DAY TWENTY FOUR

Neural Control and Chemical Coordination

Learning & Revision for the Day

- Neurons and Nerves
- Generation and Conduction of Nerve Impulse
- Human Nervous System
- Reflex Action
- Sensory Organs
- Endocrine System of Human
- Human Endocrine Glands

- Coordination is the process through which two or more organs interact and complement the functions of one another.
- In human body, the neural system and the endocrine system jointly coordinate and integrate all the activities of the organs and their functions.
- The nervous system provides an organised network of point-to-point connections for a quick coordination.
- The endocrine system provides chemical regulation through hormones in animals.
- It controls the body by using a series of tissues throughout the body formed by a network of electrically conducting cells called **neurons** or **nerve cells**.

Neurons and Nerves

- A neuron is a microscopic structure composed of three major parts, i.e. cell body, dendrites and axons.
  - **Cell body** or **Soma** contains cytoplasm with typical cell organelles and certain granules called Nissl's granules. These granules are composed of RER.
  - **Dendrites** are cytoplasmic processes from the cell body.
  - **Axon** is a single long extension of cell body which is protected by a neurilemma. The distal end of axon is branched which terminates as a bulb-like structure called **synaptic knob** which possesses synaptic vesicles containing chemical called **neurotransmitters**.

- Neurons are bundled together to form **nerves**. These nerves connect nerve centres to specific organs. The nerves can be insulated or non-insulated. The insulated nerves have coating of myelin sheath and hence called myelinated nerves. Myelin sheath is formed by oligodendroglial cells in CNS and Schwann cells in PNS. At certain places, the insulation or myelin sheath is interrupted and such places are called **nodes of Ranvier**.
- The nerves which are not coated with myelin sheath are called non-myelinated nerves.
- Neurons are categorised into three groups
  - **Multipolar neurons** are with one axon and two or more dendrites. These are found in cerebral cortex.
  - **Bipolar neurons** are with one axon and one dendrite. These are found in the retina of eye.
  - **Unipolar neurons** are with one axon only and found usually in the embryonic stage.

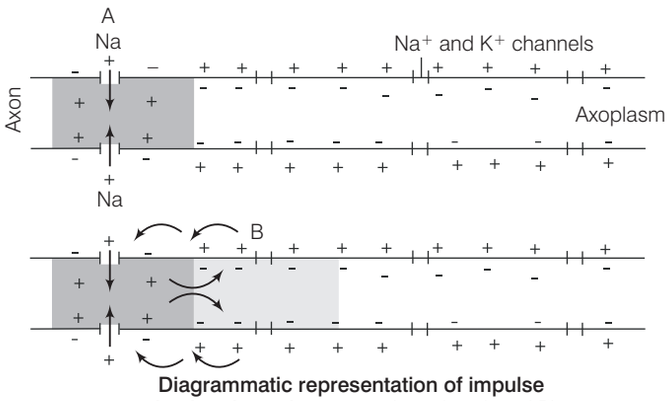
Generation and Conduction of Nerve Impulse

(i) In a resting membrane, i.e. when a neuron is not conducting any impulse, the axonal membrane is comparatively more permeable to potassium ions (K^+) and nearly impermeable to sodium (Na^+) ions.

- 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 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 $3Na^+$ outwards for $2K^+$ into the cell.
- In this condition, the electrical potential difference across the resting plasma membrane is called as the **resting potential**.

(ii) When a stimulus is applied at a site on the polarised membrane, the membrane at the site A becomes freely permeable to Na^+.

- This leads to a rapid influx of Na^+ followed by the reversal of the polarity at that site.
- The polarity of the membrane at the site A is thus, reversed and hence depolarised.
- The electrical potential difference across the plasma membrane at the site A is called the **action potential** or **nerve impulse**.
- At sites immediately ahead, the axon (e.g. site B) membrane has a positive charge on the outer surface and a negative charge on its inner surface.
- As a result, a current flows on the inner surface from site A to B.
- On the outer surface, current flows from site B to site A to complete the circuit of current flow.
- Hence, the polarity at the site is reversed and an action potential is generated at site B. Thus, the impulse (action potential) generated at site A arrives at site B.
- This sequence is repeated along the length of the axon and consequently, the impulse is conducted.
- The rise in the stimulus-induced permeability to Na^+ 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.



Diagrammatic representation of impulse conduction through an axon (at points A and B)

Transmission of Nerve Impulse

A nerve impulse flows from one neuron to another through synapses which is formed by the membranes of a pre-synaptic neuron and post-synaptic neuron, which may or may not be separated by a gap called synaptic cleft.

The two types of synapses are

(i) **Electrical synapses**, where the membranes of pre and post-synaptic neurons are in very close proximity. The 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.

(ii) **Chemical synapses**, where the membranes of the pre and post-synaptic neurons are separated by a fluid-filled space called synaptic cleft.

- Axon terminals contain vesicles filled with **neuro-transmitters** (chemical messengers).
- When an impulse arrives 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.

- The binding opens ion channels allowing the entry of ions, which can generate a new potential in the post-synaptic neuron.

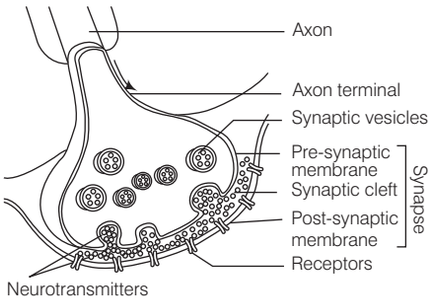


Diagram showing axon terminal and synapse

NOTE Neurotransmitters are excitatory (e.g. glutamate), inhibitory (e.g. GABA and glycine) or both (e.g. acetylcholine and norepinephrine).

Human Nervous System

- Nervous system in human beings develops from the ectoderm.
- In mammals, nervous system consists of **Central Nervous System** (CNS), **Peripheral Nervous System** (PNS) and **Autonomous Nervous System** (ANS).
- The study of nervous system including receptors is called **neurology**.

1. Central Nervous System (CNS)

- The central nervous system consists of **brain** and **spinal cord**.
- In humans, both of them are surrounded by three tissues coverings called **meninges** (two in amphibians, i.e. frog) which are **duramater** (outermost), **arachnoid mater** (middle) and **piamater** (innermost).
- The fluid present in around brain and spinal cord is called **cerebrospinal fluid**, produced by choroid plexus.
- It is a **colourless fluid** similar to the plasma with volume of about 80-150 mL in an adult and pH of about 7.33. The main functions of cerebrospinal fluid are as follows
  - It absorbs shock or jerk to protect brain and spinal cord.
  - It serves as medium for exchange of nutrients and waste products between blood and nervous tissue.
  - It serves as endocrine medium for transport of hormones.
- The CNS has two types of tissues. These are **grey matter**, containing cell bodies, dendrites and axon terminals of neurons (synapses) and **white matter** that contains axons.

Brain

The human brain is composed of more than 100 billion neurons and 10-15 trillion neuroglia that support and nourish neurons. The different regions of brain are forebrain, midbrain and hindbrain.

(i) Forebrain

It is the largest part of brain and it consists of following components

(a) **Cerebrum** The cerebrum is the most developed part in human and is divided into right and left cerebral hemispheres connected by **corpus callosum** (unique feature of mammals). The lobes of cerebrum are tabulated as below

Lobes of the Cerebrum

Cerebral lobe	Area	Associated function	Other functions of lobe
Frontal lobe	Premotor area	Centre for involuntary movements of muscles	Inner monitoring of complex thought and action, creative ideas, translation of perception and memories into plans.
	Motor area	Controls voluntary movement of muscles	Reality testing by judgement, intellectual insight, ability to abstract, reasoning, decision making, personality, expression of emotions and will power.
	Broca's area	Motor speech area	Central sulcus separates it from parietal lobe.
Parietal lobe	Gustatory area	Sense of taste	Registration of sensory perception of touch, pain, heat and cold, knowledge about position in space, taking information from environment, organising unit and communicationg to rest of brain.
Temporal lobe	Auditory area	Hearing	Decoding and interpretation of sound, language comprehension, memory and emotion.
	Olfactory area	Sense of smell	
	Wernicke's area	Understanding speech	Lateral cerebral sulcus separates it from frontal lobe.
Occipital lobe	Visual area	Sensation of light	Decoding and interpretation of visual information shape and colour. Parieto-occipital sulcus separates it from parietal lobe.

- The right lobe controls the left body and *vice-versa*. The cerebrum is composed of subregions cerebral cortex, basal ganglia and limbic system.
  - **Cerebral cortex** forms 80% of the total brain mass. It has folds or convolutions consisting of small grooves called **sulci**, large grooves called **fissures** and bulges between two gyri, which help in increasing the surface area of cortex.
  - **Basal ganglia** are found deep within cerebral hemisphere as the collection of scattered grey matter with three subcortical nuclei. It has three members, i.e. globus pallidus, putamen and caudate nucleus.
    Together putamen and caudate nucleus is called as **corpus striatum.** The basal ganglia helps to regulate the initiation and termination of movements and also controls subconscious movements of skeleton.
  - **Limbic system or emotional brain** is a loop of cortical structures surrounding corpus callosum and thalamus, including **amygdala** and **hippocampus,** on the median side of temporal lobe. It plays crucial role in wide range of emotions, i.e. pain, pleasure, affection and anger and also controls memory and olfaction.
    The amygdala is concerned only with expression of fear and aggression.
    The hippocampus functions as index to recall an event associated with memory.

(b) **Olfactory lobe** is anterioventrally positioned and functionally related to smell.

(c) **Diencephalon** consists of three major parts

- **Thalamus** forms the 4/5th of the diencephalon and consists of oval mass of grey matter. All types of sensory input and other information going to cerebrum passes through synapses in the thalamus. It is also connected with the limbic system, hence controls the emotion and memory.

