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NEURAL CONTROL AND COORDINATION

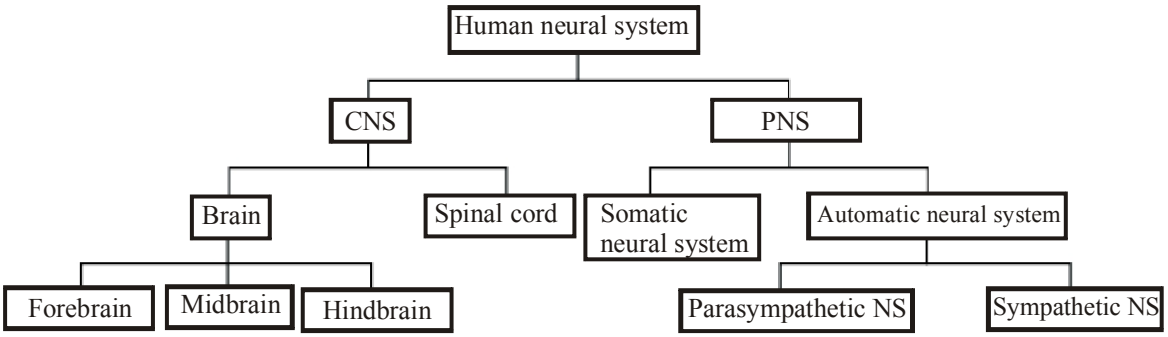
SYLLABUS

Neuron and nerves; Nervous system in humans- central nervous system, peripheral nervous system and visceral nervous system; Generation and conduction of nerve impulse; Reflex action; Sense organs; Elementary structure and function of eye and ear.

KEY CONCEPTS

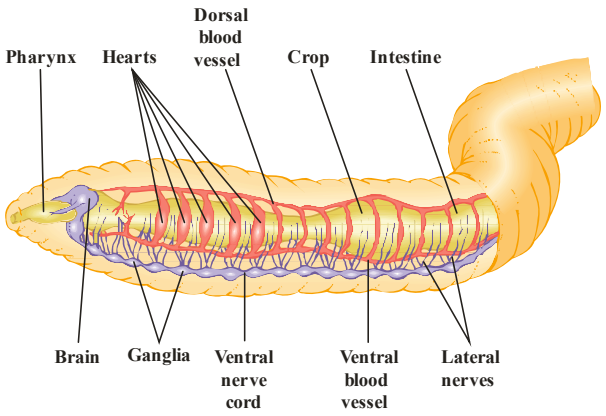
INTRODUCTION

* Nervous system is necessary to give notation about the changes that are being happened in body and to react about them.
* There are two system in body to regulate and control the body process :
  (i) Nervous system (ii) Endocrine system
* Reactions of nervous system are fast and endocrine system's reactions are slow.
* Hormones communitcate information slowly, it is called slow service.
* Nervous communicate information fast, it is called high speed service.
* Study of nervous system and receptors is neurology.
* The functions of the organs/organ systems in our body must be coordinated to maintain homeostasis.
* Coordination is the process through which two or more organs interact and complement the functions of one another.
* 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.
* The neural system provides an organised network of point-to-point connections for a quick coordination. The endocrine system provides chemical integration through hormones.

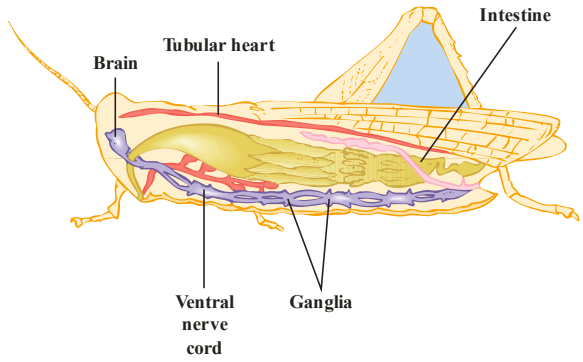


NEURAL SYSTEM

* The neural system of all animals is composed of highly specialised cells called neurons which can detect, receive and transmit different kinds of stimuli.



(a) Earthworm nervous system. Annelids have a dorsal anterior brain and one or more ventral nerve cords. Cell bodies of the neurons are located in ganglia that are connected by the ventral nerve cord.



(b) Insect nervous system. The arthropod brain is continuous with the ventral nerve cord. The brain is more specialized than in annelids.

Figure : The annelid and arthropod nervous systems

* The neural organisation is very simple in lower invertebrates. For example, in Hydra it is composed of a network of neurons. The neural system is better organised in insects, where a brain is present along with a number of ganglia and neural tissues. The vertebrates have a more developed neural system.

HUMAN NEURAL SYSTEM

* The human neural system is divided into two parts:
  (i) the central neural system (CNS)
  (ii) the peripheral neural system (PNS)
* The CNS includes the brain and the spinal cord and is the site of information processing and control. The PNS comprises of all the nerves of the body associated with the CNS (brain and spinal cord). The nerve fibres of the PNS are of two types : (a) afferent fibres (b) efferent fibres
* The **afferent nerve** fibres transmit impulses from tissues/organs to the CNS and the **efferent fibres** transmit regulatory impulses from the CNS to the concerned peripheral tissues/organs.

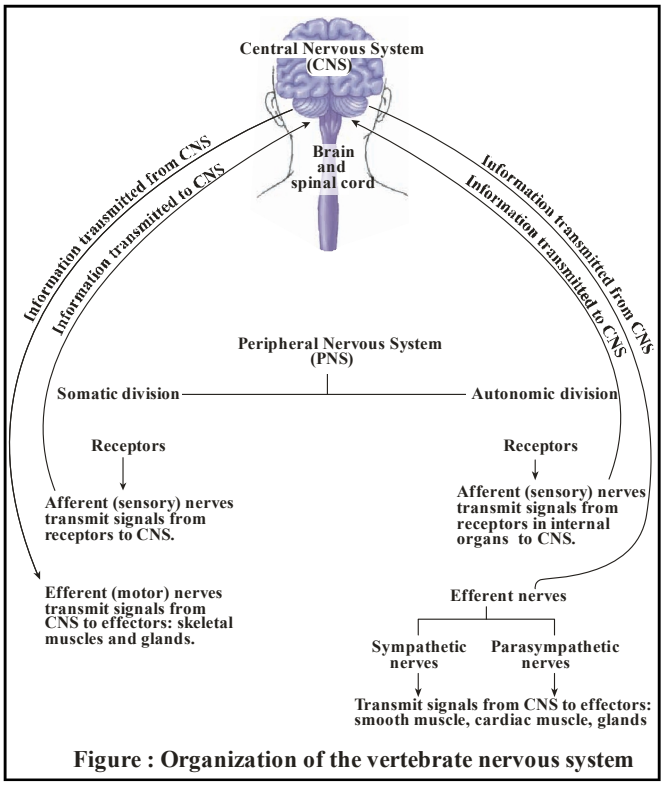


Figure : Organization of the vertebrate nervous system

* The PNS is divided into two divisions called **somatic neural system** and **autonomic neural system**.
* The somatic neural system relays impulses from the CNS to skeletal muscles while the autonomic neural system transmits impulses from the CNS to the involuntary organs and smooth muscles of the body.
* In the autonomic nervous system, there are two neurons and a synapse. The first neuron has its cell body in the central nervous system. The synapse between the two neurons is outside the ganglion. The nerve fibres passing between the CNS and the ganglia are called preganglionic fibres, those passing between the ganglia and the effector cells are postganglionic fibres.

* **Differences between Somatic and Autonomic nervous system**

Somatic	Autonomic
1. Consists of a single neuron between CNS and effector organ.	1. Has two neuron chain (connected by synapse) between CNS and effector organ.
2. Innervates skeletal muscle	2. Innervates smooth & cardiac muscle, glands and gastrointestinal neurons.
3. Can lead only to muscle excitation.	3. Can lead to excitation or inhibition of effector cells.

* The autonomic neural system is further classified into **sympathetic neural system** and **parasympathetic neural system.**
* Sympathetic and parasympathetic neural systems have antagonistic (opposite) effects on the organs.This is because of the different natures of the neurotransmitters released by the axons.
* In the parasympathetic neural systems, neurotransmitters between the axons of the neurons and target organs is acetylcholine whereas in the sympathetic neural systems,the neurotransmitters is adrenaline/noradrenaline.
* If the sympathetic nerve ending excites a particular organ, the parasympathetic usually inhibits it.
* The most important effect of the sympathetic division is commonly known as flight, fright or fight response. Thus it works in emergency situations and its effects are:

(1) Contricts peripheral blood vessels.
(2) Dilates blood vessels supplying to heart, lungs, brain etc.
(3) Decreases peristalsis temporarily.
(4) Relaxes the urinary bladder.
(5) Dilates the pupils.
(6) Reduces the secretion of saliva and other digestive juices.
(7) Increases the secretion from sweat glands.
(8) Constricts the afferent arteriole and reduces glomerular filtration rate in the kidneys.

* The parasympathetic division functions mainly during normal conditions and control those activities which conserve energy. Few such effects of parasympathetic nervous system are:

(1) Slows the heart beat rate.
(2) Reduces the blood pressure.
(3) Dilates the peripheral blood vessels.
(4) Increases peristalsis in intestine.
(5) Contricts pupils.
(6) Promotes salivation and secretion of digestive juices.
(7) Constricts the bronchioles
(8) Increases storage of sugar in liver as glycogen.
(9) Decreases sweating.

NEURON

* A neuron is a microscopic structure composed of three major parts, namely, cell body, dendrites and axon .
* The cell body contains cytoplasm with typical cell organelles and certain granular bodies called **Nissl's granules.**
* Short fibres which branch repeatedly and project out of the cell body also contain Nissl's granules and are called **dendrites.**
These fibres transmit impulses towards the cell body.
* The **axon** is a long fibre, the distal end of which is branched.
* Each branch terminates as a bulb-like structure called **synaptic knob** which possess synaptic vesicles containing chemicals called **neurotransmitters.**
* The axons transmit nerve impulses away from the cell body to a synapse or to a neuro-muscular junction.
* Based on the number of axon and dendrites, the neurons are divided into three types, i.e., **multipolar** (with one axon and two or more dendrites; found in the cerebral cortex), **bipolar** (with one axon and one dendrite, found in the retina of eye) and **unipolar** (cell body with one axon only; found usually in the embryonic stage).

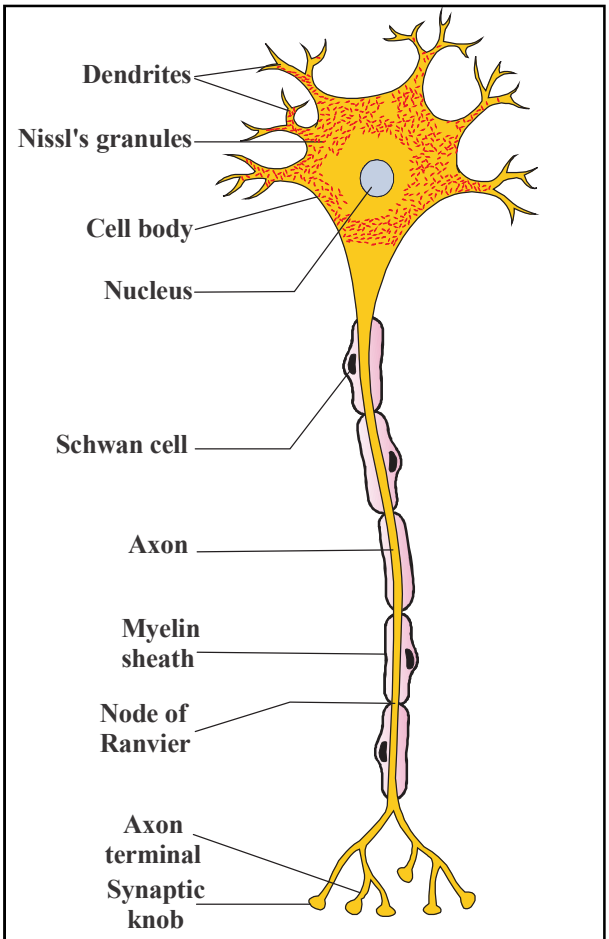


Figure : Structure of a neuron

* There are two types of axons, namely, myelinated and nonmyelinated.
  The **myelinated nerve fibres** are enveloped with **Schwann cells**, which form a **myelin sheath** around the axon. The gaps between two adjacent myelin sheaths are called **nodes of Ranvier.**
* The myelin sheath acts as a biological electrical insulation. It creates a region of high electrical resistance on the axon.
* At the areas called the nodes of Ranvier, the myelin sheath is not present due to which the nodes of Ranvier do not pose any kind of insulation to the flow of electrical impulse. Hence, there is a free flow of electrical impulse at the nodes of Ranvier.
* Myelinated nerve fibres are found in spinal and cranial nerves.
* **Unmyelinated nerve fibre** is enclosed by a Schwann cell that does not form a myelin sheath around the axon, and is commonly found in autonomous and the somatic neural systems.
* Neurons can be divided into three functional classes: afferent neurons, efferent neurons, and interneurons.
* **Afferent neurons** convey information from the tissues and organs of the body into the CNS, **efferent neurons** transmit electric signals from the CNS out to effector cells (muscle or gland cells), and **interneurons** connect afferent and efferent neurons within the CNS.

Nerve Impulse :

* Neurons are excitable cells because their membranes are in a polarised state.
* Different types of ion channels are present on the neural membrane. These ion channels are selectively permeable to different ions.
* When a neuron is not conducting any impulse, i.e., resting, the axonal membrane is comparatively more permeable to potassium ions (K^+) and nearly impermeable to sodium ions (Na^+).
* Similarly, the membrane is impermeable to negatively charged proteins present in the axoplasm.
* Consequently, the axoplasm inside the axon contains high concentration of K^+ and negatively charged proteins and low concentration of Na^+.
* In contrast, the fluid outside the axon contains a low concentration of K^+, a high concentration of Na^+ and thus form a concentration gradient.
* These ionic gradients across the resting membrane are maintained by the active transport of ions by the sodium-potassium pump which transports 3 Na^+ outwards for 2 K^+ into the cell.
* As a result, the outer surface of the axonal membrane possesses a positive charge while its inner surface becomes negatively charged and therefore is polarised.
* The electrical potential difference across the resting plasma membrane is called as the **resting potential.**
* The resting potential is the potential difference of about –70 mV that exists across the membrane. The magnitude of the resting potential is determined by (1) differences in concentrations of specific ions (mainly Na^+ and K^+) inside the cell relative to the extracellular fluid, and (2)

selective permeability of the plasma membrane to these ions.

* Ions pass through specific **passive ion channels**. K^+ leaks out more readily than Na^+ can leak in. Cl^- ions accumulate along the inner surface of the plasma membrane. Large anions such as proteins that cannot cross the plasma membrane contribute negative charges.
* The gradients that determine the resting potential are maintained by ATP-requiring **sodium-potassium pumps** that continuously transport three sodium ions out of the neuron for every two potassium ions transported in.
* If a stimulus causes the membrane potential to become less negative, the membrane becomes **depolarized**. If the membrane potential becomes more negative than the resting potential, the membrane is **hyperpolarized.**
* A graded potential is a local response that varies in magnitude depending on the strength of the applied stimulus. A graded potential fades out within a few mm of its point of origin.
* If voltage across the membrane declines to a critical point, called the threshold level, the **voltage-activated** ion channels open, allowing Na^+ to flow into the neuron, and an action potential is generated. The action potential is a wave of depolarization that moves down the axon.
* The action potential conforms to an all-or-none response, no variation exists in the strength of a single impulse. The membrane potential either exceeds threshold level, leading to transmission of an action potential, or it does not. Once begun, an action potential is self-propagating.
* As the action potential moves down the axon, **repolarization** occurs behind it. During depolarization, the axon enters an absolute refractory period, a time when it cannot transmit another action potential. When enough gates controlling Na^+ channels have been reset, the neuron enters a relative **refractory period**, a time when the threshold is higher.
* **Continuous conduction** takes place in unmyelinated neurons; it involves the entire axon plasma membrane.
* **Saltatory conduction**, which is more rapid than continuous conduction, takes place in myelinated neurons. Depolarization skips along the axon from one **node of Ranvier** to the next sites where the axon is not covered by myelin and where Na^+ channels are concentrated.

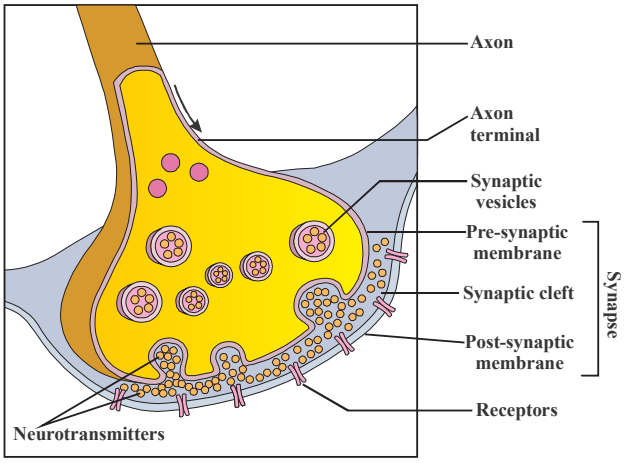


Figure : Axon terminal

* A nerve impulse is transmitted from one neuron to another through junctions called **synapses**.
* A synapse is formed by the membranes of a pre-synaptic neuron and a post-synaptic neuron, which may or may not be separated by a gap called **synaptic cleft.**
* There are two types of synapses, namely, electrical synapses and chemical synapses.
* At electrical synapses, the membranes of pre- and post-synaptic neurons are in very close proximity.
* Electrical current can flow directly from one neuron into the other across these synapses.
* Transmission of an impulse across electrical synapses is very similar to impulse conduction along a single axon.
* Impulse transmission across an electrical synapse is always faster than that across a chemical synapse. Electrical synapses are rare in our system.
* At a chemical synapse, the membranes of the pre- and post-synaptic neurons are separated by a fluid-filled space called synaptic cleft.
* Chemicals called **neurotransmitters** are involved in the transmission of impulses at these synapses.

