# NEURAL CONTROL AND COORDINATION (NERVOUS SYSTEM)

In human body the neural system and the endocrine system jointly coordinate and integrate all the activities of the organs so that they function in a synchronised fashion. Co-ordination is the process through which two or more organs interact & complement the functions of one another. The neural system provides an organised network of point-to-point connections for a quick coordination. The endocrine system provides chemical integration through hormones.

- Nervous system and endocrine system are called Integrative system of the body.
- Nervous system carries information in the form of impulses to the different parts of body. High speed services are offered by this system.

## NEURAL SYSTEM

- The neural system of all animals is composed of highly specialised cells called neurons which can detect, receive and transmit different kinds of stimuli.
- The neural organisation is very simple in lower invertebrates. For example, in Hydra it is composed of a network of neurons .
- The neural system is better organised in insects, where a brain is present along with a number of ganglia and neural tissues.
- The vertebrates have a more developed neural system.

## HUMAN NEURAL SYSTEM

The human neural system is divided into two parts :

(i) Central neural system (CNS)

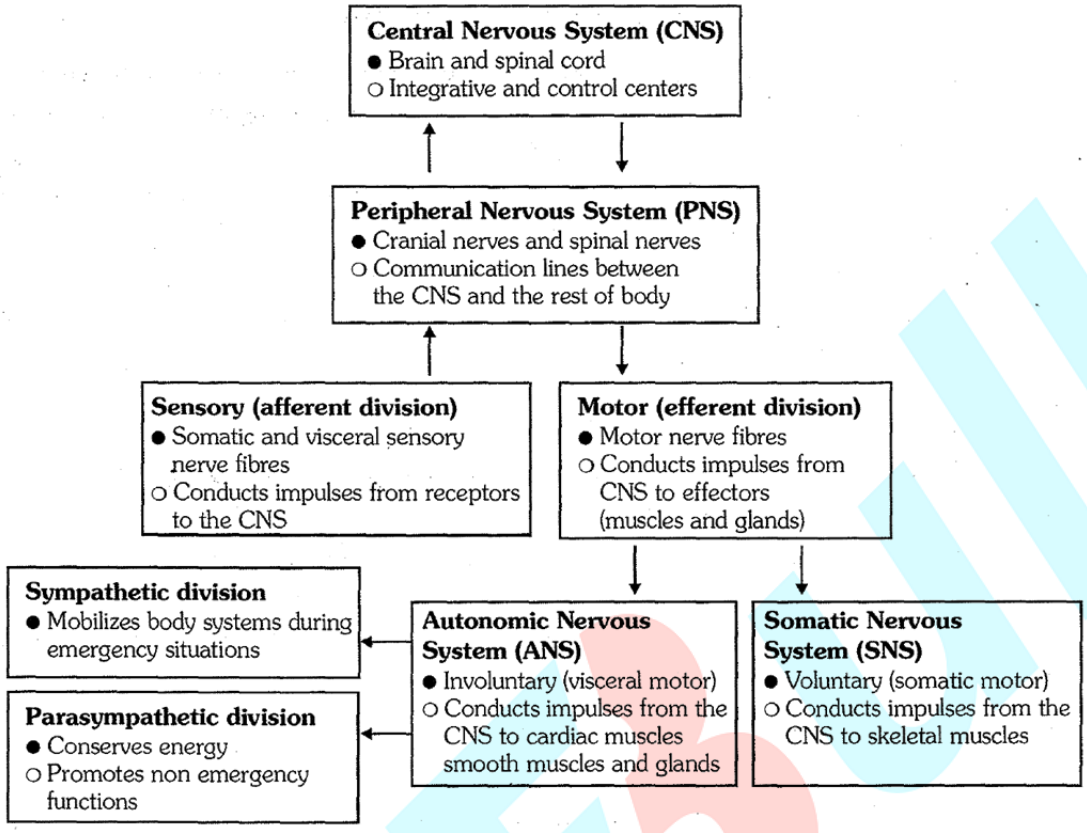
(ii) Peripheral neural system (PNS)

The CNS includes the brain and the spinal cord and is the site of information processing and control. The PNS comprises of all the nerves of the body associated with the CNS (brain and spinal cord). The nerve fibres of the PNS are of two types :

(a) Afferent fibres

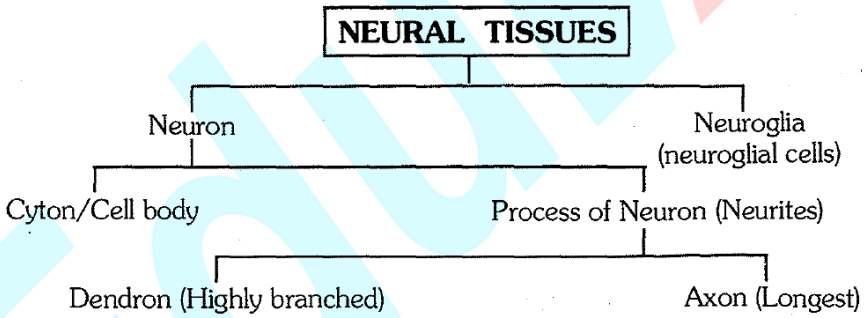
(b) Efferent fibres

- The afferent nerve fibres transmit impulses from tissues/organs to the CNS and the efferent fibres transmit regulatory impulses from the CNS to the concerned peripheral tissues/organs.
- The PNS is divided into two divisions :-
  (A) Somatic neural system (SNS)
  (B) Autonomic neural system (ANS)
- The somatic neural system relays impulses from the CNS to skeletal muscles while the autonomic neural system transmits impulses from the CNS to the involuntary organs and smooth muscles of the body.
- The autonomic neural system is further classified into sympathetic neural system and parasympathetic neural system.




## NERVOUS TISSUE

Nervous tissue originates from ectoderm and is specialized for receiving stimuli (Excitability), transmit message (conductivity)




## NEURON (NERVE CELL)

It is the functional and structural unit of nervous system. It generates and transmits nerve impulses. It is the longest cell of the body.

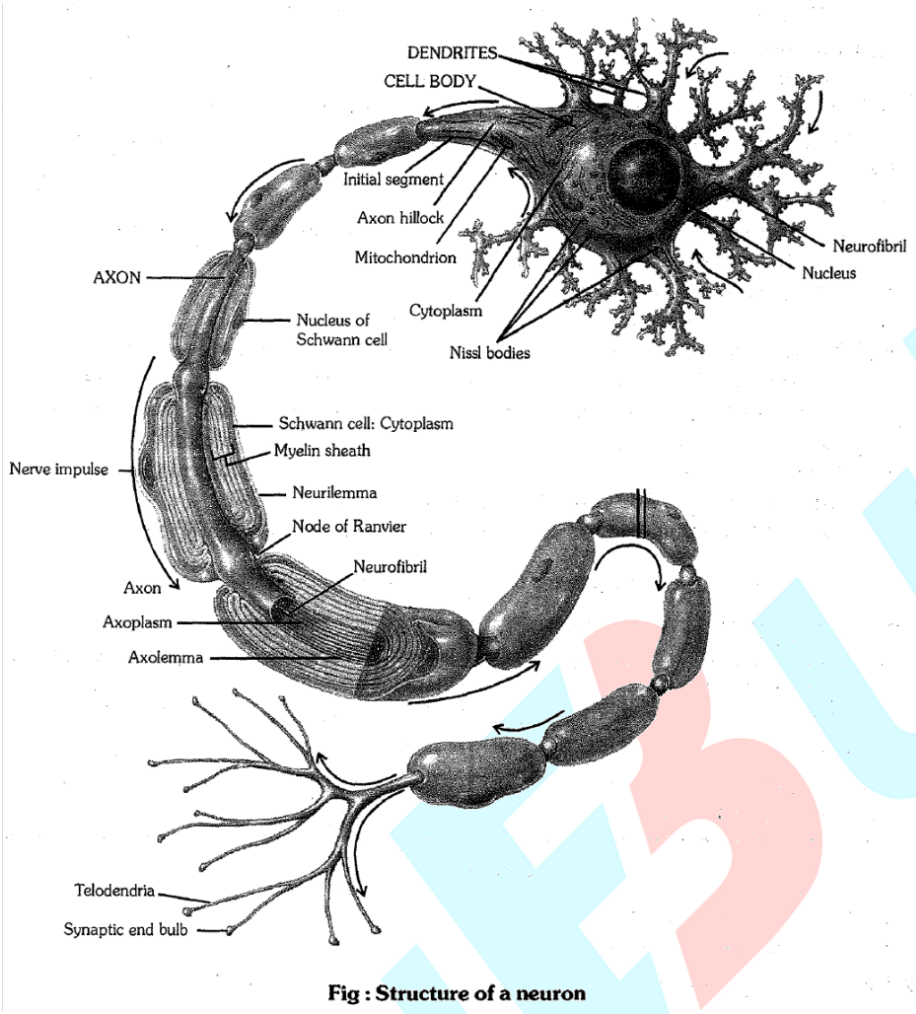



**Fig : Structure of a neuron**

**Structure of a neuron :** A nerve cell is made up of cell body & cell process - (Dendron and Axon = Neurites)

**(A) Cell body or Cyton or soma or perikaryon :**

- It contains uninucleated cytoplasm.
- Except centriole, all cell organelles are found in cytoplasm.
- Centriole is absent in the nerve cell thus cell division is absent.
- Some other cell organelles like Nissl's granule and neurofibril are also found in nerve cell.

**(i) Nissl's granules:**

- Endoplasmic reticulum & ribosome form granules like Structure called a~ Nissl's granules or Tigroid body.
- These are the centre of protein synthesis.
- Site- Cyton dendron

(ii) Many small fibrils are found in the cytoplasm called neurofibrils, these help in internal conduction in the cyton.

**(B) Cell processes :**

**(i) Dendron :-**

- It is small cell process. It's fine branches are called dendrites. Some receptor's are found on the dendrites, so dendron receive the stimuli & produce centripetal (towards the cell body) conduction.

(ii) Axon (Long process = Axon = Nervefibre) -

- It is longest cell process of cyton, its diameter is uniform.
- Axon is covered by Axolemma. Part of cyton where axon arises called Axon hillock.
- Cytoplasm which contains in axon is axoplasm.
- Nissl's granules are absent in the axoplasm.
- Axoplasm of axon contains only neurofibrils and initochondria.
- The axon hillock is the neuron's trigger zone, because it is the site where action potential are triggered.
- The terminal end of axon is Telodendria and button shape structure are called as Synaptic knob, which possess synaptic vesicles containing chemicals called neurotransmitters. The axons transmit nerve impulses away from the cell body to a synapse or to a neuro-muscular junction.
- More mitochondria are found in the telodendria which synthesize neurotransmitters like Acetylcholine (Ach) with the help of Acetyl-choline transferase enzyme.
- Axon is the functional part of nerve cell, therefore term nerve fibre usually refer to Axon.

**Differences between Axon & Dendron**

| Axon | Dendron |
|---|---|
| 1. It is always single in a neuron. | 1. One or more. |
| 2. It has no Nissl's granules. | 2. Nissl's granules present. |
| 3. It is long. | 3. Short. |
| 4. Nerve impulse travels away from the cell body. (Centripetal) | 4. Nerve impulse travels towards the cell body. (Centripetal) |

## MYELINOGENESIS

Myelin is a fatty material with a high electrical resistance and acts as an electrical insulator in the same way as the rubber and plastic covering of electrical wiring.

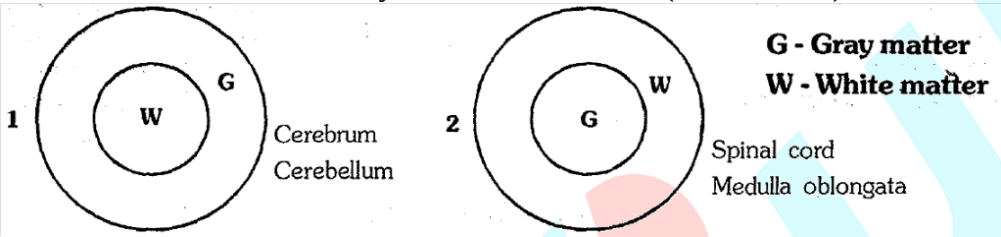
**Peripheral nervous system (PNS) :-**

- Axon is covered by a layer of phospholipids/sphingomyelin which is called as medulla or myelin sheath.
- Medulla is covered by thin cell membrane, which is called as neurilemma or sheath of schwann cells.
- The neurilemma is composed of schwann cells.
- In the peripheral nerves, myelinogenesis begins with the deposition of myelin sheath in concentric layer around the axon by schwann cells.
- Myelin sheath is discontinuous around the Axon. Those interruptions where Axon is uncovered by myelin sheath are called nodes of Ranvier
- Schwann cell takes part in the deposition of myelin sheath (myelinogenesis).
- Myelin sheath acts as insulator arid prevent's leakage of ions.

