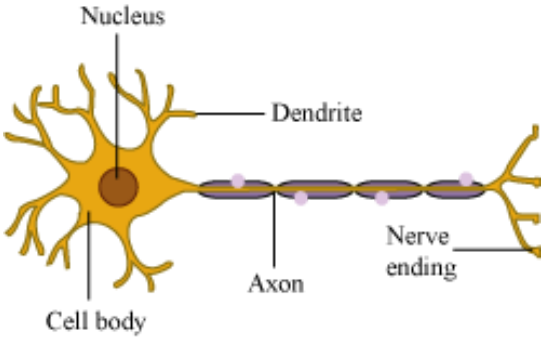
The Nervous System

Control and coordination

- Working together of various integrated body systems in response to changes in the surrounding for the maintenance of bodily functions is known as **control and coordination**
- **Nervous system and endocrine system** provide control and coordination in animals.

Nervous system

- **Neurons** -functional units of the nervous system, conduct messages in the form of electrical and chemical impulses
    - Neuron composed of cell body and dendrite, axon and nerve endings.

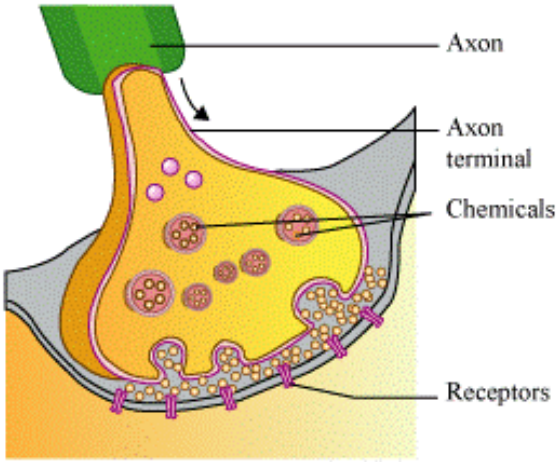


- **Types of neuron:-**
    - Sensory neuron
    - Motor neuron
    - Relaying or intermediate neuron

- **Nerve:** A nerve is a collection of nerve fibres (or axons) enclosed in a tubular medullary sheath. This sheath acts as an insulation and prevents mixing of impulses in the adjacent fibres.

- **Transmission of nerve impulse:**
  Under normal conditions, the outer side of the nerve fibre consists of positive charge as more Na+ ions are present outside axon membrane. The neuron is then said to be in polarised state. On stimulation, the membrane becomes more permeable and Na+ ions move inside causing depolarisation. Such a region is known as excited region. The point of depolarisation behaves as stimulus for the neighbouring area and this goes on. In the mean time, the previous area becomes repolarised due to active transport (using ATP) of Na+ ions with the help of **sodium pump**.

- **Synapse**- a small gap between the axon of one neuron and the dendrite of the next neuron

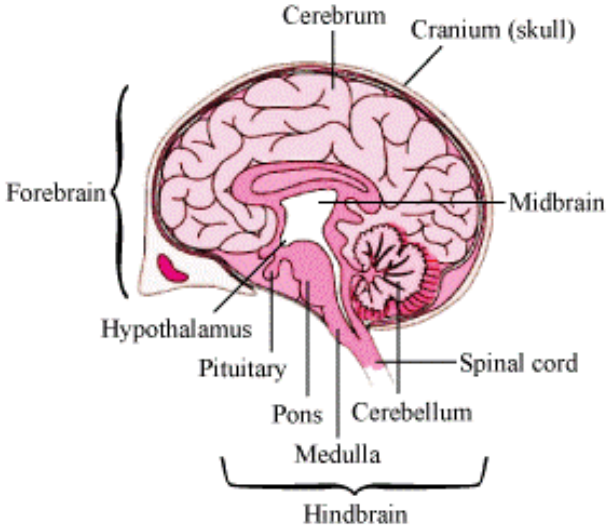


Parts of the nervous system

- Human nervous system divided into- central nervous system (CNS) and peripheral nervous system (PNS)
- CNS consists of the brain and spinal cord
- PNS consists of the nerves that connects the CNS to different parts of the body
- The Brain, spinal cord, and nerves are the important parts of the nervous system

Brain

- The brain is enclosed in a bony box called the **cranium** and spinal cord is protected by **vertebral column**.
- The brain and spinal cord are externally covered by protective covering called **meninges**.
- It is made up of three layers namely **duramater (outer layer)**, **arachnoid (middle laye**r), **piamater (inner lay**er).
- The space between meninges is filled by a watery fluid called **cerebro- spinal fluid (CSF)**.



Human brain is classified into- forebrain, midbrain, and hindbrain.

- **Forebrain-** It consists of cerebrum, thalamus, and hypothalamus.
- It has following functions:
  - It is the thinking part of the brain.
  - The forebrain has sensory regions that receive sensory impulses from various receptors.