* The axon terminals contain vesicles filled with these neurotransmitters.
* When an impulse (action potential) arrives at the axon terminal, it stimulates the movement of the synaptic vesicles towards the membrane where they fuse with the plasma membrane and release their neurotransmitters in the synaptic cleft.
* The released neurotransmitters bind to their specific receptors, present on the post-synaptic membrane. This binding opens ion channels allowing the entry of ions which can generate a new potential in the post-synaptic neuron.
* The new potential developed may be either excitatory or inhibitory.

CENTRAL NEURAL SYSTEM

* CNS of vertebrates is formed of two types of matter:

(a) **Grey matter** – It is formed of cell bodies and non myelinated nerve fibres.

(b) **White matter** – It is formed of only myelinated nerve fibres.

* The CNS is surrounded by three layers of connective tissue membranes called **meninges.**
* The outer membrane forms the **duramater** which is very tough and remains attached to the skull and neural canal of vertebrae.
* Inner membrane forms the thin, soft **piamater** which lies next to brain and spinal cord. Between the two is the **arachnoid membrane.**
* A subarachnoid space lies below the arachnoid in which cerebrospinal fluid (CSF) is filled. Most of this fluid is contained in the central canal of the spinal cord and ventricles of the brain.
* CSF has nutritive, excretory and defensive functions. It also supports the nervous tissues and protects them against mechanical shock.
* The brain is the central information processing organ of our body, and acts as the 'command and control system'.
* It controls the voluntary movements, balance of the body, functioning of vital involuntary organs (e.g., lungs, heart, kidneys, etc.), thermoregulation, hunger and thirst, circadian (24-hour) rhythms of our body, activities of several endocrine glands and human behaviour.
* It is also the site for processing of vision, hearing, speech, memory, intelligence, emotions and thoughts.
* The human brain is well protected by the skull.
* Inside the skull, the brain is covered by cranial meninges consisting of an outer layer called dura mater, a very thin middle layer called arachnoid and an inner layer (which is in contact with the brain tissue) called pia mater.
* The brain can be divided into three major parts: (i) forebrain, (ii) midbrain, and (iii) hindbrain .

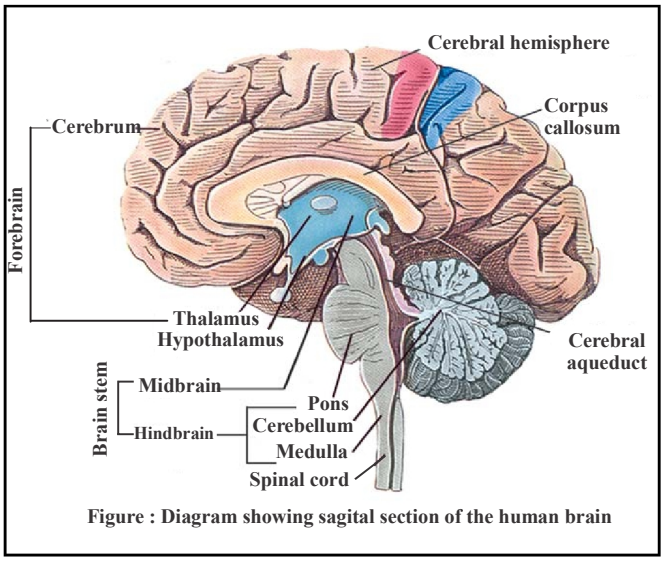


Figure : Diagram showing sagital section of the human brain

* In the early vertebrate embryo, the brain and spinal cord differentiate from a single tube of tissue, the neural tube. Anteriorly, the tube expands and develops into the brain. Posteriorly, the tube becomes the spinal cord. Brain and spinal cord remain continuous, and their cavities communicate. As the brain begins to differentiate, three bulges become visible: the hindbrain, midbrain, and forebrain

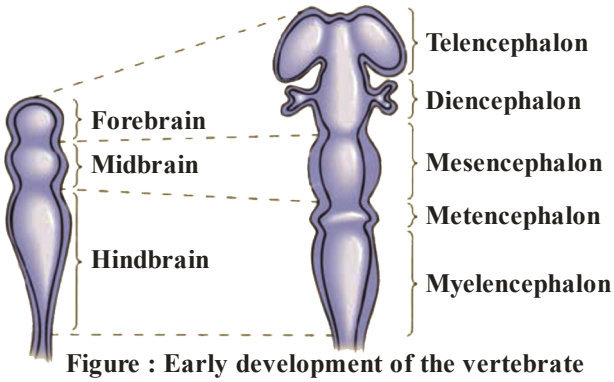


Figure : Early development of the vertebrate nervous system

Forebrain :

* The forebrain consists of cerebrum, thalamus and hypothalamus.
* The forebrain differentiates to form the **diencephalon** and **telencephalon**.
* The diencephalon develops into the thalamus and hypothalamus. The **thalamus** is a relay center for motor and sensory information.
* The **hypothalamus** controls autonomic functions; links nervous and endocrine systems; controls temperature, appetite, and fluid balance; and is involved in some emotional and sexual responses.
* The telencephalon develops into the cerebrum and **olfactory bulbs**. In most vertebrates the **cerebrum** is divided into right and left **hemispheres**. In fishes and amphibians, the cerebrum mainly integrates incoming sensory information.
* Cerebrum forms the major part of the human brain. A deep cleft divides the cerebrum longitudinally into two halves, which are termed as the left and right cerebral hemispheres.
* The hemispheres are connected by a tract of nerve fibres called **corpus callosum.**
* The layer of cells which covers the cerebral hemisphere is called **cerebral cortex** and is thrown into prominent folds.
* The cerebral cortex is referred to as the grey matter due to its greyish appearance.
* The neuron cell bodies are concentrated here giving the colour.
* The cerebral cortex contains motor areas, sensory areas and large regions that are neither clearly sensory nor motor in function.
* These regions called as the association areas are responsible for complex functions like intersensory associations, memory and communication.
* Fibres of the tracts are covered with the myelin sheath, which constitute the inner part of cerebral hemisphere.
* They give an opaque white appearance to the layer and, hence, is called the white matter.
* The cerebrum wraps around a structure called **thalamus**, which is a major coordinating centre for sensory and motor signaling.
* **Hypothalamus** lies at the base of the thalamus. The hypothalamus contains a number of centres which control body temperature, urge for eating and drinking. It also contains several groups of neurosecretory cells, which secrete hormones called hypothalamic hormones.
* The inner parts of cerebral hemispheres and a group of associated deep structures like amygdala, hippocampus, etc., form a complex structure called the limbic lobe or limbic system.
* Along with the hypothalamus, it is involved in the regulation of sexual behaviour, expression of emotional reactions (e.g., excitement, pleasure, rage and fear), and motivation.

Midbrain :

* The midbrain is located between the thalamus/ hypothalamus of the forebrain and pons of the hindbrain.
* A canal called the cerebral aqueduct passess through the midbrain.
* The dorsal portion of the midbrain consists mainly of four round swellings (lobes) called **corpora quadrigemina**. Midbrain and hindbrain form the brain stem.

Hindbrain :

* The hindbrain comprises pons, cerebellum and medulla (also called the **medulla oblongata**).
* The hindbrain subdivides into the **metencephalon** and **myelencephalon.** The myelencephalon develops into the **medulla**, which contains vital centers and other reflex centers. The **fourth ventricle**, the cavity of the medulla, communicates with the central canal of the spinal cord. The metencephalon gives rise to the **cerebellum**, which is responsible for muscle tone, posture, and equilibrium, and to the **pons**, which connects various parts of the brain.
* Pons consists of fibre tracts that interconnect different regions of the brain.
* Cerebellum has very convoluted surface in order to provide the additional space for many more neurons.
* **Cerebellum** is the second largest part of the human brain. It consists of two lateral **cerebellar hemispheres** and central **vermis.**

* It has grey matter on the outer side, comprising of three layers of cells and fibres.
* The middle layer contains characteristically large flask-shaped **Purkinje cells** which are considered the most complex neurons. A cross section through cerebellar hemispheres shows a branching tree like arrangement of grey and white matter called the **arbor vitae** (tree of life). Cerebellum is connected to the brainstem by **cerebellar peduncles.**
* The superior cerebellar peduncles connect the cerebellum to the midbrain, the **middle cerebellar peduncles** communicate with the pons and the **inferior cerebellar peduncles** connect the cerebellum to the medullar oblongata, as well as spinal cord.
* Although the cerebellum does not initiate voluntary movements, it is an important centre for coordinating and learning movements and for controlling posture and balance.
* The medulla of the brain is connected to the spinal cord. The medulla contains centres which control respiration, cardiovascular reflexes and gastric secretions.
* **Brainstem :** The brainstem is literally the stalk of the brain. It comprises of diencephalon, midbrain, pons and medulla oblongata.

REFLEX ACTION AND REFLEX ARC

* The entire process of response to a peripheral nervous stimulation, that occurs involuntarily, i.e., without conscious effort or thought and requires the involvment of a part of the central nervous system is called a reflex action.
* The reflex pathway comprises at least one afferent neuron (receptor) and one efferent (effector or excitor) neuron appropriately arranged in a series.
* The afferent neuron receives signal from a sensory organ and transmits the impulse via a dorsal nerve root into the CNS (at the level of spinal cord).
* The efferent nueuron then carries signals from CNS to the effector. The stimulus and response thus forms a reflex arc .

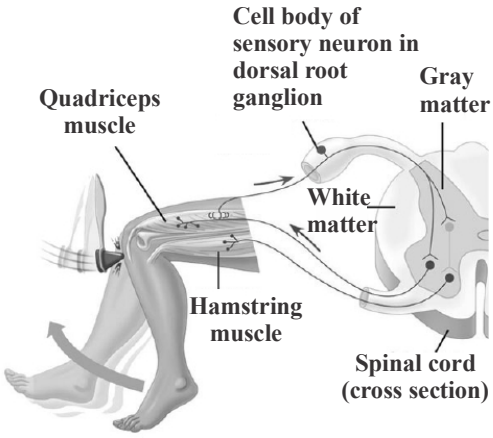


Figure : Knee jerk reflex

EYE

* Our paired eyes are located in sockets of the skull called orbits.
* The adult human eye ball is nearly a spherical structure. The wall of the eye ball is composed of three layers.
* The external layer is composed of a dense connective tissue and is called the **sclera**.
* The anterior portion of this layer is called the **cornea**.
* The middle layer, **choroid**, contains many blood vessels and looks bluish in colour.
* The choroid layer is thin over the posterior two-thirds of the eye ball, but it becomes thick in the anterior part to form the ciliary body.
* The ciliary body itself continues forward to form a pigmented and opaque structure called the **iris** which is the visible coloured portion of the eye.

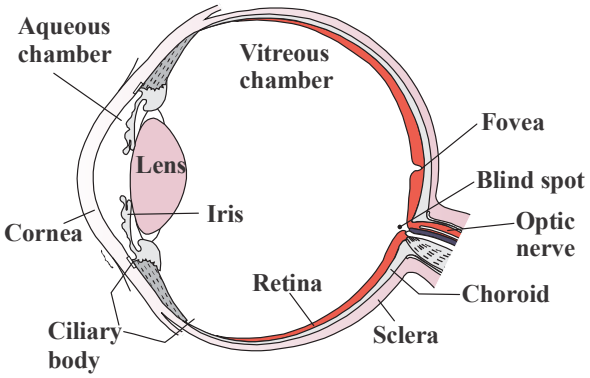


Figure : Diagram showing parts of an eye

* The eye ball contains a transparent crystalline lens which is held in place by ligaments attached to the ciliary body.
* In front of the lens, the aperture surrounded by the iris is called the **pupil**. The diameter of the pupil is regulated by the muscle fibres of iris.
* The inner layer is the retina and it contains three layers of cells - from inside to outside - ganglion cells, bipolar cells and photoreceptor cells.
* There are two types of photoreceptor cells, namely, **rods** and **cones**. These cells contain the light-sensitive proteins called the photopigments.
* The daylight (photopic) vision and colour vision are functions of cones and the twilight (scotopic) vision is the function of the rods.

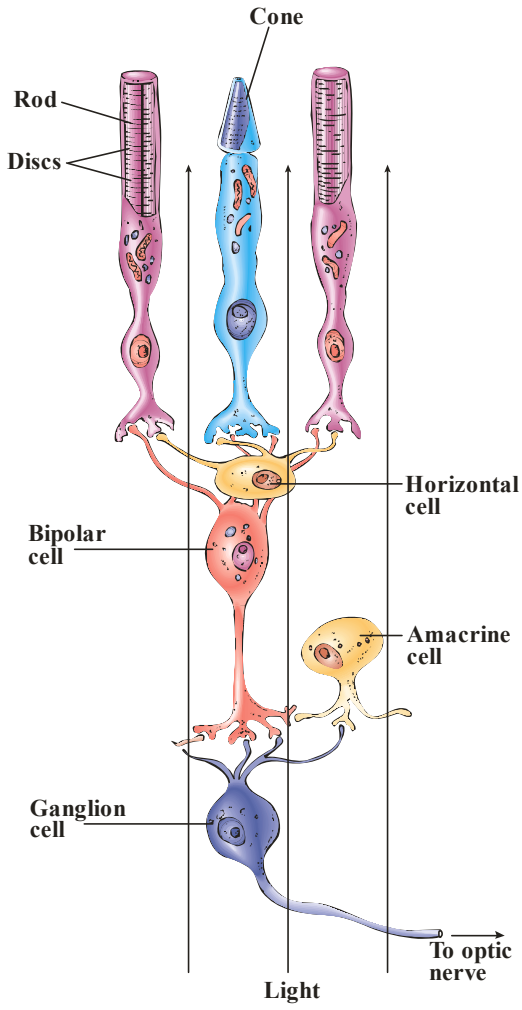


Figure : Neural pathway in the retina
The photoreceptor cells (rods and cones) are located in the back of the retina. They transmit information to bipolar cells. The bipolar cells synapse with ganglion cells. The horizontal and amacrine cells are important in local processing of visual input within the retina. Axons of ganglion cells make up the optic nerve.

* The rods contain a purplish-red protein called the **rhodopsin** or visual purple, which contains a derivative of Vitamin A.
* In the human eye, there are three types of cones which possess their own characteristic photopigments that respond to red, green and blue lights.
* The sensations of different colours are produced by various combinations of these cones and their photopigments. When these cones are stimulated equally, a sensation of white light is produced.
* The optic nerves leave the eye and the retinal blood vessels enter it at a point medial to and slightly above the posterior pole of the eye ball.
* Photoreceptor cells are not present in that region and hence it is called the **blind spot.**
* At the posterior pole of the eye lateral to the blind spot, there is a yellowish pigmented spot called **macula lutea** with a central pit called the **fovea.**
* The fovea is a thinned-out portion of the retina where only the cones are densely packed.
* It is the point where the visual acuity (resolution) is the greatest.
* The space between the cornea and the lens is called the aqueous chamber and contains a thin watery fluid called **aqueous humor.**
* The space between the lens and the retina is called the vitreous chamber and is filled with a transparent gel called vitreous humor.
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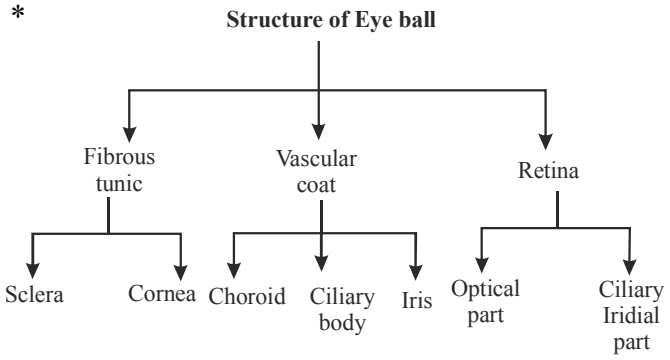
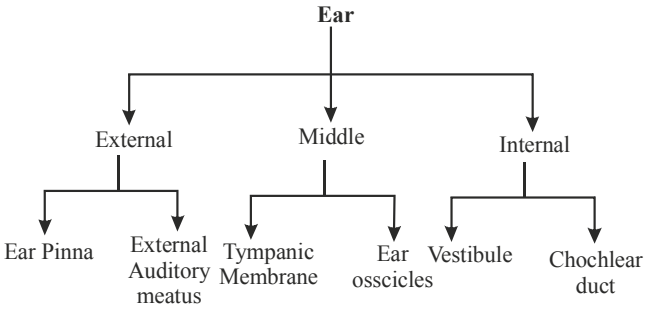


* Largest eye ball found in the deer.
* Smallest eye ball found in monkey.
* Size of eye ball in human beings –
New born = 1.75 cm, Adult = 2-2.5 cm
* Sharpest vision found in the Eagle (In day time) & In night time - Owl.

