12/01/18

Neural Control & Co-ordination

Nervous System :→

→ Made up of Nervous Tissue.

→ It is rapid.

→ It works through electric signals (Nerve Impulse).

→ Nerve impulses travel in a particular direction.

Nervous Tissue :→

→ Ectodermal in origin.

→ 2 types of cells are involved.

- Neurons (DONOT DIVIDE)
- Glia / Neuroglia cells. (THEY DIVIDE)

Structure of Neuron :→

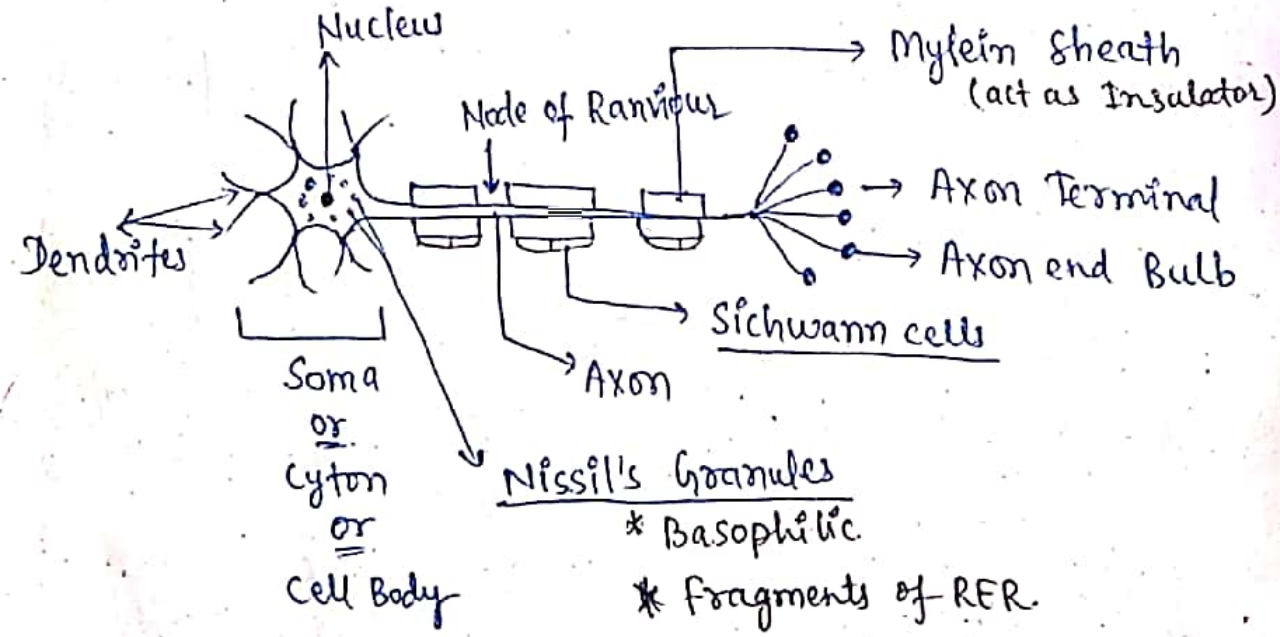


Fig :→ Neuron

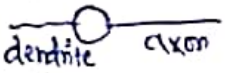
Neurons

① a) Myelinated (Spinal, Cranial Nerves)
b) Non-myelinated (ANS, SNS Somatic)

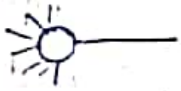
② a) Sensory neurons
* Sen. organ → CNS
b) Motor Neurons
* CNS → organ

③ a) Unipolar Neuron
* Axon & dendrite arise from same point

b) Bipolar Neuron



c) Multipolar Neuron



Glia / Neuroglia Cells

Glue (Hold)

① Astrocytes / Astroglia :-
* Hold neuron at a distance.
* Hold blood vessel close to neurons.

② Oligodendroglia :→
Ex:→ Schwann cells
↳ secretes myelin.

③ Microglia :→
* phagocytic

Nervous Systems In Animals :→

(i) Sponges :→
* Neurons absent.

(ii) Hydra :→
* Network of Neurons.
* (Nerve plexus)

(iii) Planaria :→
* 2 nerve cords which joins to form a rudimentary brain.

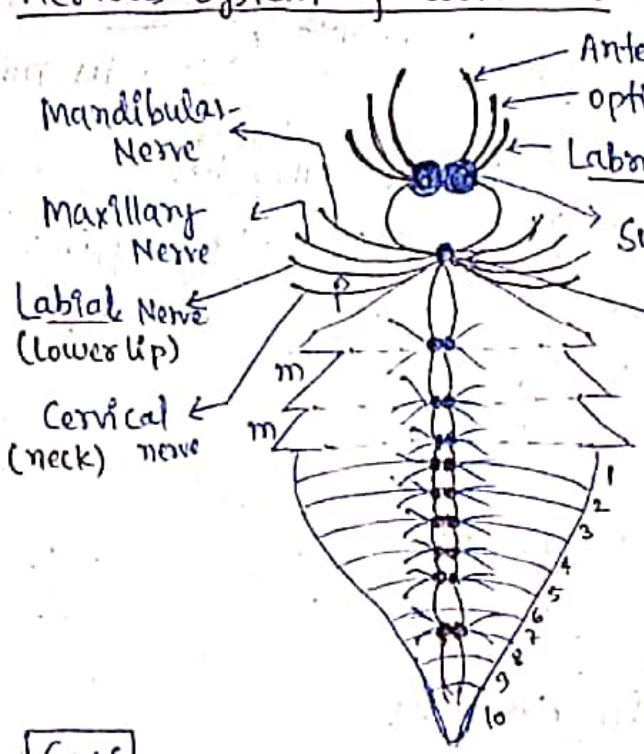
(iv) Earthworm :→

* 1 ventral nerve.
* long, paired, segmented Gangalia
  (Collection of neurons)

(v) Insects :→

* well developed N.S.

* Nervous System of Cockroach :→



Imp

3 Thoracic ganglia
6 Abdominal ganglia

Supra-oesophageal Gangalia

① Antennary Nerve :→
* to antenna.

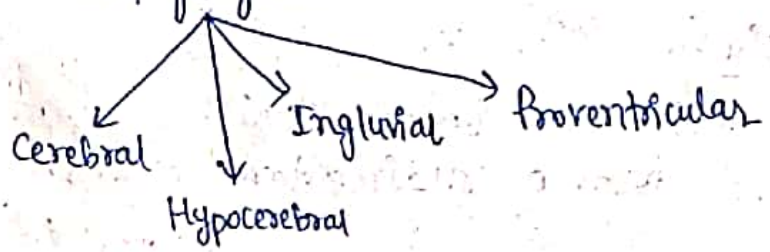
② Optic Nerve :→
* to eye.

③ Labro frontal Nerve :→
* to upper lip.

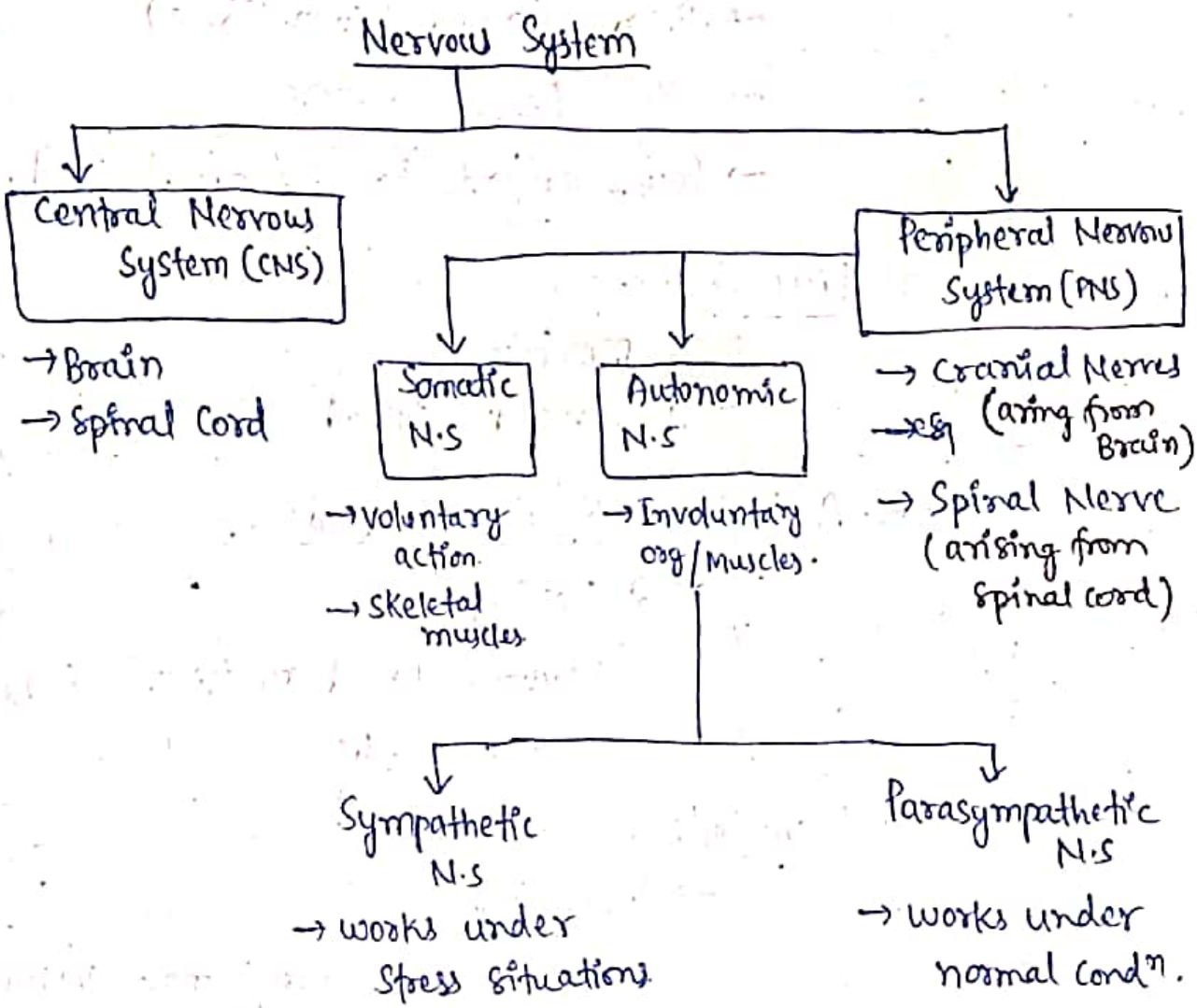
CNS
→ Brain
→ Nerve Chord

PNS
→ Nerve Fibre

ANS
→ 4 ganglian.



Nervous System In Humans :→



Note!→

1. "Grey Matter" !→
   → (cell Body of Neuron + Non-myelinated part)

2. "White Matter" :→
   → Myelinated Part

* Afferent / Sensory Nerve → Sense organ to CNS..
* Efferent / Motor Nerve → CNS to Sense organs.
* Mixed Nerve → Both

Meninges :→

→ 3 membranes (Conn. Tissue)
→ Protective in nature.
→ Found around Brain/Spinal cord.

1. Fishes :→

→ 1 Meninx
→ (Meninx primitiva)

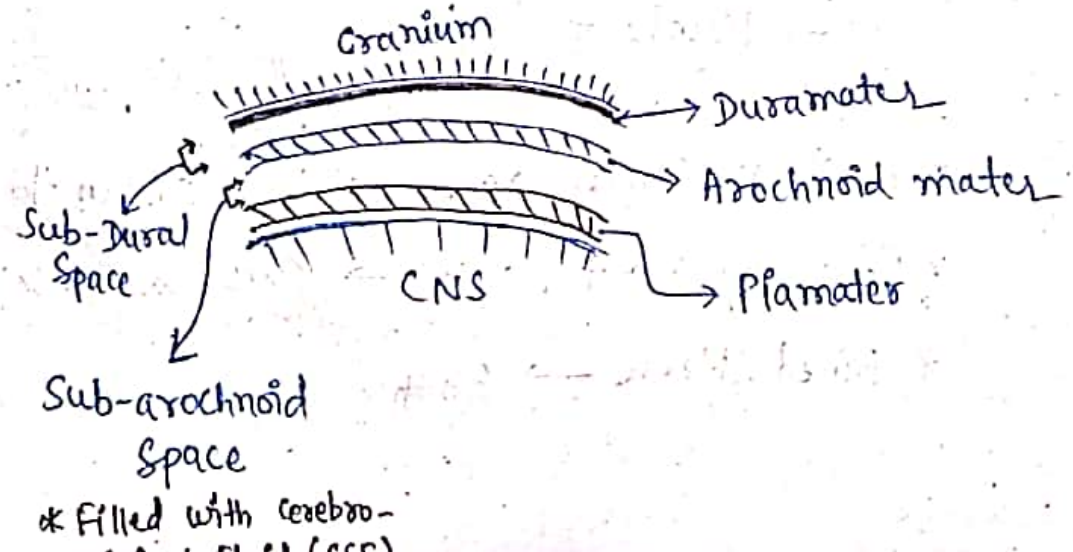
2. Amphibians, Reptiles & Birds :→

→ 2 meninges.
(i) Pia-arachnoid matter.
(ii) Dura Matter.

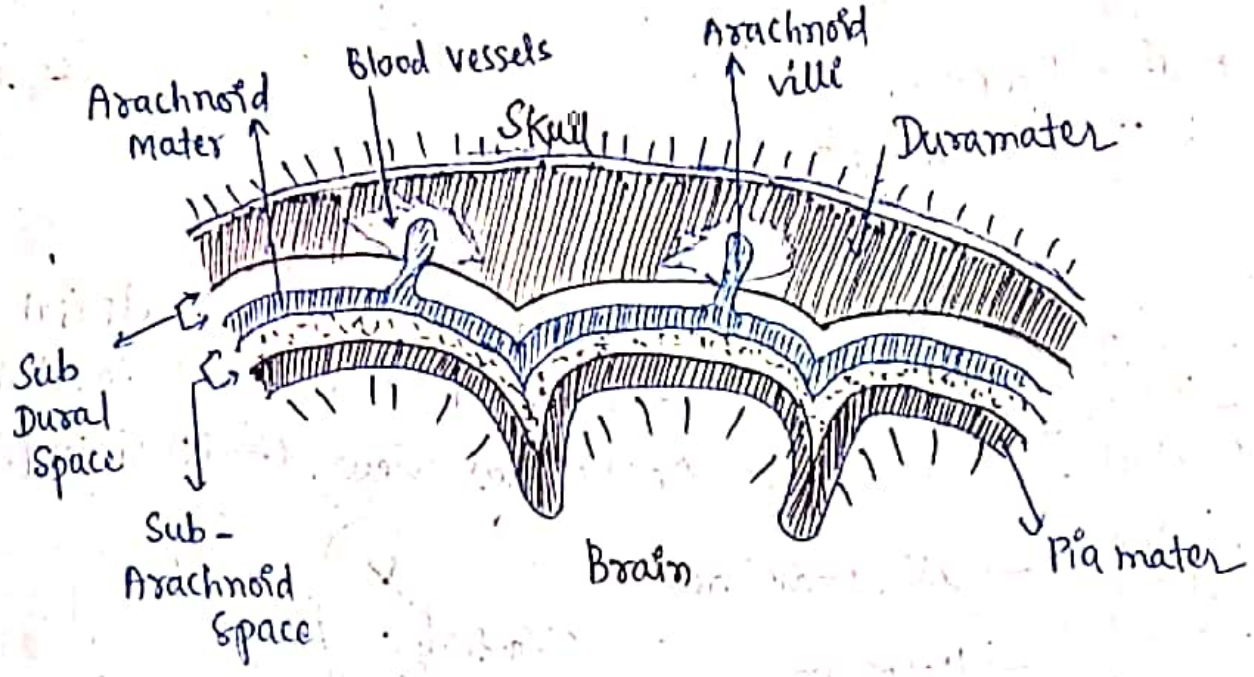
3. Mammals :→

→ 3 meninges.
(i) Pia mater → Innermost layer, Vascular, Squ. epithelium.
(ii) Arachnoid Mater → network of collagen
(iii) Dura Mater → Outermost (made of fibres).

V.V.I. Mammalian characteristics → *



* Filled with cerebro-spinal fluid (CSF).



* Spinal Cord → epidural (extra layer)
* Space → filled with Adipose tissue.

Brain :→ (Encephalon)

→ 1200–1400 gms.
→ located in cranial cavity.
→ 100 Billion neurons.

Parts

Prosencephalon (Fore Brain)
① Olfactory Lobes (not visible), hidden
② Cerebrum (Cerebal Hemi Spheres)
③ Diencephalon (hidden)

Mesencephalon (Mid Brain) ↓ hidden
① Optic Lobes
② Cerebral Peduncle

Rhombencephalon (Hind Brain)
① Cerebellum
② Pons Varolii
③ Medulla Oblongata

(i) Proencephalon :→

(a) Olfactory lobes :→

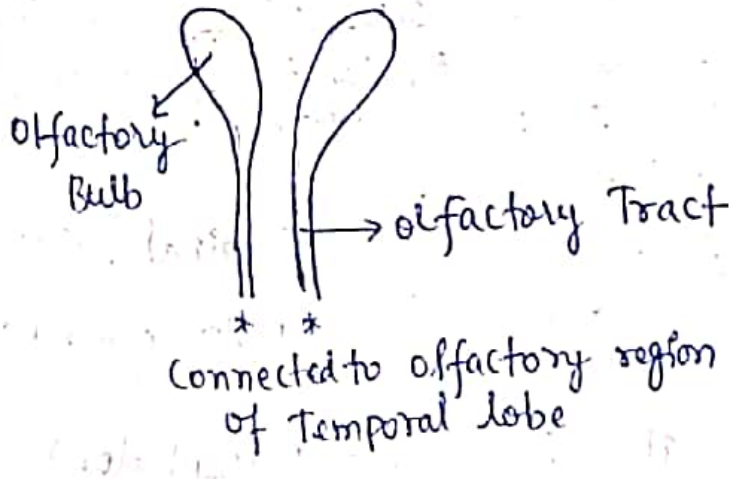
→ 1 pair

→ they are not visible in dorsal view.
they are hidden under cerebrum.

→ In ventral view, it is viewed.

→ Solid structure.

→ Helps in detection of Smell.



(b) Cerebrum :→

→ or cerebral Hemispheres.

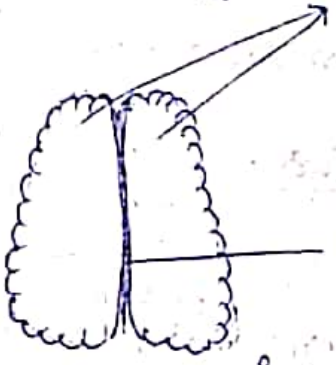


Fig :→ Dorsal view of cerebrum

Corpus Collasum :-

→ Connection b/w 2 cerebral hemispheres

→ Characteristics of Mammal only.