    - It has motor regions that control the movement of various muscles (such as the leg muscles).
    - Cerebrum controls intelligence, learning, memory, thinking, and speech.
    - Hypothalamus contains many areas that control things such as body temperature, urge for eating and drinking, etc.
- **Midbrain-** It is mainly concerned with the sense of sight and hearing.
- **Hindbrain-** It consists of pons, medulla, and cerebellum.
- It has following functions:
    - Most of the involuntary actions such as heartbeat, blood pressure, movement of food in the alimentary canal, salivation, etc., are controlled by the midbrain and medulla of the hindbrain.
    - Cerebellum is responsible for voluntary actions and maintaining the posture and equilibrium of the body.

Spinal Cord

- It is the continuation of the medulla oblongata and runs through the vertebral column.
- The spinal cord is made up of two similar halves fused together to form a central canal containing the cerebrospinal fluid.
- The outer portion of the spinal cord is known as the **white matter**, which consists of nerve fibres.
- The inner portion contains the cell bodies of neurons and is known as the **grey matter**.

- **Autonomic Nervous System (ANS)**

- ANS comprises of sympathetic as well as parasympathetic nervous system

- The general functions of the sympathetic division are concerned with preparing the body for emergencies (increased blood pressure and rate of heartbeat, increased release of stored nutrients, increased respiration rate, dilation of pupils), whereas the parasympathetic division is primarily involved with conserving energy and replenishing energy stores.

- **Peripheral Nervous System (PNS)**

- PNS comprises of cranial nerves and the spinal nerves.

- The details of cranial nerves are as follows

Number	Name	Nature	Major function
1.	Olfactory	Sensory	Smell
2.	Optic	Sensory	Sight
3.	Oculomotor	Motor	Movement of eyeball
4.	Trochlear	Motor	Rotation of eyeball
5.	Trigeminal	Mixed	Sensation of touch and taste
6.	Abducens	Motor	Rotation of eyeball
7.	Facial	Mixed	Taste, facial expression saliva secretion, neck movement
8.	Auditory	Sensory	hearing, equilibrium

9.	Glosso-pharyngeal	Mixed	Taste, saliva secretion
10.	Vagus	Mixed	Gastric and pancreatic secretion, GI movement visceral reflexes
11.	Spinal accessory	Motor	Muscle movement visceral reflex
12.	Hypoglossal	Motor	Tongue movement

- **Spinal Nerves**
- Spinal nerves are the nerves originating from the spinal cord by means of two roots- a dorsal root and a ventral root.
- All the spinal nerves are mixed nerves
- Man has 31 pairs of spinal nerves which are again put into five different categories

    1. Cervical (8 pairs)
    2. Thoracic (12 pairs)
    3. Lumbar (5 pairs)
    4. Sacral (5 pairs)
    5. Coccygeal (1 pair)

- Three types of responses of the nervous system are- **reflex action, voluntary action and involuntary action**
    - **Reflex action**
        - Sudden movement or response to a stimulus
        - Occurs in very short duration of time
        - Does not involve will or any thinking of brain
        - E.g. If we touch hot plate, we immediately pull our hand back.
    - **Voluntary action**
        - Actions such as writing, talking etc. that can be controlled consciously.
    - **Involuntary action**
        - Actions such as breathing, digestion etc. that cannot be controlled consciously.
- **Reflex action –**
    - It is an automatic action or response provoked by a stimulus.
    - Reflex pathway is comprised of the following:
        - **Receptor:** It includes sense organs that receive stimulus.
        - **Sensory or afferent neuron:** It conducts the nerve impulse from receptor to the spinal cord or brain.
        - **Association neuron:** It helps to transmit nerve impulse from sensory neuron to motor neuron.
        - **Motor or efferent neuron:** It transmits nerve impulse to the effector organs like muscles or glands.

- **Effector:** It includes muscles or glands where action takes place in response to stimulus.

Sense Organs: Organs that helps us to be aware of our surroundings are known as sense organs.

Receptors: Any cell or tissue sensitive to a selective stimuli are called receptors.

Eye

Composed of three layers:

- **Outermost layer-** sclera and cornea
- **Middle layer-** choroid, ciliary body, iris
- **Innermost layer-** retina, with rod cells and cone cells.

- Just behind the iris, a transparent, biconvex, and elastic structure called **lens** is present.

- **Rods –** Contain rhodopsin pigment that is highly sensitive to dim light

- **Cones –** Contain iodopsin pigment that is sensitive to high intensity light. Cones are also responsible for colour vision.

- **Blind spot –** Area where photoreceptors such as rods and cones are absent

- **Fovea –** Area that contains only cones. Vision is finest and sharpest in this zone.

