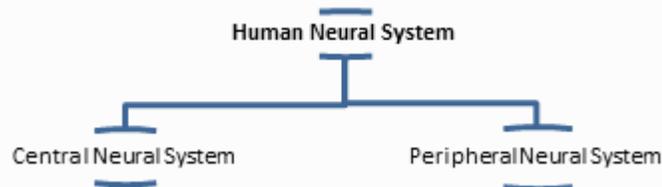


## **Neural Control and Coordination**

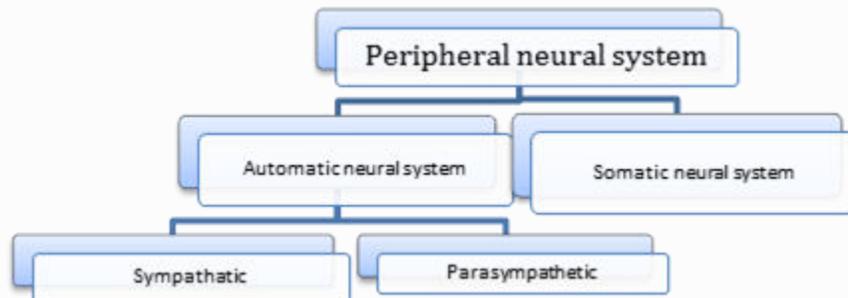
**Coordination** is the process through which two or more organs interact and complement the function of each other.

- **Neural system** provides an organized network of point to point connection for quick coordination. **The endocrine system** provides chemical integration through hormones.
- **Neural system** of animals is composed of specialized cells called neuron, which can detect, receive and transmit different kinds of stimuli. In hydra neural system is composed of network of neuron. In insects it consists of brain and a number of ganglia. Vertebrates have highly developed neural system.
- **Central nervous system (CNS)** includes brain and spinal cord. It is the site for information processing and control.



- **Peripheral nervous system** includes all nerves associated with CNS. There are two types of nerve fibres-
- Afferent fibres- transmit impulses from tissue/organ to CNS.
- Efferent fibres- transmit regulatory impulses from CNS to concerned peripheral organs.

**Somatic neural systems** relay impulses from CNS to skeletal muscles. **Autonomic neural system** transmits impulses from CNS to involuntary system and smooth muscles.

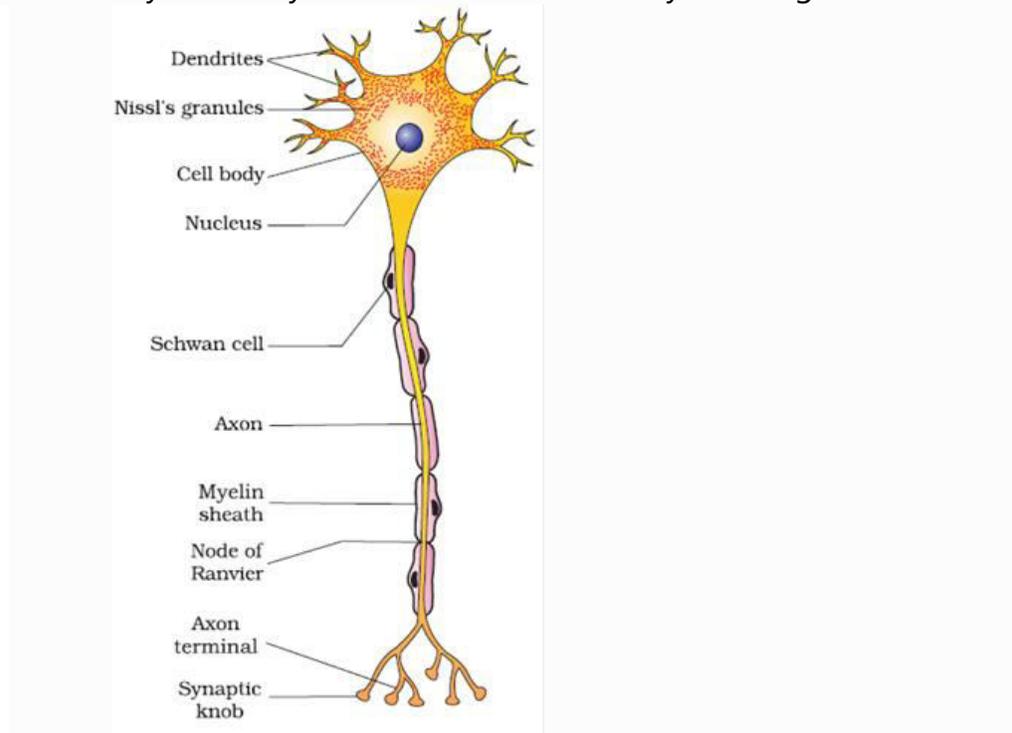


### **Neuron as Structural and Functional Unit of Neural System**

Neuron is made up of three major parts- **cell body**, **dendrite** and **axon**.