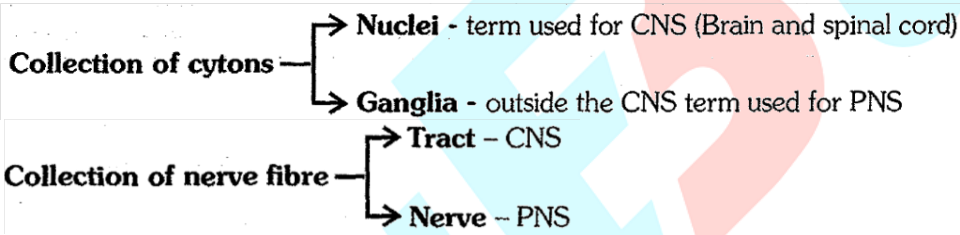
**Central nervous system (CNS) :-**

- Neurilemma or schwann cells are not present in CNS, therefore myelinogenesis process occurs with the help of oligodendrocytes (Neuroglia).
- Neurons in which myelin sheath is present, are called medullated or myelinated neurons. In some nerve cells where myelin sheath is absent, called as non medullated or non myelinated neurons.
  [Myelinated nerve fibres are found in spinal and cranial nerves. Unmyelinated nerve fibre is enclosed by a Schwann cell that does not form a myelin sheath around the axon, and is commonly found in autonomous and the somatic neural systems.]

**Gray matter:-** It is composed of nerve cells. It consists of cytons & nonmedullated nerve fibres (Gray fibers).
**White matter** - It contains myelinated nerve fibres (White fibres).




Important terms to remember



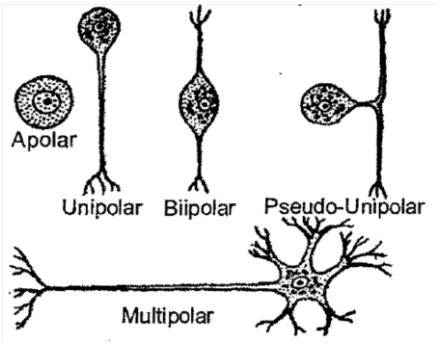

## TYPES OF NEURONS
### On the basis of number of Dendron & Axon.

s

| Unipolar | Bipolar | Multipolar |
|---|---|---|
| Single process arises from cyton.(1 Axon)<br>e.g. Nervous system of embryo | Two process arises from cyton (1 Axon & 1 dendron)<br>e.g. Olfactory epithelium<br>Retina :-<br>(i) Rod and cones (modified bipolar neurons)<br>(ii) Biopolar neuron layer of retina | Neuron which have one axon but many dendrons.<br>e.g. Most neurons of vertebrates. (Cerebral cortex) |

**Apolar/Nonpolar Neuron :-** No definite dendron/axon. Cell process are either absent or if present are not differentiated in axon and dendrons. Nerve impulse radiates in all directions. e.g. Hydra, amacrine cell of retina.

**Pseudounipolar :-** In this type, nerve cell has only axon but a small process develop from axon which act as dendron. eg. Dorsal root ganglia of spinal cord.




**Types of Neurons on the basis of function**

- Sensory or afferent — Sensory organ → CNS
- Inter neuron or Inter connecting neuron or internuncial neuron
- Motor or Efferent — CNS → Effector (organ)

**Neurotransmitters or Neurohumors or Neurohormones**

- **Stimulatory** — stimulates impulse at synapse
  e.g. 1. Acetylcholine (Ach),
  2. Nor-epinephrine or Nor-adrenaline or sympathetin
- **Inhibitory** — Inhibit impulse at synapse
  e.g. 1. GABA (Gamma Amino Butyric Acid)
  2. Serotonin,
  3. Dopamine,
  4. Glycine

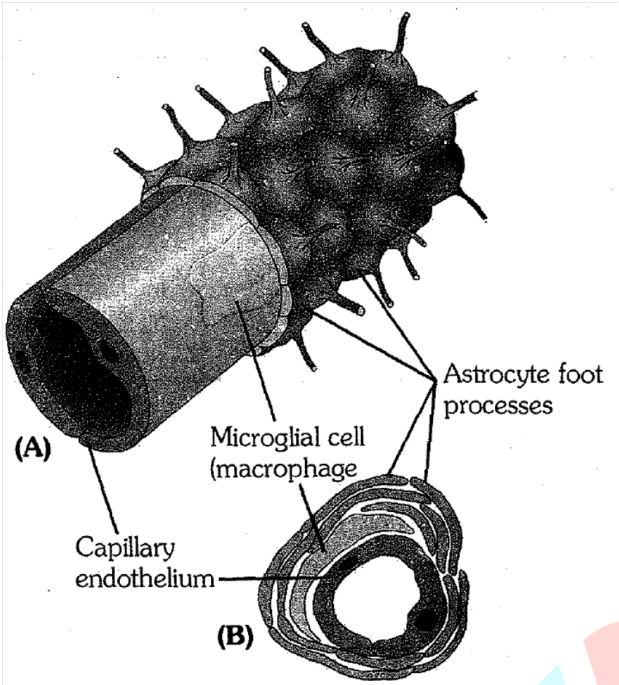
## Neuroglia/Glial cells

These are supporting cells which form a packing substance around the neurons. These are of three types :

| | Astrocytes | Oligodendrocytes | Microgliocytes |
|---|---|---|---|
| (i) | Morphology :-<br>Large cell<br>Numerous process | Smaller few process | Smallest with branching |
| (ii) | Function :-<br>1. It forms blood brain barrier | 1. Formation & Preservation of Myelin sheath in CNS. | 1. Scabvenger cells of CNS and phagocytic in nature. |

## Blood Brain Barrier (BBB) :-

The Blood-Brain Barrier is formed by Astrocyte cells, which are coupled by tight junctions. The barrier prevents the entry of neurotoxins.




**Blood brain barrier :**
(A) Longitudinal section, (B) Transverse section

## BEGINNER'S BOX-1

**1.** Which statement is correct about nerve fibres ?
(1) All nerve fibres of CNS are enclosed by Schwann cells.
(2) Only myelinated nerve fibres of PNS are enclosed by Schwann cells.
(3) All nerve fibres of PNS are enclosed by Schwann cells.
(4) Only myelinated fibres of CNS are enclosed by schwann cells.

**2.** Which neuroglial cell helps in formation of blood brain barrier ?
(1) Capillary endothelial cells (2) Astrocyte
(3) Both (1) and (2) (4) Oligodendrocyte

**3.** Which statement is true?
(1) In PNS, only non-myelinated neuron are found.
(2) In CNS, myelinated and non-myelinated neurons are found.
(3) In PNS, myelinated and non-myelinated neurons are found.
(4) Both (2) and (3)

**4.** Which structure is not found in white matter?
(1) Telodendria (2) Cell body
(3) Dendrons and non-myelinated axons (4) All of the above

**5.** Nissl's granules are made up of ?
(1) Endoplasmic reticulum and mitochondria
(2) Ribosome and Mitochondria
(3) Ribosome and Endoplasmic Reticulum
(4) Golgi body and Ribosome

**6.** Which of the following is true for Neurilemma ?
(1) Discontinuous at nodes of Ranvier

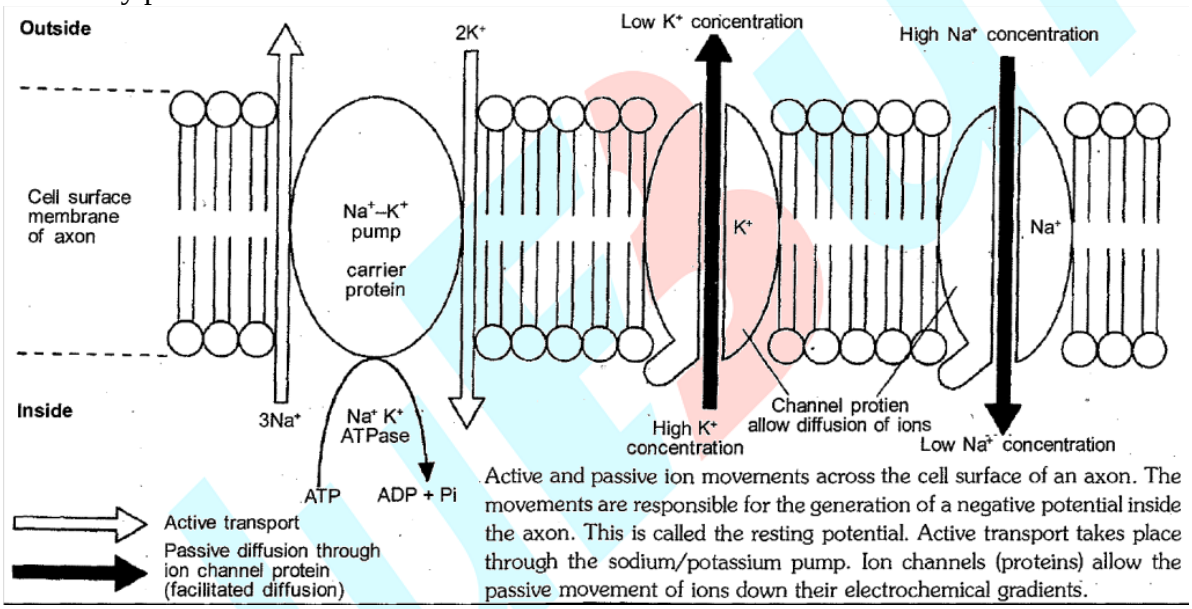
(2) Continuous at nodes of Ranvier and made by schwann cells
(3) Discontinuous at nodes of Ranvier and made by schwann cells
(4) Continuous at nodes of Ranvier and made by oligodendrocytes

**7.** Fibres which transmit impulses towards the cell body called as :-
(1) Axon terminal (2) Axon (3) Dendrites (4) Axon hillock

**8.** The axonal membrane is __ to negatively charged proteins present in the axoplasm :-
(1) Selectively permeable (2) Permeable
(3) Semipermeable (4) Impermeable

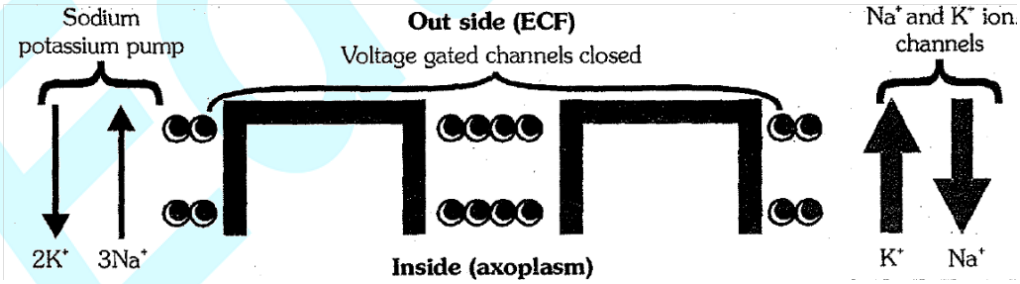
## GENERATION AND CONDUCTION OF NERVE IMPULSE

**Excitable cells** - Neurons are excitable cells because their membranes are in a polarized state due to differential concentration gradient of ions across membrane. This axolemma is selectively permeable in nature.




Active and passive ion movements across the cell surface of an axon. The movements are responsible for the generation of a negative potential inside the axon. This is called the resting potential. Active transport takes place through the sodium/potassium pump. Ion channels (proteins) allow the passive movement of ions down their electrochemical gradients.

