



Neural Control and Coordination

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INTRODUCTION

- Coordination is the process through which two or more organs **interact** and **complement** the functions of one another to **maintain homeostasis** in our 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.

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SYSTEMS MAINTAINING HOMEOSTASIS

PARAMETERS	NEURAL SYSTEM	ENDOCRINE SYSTEM
<ul style="list-style-type: none">Integration	Through Neurotransmitters Quicker	Through hormones Slower
<ul style="list-style-type: none">Neural system provides an organised network of point to point connections with target cells		

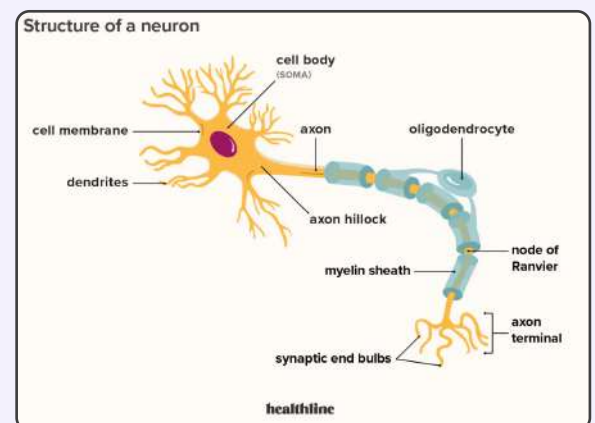
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NEURON

- Neuron is the structural and functional unit of the neural system.
- Composed** of a cell body, dendrites and axon.

Types	No. of Dendrites	Location
Multipolar	2 or more	Cerebral cortex
Bipolar	1	Retina of eye
Unipolar	0	Embryonic stage

- Above given neurons have only one axon.
- Cell body contains cell organelles
- Impulse from dendrite moves towards cell body and in axon away from cell body.



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TYPES OF AXONS/NERVE FIBRES

Parameters	Myelinated	Non-myelinated
Myelin sheath	+	-
Node of Ranvier	+	-
Location	Cranial & spinal nerves	Autonomic and somatic neural system

- Schwann cells surround both myelinated and non-myelinated nerve fibres** but they form myelin sheath only in myelinated fibres.

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CONCENTRATION GRADIENT ACROSS AXONAL MEMBRANE

- Excitability of neurons is attributed to polarised state** of neural membranes.
- It has **selectively permeable ionic channels** responsible for differential concentration gradient across the axonal membrane.
- Axonal membranes are more permeable for K^+ , nearly impermeable to Na^+ and impermeable to negatively charged proteins.**
- Ionic gradients across resting membrane are maintained by the active transport of ions by the sodium-potassium pump which pumps $3Na^+$ outwards and $2K^+$ into the cell**

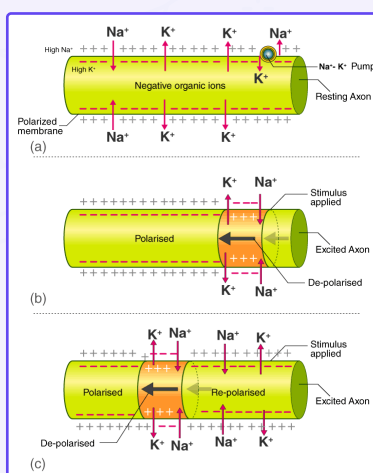
Types of fluids	Composition
ECF	$K^+ \downarrow, Na^+ \uparrow$
ICF	$K^+ \uparrow, Na^+ \downarrow$

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GENERATION OF IMPULSE

- The electrical potential difference across the resting plasma membrane is called the **resting potential**.
- The electrical potential difference across the axonal membrane after receiving **threshold stimulus is called action potential/nerve impulse**.

