4) Sacral [segment / spinal nerve] = S 5

(5) Coccygeal [segment / spinal nerve] = C 1

Total  $\Rightarrow$  31

# Function of spinal cord

# Internal structure parts of spinal cords

(i) Gray matter  $\Rightarrow$  The gray matter is the dark, butterfly (H) shaped region of the spinal cord made up of nerve cell bodies.

(ii) White matter  $\Rightarrow$  The white matter surrounds the gray matter in the spinal cord and which makes nerve contains cells coated in myelin, which makes nerve transmission occur more quickly.

(Sensory neurons)

- (iii) Posterior root  $\Rightarrow$  Posterior root contains a ganglion called as "Dorsal ganglion".  
 $\Rightarrow$  The posterior horn cell are sensory in function. The posterior root of spinal nerves enter the spinal cord through the posterior horns.

(Motor neurons)

- (iv) Anterior root  $\Rightarrow$  The anterior root is the part of the nerve that branches off the front of the spinal column.

The meninges (of between the pia & arachnoid matter.)

The brain and the spinal cord are protected by three covering called the meninges. They are CSF cerebrospinal fluid fills the ventricle of brain & space.

- (1) Dura mater  $\Rightarrow$  It forms the outer layer
- (2) Arachnoid mater  $\Rightarrow$  It forms the middle layer
- (3) Pia mater  $\Rightarrow$  It forms the inner layer.

- (1) Dura mater  $\Rightarrow$  This is the outermost layer of the spinal cord's meninges. It is a tough, protective coating.

- (2) Arachnoid mater  $\Rightarrow$  The arachnoid mater is the middle layer of spinal cord covering.

- (3) Pia mater  $\Rightarrow$  The pia mater is the layer that directly covers the spinal cord.

## # Function of spinal cord →

- ⇒ Conduct pathway for nerve impulses to and from the brain and brainstem (iv)
- ⇒ All reflex activities are mediated through spinal cord.
- ⇒ CNS is connected to the sensory receptors, muscles, and glands all over the body via the spinal nerve and their branches (v)

## # Reflexes #

- ⇒ It is also known as reflex arc.
- ⇒ It is rapid, predictable and unplanned response to a stimuli.
- ⇒ Due to receive an any type of stimulus on body, our body give rapid response to that stimuli which is rapid, and unplanned and it is known as reflexes. reflex are automatic automatic, subconscious response to stimuli within or outside the body.
- ⇒ It contain five components.

(i) Receptor → It is also known as sensory receptors. which receive stimuli

(ii) Inter ~~neuron~~ neuron → It <sup>acts</sup> as a processing center conduct nerve impulses from sensory neurons to motor neuron also known as association neuron.