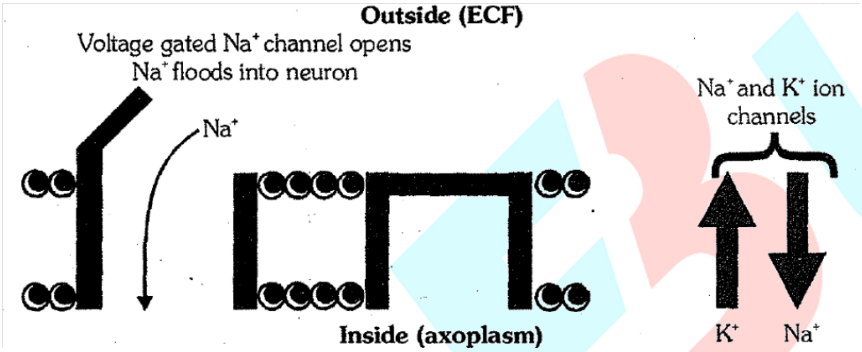
### 1. RESTING PHASE :




- The potential difference (a charge) which exists across the cell surface membrane of nerve cells, negative inside the cell with respect to the outside. The membrane is said to be polarised.
- The potential difference across the membrane at rest is called the resting membrane potential and this is about –70 mV (the negative sign indicates that inside the cell is negative with respect to the outside).
  (Range→ –60 to –85 mV)
- The resting potential is maintained by active transport and passive diffusion of ions.

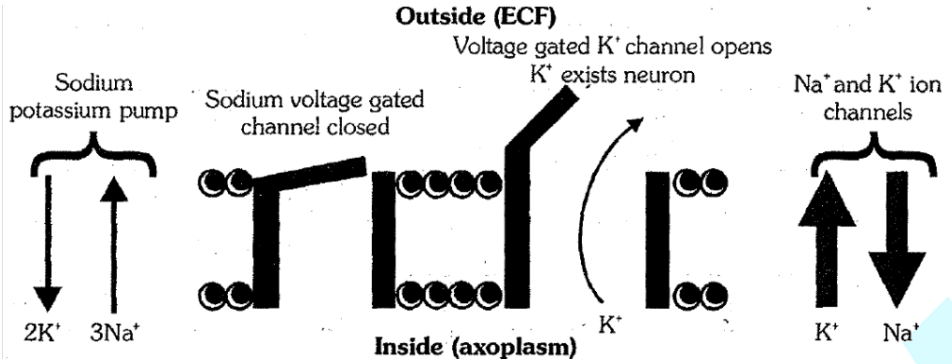
- Resting membrane potential is maintained by the active transport of ions against their electrochemical gradient by sodium potassium pump. These are carrier proteins located in the cell surface membrane. They are driven by energy supplied by ATP and couple the removal of three sodium ions from the axon with the up take of two potassium ions.
- The active movement of these ions is opposed by the passive diffusion of the ions. The rate of diffusion is determined by the permeability of the axon membrane to the ion.
- Potassium ions have a membrane permeability greater than that of sodium ions.
- Therefore potassium ions loss from the axon is greater than sodium ion gain.
- This leads to a net loss of positive ions from the axon, and the production of negative charge within the axon (Further there are many organic anions within the axoplasm, which also contribute to axoplasm negativity).
- Due to active transport (mainly) and diffusion process, positive charge is more outside and negative charge is more inside.

**2. EXCITING STAGE :**




- Once the event of depolarization occurs, a nerve impulse or nerve impulse or spike is initiated. Action potential is another name of nerve impulse. This is generated by a change in the sodium ion channels. These channels, and some, of the potassium ion channels, are known as voltage gated channel, meaning they can be opened or closed with change in voltage. In resting state these channels are closed due to binding of $Ca^{++}$.
- A potential is generated and it cause sudden opening of the sodium gates. Opening of gates increases the permeability of the axon membrane to sodium ions which enter by diffusion. This increases the number of positive ions inside the axon.
- A change of +10 mV in potential difference from RMP through influx is sufficiently significant to trigger a rapid influx of $Na^+$ ions leading to generation of action potential. This change of +10 mV is called as threshold stimulus.
- At the point where membrane (Axolemma) is completely depolarised due to rapid influx of $Na^+$ ions, the negative potential is first cancelled out and becomes "0".
- Due to further entry of Na+, the membrane potential "over shoots" beyond the zero and becomes positive upto +30 to +45mV.
- This potential is called as action potential. In this state, the inner surface of axolemma becomes positively charged and outer surface becomes negatively charged. The rise in the stimulus-induced permeability to $Na^{\pm}$ is extremely shortlived. It is quickly followed by a rise in permeability to $K^+$.

**3. REPOIARISATION :-**




- After a fraction of second, the sodium gates get closed. Depolarisation of the axon membrane causes potassium gates to open.
- Within a fraction of a second, $K^+$ diffuses outside the membrane and restores the resting potential of the membrane at the site of excitation and the fibre becomes once more responsive to further stimulation.
- Since potassium is positively charged, its exit makes the inside of cell less positive, or more negative and the process of repolarization or return to the original resting potential begins.
- The repolarization period returns the cell to its resting potential (–70 mV). The neuron is now prepared to receive another stimulus and conduct it in the same manner.
- The time taken for restoration of resting potential is called refractory period, because during this periods the membrane is incapable of receiving another impulse.
- Nerve impulse travels as action potential which passes along the axon as a wave of depolarization.
- The whole process of depolarisation and repolarisation is very fast. It takes only about 1 to 5 milli second (ms).

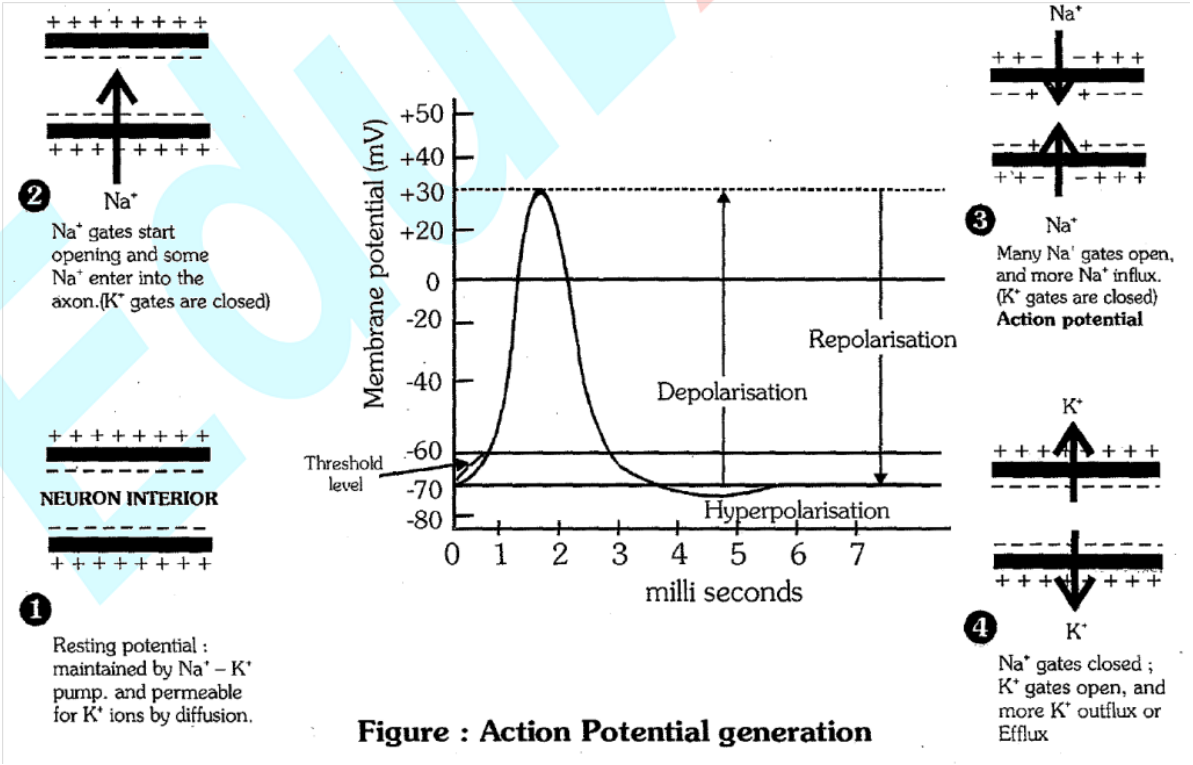



**Figure : Action Potential generation**

| Process | $Na^+$- $K^+$ pump | Passive diffusion | $Na^+$ VGC | $K^+$ VGC | Potential with value | Inside charge after the event |
|---|---|---|---|---|---|---|
| Polarisation | ✓ | ✓ | × | × | RMP (–60 to –85mV) | Negative |
| Depolarisation | × | ✓ | ✓ | × | +30 to + 45 mV | Positive |
| Repolarisation | ✓ | ✓ | × | ✓ | –70mV | Negative |
| Hyperolarisation | ✓ | ✓ | × | ✓ | –85 mV | Negative |

- Open/Operating → ✓, Closed → ×

## SALTATORY CONDUCTION OF NERVE IMPLUSE

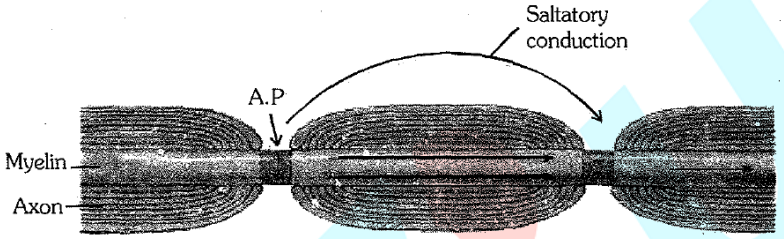



**Fig. : Diagram showing 'Saltatory conduction' in myelinated Neuron**

- This type of conduction occurs in myelinated fibre.
- This means, in effect that the action potential jumps from node to node and passes along the myelinated axon faster as compared to the series of small local circuits in a non-myelinated axon. This type of conduction is called salutatory conduction. Leakage of ions takes place only in nodes of Ranvier and less energy is required for saltatory conduction.

## SYNAPSE

- It is the junctional region between two neurons where information is transferred from one neuron to another.
- Name synapse was proposed by Charles Sherrington
- Telodendria of one neuron form synapse with dendron of next neuron.
- It transmit stimulus in the form of electrochemical wave.
  Synapse = Presynaptic knob + synaptic cleft + postsynaptic membrane
- Telodendria membrane is called pre synaptic membrane & membrane of dendron of other neuron called as postsynaptic membrane. Space between pre and post synaptic membranes is called synaptic cleft.

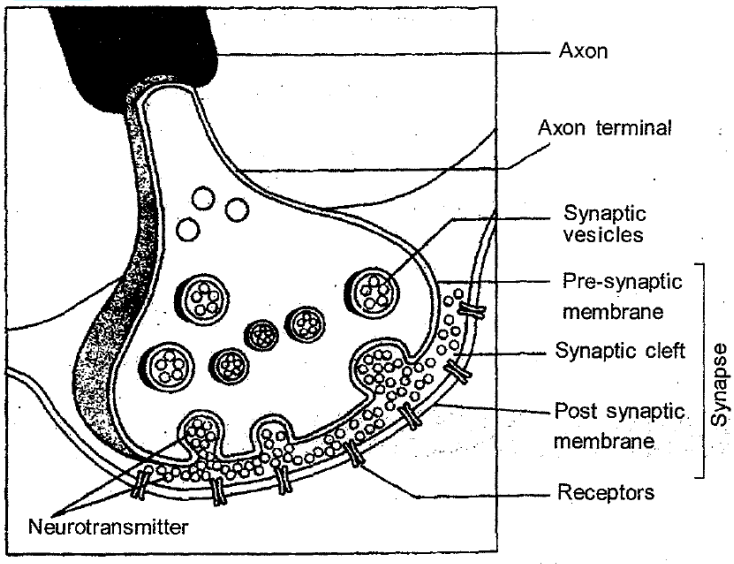



**Diagram showing axon terminal and synapse**

It may or may not be seperate.

- A nerve impulse is transmitted from the neuron to another through junction called synapse.
- There are two types of synapses, namely, electrical synapses and chemical synapses.
- At electrical synapses, the membranes of pre- and post-synaptic neurons are in very close proximity.
- Electrical current can flow directly from one neuron into the other across these synapses.
- Transmission of an impulse across electrical synapses is very similar to impulse conduction along a single axon.
- Impulse transmission across an electrical synapse is always faster than that across a chemical synapse. Electrical synapses are rare in our system.
- On the other hand, chemical synapses are characterised by a synaptic cleft. At these synapse, impulse transmission occurs with the help of a chemical, called neurotransmitter.
- Mechanism :- When the AP develops in presynaptic membrane, it becomes permeable for $Ca^{++}$. $Ca^{++}$ enter presynaptic membrane & neurotransmitter vesicles burst due to the stimulation by $Ca^{++}$ and they release neurotransmitters in synaptic cleft.
  Neurotransmitter reaches the postsynaptic membrane via synaptic cleft & binds to specific receptors. This binding opens up ion channels, allowing the entry of ions which can generate a new potential on post synaptic membrane. The potential may be excitatory (EPSP) or inhibitory (IPSP). In Excitatory postsynaptic potential (EPSP) Ach is main neuro transmitter, which develop due to opening of $Na^{+}$ gatted channels.
- On the rest of the Ach, cholinestrase enzyme functions, which is found in synaptic cleft. This enzyme decompose the Ach into choline & Acetpte.
- If neuro inhibitory transmitter (GABA) binds with post synaptic membrane to open the $Cl^{-}$ gatted channels and hyperpolarization of neuron pccurs. Now the potential is called inhibitory postsynaptic potential (IPSP) & further nerve conduction is blocked.