* Lowest sight - Monkey. [Minimum focal length].Vision of human being - Binocular stereoscopic (3 dimensional vision).
* In most of the animals monocular vision is found. e.g. Rat, Horse, Rabbit.
* Minimum distance for proper vision of eye = 25cm, Maximum sensitivity of eye is for 5000Å.
* Telescopic eye found in birds. (large focal length.)
* Colour vision found in Human, Monkey, Lizard, Snakes, Birds, Fresh water fishes.
* In Hen only cones are found. In Owl only rods are found.
* In human beings both rods and cones are found [Rods (120 million) and Cones (7 million)]
* Black and white vision due to rods & colour vision due to cones
* Dim light vision (Black & white vision) due to rods & colour vision due to cones
* Eye ball protected by –
(i) Eyebrows(ii) Eye lids & Eye lashes (iii) Glands
* Third eye lid is vestigeal in human being known as plica semilunaris. In frog and other amphibian sclerotic layer of eye ball is cartilaginous.
* Eye lids absent in snake. Immovable eye lid present in the fishes. Cornea and lens no blood and no nerve supply. Image on retina is inverted & real.

THE EAR

* The ears perform two sensory functions, hearing and maintenance of body balance.
* The ear can be divided into three major sections called the outer ear, the middle ear and the inner ear.



* The outer ear consists of the **pinna** and **external auditory meatus** (canal).
* The pinna collects the vibrations in the air which produce sound. The external auditory meatus leads inwards and extends up to the **tympanic membrane** (the ear drum).
* There are very fine hairs and wax-secreting sebaceous glands in the skin of the pinna and the meatus.
* The tympanic membrane is composed of connective tissues covered with skin outside and with mucus membrane inside.
* The middle ear contains three ossicles called **malleus, incus** and **stapes** which are attached to one another in a chain-like fashion.
* The malleus is attached to the tympanic membrane and the stapes is attached to the oval window of the **cochlea.**
* The ear ossicles increase the efficiency of transmission of sound waves to the inner ear. An **Eustachian tube** connects the middle ear cavity with the pharynx.
* The Eustachian tube helps in equalising the pressures on either sides of the ear drum.
* The fluid-filled inner ear called **labyrinth** consists of two parts, the bony and the membranous labyrinths.
* The bony labyrinth is a series of channels. Inside these channels lies the membranous labyrinth, which is surrounded by a fluid called **perilymph**.

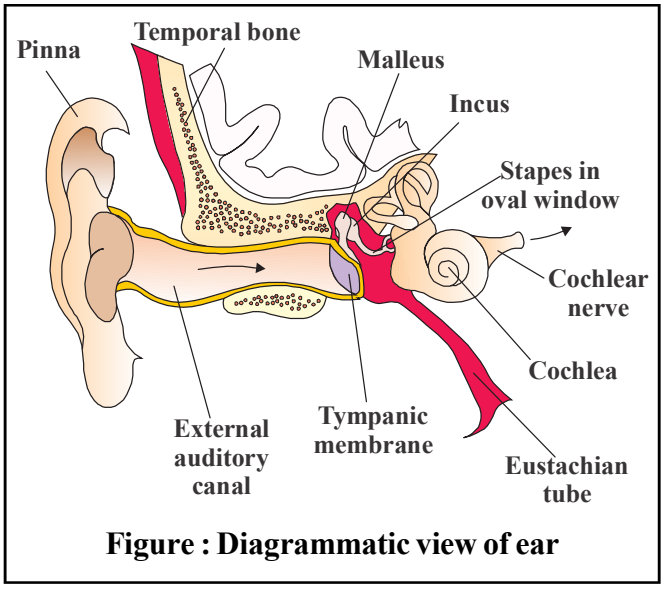


Figure : Diagrammatic view of ear

* The membranous labyrinth is filled with a fluid called **endolymph**. The coiled portion of the labyrinth is called **cochlea.**

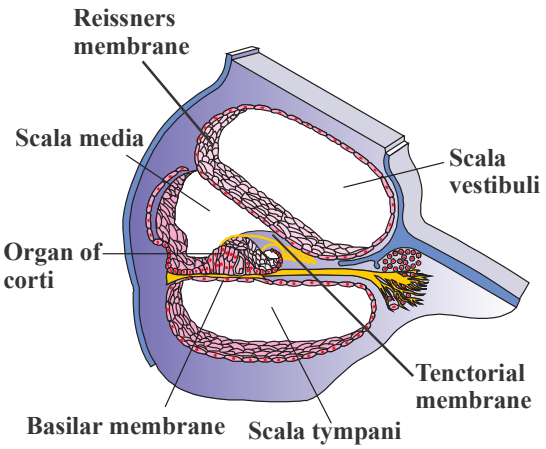


Figure : Diagrammatic representation of the sectional view of cochlea

* The membranes constituting cochlea, the reissner's and basilar, divide the surounding perilymph filled bony labyrinth into an upper scala vestibuli and a lower scala tympani.
* The space within cochlea called scala media is filled with **endolymph**. At the base of the cochlea, the scala vestibuli ends at the oval window, while the scala tympani terminates at the round window which opens to the middle ear.
* The **organ of corti** is a structure located on the basilar membrane which contains hair cells that act as auditory receptors.
* The **hair cells** are present in rows on the internal side of the organ of corti. The basal end of the hair cell is in close contact with the afferent nerve fibres.
* A large number of processes called stereo cilia are projected from the apical part of each hair cell. Above the rows of the hair cells is a thin elastic membrane called tectorial membrane.
* The inner ear contains a complex system called **vestibular apparatus**, located above the cochlea.
* The vestibular apparatus is composed of three **semi-circular canals** and the **otolith organ** consisting of the saccule and utricle.
* Each semi-circular canal lies in a different plane at right angles to each other. The membranous canals are suspended in the perilymph of the bony canals.
* The base of canals is swollen and is called **ampulla,** which contains a projecting ridge called crista **ampullaris** which has hair cells.
* The saccule and utricle contain a projecting ridge called **macula**.
* The crista and macula are the specific receptors of the vestibular apparatus responsible for maintenance of balance of the body and posture.

Mechanism of hearing :

* Sound waves pass through the **external auditory canal** and cause the tympanic membrane (eardrum) to vibrate. The ear bones **malleus, incus**, and **stapes-transmit** and amplify the vibrations through the middle ear.
* Vibrations pass through the **oval window** to fluid within the vestibular duct. Pressure waves press on the membranes that separate the three ducts of the cochlea.
* The bulging of the round window serves as an escape valve for the pressure. The pressure waves cause movements of the basilar membrane. These movements stimulate the hair cells of the organ of Corti by rubbing them against the overlying **tectorial membrane.**
* Neural impulses are initiated in the dendrites of neurons that lie at the base of each hair cell, and are transmitted by the **cochlear nerve** to the brain.

CONCEPT REVIEW

* Neural signaling involves (a) **reception** of information by a sensory receptor, (b) **transmission** by an afferent neuron to the CNS, (c) **integration** by interneurons in the central nervous system (CNS)., (d) transmission by an **efferent neuron** to other neurons or to an **effector,** (e) action by effectors, the muscles and glands. Sensory receptors and neurons outside the CNS make up the **peripheral nervous system (PNS).**
* **Glial cells** support and nourish neurons. **Microglia** are phagocytic cells. Some **astrocytes** are phagocytic, and others help regulate the composition of the extracellular fluid in the CNS. Astrocytes may also induce and stabilize synapses.

* **Oligodendrocytes** are glial cells that form myelin sheaths around axons in the CNS; **Schwann cells** form sheaths around axons in the PNS.
* **Neurons** are specialized to receive stimuli and transmit electrical signals.In a typical neuron a cell body contains the nucleus and most of the organelles. Many branched **dendrites** extend from the cell body; they are specialized to receive stimuli and send signals to the cell body.
* The single long **axon** extends from the cell body and forms branches called **axon collaterals**. The axon transmits signals into its **terminal branches** that end in synaptic terminals. Many axons are surrounded by an insulating **myelin sheath**. **Nodes of Ranvier** are gaps in the sheath between successive Schwarm cells.A nerve consists of several hundred axons wrapped in connective tissue; a ganglion is a mass of neuron cell bodies.
* Neurons use electrical signals to transmit information. In a resting neuron, one that is not transmitting an impulse, the inner surface of the plasma membrane is negatively charged compared with the outside; the membrane is **polarized.**
* The junction between two neurons or between a neuron and effector is a **synapse**. Although there are electrical synapses, most synapses are chemical. Synaptic transmission generally depends on release of a **neurotransmitter** from **synaptic vesicles** in the synaptic terminals of a **presynaptic neuron**.
* **Acetylcholine triggers** contraction of skeletal muscle.
* The **biogenic amines** include norepinephrine, serotonin and dopamine. These neurotransmitters play important roles in regulating mood. Dopamine is also important in motor function.
* Several amino acids function as neurotransmitters including **glutamate**, the main excitatory neurotransmitter in the brain and **GABA**, a widespread inhibitory neurotransmitter.
* The neuropeptides include the **endorphins** (for example, beta-endorphin) and the **enkephalins**. These neuropeptides are opioids.
* Nitric oxide (NO) is a gaseous neurotransmitter that transmits signals from the postsynaptic neuron to the presynaptic neuron, the opposite direction from other neurotransmitters.
* The vertebrate nervous system consists of the **entral nervous system (CNS)** and **peripheral nervous system** (PNS). The CNS consists of the brain and dorsal, tubular **spinal cord**. The PNS consists of sensory receptors and nerves.
* In the vertebrate embryo, the brain and spinal cord arise from the **neural tube**. The anterior end of the tube differentiates into **forebrain, midbrain, and hindbrain.**
* The midbrain is the largest part of the brain in fishes and amphibians. It is their main association area, linking sensory input and motor output. In reptiles, birds, and mammals, the midbrain serves as a center for visual and auditory reflexes.
* The medulla, pons, and midbrain make up the **brain stem.**
* In birds, the corpus striatum controls complex behavior patterns, such as flying and singing.
* In mammals, the **neocortex** accounts for a large part of the **cerebral cortex**, the **gray matter** of the brain. The cerebrum has complex association functions.
* The human brain and spinal cord are protected by bone and three **meninges**-the **dura mater, arachnoid**, and **pia mater; brain** and **spinal cord** are cushioned by cerebrospinal fluid (CSF).
* The spinal cord transmits impulses to and from the brain and controls many **reflex actions**. The spinal cord consists of **ascending tracts**, which transmit information to the brain, and **descending tracts**, which transmit information from the brain. Its gray matter contains nuclei that serve as reflex centers.
* A **withdrawal reflex** involves sensory receptors; sensory neurons, interneurons, and motor neurons; and effectors, such as muscles.
* The PNS consists of sensory receptors and nerves, including the **cranial nerves** and **spinal nerves** and their branches.
* The **somatic division** of the PNS responds to changes in the external environment. The **autonomic division** regulates the internal activities of the body.

* The **sympathetic system** permits the body to respond to stressful situations. The **parasympathetic system** influences organs to conserve and restore energy.
* Many organs are innervated by sympathetic and parasympathetic nerves, which function in an opposite way. For example, the sympathetic system increases heart rate, whereas the parasympathetic system decreases heart rate.
* The vertebrate **inner ear** consists of a **labyrinth** of fluid-filled chambers and canals that help maintain equilibrium. The **vestibular apparatus** in the upper part of the labyrinth consists of the **saccule, utricle**, and **semicircular canals.**
* The saccule and utricle contain **otoliths** that change position when the head is tilted or when the body is moving in a straight line. The otoliths stimulate hair cells that send signals to the brain, enabling the animal to perceive the direction of gravity.
* The semicircular canals inform the brain about turning movements. Clumps of hair cells, called **cristae**, are located within each bulblike enlargement, an **ampulla**. Cristae are stimulated by movements of the **endolymph**, a fluid that fills each canal.
* In birds and mammals, the **organ of Corti** within the cochlea contains auditory receptors.
* In the human eye, light enters through the **cornea**, is focused by the lens, and produces an image on the **retina**. The **iris** regulates the amount of light that can enter.
* The retina contains the photoreceptor cells: **rods**, which function in dim light and form images in black and white; and **cones**, which function in bright light and permit color vision.
* The retina also contains **bipolar cells** that send signals to **ganglion cells**. Two types of lateral interneurons integrate information: **Horizontal cells** receive signals from the rods and cones and send signals to bipolar cells, and **amacrine cells** receive signals from bipolar cells and send signals back to bipolar cells and to ganglion cells.
* When the environment is dark, ion channels in the plasma membranes of rod cells are open and the cells are depolarized; they release glutamate, which hyperpolarizes the membranes of bipolar cells so they do not send signals.
* When light strikes the photo pigment **rhodopsin** in the rod cells, its retinal portion changes shape and initiates a signal transduction process that involves **transducin**. This G protein activates an esterase that hydrolyzes cGMP, reducing its concentration. As a result, ion channels close and the membrane becomes hyperpolarized. The rod cells release less glutamate, and fewer signals are transmitted. As a result, bipolar cells become depolarized, and release neurotransmitter that stimulates ganglion cells.
* Axons of the ganglion cells make up the **optic nerves**. The optic nerves transmit information to the lateral geniculate nuclei in the thalamus. From there neurons project to the **primary visual cortex** and then to integration centers in the cerebral cortex.

IMPORTANT POINTS

* Corpora striata occur in cerebrum.
* Central nervous system controls reflex action.
* Eye muscles are innervated by oculomotor, trochelear and abducens.
* The longest cell of an animal body is neuron.
* Nerve impulse for hearing originates in cochlea.
* Cerebrum is located in part of brain = Fore-front.
* Supply of blood to visceral organs is controlled by SNS, PNS, involuntary.
* In an axon, nerve impulse travels away from cyton.
* Nerve axon takes part in conduction of impulse.
* First cranial nerve is olfactory.
* Cerebrum = memory, Cerebellum = Equilibrium, Olfactory lobes = Smell.
* Cerebrum regulates speech, hearing, vision.
* Cerebellum maintains equilibrium and posture.
* Myelin sheath covers nerve fibre.
* Cervical nerves = 8 pairs
  Thoraric nerves = 12 pairs
  Lumbar nerves = 5 pairs
  Coccygeal nerves = 1 pair
* Diencephalon = Thalamus
  Telencephalon = Amygdala
  Myelencephalon = Medulla
  Metencephalon = Cerebellum

* Cerebral cortex consists of grey matter.
* Reflex action is
  Stimuls → Sensory → Motor → Response
* Too short eye ball and too flat lens produce presbyopia.
* Structure that provides balance to the body is located in inner ear.
* Largest ear ossicle is malleus.
* Olfactory = Smell
  Algesireceptor = Pain
  Organ of Corti = Sensory and supporting cells.
* Low light intensity as during night is detected by rods.
* A serious eye defect which can lead to blindness is glaucoma.

* **Table : The Human brain**

Structure	Description	Function
Brain stem		
Medulla	Continuous with spinal cord; primarily made up of nerves passing from spinal cord to rest of brain.	Contains vital centers (clusters of neuron cell bodies) that control heartbeat, respiration, and blood pressure; contains centers that control swallowing, coughing, vomiting.
Pons	Forms bulge on anterior surface of brain stem	Connects various parts of brain with one another; contains respiratory and sleep centers.
Midbrain	Just above pons	Center for visual and auditory reflexes (e.g., pupil reflex, blinking, adjusting ear to volume of sound).
Thalamus	At top of brain stem	Main sensory relay center for conducting information between spinal cord and cerebrum; neurons in thalamus sort and interpret all incoming sensory information (except olfaction) before relaying messages to appropriate neurons in cerebrum.
Hypothalamus	Just below thalamus; pituitary gland is connected to hypothalamus by stalk of neural tissue.	Contains centers for control of body temperature, appetite, fat metabolism, and certain emotions; regulates pituitary gland.
Cerebellum	Second largest division of brain.	Reflex center for muscular coordination and refinement of movements.
Cerebrum	Largest, most prominent part of human brain; longitudinal fissure divides cerebrum into right and left hemispheres, each divided into lobes: frontal, parietal, temporal, and occipital lobes.	Center of intellect, memory, consciousness, and language; also controls sensation and motor functions.
Cerebral cortex (outer grey matter)	Arranged into convolutions (folds) that increase surface area; functionally, cerebral cortex is divided into 1. Motor areas 2. Sensory areas 3. Association areas	Control movement of voluntary muscles. Receive incoming information from eyes, ears, pressure and touch receptors, etc. Sites of intellect, memory, language, and emotion; interpret incoming sensory information
White matter	Consists of myelinated axons of neurons that connect various regions of brain; these axons are arranged into bundles (tracts)	Connects the following: 1. Neurons within same hemisphere 2. Right and left hemispheres 3. Cerebrum with other parts of brain and spinal cord

* Table : Differentiation of CNS Structures

Early Embryonic Divisions	Subdivisions	Derivatives in Adult	Cavity
Brain			
Forebrain	Telencephalon Diencephalon	Cerebrum Thalamus, hypothalamus, epiphysis (pineal body)	Lateral ventricles (first and second ventricles) Third ventricle
Midbrain	Mesencephalon	Optic lobes in fish and amphibians; superior and inferior colliculi	Cerebral aqueduct
Hindbrain	Metencephalon Myelencephalon	Cerebellum, pons Medulla	 Fourth ventricle
Spinal cord		Spinal cord	Central canal

* Myelinated and non-myelinated axons

S.N.	Myelinated axons	Non-myelinated axons
1.	Transmission of nerve impulse is faster.	Transmission of nerve impulse is slower.
2.	Myelinated axon has a myelin sheath.	Myelin sheath is absent.
3.	Node of Ranvier is present between adjacent myelin sheaths	Node of Ranvier is absent.
4.	Found in the brain, the spinal cord, the cranial and spinal nerves	Found in autonomous and somatic neural systems.
5.	Schwann cells are observed inside the myelin sheath	Schwann cells are not observed inside the myelin sheath.

