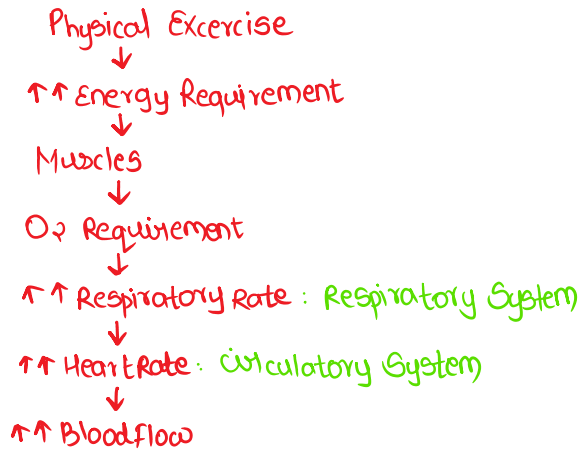


Neural Control & Coordination



Neural System:-

1. Co-ordination is process through which two or more organs interact & complement functions to one another.
2. It forms integrative system of Body
3. In Hydra : network of neurons
Insects : double ventral solid nerve cord
Vertebrates: single hollow dorsal nerve cord.

Functions :

1. Maintaining homeostasis
2. Interpretation of senses
3. Co-ordination of organs
4. Point to point connection.

Difference b/w Nervous & Endocrine System:

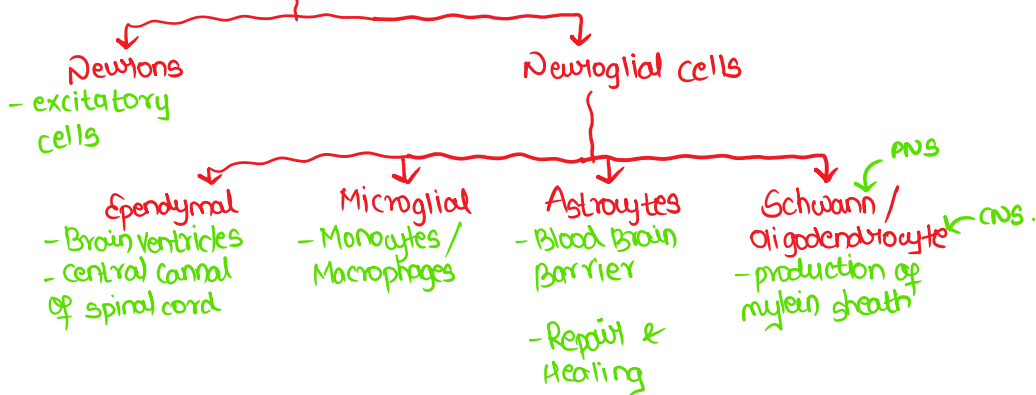
Nervous

1. fast response
2. Short duration
3. Electrical Impulse
4. Localised effect

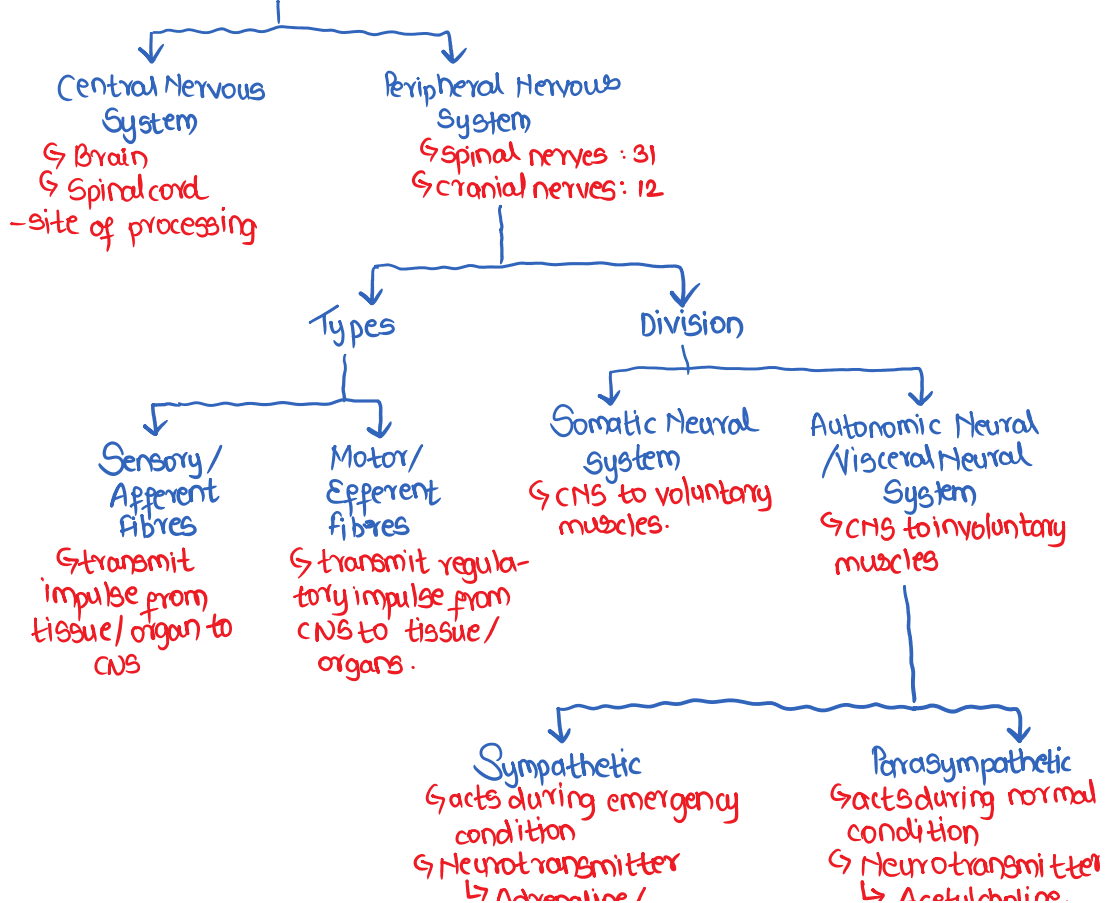
Endocrine

1. Slow response
2. Long duration
3. chemical messengers
4. Widespread Effect.

Cells of Nervous System :-



HUMAN NEURAL SYSTEM:-



Unipolar Neurons:

- ↳ only one axon with cell body
- ↳ Eg: Embryo of vertebrates.



Bipolar Neurons:

- ↳ cell body + 1 Axon + 1 dendrite
- ↳ Eg: Retina of eye
olfactory epithelium



Pseudounipolar Neurons:

- ↳ T-shaped nerve cell derived from branching of single process which grows out from cell
- ↳ Eg: Dorsal Root Ganglion of Spinal Cord.



Multipolar Neuron:

- ↳ 1 cell body + 1 Axon + many dendrites
- ↳ Eg: cerebral cortex.

Ⓑ On the basis of presence / absence of Myelin sheath:-

Myelinated Neurons

- presence of myelin sheath
- spiral wrapping of cell
- whitish in colour
↳ lipid content
- fast conduction
- aka saltatory conduction

Eg: Spinal & Cranial nerves

Non Myelinated Neurons.

- absence of myelin sheath
- innervation of cell
- Grayish in colour
- slow conduction

Eg: ANS
SNS.

Ⓒ On basis of function:-

Sensory Nerve

- impulse from receptor to CNS
- aka Afferent nerve

Motor Nerve

- impulse from CNS to effector
- aka efferent nerve

Mixed Nerve

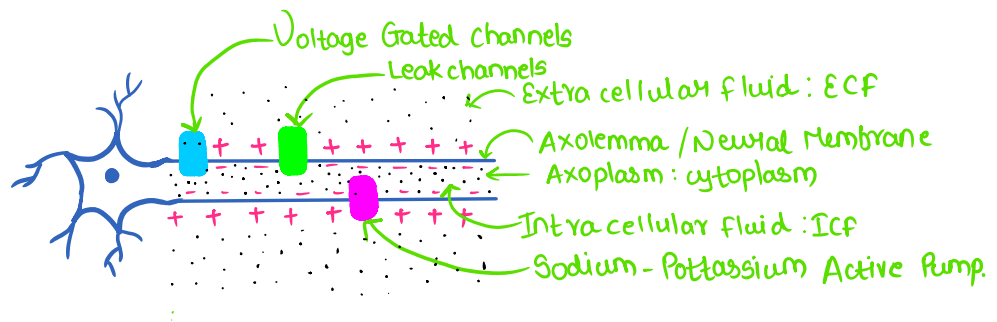
- has both sensory & motor nerves.
- -

NOTE:

- ① collection of cytons
 - Nuclei: CNS
 - ganglia: PNS
- ② collection of nerve fibre
 - Tract: CNS
 - Nerve: PNS

Generation of Nerve Impulse:-

● POLARISED STATE:-



→ Axolemma / Neural Membrane:
↳ membrane around axon

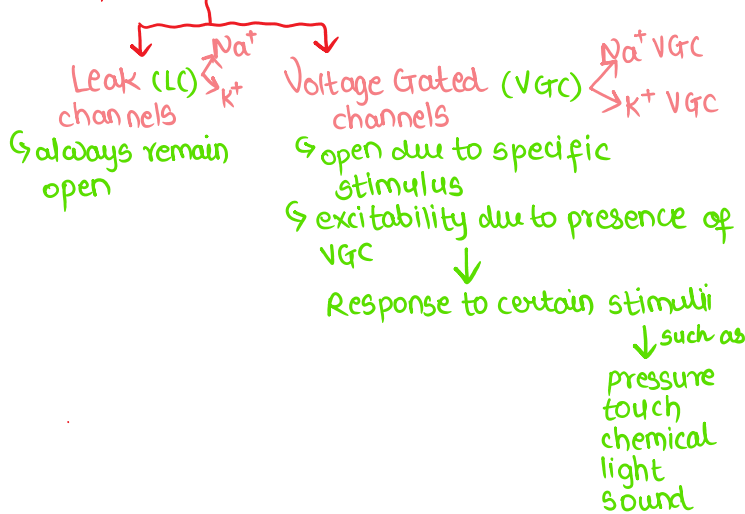
→ Axoplasm:
↳ cytoplasm inside axon

→ Fluid in Neuron:

Extra-cellular Fluid	Intra-cellular Fluid
↳ outside axon	↳ inside axon
↳ KA ECF	↳ KA ICF
↳ more Na^+	↳ more K^+

→ channels on Axolemma:
 ↳ pores formed by proteins on membrane.