## TYPE OF SYNAPSE

| | Electrical | Chemical |
|---|---|---|
| (i) Conduction | Fast | Slow |
| (ii) Synaptic cleft | 0.2 nm | > 20 nm |
| (iii) Neurotransmitter in synaptic cleft | Absent | Present |
| (iv) Occurrence in body | Rare in our body | Most common |
| (v) Synaptic delay | Absent | Present |
| (vi) Blocking | Cannot be controlled | Controlled by neurotransmitter |

## FUNCTIONAL PROPERTIES OF NERVE FIBRE

- Conduction of nerve impulse is unidirectional.
- It follow all or none law. Magnitude of response will always be same irrespective of strength of stimulus above threshold stimulus .
- Velocity of nerve impulse $\propto$ Diameter of neuron .
- This velocity is affected by physical & chemical factor, such as pressure, cold, heat, chloroform and ether etc.

## GOLDEN KEY POINTS

- Depolarization : $Na^{+}$ influx.

- ♦ Repolarization : $K^+$ efflux.
- ♦ If myelin sheath is continuous there will be no nerve impulse conduction in nerve fibres.
- ♦ If question is informing for only about channel opening and closing then consider only VGC.
- ♦ Simple diffusion channels are always open (In every state).

## BEGINNER'S BOX-2

**1.** Which statement is false regarding nerve impulse ?
(1) After applying a stimulus on polarised membrane, that site become freely permeable to Na+ and leads to rapid eflux of $Na^+$.
(2) The rise in the stimulus induced permeability to $Na^+$ is extremely short lived.
(3) After depolarization $K^+$ diffuses outside the membrane and restores the resting potential.
(4) Ionic gradients across the resting membrane are maintainined by the $Na^+ – K^+$ ATPase pump.

**2.** Resting membrane potential is achievied by :-
(1) Passive diffusion by ion channels/Leaky channels
(2) $Na^+ – K^+$ ATPase pump.
(3) Negatively charged proteins in axoplasm.
(4) All of the above

**3.** Which statement is correct regarding nerve impulse conduction ?
(1) The membrane potential change from positive to negative and then back again.
(2) Sodium ions flow out through ion channels and potassium ions flow in.
(3) Potassium channels close as the membrane potential becomes positive.
(4) The membrane potential becomes less negative due to opening of $Na^+$ VGC.

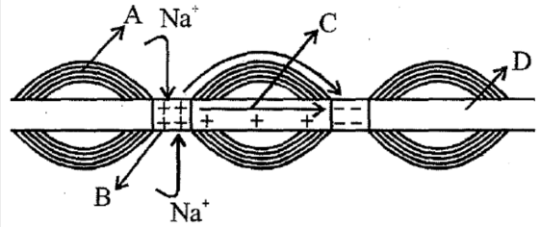
**4.** A nerve impulse is transmitted from one neuron to another neuron through junction called as :-
(1) Neuro muscular junction (2) Synapse
(3) 1 & 2 both (4) Node of Ranvier

**5.** The axoplasm inside the axon contains high concentration of ..... and ..... :-
(1) $K^+$ and $Na^+$ (2) $K^+$ and Negatively charged proteins
(3) $Na^+$ and $Cl^-$ (4) Both (1) and (3)

**6.** The ion channels are ..... to different ions :-
(1) Completely permeable (2) Impermeable
(3) Selectively permeable (4) Both (1) and (3)

**7.** The electrical potential difference accross the plasma membrane at the site of depolarisation is called :-
(1) Graded potential (2) Resting potential
(3) Action potential (4) None of the above

**8.** Given below is the diagram representing conduction of nerve impulse in myelinated neuron label the parts, with correct option:-



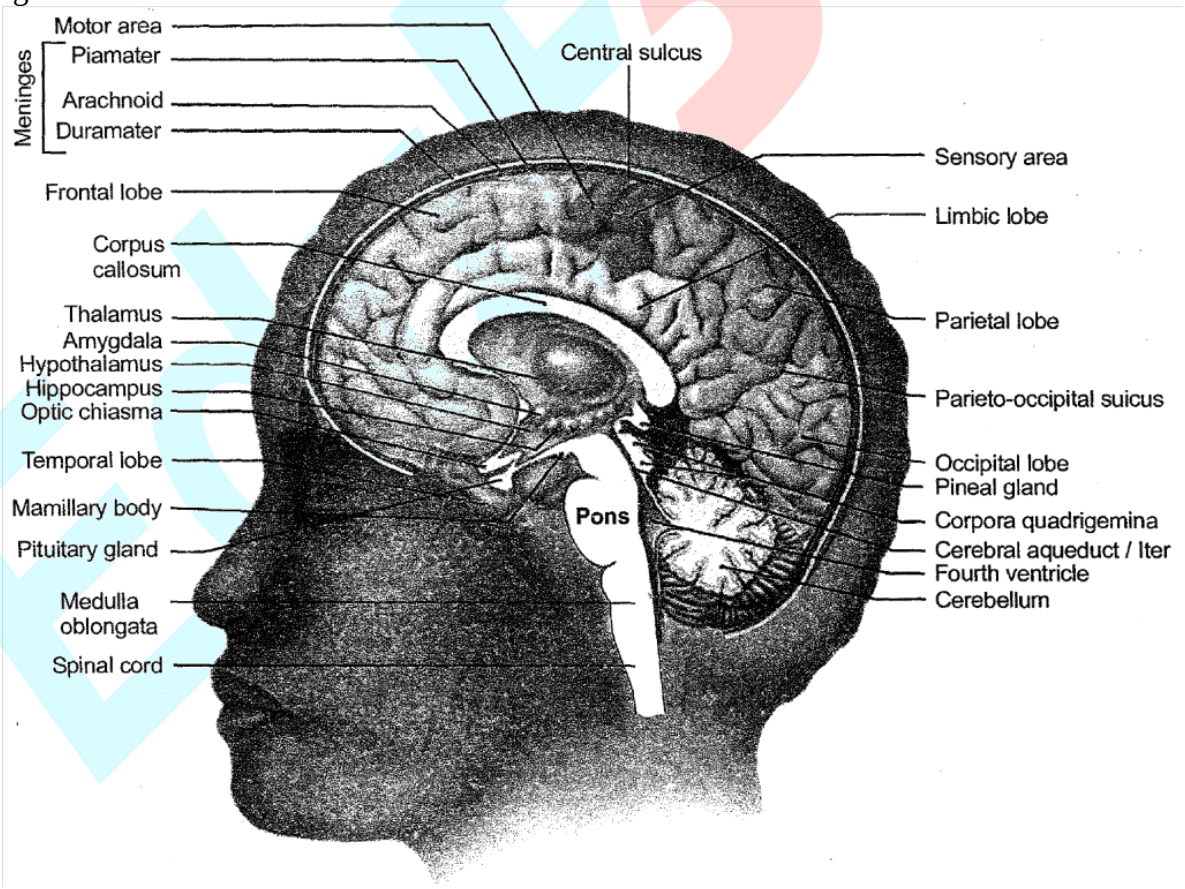

(1) A - Axolemma, B - Site of polarization C - Wave, D - Axolemma
(2) A - Myelin sheath, B - Site of Depolarisation
C - Action potential jumps from node to node D - Axoplasm
(3) A - Axoplasm, B - Repolarisation, C - Ionic movement, D - Axon
(4) A - Myelin sheath, B - Hyperpolarisation, C - Action potential, D – Axoplasm

## CENTRA NEURAL SYSTEM

- It includes the brain and the spinal-cord.
- These are formed from the neural-tube which develops from the ectoderm after the gastrula stage of embryo.

**Development of CNS :-**

Anterior part of neural tube develops into brain while caudal part of neural tube develops into spinal cord. Brain's approximately 70-80% part develops in 2 year of age & complete development is achieved in 6 years of age & spinal cord develops completely in 4 to 5 years of age.




## DIVISIONS OF HUMAN BRAIN

| | Division | Sub-divisions & Parts |
|---|---|---|
| (1) | Fore brain | 1. Olfactory lobe<br>2. Crebrum<br>3. Diencephalon |
| (2) | Mid Brain | 1. Optic lobes and Crura cerebrae |
| (3) | Hind Brain | 1. Pons<br>2. Cerebellum<br>3. Medulla oblongata (M.O.) |

## HUMAN BRAIN

**1.** The brain is the central information processing organ of our body and acts as the 'Command and control system'.

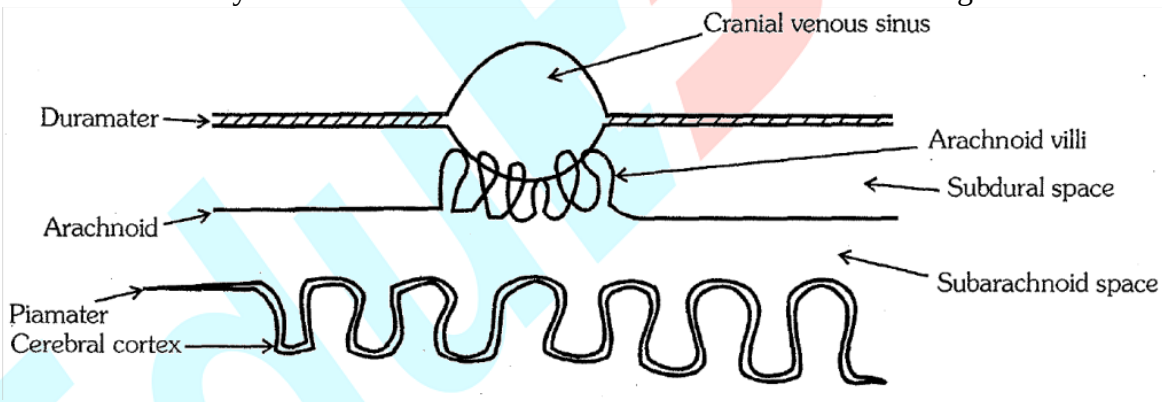
**2.** It controls the voluntary movements, balance of the body, functioning of vital involuntary organs (e.g. lungs, heart, kidney etc.), thermoregulation, hunger and thirst circadian (24 hours) rhythms of our body, activities of several endocrine glands and human behaviour.

**3.** It is also site for processing of vision, hearing, speech, memory, intelligence, emotions and thoughts.

**4.** It is situated in cranial box which is made up of 1 frontal bone, 2 parietal bone, 2 temporal bone, 1 spnenoid, 1 ethmoid 1 occipital bone. The weight of brain of an adult male is 1400 gm and of female is 1250gm.

## BRAIN MENINGES

Brain is covered by three membranes of connective tissue termed as meninges or menix.




### Meningeal layers

**(1) Duramater:**

- This is the first and the outermost membrane which is thick, strong and elastic layer .
- At several places it forms cranial venous sinuses containing blood .

**(2) Arachnoid:**

- It is middle and delicate layer and found only in mammals. (Mammalian character)
- At several places it forms villi like foldings to absorb CSF called arachnoid villi .
- Space between duramater & arachnoid is called subdural space which is filled with serous fluid.

**(3) Piamater:**

- Inner most, thin and transparent membrane, which is firmly attached to the brain.

- At some places it merges deeply into sulci of brain to form telachoroidea .
- Space between arachnoid & piamater is called subarachnoid space, which is filled with CSF.

## CEREBROSPINAL – FLUID (CSF)

- This fluid is clear and alkaline in nature just like lymph.
- CSF is present in ventricles of brain, subarachnoid space of brain & spinal cord.
- C.S.F. is formed in choroid plexus found in the ventricles of the brain.

**Functions of C.S.F. :-**

- Protection of Brain :- It acts as shock absorbing medium and works as cushion .
- It provides buoyancy to the brain, so net weight of the brain is reduced from about 1.4 kg to about 0.18 kg.

## FORE BRAIN

- The fore brain consists of Cerebrum, Diencephalon (containing epithalamus, thalamus, hypothalamus) and olfactory lobe.