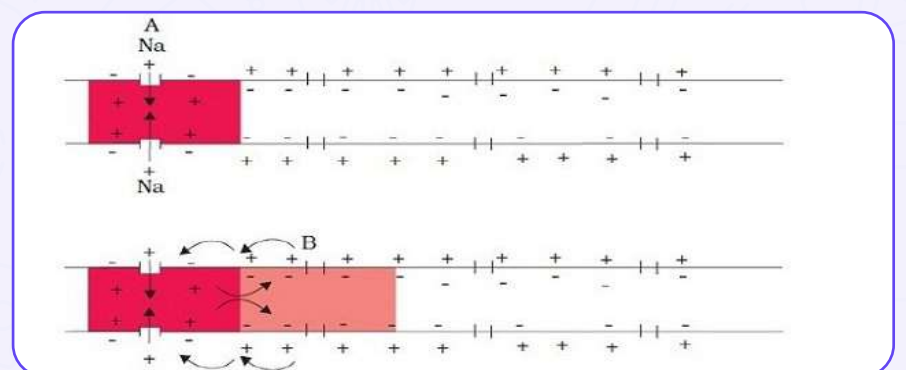
- Cycle of events**



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CONDUCTION OF IMPULSE

- Impulse generated at a site arrives at another site and same sequence is repeated along the length of axon.
- Current flows in a circuit when it moves from A to B site.**
- Flow of charge is from A to B** (Inner to outer membrane)





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TRANSMISSION OF IMPULSE

- Nerve impulse is transmitted from one neuron to another across a synapse.

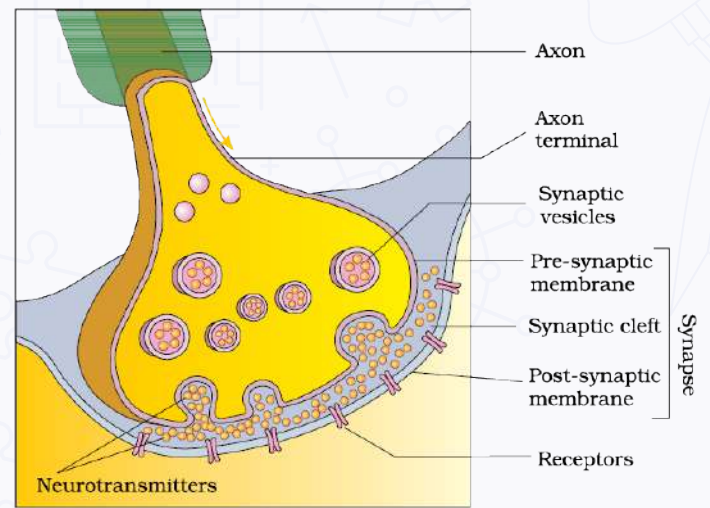
Events observed:

- Neurotransmitters released in synaptic cleft
- Bind to receptors on post synaptic neuronal (PSN) -membrane
- Opening of ion channels in PSN
- Generates a new potential in PSN

Types of Synapse

Features	Electrical synapse	Chemical synapse
• Pre & post neuron	Close proximity through gap junctions	Separated by fluid-filled synaptic cleft
• Flow of impulse	Direct	Through neurotransmitters
• Transmission	Faster	Slower
• Nature	-	Excitatory or inhibitory
• Existence	Rare	Common

Transmission of impulse across electrical synapse is very similar to impulse conduction along a single axon



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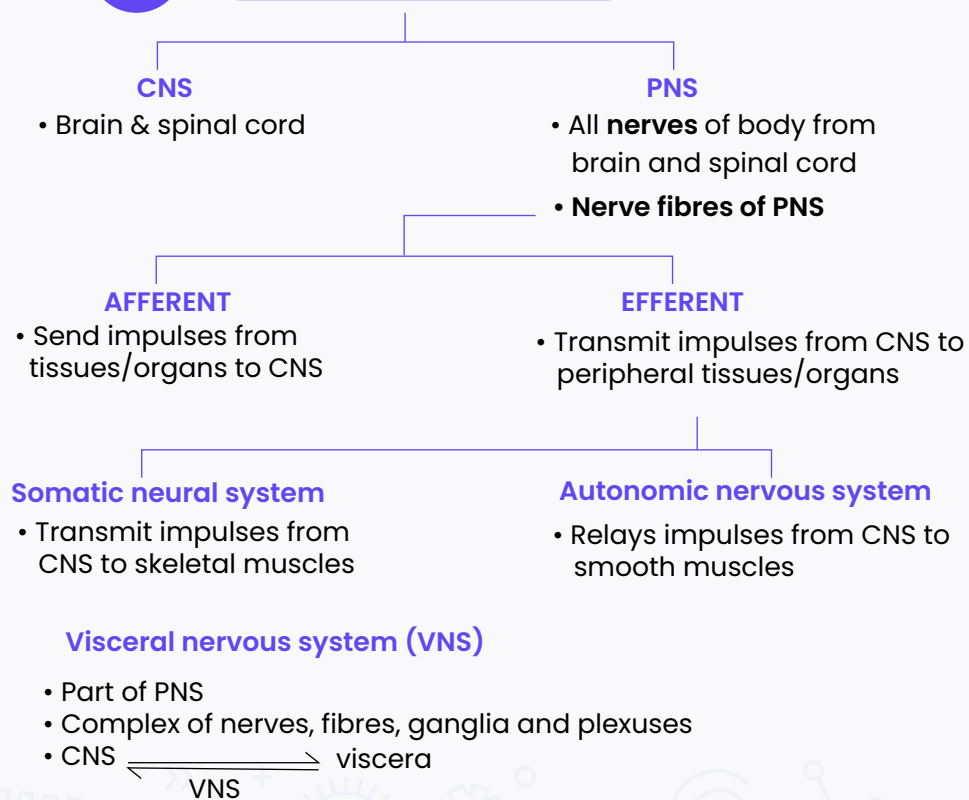
NEURAL SYSTEM