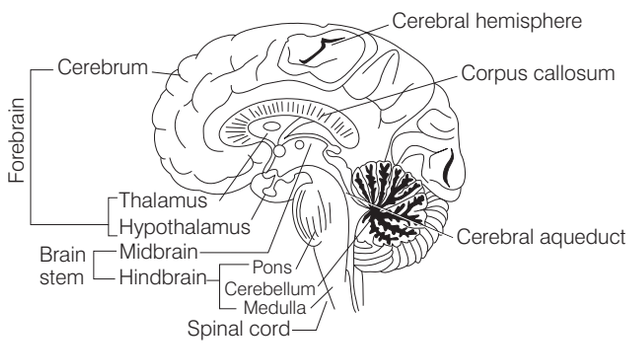


Diagram showing sagittal section of the human brain

- **Hypothalamus** nestles at the base of thalamus, integrating and controlling the visceral activities. It also helps to maintain homeostasis, controls thirst, hunger, temperature ad influences respiration and heartbeat.
- **Epithalamus** consists of **pineal gland** and **habenular nuclei.** Pineal gland secretes melatonin and habenular nuclei which is associated with olfaction.

(ii) Midbrain

- It extends from pons to diencephalon.
- A canal called **cerebral aqueduct**, passes through the midbrain.
- **Cerebral peduncles** (a part of tracts) are present in the anterior part of midbrain, whereas posterior part of the midbrain (tectum) contains four little lobes, the **corpora quadrigemia** with two superior colliculi (involved in visual activitiy) and two inferior colliculi (involved in auditory pathway).
- The midbrain have several nuclei including large and darkly pigmented nuclei (substantia nigra).
- Dopamine releasing neurons extend from substantia nigra to basal nuclei/ganglia and loss of the function of these neurons causes Parkinson's disease.
- Midbrain also contains red nuclei, which look reddish due to the rich blood supply and iron containing pigment.

(iii) Hindbrain

It consists of cerebellum, pons and medulla oblongata.

(a) The **cerebellum** or little cerebrum is second largest part of brain with a central constricted area called vermis and lateral lobes or wings called cerebellar hemispheres.

- The flocculonodular lobe on inferior surface contributes to equilibrium and balance. Deep inside the grey matter, arbor vitae are present which resemble branches of tree.
- **Purkinje cells** are distinctive neurons of cerebellum. These are unusually large, globular neurons with tremendous profusion of dendrites.
- The bundles of myelinated nerve fibres called cerebellar peduncles form communication between cerebellum and other parts of the CNS.
- The three pairs of peduncles are given below
  - **Superior cerebellar peduncle** connects cerebellum to red nuclei.
  - **Middle cerebellar peduncle** largest of three which communicates with pons.
  - **Inferior cerebellar peduncle** pathway between cerebellum, medulla oblongata and spinal cord.
- The major functions of cerebellum include, maintaining equilibrium of the body, modulating motor commands and controlling muscular and involuntary movements.

(b) **Pons varolii** It forms the floor of brain stem and serves as neuronal link between cerebral cortex and cerebellum.

- It consists of pontine nuclei, pneumotaxic area and apneustic area. Pontine nuclei are sites at which signals for voluntary movements are relayed into cerebellum.
- Both pneumotaxic and apneustic area control respiration.

(c) **Medulla oblongata** is the triangular part of brain and its roof is associated with overlying piameter to form the posterior choroid plexus.
It contains cardiac centres (control rate and force heartbeat), vasomotor centres (control blood pressure by adjusting blood vessel diameter) and two respiratory centres (control rate and depth of breathing).

Spinal Cord

- It is the part of dorsal nerve cord present in continuation with brain.
- The **filum terminale** is the terminal, non-nervous part of spinal cord which is made up of piamater.
- The **Cauda equina** is the tail-like collection of the roots of spinal nerves at the posterisor end of the spinal cord.
- The arrangement of grey matter and white matter is opposite to that seen in the brain, i.e. here, white matter lies outside and grey matter inside.
- The projections of grey matter into white matter are called horns.
- The complete spinal cord is situated and protected within the neural canal of vertebrae.

NOTE Destruction of the anterior horn cells of spinal cord results in loss of voluntary motor impulses because it contains motor neurons that affect axial muscles.

Reflex Action

- It is an immediate involuntary response to a stimulus without the intervenation of brain, controlled by spinal cord.
- Reflex action is an autonomic motor response to a sensory stimulus without brain being immediately involved.
- They are quick and fast.
- They follow the shortest route for quick response.
- These are mostly protective in function.

Reflex actions are of two types

(i) **Simple reflex** is unconditional and inborn reflex to a stimulus, e.g. blinking of the eye when an object comes near to our eyes suddenly; rapid withdrawal of hand, while burned; sneezing, coughing, yawning, knee jerk reflex, etc.

(ii) **Acquired reflex** is also called as conditioned reflex and is dependent on past experience, training and learning.

- These reflexes were first demonstrated by Ivan Petrovitch Pavlov in a hungry dog, e.g. learning of dancing, cycling, swimming, singing, driving, etc.
- **Reflex arc** is the pathway of nerve impulses generated at the receptor due to the stimulus to reach the effector organ during a reflex action. It has five components namely receptor, sensory or afferent nerve fibres, spinal cord, motor or efferent nerve fibres and effector organ.

Ventricles of Brain

The four cavities within brain are called cerebral ventricles. These are given below

Cerebral Ventricles and their Location

Ventricle	Also known as	Location
Ventricle I	Paracoel or lateral ventricle	Right cerebral hemisphere
Ventricle II		Left cerebral hemisphere
Ventricle III	Diocoel	Diencephalon
Ventricle IV	Metacoel	Between brain stem and cerebellum

Ventricle I, II and III are connected by foraman of Monro, while ventricle III and IV are connected by cerebral aqueduct.

2. Peripheral Nervous System (PNS)

- The PNS comprises of all the nerves of the body associated with the CNS. These are afferent fibres and efferent fibres.
- **Afferent fibres** transmit impulses from tissues/organs to the CNS and the **efferent fibres** transmit regulatory impulses from the CNS to the concerned peripheral tissues.
- PNS is composed of 12 pairs of cranial nerves and 31 pairs of spinal nerves.
- Cranial nerves emerge from brain, while spinal nerves arise from spinal cord.
- 10 pairs of cranial nerves are present in fishes and amphibians.
- The number of cranial and spinal nerve present in rabbit is 12 pairs and 37 pairs, respectively.
- 31 pairs of spinal nerves include 8 pairs of cervical nerves, 12 pairs of thoracic nerves, 5 pairs of lumber nerves, 5 pairs of sacral nerves and one pair of coccygeal nerves in human.

Description of Cranial Nerves of Human

Cranial Nerve	Number	Function	Innervation and Function
Olfactory	I	Sensory	Smell
Optic	II	Sensory	Vision

Cranial Nerve	Number	Function	Innervation and Function
Occulomotor	III	Motor	Eyelids, eyes, adjustments of light entering eyes, lens focusing (motor).
Trochlear (smallest)	IV	Motor	Condition of muscles (sensory), eye muscles (motor).
Trigeminal (largest)	V	Mixed	Condition of muscles (sensory).
(a) Opthalmic	—	Sensory	Eyes, tear glands, scalp, forehead and upper eyelids (sensory).
(b) Maxillary	—	Sensory	Upper teeth, upper gum, upper lip, lining of the palate and skin of the face (sensory).
(c) Mandibular	—	Mixed	Scalp, skin of the jaw, lower teeth, lower gum and lower lip (sensory).
Abducens	VI	Motor	Jaws, floor of the mouth (motor) external rectus of eye.
Facial	VII	Mixed	Condition of muscles (sensory). Taste receptors of the anterior tongue (sensory). Facial expression, tear glands and salivary glands (motor).
Auditory	VIII	Sensory	Equilibrium; vestibule hearing; cochlea.
Glossopharyngeal	IX	Mixed	Pharynx, tonsils, posterior tongue and carotid arteries (sensory). Pharynx and salivary glands (motor).
Vagus	X	Mixed	Speech and swallowing, heart and visceral organs in the thorax and abdomen (motor). Pharynx, larynx, oesophagus and visceral organs of the thorax and abdomen (sensory).
Spinal accessory	XI	Motor	Soft palate, pharynx and larynx, neck and back.
Hypoglossal	XII	Motor	Tongue muscles.

3. Autonomous Nervous System (ANS)

It was discovered by Langley. It is entirely motor and operates without concious control. It further consists of two divisions

- **Sympathetic nervous system** increases the defence system of body against adverse conditions. It is active in stress condition, e.g. pain, fear and anger.
- **Parasympathetic nervous system** provides relaxation, comfort, pleasure at the time of rest. It helps in the restoration and conservation of energy.

Contradictory Functions of Sympathetic and Parasympathetic Nervous System

Characteristics	Sympathetic	Parasympathetic
Secretion	Acetylcholine and sympathiatin	Acetylcholine only
Blood pressure	Increases	Decreases
Blood vessel to skin	Constricts	Dilates
Blood vessel to heart	Dilates	Constricts
Blood vessel to lung and muscle	Dilates	Constricts
Pupil	Dilates	Constricts
Lacrymal gland	Stimulates	Inhibits
Heartbeat	Increases	Decreases
Adrenal secretion	Stimulates	Inhibits
Breathing and BMR	Increases	Decreases
Nostrils	Dilates	Constricts
Urinary bladder	Relaxes	Constricts
Iris	Constricts	Dilates
Salivary gland	Decreases	Increases
Digestive gland	Decreases	Increases
Gut peristalsis	Decreases	Increases
Ejaculation	Increases	Decreases
Bile	Decreases	Increases
Renin (kidney)	Increases	Decreases
Bronchi	Dilates	Constricts

Disorders of Nervous System

- **Meningitis** is an inflammation of meninges due to bacterial or viral infections.
- **Poliomyelitis** is an acute viral infection that destroys the cell bodies of motor neurons in the anterior horn of spinal cord.
- **Parkinson's disease** is caused by the destruction of neurons of basal ganglia that produce dopamine. It results in tremors and shakes in the limbs, slow voluntary movements, etc.

- **Alzheimer's disease** is caused due to the destruction of vast number of neurons in the hippocampus. It also leads to loss of neurotransmitter acetylcholine.
- **Syringomyelia** is the presence of fluid-filled cavities in the spinal cord.
- **Myelodysplasia** is abnormal development of spinal cord.

Sensory Organs

- The sensory organs detect all types of changes in the environment and signals to the CNS, where all the inputs are processed and analysed. Signals are then sent to different parts/centres of the brain.
- There are specific sense organs for a particular stimulus.
- Receptors are classified generally on the basis of type of stimulus, function and location.