(iii) Sensory neuron → Then It transmits that nerve

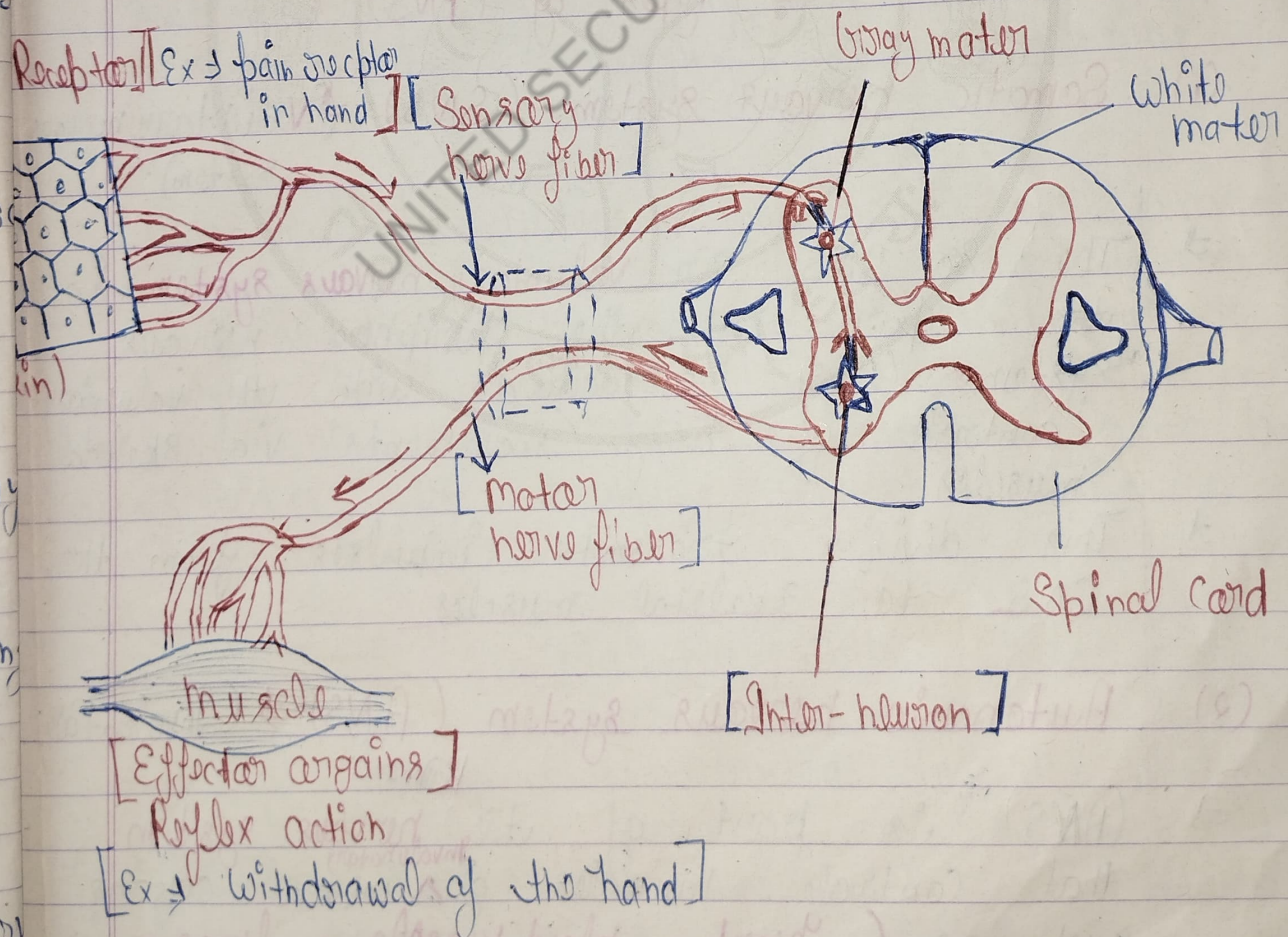
Impulse are stimuli to the spinal cord.

(iv) Motor neuron  $\Rightarrow$  It transmit that nerve impulse from the spinal cord to an effector organ.

$\Rightarrow$  This neuron acts as a pathway for propagation of impulses out of the CNS to the body part that will produce a response.

(v) Effector organ  $\Rightarrow$  It responds to stimulation by the motor neuron and produces the reflex or behavioral action. It may be muscle or gland.

### Structure



## # Peripheral nervous system # (PNS)

It is ~~the~~ primarily <sup>(शारीरिक)</sup> ~~comprise~~ of all the nerves connecting the brain and spinal cord to the sensory receptors, muscles, and glands. (अर)

⇒ [PNS] is the part of the nervous system that is outside the central nervous system (CNS) and comprises the cranial nerves ~~etc~~ excepting the optic nerve, the spinal nerves, and the autonomic nervous system (ANS).

⇒ There are two types of (PNS)

(1) Somatic nervous system (SNS) (Voluntary nervous system).

⇒ The ~~for~~ SNS or voluntary nervous system is ~~the~~ part of the peripheral nervous system (PNS) associated with the voluntary control of body movements via skeletal muscles.

⇒ This division transmits impulses from the CNS to skeletal muscles.