- Cell body contains cytoplasm, cell organelles and Nissl's granules. Short fibres projecting out from cell body is called dendrites. The axon is long fibre having branched structure at the end that terminates into knob like structure called **synaptic knob**.

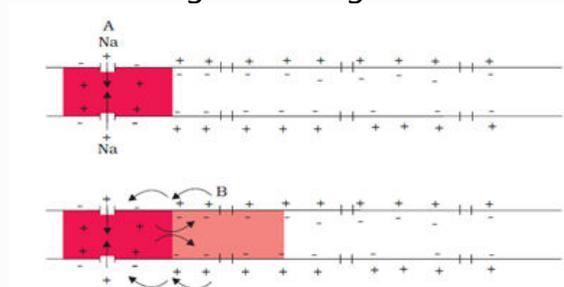
- Based on number of axon and dendrites neuron are of three types-
  - Multipolar**– one axon and two or more dendrite found in cerebral cortex.
  - Bipolar**– one axon and one dendrite found in retina of eyes.
  - Unipolar**– cell body with only one axon found in embryonic stage.



- There are two types of axon-
  - Myelinated**– fibres are enveloped with **Schwann cells** to form myelin sheath around the axon. The gap between two myelin sheaths is called **nodes of Ranvier**. Found in spinal and cranial nerves.
  - Unmyelinated**- fibre is enclosed by Schwann cells that do not form myelin sheath around the axon. Found in autonomous and somatic neural system.

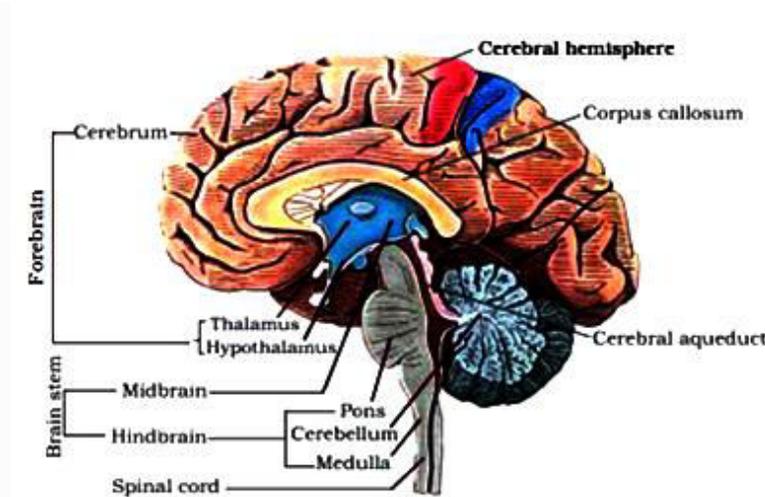
### Generation and Conduction of Nerve Impulse

- Ion channels are present in neural membrane which is selectively permeable to different ions. When neuron is not conducting impulse (resting), axonal membrane is more permeable to  $K^+$  ions and impermeable to  $Na^+$  ions.
- Ionic gradient across the resting membrane is maintained by active transport of ions by sodium-potassium pump. This will develop positive charge outside the axonal membrane and negative charge on inner side.



- The electrical potential difference across the resting membrane is called **resting potential**.
- When stimulus is applied at site A, the membrane becomes permeable to Na<sup>+</sup> ions to make rapid influx of Na<sup>+</sup> ions to create outer surface negatively charged and inner membrane positively charged that create **Action Potential** or nerve impulse.
- The nerve impulse from A moves to B in inner surface and B to A on outer surface. This process is repeated several times to transmit the impulse.
- Nerve impulse is transmitted from one neuron to another neuron through synapse.
- There are two types of synapse-
  1. **Electrical synapse**- the membrane of pre and post synaptic neuron is very close to each other and current flow directly from one neuron to another.
  2. **Chemical synapse**- pre and post synaptic neuron is separated by fluid filled space called **synaptic cleft**. Neurotransmitters are involved in transmission of impulses.

**Central Neural System** –Brain is the central information processing organ of our body and act as command and control centre. Human brain is protected by skull (cranium) and three layers of cranial meninges- outer **dura mater**, middle **arachnoid** and inner **pia mater**.



