

Neural control and coordination

Coordination is the process through which two or more organs interact and complement the functions of one another

Two systems for coordination

1, Neural system-

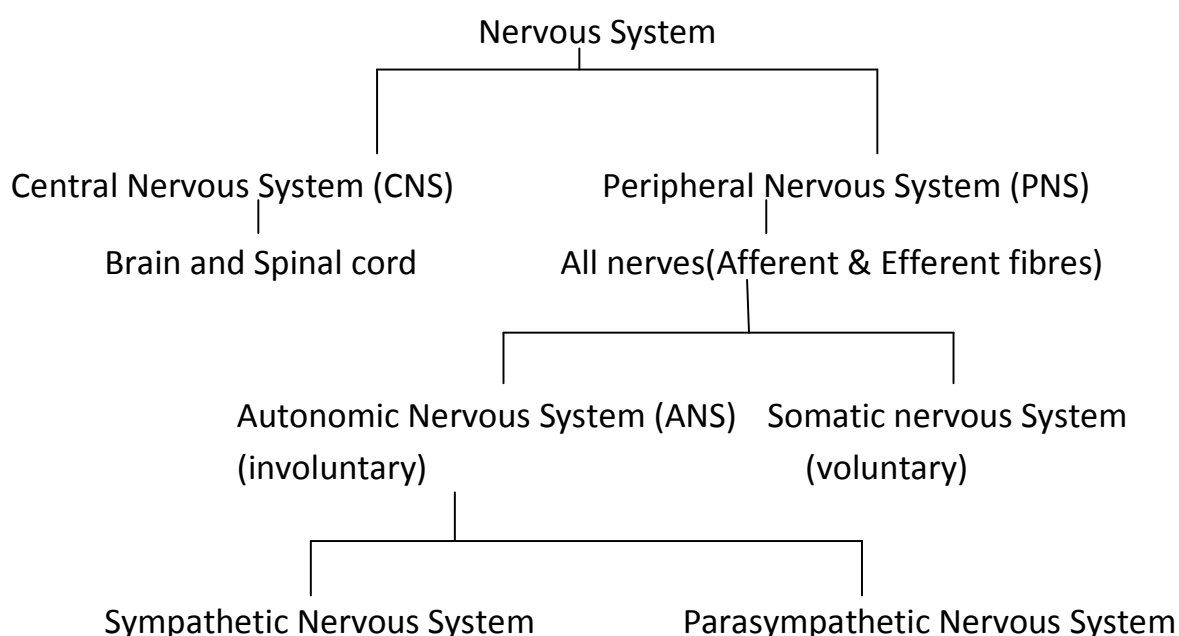
Point to point connections for a quick coordination.

2, Endocrine system

Chemical coordination through hormones. It is slow in action

NEURAL SYSTEM

COMPOSED OF SPECIALIZED CELLS- NEURONS



Cells of the nervous system, called neurons is the Functional unit of nervous system.

Three major parts 1.Cell body 2.Dentrites 3.Axon

Neurons consist of: along with all cell organelles ,

- **NISSLE GRANULES:-**Granules present in cytoplasm
- **DENDRITES:-** Short cellular extensions with many branches
- **AXON:-**Long fibre, distal end branched

- Synaptic knob: A bulb like structure in the axon terminal, which posses **synaptic vessicles**

Two types of Axons

1. Myelinated Neurons

Enveloped with **Schawn cells**.which form a myelin sheath around axon.

Nodes of Ranvier-Gap between two adjacent myelin sheath

2. Non myelinated-Myelin sheath absent

- **TYPES OF NEURONS**
- **Bipolar Neurons** –With one axon and one dendron (eg: retinal cells,).
- **Uni-polar cells**- With one axononly.(Found in the embryonic stage)
- **Multi-polar Neurons** :- With one axon and many dendrones (eg:neurons in the cerebral cortex).

The nerve impulse

This is the electrical signal which transmitted by the neurones around the nervous system.

The resting potential is the result of

1. Na⁺ ions channel

2 K⁺ ions Channel

3.Sodium potassium pump’:

. It involves a transport of 3 NA⁺ outwards and 2 K⁺ inwards

- The membrane is **impermeable to Na⁺ ions**
- The membrane is **more permeable to K⁺ ions**
- **Impermeable to negatively charged proteins in the axoplasm**
- Na k⁺ pump keeps more Na outside.
- so the **outside is positive and inside is negative**

- This charge difference is responsible for the resting potential.
- Thus the neurone is **polarised**.