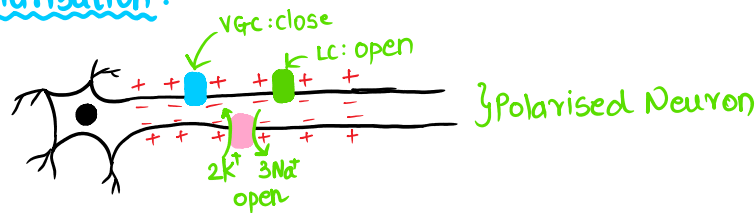
1) Ion channels



2) Sodium-Potassium Pump:
 ↳ sends 3Na⁺ in ECF ← 2K⁺ in ICF.
 ↳ maintenance of charge inside & outside the membrane.

● THE RESTING POTENTIAL:-

* Polarisation:



- when a neuron is not conducting any impulse : RESTING AXONAL MEMBRANE
 RESTING POTENTIAL ← Electrical Potential difference

- Resting neuron: Polarised State: outside = +ve charge
 inside = -ve charge

- During resting potential, Axonal membrane
 ↳ ↑↑ permeable to K⁺ & nearly impermeable to Na⁺ ion
 ↳ impermeable to -vely charged protein in axoplasm

- Axoplasm = Intracellular = ↑K⁺ ions, ↓Na⁺ ion
 Fluid ↑ -vely charge protein } Forms Ionic Gradient
 Extracellular fluid = ↑Na⁺ ions, ↓K⁺ ion
 maintained by Na-K pump



↓
 (EFFLUX) 3Na⁺: inside to outside
 (INFLUX) 2K⁺: outside to inside

Na^+ out
 (NOKIA) K^+ influx
 3 2 1-ATP

(EFFLUX) 3Na^+ : inside to outside
 (INFLUX) K^+ : outside to inside

↓
 due to which outer surface +vely charge
 inner surface -vely charge.

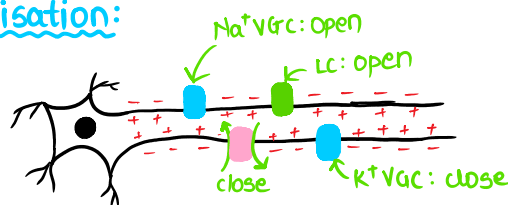
- Resting membrane potential = -40 to -90mv [Avg = -70mv]
 § minus sign indicates negative relative to outside.

- channels: Leak channels: open
 Voltage Gated channels: close
 Na^+ - K^+ pump: open

● THE ACTION POTENTIAL:-

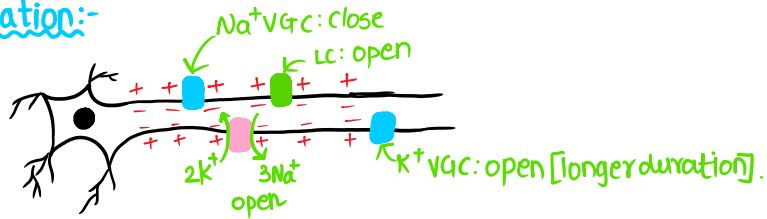
- transmission of nerve impulse: ACTION POTENTIAL
- Occurs in 4 phases:
 - § Initiation of Action potential : Threshold Stimulus
 - § transmission along a neuron
 - § transfer to target cell
 - § Effect on target cell.
- Action potential are all or none law.

* Depolarisation:



- change in membrane permeability & shift in balance of ions.
- Threshold stimulus: stimulus required to open Na^+ VGC channels
 ↳ -55mv to -60mv
- channels: 1) Na^+ VGC: open, K^+ VGC: close
 2) LC: open
 3) Na^+ K^+ pump: close
- Axonal membrane becomes permeable to Na^+
 ↓
 Influx of Na^+
 ↓
 more positive charge in axoplasm & negative charge outside axoplasm
 ↓
 Reversal of polarity: Depolarisation of Membrane.
- Action potential goes upto $+30\text{mv}$

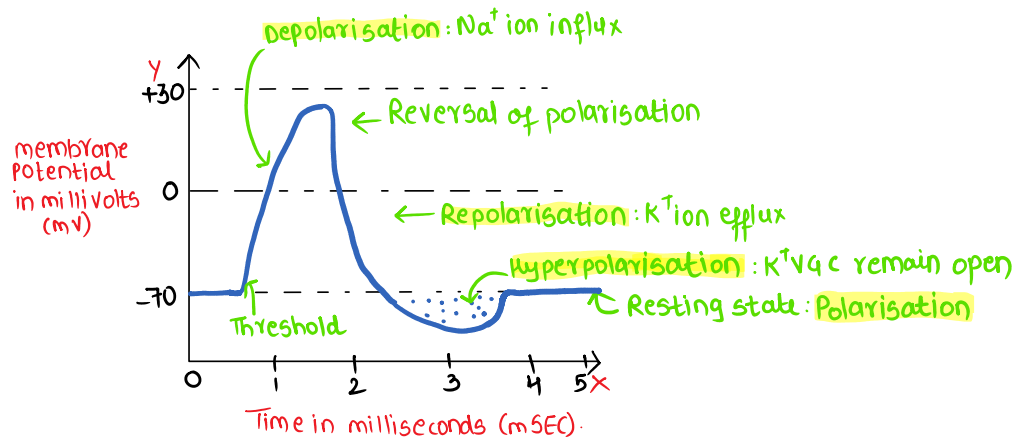
* Repolarisation:-



- channels: 1) Na^+ VGC closes = 0.5 msec
- 2) K^+ VGC open
- 3) Axonal membrane permeable to K^+ ions
- 3) LC: open
- 4) Na^+ K^+ pump: open
- pumping out of K^+ ions
- Axoplasm starts becoming negative
- potential falls back to resting potential
- It is known as repolarisation (1-5 msec)