## CEREBRUM

- Cerebrum forms the major part of the brain which is most developed in human.

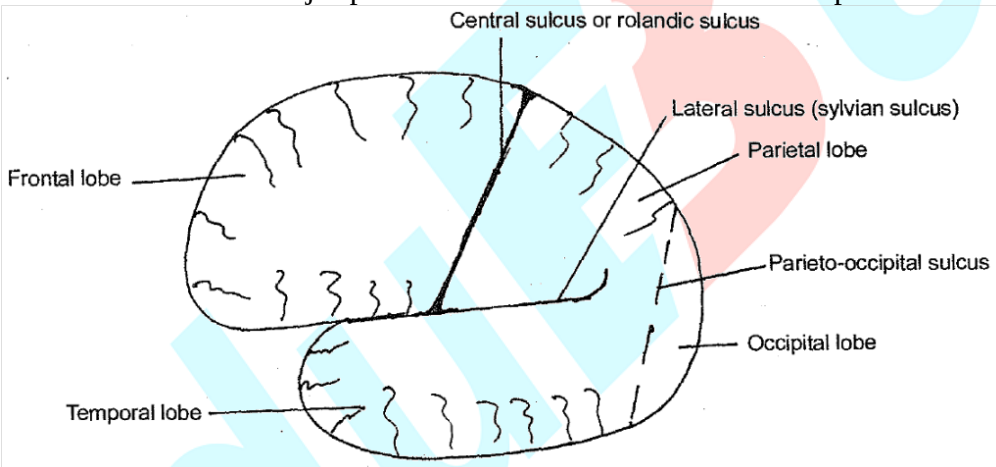



**FIG : DORSO-LATERAL SURFACE OF CEREBRAL HEMISPHERE**

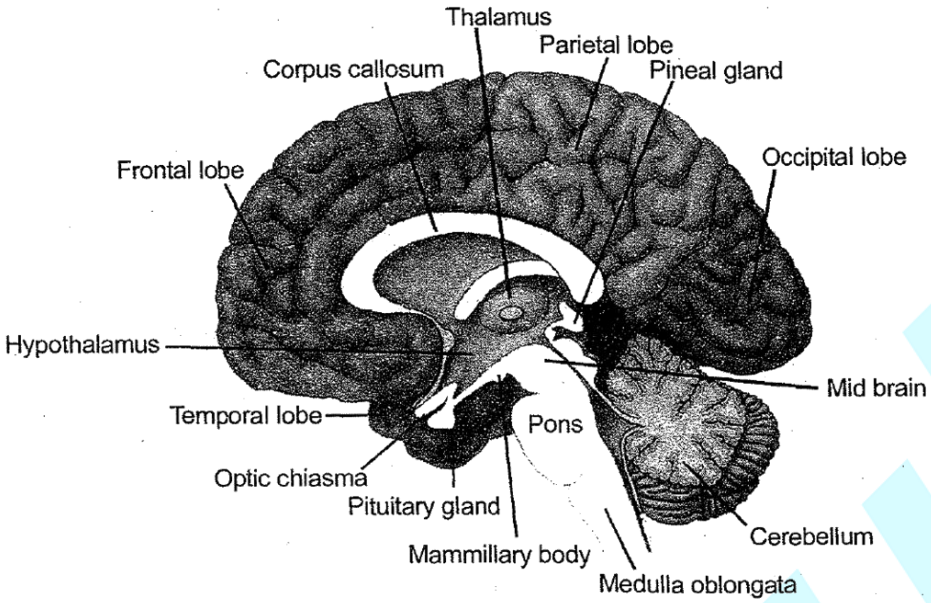



**Fig. : Mid saggital section of brain**

- Cerebrum consists of two cerebral hemispheres, on the dorsal surface a longitudinal groove is present between two cerebral hemispheres called as median fissure. Both the cerebral hemispheres partially connected with each other by curved white thick nerve fibre called corpus callosum (Largest commisure of brain) (Mammalian character).
- Each cerebral hemisphere is divided into 4 lobes-Anterior, Middle, Posterior and Lateral.
- Anterior lobe is also called frontal lobe (largest lobe) while middle lobe is called as parietal lobe. Frontal lobe is seprated by central sulcus or rolandic sulcus from parietal lobe.
- Posterior lobe is called as occipital lobe, it is separated from parietal lobe by a sulcus called parieto occipital sulcus.
- Lateral lobe or temporal lobe is separated from frontal lobe & parietal lobe by incomplete sulcus called lateral sulcus /sylvian sulcus.
- The outer part of cerebral hemisphere is called Cerebral cortex and thrown into prominent folds. These folds are found as ridges and grooves on dorsal surface of cerebral hemisphere. Ridges are known as Gyri while grooves are called sulci. Gyri and sulci increase the surface area of cerebrum.
- The cerebral cortex referred to as the gray matter due to its greyish appearance. The neuron cell bodies are concentrated here giving the colour. This thick layer of gray matter is also known as Neopallium/Pallium .
- The cerebral cortex contains three types of functional areas :-

  **(i) Sensory area**- Analysis of sensory impulses eg. Somesthetic area for general sensation (Touch, Pain, Temperature etc.)

  **(ii) Motor area**- Generation of motor impulses eg. Broca s area for fine movement of tongue and speech. Motor area for voluntary movement of limb muscles.

  **(iii) Association area**- These are large regions that are neither clearly sensory nor motor in function. They are responsible for certain complex functions like :-

  γ Intersensory associations : As you are aware that all sensory inputs like touch, sound, light, smell are sent to brain. These different sensation require association and inter connection with each other for their proper interpretation.

γ Memory : Memory of past events is recorded by the association areas also with the different lobes of the cerebrum. Memory is basically of two types: Short term memory and long term memory.

γ Communication : The ability of communication also controlled by the assoication areas of cerebral cortex.

**Function of cerebrum :** It is the most important part of brain because it controls and regulates different part of brain. This is the centre of conscious senses, will power. Voluntary movements, knowledge etc.

♦ Different sense organs send impulse here and in this part of brain, analysis and coordination of impules is done then messages are transferred to organs.

## 2. DIENCEPHALON

♦ It is small chamber like posterior part of fore brain which is covered by cerebrum. It consists of 3 parts :

(i) Epithalamus (ii) Thalamus (iii) Hypothalamus

(i) Epithalamus : It form the roof of diencephalon. Pineal body (Epiphysis cerebri) is found on epithalamus & control sexual maturity.

(ii) Thalamus: It forms upper lateral wall of Diencephalon. It form 80% of diencephalon. It acts as a relay centre. It receives all sensory inputs from all part of body & these impulses are send to the cerebral cortex. Cerebrum wraps around the thalamus. It is a major coordinating centre for sensory & motor signalling.

(iii) Hypothalamus: It forms the lower or ventral part of diencephalon. It lies at the base part thalamus.

♦ The hypothalamus contains a number of centre which control body temperature. urge for eating and drinking (Hunger and thirst).

♦ It also contains several group of neurosecretory cells. which secrete hormone called hypothalamic hormone.

♦ A cross like structure is found on anterior surface Of hypothalamus called as optic chiasma, through Infundibulum pituitary body is attached to middle part of hypothalamus. Corpus mammillare or corpus albicans or mammillary body is found on the posterior part of hypothalamus. (Mammaliare character)

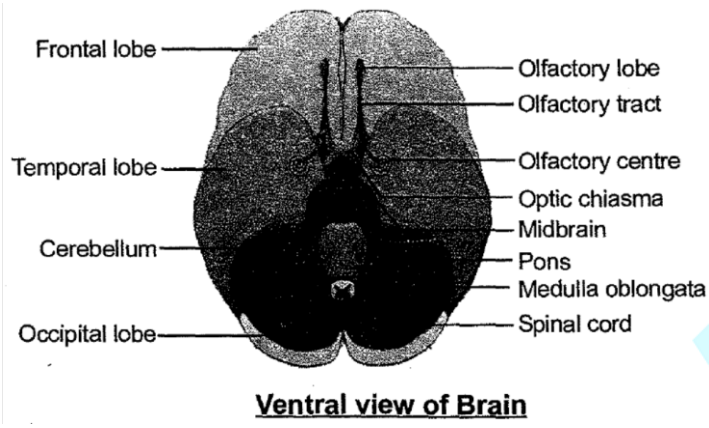
**Hypothalamus controls :-**

(1) Thermoregulation
(2) Behaviour and emotion
(3) Endocrine control
(4) Biological clock system
(5) ANS control.

**Limbic system :**

The inner part of cerebral hemispheres and a group of associated deep structures like amygdala. Hippocampus etc. form a complex structure called Limbic system. Along with the hypothalmus, it is involved in the regulation of sexual behavior, expression of emotional reactions (e.g. excitement pleasure, rage, fear) and motivation, olfaction and autonomic responses.

## 3. OLFACTORY LOBE




**Ventral view of Brain**

- One pair of broad bean size organ called olfactory lobe/bulb are found an ventral surface of frontal lobe of cerebral hemisphere. It is a small spherical & solid structure in human brain. It is connected to olfactory centre (temporal lobe) through olfactory tract and are extentions of the brain's limbic system.
  **Functions :** It is supposed to be centre of smell intensity. Some animal like sharks and dogs have well developed olfactory lobes.

## MID BRAIN

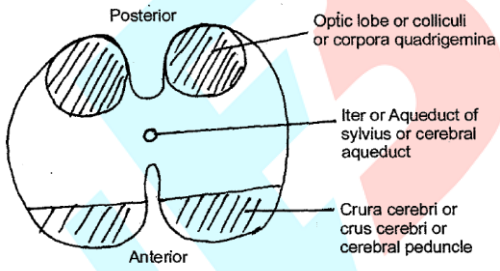



**FIG : T. S. OF MID BRAIN**

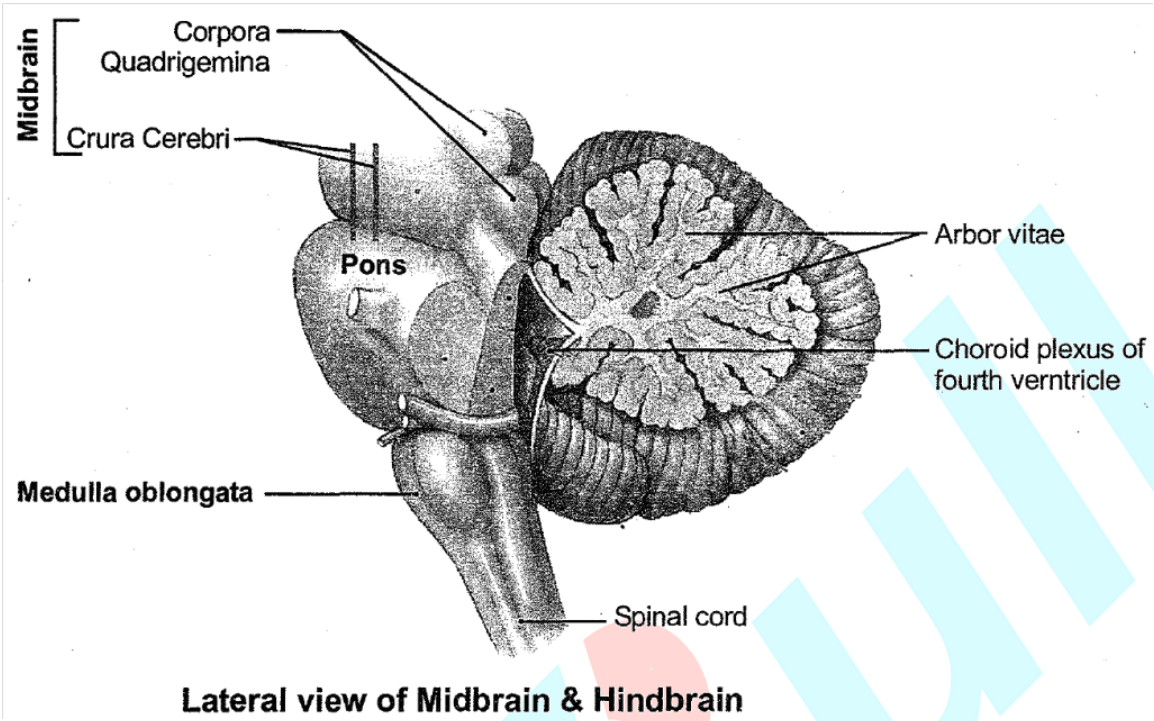
- It is a small part of brain. The midbrain is located between diencephalon of the fore brain and pons of the hind brain. A canal called Cerebral aqueduct/Aqueduct of sylvius passes through the midbrain.
- Anterior part of midbrain contains two longitudinal myelinated nerve fibre called cerebral peduncles or crus cerebri or crura cerebri.
- On posterior part of mid brain four spherical projections are found called colliculus or optic lobe. Four colliculus are collectively called as corpora quadrigemina. (2 upper & 2 lower) (Mammalian character)
- Mid brain and hind brain (except cerebellum) form the brain stem.