→ myelinated

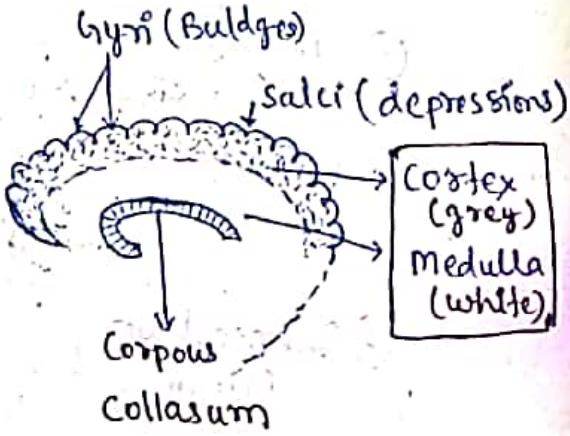


Fig :→ Lateral view of cerebrum (By cutting vertically)

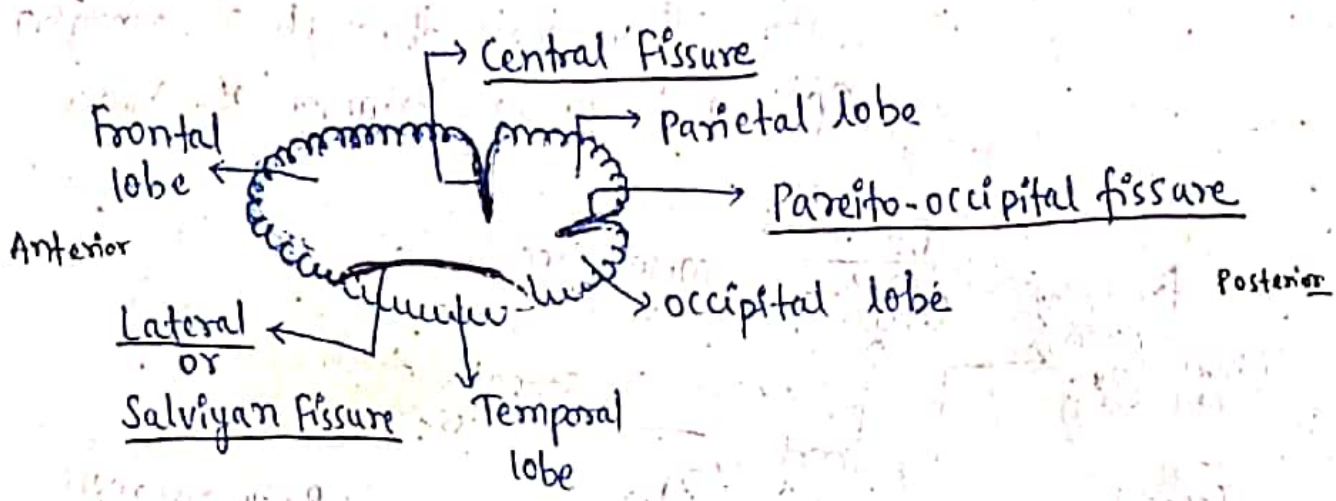
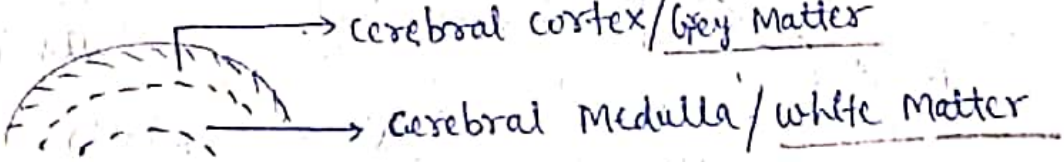


Fig:→ Lateral view of cerebrum (sideways)

* Cerebral Hemispheres :→

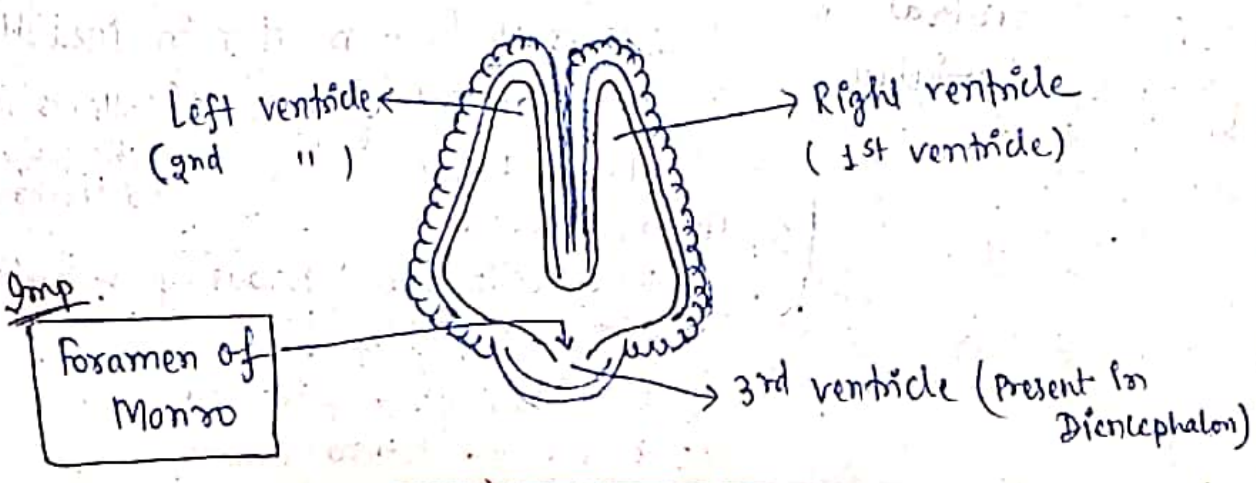


→ Roof of Cerebrum ⟹ Pallium (with Sulci & gyri)

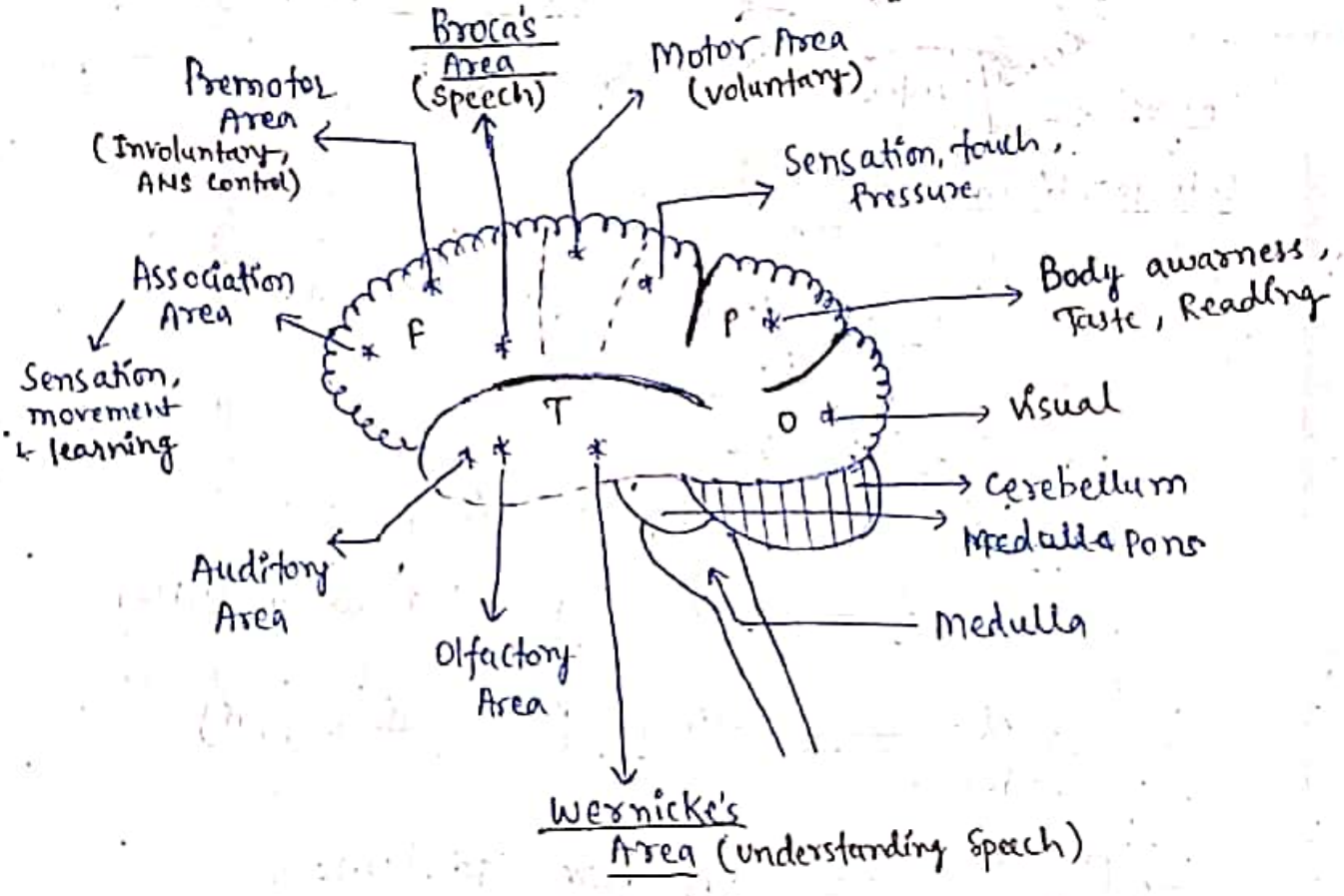
→ Floor of Cerebrum ⟹ Corpus striatum.

→ Cerebral hemispheres are hollow → cavity
⇓
ventricle

Imp → Cavity of cerebral hemisphere are called cerebral ventricle or PARACOEL.



→ The 1st & 2nd ventricle of cerebrum open into 3rd ventricle through a Common Opening known as Foramen of Monro.

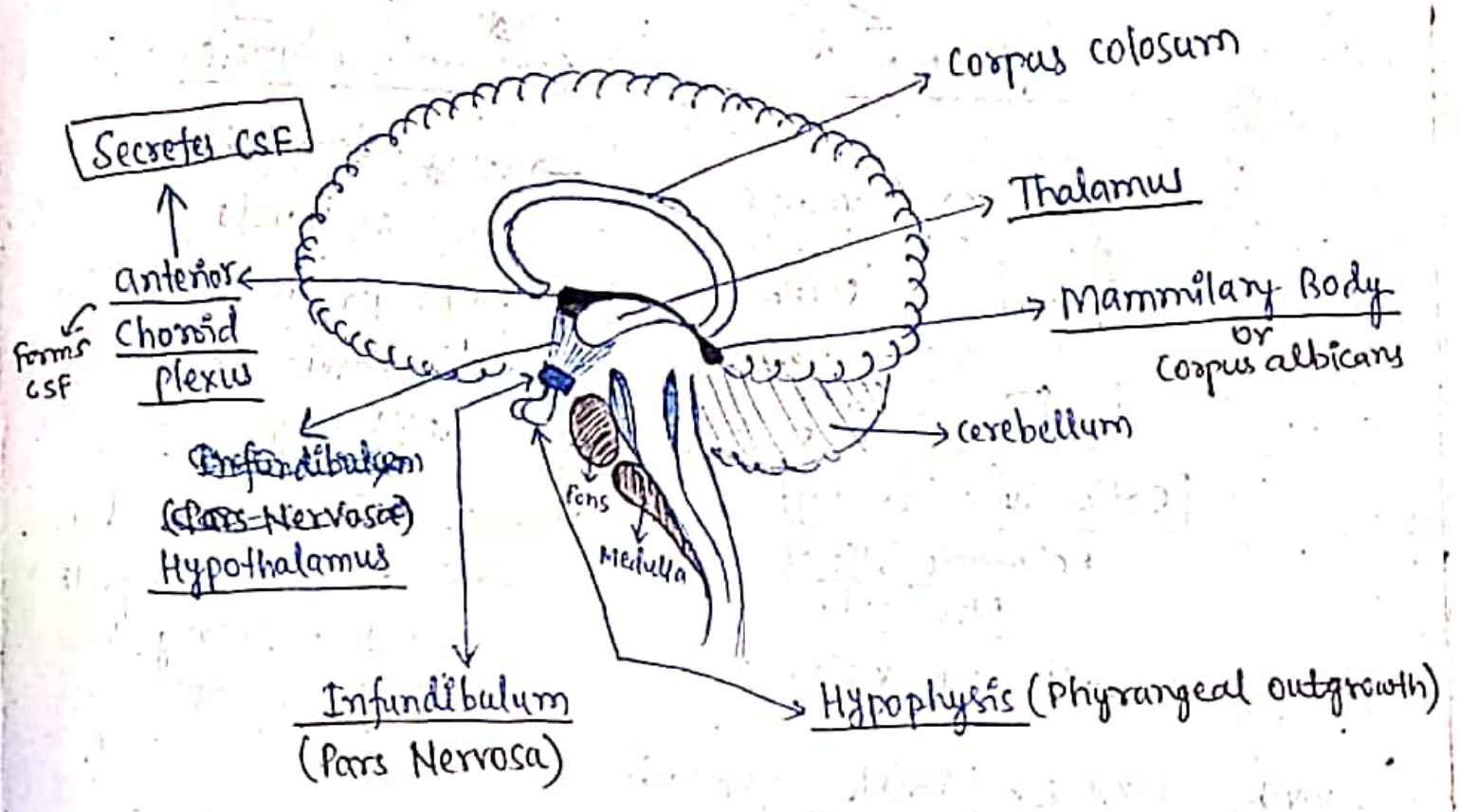


(C) Diencephelon :→

Completly hidden By Cerebral Hemispheres

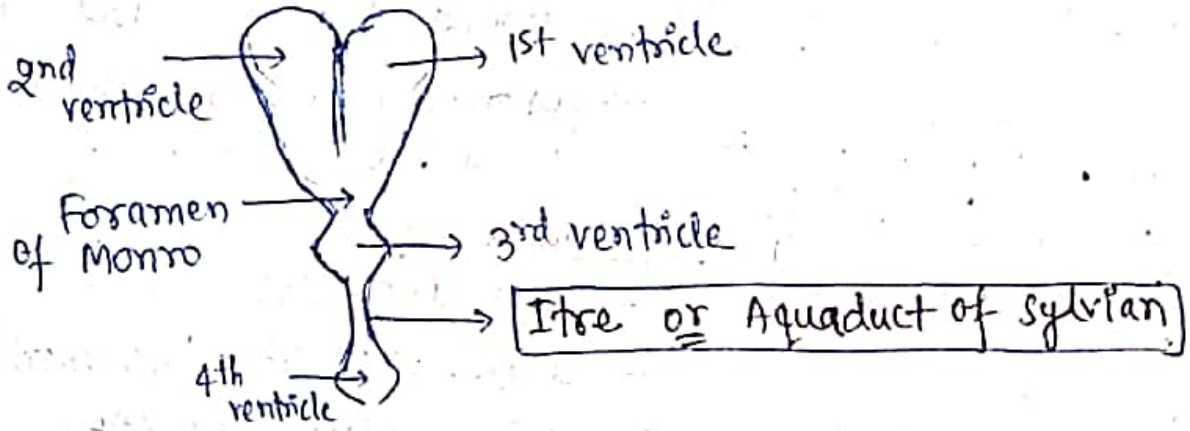
1. Epithalamus :-
   * Roof
   * Formed from Piamater.
2. Thalamus :-
   * mass of Grey matter in Medulla region
   * Acts as Relay Center (Collects sensation like pain & pass on to cerebral hemisphe
   * Paired (1 pair)
3. Hypothalamus :-
   * Connection b/w Nervous sys. & Endocrine gla
   * Thermostat of Body.
   * Thirst, BP & Salvation.
   * secretes Neuro hormones.

Fig:→ Labelling of Diencephelon of Proencephelon.



Note:→

Imp→ In Diencephelon, 3rd ventricle (cavity) is present known as ~~DI-COEL~~ DIOCOEL.



* Pituitary Gland ??

(ii) Mesencephalon or Midbrain :→

Optic Lobes

Optic Quadrigemina

*characteristic of Mammal.

*Helps in Vision

V.V.I

Cerebral Peduncle

Crura cerebri OR

→ Long, longitudinal nerve bands

→ Helps in Co-ordination b/w Forebrain & Midbrain.

Functions of Midbrain

→ Receives & Integrates visual, auditory & tactile inputs.

V.V.I

**** Limbic System :→

→ This is not a separate part of brain.

→ Actually, It is included in forebrain. i.e, cerebrum

(i) Amygdala :→

→ Almond shaped, paired structure.

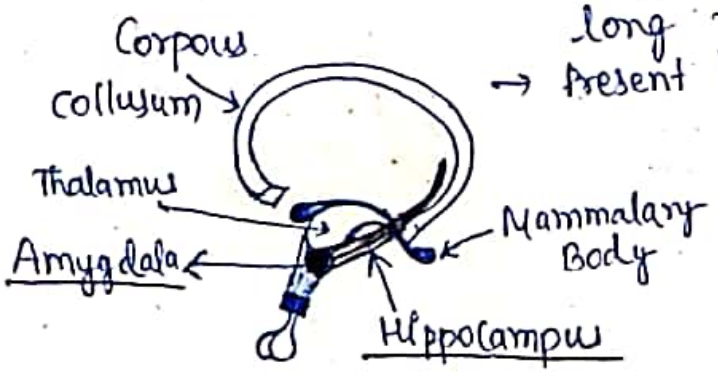
→ Controls emotions such as anger, fear & sexual behaviour.

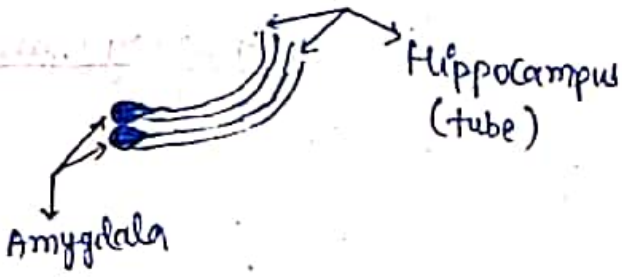
(ii) Hippocampus :→

→ Tube like extensions.

→ Converts short term memory info long term memory.

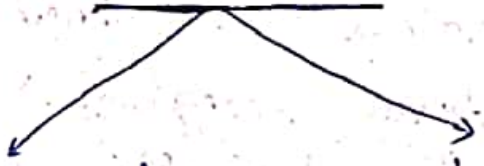
→ Present below thalamus.