Mechanism of generation of nerve impulse.

When stimulus is applied at a site, in that region

- [1] Na⁺ K⁺ pump closed
- [2] Na⁺ channel open and there is a rapid influx of Na⁺ into the neurone
- [3] This causes the inside of the neurone to become + ve: ie. A reversal of polarity occurs. This is **depolarisation**.
- [4] Na⁺ channels close and K⁺ channels now open
- [5] K⁺ ions diffuse out of the neurone

Inside of the neurone become negative. This is **repolarisation**

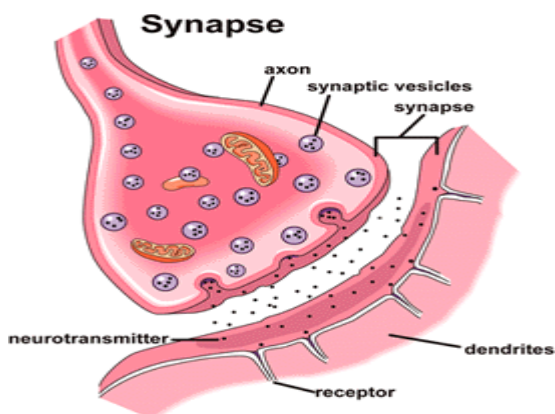
- [6] The neurone has its **resting potential restored**. During this time the Na⁺ K⁺ pump starts again.

Conduction of the nerve impulse

The generation of action potential stimulates the adjacent region. The polarity is reversed at that region also, and an action potential generated. The process is repeated and thus the impulse conducted along the length of the neuron.

Synapse

The junction between the axon terminals of a neuron and the receiving cell is called a **synapse**



Three elements:

- ❖ Presynaptic nerve terminal
- ❖ Postsynaptic element
- ❖ Synaptic cleft with synaptic fluid in it.
- ❖ **Two types of synapses**
- ❖ **1. Electrical transmission**- Here the pre and post synaptic membranes are in very close proximity.
- ❖ Direct flow of ions from one neuron to another, similar to impulse conduction along a single axon.
- ❖ It is faster than chemical synapses
- ❖ **2. Chemical transmission**-
- ❖ Presence of Synaptic cleft with synaptic fluid in it.
- ❖ Neurotransmitter substance released from presynaptic cell, diffuses across synaptic cleft, produced effect on postsynaptic neuron
- ❖ **Neurotransmitters are chemicals that are used to relay and amplify the signals between a neuron and another cell.**

Synaptic transmission

1. Impulse reaches synapse
2. Synaptic vesicles stimulated and moves towards the post synaptic membrane & fuse with it.
3. Releases neurotransmitter into the synaptic cleft.
4. Neurotransmitter diffuses through synaptic cleft.
5. Bind with the specific receptors in post synaptic membrane.
6. Opens ion channels and generate a new action potential in post synaptic neuron.

CENTRAL NERVOUS SYSTEM

The Human Brain

Protected by skull

Covered by 3 layered Meninges

1.Outer layer- **Dura matter**

2.Middle-**Arachnoid**

3.Inner- **Pia matter**

Brain -divided into 3 parts

1, Forebrain

2.Midbrain

3.Hind brain

Fore brain includes,

1, Cerebrum

2.Thalamus

3. Hypothalamus.

Cerebrum -The largest division of the brain. Two Cerebral hemispheres

Corpus callosum:- A tract of nerve fibres that connect the left and right hemispheres

Cerebral Cortex - The outermost layer of gray matter with numerous foldings. The neuron cell bodies are concentrated here. Hence the greyish colour hence called grey matter.

White matter:-Inner part of the cerebral hemisphere is white in colour. Due to the presence of myelinated nerve fibres.

Cerebral cortex includes

Motor area

Sensory area

Association area- (inter sensory association, memory , communication etc)

Thalamus:- Coordinating centre for sensory and motor signaling

Hypothalamus Functions

Control body temp.

centre of urge for drinking and eating.

Secretes hormones

it controls sexual behaviour, expression of emotions etc

hippocampus and amygdala and with inner part of cerebral hemisphere is called limbic system

Mid brain

A canal -Cerebral aqueduct

4 round swellings -corpora quadregemena

Hind brain :-Includes

Pons- fibre tracts that interconnect different regions of brain.