**Function:**

- The mid brain receives and integrates visual. tactile and auditory inputs .
- Crura cerebrai controls the muscle of limb while superior and inferior colliculus are related with pupillary (light) reflex and acoustic (Sound) reflex action respectively.

## HIND BRAIN

- The hind brain comprises pons, cerebellum and medulla (also called the medulla oblongata).




**Lateral view of Midbrain & Hindbrain**

## 1. PONS

- It is a small spherical projection. Which is situated below the midbrain and upper side of medulla oblongata. It consists of many transverse and longitudinal nerve fibre. Transverse nerve fibre connect with cerebellum while longitudinal nerve fibre connect cerebrum to medulla oblongata.

  **Function :-** It regulates the breathing reaction through pneumotaxic centre.

## 2. CEREBELLUM

- It is made up of 3lobe (2laterallobe and 1 vermis). Both lateral lobes become enlarged and spherical in shape, so lateral lobe of cerebellum are also called as cerebellar hemisphere. Cerebellum has very convoluted surface in order to provide the additional space of for many more neurons.
- Outer part of cerebellum is made up of gray matter while inner part is of white matter. White matter projects outside & forms a branched tree like structure known as Arbor Vitae.

  **Functions :** The cerebellum integrates information received from the semicircular canals of the ear and the auditory system and also by this portion of hind brain impulses are received from different voluntary muscles and joints .
- Due to this region, coordination of voluntary muscle through involuntary regulation is more developed in human compared to other animals i.e. Body balance.
- The person who take alcohol in excess their cerebellum gets affected as a result that person can not maintain his balance and walking is disturbed.
- Thus it is related with fine and skill full voluntary movements.

## 3. MEDULLA OBLONGATA

- Posterior part of hind brain is tubular and cylindrical in shape. Medulla of brain is connected to spinal cord.

- Mid brain, pons and medulla are situated in one axis and it is called as Brain stem.
  **Functions :** It is the most important part of brain which controls all the involuntary activities of the body e.g. cardiovascular reflex, respiration, metabolism, gastric secretion etc. As well as this act as conduction path for all impulses between spinal cord and remaining portions of brain.
- It is also concerned with cranial reflex action like sneezing reflex, salivation reflex, coughing reflex, swallowing reflex, vomiting reflex, yawning reflex.

## BEGINNER'S BOX-3

**1.** Which lobe of cerebral hemisphere perform voluntary motor function of body ?
(1) Parietal lobe (2) Frontal lobe
(3) Occipital lobe (4) Temporal lobe

**2.** Which part of brain contains such area which are niether clearly sensory nor motor in function?
(1) Cerebeller cortex (2) Cerebral cortex
(3) Grey matter of cerebrum (4) Both (2) and (3)

**3.** Arbor vitae are found in which part of brain ?
(1) Fore brain (2) Mid brain (3) Hind brain (4) All of the above

**4.** Which part of nervous system is the central information processing part of act as command & control system?
(1) S.N .S. (2) P.N .S. (3) A.N .S. (4) C.N .S.

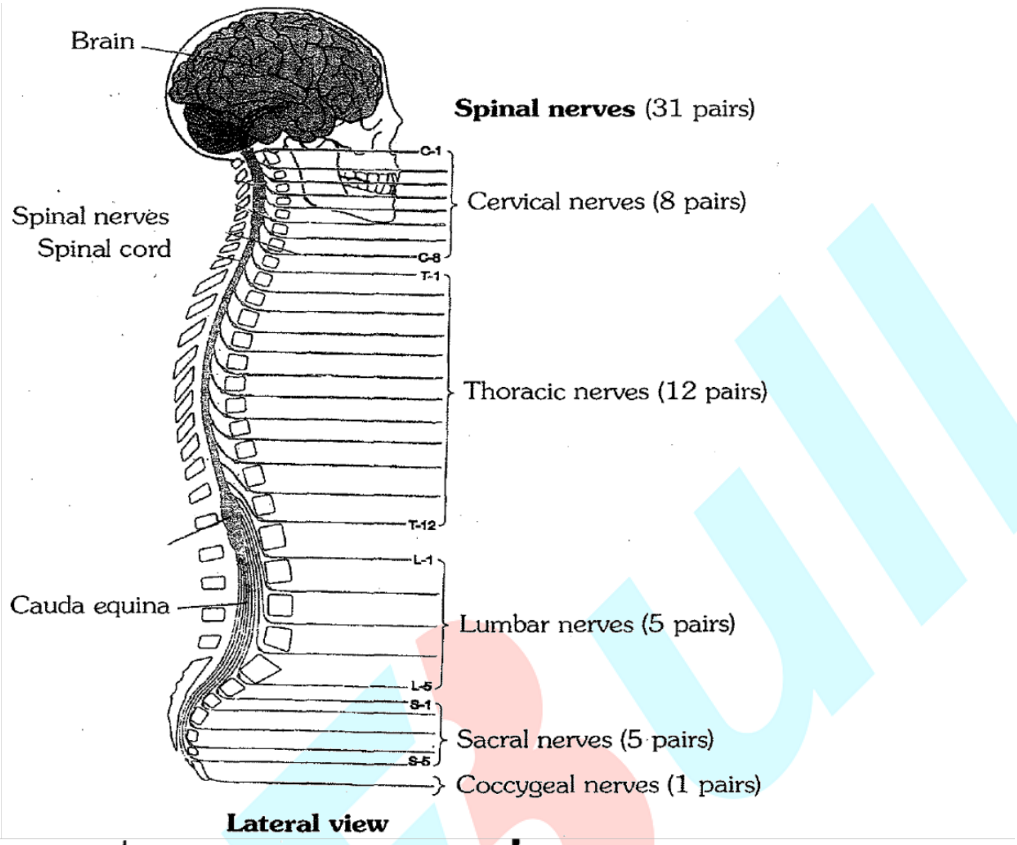
**5.** Grey matter includes :-
(1) Concentrated cell body (2) Unmyelinated axon
(3) Myelinated axon (4) (1) & (2) both

**6.** The layer of cells which covers the cerebral hemisphere is called :-
(1) Piamater (2) Duramater
(3) Cerebral cortex (4) Both (1) & (2)

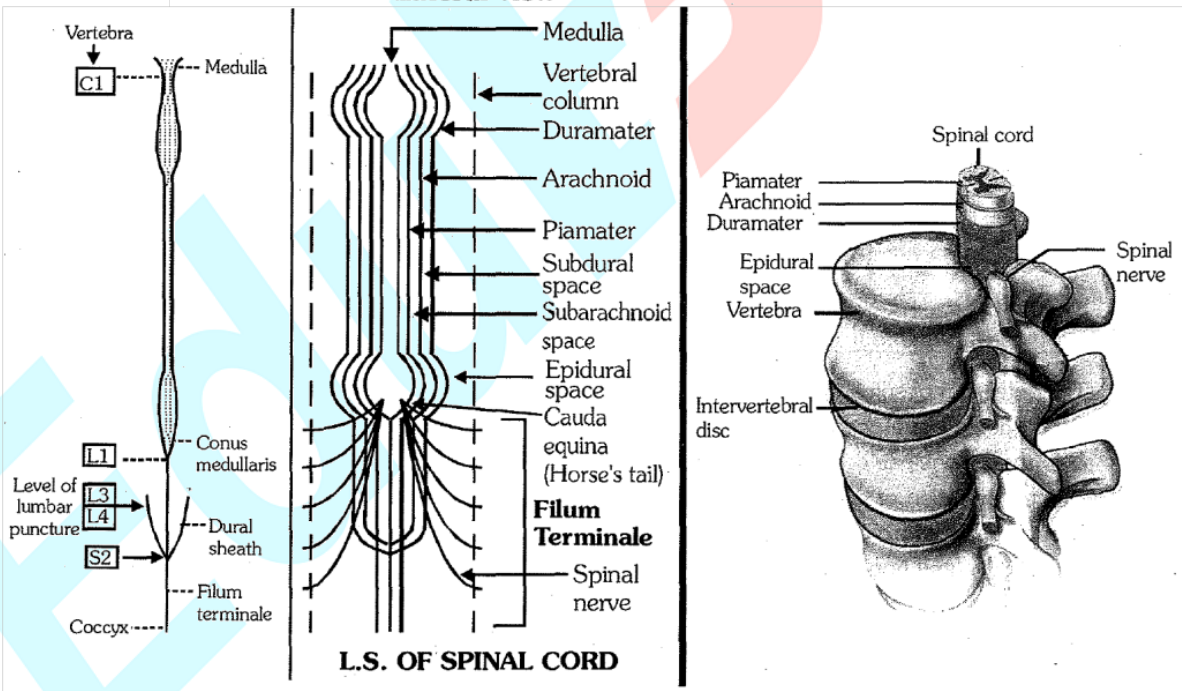
**7.** Excitment, Pleasure, Rage fear & Motivation are combined function of :-
(1) Amygdala (2) Hippocampus (3) Limbic lobe (4) All of these

**8.** Which of the following contains a number of centres which control body temperature urge for eating and drinking?
(1) Thalamus (2) Medulla oblongata
(3) Hypothalamus (4) Cerebrum

## SPINAL CORD




**Lateral view**




**L.S. OF SPINAL CORD**

- Medulla oblongata comes out from foramen of magnum & continues in neural canal of vertebral column, the continued part of MO is known as Spinal cord. It extends from base of skull to ($L_1$) lumbar vertebra.
- Its upper part is wide while lower most part is known as conus-medullaris.
  Conus medullaris present upto L1 vertebra. Terminal part of conus medullaris extend in the form of thread like structure called filum terminale.

- Filum terminale is non-nervous part. Metacoel also continues in spinal cord where it is known as neurocoel or central canal.
- The group of spinal nerve at the terminal end ($L_1$) of spinal cord form taillike structure called cauda equina (horse tail).
- Spinal cord is also covered by Duramater, Arachnoid & piamater. A narrow space is found between vertebra & duramater known as Epidural space.

Length of spinal cord is 45 cm.
Length of filum terminale is 20 cm.
Weight of spinal cord is approximately 35 gm