Different types of sensory organs are as follows

1. Eyes

- An adult human eyeball is a spherical structure.
- It is composed of three layers namely external layer, middle layer and inner layer.
- The external layer is composed of a dense connective tissue called the **sclera.** The anterior portion of this layer is called the **cornea**.
- It helps to focus light waves entering the eye. It is avascular, i.e. has no blood supply due to which cornea transplant in humans is almost never rejected.
- The middle layer is **choroid** and it contains many blood vessels.
- The choroid layer becomes thick in the anterior part to form the ciliary body.
- The ciliary body forms a pigmented and opaque structure called the **iris** (a visible coloured part of eye).
- The eyeball 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 inner layer is the retina which contains ganglion cells, bipolar cells and photoreceptor cells.
- There are two types of **photoreceptor cells**, i.e. rods and cones.
- The daylight vision and colour vision are functions of cones.
- The cone cells contain iodopsin (visual violet) pigment.
- The UV light vision is the function of rods.
- Rod cells contain photosensitive compound called rhodopsin which is composed of opsin (protein) and retinal (aldehyde of vitamin-A, i.e. retinal).
- Retinal pigment shields the retina from excess incoming light. It supplies omega 3 fatty acid and glucose to the retina.
- 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 the region called **blind spot**.
- A yellowish pigmented spot is called **macula lutea** with a central pit called the **fovea** present at the posterior pole of the eye.
- It is thinned-out portion of the retina where only the cones are densely packed. It is the point where the visual` resolution is the highest.
- 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 **vitreous humor**.

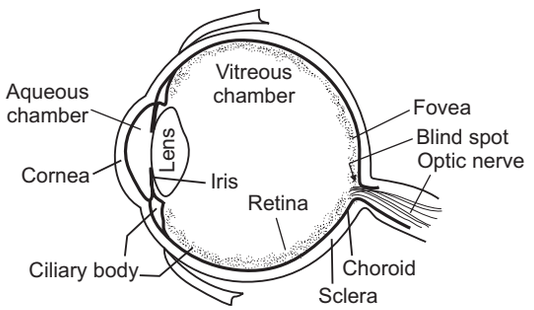


Diagram showing parts of an eye

- Albino eyes lack pigment in skin, hair and iris and the pink colour of the iris is due to the reflection of light from the blood vessel of iris.

Mechanism of Vision

- The light rays are focussed on retina through the cornea and the lens generates potentials in rods and cones.
- Light induces dissociation of the retinal from opsin, resulting in changes in the structure of the opsin.
- This causes change in the membrane permeability.
- The potential difference is generated and produces a signal that generates action potentials in the ganglion cells through the bipolar cells.
- These action potentials are transmitted by the optic nerves to the visual cortex area of the brain, where the neural impulses are analysed and the image formed on the retina is recognised, based on earlier memory and experience.
- During darkness, rhodopsin is resynthesised from opsin and retinine to restore the dark vision and photoreceptors are depolarised.

Defects of Eye

(i) **Myopia** or near-sightedness is caused due to large curvature of lens or increase in the size of eyeball due to which image of distant objects is formed in front of retina.

- The person has difficulty in seeing distant objects clearly but can see near objects clearly (short sight)
- It is corrected by using biconcave lenses.

(ii) **Hypermetropia** or long-sightedness is caused due to low convexity of lens or smaller eyeball due to which image is formed behind the retina.

- Person has difficulty in seeing near objects but can see distant objects clearly (long sight).
- It is corrected by using convex lenses.

(iii) **Cataract** is caused due to the opacity of lens. It is treated by surgical removal of lens.

(iv) **Presbyopia** is caused due to the loss of elasticity of lens. It is corrected by using bifocal lenses.

2. Ears

The ear can be divided into three major parts

(i) **Outer ear** consists of the pinna and external auditory meatus. The pinna collects the vibrations in the air which produces sound.

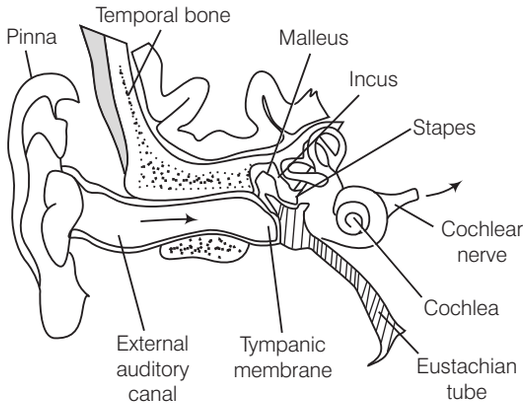
- The external auditory meatus leads inwards and extends up to the tympanic membrane.
- The tympanic membrane is composed of connective tissues covered with the skin outside and mucous membrane at inside.

(ii) **Middle ear** contains three ossicles called **malleus**, **incus** and **stapes**, which are attached like a chain.

- The malleus is attached to the tympanic membrane and stapes is attached to the oval window of the cochlea (main hearing organ).
- The membranes constituting cochlea, the Reissner's and basilar membrane divide the surrounding perilymph which is filled bony labyrinth membrane. The organ of Corti is a structure located on the basilar membrane, which contains hair cells which act as auditory receptors.

(iii) **Inner ear** contains a vestibular apparatus, which is composed of three semicircular canals and the otolith organ, consisting of the saccule and utricle.

- Vestibular apparatus has no role in hearing but is influenced by gravity and movements.
- The base of canals is swollen and is called **ampulla**.
- 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 the maintenance of balance of body and posture.



Diagrammatic view of ear

Mechanism of Hearing

- The external ear receives sound waves and directs them to the eardrum.
- The eardrum vibrates in response to the sound waves and the vibrations are transmitted through the ear ossicles to the oval window.
- The vibrations are passed through the oval window to the fluid of the cochlea, where they generate waves in the lymph.
- These waves generate ripple in the basilar membrane. As a result, nerve impulses are generated in the associated afferent neurons.
- These impulses are transmitted by the afferent fibres *via* auditory nerves to the auditory cortex of the brain, where the impulses are analysed and the sound is recognised.

Endocrine System of Human

- The internal environment of body is maintained in steady state by autonomic nervous system and the endocrine system.
- The endocrine system brings about chemical coordination with the help of hormones.
- In the vertebrate body, glands may be classified on the basis of the presence or absence of ducts as endocrine or ductless gland and exocrine or ductus glands.

(i) **Exocrine glands** secrete their secretions in ducts, to carry them to sites of action, e.g. sweat and oil glands of skin, salivary gland, liver, etc.

(ii) **Endocrine glands** do not have ducts (tubes) to carry their secretions to the target organs. The science dealing with these is called **Endocrinology**. These glands secrete their secretions into the blood for their transportation to the sites of action, e.g. thyroid, pituitary, pancreas, hypothalamus, adrenal, etc.

Hormones

- Hormones are the organic compounds which are secreted in small amount by endocrine glands of body. These can inhibit, accelerate or modify the cellular activities.
- These are first messengers, informational molecules or trigger substances of the body.
- They regulate internal environment and cellular activities of the cell.
- The first hormone to be discovered was secretin and it was discovered by **Bayliss** and **Ernst H Starling**.

  On the basis of chemical nature, hormones can be grouped as

  (i) Peptide, polypeptide, protein hormones (e.g. insulin glucagon, pituitary hormones, hypothalamic hormones, etc).

  (ii) Steroids (e.g. cortisol, testosterone, oestradiol and progesterone).

  (iii) Iodothyronines (thyroid hormones derived from tyrosine).

  (iv) Amino acid derivatives (melatonin and serotonin derived from tryptophan).
- Hormones produce their effects on target tissues with the help of hormone receptors located in the target tissues only.
- The binding of a hormone to its receptors leads to the formation of a hormone receptor complex.
- Each receptor is specific to one hormone only.
- Hormones, which interact with membrane-bound receptor do not enter the target cell, but generate the second messengers (e.g. cyclic AMP, IP_3, Ca^{2+}, etc.) which in turn regulates the cellular metabolism.
- Hormones, which interact with intracellular receptors (e.g. steroid hormones, iodothyronines, etc.) mostly regulate gene expression of chromosome and functions by the interaction of hormone-receptor complex with genome. The cumulative biochemical actions result in the physiological and developmental effects.

Human Endocrine Glands

Human endocrine system consists of the following endocrine glands

1. Hypothalamus

It is located at the floor of forebrain. It is connected with the anterior lobe of the pituitary gland by hypophysial portal blood vessels and with the posterior lobe of the pituitary gland by axons and neurons.

Hormones of Hypothalamus

Hormones	Target Organ	Action/Effect
Releasing hormones, e.g. GnRH.	Pituitary	Stimulates secretion of pituitary hormones.
Inhibiting hormones	Pituitary	Inhibits the release of pituitary hormones.

2.Pituitary Gland

- It is the smallest endocrine gland, but serves very important role in the human endocrine system.
- It directly or indirectly controls almost all other endocrine glands of the body. It is also known as **master gland**.
- It originates from the ectoderm of the embryonic germ layers.
- It is **reddish-grey** in colour and is roughly oval in shape. It is about a size of a pea seed. The pituitary gland is located in a small bony cavity of the brain called **sella tursica**.
- Anatomically, this gland is formed of two major portions, i.e.
  - Adenohypophysis
  - Neurohypophysis
- The adenohypophysis includes the **anterior** and **intermediate** lobe of pituitary, while neurohypophysis is the **posterior** lobe of this gland.

Hormones of Anterior Pituitary

- The anterior pituitary regulates several physiological processes including stress, growth, reproduction and lactation. The anterior pituitary is also known as **pars distalis**.
- The hormones secreted by this region are called **tropic hormones**. These type of hormones stimulate other endocrine glands to produce their specific hormone.
- These hormones are given below with their functions

  (i) **Growth Hormone** (GH) It stimulates the somatotropic cells of anterior lobe of pituitary gland to release its growth hormone called **somatotropin**. It stimulates body growth, protein, fat and carbohydrate metabolism. Oversecretion of this hormone during childhood causes **gigantism** (excessive growth of bones), whereas in adulthood, it causes **acromegaly** (abnormal thickness of bones). Its low secretion results in stunted growth, i.e. **pituitary dwarfism**.