(iii) Rhombencephalon or Hindbrain :→

1. Cerebellum :→ Solid, 3 lobes.



2 large lobes "Cerebellar Hemispheres"

1 small lobe, long "Vermis"

* outer is grey mater.
→ inner white matter is branched like a tree.
Arbor Vitae.

Functions of Cerebellum :→
* Maintains posture & equilibrium; muscular Co-ordination

2. Pons :→
→ oval, , inner grey, outer white
→ Helps in Co-ordination b/w forebrain & cerebellum.
→ Controls Involuntary functions.
→ Has Pneumotaxic Center → controls Breathing

3. Medulla oblongata :→
→ Triangular in shape.
→ Cavity called as 4th ventrical.
↓
anteriorly connected to 3rd ventricle by Itre. & posteriorly by Spinal cavity.

Function :→
Homeo-static Control → Roof → Non-nervous
↳ Post choroid Plexus.

→ controls all involuntary functions.
Cardiovascular reflex, respiration, metabolism gastric Secretion etc.

* Functions of Medulla oblongata :-

→ Controls Heart Beat. (cardia Center).
→ Respiratory center (Pneumotaxic Center)
→ Peristalsis, Sneezing, Vomitting, Urination, daefication Control.

Note! → V.V.I

* Pons & Medulla have grey mater inside & white mater outside.

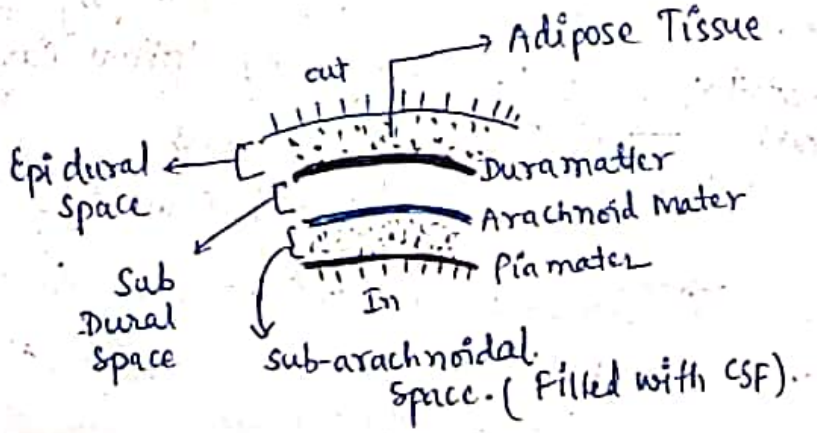
* BRAIN STEM → (Diencephelon + Mid Brain + Pons + Medulla)

* In brain stem, Reticular Activating System is present

→ Network of neurons.
→ Helps in Screening of Sensory Infolmation.

Spinal Cord :-

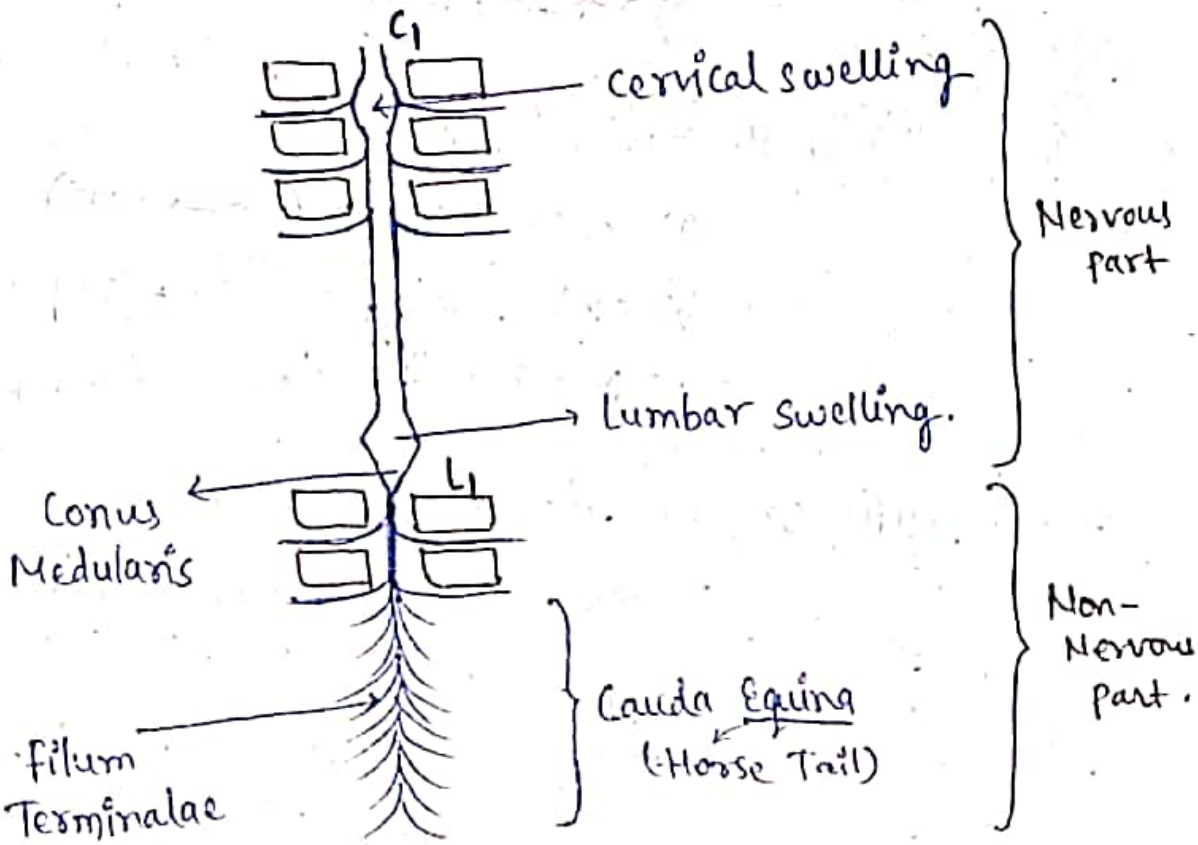
→ Also Known as Myelon.
→ 45 cm long in ♂.
→ 43 cm " " ♀.
→ 35 gms.
→ Runs through the vertebral/neural canal.
→ Protected by meninges.



→ Spinal cord starts from 1st cervical vertebrae (Atlas) to 1st Lumbar vertebrae.

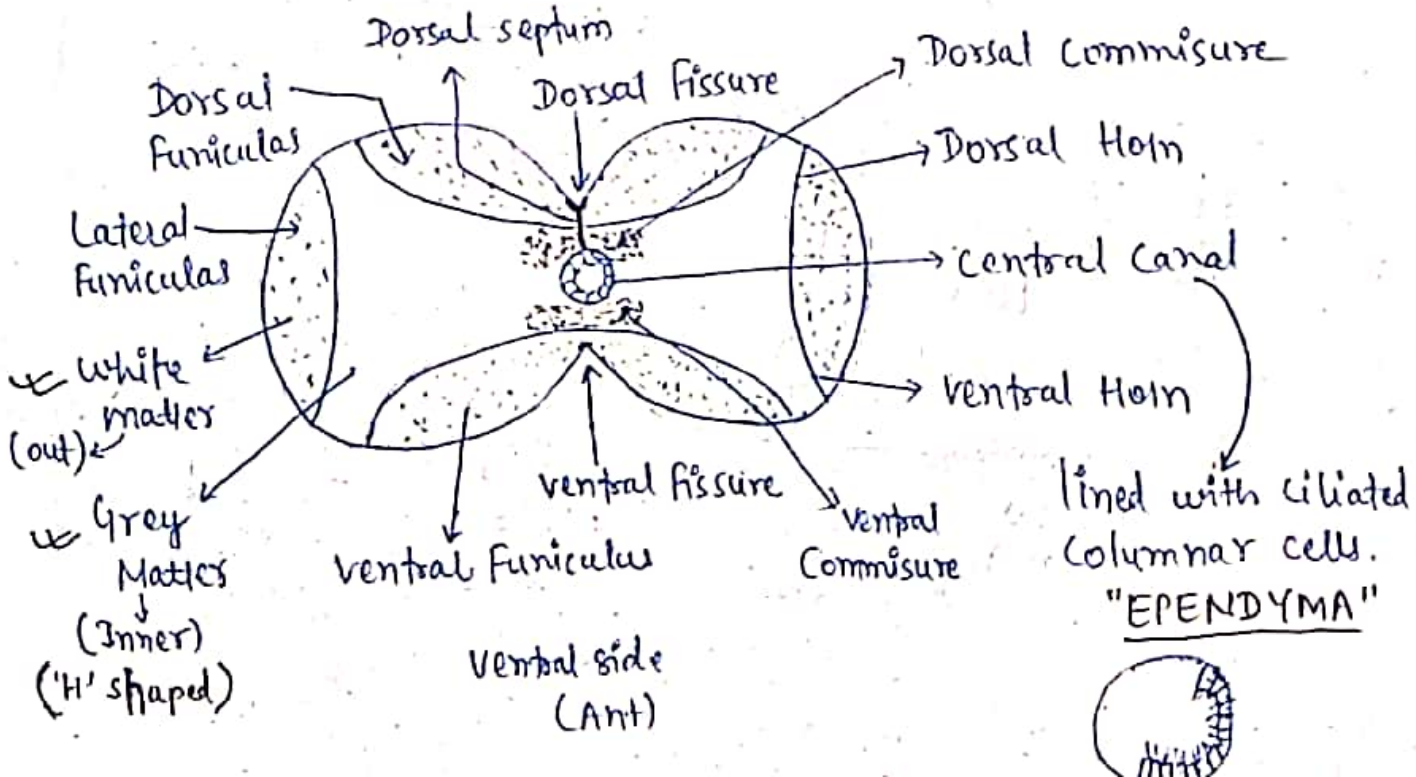
→ Total 31 segments.

$C_8 T_{12} L_5 S_5 Co_1$



Transverse Section of Spinal cord :→

Function of Spinal cord
↓
Reflex Action.



PNS :→

Nerves :→

(i) On the basis of Presence & absence of Myelin Sheath.

a) Myelinated Nerves

b) Non-myelinated Nerves.

(ii) On the basis of function :→

a) Sensory Nerve (SO → CNS)

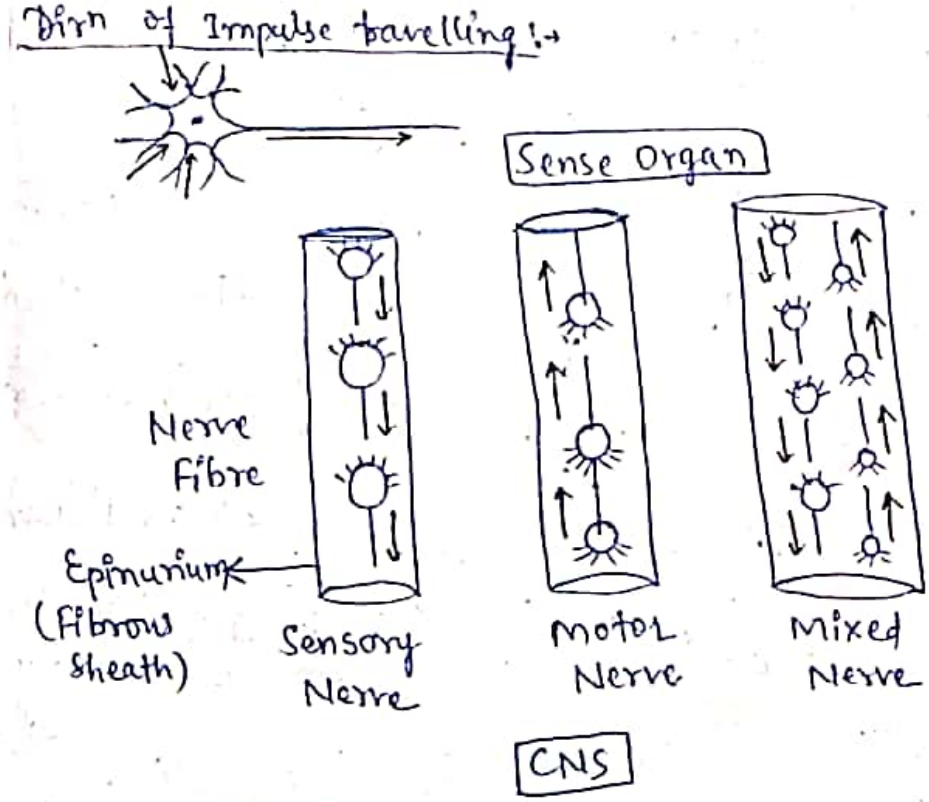
b) Motor Nerve (CNS → organ)

c) Mixed Nerve (Both sensory & motor)

(iii). On the basis of Origin :→

a) Cranial Nerves ⇒ originate from Brain. (12 Pairs)

b) Spinal Nerves ⇒ originate from Spinal Cord. (31 Pair)



(1) Cranial Nerves :→

→ 12 pairs of cranial nerves.

→ 10 pairs arise or end in brain stem.

→ 2 pairs i.e. 3rd & 4th arise from Midbrain.

→ They can be :-

- Sensory ⇒ I, II, VIII
- Motor ⇒ III, IV, VI, XI, XII
- Mixed ⇒ V, VII, IX, X

} 12

Trick! →

O^3T^2 AFAGVSH

1. S O → olfactory
2. S O → optic
3. M O → occulomotor
4. M T → Trochlear (Pathetic)
5. Mixed (T) → Trigeminal
   - V_1 → Opthalmic
   - V_2 → Maxillary
   - V_3 → Mandibular
   - * Dentist Nerve
6. M A → Abducense
7. Mixed F → facial
8. S A → Auditory
9. Mixed G → Glossopharyngeal
10. Mixed V → Vagus
11. M S → Spinal accessory (accessory spines)
12. M H → Hypoglossal

Imp Note! →

Vagus (10th) nerve is the only nerve which leaves Skull region and goes upto visceral organs (Heart, lungs etc) while all the other nerves remain in the skull region or Neck part.

Cranial Nerves	origin	Innervation	Nature	Functions
I Olfactory	Olfactory epithelium	Olfactory Lobes	S	Smell.
II Optic	Retina	Diencephelon	S	Vision.
III Occulomotor	Mid Brain	Eye Muscles, irish, tear glands	Motor	Movement of Eyeball.
IV Trochlear	Mid Brain	Eye Muscles (oblique)	Motor	Rotation of Eyeball
V Trigeminal	Medulla	Skin receptor, lip, teeth, gum.	Mixed	Tactile & Jaw Movement.
VI Abducens	"	Exterior Rectus Muscle	motor, ~~mixed~~	Rotation of Eyeball.
VII Facial	"	Taste Bud (post. 2/3), Muscles of face, neck, salivary glands.	Mixed.	Tasting of food, saliva production, mov. of neck, facial expressions.
VIII Auditory	Inner Ear	Medulla	Sensory	Hearing & Equilibrium
IX Glossophyrangeal	Medulla	Taste Bud (ant. 1/3), Muscles of pharynx	Mixed	Tasting of Food, Swallowing
X Vagus	"	S → visceral organ M → Muscles of Heart, kidney, lungs, BV.	Mixed	Visceral Functions
XI Spinal Accessory	"	Muscles of larynx, Pharynx, Neck	Motor	Mov. of Neck, larynx, Shoulder.
XII Hypoglossal	"	Hypoglossal Muscles like → Tongue	Motor	Tongue Movement

(ii) Spinal Nerves :→

→ Arise from Spinal Cord.

→ 31 pairs.

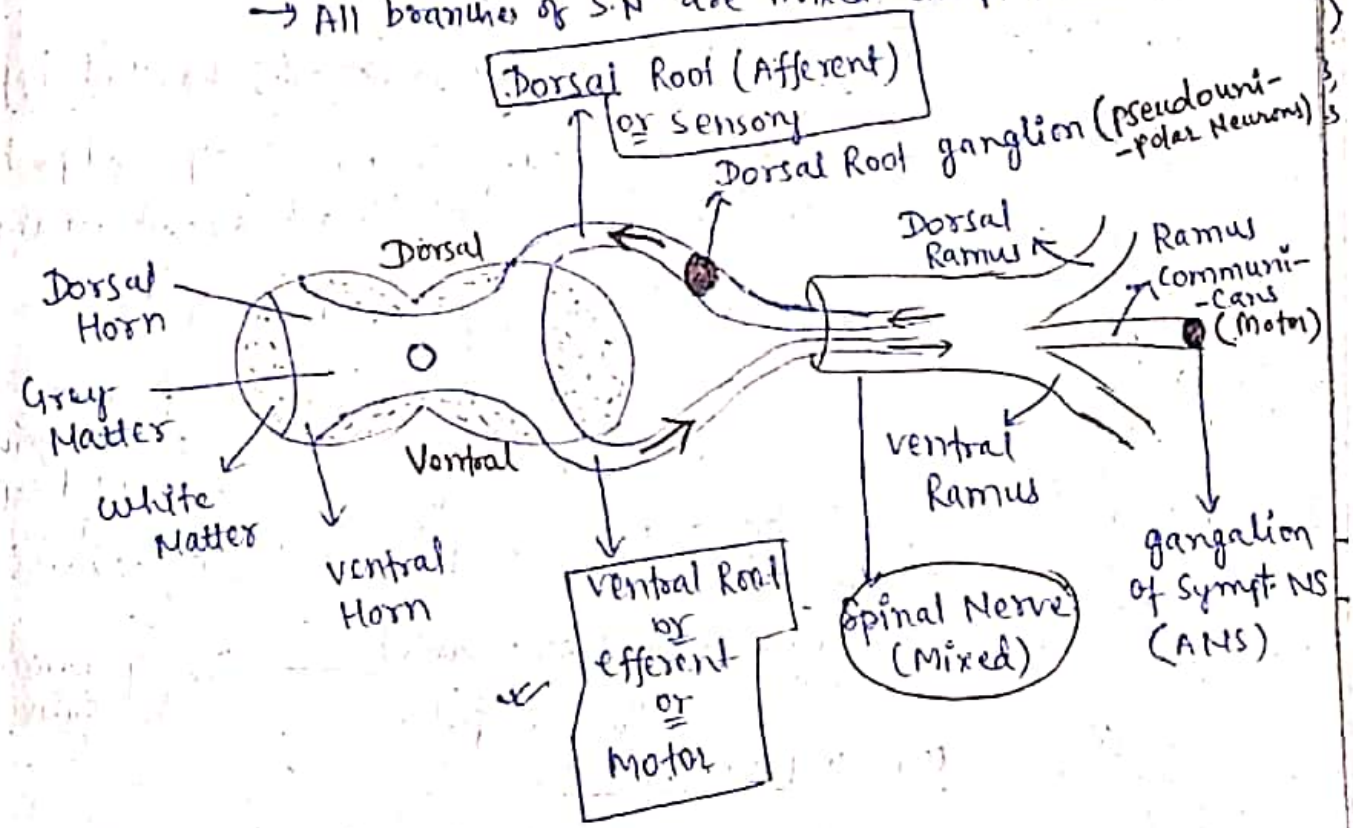
- Cervical – 8
- Thoracic – 12
- Lumbar – 5
- Sacral – 5
- Coccygeal – 1

} 31 pairs

→ Spinal Formula $C_8T_{12}L_5S_5C_1$

Imp → Spinal Nerves are Mixed nerves (All)

→ All branches of S.N are mixed except Ramus Communicans



Reflex Action :→

→ spontaneous

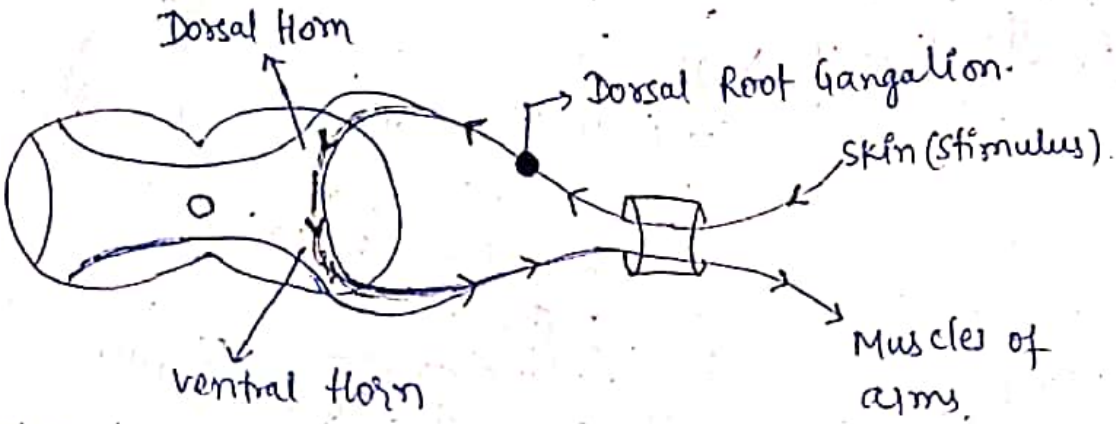
→ Automatic

→ short-lived Response

→ Mechanical Action.