- **Aqueous chamber –** Space between cornea and lens; contains **aqueous humour**.

- **Vitreous chamber –** Space between lens and retina; contains **vitreous humour**

Pupil regulates the amount of light entering into the eyes.

- **Specific abilities of eyes**
  - Power of Accommodation
  - Stereoscopic Vision

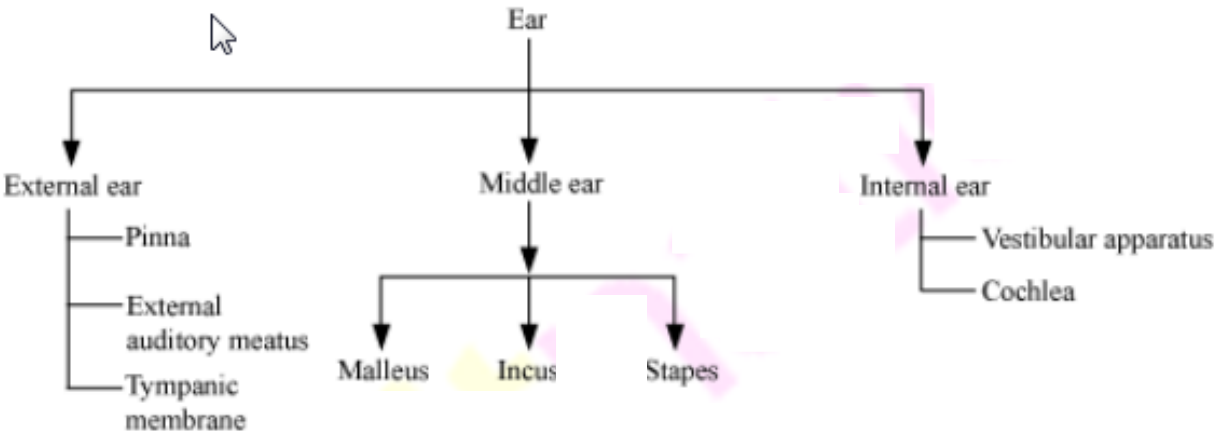
Common Defects of Eye

Defect	Characteristic features
Myopia (short-sightedness)	• In this, nearby things are visible clearly, but distant things become blurred. • Can be corrected using a concave lens
Hypermetropia (long- sightedness)	• In this, the nearby objects appear blurred while the distant objects are clear. • Can be corrected using a convex lens

Astigmatism	• Uneven curvature of the cornea is responsible for imperfect image of the objects.
Glaucoma	• The aqueous humour is regularly supplied by arterial capillaries and reabsorbed by venous capillaries of ciliary body.
Presbyopia	• In this, the lens loses its flexibility in older people and they are not able to see nearby objects clearly. • This defect is corrected by wearing spectacles with convex lens.
Cataract	• The protein fibres in the lens degenerate and the lens becomes opaque. The person loses clarity in the vision.
Squint	• In squint, either both the eyes converge (cross eye) or diverge (wide eye).
Colour blindness	• Person cannot differentiate between colours such as red and green.
Diabetic retinopathy	• It occurs in the people with prolonged diabetes. • The blood vessels of the retina may leak, close up or begin to grow due to diabetes. • The blood may enter the clear jelly like fluid called vitreous humour and make it opaque causing blindness.

Ear

- Organ for hearing and equilibrium



- **Crista and macula** are receptors of vestibular apparatus that are responsible for maintaining body balance and posture.
- **Organ of corti** is the main hearing structure of internal ear. It is located on basilar membrane that has hair cells. The middle ear contains three small bones – malleus, incus, and stapes (arranged from outside to inside).

- **Mechanism of hearing**

Pinna collects sound waves and directs it towards ear drum

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Transmission of vibrations towards fenestra ovalis through ear ossicles

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Generation of sound waves in lymph

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Ripple created in basilar membrane bends the hair cells (of organ of corti) against tectorial membrane

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Sound waves converted into nerve impulses

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Impulse carried to cortex of brain

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Impulse analyzed and sound is recognized

Role of Ear in balancing Body

When we turn our head

fluid inside the semicircular canals moves

pushing against the sensory hair cells

sending nerve impulse to brain -->via auditory nerve

cells present in the semicircular canals are highly sensitive to dynamic equilibrium.

we are able to balance our body.

Nose

- It is the sense organ of smell.
- Sensory receptors are present in the nasal cavity.
- Sends impulses through olfactory nerve.

Skin

- It is the sense organ for the sense of touch and feel.
- Also protects the body.
- Has two layers, epidermis and the dermis.
- Has sweat glands, oil glands and hair follicles.

Tongue

- It is the sense organ of taste.
- Have taste buds to recognize tastes like sweet, sour, bitter and salty.