  (ii) **Prolactin** (PRL) The prolactin releasing hormone stimulates lactotroph cells of the anterior lobe of pituitary gland to secrete prolactin. PRL regulates the growth of mammary glands and stimulates the production of milk in them.

(iii) **Thyroid Stimulating Hormone** (TSH) stimulates the synthesis and secretion of thyroid hormones from the thyroid gland.

(iv) **Adrenocorticotropic Hormone** (ACTH) This is secreted when Adreno Corticotropin Releasing Hormone (ACRH) stimulates the corticotroph cells of anterior lobe of pituitary. This stimulates the synthesis and secretion of steroid hormones called **glucocorticoids** from the adrenal cortex.

(v) **Gonadotropin Hormone** It secretes **Luteinizing Hormone** (LH) and **Follicle Stimulating Hormone** (FSH).

- **Luteinizing Hormone** (LH) In males, it stimulates the synthesis and secretion of hormones called **androgens** from testis. In females, it induces ovulation of fully mature follicles (Graafian follicles).
- **Follicle Stimulating Hormone** (FSH) In males, the FSH and androgens together regulate spermatogenesis. In females, this hormone stimulates the growth and development of ovarian follicles.

Hormones of Intermediate Pituitary

- The intermediate pituitary lobe is also known as **pars intermedia**. This portion of adenohypophysis secretes only one hormone, i.e. Melanocyte Stimulating Hormone (MSH).
- MSH acts on melanocytes (melanin containing cells) and regulates the pigmentation of the skin.

Hormones of Posterior Pituitary

The posterior lobe of pituitary releases two main hormones. These are

(i) **Oxytocin** It acts on the smooth muscles of pregnant mother and stimulates a vigorous contraction of uterus at the time of childbirth. It also plays role in ejection of milk from the mammary glands in females. Hence, it is also known as the birth hormone.

(ii) **Vasopressin/ADH** This hormone acts mainly at the kidney, stimulating the reabsorption of water and electrolytes by the distal tubules, thereby reducing the loss of water through urine (diuresis).

Deficiency of Antidiuretic Hormone (ADH) causes a type of diabetes known as **diabetes insipidus** in which person suffers from loss of water due to frequent urination resulting in excessive thirst and dehydration.

3. Thyroid Gland

- The thyroid gland is known to be the largest endocrine gland.
- It is endodermal in origin, i.e. originates from the endoderm of the embryo. The thyroid gland is bilobed and highly vascular organ.
- It surrounds the front of the larynx and is composed of two lobes. Each of its lobe is located on either sides of the trachea in the neck interconnected with each other through a thin flap of connective tissue called **isthmus**.
- It is composed of follicles (round in shape) held together by loose connective tissue called **stromal tissues**. Each thyroid follicle is composed of follicular cells, enclosing a cavity.

Hormones of Thyroid Gland

The hormones secreted by thyroid gland are

(i) **Tetraiodothyronine or thyroxine** (T_4) and **triiodothyroxin** (T_3). Both these hormones are released from follicular cells of thyroid gland. They are named so, because they contain four and three iodine, respectivley. T_3 and T_4 hormones have similar effects, thus these are collectively known as Thyroid Hormone (TH).

(ii) **Calcitonin** (CT) This hormone is proteinaceous in nature. It acts on bone and kidneys to reduce blood calcium level.

Functions of Thyroid Hormones

Thyroid hormones have serve several functions in the body, such as

(a) These hormones regulate and maintain the **Basal Metabolic Rate** (BMR), i.e. both T_3 and T_4 hormones increase the overall metabolic rate of the body.

(b) They support the process of formation of red blood cells and also help in controlling the metabolism of carbohydrates, proteins and fats.

(c) They influence the maintenance of water and electrolyte in our body.

Disorders Caused by Thyroid Hormones

Following abnormalities may occur due to hypo or hyper secretion of thyroid hormones

I. **Hypothyroidism** Insufficient or low secretion of thyroxine hormone may lead to following three conditions

(i) **Simple goitre** It occurs due to insufficient amount of iodine in food. Due to this disorder, the thyroid gland gets enlarged and swollen neck is one of its symptoms.

(ii) **Cretinism** Hypothyroidism in women at the time of pregnancy mainly affects the physical and mental growth of children, due to which he/she has retarted growth and mental development.

(iii) **Myxoedema** It occurs due to improper functioning of thyroid gland in adults. Symptoms include puffy appearance due to deposition of fat under skin (low BMR).

II. **Hyperthyroidism** It is the condition during which rate of synthesis and secretion of thyroid hormone is increased to abnormally higher levels. It may occur due to cancer of the thyroid gland or due to development of nodules of the thyroid gland. It adversely affects the body physiology of an organism.

A condition called **exophthalmic goitre** is characterised by high metabolic rate causing excessive leanness.

4. Parathyroid Gland

- This gland develops from the endoderm of the embryo.
- It is present as four small pouches, two of each are embedded in the posterior surface of each lobe of thyroid gland.
- It develops as epithelial buds from third and fourth pairs of pharyngeal pouches.
- The hormone secreted by parathyroid gland is **Parathormone** (PTH) or Collip's hormone.
- PTH acts directly on bone to increase bone dissolution demineralisation and mobilises Ca^{2+} ions into blood. It is a hypercalcemic and hypophosphatemic hormone.
- Excess secretion of parathormone (PTH), usually by benign tumours of the gland, causes reabsorption of calcium from bones and raises the blood calcium level.
- PTH deficiency causes abnormally low level of ionised calcium in the blood. This reduces absorption of calcium from the small intestine and reabsorption from the bones. Hypoparathyroidism may also lead to parathyroid tetany.

5. Pancreas

- It is a composite gland that acts as both exocrine and endocrine gland. Such glands are also called **heterocrine gland**.
- It originates from the endoderm of the embryonic germ layers.
- It lies below the stomach, in the loop of duodenum.
- It is elongated yellowish gland that consists of large number of acini and ducts. Besides these, pancreas consists of 1-2 millions of small group of specialised cells, called **Islets of Langerhans** (after the name of their discoverer **Paul Langerhans** in 1869). In normal human pancreas, these cells represent only 1-2% of the pancreatic tissue.
- Each islet consists of major two types of cells as
  - **α-cells** (about 25%) It secretes a peptide hormone called **glucagon**.
  - β-cells (about 60%) It secretes another peptide hormone called **insulin**.

Hormones of Pancreas

Glucagon and **insulin** have antagonistic effect on blood glucose level. This can be cleared from the functioning given below

(i) **Glucagon** This peptide hormone plays an important role in maintaining the normal blood glucose levels. It brings about change of liver glycogen to blood glucose.
- It acts mainly on liver cells (hepatocytes) and stimulates glycogenolysis, which results in an increased blood sugar known as **hyperglycaemia**.
- Apart from this, glucagon also stimulates the process of gluconeogenesis which also contributes to hyperglycaemia. Glucagon is known as **hyperglycaemic hormone** because it reduces the cellular glucose uptake and utilisation.
- It reduces glycogenesis and also enhances lipolysis.

(ii) **Insulin** This peptide hormone plays a major role in regulation of glucose level in the blood. It mainly acts on **hepatocytes** and **adipocytes** (cells of adipose tissue), increasing the cellular glucose uptake and utilisation. As a result, the movement of glucose takes place rapidly from blood to liver cells and cells of adipose tissues by decreasing the blood glucose level (hypoglycaemia).
- Insulin stimulates the conversion of glucose to glycogen (glycogenesis) in the target cells.
- Decreases gluconeogenesis.
- Decreases glycogenolysis.
- Also reduces the catabolism of proteins and fats.
- Increases synthesis of fat in the adipose tissue from fatty acids.

Abnormalities of Insulin Hormone

- Low secretion of insulin hormone in humans is responsible for causing **diabetes mellitus** or **hyperglycemia**.
  The symptoms include
  - The person starts losing glucose (sugar) in urine and has high level of glucose in the blood.
  - A diabetic person loses weight and feels more thirsty due to loss of water by frequent urination.
- Oversecretion of insulin results in lowering of sugar level in the blood known as **hypoglycemia** due to which a person may enter a state of coma or even death may occur.

6. Adrenal Glands

- Our body has a pair of adrenal glands, each located at the anterior part of each kidney.
- Adrenal glands are conical, yellowish bodies composed of two types of tissues, i.e. adrenal cortex and adrenal medulla.

Adrenal Cortex

It is an external, firm and pale-yellowish tissue derived from the mesoderm of embryo. It is formed of three concentric layers, i.e. an inner, a middle and an outer layer. Hormones secreted by these three layers of adrenal cortex are collectively known as **corticoids**. Three groups of steroid hormones are secreted by adrenal cortex such as

(i) **Glucocorticoids** (Cortisol) It regulates the metabolism of carbohydrates, fats and proteins in the body.
- Its main functions are to maintain electrolytes, body fluid volume, osmotic pressure and blood pressure of the body.
- Cortisol stimulates the liver for the synthesis of carbohydrates from non-carbohydrate sources (like amino acids and glycerol). This process is known as **gluconeogenesis**.
- Cortisol is involved in the maintenance of cardiovascular system and in proper functioning of kidney.
- Cortisol produces anti-inflammatory reactions and functions in the suppression of immune response.
- It stimulates the production of RBCs.

(ii) **Mineralocorticoids** (Aldosterone) They regulate the balance of water and electrolytes in our body.
- Aldosterone is the major mineralocorticoid found in our body.
- It mainly acts on renal tubules, stimulating the reabsorption of Na^+ and water. It also stimulates the excretion of K^+ and phosphate ions from the body.
- Its main functions are to maintain electrolytes, body fluid volume, osmotic pressure and blood pressure of the body.

(iii) **Sexcorticoids** (Androgen) Adrenal cortex produces a small quantity of androgenic steroids, i.e. sex hormone (androgens), both in males and females.
- These hormones are secreted as **DHEA** (Dihydroxy epiandrosterone), which acts as a precursor of both testosterone and oestrogen.
- It plays a major role in the growth of axial, pubic and facial hair during puberty.
- Development of acne in a young girl is due to the overproduction of these hormones.
- It plays an important role in the development of embryo (foetus).