- Neurons can detect, receive & transmit stimulus

- Hydra
 - Network of neurons
- Insects
 - Organised neural system with brain and ganglia
- Vertebrates
 - Well developed neural system

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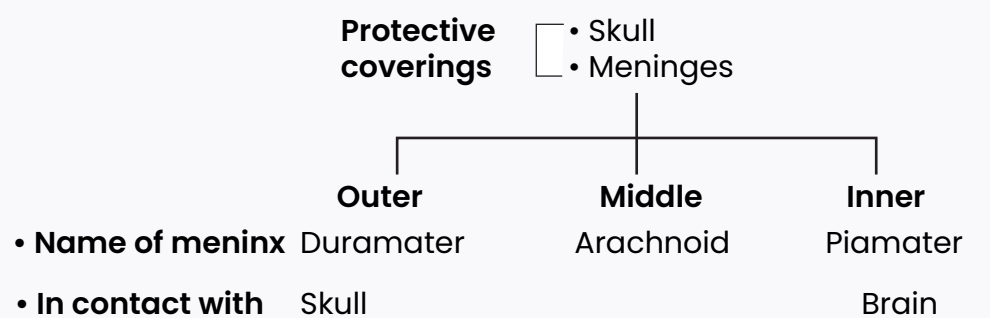
HUMAN NEURAL SYSTEM



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CENTRAL NERVOUS SYSTEM

- Acts as command & control system of the body



Major Divisions of Brain

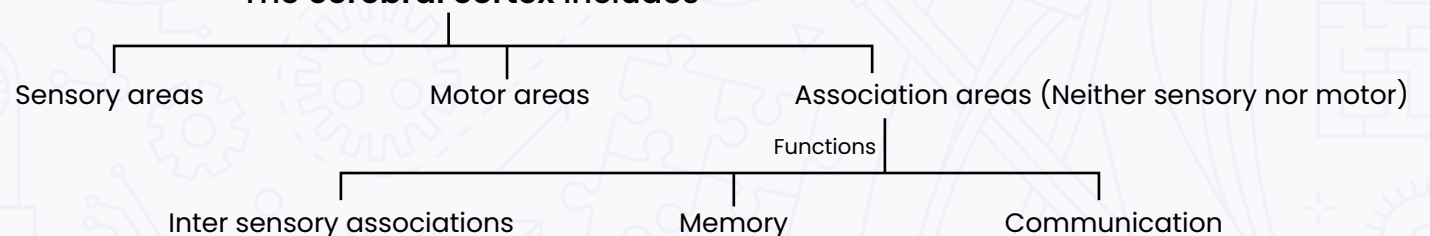
Divisions	Major parts
Forebrain	Cerebrum, thalamus, hypothalamus
Midbrain	Corpora quadrigemina
Hindbrain	Pons, medulla, cerebellum