Cerebellum-balancing region

Medulla oblongata-connect spinal cord-Centre for respiration , cardiovascular reflexes and gastric secretions

REFLEX ACTION-Reacting without thinking

- Sometimes a stimulus requires an immediate response. An involuntary response doing without a thinking is called **reflex action**.
- They can be very important in preventing injury to ourselves.

A reflex arc-The nerve pathway taken in a reflex action is called a reflex arc. The nervous message goes to the spinal cord, then a message passes from the spinal cord directly to an effectors to give an immediate response.

- The signal from the sensory organ
- A **Afferent neuron (sensory neuron)(Via a dorsal nerve root)** carries the message from the sensory organ to the **central nervous system** (at the level of the spinal cord).
- An **Efferent neuron(Motor neuron)** carries the message from the central nervous system to the effector.
- This is a **reflex arc**.
- In most reflex arcs the sensory neuron connects to motor neurons through **interneurons**
- **Sensory organ----afferent neuron----inter neuron----efferent neuron—response in Effector**

Eg:-The knee jerk reflex action

Structure of human eye

Consists of 3 layers

1. SCLERA (outer), 2. CHOROID (middle), 3. RETINA (inner)

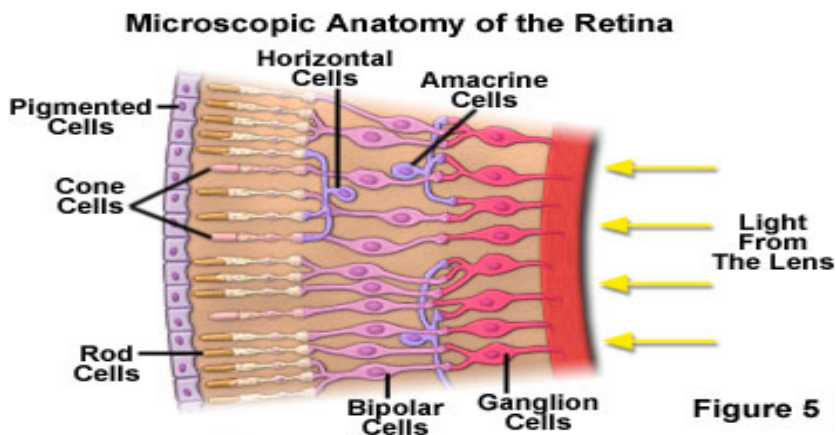
- **Sclera:** a tough white layer of eye –Protects & give shape to the eye
- **Cornea:** transparent covering of the front of the Sclera.
 - Allows passage of light into the eye and functions as a window
- **Choroid:** pigmented layer,
- Contains blood vessels and bluish or brown in colour
 - Anteriorly it forms the ciliary body,
 - It continues forward as a pigmented portion – iris.

The Iris

- Visible coloured part of the eye
- Elongated from ciliary body
- **Pupil** – the round, central opening of iris
- The iris regulates the size of the pupil

Retina

- Retina – INNER layer,
- Composed of three layers
 - Ganglion cells
 - Bipolar cells
 - Photoreceptor cells



- photoreceptor cells synapse with neurons called bipolar cells
- Bipolar cells synapse with ganglion cells of optic nerve

Photoreceptors

- Two types
1. **Rod cells** – Allow vision in dim light
 - Contain photopigment Rhodopsin-(visual purple)
 - It is composed of
 1. **Opsin** (a protein)
 2. **Retinal** (aldehyde of vitamin A)
 2. **Cone cells** – Operate best in bright light
 - Enable color vision
 - **Three types of cone cells (green cones, red cones, blue cones)**
 - Sensations of different colours are produced by various combinations of these cones. When all these cone are stimulated equally sensation of white light is produced

Difference between Rod and Cone

Cone

- Cone shaped

Rod

- Rod shaped
- Photopigment – Iodopsin(photopsin)
- Scotopic vision(twilight vision)

- Photopigment-Rhodopsin
- Photopic vision
- Photopic vision(colour vision)

Blind spot A small, circular region in the retina where optic nerve emerge from the eyeball. It has no rods or cones and insensitive.

Macula lutea-(Yellow spot):-A yellowish central area of the retina that is rich in cones ,with a central pit called **Fovea** . It is the point of highest vision.