Abnormalities of Hormones from Adrenal Cortex

- **Hyposecretion of hormones** from adrenal cortex causes **Addison's disease**. Symptoms include loss of skin pigment, loss of weight, low blood sugar, sensitivity to cold and susceptibility to infections, etc.
- **Hypersecretion of cortisol** hormones from adrenal cortex causes **Cushing's syndrome**. Symptoms include high blood sugar, obesity, weakening of bones (osteoporosis), retention of salt and water in tissues, etc.
- **Hypersecretion of sexcorticoids** causes adrenal virilism in females. The female develops male secondary sexual characters such as appearance of beard, moustaches, etc.

Adrenal Medulla

- The adrenal medulla lies in the centre of the adrenal gland. It is an internal, soft, dark reddish-brown tissue derived from the ectoderm.
- The adrenal medulla secretes two hormones, i.e.
  - Adrenaline (epinephrine)
  - Noradrenaline (norepinephrine)
- Both hormones belong to the category of compounds known as **catecholamines** and are secreted in response to any kind of stress, danger and during emergency situations like increased respiratory rate, heartbeat, etc.
- The CNS at the time of stress or danger stimulates the adrenal medulla to release both these hormones. These are also known as **emergency hormones** or **hormones of fight** or **flight**.
- These hormones serve following purposes
  - Increase alertness.
  - Dilation of pupil.
  - Piloerection (raising of hairs of hands and legs).
  - Increase in heartbeat and rate of respiration.
  - Stimulate the breakdown of glycogen due to which the concentration of glucose increases in the blood.
  - Stimulate breakdown of lipids and proteins.

7. Thymus Gland

- This gland is endodermal in origin. It has developed from the epithelium of the outer part of third gill pouch or epithelium of gill cleft.
- It is a lobular structure present in between pericardium and upper part of sternum.
- It is covered from outside by a capsule of loose connective tissue. It possesses a dense perished cortex and a loose central medulla on the inner side.
- Thymus gland is well-developed in newborn child and it reduces continuously from adulthood to old age.
- The peptide hormone secreted by this gland is thymosin. Thymosin promotes proliferation and maturation of T-lymphocytes which produces cell-mediated immunity. It also promotes the production of antibodies to provide humoral immunity.

8. Pineal Gland

- It develops from the ectoderm of the embryo.
- The pineal gland (epiphysis) is located on the dorsal side of forebrain.
- It is a stalked, small, rounded, reddish-brown gland which resembles a pine cone. Its weight is about 150 mg and length is about 10 mm. It consists of pineal cells and supporting gland cells.
- The pineal gland secretes following three hormones
  - **Melatonin** It is a derivative of amino acid tryptophan. It targets melanophore cells of skin. It has antagonistic action to Melanocyte Stimulating Hormone (MSH) secreted by the pars intermedia of pituitary. Melatonin plays very important role in the regulation of a biological clock. It controls sleep-wake cycle, body temperature, etc. In addition, melatonin also influences metabolism, pigmentation on skin, the menstrual cycle as well as defence capability.
  - **Serotonin** It is a biogenic amine hormone (5-Hydroxy tryptamine) which acts as a vasoconstrictor to increase blood pressure.
  - **Adrenoglomerulotropin** It stimulates the zona glomerulosa of adrenal cortex to secrete aldosterone.
- In man, the pineal gland starts calcifying at the time of puberty. Such calcium deposits are called **brain sand**. Its presence may indicate increased secretory activity.

9. Gonads

- These are sex glands that develop from the mesoderm of the embryo. The main function of the gonads is to produce gametes. These are mixed glands, i.e. they are both exocrine and endocrine in function.

Testis

- In man, a pair of testis is present in the scrotal sac (outside abdomen). Testes produce sperms as well as sex hormones.
- Testis is composed of seminiferous tubules and interstitial tissue.
- The Leydig cells or interstitial cells which are present in the intertubular spaces produce a group of hormones called **androgens** mainly testosterone.
- Male sex hormone androgens are steroid hormones produced under the control of ICSH (LH) of anterior pituitary.
- Testosterone initiates development of male secondary sex organs (seminal vesicles, prostate gland, scrotum and penis), external male sex characters (beard, moustaches, masculine voice, body hair), growth in body tissue, broadening of shoulders, aggressiveness, growth of muscles, increased sebaceous gland activity, etc.

Ovary

- Ovary is a paired structure located in the abdomen in females. It is the primary female sex organ which produces one ovum during each menstrual cycle.
- Ovary is composed of ovarian follicles and stromal tissues. After ovulation, the ruptured follicle is converted to a structure called **corpus luteum**.
- The two important female sex hormones, secreted by ovaries are oestrogen and progesterone.
  - **Oestrogen** It is secreted by the ovarian follicles and influenced by FSH, a secretion of anterior pituitary. It is the main female sex hormone. It initiates the development of female secondary sex organs like vagina, duct system of mammary glands, uterus, Fallopian tubes and accessory female sex characters like breasts, high pitch voice and development of female body pattern and onset of menstrual cycle.
  - **Progesterone** It is secreted mainly by the corpus luteum under the influence of LH of anterior pituitary.

    It causes temporary changes in endometrial lining of uterus (secretory phase of menstrual cycle) for receiving egg. This hormone basically supports pregnancy. Progesterone also acts on the mammary glands. It stimulates the formation of alveoli and milk secretion through mammary glands. Alveoli are sac-like structures that store milk in mammary glands.

Disorders of Sex (Gonadal) Hormones

- Abnormal functioning of sex hormones, i.e. testosterone, oestrogen and progesterone leads to following disorders in human males and females. These are as follows
  - **Eunuchoidism** It is a hormonal disorder due to **deficient secretion of testosterone** in males. In this case, the secondary male sex organs, such as prostate gland, seminal vesicle and penis are underdeveloped and non-functional.
  - **Precocious puberty in males** It occurs in boys due to excessive production of testosterone before the age of 10 years. It causes early enlargement of penis, faster body growth, development of pubic and axillary hair, muscularisation and then stunting.

    In girls, it occurs before 9 years by the excess production of oestrogen. It causes early development of breasts and pubic hair, but ovarian cycle does not occur.
  - **Gynaecomastia** It is the development of breast tissue in males. Gynaecomastia occurs mainly due to the disturbance in oestrogen and testosterone ratio.

Other than endocrine glands, hormones secreted by other organs and their functions are tabulated below

Major Sources of other Vertebrate Hormones

Gland/Organ	Hormone	Function	Target Area
Placenta	Oestrogens, progesterone, human Chorionic Gonadotropin (hCG) and human Chorionic Somatotropin (hCS)	Maintain pregnancy	Ovaries, mammary glands and uterus
Digestive tract	Secretin	Stimulates release of pancreatic juice to neutralise stomach acid.	Cells of pancreas
	Gastrin	Stimulates digestive enzymes and HCl in stomach.	Stomach mucosa
	Cholecystokinin (CCK)	Stimulates release of pancreatic enzymes and bile from gall bladder.	Pancreas and gall bladder
Heart	Atriopeptin	Lowers blood pressure and maintains fluid balance.	Blood vessels and kidneys
Kidneys	Erythropoietin	Stimulates red blood cell production.	Bone marrow
	Urotensin	Stimulates constriction of arteries.	Major arteries
	Calcitrol	Aids in the absorption of dietary calcium and phosphorus.	Small intestine
Adipose tissue	Leptin	Suppresses appetite.	Brain

DAY PRACTICE SESSION 1

FOUNDATION QUESTIONS EXERCISE

1 Integration system in the body is
(a) nervous system and respiratory system
(b) endocrine system and circulatory system
(c) circulatory system and digestive system
(d) nervous and endocrine system

2 Node of Ranvier occurs where
(a) nerve is covered with myelin sheath
(b) neurilemma is discontinuous
(c) neurilemma and myelin sheath are discontinuous
(d) myelin sheath is discontinuous

3 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

4 Myelin sheath is produced by → NEET 2017
(a) Schwann cells and oligodendrocytes
(b) Astrocyctes and Schwann cells
(c) Oligodendrocytes and osteoclasts
(d) Osteoclasts and astrocytes

5 Nerve impulse travels as
(a) mechanical impulse
(b) chemical impulse
(c) electrical impulse
(d) magnetic impulse

6 During the transmission of nerve impulse through a nerve fibre, the potential on the inner side of the plasma membrane has which type of electric charge?
(a) First negative, then positive and again back to negative
(b) First positive, then negative and continue to be negative
(c) First negative, then positive and continue to be positive
(d) First positive, then negative and again back to positive

7 Na^+-K^+ pump is found in membranes of many cells, like nerve cells. It works against electrochemical gradient and involves an integral protein ATPase. For each molecule of ATP used
(a) 3 ions of Na^+ are pumped out and 2 ions of K^+ are taken in
(b) 3 ions of Na^+ are taken in and 2 ions of K^+ are pumped out
(c) 2 ions of Na^+ are thrown out and 3 ions of K^+ are absorbed
(d) 3 ions of K^+ are absorbed and 3 ions of Na^+ are pumped out

8 Unidirectional transmission of a nerve impulse through nerve fibre is due to the fact that
(a) nerve fibre is insulated by a medullary
(b) sodium pump starts operating only at the cyton and then continues into the nerve fibre
(c) neurotransmitters are released by dendrites and not by axon endings
(d) neurotransmitters are released by the axon endings and not by dendrites

9 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

10 Which one of the following does not act as a neurotransmitter?
(a) Acetylcholine (b) Epinephrine
(c) Norepinephrine (d) Cortisone

11. CNS is mostly made up of
(a) motor neurons and sensory neurons
(b) sensory neurons and association
(c) association neurons
(d) motor neurons and association neurons

12. Cerebrospinal Fluid (CSF) is found within the
(a) epidural space, subarachnoid space and dural sinuses
(b) the subarachnoid space, dural sinuses and ventricles
(c) central canal, epidural space and subarachnoid space
(d) ventricles, central canal and subarachnoid space

13. Regarding cerebrospinal fluid, which of the following is a false statement?
(a) It has a specific gravity of 1.007
(b) It maintains a volume of 140-200 mL and a fluid pressure of 10 mm Hg
(c) It moves metabolic wastes away from the cells of nervous tissue
(d) It is produced in the choroid plexuses and gets drained into the cerebral arterial circle