Brain can be divided 3 parts- **forebrain, midbrain and hindbrain**.

**Forebrain**– consists of **cerebrum, thalamus and hypothalamus**. Cerebrum is divided into left and right cerebral hemispheres which are covered by cerebral cortex (grey matter). Cerebral cortex contains sensory neuron, motor neuron and association area. Association area controls complex functions like intersensory associations, memory and communication.

**Thalamus**– cerebrum wraps around a structure called thalamus. It is a major coordinating centre for sensory and motor signaling.

**Hypothalamus** controls the urge for eating, drinking and body temperature. They also release hypothalamic hormones. Limbic system is involved in controlling sexual behavior and expression of emotional reactions.

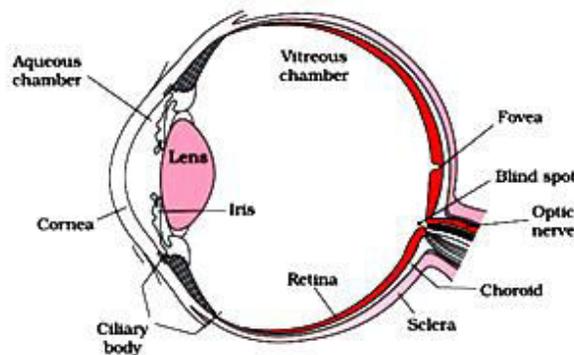
**Midbrain** is located between hypothalamus and pons of hindbrain. Dorsal portion consists of four round lobes called **corpora quadrigemina**. They are involved in relay of impulses back and forth between cerebrum, cerebellum, pons and medulla.

**Hind brain** consists of **pons, medulla oblongata** and **cerebellum**.

Pons consists of fibre tracts that interconnect different regions of the brain.

The medulla contains centres which control respiration, cardiovascular reflexes and gastric secretions. Cerebellum controls balance and posture

**Reflex action** is a spontaneous autonomic mechanical response to a stimulus without the will of the organism. It is controlled by spinal cord. The afferent neuron receives the signal from sensory organs and transmits the impulse to CNS. The efferent neuron carries the impulse from CNS to effector. Ex- knee-jerk reflex. The path followed by reflex action is called reflex arc.



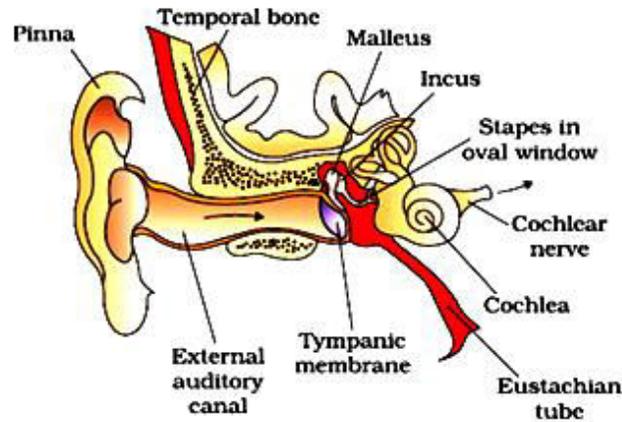
**Human Eye** – spherical structure consists of three layers, external layer is **sclera** whose anterior part is called **cornea**, middle layer **choroid** and innermost layer is called **retina**. Retina contains three layers of cells – inner ganglion cells, middle bipolar cells and outer photoreceptor cells.

There are two types of photoreceptor cells called **rods and cones**. The daylight (photopic) vision and colour vision are functions of cones. The twilight (scotopic) vision is the function of the rods.

### **Mechanism of Vision**

The light rays of visible wavelength fall on retina through cornea and lens to generate impulses in rods and cones. Photosensitive pigments opsin and retinal get dissociated due to light to change its shape. Change in shape of opsin cause change of permeability to generate action potential that is transmitted to brain via optic nerve.

## Human Ears



Divided into three regions: outer ear, middle ear and inner ear.

The middle ear contains three ossicles called **malleus, incus and stapes**. The fluid filled inner ear is called the labyrinth, and the coiled portion of the labyrinth is called cochlea. The **organ of corti** contains hair cells that act as auditory receptors and is located on the basilar membrane.

### Mechanism of Hearing

External ear receives the sound wave and directs them to ear drum. Vibration of ear drum leads to vibration of ear ossicles. The vibration reaches cochlea that generate wave in lymph. The waves generate ripples in basilar membrane and hair cells in them. As a result, nerve impulses are generated in afferent neuron that passes to brain via auditory nerves.