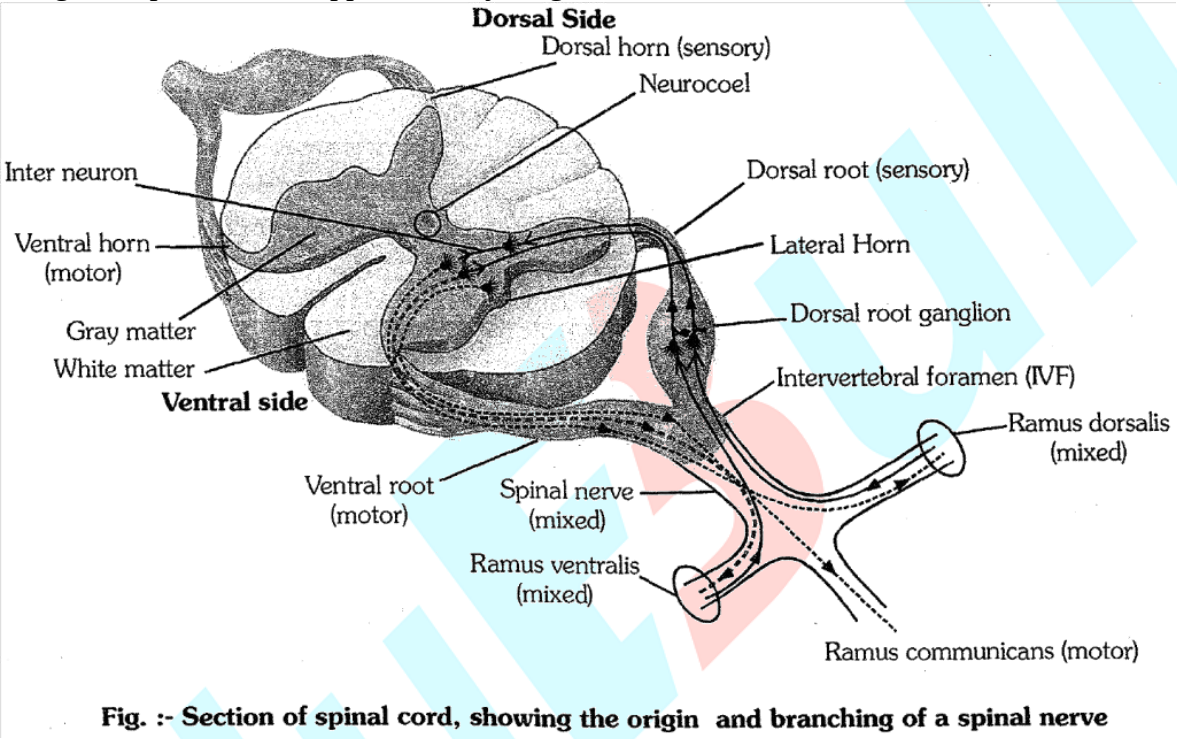



**Fig. :- Section of spinal cord, showing the origin and branching of a spinal nerve**

- The outer-part of spinal cord is of white matter while inner-part contain gray matter.
- On the dorso-lateral & ventro-lateral surface of spinal cord, the gray matter (butter fly shaped) projects outside & forms the one pair dorsal & ventral horn.
- Due to formation of dorsal & ventral horn white matter is divided in 4 segments & segment is known as Funiculus or white column.
- Dorsal & ventral horn continue in a tube like (bundle of never fibres) structure known as Dorsal root and Ventral root. In root of dorsal horn, ganglia is present called Dorsal root ganglia.
- Sensory neurons are found in the dorsal root ganglia which is pseudounipolar in nature. Its axon extend & gets embedded into gray matter of spinal cord & make synapse with ventral root neuron.
- Multipolar motor neurons are found in the ventral root. Its cyton and dendron are embedded into gray matter of spinal cord where they make synapse with axon of sensory neuron.
- Both sensory & motor nerve fibers combindly come out from intervertebral foramen & form spinal nerve.
- In some part of spinal cord on both side lateral horns are also found. Motor neurons are found in these horn. There nerve fibre follow the ventral root & comes out through intervertebral foramen. These fibre called Ramus communicans.

- Ramus communicans forms ANS.
- Spinal nerve & its branches are mixed type (except ramus communicans).

**Functions of spinal cord :-**

(1) It acts as a bridge between brain & organs of the body.
(2) It also provides relay path for the impulses coming from brain
(3) Spinal cord regulates and conducts most of the reflex action.

## PERIPHERAL NERVOUS SYSTEM

- All the nerves arising from brain and spinal cord are included in peripheral nervous system. Nerves arising from brain are called cranial nerves, and nerves coming out of spinal cord are called spinal nerves.
- 12-pairs of cranial nerves are found in reptiles, birds and mammals but amphibians and fishes have only 10-pairs of cranial nerves.

### (A) CRANIAL NERVES)

| No. | Name | Nature | Function |
|---|---|---|---|
| **I.** | Olfactory | Sensory | Smell |
| **II.** | Optic | Sensory | Sight |
| **III.** | Occulomotor | Motor | Movement of eyeball |
| **IV.** | Trochlear | Motor | Movement of eyeball |
| **V.** | Trigeminal (Dentist nerve) | Mixed | Teeth and Jaw muscles (mastication) |
| **VI.** | Abducens | Motor | Movement of eyeball |
| **VII.** | Facial | Mixed | Taste (antr 2/3 part of Tongue Facial expression |
| **VIII.** | Auditory | Sensory | Hearing and equilibrium |
| **IX.** | Glossopharyngeal | Mixed | Taste (Posterior 1/3 part of tongue) & saliva secretion |
| **X.** | Vagus (Pneumogastric) | Mixed | Visceral sensations and movements |
| **XI.** | Accessory spinal | Motor | Movement of pharynx, larynx |
| **XII.** | Hypoglossal | Motor | Movement of tongue |

### (B) SPINAL NERVES

- In Human only 31 pairs of spinal- nerves are found.
- Each spinal nerve is mixed type and arises from the roots of the horns of gray matter of the spinal cord. In dorsal root only afferent or sensory fibres and in ventral root efferent or motor fibres are found.
- Both the roots after moving for distance in the spinal cord of vertebrates combine with each other and come out from the Inter verterbal foramen in the form of spinal nerves.
- As soon as the spinal nerves come out of the inter vertebral foramen they divide into 3 branches:-

$$\left.\begin{array}{l}\text{(i) Ramus – dorsalis}\\ \text{(ii) Ramus ventralis}\end{array}\right] \text{S.N.S. (Somatic nervous system)}$$

(iii) Ramus communicans → A.N.S. [Sympathetic nervous system / Paraympathetic nervous system]

## GOLDEN KEY POINTS

- Longest cranial nerve is Vagus nerve.
- Largest cranial nerve is Trigeminal nerve.
- Smallest cranial nerve is Abducens nerve.
- Thinnest Cranial nerve Trochlear nerve.
- I, II and VIII cranial nerves are pure sensory nerves.
- III, IV, VI, XI and XII are pure motor cranial nerves.
- V, VII, IX, X are mixed cranial nerves.

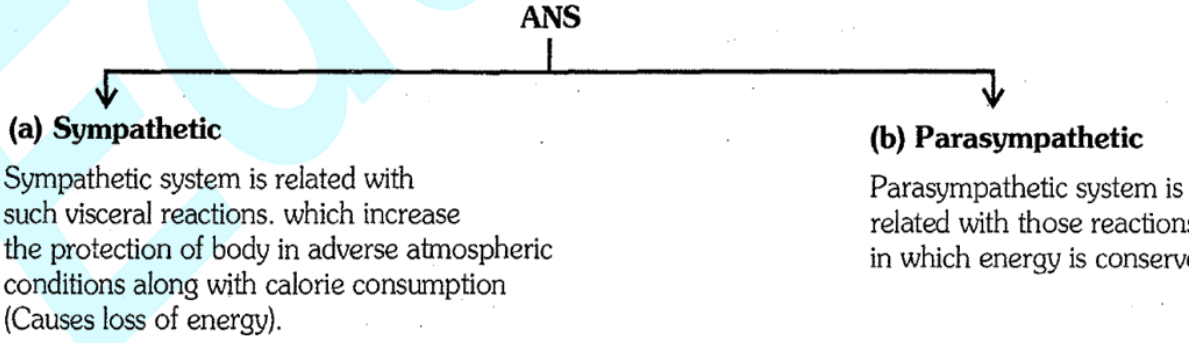
## AUTONOMIC OR VISCERAL NERVOUS SYSTEM

- The autonomic nervous system. Viseral nervous system is a part of peripheral nervous system that comprises the whole complex of nerves, fibres, ganglia and plexuses by which impulses travel from the central nervous system to the viscera and from the viscera to central nervous system. It controls activities inside the body that are normally involuntary, such as heart beat, peristalsis, sweating etc.
- It consists of motor neuron passing to the smooth muscle of internal organs. Smooth muscles are involuntary muscles. Most of the activities of the autonomic nervous system is controlled within the spinal cord or brain by reflexes known as visceral reflexes and does not involve the conscious control of higher centres of the brain.
- Overall control of the autonomic nervous system is maintained by centres in the medulla (a part of the hind brain) and hypothalamus.
- The autonomic nervous system is composed of two type of neurons.
  (a) Preganglionic neuron (myelinated)
  (b) Postganglionic neuron (non myelinated)

**Sites of ANS -**

Involuntary muscles, Exocrine glands, Blood vessels, skin (Pilomotor muscles, Blood vessels, Sweat glands)

**Divisions of ANS :** There are the two division of the autonomic nervous system :-




In this way, autonomic nervous system controls the activites of visceral organs double sided i.e. antagonistic to each other.

**Autonomic Nervous Control of Visceral Organs**

| S. No. | Name of Visceral Organs | Affect of sympathetic nervous system | Affect of parasympathetic nervous system |
|---|---|---|---|

| | | | |
|---|---|---|---|
| **1.** | Secretion | Acetyl choline + sympathetin | Only acetylcholine |
| **2.** | Iris of eye | Dilates pupils | Constricts pupils |
| **3.** | Heart | Increases the rate of cardiac contraction | Inhibits the rate of cardiac contraction |
| **5.** | Secretion of adrenal gland | Stimulates adrenal secretion | Inhibits adrenal secretion |
| **6.** | Lungs, trachea and bronchi | Dilates trachea bronchi & lungs for easy breathing | Constricts these organs during normal breathing . |
| **7.** | Alimentary canal | Inhibits peristalsis of alimentary canal. | Stimulates the peristalsis of alimentary canal |
| **8.** | Digestive glands | Inhibits the secretion of sweat | Stimulates the secretion of the glands. |
| **9.** | Sweat glands | Stimulates secretion of sweat | Inhibits secretion of sweat |
| **10.** | Arrector pilli muscles | Stimulates contraction of these muscles of skin, causing goose flesh | Relaxes Arrector pilli muscles. |
| **11.** | Urinary bladder | Relaxes the muscles of urinary bladder (Inhibits Micturition) | Contracts the muscles for ejaculation |
| **12.** | Anal sphincter | Closes anus by contracting anal sphincters. | Relaxes anal sphincter and opens the anus (Defaecation). |
| **13.** | External genitalia of male (penis) | Ejaculation | Erection |

## BEGINNER'S BOX-4

**1.** Which spinal nerve is not part of cauda equina ?
(1) Sacral spinal nerves (2) Lumber spinal nerves
(3) Thoracic spinal nerves (4) Coccygeal spinal nerve

**2.** Which structure is pure sensory ?
(1) Ramus dorsalis (2) Dorsal root
(3) Spinal nerve (4) Ventral root

**3.** The lower most part of the spinal cord upto which, the nervous part extend :-
(1) Epidural space (2) Conus medullaris
(3) Cauda equina (4) Central canal

**4.** Sensory neurous found in the dorsal root Ganglia are :-
(1) Motor (2) Apolar (3) Pseudounipolar (4) Multipolar

**5.** The group of cranial nerves which are associated with the movement of eye ball are :-
(1) I, II, VIII (2) III, IV, VI (3) VII, IX, XII (4) III, IV, VII

**6.** Somatic nervous system is formed by :-
(1) Ramus dorsalis (2) Ramus communicans
(3) Ramus ventralis (4) Both 1 & 3

**7.** Which of the following is not a function of parasympathetic nervous system ?

(1) Inhibition of peristalsis of alimentary canal
(2) Relaxation of arrector pilli muscles
(3) Erection of penis
(4) Contraction of urinary bladder

**8.** Which of the following nerves is purely sensory ?
(1) Occulomotor (2) Trochlear (3) Facial (4) Optic

## REFLEX ACTIONS

- "Marshal Hall" first observed the reflex actions.
- The entire process of response to a pheriperal nervous stimulation, that occurs involuntarilv i.e. without conscious effort or thought and requires the envolvement of a part of the central nervous svstem is called a reflex action.
- Reflex actions are spontaneous, automatic, involuntary, mechanical responses produced by stimulating specific receptors.
- Reflex actions are involuntary actions. Reflex actions are completed very quickly as compared to normal actions. They prevent body from any adverse effect.
- It is form of animal behaviour in which the stimulation of a sensory organ (receptor) result in the activity of some organ without the intervention of will.

## REFLEX ARC

- The reflex pathway comprises at least one afferent neuron {receptor) and one efferent (effector or excitor) neuron appropriately arranged in a series.
- The afferent neuron receives signal from a sensory organ and transmits the impulse Via a dorsal nerve root into the CNS (at the level of spinal cord).
- The efferent nueuron then carries signals from CNS to the effector.
- The path of completion of reflex action is called reflex arc.
- Sensory fibres carry sensory impulses in the gray matter. These sensory impulses are converted now into motor impulses and reach up to muscles. These muscles show reflex actions for motor impulses obtained from motor neurons.

**Types of Reflex action :-**

**(i) On the basis of site :-**

| **(A) Cranial reflex :** | **(B) Spinal reflex :** |
|---|---|
| (i) These actions are completed by brain.<br>(ii) No urgency is required for these actions.<br>(iii) These are slow actions<br>e.g. watering of mouth to see good food. | (i) These actions are completed by spinal cord.<br>(ii) Urgency is required for these actions.<br>(iii) These are very fast actions<br>e.g. Displacement of the leg at the time of pinching by any needle. |

**(ii) On the basis of previous experiences :-**

**(A) Conditioned reflex :**

Previous experience is required to complete these actions e.g. swimming, cycling, dancing, singing etc. These actions were studied first by Evan Pavlov on dog.