* path of Reflex action ⇒ Reflex arc.

S.O ⟶ Sensory Nerve ⟶ Spinal Cord (Modulation) ⟶ Motor Nerve ⟶ Effective organ



Advantages :-

(i) Very Fast Response (Protective Feature)

(ii) Prevents overloading of Brain.

Two types of Reflex Action :-

1. Unconditioned / Inborn / Inherited Reflexes :-

→ Suckling of nipples by ~~baby~~ baby.
Crying of little baby when hungry.

2. Conditioned / Acquired Reflexes :-

→ Riding a bicycle
→ swimming
} acquired over a period of time when going through a repeated exposure.

Ex:- Pavlov's Bell and dog experiment.

Dog → Food accompanied by ringing bell → Dog produces saliva

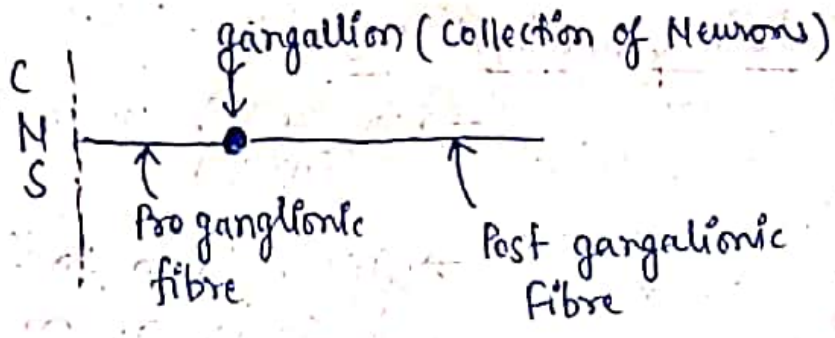
Over a period of time,

Dog → only bell is rung → Dog produces saliva.

~~Ans~~ ANS :-

ANS

- Sympathetic N.S.
- Parasympathetic N.S.



(1) Sympathetic N.S :→ (Stress situation)

→ 21 Sympathetic gangalion.

- 3 – cervical
- 12 – ~~lumbus~~ Thoracic
- 5 – Lumbar
- 1 – Sacral

→ 21 gangallions are connected to form a Sympathetic Cord.

→ Symp. Cord is on either side of the spinal cord.

→ Adrenargic. (Bcoz. symp sys works in stress situation. ∴ adrenalin neurotransmitter is present.)

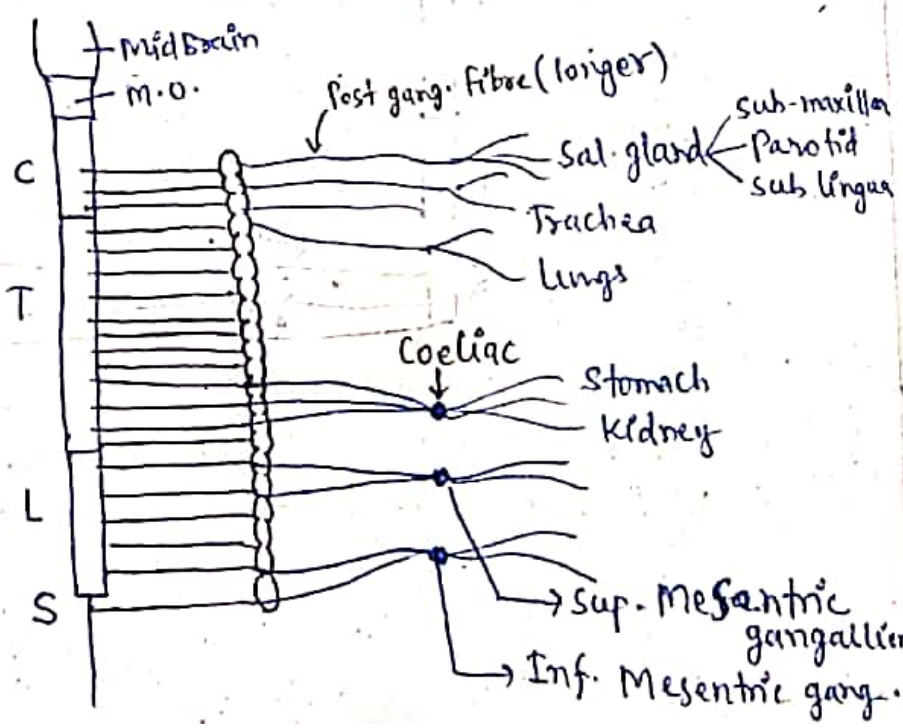
→ Widespread effect (Post gangallionic fibre is long & distributed)

→ Outflow is Thoracico-Lumbar.

Sympathetic Trunk
- 3 – cervical
- 12 – Thoracis
- 5 – Lumbar
- 1 – Sacral

V.V.I ** 3 collateral gangallions :-

(i) Coelic
(ii) Sup. Mesentric
(iii) Inf. Mesentric



(ii) Parasympathetic N.S :→

→ ~~works for~~ Favours normal situation.

→ Arises from Brain stem (cranial nerves) & Sacral region of spinal cord.

→ Thus, outflow is Cranio-Sacral.

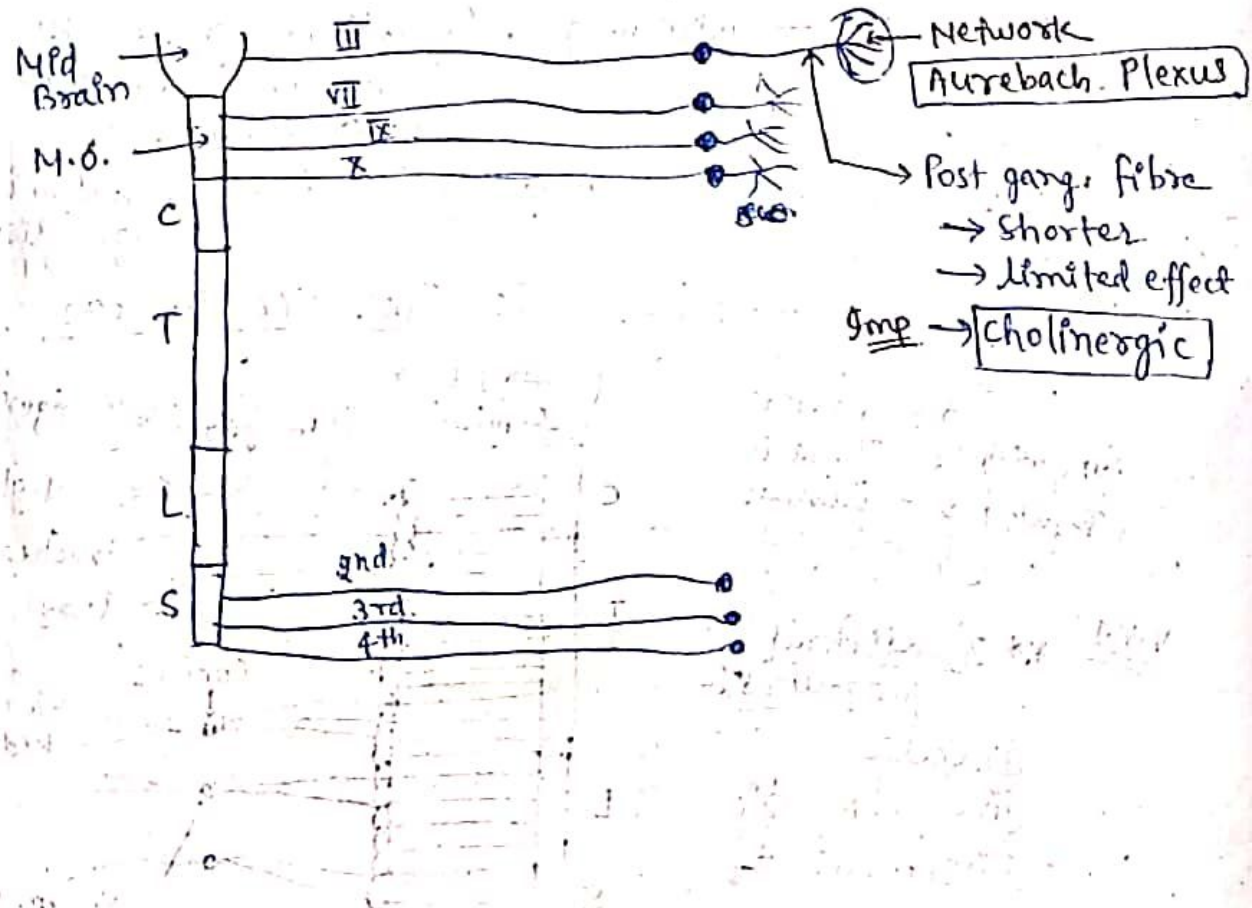
(i) Brain Stem :→

C.N → III, VII, IX, X

- III → Occulo motor
- VII → facial
- IX → glasso phyrangeal
- X → vagus

(2) Sacral Region :→

2nd, 3rd, 4th.



Difference b/w Sympathetic & Parasympathetic N.S :→

Characteristics	Sympathetic N.S.	Para-Sympathetic N.S
1. Position of gangalia.	Symp. trunk → (21 gangalia) Near to spinal cord	Gangalia are close to organs.
2. Pre ganglionic fibre	Short	Long
3. Post-Ganglionic fibre	Long	V. short
4. Nature of outflow	Thoracico-lumbar	Cranio-Sacral.
5. Neurotransmitter	(Ach + Sympathetin) ~~Adrenaline~~	Acetylcholine. only
6. Effect	Widspread	Limited effect.
7. Mode of working.	By expenditure of energy. → prepares for Stress situations	By conserving energy → Favours comfort, calmness at rest.

Difference b/w Sympathetic & Para-sympathetic N.S :→

Functions	Sympathetic N.S.	Para-sympathetic
1. Heart	↑es amplitude & heart rate.	↓es amplitude & heart rate
2. B.P	↑es arterial B.P.	↓es B.P.
3. RBC Count	Increases	Decreases
4. Blood clotting period	Decreases	Increases
5. Liver	Promotes glycogenolysis	Promotes Glycogenesis.
6. Saliva Secretion	↓es saliva secretion	↑es saliva secretion.

Functions	Sympathetic N.S	Parasympathetic N.S
7. Gastric Secretion	decreases	Increases
8. Peristalsis	"	"
9. Pancreatic Sec.	"	"
10. Intestinal Sec.	"	"
11. Gall Bladder	Relaxes	Contraction.
12. Blood Supply to skin.	Cutaneous Blood vessels Constrict. less Blood supply to skin → pale	Normal Blood Supply to skin
13. Hair (goose Flesh)	Contraction of arrecter pili (erects)	arrecter pili muscle relaxes.
14. Pupil	Dilation of Pupil	Constriction
15. Sec. of Tears	Increases	decreases
16. Trachea & Bronchi	dilates	Constricts
17. Urinary Bladder	Relaxes (Inhibit Micturition)	Contraction
18. Anus	Anal Sphincter Contract.	Anal Sphincter relax.

Properties of Nerve Fibres :→

(1) Excitability :→

→ stimulus ⇒ state of local excitation.

↳ Physical stimulus = Heat, cold.

Chemical " = acid, Base

Mechanical " = Injury

Electrical " = Electricity.

(ii) All or None Rule :→

** Threshold Value Stimulus

↳ Stimulus of particular strength.
(−55 to − 60 mV)

→ Below this value, no excitation.

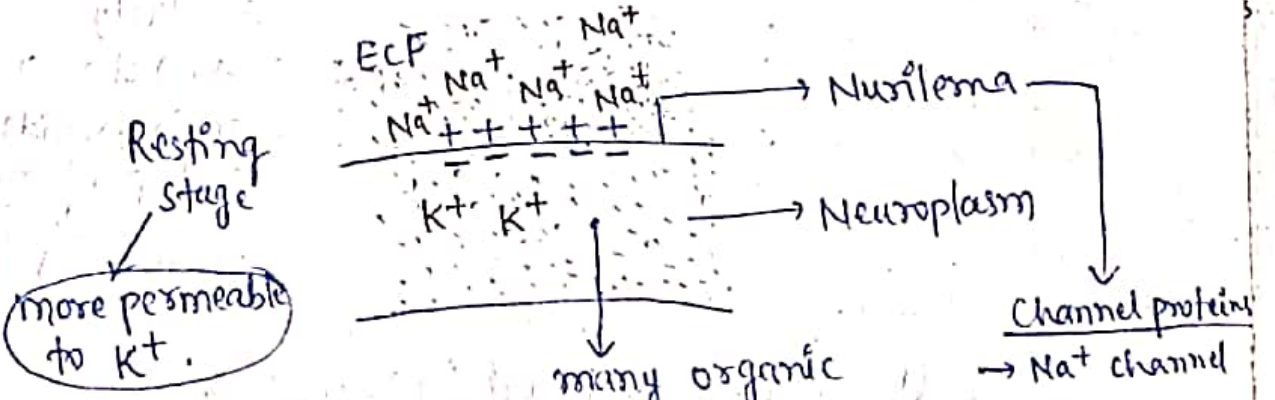
→ Beyond this value, strength of excitation is less.

Thus, (−55 to − 60 mV) is always maxm.

(iii) Differential Permeability :→

↓

At different time, membrane(nurilema) is permeable to different types of ions.



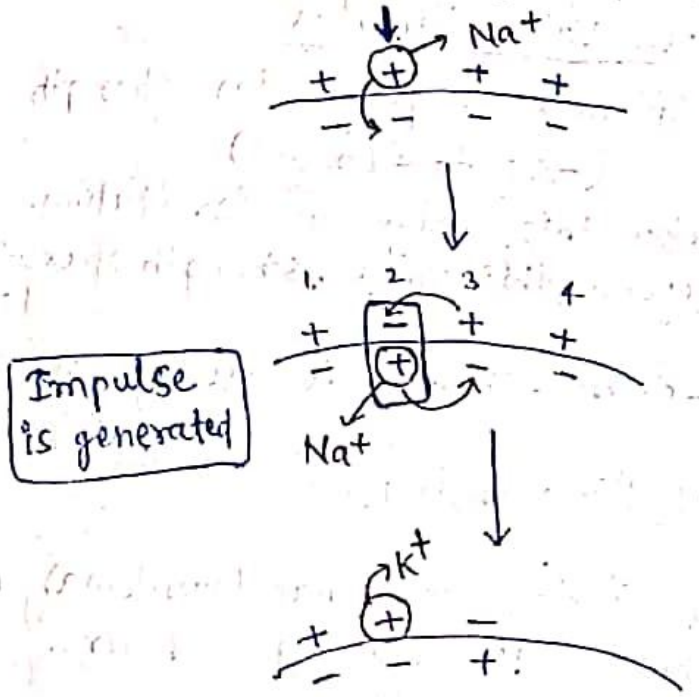
At Resting Stage →

→ 10 times more Na^+ ions on outer side, than Na^+ on inner side during resting stage.

→ 30-40 times more K^+ ions on inner side than outer side during resting state but a large quantity of (−ve)ly charged proteins are present inside nurilema which makes the membrane (−ve) on inner side.

Imp. **Resting Potential ⇒ −70 mV**

(iv) Conductivity :→



(i) Firstly, during resting stage,
(+ve) charge on outer side is due to Na^+.

(ii) After getting stimulus, memb. permeability inc. for Na^+.
Na^+ goes inside.
→ (+ve) charge on inner is due to Na^+.

(iii) Now, (+ve) charge at position 3 moves to 2.
Similarly,
(+ve) charge at position 2 on inner side, moves to 3rd position.
⇓
Called as Conductivity

(v) Refractory period (Resting) :→

- Absolute ref. Pd.
  → No excitation even on giving threshold stimulus
  4 milisec.
- Relative ref. Pd.
  → Can get excited when more than threshold value stimulus is provided.
  3 milisec.

(vi) Summation :→

→ when stimulus of less than threshold value are given continuously, then
↓
Nerve get excited.

Mechanism of Conduction of Nerve Impulse :→

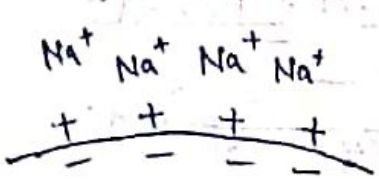
(i) Generation of Impulse :→

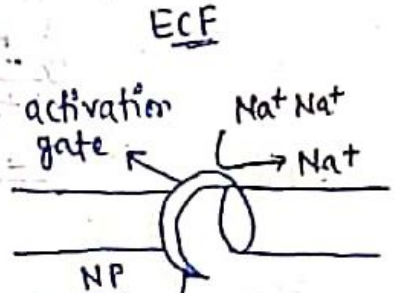
Resting Nerve fibre

→ Polarized.