- K^+ VGC remain open for longer duration
- ↓
- membrane potential becomes more negative
- ↓
- Goes up till -90mV
- ↓
- It is known as * **HYPERPOLARISATION**

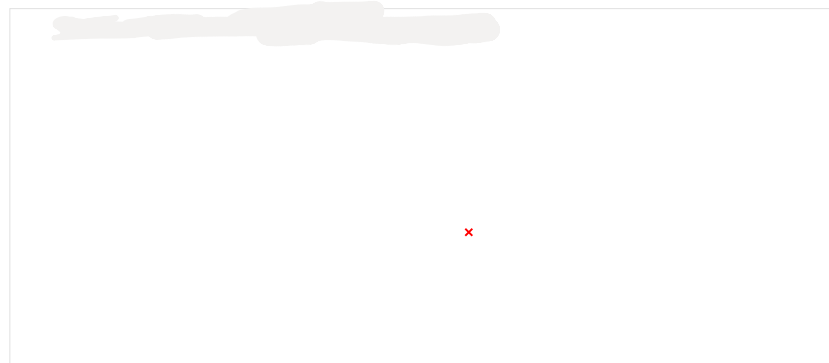
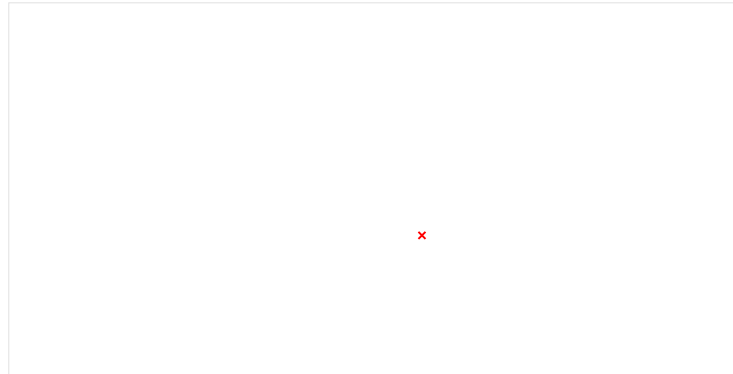
NOTE: Spike Potential: Sharp rise & rapid fall.



Polarisation Depolarisation Repolarisation Hyperpolarisation

Ion Channel	OPEN	OPEN	OPEN	OPEN
Na^+ VGC	CLOSE	OPEN	CLOSE	CLOSE
K^+ VGC	CLOSE	CLOSE	OPEN	OPEN
Na-K pump	OPEN	CLOSE	OPEN	OPEN
charge	-70mV	+30mV	-70mV	-90mV

Conduction Of Nerve Impulse:-



NOTE: 1) site A : +ve charge } inner side } current flows from
site B : -ve charge (axoplasm) } inner surface of site A to B.

2) site A : -ve charge } outer side } current flows from
site B : +ve charge } outer surface of site B to A

3) Nerve fibres show ALL OR NONE LAW

4) Refractory period: time period to restore initial stage (4-5 msec)

NOTE: factors Affecting Conduction:

1) Speed of conductⁿ \propto Diameter

2) Speed of conductⁿ \propto Myelin Sheath

3) Speed of conductⁿ \propto Temperature

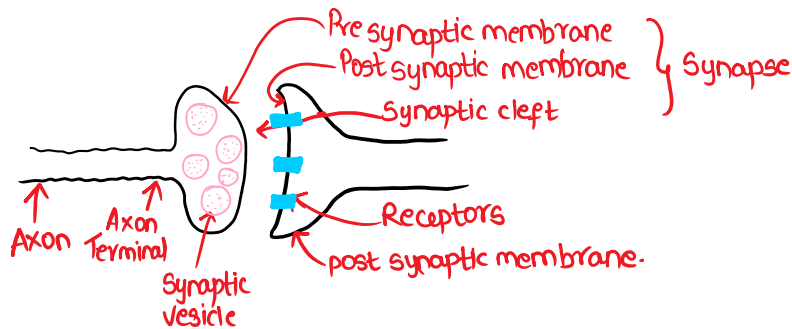
4) Speed of conductⁿ \propto $\frac{1}{\text{ether, chloroform}}$

5) Speed of conductⁿ doesn't depend upon length of Neuron.

SYNAPSE:-

- Conduction: **SALTATORY CONDUCTION**
 ↳ Saltare
 ↓
 Jump.
- In myelinated nerve fibres, myelin sheath is present which is made up of **GLYCOLIPID**.
 ↳ acts as insulator
- Discontinuity of myelin sheath: **NODES OF RANVIER**.
- In saltatory conduction, the impulse (Action Potential) jumps from one node of ranvier to another.