14. Sequence of meninges from inner to outside is
(a) duramater—arachnoid—piamater
(b) duramater—piamater—arachnoid
(c) arachnoid—duramater—piamater
(d) piamater—arachnoid—duramater

15. Match the following columns.

	Column I		Column II
A.	Piamater	1.	Outer meninges
B.	Duramater	2.	Maintains posture and muscle tone
C.	Cerebellum	3.	Reflex action
D.	Medulla oblongata	4.	Inner meninges
		5.	White matter

Codes

	A	B	C	D
(a)	1	2	3	4
(b)	5	2	3	1
(c)	4	1	2	3
(d)	1	5	2	3

16. Centre for sense of smell is situated in
(a) cerebellum (b) olfactory lobes
(c) cerebrum (d) midbrain

17. The human hindbrain comprises three parts, one of which is → CBSE-AIPMT 2012
(a) spinal cord (b) corpus callosum
(c) cerebellum (d) hypothalamus

18. The nerve centres, which control the body temperature and the urge for eating are contained in
(a) hypothalamus (b) pons
(c) cerebellum (d) thalamus

19. Match the following columns.

	Column I		Column II
A.	Cerebrum	1.	Controls the pituitary
B.	Cerebellum	2.	Controls vision and hearing
C.	Hypothalamus	3.	Controls the rate of heartbeat
D.	Midbrain	4.	Seat of intelligence
		5.	Maintains body posture

Codes

	A	B	C	D		A	B	C	D
(a)	5	4	2	1	(b)	4	5	2	1
(c)	5	4	1	2	(d)	4	5	1	2

20. Which of the following structures or regions is incorrectly paired with its function? → NEET 2018

(a) Hypothalamus	–	Production of releasing hormones and regulation of temperature, hunger and 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 fibres connecting left and right cerebral hemispheres.

21. Destruction of the anterior horn cells of the spinal cord would result in loss of → CBSE-AIPMT 2015
(a) sensory impluses
(b) voluntary motor implulses
(c) commissural impulses
(d) integrating implulses

22. Sympathetic nervous system increases
(a) heartbeat
(b) secretion of saliva
(c) secretion of digestive juices
(d) All of the above

23. Which of the following is not a function of ANS?
(a) Innervation of all visceral organs
(b) Transmission of sensory and motor impulses
(c) Regulation and control of vital activities
(d) Conscious control of motor activities

24. How do parasympathetic neural signals affect working of the heart? → CBSE-AIPMT 2014

(a) Reduce both heart rate and cardiac output
(b) Heart rate is increased without affecting the cardiac output
(c) Both heart rate and cardiac output increase
(d) Heart rate decreases but cardiac output increases

25. The main functions of sympathetic nervous system are

(a) the contraction of skin blood vessels and sudden increase of blood pressure
(b) contraction of muscles, secretion of sweat glands and rapid coagulation of blood
(c) dilation of bronchi, contraction of heart and sudden decrease in the number of RBCs in the blood
(d) All of the above

26. The cranial nerve which is showing the maximum branching is

(a) trigeminal
(b) vagus
(c) optic
(d) facial

27. Which pairing of nerve and organ innervation is incorrect?

(a) Phrenic nerve — Diaphragm
(b) Vagus nerve — Abdominal viscera
(c) Glossopharyngeal nerve — Taste buds
(d) Abducens nerve — Facial muscles

28. Injury to vagus nerve in human is not likely to affect

(a) tongue movements
(b) gastrointestinal movements
(c) pancreatic secretion
(d) cardiac movements

29. In a man, abducens nerve is injured. Which one of the following functions will be affected?

(a) Movement of the eyeball
(b) Swallowing
(c) Movement of the tongue
(d) Movement of the neck

30. The homeostatic regulation of an animal requires three basic components,..... to detect changes, ... to evaluate the changes and ..... to adjust the changes, respectively.

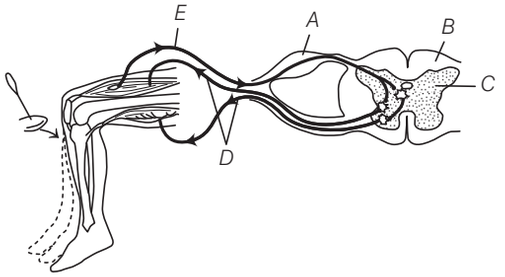
Fill in the blanks with correct option.

(a) receptor, affectors, effectors
(b) brain, spinal cord, effectors
(c) receptors, integrators, effectors
(d) integrators, receptors, effectors

31. Stimulation of muscle firbe by a motor neuron occurs at → CBSE-AIPMT 2014

(a) the neuromuscular junction
(b) the transverse tubules
(c) the myofibril
(d) the sarcoplasmic reticulum

32. Identify the parts labelled as *A* to *E* and choose the correct option for the given diagrammatic representation of reflex action showing knee-jerk reflex.



(a) *A*–Dorsal root ganglion, *B*–White matter, *C*–Grey matter, *D*–Afferent pathway, *E*–Efferent pathway
(b) *A*–Dorsal root ganglion, *B*–White matter, *C*–Grey matter, *D*–Efferent pathway, E–Afferent pathway
(c) *A*–Dorsal root ganglion, *B*–Grey matter, *C*–White matter, *D*–Efferent pathway, *E*–Afferent pathway
(d) *A*–Ventral root ganglion, *B*–White matter, *C*–Grey matter, *D*–Efferent pathway, *E*–Afferent pathway

33. Human eyeball consists of three layers and it encloses

(a) lens, iris, optic nerve
(b) lens, aqueous humor and vitreous humor
(c) cornea, lens, iris
(d) cornea, lens, optic nerve

34. A characteristic of human cornea

(a) is the absence of blood circulation
(b) is the generation of cataract in old age
(c) has lacrimal gland for secretion of tears
(d) is secreted by conjunctiva and glandular layer

35. Cornea transplantation is successful as cornea is

(a) easily available (b) without blood supply
(c) easily preserved (d) easily stiched

36. The point in eye of mammals from which optic nerves and blood vessels leave the eyeball is

(a) yellow spot (b) blind spot
(c) pars optica (d) None of these

37. In a similarity with photographic camera, retina acts as

(a) shutter (b) lens (c) diaphragm (d) film

38. The 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

39. Which one is photosensitive in mammals?

(a) Retinol (b) Rhodopsin
(c) Melanin (d) Sclerotin

40. Photosensitive compound in human eye is made up of
→ NEET-I 2016
(a) opsin and retinal (b) opsin and retinol
(c) transducin and retinene (d) guanosine and retinol

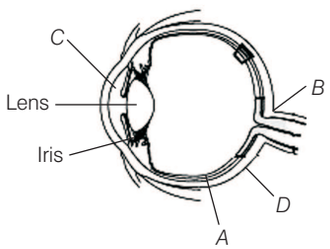
41. Choose the correct statement. → NEET-II 2016
(a) Nociceptors respond to changes in pressure
(b) Meissner's corpuscles are thermoreceptors
(c) Photoreceptors in the human eye are depolarised during darkness and become hyperpolarised in response to the light stimulus
(d) Receptors do not produce graded potentials

42. In mammalian eye, the 'fovea' is the centre of the visual field, where → CBSE-AIPMT 2015
(a) high density of cones occurs, but has no rods
(b) the optic nerve leaves the eye
(c) only rods are present
(d) more rods than cones are found

43. Which one of the following statements is not correct?
→ CBSE-AIPMT 2014
(a) Retinal is the light absorbing portion of visual photopigments
(b) In retina, the rods have the photopigment rhodopsin
(c) Retinal is a derivative of vitamin-C
(d) Rhodopsin is the purplish-red protein present in rods only

44. The purplish-red pigment rhodopsin contained in the rods type of photoreceptor cells of the human eyes is a derivative of → CBSE-AIPMT 2011
(a) Vitamin–C (b) Vitamin–D (c) Vitamin–A (d) Vitamin–B

45. Parts *A, B, C* and *D* of the human eyes are shown in the diagram. Select the option which gives correct identification along with its functions/characteristics.
→ NEET 2013



(a) *A*–Retina; contains photoreceptors-rods and cones
(b) *B*–Blind spot; has only a few rods and cones
(c) *C*–Aqueous chamber; reflects the light, which does not pass through the lens
(d) *D*–Choroid; its anterior part forms ciliary body

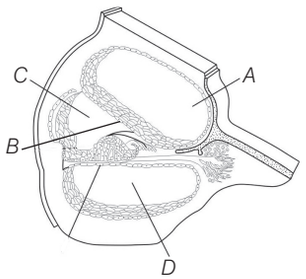
46. In myopia or short-sightedness,
(a) image is formed slightly in front of retina because eye ball is longer
(b) eyeball is normal but image is formed over blind spot
(c) eyeball is normal but image is formed slightly behind the retina due to faulty lens
(d) curvature of cornea becomes irregular

47. Static balance is maintained by
(a) maculae (b) cristae
(c) organ of Corti (d) Reissner's membrane

48. Dynamic balance is maintained by
(a) maculae (b) cristae
(c) organ of Corti (d) Reissner's membrane

49. Which part of the human ear plays no role in hearing as such, but is otherwise very much required?
→ CBSE-AIPMT 2012
(a) Eustachian tube (b) Organ of Corti
(c) Vestibular apparatus (d) Ear ossicles

50. Given below is a diagrammatic, cross-section of a single loop of human cochlea.



Which one of the following options correctly represents the names of three different parts?
(a) *B*–Tectorial membrane, *C*–Perilymph, *D*–Secretory cells
(b) *C*–Endolymph, *D*–Sensory hair cells, *A*–Serum
(c) *D*–Sensory hair cells, *A*–Endolymph, *B*–Tectorial membrane
(d) *A*–Perilymph, *B*–Tectorial membrane, *C*–Endolypmh

51. Chemically hormones are
(a) biogenic amines (b) proteins
(c) steroids (d) All of these

52. Which of the following is an amino acid derived hormone? → NEET 2018
(a) Estradiol (b) Ecdysone
(c) Epinephrine (d) Estriol