* Dendrites and axons

S.N.	Dendrites	Axons
1.	Dendrite is a small projection arising from the neuron. It conducts the nerve impulse toward the cell body.	Axon is a single, long projection that conducts the nerve impulse away from cell body to the next neuron.
2.	Nissl's granules are present in dendrites.	Nissl's granules are absent from axons.
3.	Dendrites are always non-myelinated.	Axons can be myelinated or non myelinated.

* Difference between electrical transmission and chemical transmission

S.N.	Electrical Transmission	Chemical Transmission
1	It occurs by electric synapse.	It occurs by chemical synapse.
2	Synaptic cleft is mayor may not present.	Synaptic cleft is present.
3	At electrical synapses, electrical current can flow directly from one neuron into the other across these synapses.	The rise in the stimulus-induces permeability to Na^+ is extremely short lived. It is quickly followed by a rise in permeability to K^+. Within a fraction of a second, K^+ diffuses outside the membrane and restores the resting potential of the membrane at the site of excitation.
4	Impulse transmission across an electrical transmission is always faster. Electrical synapses are rare in our system.	Chemical transmission is slower.

QUESTION BANK

EXERCISE - 1 (LEVEL-1) [NCERT EXTRACT]

SECTION - 1 (VOCABULARY BUILDER)

Choose one correct response for each question.

For Q.1-Q.4

Match the column I with column II.

Q.1

	Column I	Column II
(a)	Cell body with one axon and two or more dendrites.	(i) Myelinated and non-myelinated.
(b)	Cell body with one axon and one dendrite.	(ii) Unipolar neuron
(c)	Cell body with one axon only	(iii) Bipolar neuron
(d)	Axons form nerve fibres which are of two types	(iv) Multipolar neuron

(A) a-iv, b-ii, c-i, d-iii (B) a-iii, b-iv, c-i, d-ii
(C) a-iv, b-iii, c-ii, d-i (D) a-iv, b-i, c-ii, d-iv

Q.2

	Column I	Column II
(a)	External layer of eyeball	(i) Choroid
(b)	Inner layer of eyeball	(ii) Orbits
(c)	Middle layer of eyeball	(iii) Sclera
(d)	Socket of the skull	(iv) Retina

(A) a-iv, b-ii, c-i, d-iii (B) a-iv, b-iii, c-i, d-ii
(C) a-iii, b-iv, c-i, d-ii (D) a-i, b-ii, c-iii, d-iv

Q.3

	Column I	Column II
(a)	Synapse	i. communication by neurons
(b)	Neural circuits	ii. targets of efferent neurons such as muscles and glands
(c)	Neurotransmitter	iii. a chain of neurons
(d)	Node of Ranvier	iv. gaps between Schwann cells that expose axons.
(e)	effector	v. a special junction between a neuron and another neuron or between a neuron and other effector cell.
(f)	Neural signaling	vi. chemical released from an axon terminus into a synapse.

(A) a - v, b-iii, c-vi, d-iv, e-ii, f-i
(B) a - vi, b-iii, c-v, d-iv, e-i, f-ii
(C) a - iv, b-i, c-vi, d-v, e-ii, f-iii
(D) a - v, b-ii, c-i, d-iv, e-iii, f-vi

Q.4

	Column I	Column II
(a)	Resting potential	i. chemicals involved in the transmission of impulses at synapses.
(b)	Nerve impulse	ii. gap between the pre-synaptic and post synaptic neurons
(c)	Synaptic cleft	iii. electrical potential difference across the resting neural membrane
(d)	Neuro-transmitters	iv. an electrical wave like response of a neuron to a stimulation.

(A) a-iv, b-ii, c-i, d-iii (B) a-iii, b-iv, c-ii, d-i
(C) a-ii, b-i, c-iv, d-iii (D) a-i, b-ii, c-iii, d-iv

SECTION - 2 (BASIC CONCEPTS BUILDER)

For Q.5 to Q.28 :

Choose one word for the given statement from the list.

Autonomous, Somatic, Nissl's granules, Afferent fibres, Malleus, Stapes, Nodes of Ranvier, Efferent fibres, Rods, Unmyelinated, Cones, Autonomic, Homeostasis, White, Afferent neuron, Efferent neuron, CNS, Effector, Brain, Neural system, Away from; Towards, Middle ear, Pharynx, Myelinated, Duramater, Arachnoid, Piamater, Blood vessels, Bluish, Organ of corti, Basiliar membrane, Command, Control, Spinal, Cranial, Hair cells, Electrical, Chemical, Potassium, Sodium, Long, Distal.

Q.5 The functions of the organs/organ systems in our body must be coordinated to maintain ____.

Q.6 When different cones of human eye are stimulated equally, a sensation of _____ light is produced.

Q.7 The nerve fibres of PNS are of two types, ____ and ____.

Q.8 The cell body of neuron contains certain granular bodies called ____.

Q.9 The system, responsible for providing an organised network of point to point connections for a quick coordination, is called ____.

Q.10 The gaps between two adjacent myelin sheaths is called ____.

Q.11 The axons transmit nerve impulses ____ the cell body while the dendrites transmit impulses ____ the cell body.

Q.12 There are two types of photoreceptor cells, i.e., __ and __. These cells contains photopigments.

Q.13 The middle layer of hyman eye, choroid contains ____ and looks ____ in colour.

Q.14 The _____ is a structure located on the _____ which contains _____ that acts as auditory receptors.

Q.15 The ____ neural system relays impulses from the CNS to skeletal muscles while the _____ neural system transmits impulses from the CNS to the involuntary organs and smooth muscles of the body.

Q.16 Myelinated nerve fibres are found in _____ and ____ nerves.

Q.17 _____ is attached to the tympanic membrane and the _____ is attached to the oval window of the cochlea.

Q.18 Synapses are of two types namely ___ synapses and ____ synapses.

Q.19 ____ nerve fibre is enclosed by a Schwann cell that do not form a myelin sheath around the axon.

Q.20 Brain acts as the ____ and ___ system.

Q.21 ____ is not involved in knee-jerk reflex.

Q.22 Unmyelinated nerve fibre, that do not form a myelin sheath around the axon, is commonly found in ___ and the ___ neural systems.

Q.23 Inside the skull brain is covered by cranial meninges consisting of an outer layer called ____, a very thin middle layer called ____ and an inner layer which is in contact with the brain tissue called ____.

Q.24 Eustachian tube connects ___ cavity with ____.

Q.25 In resting stage, the axonal membrane is comparatively more permeable to ____ ions and nearly impermeable to ____ ions.

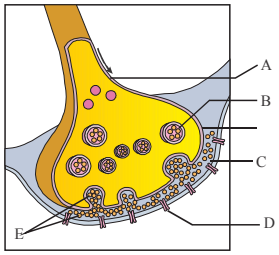
Q.26 The _____ receives signal from a sensory organ and transmits the impulse via a dorsal nerve root into the CNS (at the level of spinal cord) while the ___ carries Signals from ____ to the ____.

Q.27 The axon is a ____ fibre, the ____ end of which is branched.

Q.28 The ____ nerve fibres are enveloped with Schwann cells, which form a myelin sheath around the axon

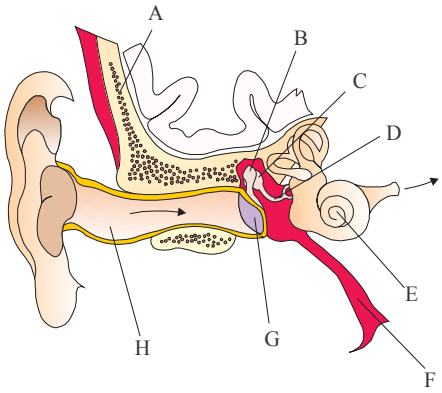
SECTION - 3 (ENHANCE DIAGRAM SKILLS)

Q.29 Identify the point A, B, C, D and E respectively.



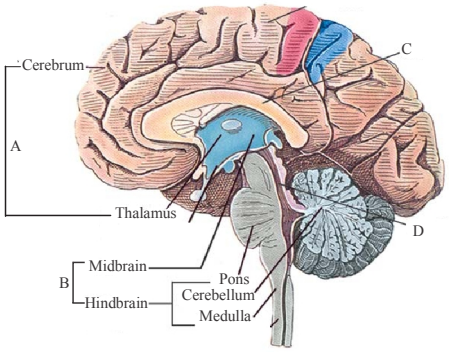
(A) A-Axon terminal, B-Synaptic cleft, C-Synaptic vesicles, D-Neurotransmitters, E-Receptors
(B) A-Axon terminal, B-Synaptic vesicles, C-Synaptic cleft, D-Receptors, E-Neurotransmitters
(C) A-Synaptic cleft, B-Synaptic vesicles, C-Axon terminal, D-Neurotransmitters, E-Receptors
(D) A-Synaptic cleft, B-Axon terminal, C-Synaptic vesicles, D-Neurotransmitters, E-Receptors

Q.30 Given is the diagram of ear. Identify A to H



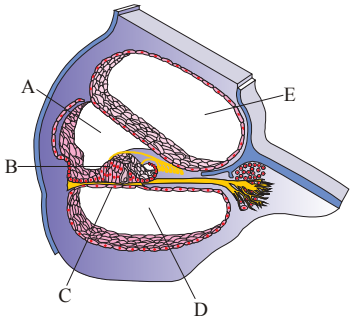
Choose the correct option.
(A) A-Temporal bone, B-Malleus, C-Incus, D-Stapes, E-Cochlea, F-Eustachian tube, G-Tympanic membrane, H-External auditory canal
(B) A-Tympanic membrane, B-Malleus, C-Incus, D-Stapes, E-Cochlea, F-Eustachian tube, G-Temporal bone, H-External auditory canal
(C) A-Tympanic membrane, B-Incus, C-Malleus, D-Stapes, E-Cochlea, F-Eustachian tube, G-Temporal bone, H-External auditory canal
(D) A-Temporal bone, B-Malleus, C -Incus, D-Cochlea, E-Stapes, F-Eustachian tube, G-tympanic membrane, H-External auditory canal

Q.31 Given is the diagram of human brain. Identify A, B, C and D correctly.



(A) A-Forebrain, B-Brain stem, C-Corpus callosum, D-Cerebral aqueduct
(B) A-Forebrain, B-Brain stem, C-Cerebral aqueduct, D-Corpus callosum
(C) A-Forebrain, B-Brain stem, C-Corpus callosum, D-Cerebral aqueduct
(D) A-Forebrain, B-Brain stem, C-Cerebral aqueduct, D-Corpus luteum

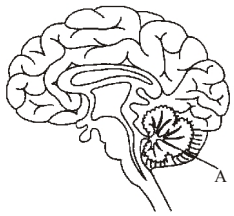
Q.32 Identify A to E in the sectional view of cochlea of human ear.



Choose the correct option.
(A) A-Scala media, B-Organ of Corti, C-Basiliar membrane, D-Scala tympani, E-Scala vestibuli
(B) A-Scala vestibuli, B-Organ of Corti, C-Basiliar membrane, D-Scala tympani, E-Scala media

(C) A-Scala vestibuli, B-Basiliar membrane, C-Organ of Corti, D-Scala tympani, E-Scala media
(D) A-Scala vestibuli, B-Basiliar membrane, C-Scala tympani, D-Organ of Corti, E-Scala media.

Q.33 Identify the part of brain which is represented by A in the given diagram.



(A) Medulla oblongata (B) Cerebellum
(C) Pons (D) Midbrain

SECTION - 4 (ENHANCE PROBLEM SOLVING SKILLS)

Choose one correct response for each question.

PART - 1 : NEURAL SYSTEM

Q.34 Which of the following is the correct function of endocrine system with reference to chemical coordination?
(A) Provides neural integration through hormones.
(B) Provides chemical integration through hormones.
(C) Provides an organised network of point to point connections for a quick coordination.
(D) None of the above

Q.35 In *Hydra*, neural organisation is comprises of
(A) Network of neurons (B) CNS and PNS
(C) CNS (D) PNS

Q.36 Which pair of systems jointly coordinate and integrate all the activities of the organs, so that they function in a synchronised fashion?
(A) Neural and respiratory.
(B) Neural and digestive system.
(C) Neural and endocrine system.
(D) Neural and circulatory system.

Q.37 What kind of neural organisation can be seen in lower vertebrates?
(A) Simple neural system
(B) Complex neural system
(C) Highly developed neural system
(D) Very poor neural system

Q.38 Mechanism of neural coordination involves
(A) transmission of nerve impulse.
(B) impulse conduction across a synapse.
(C) physiology of reflex action.
(D) All of the above.

Q.39 For quick coordination, our neural system is organised through –
(A) organ to organ connections.
(B) cell to cell connections.
(C) point to point connections.
(D) point to cell connections.

Q.40 The highly specialised cells called neurons can
(A) detect stimuli (B) receive stimuli
(C) transmit stimuli (D) All of the above

PART - 2 : HUMAN NEURAL SYSTEM

Q.41 Which of the following is known as the site of information processing and control?
(A) CNS (B) PNS
(C) Both (A) and (B) (D) Neurons

Q.42 Involuntary activities of the body are controlled by –
(A) autonomic nervous system
(B) somatic nervous system
(C) Both (A) and (B)
(D) None of the above

Q.43 The afferent nerve fibres transmit impulses
(A) from tissues/organs to the CNS.
(B) from the CNS to the concerned peripheral tissues/organs.
(C) from the CNS to skeletal muscles.
(D) from the CNS to the involuntary organs.

Q.44 The system that transmits impulses from CNS to skeletal muscles is –
(A) sympathetic neural system.
(B) parasympathetic neural system.
(C) somatic neural system.
(D) autonomic neural system.

Q.45 The human neural system comprises
(A) PNS only (B) CNS only
(C) Both (A) and (B) (D) None of these

Q.46 The sympathetic and parasympathetic neural system combines to form
(A) somatic neural system
(B) autonomic neural system.
(C) central neural system.
(D) peripheral neural system.

Q.47 The PNS includes
(A) central neural system and sympathetic neural system.
(B) somatic neural system and autonomic neural system.
(C) only sympathetic neural system.
(D) only somatic neural system.

Q.48 The PNS comprises of
(A) brain
(B) spinal cord
(C) Both (A) and (B)
(D) all the nerves of the body associated with the CNS

Q.49 The efferent nerve fibres transmit impulses
(A) from tissues/organs to the CNS.
(B) from the CNS to the smooth muscles.
(C) from the CNS to the concerned peripheral tissues/organs.
(D) from the CNS to the involuntary organs.

Q.50 The function of our visceral organs is controlled by
(A) Sympathetic and somatic neural system.
(B) Sympathetic and para sympathetic neural system.
(C) Central and somatic nervous system.
(D) None of the above

Q.51 The system that transmits impulse from the CNS to the involuntary organs and smooth muscles of the body.
(A) Sympathetic neural system.
(B) Parasympathetic neural system.
(C) Somatic neural system.
(D) Autonomic neural system.

Q.52 Brain and spinal cord, combinely form the
(A) CNS (B) PNS
(C) Both (A) and (B) (D) Neural system

PART - 3 : NEURON

Q.53 Nissl's granules are found in –
(A) cell body (B) dendrites
(C) Both (A) and (B) (D) axon

Q.54 The electrical potential difference across the plasma membrane when concentration of K^+ is high inside axon and low outside axon is called as the –
(A) action potential (B) resting potential
(C) refractory potential (D) All of these

Q.55 Unipolar neurons can be seen in the
(A) embryonic stage (B) cerebellum
(C) cerebral cortex (D) retina of eye

Q.56 Resting membrane potential is maintained by
(A) Hormones (B) Neurotransmitters
(C) Ion pumps (D) None of the above

Q.57 Synaptic knob possesses
(A) granular vesicles (B) Nissl's vesicles
(C) synaptic vesicles (D) None of these

Q.58 A synapse is formed by the membrane of
(A) presynaptic axon and a postsynaptic dendrite.
(B) presynaptic dendrite and postsynaptic dendrite.
(C) presynaptic dendrite and postsynaptic axon.
(D) None of the above

Q.59 In the resting stage of a neuron, concentration gradient generates due to –
(A) high concentration of K^+ and low concentration of Na^+ inside the axon.
(B) high concentration of Na^+ and low concentration of K^+ inside the axon.
(C) low concentration of Na^+ outside the axon
(D) high concentration of K^+ outside the axon.