→ Resting Potⁿ −70 mV

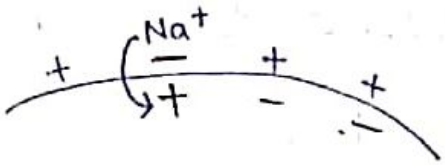
→ Na^+ channels are closed.

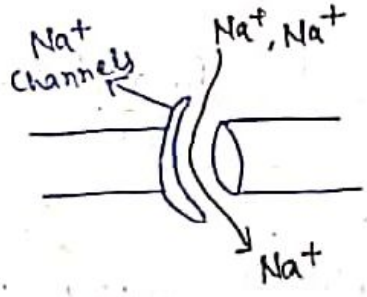




After Stimulus Is received (Threshold Potⁿ) (−70 → −55)

→ Depolarised.

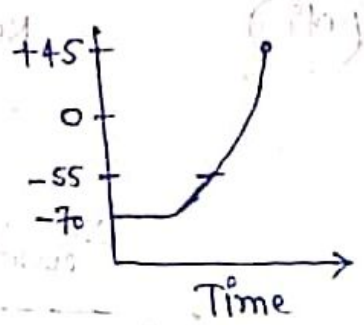




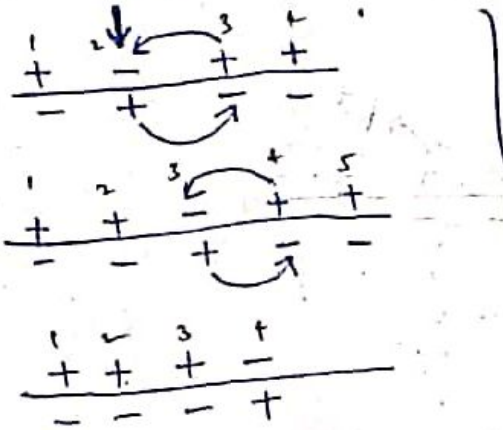
→ Impulse is generated.

→ Na^+ channels are opened

→ **Action Potⁿ is generated** (+45 to +50)

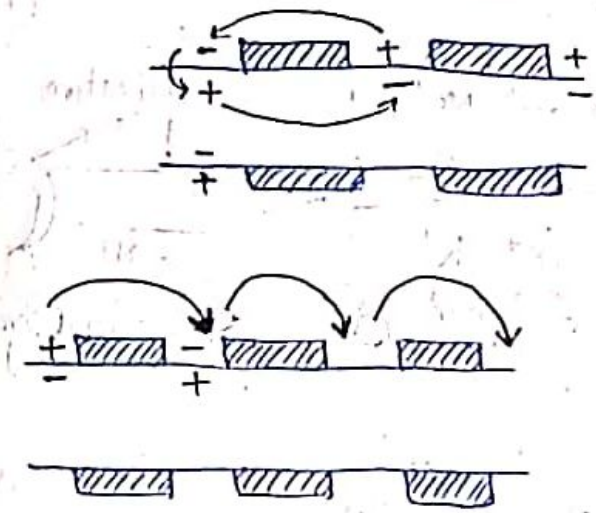


(ii) Conduction or Propagation of Impulse :→



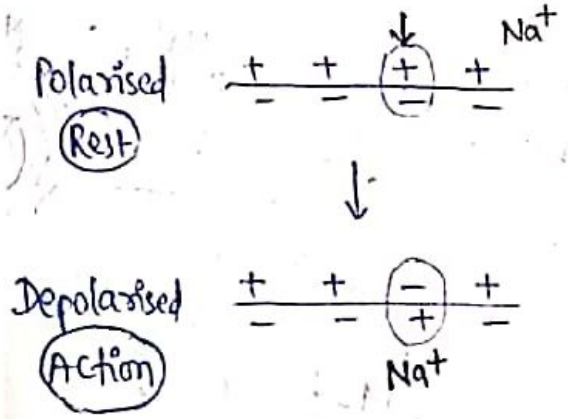
Conduction on Non-myelinated sheath.

On Myelinated sheath :→

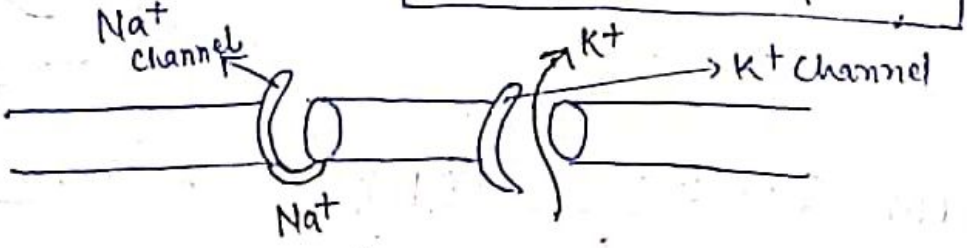


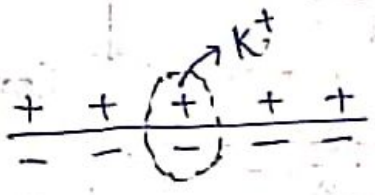
→ saltatory conduction
→ Impulse jumps from one node of Ranvier to other.
→ 20 times fester then non-myelinated.

(iii) Repolarisation :→



Action potn (+45 mv)
↓
Na+ channels closed
K+ " open.

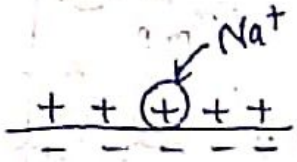




(iv) Refractory Period :→

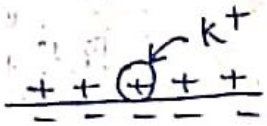
Initially

Neuritema polarized



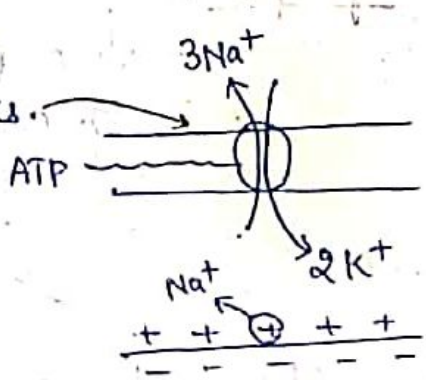
After receiving stimulus

it got depolarised & again repolarised but due to K^+ ion on outside.



To make correction :→

Na^+/K^+ pump works. & ~~again~~, Now memb. gets polarised due to Na^+ ions.

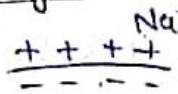


→ This time lag to make correction is called as Refractory period.

Summary of Mechanism of Nerve Impulse Conduction :→

(i) Polarised

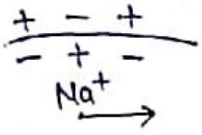
Na^+ ch. are closed.



Resting potn = (-70 mv)

(ii) Depolarised

Na^+ ch. open

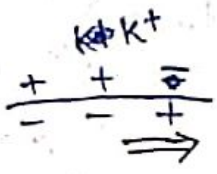


Action potn = (+45 to +50)

(iii) Repolarisation

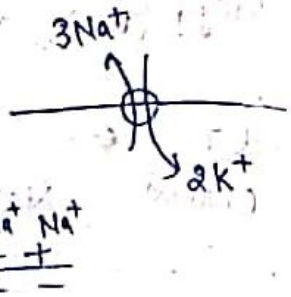
K^+ ch. open

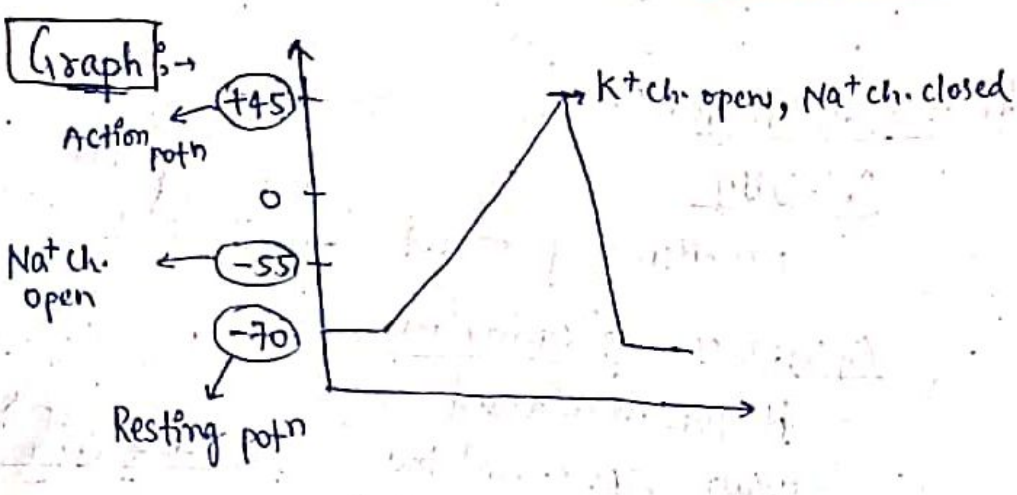
Na^+ ch. closed



(iv) Refractory Period :-

Na^+/K^+ ch. works.





Synapse :→

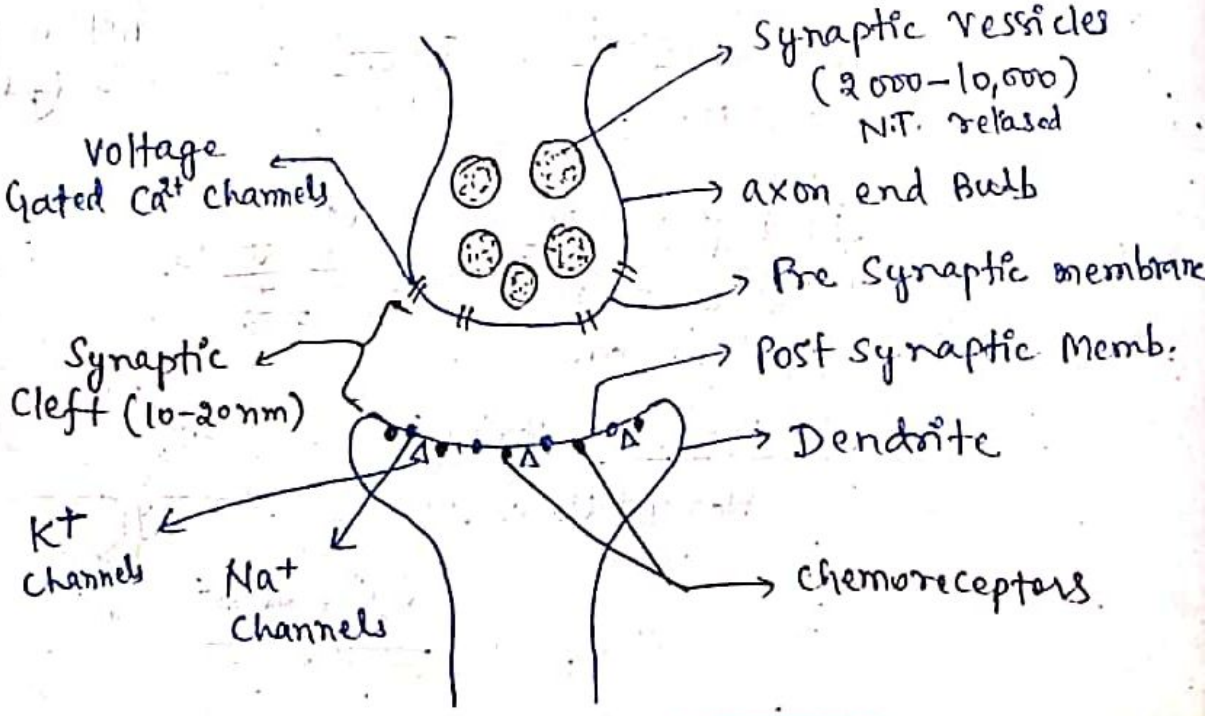
→ close proximity area b/w axon end bulb of one neuron & dendrite of other.

Synapses

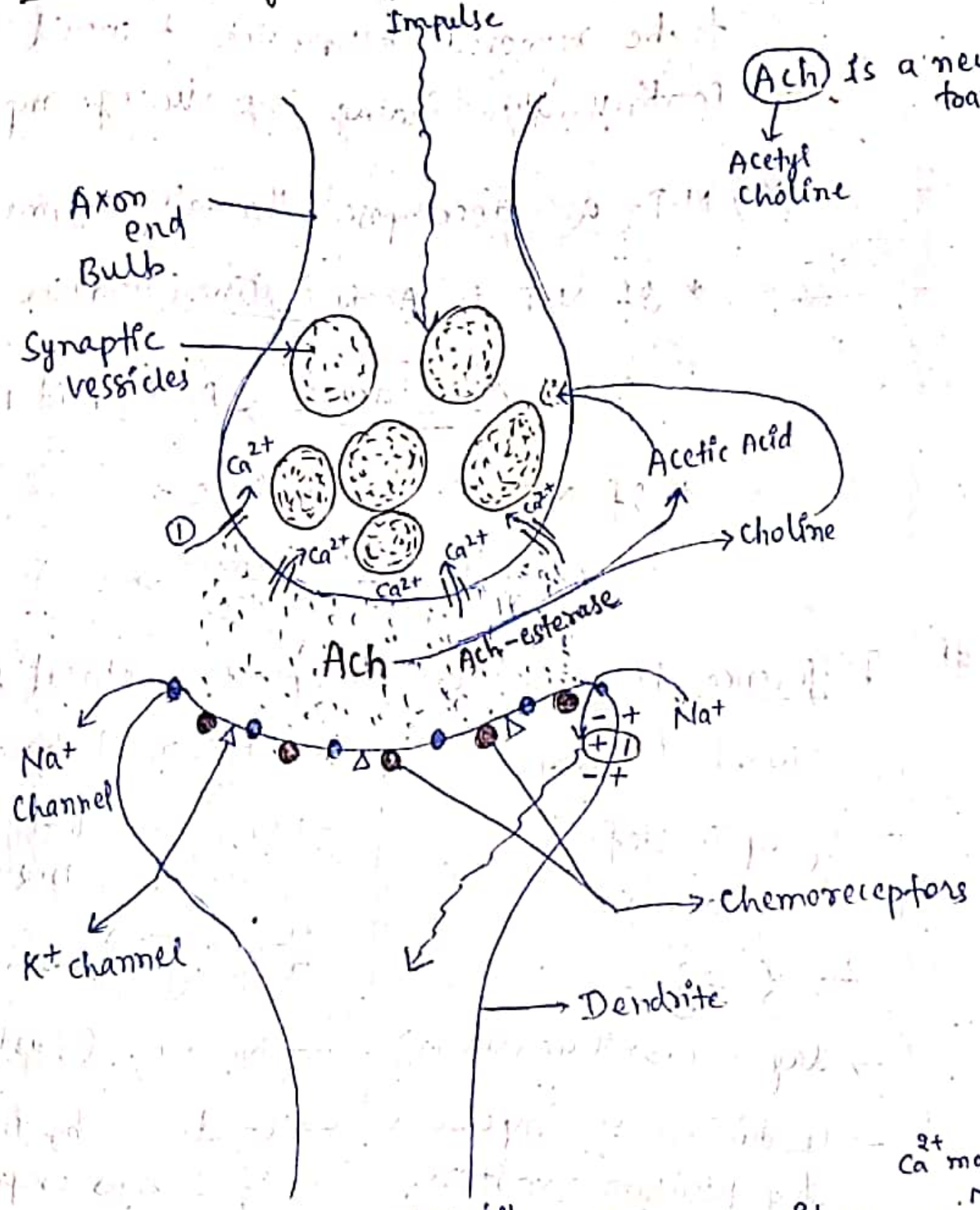
Chemical Synapse
→ chemical sqrd i.e. Neurotransmitters (NT)
→ Synaptic cleft 10-20 nm

Electrical Synapse
→ ions / charges jump
→ synaptic cleft (0.2 nm)

* Chemical Synapse :-



Conduction of Impulse through Chemical Synapse :→



(i) Impulse → reaches axon end bulb. → Ca^{2+} Ch. open → Ca^{2+} more inside pre syn. memb.

(ii) Ca^{2+} binds to inner Pre-Synaptic membrane.

(iii) Ca^{2+} triggers rupture of vessicles to release Neuro-transmitter through exocytosis.

(iv) N.T. binds to chemoreceptor on post synaptic membrane which changes the permeability of post synaptic membrane thus, an impulse is induced in latter part.

(v) The N.T. released in the synaptic cleft has to be removed, otherwise it would be continuously binding & producing impulse.

(vi) N.T. are decomposed through enzymes.

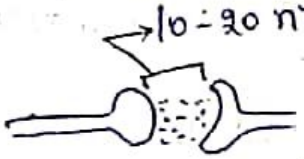
* If N.T. is Acety-choline (Ach) :-

Ach —(Ach-estarase)→ Acetic Acid + Choline

* If N.T. is Adrenaline -

Adrenaline —(Monoamine oxidase)→

Difference b/w. chemical synapse & Electrical Synapse:-

Chemical Synapse	Electrical Synapse
→ Synaptic cleft 10-20 nm 	→ Synaptic cleft 0.2 nm. 
→ lag = 0.5 milisec (slower)	→ No lag (Faster)
→ Conduction of impulse is by Neurotransmitters.	→ Cond. is by transfer of charges or potn.
→ Synaptic vessicles with N.T. are present	→ No synaptic vessicle.
→ Mitochondria is numerous in axon end Bulb.	→ Few mitochondria in axon end bulb.
→ Post synaptic membrane has chemoreceptors.	→ No chemoreceptors on post. Syn. membrane

Speed of Nerve Impulse :→

→ Faster on myelinated nerve.

⇓

45 m/s

20 times faster as compared to non-myelinated nerve.

→ Diameter of Nerve :→

Thicker Nerve → faster conduction

Ex:→ squids, earthworms.

* C-fibre in skin are non-myelinated but thicker.

→ Temp. & PH

Sense Organs :→

→ Groups of specialized cells which receives stimuli.

→ Classification by 'Sherington'.

Receptors

- Exteroreceptors
  * detect ext. stimuli
- Proprioreceptors
  * located in tendon & ligament.
- Interoreceptors
  * detect internal stimuli.

* Extero Receptors :→

(i) Phonoreceptors → sound / ear

(ii) Photoreceptors → light / eye

(iii) Gustatoreceptors → tongue

(iv) Olfactoreceptors
→ Smell.