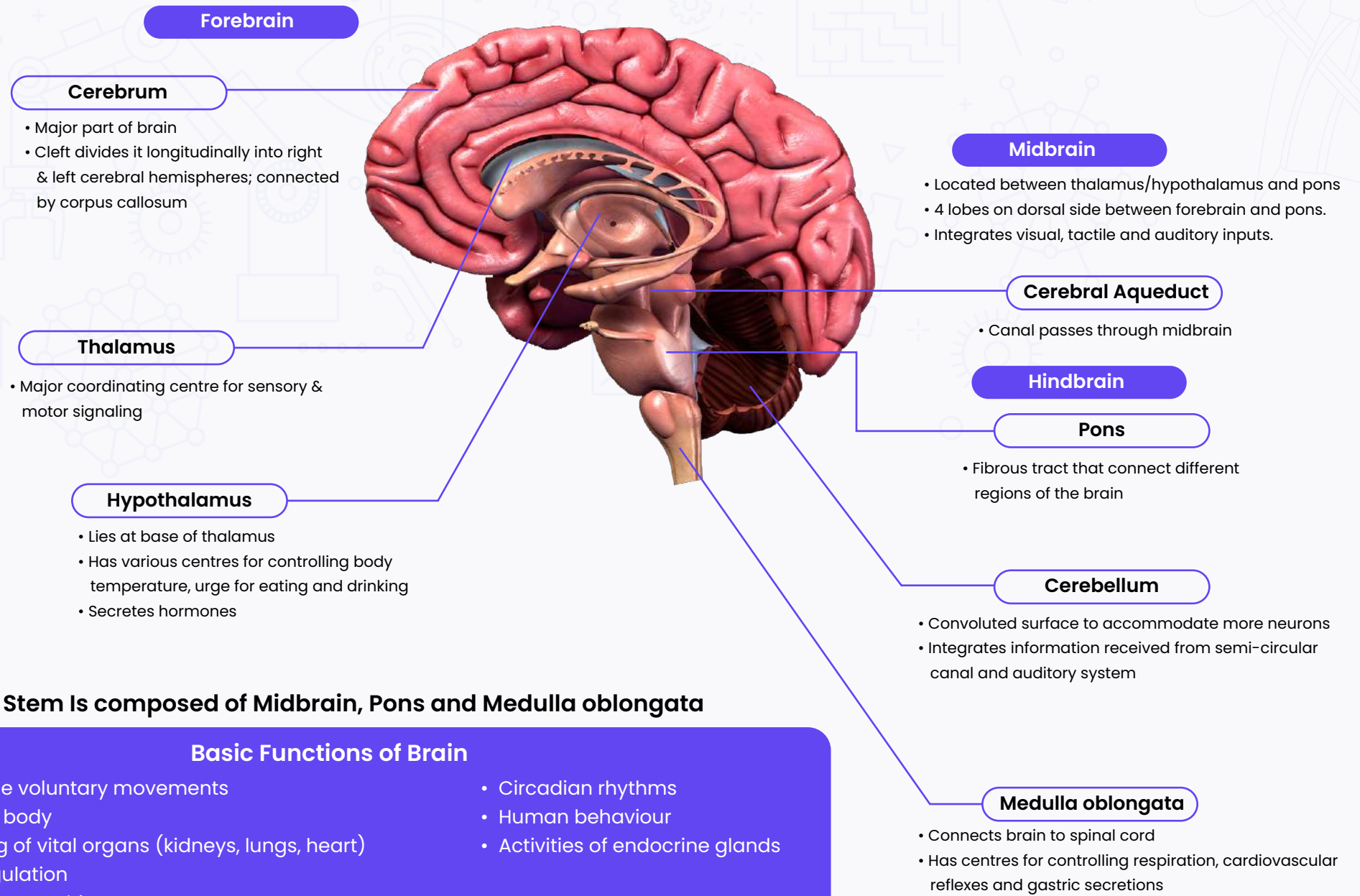
BRAIN

Brain is central information processing organ of the body

Regions in cerebral hemisphere	Appearance	Composition
<ul style="list-style-type: none">• Outer/cortex• Inner	<ul style="list-style-type: none">GreyWhite	<ul style="list-style-type: none">Concentrated cell bodiesMyelinated nerve fibres

The cerebral cortex includes





Limbic System/Limbic Lobe

- **Parts included:** Inner part of cerebral hemisphere, hippocampus, amygdala and hypothalamus
- **Functions:**
 - Involved in expression or emotional reactions (e.g. excitement, pleasure, fear.)
 - Motivation
 - Regulation of sexual behaviour
 - Autonomic responses
 - Olfaction