- The **lens** and **ciliary body** divide the eye into two cavities.
 - The anterior cavity is filled with **aqueous humor**(watery fluid)
 - The posterior cavity is filled with **vitreous humor** (transparent jell)

MECHANISM OF VISION

- 1.Light enters into eye through Cornea, Pupil and lens then focused on retina.
- 2.Light induces dissociation of retinal from opsin in the photo receptor cell
- 3.Changes in the membrane permeability occurs and generates an action potential
- 4.This action potential passes through bipolar cells and then to ganglionic cells.
- 5.Reaches visual cortex of brain through optic nerve.
- 6.Image is recognised

HUMAN EAR

Three Major Section of the Ear

1 External ear,

2 Middle ear,

3 Inner ear.

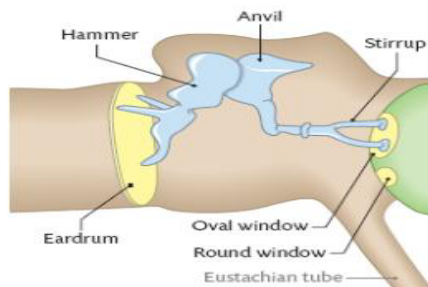
The external ear

Pinna:-collects and directs sound waves through the **auditory canal** to the **eardrum**.

Auditory canal :-The auditory canal contains modified sweat glands that secrete earwax.

Middle Ear

- **ossicles** :-Three linked, movable bones called "**ossicles**, namely Malleus, incus & stapes"
- *Function* -convert the sound waves into mechanical vibrations.
- **The Eustachian tube** :-functions to equalize air pressure on both sides of the eardrum.
- Sound waves passes through- **pinna -auditory canal- Eardrum.-Malleus-Incus-Stapes-Ovalwindow**



Inner Ear

- Consists of fluid filled cavities called **labrynth**
- mainly 2 parts
 - The bony tubes, the ***bony labyrinth***,
 - Filled it with a fluid called **perilymph**.
 - Within this bony labyrinth lies ***membranous labyrinth***,
 - Filled it with the fluid **-endolymph**.

Bony labyrinth consists of three parts

- Semicircular canals
- Vestibule

- Cochlea
- The **semicircular canals**, helps maintain **balance**.
- Snail-shaped **cochlea**, which functions in **Hearing**
- Interconnecting the cochlea and the semicircular canals is the **vestibule**,
- **Membranous labyrinth**
- Membrane-walled sacs and ducts
- Fit within the bony labyrinth
- Filled with a clear fluid – endolymph
- Consists of three main parts
- Semicircular ducts
- Utricle and saccule
- Cochlear duct
- **The Cochlea**
- **Two membranes of cochlea**
- 1, Reissners membrane
- 2, Basilar membrane
- These membrane divides the cavity of bony labrynth into 3 channels namely,
- 1. Scala vestibuli –upper canal -connects with oval window
- 2. Scala media - middle canal (contains receptors for hearing and filled with endolymph)
- 3. Scala tympani –lower-connects with round window

Organ of Corti

- The *organ of corti* is the hearing sense organ and lies on the Basilar membrane.
- It consists of supporting cells and hair cells

- Protruding from each hair cell are hairs called *stereocilia*
- The tectorial membrane lies above the stereocilia
- Hair cells of the organ presses against the tectorial membrane as perilymphatic pressure waves pass.
- Mechanism of hearing
- **The pinna and the auditory canal collects the waves.**
- **Sound wave strikes on the tympanic membrane and it vibrates.**
- **This vibration passes through the malius, incus, stapes and to the oval window.**
- **From the oval window it passes to the perilymph in the scala vestibuli of cochlea**
- **This generates waves in the perilymph and in the basilar membrane.**
- **Due to the movement of basilar membrane the Hair cells presses against the tectorial membrane.**
- **This causes the generation of nerve impulse. It is transmitted by the afferent fibres of auditory nerve to the brain.**

The vestibular apparatus

- Composed of 3 semicircular canals and the otolith organ consisting of utricle and saccule.

The Semicircular Canals

Balance in function

- Three semicircular canals
- Each lies in a different plane at right angles to each other.
- Two in the vertical plane and One in the horizontal plane
- The base of the canals are swollen and called **ampulla**
- Ampulla contains a projecting ridge –**Crista ampullaris**
- Utricle & Saccule-Have a **macula** containing hair cells

- Hair cells embedded in gelatinous otolithic membrane
- Which contains calcium carbonate crystals (otoliths) that resist change in movement
- **How We Balance –
The Vestibular System**
- The hair cells for both position and movement create nerve impulses.
- These impulses travel over the vestibular nerve to synapse in the brain stem, cerebellum, and spinal cord.

For example, a sudden loss of balance creates endolymph movement in the semicircular canals that triggers leg or arm reflex movements to restore balance.