(v) Tangoreceptors
→ pain, touch, Pressure (skin)

(vi) Georeceptors
→ Maintaining posture against gravity.

(vii) Electroreceptors
→ Charge detection.

(viii) Rheoreceptors
→ water current.

* Intero Receptors :→

(i) Statoreceptors :-
→ Posture & equilibrium.
→ Inner ear (christae & Macula)

(ii) Baroreceptors :→
→ Pressure change (BP)
→ Eg→ Carotid bodies (detect changes in BP)

(iii) Viscero receptors :-
→ in visceral organs
→ Pain.

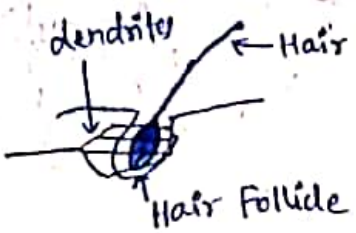
~~# Tango Receptors~~

(1) # Skin Receptors :→

(1) Tango Receptors
→ For detection of Touch only

(a) Basket Nerve Endings

→ Nerve Baskets
→ around the hair follicle

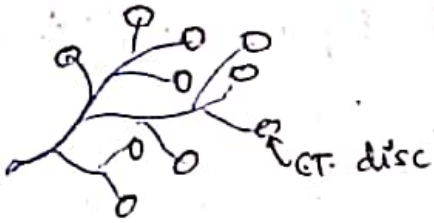


(b) Meissener's Corpuscles :-

→ In dermis
→ on lips, figertips, teats.

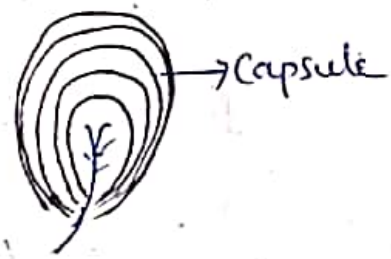
(c) Markel's discs :→

→ In epidermis



(d) Golgi-mazzoni corpuscles :→

→ sub-cutaneous zone of fingers.



(2) Thermo Receptors :→

* For detection of both warmth & coldness.

(a) Calorecceptors :-

→ For warmth (25°-45°C)
→ (16,000-30,000)
→ Ruffinie's Endings

(b) Frigidoreceptors :-

→ (End Bulb of Krouse)
→ For cold (10-20°C)
→ 1,50,000-2,58,000

Note!→

Ampullae of Lorenzini (Thermoreceptor) is found on fish snout.

Ex!→ Scolidon i.e. dog fish.

③ Algesi Receptors :→

→ For Pain.
→ Free nerve endings
→ In deep epidermis.
(4 million)

* Nocireceptors :→

↳ For painful (injury) stimulus.
→ Spreaded all over skin.

④ Pacinian Corpuscles :→

→ Pressure receptors.
→ In dermis.
→ Stimulated by deep pressures & vibrations.
(5,00,000)

⑤ Rheoreceptors :→

→ For detection of water currents
→ Found in lateral lines organs in fishes, tadpoles.

2) # Olfactory Receptors :→

→ For smell

→ Found in Olfactory chamber of nasal chamber

↓

Olfactory epithellium
(Schneiderian membrane)

* Columnar cells.
* Pseudo stratified epithellium
  - Pseudo → False
  - stratified → layers
* Glandular & Sensory.

→ Four types of cells are found in olfactory receptors

(i) Olfactory cells :→

→ Spindle shaped
→ Modified Bipolar Neurons
→ life → 2 months.
→ Chemoreceptors.

(ii) Supporing cells

(iii) Basal cells :→

→ Small
→ Give rise to olfactory cells.

(iv) Mucous Gland :→

→ Bowman's Gland
→ Secretes Mucous.

Note :→

Olfactory Adaptation :→

olf. cells undergoes → Fatigue easily.

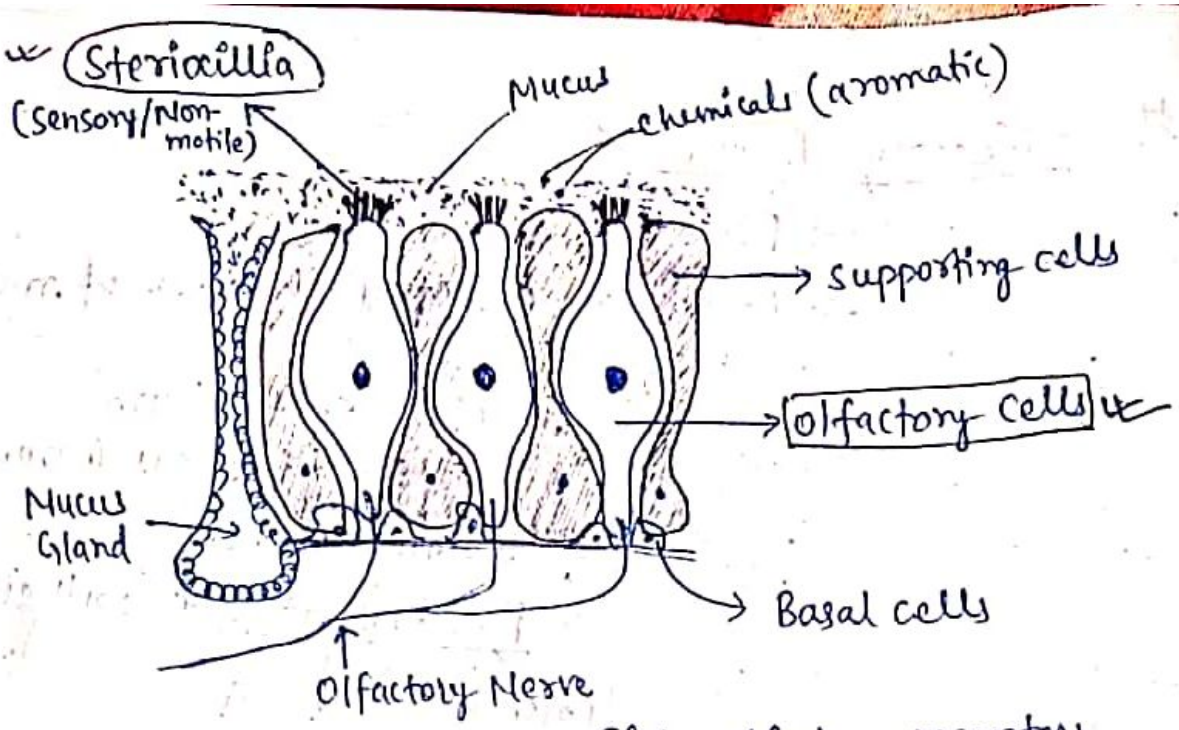


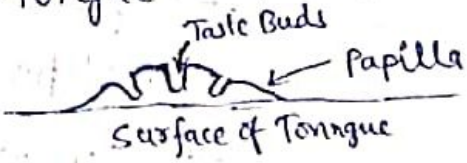
Fig:→ Olfactory receptors.
(Schniderian memb.)

③ # Gustatoreceptors :→

↓

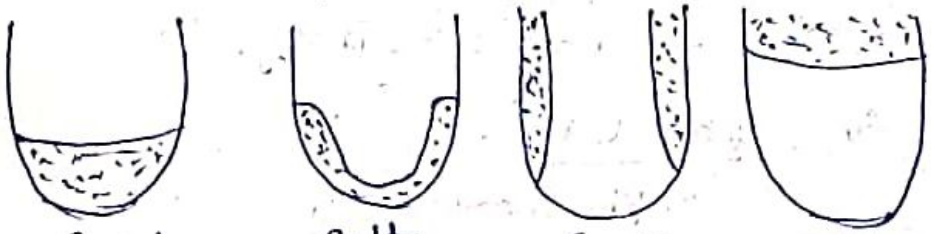
Taste Receptors.

→ Taste Buds ⇒ present inside papillae on tongue



→ also present on soft pallate & epiglottis.

→ 4 Basic Tastes :→



Sweet	Salty	Sour	Bitter
e.g→ Sugar, dextrins	e.g→ Na^+	e.g→ acids	e.g→ Coffeine, drugs

Taste Buds :-

→ Oval in shape.

→ Consist of 2 cells

- gustatory cells
  - * (Sensory)
  - * Chemoreceptors
- Supporting cells

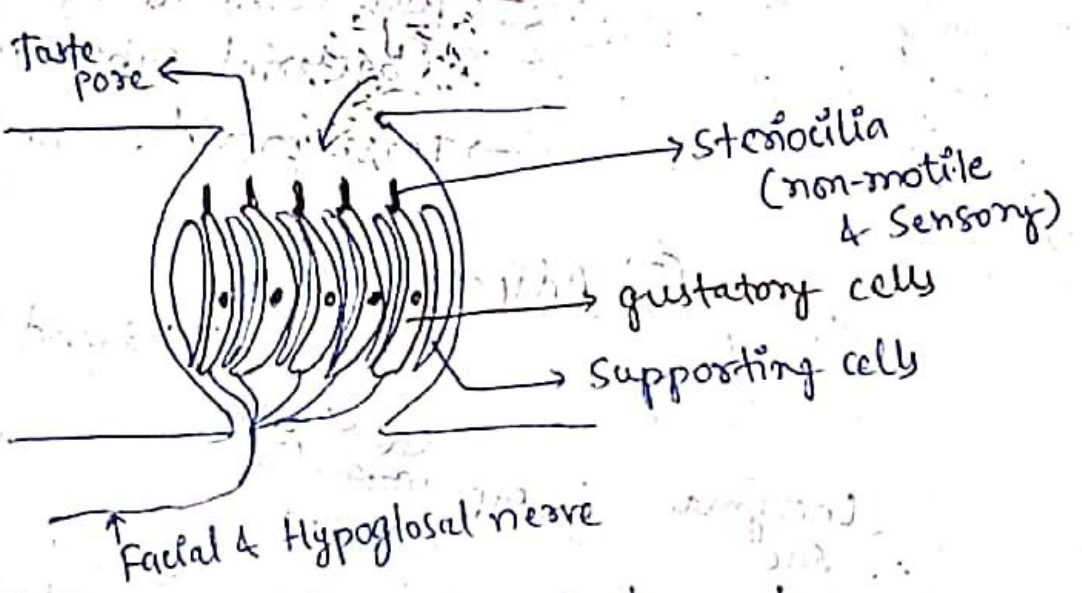


Fig :- Taste Bud.

④ # Photoreceptors :-

→ Eye (present in orbits)

→ eye → 2.5 cm in diameter

→ 7 gm wt.

→ Binocular vision (3-D vision).

Protection of Eye :-

① Eyebrows (esp. in Camels)

② Eye lashes

↓ contains Hair

③ Eyelids :→

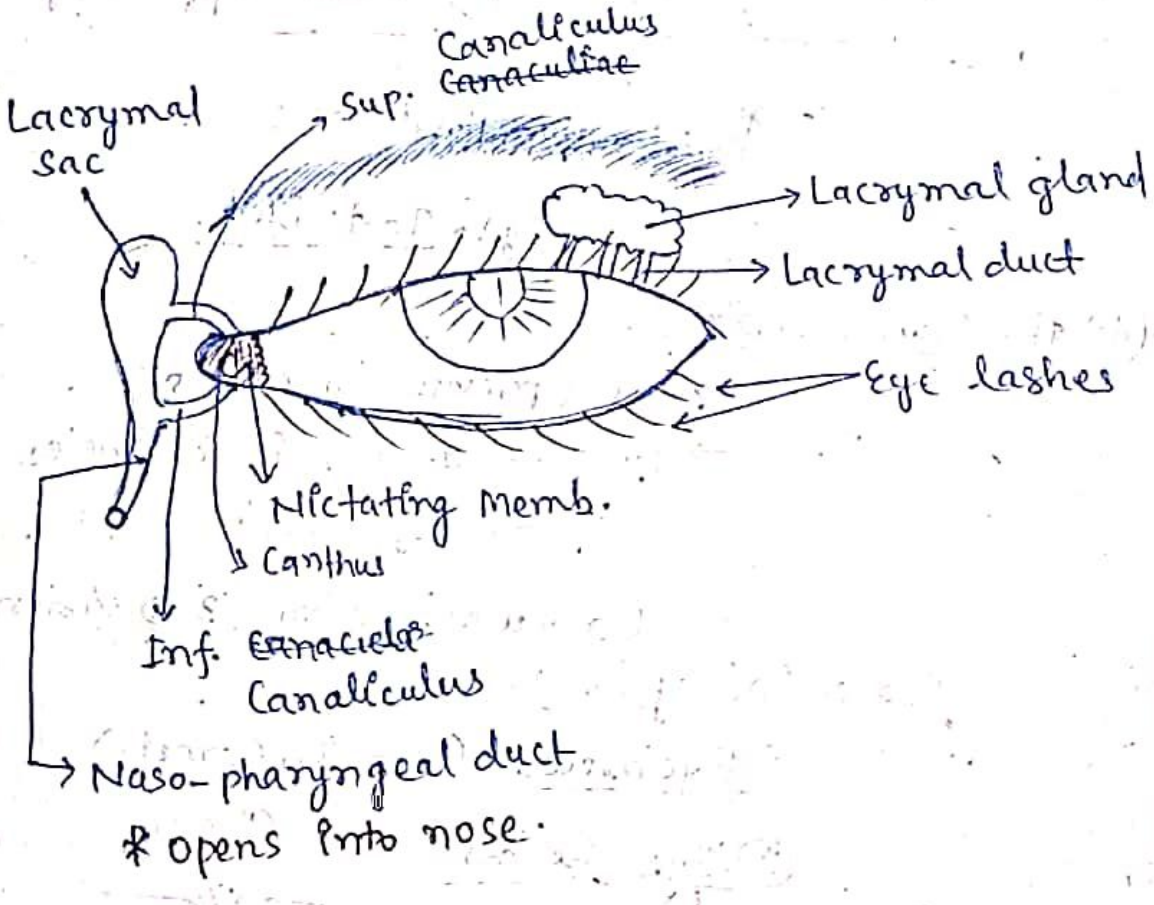
→ 2 Functional lids in humans.
→ 1 lid is vestigial in humans (Nictating membrane)

④ Lacrymal gl (Tear gland) :→

→ Tear contains Lysozyme (bacterial substance).
→ Tears provide nourishment to Cornea.

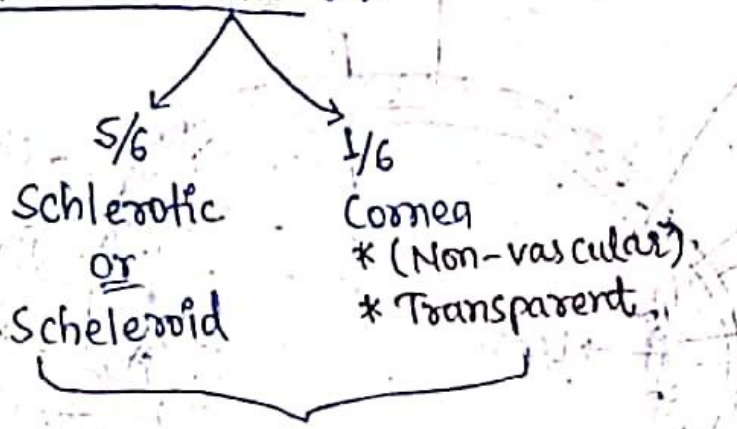
⑤ Adipose Tissue

→ Present around eyeballs.



Structure of Human Eye :→

① Fibrous Tunic :→



* Complete layer
* Maintains shape of eyeball
* Provides attachment surface for muscles.

② Vascular Coat :→

↳ Also called 'Uvea'.

→ Incomplete

→ Three parts :-

(i) Choroid (melanin)

(ii) Ciliary Part

(iii) Iridal Part.

③ Retina :→

(i) → optical part (rods & cones)

(ii) → Ciliary Part

(iii) → Iridal Part

Note!→

* Ciliary part of vascular Coat + Ciliary part of Retina = Ciliary Body.

* Iridal Part of vascular Coat + Iridal Part of Retina = Iridal Body.

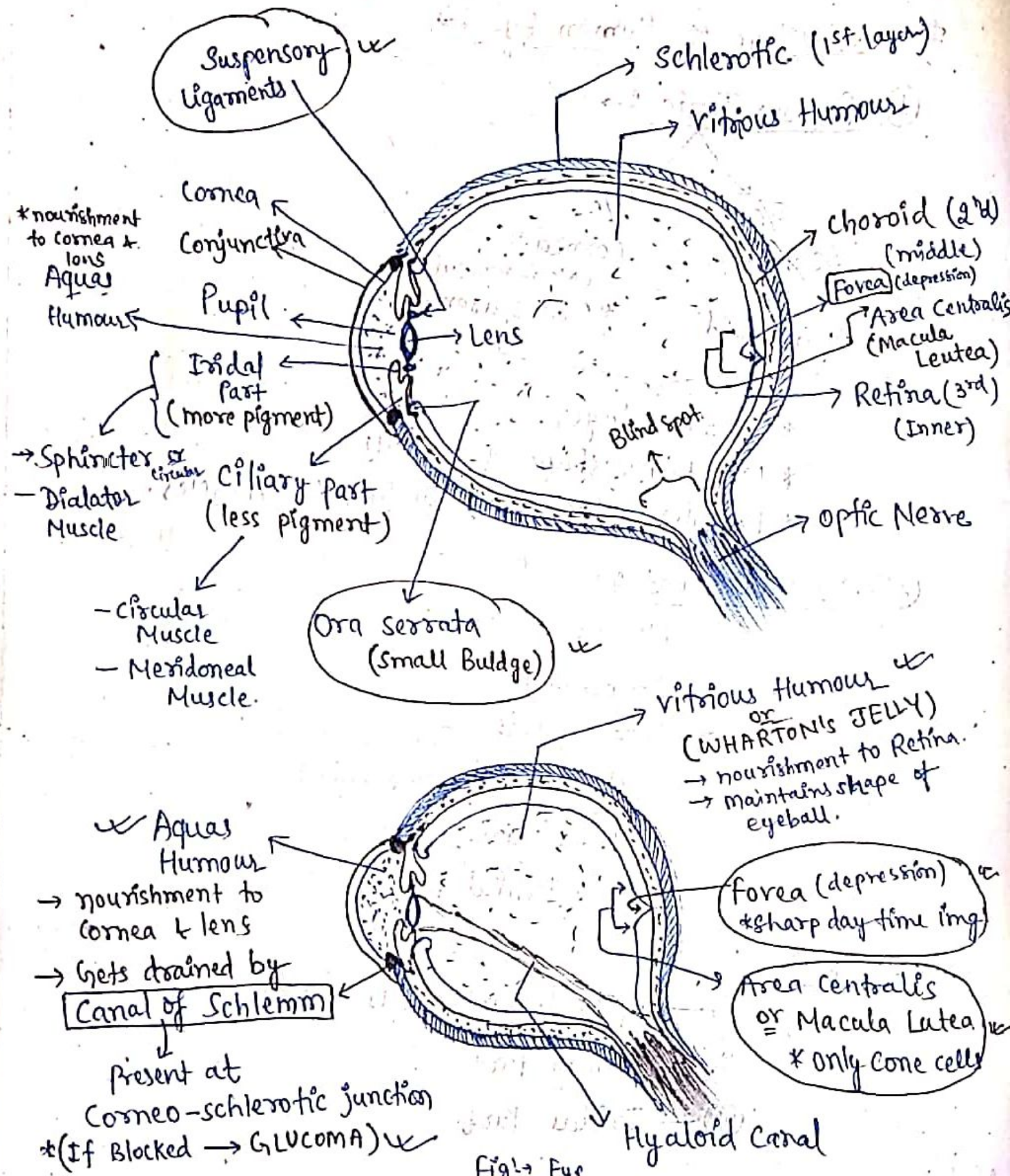


Fig:→ Eye

ant. Less Convex → ← More Convex (post.)