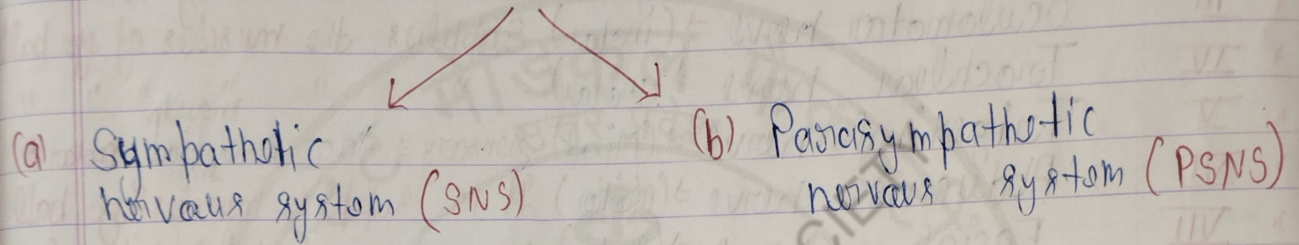
(2) Autonomic nervous system (ANS) ⇒ (Involuntary)

⇒ (ANS) is part of the <sup>Peripheral</sup> ~~nervous~~ <sup>Involuntary</sup> system that controls muscles of <sup>internal</sup> organs such as (heart, blood vessels, lungs).

Stomach and Intestine) and glands such as (salivary glands and sweat glands).

→ This division transmits impulses from the CNS to the Involuntary organs and smooth muscles of the body.

[ANS]



(a) Sympathetic nervous system → It is responsible for stimulation or speeding up of activity by the use of energy, by employing nor-epinephrine as a neurotransmitter.

(b) Parasympathetic nervous system (PSNS) → It is responsible for stimulation or speeding up of other activities of the body like digestion, urination and defecation. → PSNS also slow down or sustains other body activities by employing acetylcholine as a neurotransmitter.

# Cranial nerves # [CN]

Cranial nerves (CN) attached to the brain are bundles of processes of neurons that innervate muscles or glands or carry impulses from sensory areas. they are called cranial nerves.

because they <sup>उपर आता</sup> emerge through foramina or fissure in the cranium (skull) and are covered by sleeves of meninges.

There are [12] pairs of cranial nerves.

| nerve name & No | Composition                                                | functions                                                              |
|-----------------|------------------------------------------------------------|------------------------------------------------------------------------|
| CN I            | Olfactory nerve $\Rightarrow$ (Sensory)                    | It is the nerve of smell                                               |
| " II            | Optic nerve $\Rightarrow$ (Sensory)                        | It is the nerve of vision                                              |
| " III           | Oculomotor nerve $\Rightarrow$ (Motor)                     | Supplies the muscles of eye ball                                       |
| " IV            | Trochlear nerve $\Rightarrow$ (Motor)                      | " " " " " "                                                            |
| " V             | Trigeminal nerve $\Rightarrow$ (Mixed)                     | Sensory $\Rightarrow$ face & forehead, motor $\Rightarrow$ " " " " " " |
| " VI            | Abducens nerve $\Rightarrow$ (Motor)                       | It is supplies muscles of eye ball                                     |
| " VII           | Facial nerve $\Rightarrow$ (Motor)                         | " " " " " " " " " " " "                                                |
| " VIII          | Auditory / Vestibulocochlear nerve $\Rightarrow$ (Sensory) | hearing, balance                                                       |
| " IX            | Glossopharyngeal nerve $\Rightarrow$ (Mixed)               | tongue, "pharyngeal"                                                   |
| " X             | Vagus nerve $\Rightarrow$ (Mixed)                          | It is distributed to pharynx, larynx                                   |
| " XI            | Accessory nerve $\Rightarrow$ (Motor)                      | <sup>Serves</sup> muscles <sup>that move</sup> of neck etc.            |
| " XII           | Hypoglossal nerve $\Rightarrow$ (Motor)                    | It is supplies the muscles                                             |

$\Rightarrow$  Cranial nerves connect muscles and sense organs of head, neck, thorax and abdomen region directly to the brain.

# 11. Anatomy and physiology of Sympathetic and parasympathetic nervous system (ANS)

= Sympathetic nervous system

⇒ Definition (Back) ⇒

mastication]  
 , lacrimal and salivary gland  
 muscles.  
 , lungs , heart , stomach , intestine]  
 head and shoulder (movement)  
 to tongue.

Role of the sympathetic division ⇒

⇒ The sympathetic division is the "fight-or-flight" system.

⇒ Involves activities - Exercise, excitement, Emergency, and embarrassment.

⇒ Promotes adjustments during exercise - blood flow to organs is reduced (↓), flow to muscles is increased (↑).

⇒ Heart rate increases and breathing is rapid and deep.