Q.60 Neuron is composed of
(A) cell body (B) dendrites
(C) axon (D) All of these

Q.61 When the neuron is resting the axonal membrane is ____ to negatively charged proteins present in the axoplasm.
(A) permeable (B) partially permeable
(C) impermeable (D) selectively permeable

Q.62 Multipolar neurons are found in the
(A) retina of eye (B) cerebral cortex
(C) embryonic stage (D) None of these

Q.63 Presynaptic neuron and a post-synaptic neuron may or may not be separated by a gap called
(A) synaptic knob (B) neuroreceptor gap
(C) synapse (D) synaptic cleft

Q.64 The axons transmit nerve impulses from the cell body to a
(A) synapse
(B) dendrite of the same cell
(C) axon of another cell
(D) All of these

Q.65 On the basis of nature of nerve fibres, the nerves are –
(A) medullated and non-medullated nerves.
(B) myelinated and non-myelinated nerves.
(C) sensory, motor and mixed nerves.
(D) sensory and motor nerves.

Q.66 On postsynaptic membrane, the new potential developed is –
(A) always inhibitory.
(B) always excitatory.
(C) may be excitatory or inhibitory.
(D) neither excitatory nor inhibitory.

Q.67 Dendrites are
(A) branched short fibres.
(B) projections out of the cell body.
(C) Nissl's granules containing body.
(D) All of the above.

Q.68 Schwarm cells, form a myelin sheath around the
(A) dendrite (B) cell body
(C) nucleus (D) axon

Q.69 A nerve impulse is transmitted from one neuron to another through the junctions called –
(A) neuromuscular junction
(B) neuroreceptor junction
(C) neurosynaptic junction
(D) neuroglandular junction

Q.70 Bipolar neurons are found in the
(A) embryonic stage (B) cerebral cortex
(C) cerebellum (D) retina of eye

Q.71 Potential difference across resting membrane is negatively charged. This is due to differential distribution of the following ions
$^+$ & K^+ ions (B) CO^{3++} & Cl^- ions
(C) Ca^{++} & Mg^{++} ions (D) Ca^{+4} & Cl^- ions

Q.72 Synaptic knob is bulb-like structure which is present
(A) at the end of axon terminal
(B) at the node of Ranvier
(C) in the cell body
(D) at the end of dendrites

Q.73 A wave of action potential is termed as
(A) sensory impulse (B) nerve impulse
(C) activation impulse (D) motor impulse

Q.74 Axons can be
(A) non-myelinated (B) myelinated
(C) Either (A) or (B) (D) None of these

Q.75 The cell body of neuron contains of
(A) cytoplasm (B) cell organelles
(C) granular bodies (D) All of these

Q.76 Synaptic vesicles contains chemicals called
(A) synaptic fluid (B) neurotransmitters
(C) vesicular fluid (D) All of these

Q.77 Chemicals which are released at the synaptic junction are called
(A) Hormones (B) Neurotransmitters
(C) Cerebrospinal fluid (D) Lymph

Q.78 The function of Na^+ and K^+ pump is to move–
(A) Na^+ in and K^+ out (B) Na^+ out and K^+ in
(C) Na^+ out and Cl^- in (D) Cl^- out and Na^+ in

Q.79 Dendrites transmit impulses towards the
(A) cell body (B) axon
(C) Both (A) and (B) (D) None of these

Q.80 The neurons may be
(A) multipolar (B) bipolar
(C) unipolar (D) All of these

PART - 4 : CENTRAL NERVOUS SYSTEM

Q.81 Inside the skull, the brain is covered by –
(A) arachnoid (B) cranial meninges
(C) piamater (D) duramater

Q.82 Association areas of the brain are –
(A) always sensory areas.
(B) always motor areas.
(C) neither sensory nor motor areas.
(D) None of the above

Q.83 What is the location of hypothalamus?
(A) At the base of the cerebellum.
(B) At the base of the thalamus.
(C) Above the thalamus.
(D) Above the cerebellum.

Q.84 Brain stem is formed by
(A) midbrain and forebrain.
(B) forebrain and hindbrain.
(C) midbrain and hindbrain.
(D) All of the above.

Q.85 Select the correct sequence of meninges from inner to outerside.
(A) Duramater → Arachnoid → Piamater
(B) Arachnoid → Duramater → Piamater
(C) Piamater → Duramater → Arachnoid
(D) Piamater → Arachnoid → Duramater

Q.86 Which part constiutes the major part of the brain?
(A) Cerebrum (B) Hypothalamus
(C) Thalamus (D) Cerebellum

Q.87 Functions of association areas in cerebral cortex includes
(A) intersensory associations (B) memory
(C) communication (D) All of the above

Q.88 Brain controls the
(A) voluntary movements
(B) balance of the body
(C) functioning of vital involuntary organs
(D) All of the above

Q.89 Thalamus is a structure wrapped by cerebrum, is –
(A) a major centre for motor signaling
(B) a major coordinating centre for sensory and motor signaling.
(C) a major coordinating centre for sensory signal only.
(D) not a nervous part of a brain.

Q.90 The medulla contains centres which control
(A) respiration
(B) cardiovascular reflexes
(C) gastric secretions
(D) All of the above

Q.91 An area in the brain which is associated with strong emotions is
(A) Cerebral cortex (B) Cerebellum
(C) Limbic system (D) Medulla

Q.92 The inner parts of cerebral hemispheres and a group of associated deep structures like amygdala, hippocampus, etc. form a complex structure called
(A) arbor vitae
(B) limbic lobe/limbic system
(C) corpora quadrigemina
(D) reticular system

Q.93 The forebrain consists of
(A) cerebrum (B) thalamus
(C) hypothalamus (D) All of these

Q.94 Inner part of cerebral cortex is referred as
(A) white matter
(B) grey matter
(C) Both (A) and (B)
(D) non-myelinated nerve fibres

Q.95 The human brain is well protected by the
(A) skull (B) meninges
(C) hairs (D) piamater

Q.96 Association areas are regions found in
(A) cerebrum (B) cerebral cortex
(C) cerebellum (D) diencephalon

PART - 5 : REFLEX ACTION AND REFLEX ARC

Q.97 The process of response to a peripheral nervous stimulation, that occurs involuntarily is called
(A) reflactory potential (B) action potential
(C) reflex action (D) activation potential

Q.98 Which of the following neuron is also called excitor neuron?
(A) Afferent neuron (B) Efferent neuron
(C) Interneuron (D) Both (B) and (C)

Q.99 Given below are different components of reflex arc.
I. Effector organ II. Interneuron
III. Motor neuron IV. Sensory neuron
V. Sensory receptor
Arrange these in correct order of action potential that follows a sensory receptor stimulation.
(A) V, IV, III, II, I (B) V, IV, II, III, I
(C) V, III, IV, I, II (D) V, II, IV, III, I

Q.100 The reflex pathway comprises
(A) one afferent neuron
(B) one efferent neuron
(C) one afferent and one efferent neuron
(D) one afferent and one receptor neuron

PART - 6 : SENSORY RECEPTION AND PROCESSING

Q.101 The wall of the human eyeball is composed of
(A) sclerotic, choroid and retinal layer
(B) sclera, cornea and choroid
(C) sclera, cornea and ciliary body
(D) sclera, choroid and iris

Q.102 The anterior portion of sclera is called
(A) iris (B) cornea
(C) ciliary body (D) pupil

Q.103 The rods contains a purplish-red protein called
(A) opsin (B) rhodopsin
(C) photopsin (D) iodopsin

Q.104 Coiled portion of the labyrinth is called
(A) cochlea (B) ear drum
(C) pinna (D) ear canal

Q.105 Outer ear of humans consists of
(A) pinna
(B) external auditory meatus
(C) Both (A) and (B)
(D) labyrinth

Q.106 Three major components of human eyeball are
(A) lens, aqueous humor and vitreous humor.
(B) lens, iris and optic nerve.
(C) cornea, lens and optic nerve.
(D) cornea, lens and iris.

Q.107 A transparent crystalline structure which is held in place by ligaments attached to the ciliary body, is called the
(A) ciliary body (B) lens
(C) iris (D) pupil

Q.108 Pinna
(A) collects the vibrations in the air which produce sound.
(B) are wax secreting glands.
(C) increase the efficiency of transmission of sound waves to the inner ear.
(D) All of the above.

Q.109 Labyrinth, fluid-filled inner ear consists of
(A) bony labyrinth (B) membranous labyrinth
(C) Both (A) and (B) (D) Ear drum

Q.110 Mark the vitamin present in Rhodopsin
(A) Vit A (B) Vit B
(C) Vit C (D) Vit D

Q.111 The inner layer of human eye is called
(A) choroid (B) sclera
(C) retina (D) cornea

Q.112 The organ of corti is a structure present in
(A) External ear (B) Middle ear
(C) Semi circular canal (D) Cochlea

Q.113 At the posterior pole of the eye lateral to the blind spot, there is a yellowish pigmented spot called –
(A) corpus luteum (B) fovea
(C) macula quadrigenina (D) macula lutea

Q.114 Rhodopsin is also known as visual
(A) red (B) yellow
(C) brown (D) purple

Q.115 In humans, tympanic membrane is composed of connective tissues which is covered with
(A) skin outside and with mucus membrane inside.
(B) mucus membrane only.
(C) mucus membrane outside and with skin inside.
(D) skin only.

Q.116 The part of internal ear responsible for hearing is
(A) Cochlea (B) Semicircular canal
(C) Utriculus (D) Sacculus

Q.117 Our paired eyes are located in sockets of the skull called
(A) orbits (B) cornea
(C) iris (D) lens

Q.118 Human ear can be divided into
(A) outer ear (B) middle ear
(C) inner ear (D) All of these

Q.119 Photoreceptor cells of human eye are
(A) rods (B) cones
(C) Both (A) and (B) (D) ganglion cells

Q.120 In humans, tympanic membrane (ear drum) separates lympanic cavity from
(A) pinna (B) auditory meatus
(C) Eustachian tube (D) cochlea

Q.121 Choroid becomes thick in the anterior part of eye to form the
(A) iris (B) ciliary body
(C) pupil (D) lens

Q.122 There are different types of cones in human eye that responds to
(A) red and green lights.
(B) green and blue lights.
(C) red and blue lights.
(D) red, green and blue lights.

Q.123 Human eyeball consists of three layers and it encloses
(A) Lens, iris, optic nerve
(B) Lens, aquous humor and vitreous humor
(C) Cornea, lens, iris
(D) Cornea, lens, optic nerve

Q.124 At blind spot –
(A) optic nerves leave the eye and retinal blood vessels enter it.
(B) retinal blood vessels leave the eye and optic nerves enter it.
(C) there is no involvement of optic nerves at all.
(D) there is no involvement of retinal blood vessels at all.

Q.125 Which of the following statements are correct for cones of human eye?
I. Cones are responsible for daylight vision.
II. Cones are responsible for colour vision.
III. Cones are responsible for photopic vision.
(A) Only I (B) I and II
(C) II and III (D) I, II and III

Q.126 Human ears perform sensory
(A) hearing organs
(B) maintenance of body balance
(C) Both (A) and (B)
(D) voice production

Q.127 While travelling to higher altitude, people can feel pain in the ear and dizziness. Which part among the following is involved?
(A) Cochlea, ear ossicles
(B) Tympanic membrane
(C) Eustachian tube, utricle, saccule and semicircular canals
(D) None of the above

Q.128 Sclera of human eye is composed of
(A) blood vessels (B) ganglion cells
(C) photoreceptor cells (D) connective tissue

Q.129 Internal ear of humans is filled with
(A) lymph (B) endolymph
(C) perilymph (D) Both (B) and (C)

Q.130 Which is the visible coloured portion of the eye?
(A) Pupil (B) Lens
(C) Iris (D) Ciliary body

Q.131 Wax gland present in the ear canal is called
(A) Sweat gland
(B) Prostate gland
(C) Cowper's gland
(D) Sebaceous gland/ceruminous gland

Q.132 The sensations of different colours in human eye is produced due to the combination of –
(A) rods and their photopigments
(B) red and blue lights
(C) cones and their photopigments
(D) red and green lights

Q.133 Middle ear of humans contains ossicles, i.e.,
(A) malleus (B) incus
(C) stapes (D) All of these

Q.134 The choroid layer of human eye is
(A) thin over the posterior 2/3 of eyeball.
(B) thick over the posterior 4/3 of eyeball.
(C) coloured over the anterior 2/3 of eyeball.
(D) opaque structure over the anterior 4/3 of eyeball.

Q.135 Aqueous chamber which is filled by aqueous humour is the space
(A) behind the lens.
(B) beween sclera and retina.
(C) between cornea and lens.
(D) beetween choroid and sclera.

Q.136 Scala vestibuli, scala media and scala tympani of human ear contains respectively –
(A) perilymph, endolymph and perilymph
(B) endolymph, perilymph and endolymph
(C) perilymph, endolymph and endolymph
(D) perilymph, haemolymph and endolymph

Q.137 Pupil, is the aperture surrounded by the
(A) ciliary body (B) connective tissue
(C) iris (D) choroid

Q.138 The pressure on either sides of the ear drum gets equalised by
(A) pinna (B) Eustachian tube
(C) cochlea (D) labyrinth

Q.139 Blind spot is called so because of
(A) the presence of photoreceptor cells.
(B) presence of optic nerves.
(C) the absence of photoreceptor cells.
(D) None of the above.

Q.140 The gelatinous, elastic membrane covering the sensory hair cells of the human ear is known as
(A) basilar (B) tectorial
(C) Reissners's (D) neuro-sensory

Q.141 Vitreous chamber, which is filled by vitreous humor is the space
(A) behind the lens.
(B) in front of lens.
(C) between choroid and retina.
(D) between choroid and sclera.

Q.142 The vestibular apparatus of human ear is composed of
(A) oval window (B) otolith organs
(C) three semicircular canals (D) (B) and (C)

EXERCISE - 2 (LEVEL-2)

Choose one correct response for each question.

Q.1 The principal integration center of homeostatic regulation and leads to the release of hormones.
(A) cerebellum (B) cerebrum
(C) thalamus (D) hypothalamus

Q.2 The part of the mammalian brain that integrates information about posture and muscle tone.
(A) cerebrum (B) cerebellum
(C) myencephalon (D) medulla oblongata

Q.3 The brain and the spinal cord are wrapped in a connective tissue layer called the –
(A) gray matter (B) merunges
(C) dura matter (D) sclera

Q.4 If only one temporal lobe is damaged, you would expect
(A) blindness in one eye
(B) total blindness
(C) loss of hearing in one ear
(D) partial loss of hearing in both ears

Q.5 Sensory transduction involves –
(A) one sensory stimulus being converted to another.
(B) an increase in the amplitude of an action potential.
(C) stimulus causing a change in membrane potential of sensory cell.
(D) a reduced response of a sensory cell in the face of constant intensity of stimulus.

Q.6 Variations in the quality of sound are recognized by–
(A) number of hair cells stimulated
(B) pattern of hair cells stimulated
(C) amplitude of action potential
(D) frequency of action potential

Q.7 The membrane in contact with the stapes that transmits sound waves to the inner ear –
(A) oval window (B) round window
(C) tympanic membrane (D) basilar membrane

Q.8 Responsible for differences in absorption characteristics that underlie color vision.
(A) rod cells (B) retinal
(C) carotine (D) opsin

Q.9 Photoreceptive cells that are specialized for detection of light of low intensity.
(A) rod cells (B) ganglion cells
(C) horizontal cells (D) cone cells

Q.10 The part of the neuron that transmits an impulse from the cell body to an effector cell is the –
(A) dendrite (B) axon
(C) Schwann body (D) collateral

Q.11 Summing incoming neural signals is part of –
(A) reception (B) transmission
(C) integration (D) action by effectors

Q.12 Which of the following are phagocytic cells that remove debris from tissue in the CNS?
(A) Schwann cells (B) axons
(C) oligodendrocytes (D) microglia

Q.13 Action potentials are transmitted to synaptic terminals by–
(A) ganglia (B) axon
(C) dendrites (D) cell body

Q.14 In responding to a stimulus, a motor neuron signals a(an)
(A) efferent neuron (B) receptor
(C) afferent neuron (D) effector

Q.15 The myelin sheath is produced around axons outside the CNS by the
(A) axon (B) neuron cell body
(C) dendrites (D) Schwann cells

Q.16 Which of the following does not contribute to the resting potential of a neuron?
(A) sodium-potassium pumps
(B) ion channels
(C) differences in concen. of ions across the membrane
(D) graded potentials

Q.17 A neuron that begins at a synapse is called a –
(A) presynaptic neuron (B)postsynaptic neuron
(C) synapsing neuron (D) neurotransmitter

Q.18 Neurotransmitter receptors often –
(A) are voltage-activated ion channels.
(B) permit influx of chloride ions, leading to depolarization of the membrane.
(C) work through a second messenger.
(D) inhibit reuptake of the neurotransmitter.