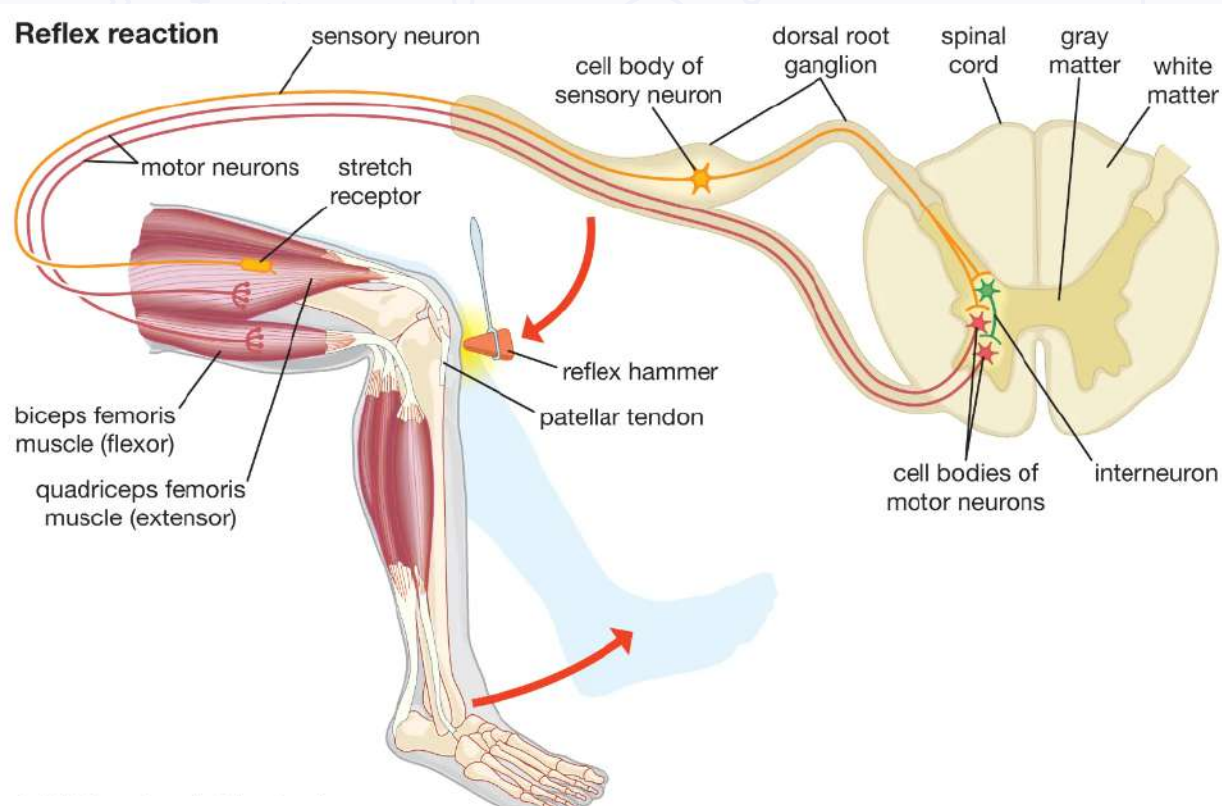
Reflex Action and Reflex ARC

Its a response to peripheral nervous stimulation

Involuntary i.e., without conscious effort

Involves part of CNS

Receptor $\xrightarrow[\text{neuron}]{\text{Afferent}}$ CNS $\xrightarrow[\text{neuron}]{\text{Efferent}}$ Effector/Excitor



Neurons are arranged in series in a reflex pathway.

Afferent neurons transmit impulse via dorsal nerve root.