Lens → Crystalline, transparent protein
→ Covered by memb. → Capsule.

Structure of Retina :→

→ Retina has 3 parts :-
- optical part
- Ciliary part
- Iridal part

→ We have to study optical part.

→ Optical part has 4 layers :-

(i) Pigment cell (outermost, attached to choroid or middle layer)

(ii) Photosensitive cells (Rods, cones)

(iii) Bipolar neurons

(iv) Retinal gangalionic cells (innermost, attached to vitrious humour).

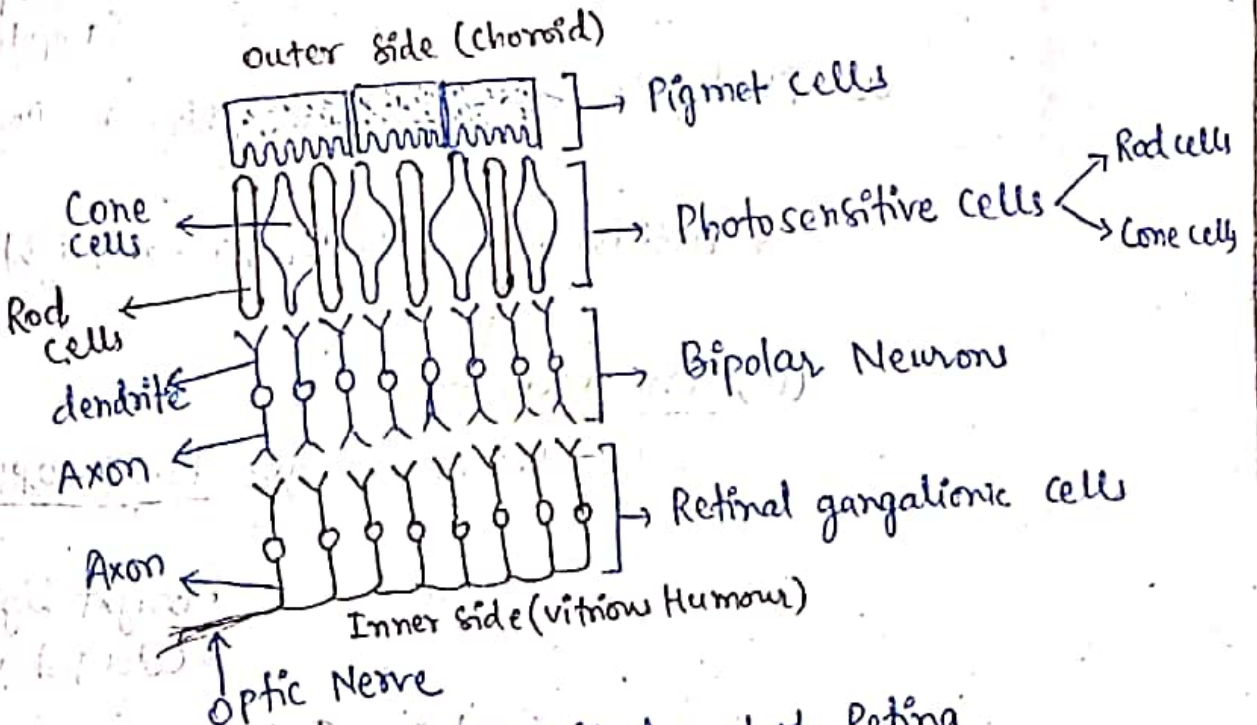


Fig :→ Optical part of Retina.

Note :→

Two more cells → collects Stimulus
* Horizontal cells (present b/w photosensitive cell & Bipolar Neurons)
* Amacrine cells (present b/w Bipolar & gangalionic cell)

(*) Pigment cells :→

→ melanin

→ Cuboidal with Microvilli.

* Photosensitive cells :→

(i) Rods cells :→

→ Responsible for SCOTOPIC vision.

↓

- dim ligh / twilight
- Night vision
- B/w vision

→ Contains RHODOPSIN (visual Purple)

↜ Rhodopsin $\xrightarrow[\text{Bleaching}]{h\nu\ (\text{light})}$ Scotopsin + (Retinal)

↓

Cause depolarisation. (Impulse generation)

↜ Rhodopsin $\xleftarrow{\text{Night}}$ Scotopsin + Retinal

* deficiency of Rhodopsin → 'Night Blindness'.

(ii) Cone cells :→

→ Responsible for PHOTOTOPIC vision.

↓

- Bright light
- Coloured vision

→ Contain IODOPSIN (visual violet).

→ 3 types of cells :→

eye is most sensitive to green.

↜ CHLOROLABS ⟶ sensitive to green

CYANOLABS ⟶ " " Blue

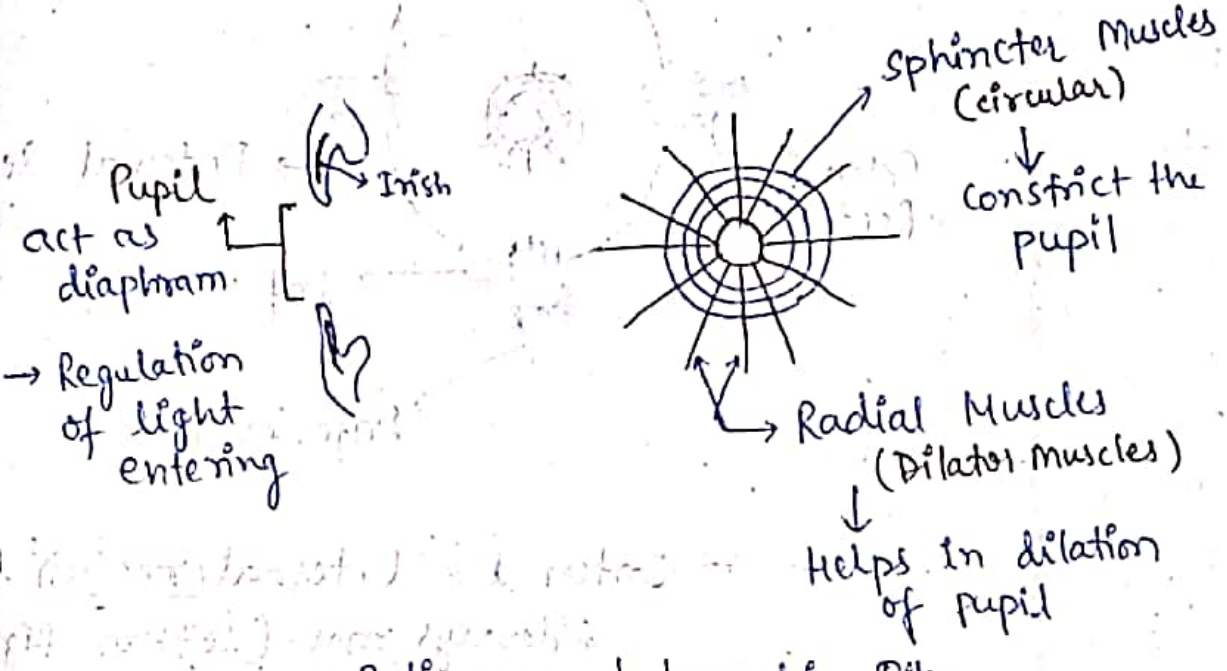
ERYTHROLABS ⟶ " " Red.

Note:→ Most of the domestic animals, shark donot have Cone cells (No colour vision).

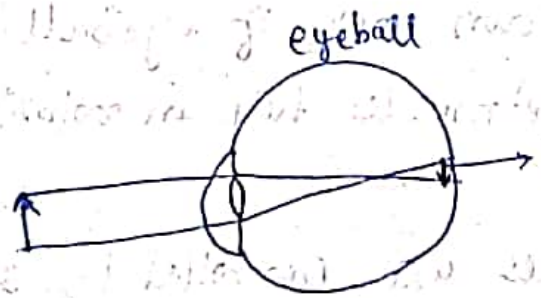
working of Human Eye :→

→ Conjunctiva, cornea (max. Refaction)
aq. Humour, lenses ←
vitrious Humar.
These all refract light to Retina.

→ Pupil act as a Diaphram.



→ Retina as photographic Film.



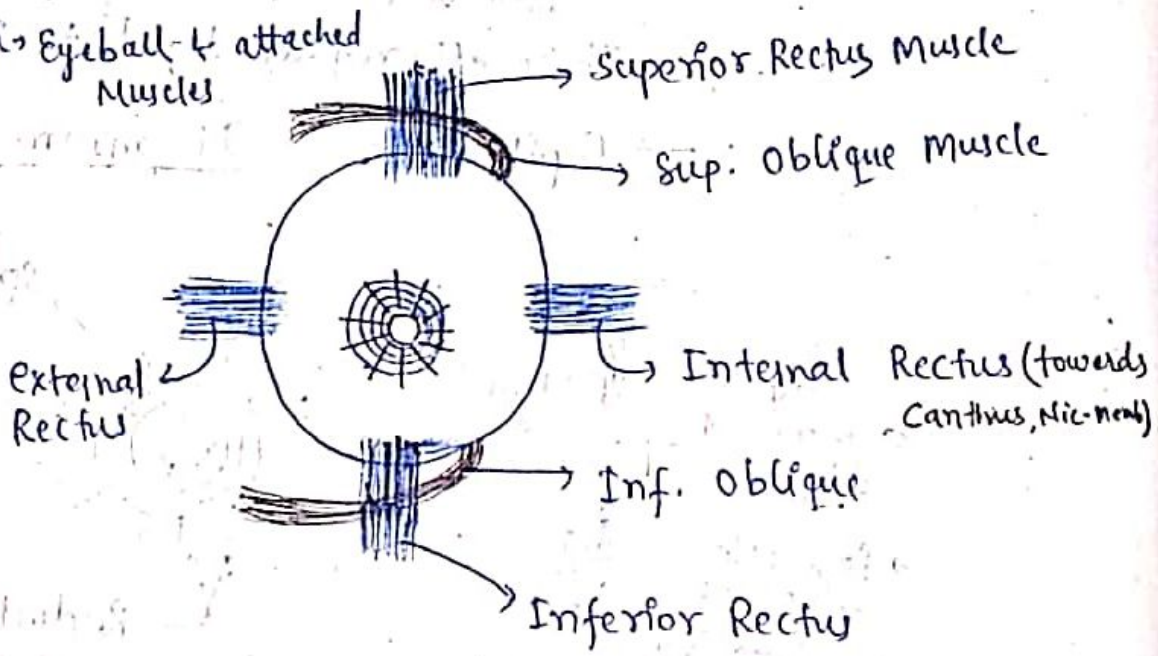
→ ~~fact~~ signal goes to occipital lobe of cerebral hemisphere
↓
Interpretation.

Movement of Eyeball :→

→ Sclerotic layer of eye
- Maintains shape of eyeball
- provides attachment surface for muscles.

→ 6 muscles control the mov. of eyeball.

Fig:→ Eyeball & attached Muscles



→ Internal & External (rectus) helps in sideways mov. (left or Right)

→ while Sup. & Inf. rectus helps in Up-down mov. of eyeball

→ (Oblique) muscles help in rotation.

VVI Note:→

→ These 6 muscles are controlled by 3 cranial nerves

III, IV & VI
- III → Oculomotor
- IV → Trochlear
- VI → Abducens

Power of Accomodation :→

→ ability of lens to adjust Focal length.

→ Accomodator apparatus

(i) Ciliary Body → Meridonial, circular Muscles

Imp.

(ii) Suspensory Ligaments ("zonula of Zinn)

Defects of Human Eye :→

→ Power of accomodation of eye is somewhat lost.

1. Myopia :→

→ (Near Sightedness)

→ ~~Far obj~~ can see close objects.

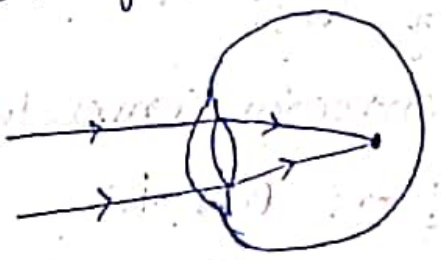
→ far obj. are not clearly seen.

→ correction → Concave lens.

opposite word
sight → Blind

Reasons of Myopia :→

(a) Converging power increases.



(b) Large Eye ball

2. Hypermetropia :→

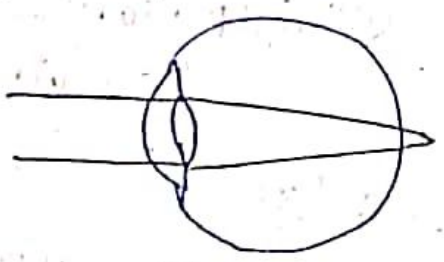
→ Far sightedness.

→ Far objects are clearly visible

→ Near objects are not visible.

Reasons for Hypermetropia :→

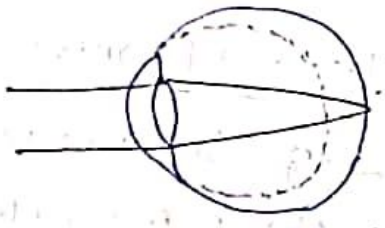
(a) Converging Power decreases



Correction :→

Convex lens ()

(b) Smaller eyeball :-



3. Presbyopia :→

→ Similar to Hypermetropia

→ Due to ageing loss of ~~elasity~~ elasticity of lens.

→ Correction : Convex lens.

4. Astigmatism :→ (M+H.M)

→ Due to diff. curvature or thickness of cornea or lens.

→ At some places, img formed behind retina
" " " , img " infront retina

→ Correction Cylindrical lenses

5. Cataract :→
→ lens becomes opaque.
→ correction surgery (replacing of lens).

6. Glucoma :→
→ Blocking of Canal of schlemm.
→ Intraocular Pressure ↑es due to improper draining of Aquas. Humm
→ lead to Blindness.

7. Squint (Strabismus) :→
→ Defect of eyeball muscle.
→ Improper working/weaking of rectus or oblique muscle.
→ correction by surgery at early age.

Miscellaneous Points :→

** Pecten :→ Vascular, pigmented structure in the eye of birds (except Kiwi).

** Tapetum Callosum :→
→ Reflective membrane b/w Retina & choroid.
→ function is to reflect all the light to retina.
→ Glowing of eye of cats, dogs, cattles.

** Tapetum Lucidum :→
→ Similar reflective layer.
→ found in Elasmobranchs (cartilaginous fishes)
→ Made up of crystals of Guanine.

⑤ Organ of Hearing & Equilibrium :→

→ Ears.

(a) Phonoreceptors → Hearing

(b) Statoreceptors → Equilibrium

Structure of Ear :→

1. External Ear :→

- **Pinna**
  - * Cartilage supported
  - * 3 auricular muscles (vestigial in Humans)
- **External Auditory meatus or canal.**
  - * 2.5 cm

Note!→ Tympanic Membrane joins Ext. ear to middle ear.

→ Stretched mem. of C.T.

2. Middle Ear :→

→ Air filled cavity.

→ 3 ear ossicles present which help in amplification of sound.

(a) Malleus
* Hamer Shaped

(b) Incus
* Anvil Shaped

(c) Stapes
* ~~Sattir~~ Stirrup

Staff uses this supporting stru.

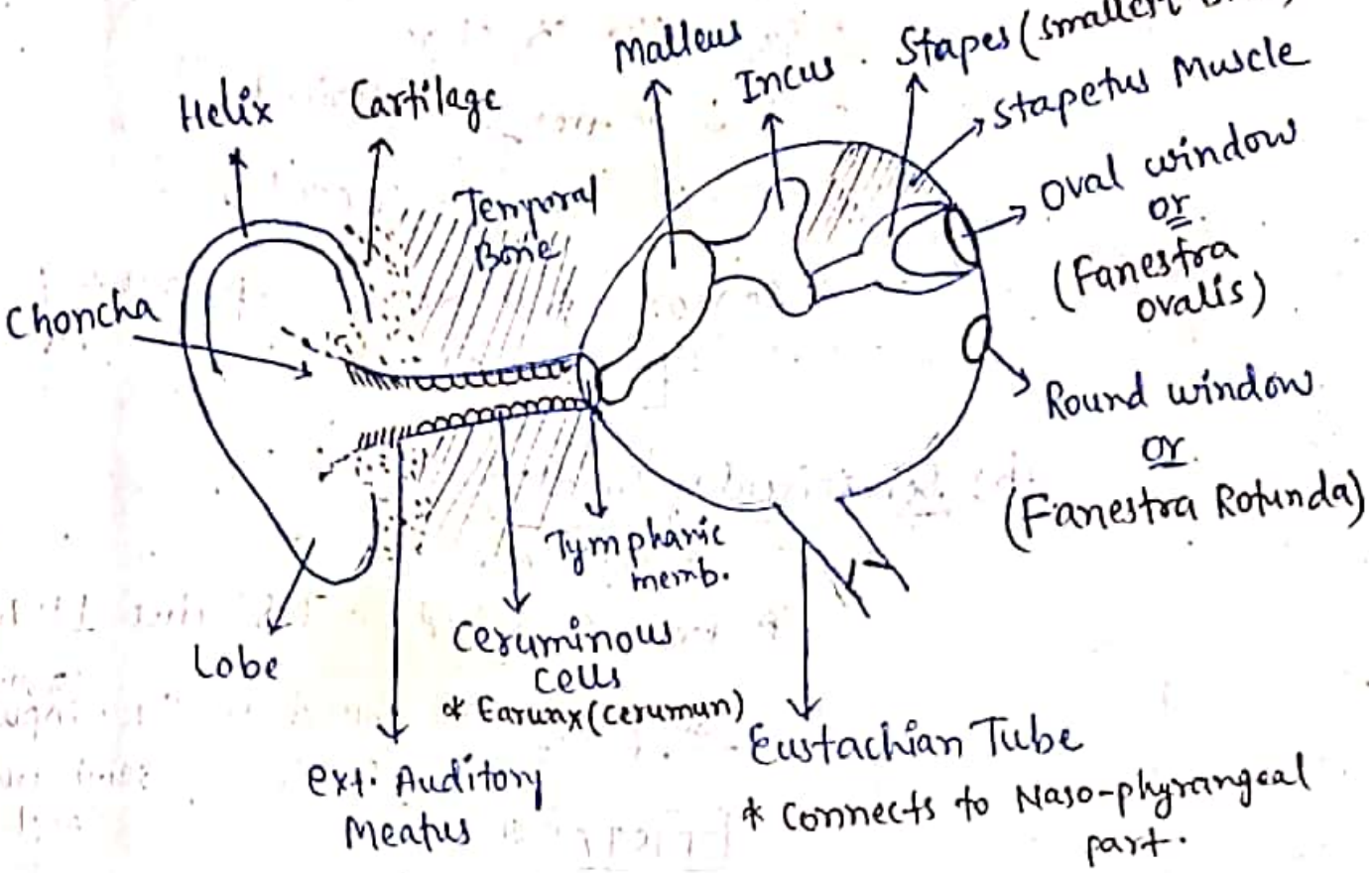
M I S

* (Iron stru. which helps to climb on Horse).

v.v.I Note!→

* Middle ear on ant. side → Tympanic memb.
* Middle ear on post. side is connected to COCHLEA.