Q.19 Branchlike extensions of the cell body involved in receiving stimuli are –
(A) dendrites (B) axons
(C) Schwann bodies (D) collaterals

Q.20 A presynaptic neuron in the cerebrum synapses with hundreds of other neurons. This is an example of –
(A) convergence (B) divergence
(C) summation (D) a reverberating circuit

Q.21 A radially symmetrical animal is likely to have –
(A) a forebrain (B) a nerve net
(C) cerebral ganglia (D) a ventral nerve cord

Q.22 Which part of the brain maintains posture, muscle tone, and equilibrium?
(A) cerebrum (B) medulla
(C) cerebellum (D) neocortex

Q.23 Which part of the brain controls autonomic functions and regulates body temperature?
(A) cerebrum (B) hypothalamus
(C) cerebellum (D) pons

Q.24 In a withdrawal reflex, following reception, a signal is transmitted by
(A) a motor neuron to an association neuron in the CNS.
(B) an association neuron in the CNS to an afferent neuron.
(C) an afferent neuron in the CNS to a motor neuron.
(D) a sensory neuron to an interneuron in the CNS.

Q.25 Association areas in the human brain are concentrated
(A) cerebral cortex (B) medulla
(C) ventricle (D) hippocampus

Q.26 The human brain is protected by –
(A) meninges, cerebrospinal fluid, and skull bones.
(B) meninges and skull bones only.
(C) dura mater and fourth ventricle.
(D) pia mater and skull bones.

Q.27 The principal integration center for the regulation of viscera is the
(A) cerebellum (B) cerebrum
(C) thalamus (D) hypothalamus

Q.28 Implicit memory is –
(A) short-term memory.
(B) long-term memory.
(C) factual knowledge of people, places, or objects.
(D) unconscious memory for perceptual or motor skills.

Q.29 The heart rate is slowed by –
(A) sympathetic nerves.
(B) parasympathetic nerves.
(C) corpus callosum.
(D) Sympathetic and parasympathetic nerves.

Q.30 The brain and spinal cord are wrapped in connective tissue called –
(A) gray matter (B) meninges
(C) gyri (D) sulcus

Q.31 After taking a mood-altering drug for several weeks, a patient notices it no longer works as effectively. This is an example of
(A) psychological dependence (B) withdrawal
(C) addiction (D) tolerance

Q.32 Which of the following statements are incorrect?
I. The space between cornea and lens is filled with watery fluid.
II. Rhodopsin is red protein, hence called visual red.

III. The anterior transparent portion of choroid is called cornea.
IV. When all cones are stimulated equally, a sensation of no light (dark) is produced.
(A) Only II (B) I and II
(C) All are correct (D) All except II

Q.33 Along with hypothalamus, limbic system is involved in the
I. thermoregulation.
II. regulation of sexual behaviour.
III. expression of emotional reactions (e.g, excitement, pleasure, rage and fear).
IV. motivation.
(A) All except I (B) Only I
(C) I, III and IV (D) I, III and IV

Q.34 Which of the following is not true of a sensory receptor?
(A) detects a stimulus in the environment.
(B) converts energy of the stimulus into electrical energy.
(C) produces a receptor potential.
(D) interprets sensory stimuli.

Q.35 A sensory receptor absorbs energy from some stimulus. The next step is –
(A) release of neurotransmitter
(B) transmission of an action potential
(C) energy transduction
(D) transmission of a receptor potential

Q.36 Which of the following are not correctly matched?
(A) mechanoreceptors – touch, pressure
(B) electroreceptors – voltage
(C) photoreceptors – light
(D) chemoreceptors – gravity

Q.37 Which of the following is not located in the vertebrate inner ear?
(A) vestibular apparatus (B) cochlea
(C) malleus (D) organ of Corti

Q.38 The auditory receptors are located in the –
(A) utricles (B) organs of Corti
(C) vestibular apparati (D) saccule

Q.39 Sense organs that detect changes in pH, osmotic pressure & temperature within body organs are–
(A) exteroceptors (B) proprioceptors
(C) interoceptors (D) mechanoreceptors

Q.40 In the human visual pathway, after light passes through the cornea, it
(A) stimulates ganglion cells
(B) passes through the lens
(C) sends signals through the optic nerve
(D) depolarizes horizontal cells

Q.41 Cones –
(A) are most concentrated in the ganglion area.
(B) are more numerous than rods.
(C) are responsible for vision in bright light.
(D) are found in all animals with photoreceptors.

Q.42 Rhodopsin –
(A) is concentrated in bipolar cells.
(B) binds with a G protein.
(C) changes shape when the membrane of the cone is depolarized.
(D) sends signals to the lateral geniculate nuclei

Q.43 Choose the correct statement –
I. The medulla is connected to the spinal cord.
II. Medulla contains controlling centres for respiration, cardiovascular reflexes and gastric secretion.
III. Cerebellum has very convoluted surface in order to provide the additional space for more neurons.
(A) Only I (B) I and III
(C) Only III (D) I, II and III

Q.44 In old age farsightedness is a defect of eye in man, in which –
(A) Eye ball becomes short.
(B) Eye ball becomes elongated.
(C) Lens become more concave.
(D) Lens become more spherical.

Q.45 Stereoscopic vision is found in –
(A) All mammals (B) All vertebrates
(C) Primates (D) Frog

Q.46 The pathway of reflex arc as :
(A) sense organ, spinal cord, motor neuron, sensory nerve, muscle.
(B) sense organ, sensory, neuron, motor neuron spinal cord, muscle.
(C) sense organ, motor neuron, spinal cord, sensory neuron, muscle.
(D) sense organ, motor neuron, spinal cord, sensory neuron, muscle.

Q.47 The sense of balance maintained with the help of
(A) hammer (B) sbirrup
(C) semicircular canals (D) cochlea

Q.48 Fenestra ovalis is the opening of –
(A) Cranium (B) Tympanum
(C) Tympanic cavity (D) Brain

Q.49 Function of ear ossicles in humans is
(A) to equalise the pressure on either sides of ear drum.
(B) collects the vibrations in the air which produce sound.
(C) to increase the efficiency of transmission of sound waves to the inner ear
(D) All of the above

Q.50 A small region on the retina of the eye which contains only cones is called –
(A) Area centra lis (B) Fovea centralis
(C) Blind spot (D) Ora serrata

Q.51 The middle ear and internal ear of mammals are enclosed in which of the following bones –
(A) Mastoid
(B) Ethmoid
(C) Tympanic bulla
(D) Tympanic bulla and periotic bone (temporal bone)

Q.52 Hyalocytes cells occurs in –
(A) Aqueous humor (B) Vitreous humor
(C) Both (D) None of them

Q.53 For the synthesis of rhodopsin, which of the following food is needed –
(A) Mango (B) Rice
(C) Carrot (D) Tomatoes

Q.54 No image formation occurs on blind-spot of retina because–
(A) It is not present on the optical axis of the eye.
(B) Here cones and rods are absent.
(C) On this part only cones are present.
(D) The nerve fibres of this region do not contribute in the formation of optic chiasma.

Q.55 Choose the correct statements for iris –
I. The ciliary body extends forward to form iris.
II. It is pigmented and opaque structure.
III. It is the visible coloured portion of the eye.
(A) I and II (B) I and III
(C) II and III (D) I, II and III

Q.56 The brain can be divided into
(A) Telencephalon, Rhombencephalon, Diencephalon
(B) Mesencephalon, Telencephalon, Diencephalon
(C) Prosencephalon, Mesencephalon, Rhombencephalon
(D) Diencephalon, Prosencephalon, Rhombencephalon

Q.57 Which of the following is not correct for rods?
I. Twilight vision is the function of the rods.
II. It is responsible for daylight vision sometimes.
III. The rods contain a protein called rhodopsin.
IV. Rods are photoreceptor cells.
Choose the correct option.
(A) Only I (B) Only II
(C) I and III (D) II and III

Q.58 Which of the following statements are correct about the cortex of cerebum? Choose the correct codes given below.
I. It consists of grey matter.
II. It shows prominent folds.
III. It consists of white matter.
IV. It contains motor areas, sensory areas and association areas.
(A) Only I (B) I and II
(C) I, II and IV (D) I, III and IV

EXERCISE - 3 (LEVEL-3)

Choose one correct response for each question.

Q.1 Arrange the following events in neural signaling in the correct order.
(a) integration (b) transmission
(c) response (d) reception
(A) b, d, a, c (B) b, d, c, a
(C) d, b, a, c (D) c, d, a, b

Q.2 The regulation of blood pressure is primarily under the control of –
(i) somatic nervous system
(ii) autonomic nervous system
(iii) parasympathetic division
(iv) sympathetic division
Choose the correct option –
(A) (ii), (iii) (B) (i), (iii)
(C) (ii), (iv) (D) (i), (ii)

Q.3 The regulation of feeding and digestion are primarily under the control of –
(i) somatic nervous system
(ii) autonomic nervous system
(iii) parasympathetic division
(iv) sympathetic division
Choose the correct option –
(A) (ii), (iii) (B) (i), (iii)
(C) (ii), (iv) (D) (i), (ii)

Q.4 Cerebrospinal fluid –
(i) circulates in the central canal.
(ii) circulates in the ventricles of the brain.
(iii) is within layer of the meninges.
(iv) mixes with blood.
(v) cushions brain & spinal cord from jarring movements.
Choose the correct option –
(A) (i), (ii), (iii), (v) (B) (i), (iii), (v)
(C) (i), (ii), (iii), (iv) (D) (i), (ii)

Q.5 The part of the brain that coordinates muscular activity.
(i) cerebrum (ii) cerebellum
(iii) myencephalon (iv) medulla oblongata
Choose the correct option –
(A) (ii), (iii) (B) (i), (iii)
(C) (ii), (iv) (D) (i), (ii)

Q.6 The cerebrum typically is –
(i) divided into two hemispheres
(ii) mostly gray matter
(iii) mainly cell bodies & some sensory neurons
(iv) mostly white matter
(v) mainly axons connecting various other parts of the brain. Choose the correct option –
(A) (i), (ii), (iii), (v) (B) (i), (iv), (v)
(C) (i), (ii), (iii), (iv) (D) (i), (ii)

Q.7 Sensory structures that help provide information about the position/orientation of a body.
(i) statocysts (ii) tympanum
(iii) vestibular apparatus (iv) organ of Corti
(v) neuromasts
Choose the correct option –
(A) (i), (ii), (iii), (v) (B) (i), (iii), (v)
(C) (i), (ii), (iii), (iv) (D) (i), (ii), (iii)

Q.8 Movement of limbs is detected by –
(i) muscle spindles (ii) Golgi tendon organ
(iii) joint receptors (iv) barrow receptors
(v) carotid bodies.
Choose the correct option –
(A) (i), (ii), (iii), (v) (B) (i), (iii), (v)
(C) (i), (ii), (iv) (D) (i), (ii), (iii)

Q.9 Visual images can be focused by –
(i) lateral inhibition
(ii) moving the lens back and forth relative to the retina
(iii) altering the number of ommatidia
(iv) changing the shape of the lens
Choose the correct option –
(A) (ii), (iii) (B) (i), (iii)
(C) (ii), (iv) (D) (i), (ii)

Q.10 Used by animals for the location and capture of food.
(i) echolocation (ii) electro receptors
(iii) pit organs (iv) cochlea
(v) Pacinian corpuscle
Choose the correct option –
(A) (i), (ii), (iii), (v) (B) (i), (iii), (v)
(C) (i), (iii), (iv) (D) (i), (ii), (iii)

Q.11 Which of the following occurs first when voltage reaches the threshold level?
(A) gates of certain voltage-activated ion channels open.
(B) K^+ channels close.
(C) the membrane hyperpolarizes.
(D) neurotransmitter is released.

Q.12 Saltatory conduction
(A) requires more energy than continuous conduction.
(B) occurs in unmyelinated neurons.
(C) occurs when the action potential jumps from one node of Ranvier to the next.
(D) slows transmission of an impulse.

Q.13 Which of the following is/are associated with informing the brain about turning movements?
(A) semicircular canals (B) saccule
(C) lymph (D) otoliths

Q.14 In the process of hearing, the basilar membrane vibrates. Which event occurs next?
(A) tympanic membrane vibrates.
(B) bones in middle ear amplify and conduct vibrations.
(C) cochlear nerve transmits impulses to organ of Corti.
(D) hair cells in organ of Corti are stimulated.

Q.15 In olfaction –
(A) pheromones stimulate the taste buds.
(B) the number of odorous molecules determines the magnitude of the receptor potential.
(C) chemical signals are converted directly into electrical signals.
(D) a G protein is activated and leads to the closing of gated channels.

Note (Q.16-Q.21) :
(A) Statement- 1 is True, Statement-2 is True, Statement-2 is a correct explanation for Statement-1.
(B) Statement -1 is True, Statement -2 is True ; Statement-2 is NOT a correct explanation for Statement-1.
(C) Statement - 1 is True, Statement- 2 is False.
(D) Statement -1 is False, Statement -2 is False.

Q.16 **Statement 1 :** The chemical stored in the synaptic vesicles are termed as neurotransmitters.
Statement 2 : Synaptic vesicles release these chemicals in the synaptic cleft.

Q.17 **Statement 1 :** Nerve conduction is the one way conduction.
Statement 2 : Nerve impulse is transmitted from dendrite terminals to axon terminals.

Q.18 **Statement 1 :** Cerebrospinal fluid is present throughout the central nervous system.
Statement 2 : CSF has no such function.

Q.19 **Statement 1 :** The presynaptic neuron transmits an impulse (action potential) across the synaptic cleft to the postsynaptic neuron.
Statement 2 : For the transmission of impulses at synapses, chemicals called neurotransmitters are responsible.

Q.20 **Statement 1 :** The cerebral cortex is referred to the grey matter of the brain.
Statement 2 : It is due to the high concentration neuron cell bodies in it.

Q.21 **Statement 1 :** Humans can sense changes in the environment.
Statement 2 : Sensory organs detect all types of changes in environment.

Q.22 Which of the following statements are correct about the midbrain?
I. Located between the thalamus/ hypothalamus.
II. Has a canal named cerebral queduct passes through.
III. Dorsal part consists of 4 lobes.
Choose the correct option.
(A) I and II (B) II and III
(C) I and III (D) I, II and III

Q.23 Hypothalamus controls –

I. urge for eating and drinking.
II. thermoregulation.
III. hormones production that regulates the secretion of pituitary gland.
IV. creative thinking and consciousness.

(A) I and III are correct
(B) II and III are correct
(C) I and II are correct
(D) I, II and III are correct

Q.24 Following are the steps of mechanism of vision in random order.

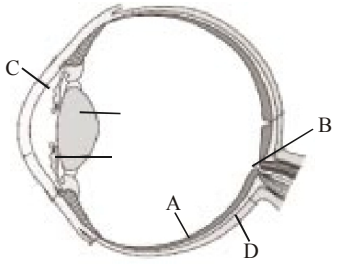
I. Neural impulses are analysed and image formed on retina is recognised by visual cortex.
II. Membrane permeability changes.
III. Ganglion cells are excited.
IV. Bipolar cells are depolarised.
V. Action potential (impulse) is transmitted by optic nerves to visual cortex.
VI. Potential differences are generated in the photoreceptor cells.
VII. Light energy causes a change in shape of rhodopsin, leading to the dissociation of retinal (an aldehyde of vitamin-A) from opsin (a protein).
VIII. Structure of opsin is changed.

Choose the correct sequence.
(A) I, II, III, IV, V, VI, VII, VIII
(B) VIII, VII, VI, V, IV, III, II, I
(C) I, IV, III, II, VII, VIII, VI, V
(D) VII, VIII, II, VI, IV, III, V, I

EXERCISE - 4 (PREVIOUS YEARS AIPMT/NEET EXAM QUESTIONS)

Choose one correct response for each question.

Q.1 Parts A, B, C and D of the human eye are shown in the diagram. Select the option which gives correct identification along with its functions/ characteristics – **[NEET 2013]**

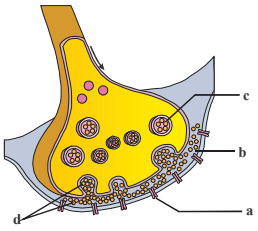


(A) D- Choroid - its anterior part forms ciliary body.
(B) A - Retina - contains photo receptors–rods and cones.
(C) B - Blind spot - has only a few rods and cones.
(D) C - Aqueous chamber reflects the light which does not pass through the lens.

Q.2 The most abundant intracellular cation is : **[NEET 2013]**

(A) K^+ (B) Na^+
(C) Ca^{++} (D) H^+

Q.3 A diagram showing axon terminal and synapse is given. Identify correctly at least two of a-d.



[NEET 2013]

(A) c-Neurotransmitter ; d-Ca^{++}
(B) a-Receptor ; c-Synaptic vescles
(C) b-Synaptic connection; d-K^+
(D) a-Neurotransmitter; b-Synaptic cleft

Q.4 Injury localized to the hypothalamus would most likely disrupt – **[AIPMT 2014]**

(A) Short term memory.
(B) Co-ordination during locomotion.
(C) Executive function, such as decision making
(D) Regulation of body temperature.

Q.5 Which one of the following statements is not correct? **[AIPMT 2014]**

(A) Retinal is the light absorbing portion of visual photo pigments.
(B) In retina the rods have the photopigment rhodopsin while cones have three different photopigments.
(C) Retinal is a derivative of vitamin C.
(D) Rhodopsin is the purplish red protein present in rods only.