53. The amino acid, tryptophan is the precursor for the synthesis of → NEET-I 2016
(a) thyroxine and tri-iodothyronine
(b) oestrogen and progesterone
(c) cortisol and cortisone
(d) melatonin and serotonin

54. Which one of the following is not a second messenger in hormone action?
(a) *c*-GMP (b) Calcium (c) Sodium (d) *c*AMP

55. Hormones are
(a) non-nutrient chemicals
(b) intercellular messengers
(c) produced in trace amounts
(d) All of the above

56. What is correct to say about the hormone action in humans? ➞ CBSE-AIPMT 2012

(a) Glucagon is secreted by β-cells of islets of Langerhans and stimulates glycogenolysis
(b) Secretion of thymosin is stimulated with ageing
(c) In females, FSH first binds with specific receptors on ovarian cell membrane
(d) FSH stimulates the secretion of oestrogen and progesterone

57. Through negative feedback, a hormone may shut off the secretion of an anterior pituitary hormone by

(a) stimulating the release of a (hypothalamic) releasing hormone
(b) inhibiting the release of a (hypothalamic) inhibiting hormone
(c) inhibiting the release of a (hypothalamic) releasing hormone
(d) All of the above

58. Which of the following is an accumulation and release centre of neurohormones?

(a) Posterior pituitary lobe
(b) Intermediate lobe of the pituitary
(c) Hypothalamus
(d) Anterior pituitary lobe

59. GnRH, a hypothalamic hormone, needed in reproduction, acts on ➞ NEET 2017

(a) anterior pituitary gland and stimulates secretion of LH and oxytocin
(b) anterior pituitary gland and stimulates secretion of LH and FSH
(c) posterior pituitary gland and stimulates secretion of oxytocin and FSH
(d) posterior pituitary gland and stimulates secretion of LH and relaxin

60. Pars nervosa is a part of

(a) brain (b) spinal cord
(c) pituitary gland (d) pineal gland

61. Hormone that promotes cell division, protein synthesis and bone growth is

(a) ADH (b) ACTH (c) PTH (d) GH

62. If a person takes large amount of water, the amount of ADH in blood will

(a) increase (b) decrease
(c) first increase then decrease (d) will remain unchanged

63. Which one of the following hormones though synthesised elsewhere, is stored and released by the master gland? ➞ CBSE-AIPMT 2015

(a) Antidiuretic hormone
(b) Luteinising hormone
(c) Prolactin
(d) Melanocyte stimulating hormone

64. The posterior pituitary gland is not a 'true' endocrine gland because ➞ NEET-II 2016

(a) it is provided with a duct
(b) it only stores and releases hormones
(c) it is under the regulation of hypothalamus
(d) it secretes enzymes

65. Melanocyte Stimulating Hormone (MSH) is produced by

(a) anterior pituitary
(b) posterior pituitary
(c) pars intermedia of pituitary
(d) parathyroid

66. The portion of the pituitary gland that arises from the roof of the primitive oral cavity is the

(a) adenohypophysis (b) pars nervosa
(c) neurohypophysis (d) infundibulum

67. Ovulation is stimulated by

(a) LH (b) FSH
(c) oestrogen (d) progesterone

68. Somatostatin is secreted by

(a) pituitary (b) thyroid
(c) pineal (d) hypothalamus

69. Adrenocorticotropin is a hormone, which is produced from

(a) pituitary (b) adrenal
(c) thyroid (d) adrenal medulla

70. Function of ACTH is to

(a) stimulate pituitary
(b) stimulate the adrenal cortex to produce hormones
(c) suppress the activity of adrenal cortex
(d) stimulate thyroid

71. The gonadotropic hormone is secreted by

(a) posterior part of thyroid
(b) adrenal cortex
(c) adenohypophysis of pituitary
(d) interstitial cells of testes

72. Hormone oxytocin controls

(a) growth (b) lactation
(c) childbirth (d) Both (b) and (c)

73. Which one of the following hormones is not involved in sugar metabolism? ➞ CBSE-AIPMT 2015

(a) Cortisone (b) Aldosterone
(c) Insulin (d) Glucagon

74. Which of the following pairs of hormones are not antagonistic (heaving opposite effects) to each other? ➞ NEET-I 2016

(a) Insulin – Glucagon
(b) Aldosterone – Atrial Natriuretic Factor
(c) Relaxin – Inhibin
(d) Parathormone – Calcitonin

75. Hypersecretion of growth hormone in adults does not cause further increase in height because ➞ NEET 2017
(a) growth hormone becomes inactive in adults
(b) epiphyseal plates close after adolescence
(c) bones loose their sensitivity to growth hormone in adults
(d) muscle firbes do not grow in size after birth

76. Stimulation of the mother's nipples by a nursing baby initiates a sensory impulses, which pass into the central nervous system and eventually reach the hypothalamus. These impulses result in
(a) synthesis and release of prolactin from the posterior pituitary
(b) release of lactogenic hormone from the anterior pituitary
(c) release of oxytocin from the posterior pituitary
(d) release of prolactin inhibiting factor

77. Which among the following is not true for thyroid gland?
(a) Endodermal in origin (b) Bilobed
(c) Highly vascular organ (d) Ectodermal in origin

78. Thyrocalcitonin
(a) elevates K^+ level in blood
(b) lowers Ca^{2+} level in blood
(c) elevates Ca^{2+} level in blood
(d) None of the above

79 Hormone controlling metabolism is
(a) ACTH from pituitary
(b) FSH from pituitary
(c) thyroxin from thyroid
(d) adrenalin from adrenal medulla

80. Ca^{2+} level is controlled by
(a) thyroid (b) hypothalamus
(c) pituitary (d) thyroid and parathyroid

81. The excessive amount of calcium is regulated by
(a) thyroxin (b) calcitonin
(c) epinephrine (d) progesterone

82. The blood calcium level is lowered by the deficiency of
(a) parathormone (b) thyroxine
(c) calcitonin (d) Both (a) and (c)

83. Damage to thymus in a child may lead to
(a) a reduction in haemoglobin content of blood
(b) a reduction in stem cell production
(c) loss of antibody-mediated immunity
(d) loss of cell-mediated immunity

84. Name a peptide hormone which acts mainly on hepatocytes, adipocytes and enhances cellular glucose uptake and utilisation. ➞ NEET-II 2016
(a) Insulin (b) Glucagon (c) Secretin (d) Gastrin

85. Glucagon produced by α-cells of islets of Langerhans
(a) converts glucose to glycogen
(b) converts glycogen to glucose
(c) decreases concentration of glucose in blood
(d) None of the above

86. Which one of the following pairs is incorrectly matched? ➞ CBSE-AIPMT 2010
(a) Glucagon — Beta cells (source)
(b) Somatostatin — Delta cells (source)
(c) Corpus luteum — Relaxin (secretion)
(d) Insulin — Diabetes mellitus (disease)

87. Which of the following is correct about pancreas?
(a) Pancreas is mixed gland
(b) Exocrine portion of pancreas secretes an alkaline pancreatic juice containing enzymes
(c) Endocrine portion of pancreas secretes insulin and glucagon
(d) All of the above

88. Which one of the following is an emergency gland?
(a) Testes (b) Adrenal
(c) Thymus (d) Pituitary

89. Adrenaline affects directly
(a) β-cells of Langerhans
(b) epithelial cells of stomach
(c) SA-node
(d) dorsal root of spinal nerve

90. The outermost layer of adrenal cortex is
(a) zona glomerulosa (b) zona reticularis
(c) zona fasciculata (d) None of these

91. The endocrine gland that is formed from two different germ layers is the
(a) ovary (b) thyroid gland
(c) pancreas (d) adrenal gland

92. The group of adrenocortical hormones concerned with electrolyte balance is the
(a) glucocorticoids
(b) mineralocorticoids
(c) androgens
(d) epinephrine and norepinephrine

93. Epinephrine is secreted from
(a) adrenal medulla and decreases heartbeat
(b) adrenal medulla and increases heartbeat
(c) pancreas and increases heartbeat
(d) pancreas and decreases heartbeat

94. Which hormone causes dilation of blood vessels, increased oxygen consumption and glycogenolysis?
(a) ACTH (b) Insulin
(c) Adrenaline (d) Glucagon

95. Which of the following takes part in salt balancing?
(a) Mineralocorticoid (b) Glucocorticoid
(c) Somatotropin (d) Follitropin

96. Which one of the following hormones is a modified amino acid?
(a) Epinephrine (b) Progesterone
(c) Prostaglandin (d) Oestrogen

97. Feeling the tremors of an earthquake, a scared resident of seventh floor of a multistoreyed building starts climbing down the stairs rapidly. Which hormone initiated this action?
(a) Thyroxin (b) Adrenaline
(c) Glucagon (d) Gastrin

98. Fight or flight reactions cause the activation of
→ CBSE-AIPMT 2014
(a) the parathyroid glands, leading to increased metabolic rate
(b) the kidney, leading to suppression of reninangiotensin-aldosterone pathway
(c) the adrenal medulla, leading to increased secretion of epinephrine and norepinephrine
(d) the pancreas leading to a reduction in the blood sugar levels

99. Which one of the following glands is correctly matched with the accompanying description?
(a) Thyroid — Hyperactivity in young children causes cretinism
(b) Thymus — Starts undergoing atrophy after puberty
(c) Parathyroid — Secretes parathormone, which promotes movement of calcium ions from blood into bones during calcification
(d) Pancreas — Delta cells of the islets of Langerhans secrete a hormone, which stimulates glycolysis in liver

100. Hormone melatonin is secreted by
(a) adrenal (b) thymus (c) pituitary (d) pineal

101. Both the ovaries are removed from a female rat. The hormone titre decreases in case of
(a) oxytocin
(b) prolactin
(c) oestrogen
(d) gonadotropin releasing factor

102. Testosterone is secreted by
(a) Leydig's cells (b) Sertoli cells
(c) Spermatogonia (d) Both (a) and (b)

103. Withdrawal of which of the following hormones is the immediate cause of menstruation?
(a) Oestrogens (b) FSH
(c) FSH-RH (d) Progesterone

104. Corpus luteum produces
(a) progesterone
(b) cortisol
(c) oestradiol
(d) testosterone

105. Which of the following hormones is not a secretion product of human placenta?
(a) Human chorionic gonadotropin
(b) Prolactin
(c) Oestrogen
(d) Progesterone

106. The hormone, which brings about the contraction of gall bladder is
(a) oxytocin (b) gastrin
(c) cholecystokinin (d) secretin

107. Luteinising Hormone (LH) in female
(a) helps in the appearance of secondary sexual characters
(b) stimulates ovary to secrete oestradiol
(c) helps in the release of ovum from the ovary
(d) controls the blood pressure

108. Select the answer which correctly matches the endocrine gland with the hormone it secretes and its function/deficiency symptom.
→ NEET 2013

	Endocrine Gland	Hormone	Function/Deficiency Symptom
(a)	Anterior pituitary	Oxytocin	Stimulates uterus contraction during childbirth
(b)	Posterior pituitary	Growth Hormone (GH)	Oversecretion stimulates abnormal growth
(c)	Thyroid gland	Thyroxine	Lack of iodine in diet results in goitre
(d)	Corpus luteum	Testosterone	Stimulates spermatogenesis

109. Identify the hormone with its correct matching of source and function.
→ CBSE-AIPMT 2014

(a)	Oxytocin	–	Posterior pituitary growth and maintenance of mammary glands
(b)	Melatonin	–	Pineal gland, regulates the normal rhythm of sleep-wake cycle
(c)	Progesterone	–	Corpus luteum, stimulation of growth and activities of female secondary sex organs
(d)	Atrial natriuretic factor	–	Ventricular wall increases the blood pressure.