Inter neuron is not a part of this stretch reflex



Sensory reception and processing

Sensory organs detect all types of changes in the environment

Sensory receptors

(Detect stimuli)

Input

CNS

(Process & analyse)

Output

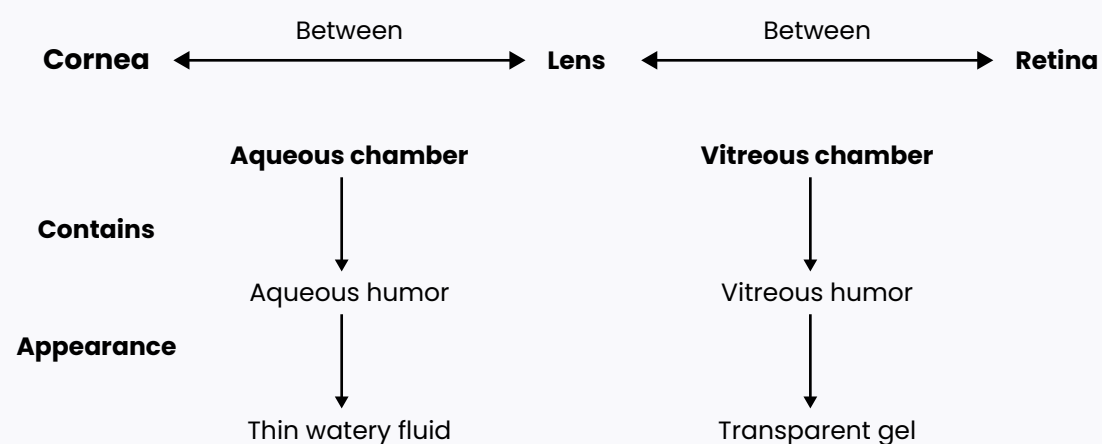
Parts/Organs

(Response to stimuli)

SENSE ORGANS

Sense organ	Sense	Features associated
Nose (single)	Smell	<ul style="list-style-type: none">• Mucus coated olfactory epithelium having three types of cells• Neurons extend directly into bean sized olfactory bulb that are extensions of limbic system.
Tongue (single)	Taste	<ul style="list-style-type: none">• Input from taste buds is conveyed to the brain and a complex flavour of food or drink is perceived
Ear (paired)	Hearing, balance	<ul style="list-style-type: none">• Input from organ of Corti and vestibular apparatus is conveyed to CNS.
Eye (paired)	Vision	<ul style="list-style-type: none">• Enclosed in sockets of skull (orbits)• Nearly spherical in structure

CHAMBERS IN EYE



EYE

• The wall of the eyeball is composed of three layers:

- External
- Middle
- Inner

Middle layer (Choroid)

Iris – Anterior, opaque, pigmented, visible coloured portion of the eye
Regulates the diameter of pupil through its muscle fibres

Ciliary body – Thick anteriorly
Holds the lens in place through ligaments

Choroid – Thin over posterior 2/3rd part
Contains many blood vessels and looks bluish

Inner layer (Retina)

Retina – Outer - Photoreceptor cells types: Rods & cones
Middle - Bipolar cells
Inner - Ganglion cells

Fovea – Only cones are densely packed
Thinned central portion of retina
Point with greatest visual acuity or resolution

Blind spot – Lies medial to and slightly above posterior pole of eye ball
No rods or cones here

Optic nerve – Retinal blood vessels enter
Optic nerve leaves the eye

External Layer (Sclera)

Anterior - Cornea
Posterior - Sclera

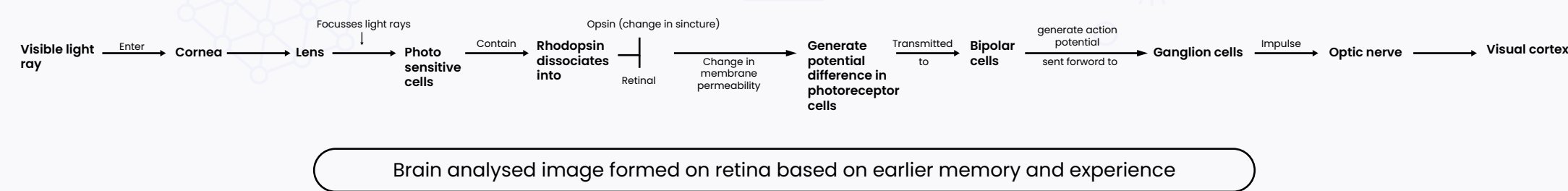
Composition
Dense connective tissue

Macula lutea – Yellowish pigmented spot lying at the posterior pole of eye lateral to the blind spot with a central pit called fovea.