Fig:- Outer & Middle ear :-



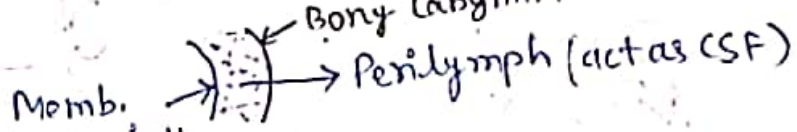
~~3. Middle Ear :-~~

3. Inner Ear :-

→ Soft, whitish, membranous structure.

→ Also known as "Membranous Labyrinth"

→ Placed in the same shaped bony structure — "Bony Labyrinth".



→ Three parts of Inner Ear :-

Equilibrium / Balancing { (a) vestibule, (b) semicircular canals

Hearing ← (c) cochlea.

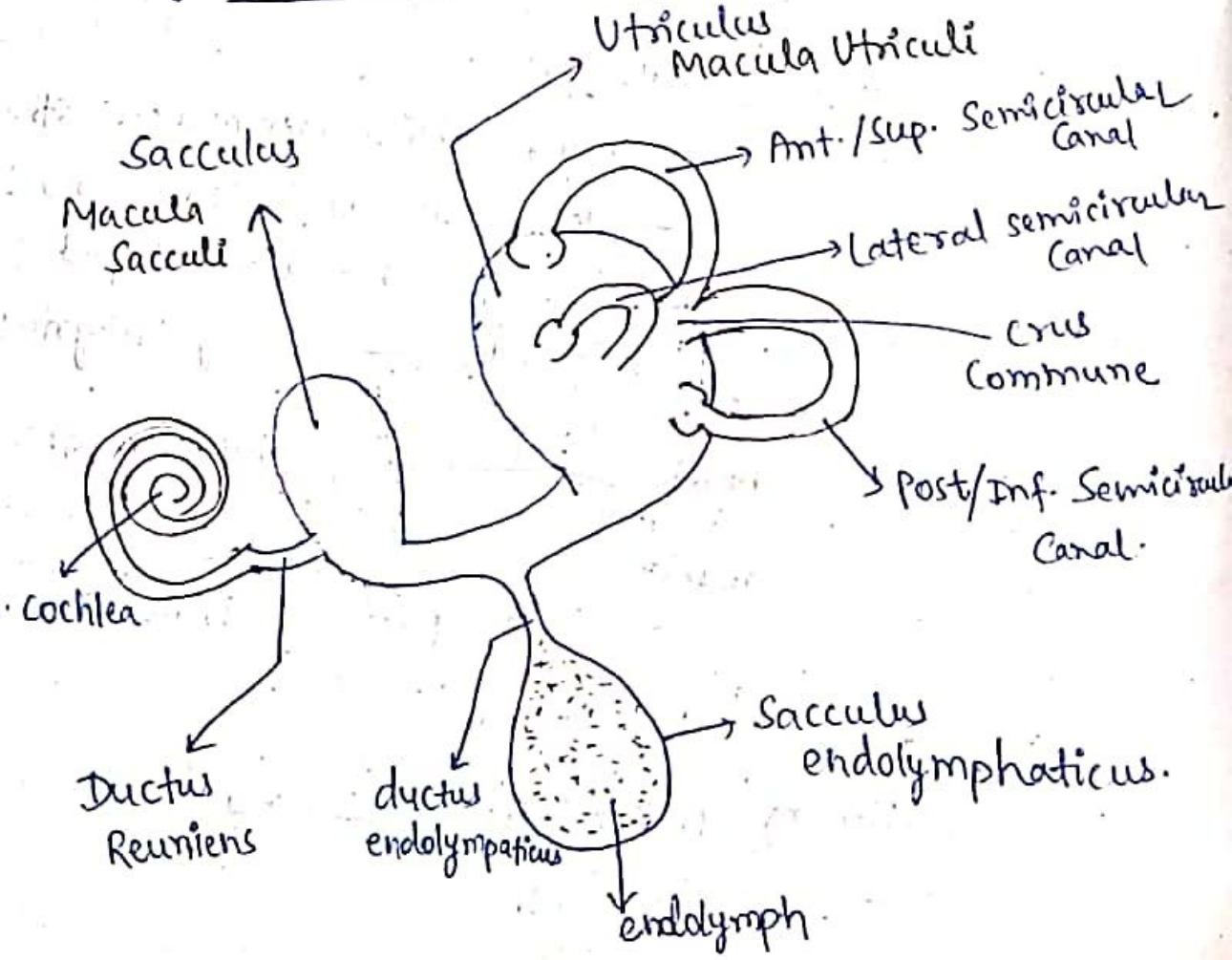
(a) Vestibule :→

* Sac like structure.
* 2 structures — Utriculus
  Sacculus
* Sensory structures are present in vestibule
  "MACULA"

(b) Semicircular Canal :→

* 3 in number.
* ~~Present~~ Attached to Utriculus laterally.
* Sensory structure found in the Ampulla (Swollen) region of semi-circular canal.
  "CRISTAE" (3)

Fig:→ Inner Ear



Crista & Macula of inner Ear :→

1. Macula :→

→ 2 in no.
→ Found in Utriculus & Sacculus of vestibules.
→ Maintains static equilibrium (resting).
& linear acceleration (walking straight)

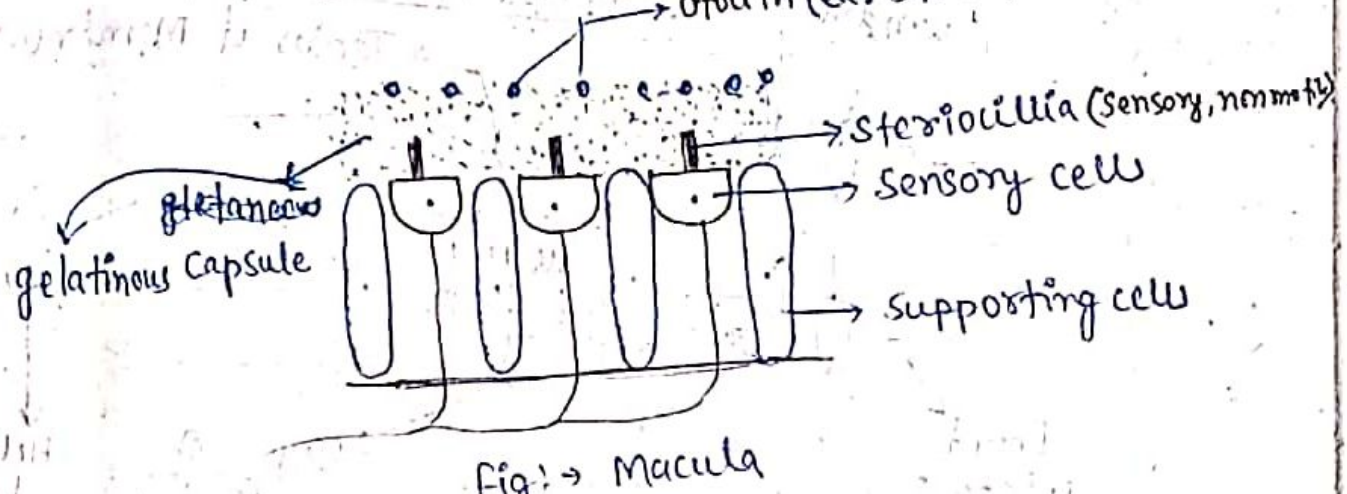
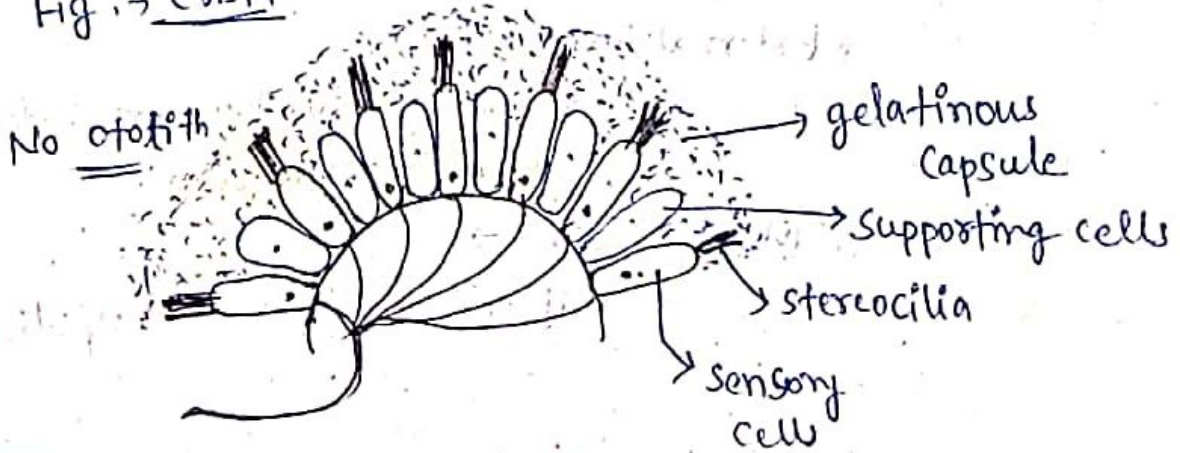


Fig :→ Macula

2. Crista ampullaris :→

→ 3 in no.
→ Found in ampulla (swelling) of semi-circular canal.
→ No otolith (ear stone) is found.
→ Maintains Dynamic equilibrium
& angular acc^{n} (moving/ taking turn)

Fig :→ Crista



Cochlea :→

→ Coiled structure 2 3/4

→ For simplicity, we draw its linear structure.

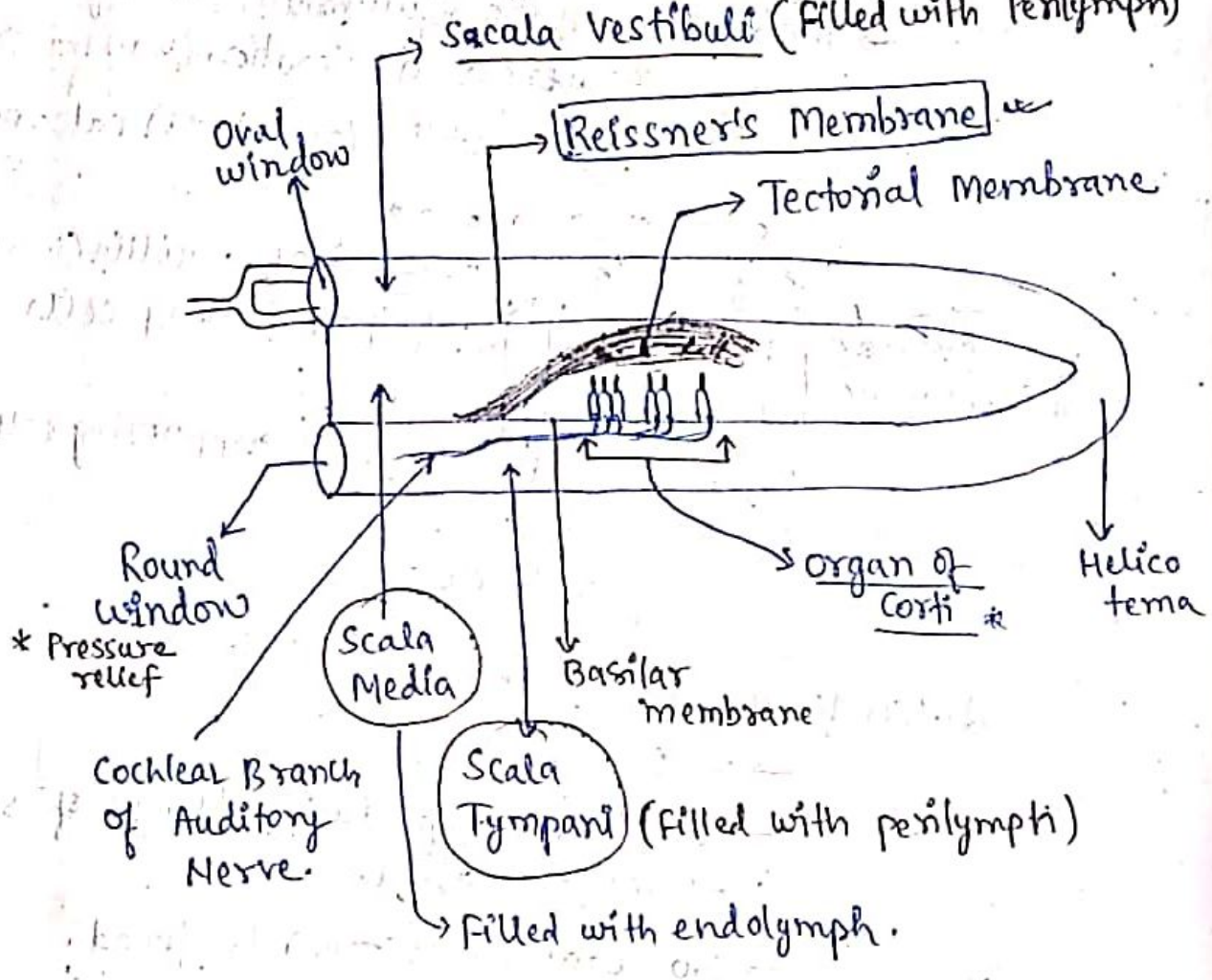


Fig:→ linear view of cochlea.

working of ear :→

* External Ear :→
  → collection of sound waves & focus on Tympanic membrane.
* Middle Ear :→
  → Amplification of sound by 22 times.

Note:- Loudness of sound → depends on no. of cells of organ of corti gets stimulated.

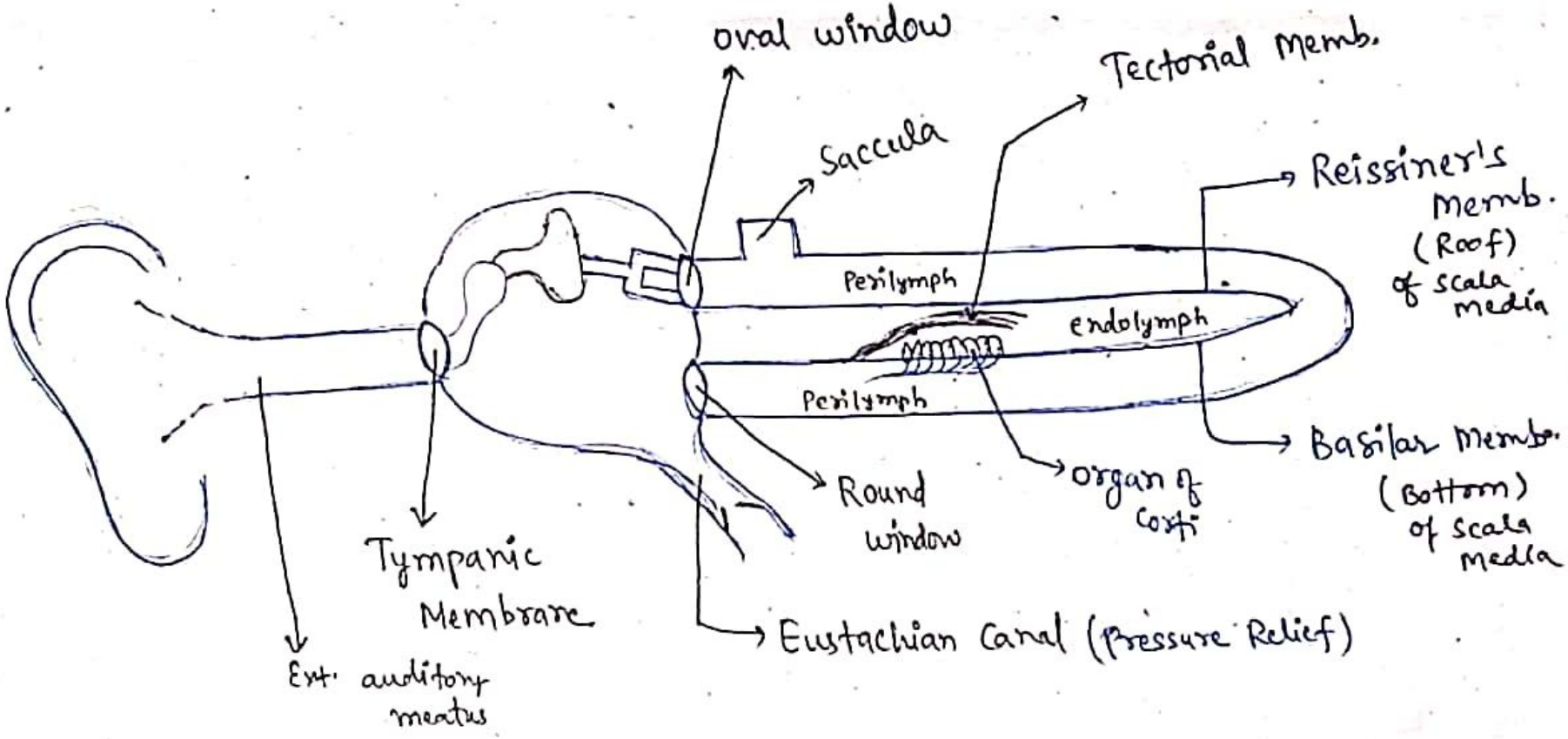


fig:- Connection of Ear.