Transmission Of Impulse:-



- Synapse:- nerve impulse is transmitted from one neuron to another through junction called synapses.
 - made up of membranes $\left\{ \begin{array}{l} \text{presynaptic membrane} \\ \text{postsynaptic membrane} \end{array} \right.$ which may or may not be separated by gap called synaptic cleft.
- Types of Synapse:

Electrical Synapse

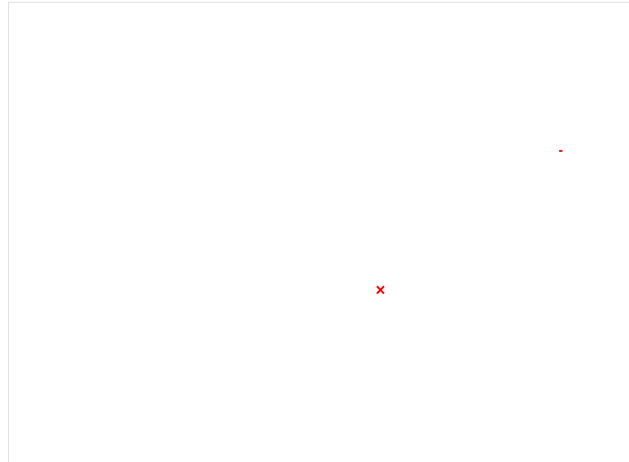
- pre & post synaptic membrane are in close association with each other
- Electrical current flows from one neuron to another
- synaptic cleft absent
- No synaptic delay

Chemical Synapse

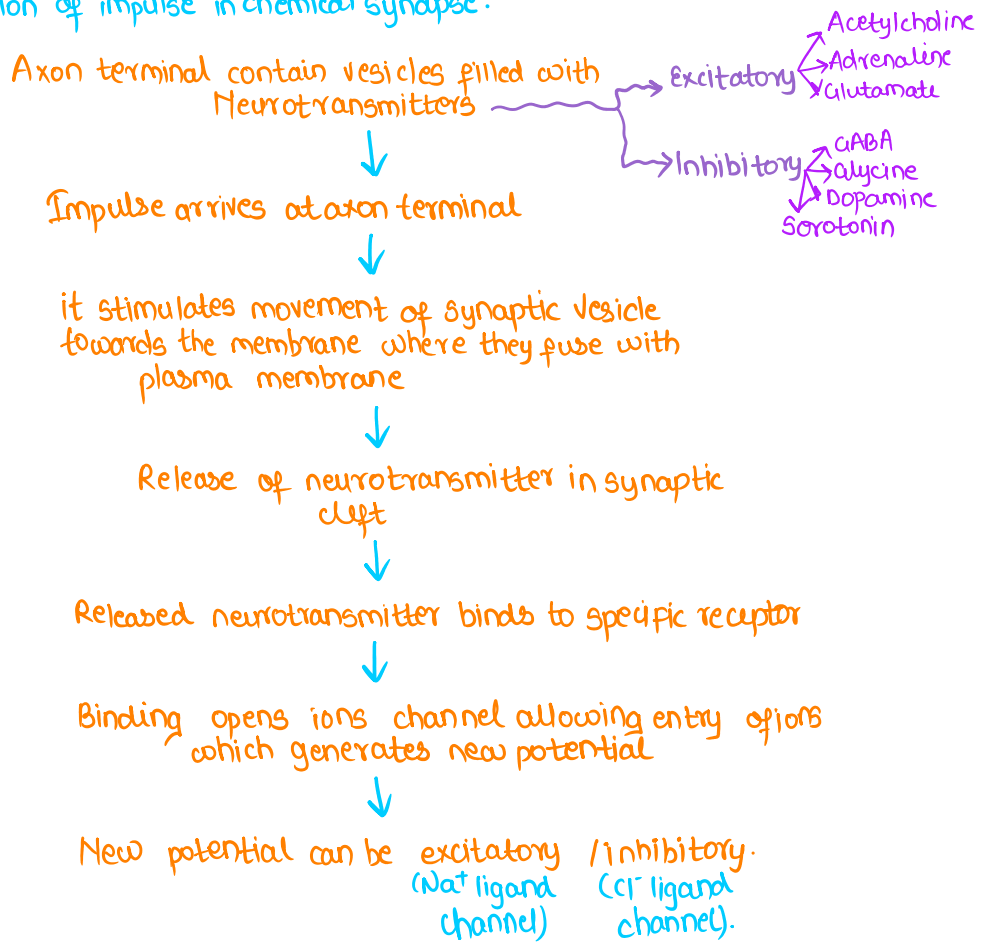
- pre & post synaptic membrane are separated by fluid filled space called synaptic cleft.
- chemicals are released which binds with the receptor
- Synaptic cleft present
- Synaptic delay present

- Can't be block
- Gap junctions present
- 0.2nm

- can be block
- Gap junctions absent
- 720nm.



Transmission of impulse in chemical synapse:



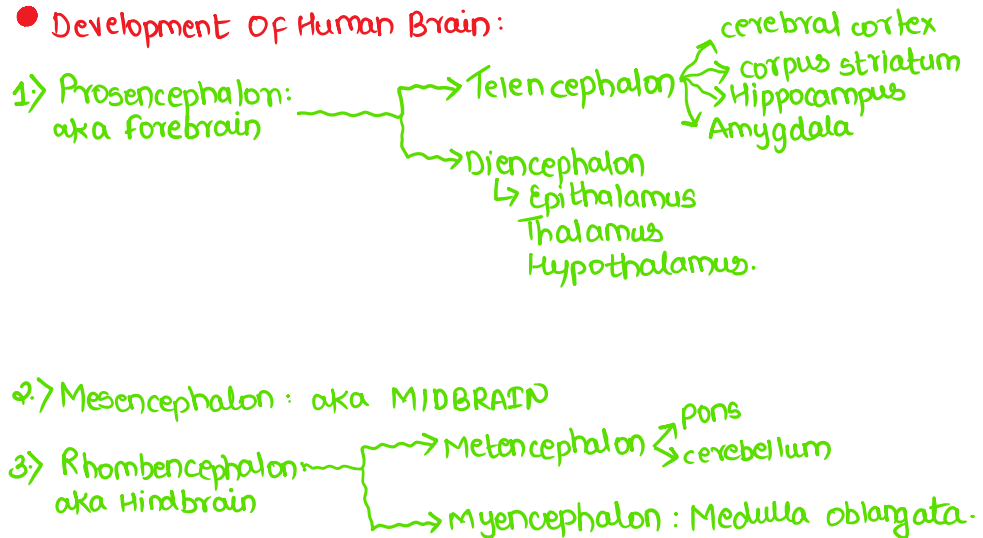
NOTE: Impulse conduction is always in one way.

Central Nervous System:- BRAIN & SPINAL CORD.

● Human Brain:

- aka encephalon
- study: encephalogy
- central information processing organ of body
- center for intelligence, memory, vision, hearing, etc
- command & control system
 - ↳ all voluntary & involuntary actions.

● Development Of Human Brain:



● Structure:-

- soft, delicate, walnut shape
- well protected by Brain Box / Cranium: made up of 8 bones.
- Inside skull brain is covered by layers: CRANIAL MENINGES.

↓
three in number

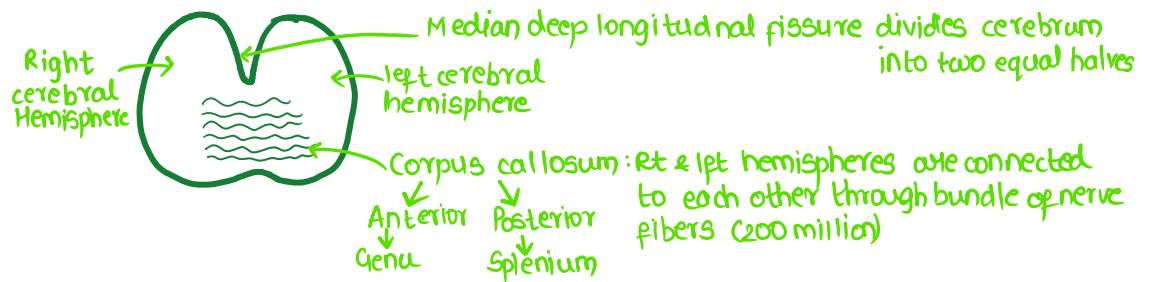


● Major function of Human Brain :-

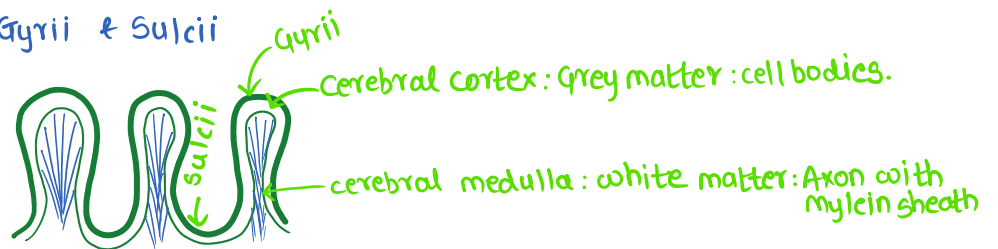
- a) Voluntary movements
- b) Balance of body
- c) Functioning of vital organs
- d) Thermoregulation
- e) Hunger & thirst
- f) Circadian rhythm of body
- g) Activities of endocrine glands.
- h) Human behaviour
- i) Interpretation of Senses.

● forebrain :- A) CEREBRUM

- ↳ most prominent part of brain
- ↳ forms the major portion of brain



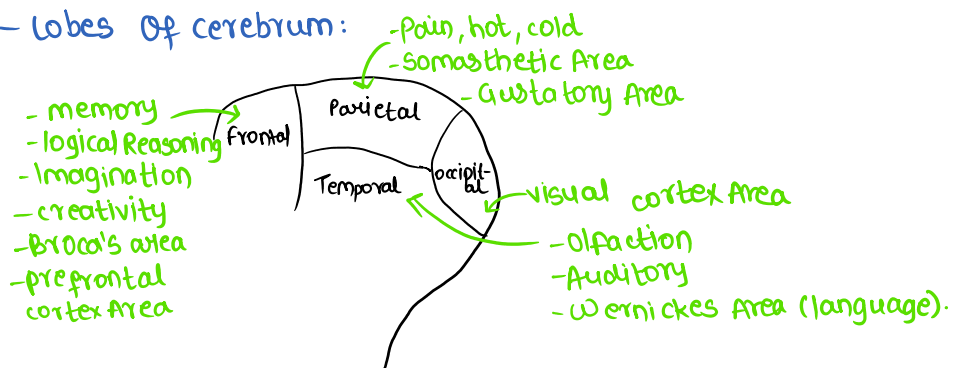
- Gyrii & Sulcii



- Major Areas of Cerebrum:

- 1) Sensory Area
- 2) Motor Area
- 3) Association Area: Intersensory
Memory
Communication.