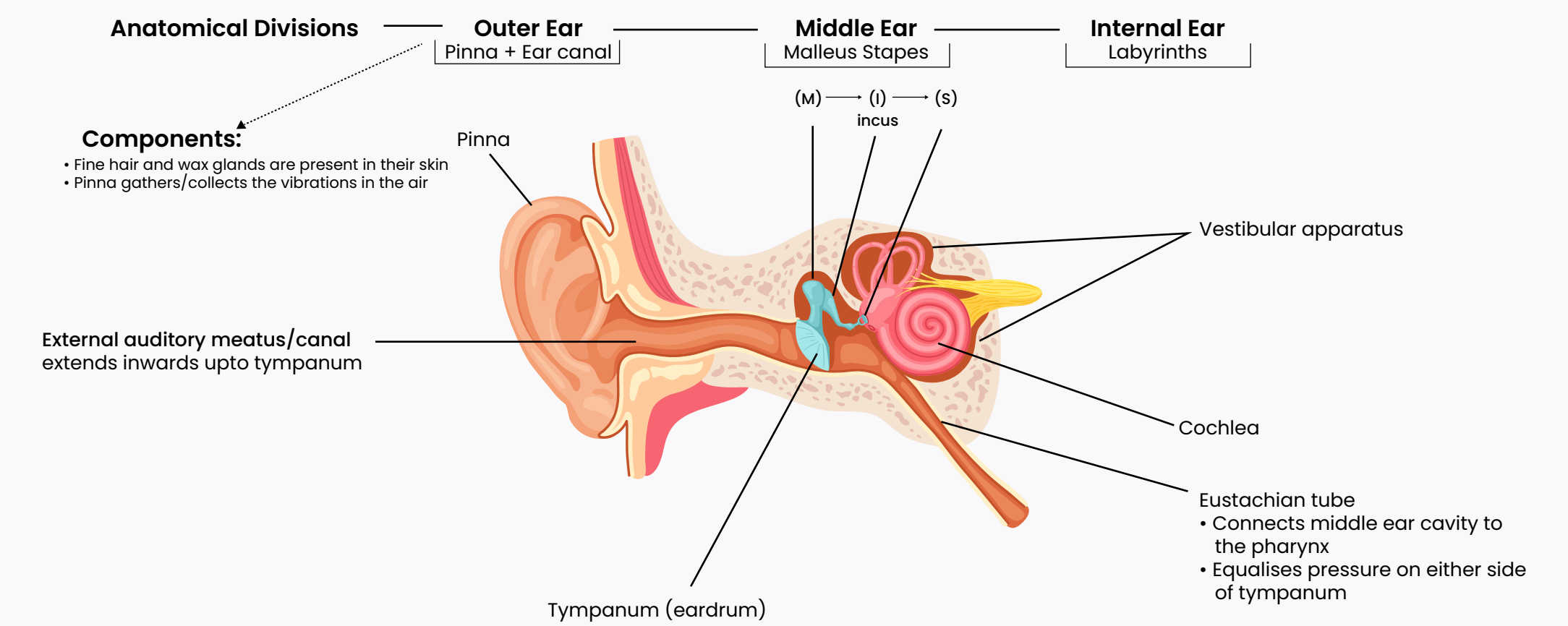


Photoreceptor cells		Vision	Photopigments (light sensitive proteins)
Rods		Twilight/Scotopic vision	Rhodopsin/ Purplish red protein/visual purple
Cones		Day light/ Photopic vision and Colour vision	Types of cones Red - Different photopigments in these cones Green - Sensation of different colours by various combinations Blue -Equal stimulation of these gives sensation of white light

Mechanism of vision



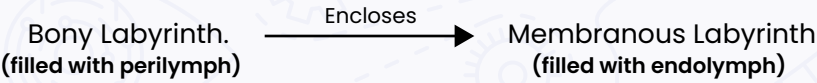
THE EAR



- Tympanic/membrane is composed of
 - (a) Connective tissue covered with skin on the outside
 - (b) Mucus membrane on the inside
- Ear ossicles ——— Arranged in a chain (M—I—S)
- Structural details ———
 - Malleus is attached to tympanum
 - Stapes is attached to the oval window
- Function ——— Increase efficiency of transmission of sound waves to the inner ear