Q.6 A gymnast is able to balance his body upside down even in the total darkness because of : **[AIPMT 2015]**

(A) Vastibular apparatus (B) Tectorial membrane
(C) Organ of corti (D) Cochlea

Q.7 Which of the following regions of the brain is incorrectly paired with its function? **[AIPMT 2015]**

(A) Cerebellum-language comprehension.
(B) Corpus callosum - communication between the left and right cerebral cortices.
(C) Cerebrum - calculation and contemplation.
(D) Medulla oblongata - homeostatic control.

Q.8 Destruction of the anterior horn cell of the spinal cord would result in loss of : **[RE-AIPMT 2015]**

(A) voluntary motor impulses.
(B) commissural impulses.
(C) integrating impulses.
(D) sensory impulses.

Q.9 In mammalian eye, the 'fovea' is the center of the visual field, where: **[RE-AIPMT 2015]**

(A) the optic nerve leaves the eye.
(B) only rods are present.
(C) more rods than cones are found.
(D) high density of cones occur, but has no rods.

Q.10 Photosensitive compound in human eye is made up of – **[NEET 2016 PHASE 1]**
(A) Guanosine and Retinol
(B) Opsin and Retinal
(C) Opsin and Retinol
(D) Transducin & Retinene

Q.11 Choose the correct statements. **[NEET 2016 PHASE 2]**
(A) Nociceptors respond to changes in pressure.
(B) Meissner's corpuscles are thermoreceptors.
(C) Photoreceptors in the human eye are depolarised during darkness and become hyperpolarized in response to the light stimulus.
(D) Receptors do not produce graded potentials.

Q.12 Myelin sheath is produced by **[NEET 2017]**
(A) Schwann Cells and Oligodendrocytes
(B) Astrocytes and Schwann Cells
(C) Oligodendrocytes and Osteoclasts
(D) Osteoclasts and Astrocytes

Q.13 Receptor sites for neurotransmitters are present on **[NEET 2017]**
(A) Membranes of synaptic vesicles
(B) Pre-synaptic membrane
(C) Tips of axons
(D) Post-synaptic membrane

Q.14 Good vision depends on adequate intake of carotene rich food. Select the best option from the following statements **[NEET 2017]**
(a) Vitamin A derivatives are formed from carotene
(b) The photopigments are embedded in the membrane discs of the inner segment.
(c) Retinal is a derivative of vitamin A.
(d) Retinal is a light absorbing part of all the visual photopigments.
(A) (a) & (b) (B) (a), (c) & (d)
(C) (a) & (c) (D) (b), (c) & (d)

Q.15 Transparent lens in the human eye is held in its place by **[NEET 2018]**
(A) smooth muscles attached to the iris
(B) ligaments attached to the iris
(C) ligaments attached to the ciliary body
(D) smooth muscles attached to the ciliary body

Q.16 Which of the following structures or regions is incorrectly paired with its functions? **[NEET 2018]**
(A) Hypothalamus : production of releasing hormones & regulation of temperature, hunger & thirst.
(B) Limbic system : consists of fibre tracts that interconnect different regions of brain; controls movement.
(C) Medulla oblongata : controls respiration and cardiovascular reflexes.
(D) Corpus callosum : band of fibers connecting left and right cerebral hemispheres.

Q.17 Nissl bodies are mainly composed of **[NEET 2018]**
(A) Nucleic acids and SER
(B) DNA and RNA
(C) Proteins and lipids
(D) Free ribosomes and RER

Q.18 Which part of the brain is responsible for thermoregulation? **[NEET 2019]**
(A) Cerebrum (B) Hypothalamus
(C) Corpus callosum (D) Medulla oblongata

Q.19 Which of the following statements is correct? **[NEET 2019]**
(A) Cornea is an external, transparent and protective proteinacious covering of the eye-ball.
(B) Cornea consists of dense connective tissue of elastin and can repair itself.
(C) Cornea is convex, transparent layer which is highly vascularised.
(D) Cornea consists of dense matrix of collagen and is the most sensitive portion the eye.

ANSWER KEY

EXERCISE-1 (SECTION-1&2)

(1) (C) **(2)** (C)
(3) (A) **(4)** (B)
(5) Homeostasis
(6) White
(7) Afferent fibres; efferent fibres
(8) Nissl's granules **(9)** Neural system
(10) Nodes of Ranvier
(11) Away from; towards **(12)** Rods; cones
(13) Blood vessels, bluish
(14) Organ of corti, basiliar membrane, hair cells
(15) Somatic; autonomic **(16)** Spinal; cranial
(17) Malleus, stapes
(18) Electrical, chemical
(19) Unmyelinated
(20) Command; control **(21)** Brain
(22) Autonomous; somatic
(23) Duramater, arachnoid, piamater
(24) Mddle ear; pharynx **(25)**Potassium; sodium
(26) Afferent neuron, efferent neuron, CNS, effector
(27) Long; distal **(28)** Myelinated

EXERCISE - 1 [SECTION-3 & 4]

Q	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53
A	B	A	A	A	B	B	A	C	A	D	C	D	A	A	A	C	C	B	B	D	C	B	D	A	C
Q	54	55	56	57	58	59	60	61	62	63	64	65	66	67	68	69	70	71	72	73	74	75	76	77	78
A	B	A	C	C	A	A	D	C	B	D	A	C	C	D	D	C	D	A	A	B	C	D	B	B	B
Q	79	80	81	82	83	84	85	86	87	88	89	90	91	92	93	94	95	96	97	98	99	100	101	102	103
A	A	D	B	C	B	C	D	A	D	D	B	D	C	B	D	A	A	B	C	B	B	C	A	B	B
Q	104	105	106	107	108	109	110	111	112	113	114	115	116	117	118	119	120	121	122	123	124	125	126	127	128
A	A	C	D	B	D	C	A	C	D	D	D	A	A	A	D	C	B	B	D	B	A	D	C	C	D
Q	129	130	131	132	133	134	135	136	137	138	139	140	141	142											
A	B	C	D	C	D	A	C	A	C	B	C	B	A	D											

EXERCISE - 2

Q	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
A	D	B	B	C	C	B	A	D	A	B	C	D	B	D	D	D	B	C	A	B	B	C	B	D	A
Q	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50
A	A	D	D	B	B	D	A	A	D	C	D	C	B	C	B	C	B	D	A	C	C	C	C	C	B
Q	51	52	53	54	55	56	57	58																	
A	D	B	C	B	D	C	B	C																	

EXERCISE - 3

Q	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
A	A	C	A	A	D	B	B	D	C	D	A	C	A	D	B	B	C	C	B	A	A	C	D	D

EXERCISE - 4

Q	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
A	B	A	B	D	C	A	A	A	D	B	C	A	D	B	C	B	D	B	D

SOLUTIONS

EXERCISE-1

(1) (C) **(2)** (C)
(3) (A) **(4)** (B)
(5) Homeostasis
(6) White
(7) Afferent fibres; efferent fibres
(8) Nissl's granules
(9) Neural system
(10) Nodes of Ranvier
(11) Away from; towards
(12) Rods; cones
(13) Blood vessels, bluish
(14) Organ of corti, basiliar membrane, hair cells
(15) Somatic; autonomic
(16) Spinal; cranial
(17) Malleus, stapes
(18) Electrical, chemical
(19) Unmyelinated
(20) Command; control
(21) Brain
(22) Autonomous; somatic
(23) Duramater, arachnoid, piamater
(24) Mddle ear; pharynx
(25) Potassium; sodium
(26) Afferent neuron, efferent neuron, CNS, effector
(27) Long; distal
(28) Myelinated
(29) (B) **(30)** (A)
(31) (A) **(32)** (A)
(33) (B) **(34)** (B)
(35) **(A).** Level of organisation in case of cnidarian is tissue level. So, the neural organisation must be made up to this level. In Hydra, neural organisation is made up of network of neurons.
(36) **(C).** Coordination is the process through, which two or more organs interact and complement the function of one another. The neural system provides an organised network of point to point connections for a quick coordination. But this system is short lived. As the nerve fibres do not innervate all cells of the body and the cellular functions need to be continuously regulated, a special kind of coordination and integration has to be provided. This function is carried out by hormones released by glands of endocrine system.
(37) **(A).** Neural system is an organ system. So, it must follow the flow of development of organ system in an organism. In case of lower organism, each kind of organisation is simple. So, neural organisation must be simple.
(38) **(D).** Neural system is made up from neurons and is responsible for transmission of the nerve impulse, from pre-synaptic nerve to post-synaptic nerve and physiology of reflex action.
(39) **(C).**
(40) **(D).** The plasma membrane of neuron is polarised due to difference in the concentration of positive ions across it. This difference is actively maintained by pump. When any deflection in this condition happens, it can be easily detected by plasma membrane it and further transmitted to other neurons.
(41) **(A).**
(42) **(A).**
(43) **(A).** The afferent nerve fibres transmit impulses from tissues/organs to the CNS and it is the efferent nerve fibres that transmits regulatory impulses from the CNS to the concerned peripheral tissue/organs.
(44) **(C).**
(45) **(C).** The human neural system comprises of PNS and CNS both. PNS consists of all the nerves (cranial nerves and spinal nerves) associated with CNS. CNS is the site of information processing and control.
(46) **(B).**
(47) **(B).** The PNS includes somatic nervous system and autonomic nervous system.

Somatic Nervous System	Autonomic Nervous System
• Relays voluntary impulses from the CNS to skeletal muscles.	• Relays impulses from the CNS to the involuntary organs and smooth muscles of the body.
• The nerve fibres forming the nerves of the PNS are (a) Efferent nerve fibres and (b) efferent nerve fibres	• The nerve fibres forming the nerves of the PNS are efferent nerve fibres. It is divided into sympathetic nervous system and parasympathetic nervous system.

(48) **(D).** The PNS comprises of all the nerves (cranial nerves and spinal nerves) of the body associated with the CNS (brain and spinal cord).

(49) **(C).**

(50) **(B).** Sympathetic and parasympathetic neural systems are the part of autonomic neural system. This system controls and coordinates the functions of visceral organs.

(51) **(D).** Autonomic nervous system, a type of peripheral nervous system transmits impulses from the CNS to the involuntary organs and smooth muscles of the body.

(52) **(A).** Brain and spinal cord combinely form the CNS. CNS lies along the main axis of the body, it consists of the upper large brain or encephalon situated in the head and the lower long, narrow spinal cord located in the neck and trunk. CNS is the site of information process and control.

(53) **(C).**

(54) **(B).**

(55) **(A).** Unipolar neurons are neurons which have a cell body with axon only they can be seen in the embryonic stage.

(56) **(C).** The concentration gradients across the resting membrane are maintained by the active transport of ions by the sodium-potassium pump which transports 3 Na^+ outward for 2 K^+ into the cell.

(57) **(C).** Synaptic knob possess synaptic vesicels containing chemicals called neurotransmitters.

(58) **(A).** One nerve fibre is attached to another nerve fibre via a junction called synapse. It is not a tight junction. A synapse is formed by the membrane of a presynaptic neuron and postsynaptic neuron, which mayor may not is separated by a gap called synaptic cleft. i.e., axon of one neuron end on the dendrite of next neuron.

(59) **(A).**

(60) **(D).**

(61) **(C).**

(62) **(B).** Multipolar neurons are the neurons with one axon and two or more dendrites. These are found in the cerebral cortex.

(63) **(D).**

(64) **(A).** The axons transmit nerve impulses away from the cell body to a dendrite or to a neuromuscular junction.

(65) **(C).** On the basis of nature of nerve fibres, the nerves are of three types.

(i) **Sensory (Afferent) Nerves :** These contains only sensory nerve fibres.

(ii) **Motor (Efferent) Nerves :** These contains only motor nerve fibres.

(iii) **Mixed nerves :** These contains both sensory and motor nerve fibres.

(66) **(C).** The kind of action potential to be developed on the membrane of postsynaptic neuron depends upon the action of neurotransmitter.

(67) **(D).** Dendrites are short fibres, which branch repeatedly and projects out of the cell body and also contain Nissl's granules.

(68) **(D).**

(69) **(C).**

(70) **(D).** Bipolar neurons are the neurons with one axon and one dendrite. They are found in the retina of eye.

(71) **(A).**

(72) **(A).** Synaptic knob is bulb like structure present at the end of axon terminal.

(73) **(B).** A wave of action potential is termed as a nerve impulse.
When a nerve fibre receives stimulus inside the cell, plasma membrane become positively charged with respect to outside. The change in polarity across the plasma membrane is known as an action potential. The membrane with this reversed polarity across it is said to be depolarised. The reversed polarity then passes a wave along the nerve fibre. This wave of reversed polarity or dipolarisation (action potential) moving down an axon is called a nerve impulse.

(74) **(C).**

(75) **(D).** The cell body contains cytoplasm with typical cell organelles and certain granular bodies called Nissl's granules.

(76) **(B).**

(77) **(B).** A typical synapse consists of a bulbous expansion of a nerve terminal called a pre-synaptic knob lying close to the membrane of a dendrite. The cytoplasm of the synaptic knob contains mitochondria, smooth endoplasmic reticulum, microfilaments and numerous synaptic vesicles. Each vesicle contains neurotransmitter (chemical substance) responsible for the transmission of the nerve impulse across the synapse.

(78) **(B).** The process of expelling out sodium ions and drawing in potassium ions against concentration and electrochemical gradients is termed as sodium potassium pump. It occurs normally to maintain the normal difference in the ionic concentrations and electric potential between the outside and inside of the plasma membrane, the steady state of a resting nerve fibre.

(79) **(A).**

(80) **(D).** Based on the number of axon and dendrites, the neurons are multipolar (with one axon and two or more dendrites; found in the cerebral cortex), bipolar (with one axon and one dendrite; found in the retina of eye) and unipolar (cell body with one axon; found usually in the embryonic stage).

(81) **(B).** The human brain is well protected by the skull. Inside the skull, the brain is covered by cranial meninges, consisting of an outer layer called duramater, a very thin middle layer called arachnoid and an inner layer called piamater.

(82) **(C).** The cerebral cortex contains motor areas, sensory areas and large regions that are neither clearly sensory motor in function. These regions are called as the association areas. These are responsible for complex functions like intersensory associations, memory and communication.

(83) **(B).**

(84) **(C).** The midbrain is located between the thalamus/hypothalamus of the forebrain and pons of the hindbrain. The hindbrain comprises pons, cerebellum and medulla. Midbrain and hindbrain forms the brain stem.

(85) **(D).**

(86) **(A).**

(87) **(D).** Functions of association areas in cerebral cortex includes intersensory associations, memory and communication.

(88) **(D).** Brain acts as the command and control system and it controls the voluntary movements, balance of the body, functioning of vital involuntary organs (lungs, heart, kidneys, etc.), thermoregulation, hunger and thrist, circadian (24-hours) rhythms of our body, activities of several endocrine glands and human behaviour.
It is the site for processing of vision, hearing, speech, memory, intelligence, emotions and thoughts.

(89) **(B).** The cerebrum wraps around a structure called thalamus, which is a major coordinating centre for sensory and motor signalling.

(90) **(D).** The medulla is also called as the medulla oblongata. The medulla contains centres which control respiration, cardiovascular reflexes and gastric secretions.

(91) **(C).** Certain components of the cerebrum and diencephalon constitute the limbic system. It is sometimes called the "emotional brain" because it controls emotional behaviour expressed in the form of joy, sorrow, fear, fight, friendship, liking and disliking.

(92) **(B).**

(93) **(D).** The forebrain consist of cerebrum, thalamus and hypothalamus. Cerebrum forms the major part of the brain. It is divided longitudinally into two halves, which are termed as right and left cerebral hemisphere. The cerebrum wraps around a structure which is called thalamus and is a major centre for coordinating sensory and motor signalling. Hypothalamus is a very important part of the brain which lies at the base of the thalamus. It contains a number of centres which controls body temperatures, urge for eating and drinking. It also secretes hormones called hypothalamic hormones.

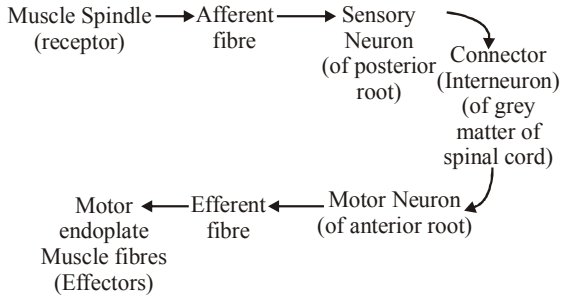
(94) **(A).** Cerebrum forms the major part of the human brain. A deep cleft divides the cerebrum longitudinally into two halves, termed as the left and right cerebrum hemispheres. The layer of cells, which covers the cerebral hemisphere is called cerebral cortex. Cerebral cortex is referred to as the grey matter. While the inner part is made up of white matter.

(95) **(A).** The human brain is well protected by the skull. The brain is situated in the cranial cavity of the skull. The cranial bones protects it from mechanical injury.

(96) **(B).** Association areas are neither sensory nor motor in function and are found in the cerebral cortex.

(97) **(C).** **(98)** **(B).**

(99) **(B).**



(100) **(C).** The reflex pathway comprises at least one afferent neuron , receptor and one efferent (effector or excitor) neuron appropriately arranged in a series.