Initially these actions are voluntary at the time of learning and after perfection , these become involuntary.

**(B) Unconditioned reflex :**

These actions do not require previous experience e.g. sneezing, coughing, yawning, sexual behaviour for opposite sex partner, migration in birds etc.

**(iii) On the basis of synapse :**

**(A) Monosynaptic :**

In this type of reflex arc, there is a direct synapse (relation) found between sensory and motor neurons, thus nerve impulse travels through only one synapse. eg. -Stretch reflex/ Knee-Jerk reflex

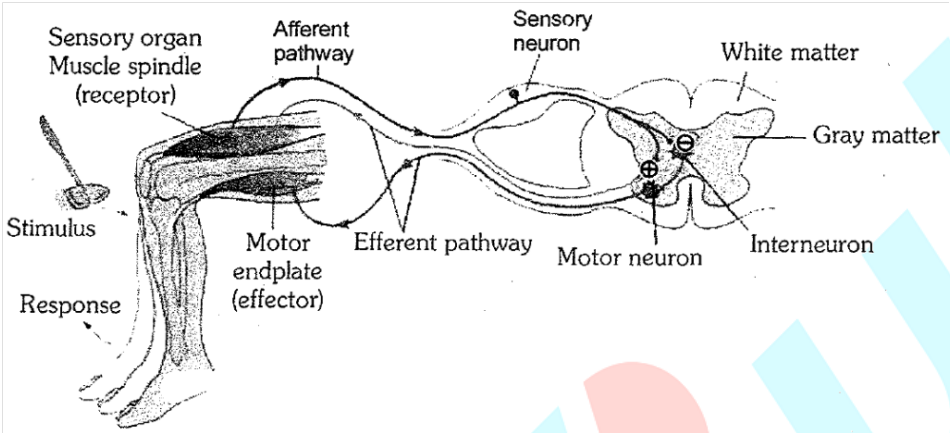



**Fig. Knee jerk reflex (Monosynaptic reflex arch)**

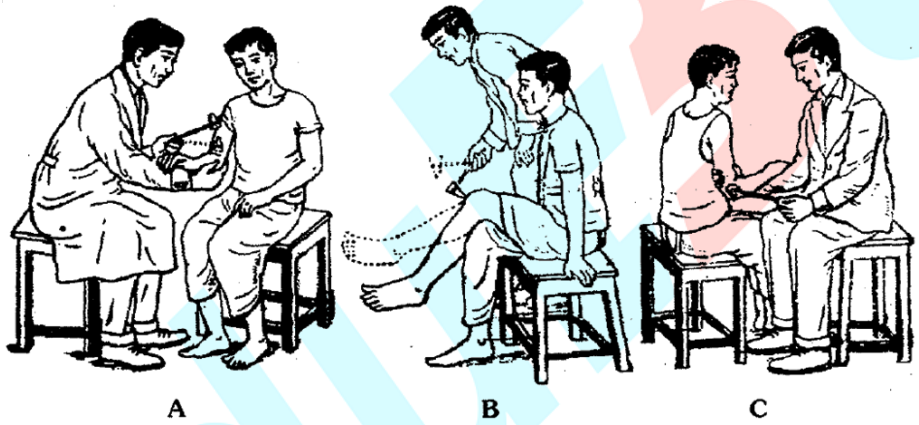



Fig. Diagrammatic representation of reflex (Monosynaptic)

**A = Bicepse tendon reflex, B = Knee jerk, C = Triceps tendon reflex.**

**(B) Polysynaptic :**

- In this type of reflex arc, there are one or more small neurons found in between the sensory and motor neurons. These small neurons are called connector neuron or inter neurons or internuncial neurons
  e.g. withdrawal reflex.
- In such synapse nerve impulse will have to travel through more than one synapse.

## BEGINNER'S BOX-5

**1.** The form of animal behavior in which stimulation of sensory organ result in the activity of some organ without the intervention of will is known is :-

(1) Slow action (2) Reflex action

(3) Voluntary response (4) Planned response

**2.** The (A) neuron receives signals from sensory organ and transmit the impulse via (B) nerve root into the CNS.
(1) A - Afferent, B - Dorsal (2) A - Afferent, B - Ventral
(3) A - Efferent, B – Dorsal (4) A- Efferent, B- Ventral

**3.** All of the following are examples of conditioned reflex except :-
(1) Swimming (2) Dancing (3) Playing piano (4) Sneezing

**4.** The (B) neuron carries the signal from CNS to the effector via (B) root.
(1) A - Efferent, B - Dorsal (2) A - Afferent, B - Dorsal
(3) A - Efferent, B - Ventral (4) A - Afferent, B – Dorsal

**5.** The direction of against stimulus response is opposite in which of the following reflex action ?
(1) Biceps tendon reflex (2) Knee jerk reflex
(3) Tricep tendon reflex (4) Withdrawal reflex

**6.** At least pow many afferent and efferent neuron and involved in any reflex action ?
(1) One afferent, one efferent neuron
(2) One afferent, two efferent, one interneuron
(3) One afferent, one efferent, two interneuron
(4) Two efferent, one efferent, one interneuron

**SPECIAL NOTE : MAJOR FUNCTIONS OF THE BRAIN**

| Part of Brain | Description | Function |
|---|---|---|
| Frontal lobe of cerebrum (Fore-brain) | All those movements which are under the voluntary control of the body, that are performed with the will of the organism are called the voluntary movements. Walking, running, talking, typing, Writing are some of the voluntary movements. | Voluntary movements |
| Cerebellum (Hind brain) | The brain controls the balance of the body. Balance is required in the static as well as dynamic activities.<br>(a) Static activities are those activities which are performed without changing the location of the body i.e. standing, sitting, lying positon.<br>(b) Dynamic activities involve the change in the location of the body i.e. walking, running. | Balance of the Body |
| Hypothalamus and Medulla-oblongata | The functioning of vital involuntary organs like and heart lungs, digestive tract, liver, kidney, Medulla-oblongata reproductive tract are controlled by brain. The activities like heart beat, digestion of food, I excretion, gametogenesis all are controlled by human brain. | Functioning of the vital involuntary organs |
| Hypotalamus | The control of body temperature is called is called the thermoregulation. The enviornmental condition keep on changing but the internal body temperature is maintained at a constant level i.e. around 37°C. This temperature regulation is called the thermoregulation which is also under the control of | Thermoregulation |

| | | |
|---|---|---|
| | brain. | |
| Hypothalamus | The hunger and thirst are also under the control of human brain. | Hunger and thirst |
| Pineal gland and Hypothalamus | Our body adapts itself according to its daily scheduled activities and maintains its, 24-hour rhythm of sleeping, awakening etc. This 24-hour rhythm of the body is called the circadian rhythm of the body. | Circadian (24 hour) rhythms of our body |
| Hypothalamus | The ductless glands called the endocrine glands are under the control of the brain. Some hormones like growth hormone, oxytocin, leutinizing hormone are regulated by the brain itself. However other endocrine glands (outside the brain) like thyroid, adernal gland etc are also under the direct control of the brain by neural as well as endocrine signals. | Activities of endocrine glands |
| Cerebrum | The human behavior, creative ideas, ability of decision making, will- power intelligence, thoughts. | Higher functions |
| Cerebrum (Hippocampus) | First of all any information is stored in brain in terms of recent or short term memory but after repetition of the same (by making more number of synapse) it is converted into long term or permanent memory. | Memory |
| Cerebrum :<br>Parietal lobe<br>Occipital lobe<br>Temporal lobe | <br>Touch, pain, temperature, vibration, pressure, taste<br>Vision<br>Hearing, smell | Processing and analysis of various sensation |
| Hypothalamus and limbic system (amygdale) | Love, anger, hate, jealous, rage. | Emotion and Human behavior |

## EXTRA POINTS

**1.** In human brain more than 100 billion neurons are present.
**2.** Each neuron cell connect with 25,000 other cell.
**3.** Glycine is neuro inhibitory hormone present in spinal cord.
**4.** Glutamic acid is mainly used by our brain cells as excitatory neurotransmitter.
**5.** The velocity of nerve- impulse is 5 to 50 times more faster in Myelinated nerve- fibres than in Non-myelinated nerve -fibres.
**6.** In mammals the speed of nerve impulse is 100-130 m/sec (maximum). In frog, the speed of nerve impulse is 30m/sec. In reptiles the speed is 15 to 35m/sec.
**7.** Malathione :- This substance is used as insecticide and it destroy the acetyl cholinesterase in syna pse area.
**8.** Botulism :- It is food poisoning disease and it produces by Clostridium botulinum bacteria. This bacteria release neurotoxin.
**9.** Curare :- is drug which blocks acetylcholine receptor on skeletal muscle, so that it can be used by a surgeon for keeping a muscle relaxed during operation.
**10.** "Meningitis". It arises due to infection or inflammation or injury in the meninges. Infection may virus or bacteria or both.
**11.** Cerebrum is the centre of following:-

(1) Intelligence (2) Emotion (3) Will- power (4) Memory
(5) Consciousness (6) Experience (7) Knowledge (8) Voluntary
(9) Laughing and weeping (10) Defaecation and micturition

**12.** Increase in the amount of cerebra- spinal fluid is a diseased condition termed as the hydrocephalus

**13.** Trigeminal nerve is also called "the dentists nerve" because the dentists desensitizes this nerve with some anaesthetic before pulling out the troubling tooth.

**14.** Acetylcholine is synthesized by the Mitochondria.

**15.** Reticular activating System :
It is special sensory fibre which is situated in Brain stem & further go into Thalamus. It is related consciousness, alertness & awakening. Therefore it is also called gate keeper of consciousness.

**16.** Parkinson's disease :- It occurs due to hyposecretion of dopamine which creates rigidity is muscle leads to muscle tremors. It begin from progressive degeneration of neuron of basal nuclei ultimately creates mask like face.

**17.** Hutington's chorea (Autosomal dominant disorder):- It develops a deficiency of neurotransmitter GABA which causes rapid, involuntary & progressive dementia followed by death. It's a impairment of cerebellum.

**18.** Alzheimer's disease- In this disease, the cerebral cortex is atrophied and ultimately the ventricle enlarges. Symptoms consist loss of memory particularly recent memory due to hyposecretion of acetylcholine, its' also caled dim entia of old age. β amyloid, Protein also increases (Partial loss of memory). Alzheimer disease is more common in "Down syndrome".
Treatment- No effective treatment available.

**19.** Nor-adranaline is one of the neurotransmitter that plays a role in mood changes. If the level of nor-adranalins is low for some reason, then the signal sending activity become low and the person suffers from depression. An enzyme monoamine oxidase is responsible for degradation of noradrenaline at syml.pse. Drugs which cause inhibition of this enzyme are used in treatment of depression.

**20.** Tabun, sarin, soman are organophosphate chemical. These chemical are known as "Nerve gas". These gases block cholinesterase activity and are known as anticholinesterase agents. It protect Acetyl cholin from hydrolysis at synapse and potentiate cholinergic effect i.e. potentiate effects of parasympathetic nervous system.
Malthione, parethione are other organiphosphates which are used as insecticides.

**21.** In spinal cord of human ten laminae are present in gray matter.

**22.** Cavities of brain (Ventricles)
• Paracoel or Lateral ventricle or I & II ventricle (largest) -Found in Cerebral hemisphere
• III Ventricle or Diocoel- Found in Diencephalon
**Note:** I & II open in III Ventricle via Foramen of Monro
• IV Ventricle- Cavity of hind brain.
**Note:** Cavity of Medulla Oblongata - Metacoel
Cavity of Spinal cord- Neurocoel/Central Canal

## ANSWER KEY

## BEGINNER'S BOX-1

**1.** (3) **2.** (2) **3.** (4) **4.** (4) **5.** (3) **6.** (2) **7.** (3)
**8.** (4)

## BEGINNER'S BOX-2

**1.** (1) **2.** (4) **3.** (4) **4.** (2) **5.** (2) **6.** (3) **7.** (3)
**8.** (2)

## BEGINNER'S BOX-3

**1.** (2) **2.** (4) **3.** (3) **4.** (4) **5.** (4) **6.** (3) **7.** (3)
**8.** (3)

## BEGINNER'S BOX-4

**1.** (3) **2.** (2) **3.** (2) **4.** (3) **5.** (2) **6.** (4) **7.** (1)
**8.** (4)

## BEGINNER'S BOX-5

**1.** (2) **2.** (1) **3.** (4) **4.** (4) **5.** (4) **6.** (1)