⇒ The skin is cold and sweaty, and the pupils dilate.

# The role of the adrenal medulla in the sympathetic division ⇒

⇒ Adrenaline (also called epinephrine) is produced in the medulla of the adrenal glands.

⇒ The adrenal glands are located on the top of each kidney.

⇒ The Sympathetic nervous system stimulates the adrenal gland to release the hormone adrenaline or epinephrine into the bloodstream.

⇒ Adrenaline is a modified amino acid hormone.

⇒ Adrenaline increases heart rate and (BP) ↑.

# Parasympathetic nervous system #

⇒ Allow body to function under rest and digest.

⇒ Stimulates digestive glands increases motility of smooth muscle of digestive tract, decreases (↓) heart rate.

⇒ Pupil constrict

# Role of (ACh) acetylcholine ⇒

⇒ ACh is the chief neurotransmitter of the parasympathetic nervous system (PNS).

⇒ It contracts smooth muscles, dilates blood vessels, and slows heart rate.

⇒ ACh is an organic chemical that functions in the brain and body of many types of animals (and humans) as a neurotransmitter.

• a chemical message released by nerve cells to send signal to other neurons, muscle cells and gland cells.

| Sympathetic             | Sympathetic nervous System                                                                                                                                           | Parasympathetic nervous System                                                                                                                                                  |
|-------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| used<br>the<br>the      | (1) Sympathetic nervous system is part of <b>ANS</b> that serve to <b>accelerate</b> (↑) the heart rate, <b>Increase (BP)</b> , and <b>constrict blood vessels</b> . | ✓ Parasympathetic nervous system is part of <b>ANS</b> that <b>slow</b> the heart rate, <b>Increase</b> intestinal & glandular activity and <b>relax</b> the sphincter muscles. |
| blood stream<br>hormone | (2) <b>Noradrenaline</b> is released at the effector<br>(उत्तम चीज है)                                                                                               | ✓ <b>Ach acetylcholine</b> is released at effector.                                                                                                                             |
| and<br>activity         | (3) Originate from <b>cerebral, thoracic, and lumbar</b> regions of the <b>(CNS)</b>                                                                                 | Originates from <b>cerebral and sacral</b> regions of the <b>CNS</b> .                                                                                                          |
| and<br>activity         | (4) Prepares the body for an intense physiological activity.                                                                                                         | Relaxes the body by <b>Inhibit</b> high energy function.                                                                                                                        |
| the                     | (5) Action is a <b>quick</b> response                                                                                                                                | Action is a <b>slow</b> response                                                                                                                                                |
| the                     | (6) <b>Pre-ganglionic</b> fiber are <b>"short"</b>                                                                                                                   | <b>Pre-ganglionic</b> fiber are <b>"long"</b>                                                                                                                                   |
| the                     | (7) <b>Post ganglionic</b> fiber are <b>"long"</b>                                                                                                                   | <b>Post-ganglionic</b> fiber are <b>"short"</b>                                                                                                                                 |
| the                     | (8) Generates an <b>excitatory</b> homeostatic effect                                                                                                                | Generates <del>an</del> an <b>Inhibitory</b> homeostatic effect                                                                                                                 |
| the                     | (9) <b>Increase</b> (↑) heart beat, blood, and metabolic rate                                                                                                        | <b>Decrease</b> (↓) heart beat, blood level, and metabolic rate.                                                                                                                |

|      |                                                                   |                                                          |
|------|-------------------------------------------------------------------|----------------------------------------------------------|
| 18 ⇒ | The receptors are $\alpha$ and $\beta$ types.                     | Receptor are muscarinic type.                            |
| 7 ⇒  | Stimulates secretion of lacrimal gland, sweat, and adrenal gland. | Inhibit secretion of lacrimal, sweat, and adrenal gland. |
| 8 ⇒  | Inhibit secretion of salivary and digestive gland                 | Stimulates secretion of salivary and digestive gland     |
| 9 ⇒  | It stimulates secretion of glucagon.                              | Stimulates secretion of Insulin.                         |
| 10 ⇒ | It dilates pupil.                                                 | It constricts pupil                                      |
| 11 ⇒ | Stimulates <sup>Inhibit</sup> sex structure                       | stimulate sex structure                                  |