(101) **(A).** Human eye ball is enveloped by three layers, i.e., sclerotic layer, choroid layer and retinal layer. Outermost sclerotic layer is white portion of eye which mergas with transparent round window called cornea in center. Middle choroid layer lie close to retina and contain light absorbing pigments. In front it form ciliary body, which is hidden by iris. Retinal, the innermost thin transparent appear purplish due to the presence of eye pigment-rhodopsin.

(102) (B) **(103)** (B) **(104)** (A)

(105) (C) **(106)** (D) **(107)** (B)

(108) **(D).** The pinna collects the vibrations in the air, which produce sound. The external auditory meatus leads inwards and extends upto the tympanic membrane (the ear drum). There are very fine hairs and wax secreting sebaceous glands in the skin of pinna and meatus. The tympanic membrane is composed of connective tissues covered with skin outside and with mucus membrane inside.

(109) **(C).**

(110) **(A).** Rhodopsin is a pigment present in the rod cells of the retina. It consists of two components-opsin and retinal (= retenene). Retinal is an aldehyde of vitamin A. absorbs light falling on the rod and changes its form and separates from the opsin component. This initiates the transmission of a nerve impulse to the brain. Rhodopsin allows vision in dim light (night vision).

(111) **(C).** The inner layer of human eye is called retina.

(112) **(D).** Cochlea is the main hearing organ in the internal ear. Internally, it consists of three fluid filled chambers the upper scala vestibuli, lower scala tympani and middle scala media. Scala media bears an upper membrane the Reissner's membrane, and a lower membrane, the basilar membrane. On the basilar membrane, the organ, of Corti is present.

(113) (D). A small oval, yellowish area of the retina lying exactly opposite to the centre of the cornea is named the macula lutea or yellow spot which at its middle has a shallow depression, the fovea-central is. The fovea central is has cone cells only. It is devoid of rods and blood cells.

(114) (D).

(115) (A).

(116) (A). Internal ear is a delicate, irregular organ called membranous labyrinth. Membranous labyrinth consists of 3 parts: vestibule, semicircular canals and cochlear duct. Cochlea is the main hearing organ.

(117) (A). Our paired eyes are located in sockets of skull called orbits. The adult human eyeball is nearly spherical in structure. The wall of the eyeball is composed of three layers. The anterior portion of this layer is called cornea. The middle layer choroid contains many blood vessels and looks bluish in colour. The inner layer is retina and it contains three layers of cells, i.e., from inside to outside called ganglion cells, bipolar cells and photoreceptor cells.

(118) (D). Anatomically, the ear can be divided into three major sections called the outer ear, the middle ear and the inner ear. The outer ear consists of pinna and external auditory meatus (canal).

(119) (C).

(120) (B). The tympanic membrane is a thin, oval, tightly stretched membrane closing the external auditory canal internally. It separates the tympanic cavity from the external auditory meatus.

(121) (B). Choroid infront from ciliary body, which is thick round and referred. It is hidden by iris (coloured membrane).

(122) (D).

(123) (B).

(124) (A).

(125) (D).

(126) (C). The ears perform two sensory functions, hearing and maintenance of body balance.

(127) (C).

(128) (D). The external layer of eyeball is composed of dense connective tissue. This dense connective tissue layer is called sclera, which is protective in nature.

(129) (B).

(130) (C).

(131) (D). Ear canal is lined by hairy skin and ceruminous glands (wax glands). These glands secrete a waxy substance cerumen (ear wax) which prevents the foreign bodies entering the ear.

(132) (C).

(133) (D). The middle ear contains three ossicles called malleus, incus and stapes, which are attached to one another in a chain-like fashion. The malleus is attached to the tympanic membrane and the stapes is attached to the oval window of the cochlea. The ear ossicles increase the efficiency of transmission of sound waves to the inner ear. An Eustachian tube connects the middle ear cavity with the pharynx. The Eustachian tube helps in equalising the pressures on either sides of the eardrum.

(134) (A) **(135)** (C)

(136) (A) **(137)** (C)

(138) (B)

(139) (C). The optic nerves leave the eye and the retinal blood vessels enter it at a point medial to and slightly above the posterior pole of the eyeball. Photoreceptor cells are not present in that region and hence it is called the blind spot. At the posterior pole of the eye, lateral to the blind spot there is a yellowish pigmented spot called macula lutea with a central pit called the fovea. The fovea is a thinned-out portion of the retina where only the cones are densely packed. It is the point where the visual acuity (resolution) is the greatest.

(140) (B). In the middle ear, the organ of Corti is a structure located on the basilar membrane which contains the hair hair cell that acts as the auditory receptors. The hair cells are present in rows on the internal side of the organ of Corti. The basal end of the hair cell is in close contact with the afferent nerve

fibres. A large number of processes called stereo cilia are projected from the apical part of each hair cell. Above the rows of the hair cells is a thin elastic membrane called tectorial membrane.

(141) **(A).** Vitreous chamber is the space between the lens and the retina. The vitreous humour is the transparent, colourless, gelatinous mass that fills.

(142) **(D).** The inner ear contains a complex system called vestibular apparatus located above the cochlea. The vestibular apparatus is composed of three semi-circular canals and the otolith organ consisting of the saccule and utricle. Each semicircular canal lies in a different plane at the right angles to each other.

The membranous canal suspended in perilymph of the bony canals. The base of the canals is swallon and is called ampulla, which contains a projecting ridge called crista ampullaris, which contains hair cells. The saccule and utricle contains a projecting ridge called macula. The crista and macula are the specific receptors of the vestibular apparatus which are responsible for maintenance of balance of the body and posture.

EXERCISE-2

(1) **(D).** (D) is correct because the hypothalamus is responsible for coordination various growth, development,reproductive, osmoregulatory and other processes; neurons in the hypothalamus release hormones that affect these processes; (A) is not correct because this region is involved in sensory integration and motor control; (B) is not correct because this region is involved in high functions such as emotions, memory, ete.; (C) is not correct because this region is the region that receives sensory information.

(2) (B) **(3)** (B) **(4)** (C) **(5)** (C)

(6) (B)

(7) **(A).** The stapes stirrup is a bone in the middle ear of humans and other mammals which is involved in the conduction of sound vibrations to the inner ear. The stirrup-shaped small bone is on and transmits these to the oval window. The stapes is the smallest and lightest named bone in the human body, and is so-called because of its resemblance to a stirrup.

(8) **(D).** Opsins are a group of light-sensitive proteins found in photoreceptor cells of the retina.

(9) **(A).** Rod cells, or rods, are photoreceptor cells in the retina of the eye that can function in less intense light than the other type of visual photoreceptor, cone cells.

(10) (B) **(11)** (C)

(12) **(D).** Microglia are a type of glial cell located throughout the brain and spinal cord. Microglia account for 10–15% of all cells found within the brain. As the resident macrophage cells, they act as the first and main form of active immune defense in the central nervous system (CNS).

(13) (B) **(14)** (D)

(15) **(D).** The insulating covering that surrounds an axon with multiple spiral layers of myelin, that is discontinuous at the nodes of Ranvier, and that increases the speed at which a nerve impulse can travel along an axon–called also medullary sheath.

The myelin sheath is made of a material called myelin, which is produced by special cells known as Schwann cells.

(16) (D)

(17) **(B).** Postsynaptic neuron : a neuron to the cell body or dendrite of which an electrical impulse is transmitted across a synaptic cleft by the release of a chemical neurotransmitter from the axon terminal of a presynaptic neuron.

(18) (C) **(19)** (A) **(20)** (B) **(21)** (B)

(22) **(C).** The cerebellum receives information from the sensory systems, the spinal cord, and other parts of the brain and then regulates motor movements. The cerebellum coordinates voluntary movements such as posture, balance, coordination, and speech, resulting in smooth and balanced muscular activity.

(23) **(B).** The hypothalamus is a portion of the brain that contains a number of small nuclei with a variety of functions. One of the most important functions of the hypothalamus is to link the nervous system to the endocrine system via the pituitary gland (hypophysis).

(24) (D) **(25)** (A)

(26) **(A).** Brain is protected by the bones of skull. Brain is also swaddled in several layers of membranes called meninges. The fluid between these layers produces a water cushion that protects your brain if you knock or bump your head.

(27) **(D).** The visceral motor system is regulated in part by circuitry in the cerebral cortex.The major center in the control of the visceral motor system is the hypothalamus.

(28) **(D).** Implicit memory is a type of memory in which previous experiences aid the performance of a task without conscious awareness of these previous experiences.

(29) **(B).** Heart rate is controlled by the two branches of the autonomic (involuntary) nervous system. The sympathetic nervous system (SNS) and the parasympathetic nervous system (PNS). The sympathetic nervous system (SNS) releases the hormones (catecholamines - epinephrine and norepinephrine) to accelerate the heart rate. The parasympathetic nervous system (PNS) releases the hormone acetylcholine to slow the heart rate

(30) (B) **(31)** (D)

(32) **(A).** Rhodopsin, also known as visual purple, is a biological pigment in photoreceptor cells of the retina that is responsible for the first event in the perception of light.

(33) (A) **(34)** (D)

(35) (C) **(36)** (D)

(37) **(C).** The malleus or hammer is a hammer-shaped small bone or ossicle of the middle ear which connects with the incus and is attached to the inner surface of the eardrum.

(38) **(B).** Organ of Corti : A structure in the cochlea of the inner ear which produces nerve impulses in response to sound vibrations.

(39) (C) **(40)** (B) **(41)** (C)

(42) **(B).** Rhodopsin is a biological pigment found in the rods of the retina and is a G-protein-coupled receptor (GPCR). Rhodopsin is extremely sensitive to light, and thus enables vision in low-light conditions. When rhodopsin is exposed to light, it immediately photobleaches.

(43) **(D).** The hindbrain comprises pons, cerebellum and medulla also called the medulla oblongata. Pons consists of fibre tracts that interconnect different regions of the brain. Cerebellum has very convoluted surface in order to provide the additional space for many more neurons. The medulla of the brain is connected to the spinal cord. The medulla contains centres which control respiration, cardiovascular reflexes and gastric secretions.

(44) (A) **(45)** (C) **(46)** (C)

(47) **(C).** The semicircular canals or semicircular ducts are three semicircular, interconnected tubes located inside each ear.
The three canals are:

1. The horizontal semicircular canal (also known as the lateral semicircular canal),
2. Superior semicircular canal (also known as the anterior semicircular canal),
3. The posterior semicircular canal (also known as the inferior semicircular canal).

(48) **(C). Fenestra ovalis :** A small natural hole or opening, especially in a bone. The mammalian middle ear is linked by the fenestra ovalis to the vestibule of the inner ear, and by the fenestra rotunda to the cochlea.
The tympanic cavity is a small cavity surrounding the bones of the middle ear.

(49) **(C).** To increases the efficiency of transmission of sound waves to the inner ear.

(50) **(B). Fovea centralis :** A small depression in the retina of the eye where visual acuity is highest. The centre of the field of vision is focused in this region, where retinal cones are particularly concentrated.

(51) (D)

(52) **(B).** Hyalocytes, also known as vitreous cells, are cells of the vitreous body, which is the

clear gel that fills the space between the lens and the retina of the eye.

(53) (C) **(54)** (B) **(55)** (D)

(56) **(C).** The brain can be divided into three major parts (i) Forebrain (ii) Midbrain (iii) Hindbrain, i.e., prosencephalon, mesencephalon and rhombencephalon.

(57) **(B).**

(58) **(C).** Inner part of cerebral hemisphere is called the white matter, due to the fibres of the tracts covered with the myelin sheath.

EXERCISE-3

(1) **(A).**

(2) **(C).** (ii) is correct because the autonomic nervous system has primary responsibility for the viscera and blood vascular system; (iv) is correct because most arteriole are innervated only with branches of the sympathetic division.

(3) **(A).** (ii) is correct because the autonomic nervous system has primary responsibility for the viscera and blood vascular system; (iv) is correct because the parasympathetic division is responsible for coordinated most processes associated with feeding and digestion (e.g., saliva release, gut peristalysis, etc.)

(4) (A) **(5)** (D) **(6)** (B)

(7) **(B).** (i) is correct because these are used by invertebrates to detect position; (iii) is correct because this structure is used for maintaining equilibrium in vertebrates; (v) is correct because some fish have these structures to provide information about orientation; (ii) & (iv) are not correct because these structures detect vibration (sound)]

(8) (D)

(9) **(C).** Invertebrates use (ii) to focus images, whereas vertebrates use (iv); (i) is not correct because this process sharpens images by enhancing contrast; (iii) is not correct because this structure is the visual unit of a compound eye.

(10) (D) **(11)** (A) **(12)** (C)

(13) (A) **(14)** (D) **(15)** (B)

(16) **(B).** The axon terminal of the neuron contains many membrane bound vesicles called synaptic vesicles, in its cytoplasm. Within these vesicles, chemical substances such as adrenaline and acetylcholine remain stored. These chemicals are called neurotransmitters, because they help to transmit nerve impulses across the synapses. When a nerve impulse passes the axon terminal, its synaptic vesicles release their stored chemicals to the synaptic cleft. These diffuse through the cleft to reach the membrane of the next neuron, stimulating the latter. This causes the nerve impulse to be transmitted along the next neuron.

(17) **(C).** Nerve impulses are always transmitted across a synapse from the axon terminals of one neuron to the dendrite/cell body of the next neuron but never in the reverse direction. Since the neurotransmitter is present only in the axon terminals and not in the dendrite or cell body, it can not be released from the dendrite or cell body even if the impulse reaches there. So, the impulse can not be transmitted from the dendrite or cell body of the neuron to the axon of the preceding neuron across the synapse, diverge the parallel rays before their entry into the eye; this brings the rays to a sharp focus on the retina.

(18) **(C).** An extracellular fluid, called cerebrospinal fluid is present throughout the central nervous system. It affords some protection to central nervous system from injury and shock.

(19) **(B).**

(20) **(A).** The layer of cells which covers the cerebral hemispheres is called cerebral cortex and is thrown into prominent folds. It is referred to as the grey matter. It is called grey matter due to its greyish appearance. Neuron cell bodies are concentrated here to give it the greyish appearance.

(21) **(A).** The sensory organs detect all types of changes in the environment and send appropriate signals to the CNS, where all the inputs are processed and analysed. Signals are then sent to different parts of the brain.

(22) **(C).** Midbrain is located between the thalamus/ hypothalamus of the forebrain and pons of the hindbrain. A canal, called the cerebral aqueduct passess through the midbrain. The dorsal portion of the midbrain consists of four round swellings (lobes) called corpora quadrigemina.

(23) **(D).** The hypothalamus contains a number of centres which control body temperature, urge for eating and drinking. It also contains several groups of neurosecretory cells, which secretes hormones called hypothalamic hormones.

(24) **(D).** **Steps of Vision :** Light energy causes change in the shape of rhodopsin, leading to dissociation of retinal from opsin.
Structure of opsin changes. Membrane permeability changes. Potential differences are generated in photoreceptor cells. Bipolar cells are depolarised. Ganglion cells are excited. Action potential (Impulse) are transmitted by optic nerves to visual cortex. Neural impulses are analysed and image formed on ratina is recognised by visual cortex.

EXERCISE-4

(1) **(B).** A- Retina - contains photo receptors cells - rods and cones.

(2) **(A).** The most abundant intracellular cation is K^+.

(3) **(B).** a-Receptor
c- Synaptic vesicles

(4) **(D).** Hypothalamus regulates body temperature.

(5) **(C).** Retinal pigment is an aldehyde of vitamin A.

(6) **(A).** Vastibular appratus are related with balance of body while rest the options are related with hearing process.

(7) **(A).** Cerebellum is resposible for co-ordination of body movements.

(8) **(A).** The anterior horns of spinal cord contains cells with fibres that form the anterior (motor) root end and are essential for the voluntary and reflex activity of muscles they innervate. If the anterior horn motor cells are destroyed, the nerves cannot regenerate and muscles are never useful again.

(9) **(D).** Fovea is present at centre of macula lutea, which is centre of highest resolution has only cones.

(10) **(B).** Photosensitive pigment rhodopsin in human eye is made up of opsin protein and retinal [aldehyde form of vitamin A (Retinol)]

(11) **(C).** Photoreceptors (Rod cells) in human eye are depolarised during darkness and become hyperpolarised in response to the light stimulus.

(12) **(A).** Oligodendrocytes are neuroglial cells which produce myelin sheath in central nervous system while Schwann cell produces myelin sheath in peripheral nervous system.

(13) **(D).** Pre-synaptic membrane is involved in the release of neurotransmitter in the chemical synapse.The receptors sites for neurotransmitters are present on post-synaptic membrane.

(14) **(B).** Carotene is the source of retinal which is involved in formation of rhodopsin of rod cells. Retinal, a derivative of vitamin A, is the light-absorbing part of all visual photopigments.

(15) **(C).** Lens in the human eye is held in its place by suspensory ligaments attached to the ciliary body.

(16) **(B).** Limbic system is emotional brain. It controls all emotions in our body but not movements.

(17) **(D).** Nissl granules are present in the cyton and even extend into the dendrite but absent in axon and rest of the neuron. Nissl granules are in fact composed of free ribosomes and RER. They are responsible for protein synthesis.

(18) **(B).** Hypothalamus in the thermoregulatory centre of our brain. It is responsible for maintaining constant body temperature.

(19) **(D).** Cornea consists of dense matrix of collagen and corneal epithelium. It is the most sensitive part of eye.