- Lobes Of cerebrum:



B) Diencephalon:-

Epithalamus

- forms roof
- Non nervous part
- encloses pineal gland & habenula
- controls sexual maturity
- smallest part

Thalamus

- cerebrum wraps around thalamus
- Act as Relay centre
- major coordinating centre for sensory & motor signaling.
- forms lateral wall
- Gate Keeper of Brain

Hypothalamus

- connection b/w Nervous & endocrine system of Body
- forms the floor
- located at base of thalamus
- has neurosecretory cells which secrete HYPOTHALAMIC HORMONE
- Functions: Biological clock
Thermoregulation (thermo-stat)
Hunger
Thirst
Emotional Behaviour

• LIMBIC SYSTEM:-

1. inner part of cerebral hemispheres & deep associated structures

2. aka limbic lobe

3. look likes wish bone or fork

4. made up of Hippocampus + Amygdala + olfactory lobe

- conversion of short term memory to long term.
- Smell

- Almond shape
- controls anger & Rage

- broad bean size found in ventral surface of frontal lobe
- center of smelling power.

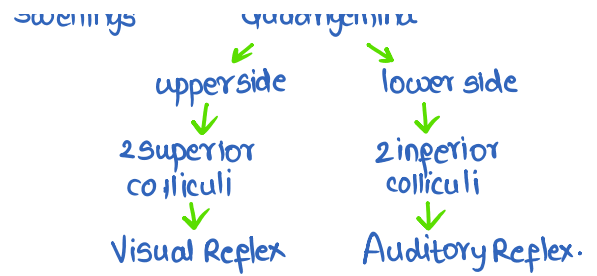
5. Limbic System + Hypothalamus = Emotional Brain

- Motivation ↓
- Sexual Behaviour ↓
- Emotions ↓

● MIDBRAIN:-

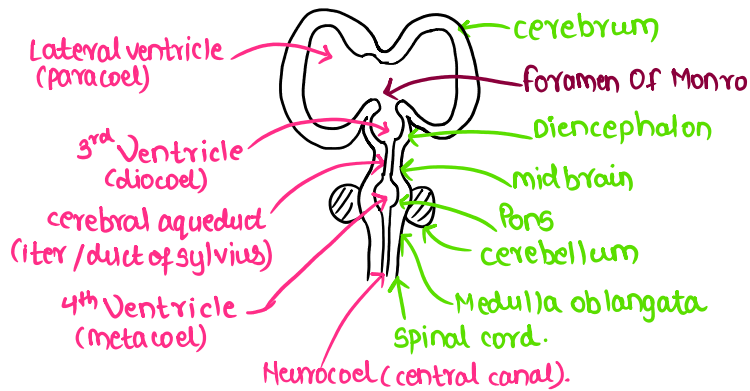
1. Located b/w thalamus/Hypothalamus of forebrain & pons of hind Brain.





3. Anterior part contains 2 longitudinal bundles of myelinated nerve fibers called CRURA CEREBRI (cerebellum peduncle).
 ↳ connects cerebrum with cerebellum
 ↳ controls muscles of limbs.

4. Ventricles:



• Around 4th Ventricle
 ↳ 3 openings
 ↳ 2 lateral Apertures
 ↳ foramina of Luschka
 ↳ 1 Median Aperture
 ↳ foramina of Magendie.

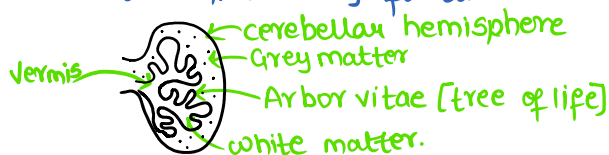
5. Midbrain receives tactile, visual, auditory inputs.

● HIND BRAIN:

- Ⓐ Pons: 1. acts as bridge
 2. link b/w cerebellum & cerebral cortex.
 3. has transverse nerve fibers & longitudinal nerve fibers.
 4. has pneumotaxic center

Ⓑ Cerebellum:-

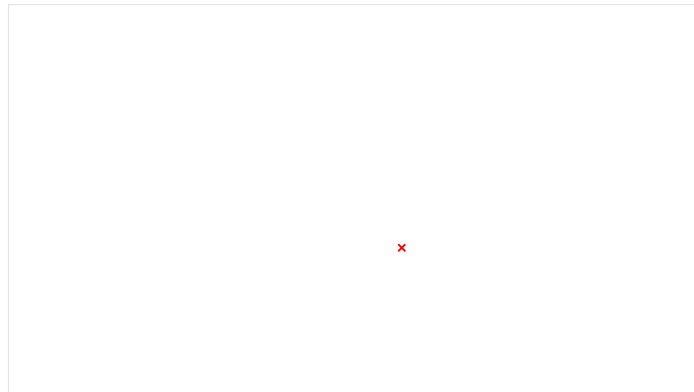
1. Second largest part of Brain
2. aka little brain
3. has 2 cerebellar hemispheres
4. Body Balancing
5. controls involuntary functions.



© Medulla oblongata:-

1. connects to spinal cord
2. contains centers: Respiration, Cardiovascular, Gastric Reflexes, secretions.
3. has Respiratory Rhythm centre
4. Destruction of medulla oblongata causes immediate death.