LABYRINTH

It is a fluid filled inner ear, consists of two parts: Bony and Membranous labyrinths

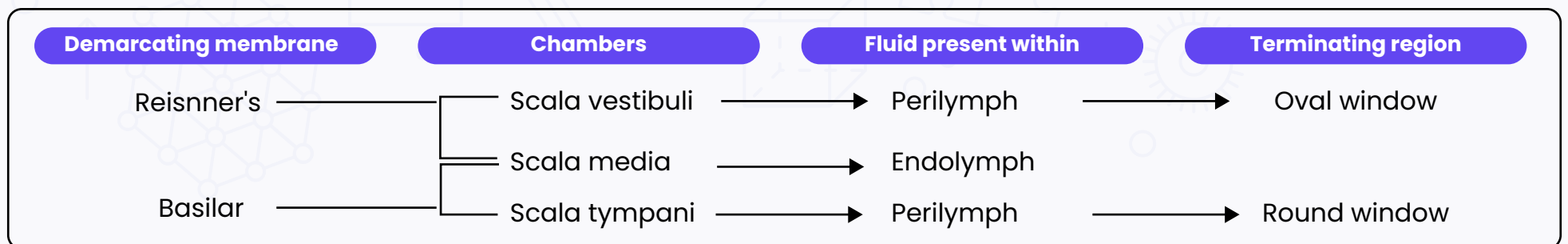


Parts of Membranous labyrinth	Sub-parts	Receptors	Basic functions
Vestibular apparatus (complex system)	(a)Semicircular canals (b)Otolith Organ <ul style="list-style-type: none">• Utricle• saccule	Crista ampullaris Macula	<ul style="list-style-type: none">• Maintenance of balance of the body and posture.• Influenced by gravity and movements
Cochlea (coiled appearance)		Sensory hair cells in organ of Corti	<ul style="list-style-type: none">• Hearing



- Semicircular canals lie at right angle to each other and the base of each canal is swollen called ampulla.
- These membranous canals are suspended/surrounded by perilymph of the bony canals
- Vestibular apparatus is present above the coiled cochlea.
- Receptors present in vestibular apparatus have hair cells.

COCHLEA



Organ of Corti

Located on Basilar membrane

Contains sensory hairs present in rows on internal side of organ of Corti, that act as auditory receptors

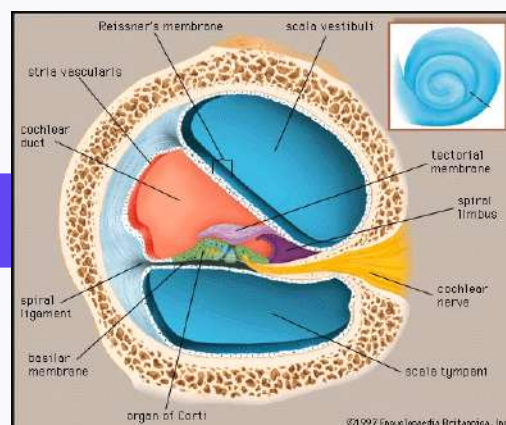
Sensory hair cells

Apical part - Possess stereocilia

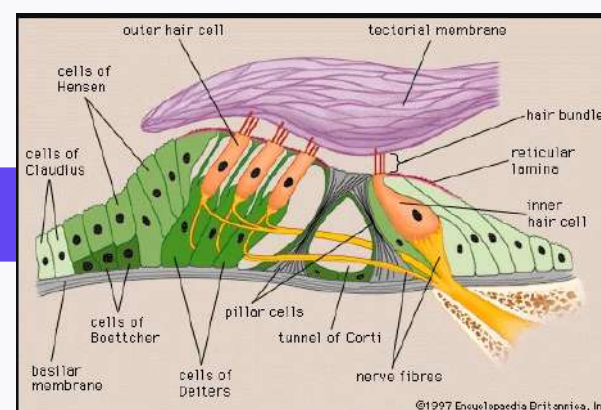
Above them there is thin elastic membrane called Tectorial membrane

Basal part - Is in close contact with afferent nerve fibres forming the auditory nerve

Sectional view of cochlea



Sectional view of organ of Corti



MECHANISM OF HEARING

- Ear converts sound waves into neural impulses
- The cerebellum integrates information received from the semicircular canals of the ear and the auditory system.