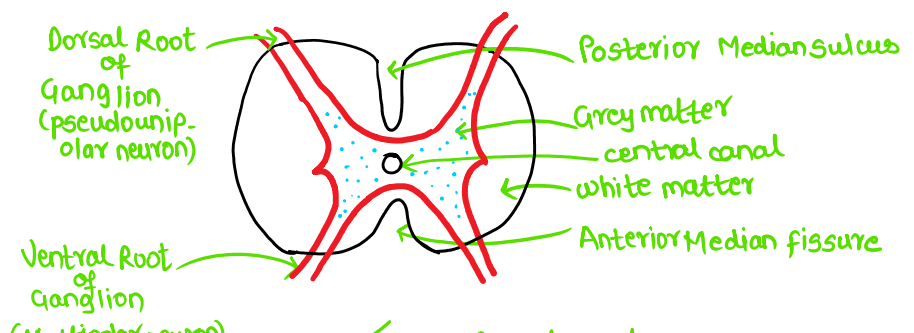
● Brain Stem: Midbrain + Pons + Medulla.



● Spinal Cord:-

- elongated cylindrical structure
- located in neural canal of vertebral column
- Runs downward through FORAMEN MAGNUM
- continues with medulla oblongata.
- L: 45cm
- extends down upto 1st lumbar vertebra tapers to a point called conus medularis / conus terminalis

- Structure: 1. has anterior & posterior median fissure
- 2. Grey matter: inner: filled with CSF
White matter: outer
- 3. Roots: Dorsal root → sensory } controls reflex activities.
Ventral root → motor



- functions: 1) connects PNS & CNS
- 2) controls reflex actions
- 3) minor coordinating centre.

• **Reflex Action & Reflex Arc:-**

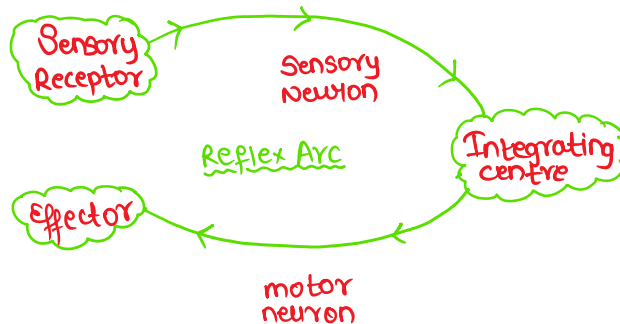
↳ Marshall Hall.

- Autonomic
- unplanned
- Quick/Rapid
- Sudden
- Involuntary
- protective mechanism

} Body Action towards the stimulus.

- The entire process of response to a peripheral nervous stimulation that occurs involuntarily i.e without conscious effort or thought and requires involuntary involvement of part of CNS is called Reflex Action.

- Reflex pathway: 1 Afferent neuron (Receptor) } properly arranged
1 Efferent neuron (Effector) } in series.



- **Knee - Jerk Reflex:** involuntary sudden reflexive response of body (Monosynaptic Reflex).

Sudden stimulus provided with strike of knee hammer at patella bone

Stimulus carried by Afferent neuron to spinal cord via DORSAL ROOT GANGLION

Interneuron : connection b/w sensory & motor neurons

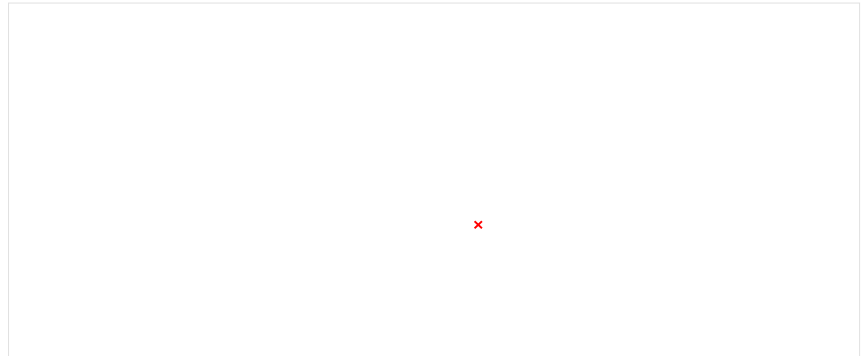
Stimulatory forms synapse
 Inhibitory forms synapse

with neurons
of quadriceps
of thigh

with neurons
of hamstring of
thigh



Stimulation of contraction of quadricep
muscles & inhibition of contraction of
hamstrings muscle.



● Peripheral Nervous System:

↳ Spinal nerves: 31 pairs
All are mixed
C₈ T₁₂ L₅ S₅ C₁

↳ Cranial Nerves : 12 pairs.

Pneumonic	Name	Number	Function	Nature
On	Olfactory	I	smell	Sensory
Occasion	Optic	II	sight	Sensory
Of	Oculomotor	III	movement of EyeBall	Motor
Party	Trochlear (Bethetic)	IV	Rotation of EyeBall	Motor
The	Trigeminal	V	Scalp, nose, eyelid, teeth, jaw	Mixed
Attractive	Abducens	VI	Rotation of Eye	Motor
Faces	Facial	VII	Ant. 2/3 tongue, face muscle	Mixed
Are	Auditory	VIII	Hearing & Balancing	Sensory
Greeted	Glossopharyngeal	IX	Post 1/3 tongue, pharynx	Mixed
Very	Vagus (longest)	X	Vital Organs	Mixed
Sweetly	Spinal Accessory	XI	Palate, larynx, Vocal Cord	Motor
High.	Hypoglossal	XII	Tongue Muscles, Neck.	Motor