110. Acromegaly is caused by
(a) hypersecretion of FSH
(b) hyposecretion of ACTH
(c) hypersecretion of GH
(d) hyposecretion of GH/STH

111. While dwarfs and cretins are somewhat of the same height, the main difference is that
(a) dwarfs have normal intelligence, while cretins do not
(b) cretins are mentally deranged
(c) the head of cretin is especially large
(d) the dwarfs have elongated chin

112. Toxic agents present in food which interfere with thyroxin synthesis lead to the development of → CBSE-AIPMT 2010
(a) toxic goitre (b) cretinism
(c) simple goitre (d) thyrotoxicosis

113. A pregnant female delivers a baby, who suffers from stunted growth, mental retardation, low intelligence quotient and abnormal skin. This is the result of → NEET 2013
(a) deficiency of iodine in diet
(b) low secretion of growth hormone
(c) cancer of the thyroid gland
(d) oversecretion of pars distalis

114. Grave's disease is caused due to → NEET-II 2016
(a) hyposecretion of thyroid gland
(b) hypersecretion of thyroid gland
(c) hyposecretion of adrenal gland
(d) hypersecretion of adrenal gland

115. Deficiency of the adrenal cortex activity leads to
(a) Cushing disease
(b) Conn's syndrome
(c) Addison's disease
(d) Simmond's disease

116. A health disorder that results from the deficiency of thyroxin in adults and characterised by → CBSE-AIPMT 2009
I. a low metabolic rate
II. increase in body weight
III. tendency to retain water in tissues is
(a) hypothyroidism (b) simple goitre
(c) myxoedema (d) cretinism

117. Which one is correctly matched?
(a) Relaxin–Gigantism
(b) Prolactin–Cretinism
(c) Parathyroid hormone – Tetany
(d) Insulin–Diabetes insipidus

118. A person is having problems with calcium and phosphorus metabolism in his body. Which one of the following glands may not be functioning properly?
(a) Parathyroid (b) Parotid
(c) Pancreas (d) Thyroid

119. **Assertion** The imbalance in concentration of Na^+, K^+ and proteins generates resting potential.

Reason To maintain the unequal distribution of Na^+ and K^+, the neurons use electrical energy.
(a) If both Assertion and Reason are true and Reason is the correct explanation of Assertion
(b) If both Assertion and Reason are true, but Reason is not the correct explanation of Assertion
(c) If Assertion is true, but Reason is false
(d) If both Assertion and Reason are false

DAY PRACTICE SESSION 2

PROGRESSIVE QUESTIONS EXERCISE

1. Which of the following is not a steroid hormone?
(a) Oestrogen (b) Cortisone
(c) Adrenaline (d) Testosterone

2. Which of the following diseases is not related to thyroid gland?
(a) Myxoedema (b) Acromegaly
(c) Cretinism (d) Goitre

3. Diabetes is due to
(a) iodine deficiency (b) hormonal deficiency
(c) Na^+ deficiency (d) enzyme deficiency

4. A steroid hormone which regulates glucose metabolism is
(a) cortisol (b) corticosterone
(c) 11–deoxycorticosterone (d) cortisone

5. Which of the following endocrine glands stores its secretion in the extracellular space before discharging into the blood?
(a) Pancreas (b) Adrenal (c) Testis (d) Thyroid

6. Third ventricle of brain is also known as
(a) metacoel (b) rhinocoel (c) paracoel (d) diacoel

7. In the blind spot, where the optic nerves leave the eyes
(a) rods and cones are absent
(b) only cones are present
(c) only rods are present
(d) special neurons are present

8. The defective condition of eye, in which distant objects are seen distinct but near objects are indistinct is called
(a) myopia (b) astigmatism
(c) presbyopia (d) hypermetropia

9. Hormones thyroxine, adrenaline and the pigment melanin are formed from
(a) tryptophan (b) glycine
(c) tyrosine (d) proline

10. Source of somatostatin is the same as that of
(a) insulin and glucagon
(b) vasopressin and oxytocin
(c) thyroxin and calcitonin
(d) somatotropin and prolactin

11. In the resting state of the neural membrane, diffusion due to concentration gradients, if allowed, would drive
(a) K^+ into the cell (b) K^+ and Na^+ out of the cell
(c) Na^+ into the cell (d) Na^+ out of the cell

12. Injury to adrenal cortex is not likely to affect the secretion of which one of the following?
(a) Aldosterone
(b) Both androstenedione and dehydroepiandrosterone
(c) Adrenaline
(d) Cortisol

13. Which of the following statements is correct about node of Ranvier?
(a) Axolemma is discontinuous
(b) Myelin sheath is discontinuous
(c) Both neurilemma and myelin sheath are discontinuous
(d) Covered by myelin sheath

14. A person passes excessive urine and drinks much water but his glucose level is normal. It is due to
(a) increased secretion of glucagon
(b) fall in glucose released in urine
(c) reduction in insulin secretion
(d) reduction in vasopressin secretion in posterior pituitary

15. What is the proper sequence of adrenal cortex zones, from the outside in?
(a) Zona glomerulosa–Zona fasciculata–Zona reticularis
(b) Zona glomerulosa–Zona reticularis–Zona fasciculata
(c) Zona reticularis–Zona fasciculata–Zona glomerulosa
(d) Zona fasciculata–Zona reticularis–Zona glomerulosa

16. Parkinson's disease (characterised by tremors and progressive rigidity of limbs) is caused by degeneration of brain neurons that are involved in movement control and make use of neurotransmitter
(a) acetylcholine (b) norepinephrine
(c) dopamine (d) GABA

17. An action potential in the nerve fibre is produced when positive and negative charges on the outside and the inside of the axon membrane are reversed because
(a) more potassium ions enter the axon as compared to sodium ions leaving it
(b) more sodium ions enter the axon as compared to potassium ions leaving it
(c) all potassium ions leave the axon
(d) all sodium ions enter the axon

18. Which one of the following pairs of hormones are the examples of those that can easily pass through the cell membrane of the target cell and bind to a receptor inside it (mostly in the nucleus)?
(a) Insulin and glucagon (b) Thyroxine and insulin
(c) Somatostatin and oxytocin (d) Cortisol and testosterone

19. Which of the following are the three initial developmental regions of the brain?
(a) Telencephalon, prosencephalon, rhombencephalon
(b) Rhombencephalon, prosencephalon, mesencephalon
(c) Metencephalon, myelencephalon, prosencephalon
(d) Prosencephalon, diencephalon, mesencephalon

20. Which one of the following pairs correctly matches a hormone with a disease resulting from its deficiency?
(a) Luteinizing hormone — Failure of ovulation
(b) Insulin — Diabetes insipidus
(c) Thyroxine — Tetany
(d) Parathyroid hormone — Diabetes mellitus

21. Given below is a table comparing the effects of sympathetic and parasympathetic nervous system for four features (a–d). Which one feature is correctly described?

	Feature	Sympathetic Nervous System	Parasympathetic Nervous System
(a)	Salivary gland	Stimulates secretion	Inhibits secretion
(b)	Pupil of the eye	Dilates	Constricts
(c)	Heart rate	Decreases	Increases
(d)	Intestinal peristalsis	Stimulates	Inhibits

22. Match the source gland with its respective hormone as well as the function.

	Source Gland	Hormone	Function
(a)	Posterior pituitary	Vasopression	Stimulates reabsorption of water in the distal tubules in the nephron
(b)	Corpus luteum	Oestrogen	Supports pregnancy
(c)	Thyroid	Thyroxine	Regulates blood calcium-level
(d)	Anterior pituitary	Oxytocin	Contraction of uterus muscles during childbirth

23. Which one of the following is the correct difference between rod cells and cone cells of our retina?

	Rod cells	Cone cells
(a) Visual acuity	High	Low
(b) Visual pigment contained	Iodopsin	Rhodopsin
(c) Overall function	Vision in poor light	Colour vision and detailed vision in bright light
(d) Distribution	More concentrated in centre of retina	Evenly distributed all over retina

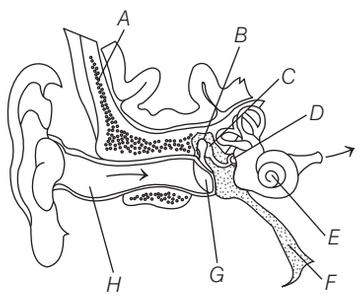
24. Given below is an incomplete table about certain hormones, their source glands and one major effect of each on the body in humans. Identify the correct option for the three blanks *A, B* and *C*.

Gland	Secretion	Effect on Body
A	Oestrogen	Maintenance of secondary sexual characters
Alpha cells of islets of Langerhans	*B*	Raises blood sugar level
Anterior pituitary	*C*	Oversecretion leads to gigantism

Codes

	A	*B*	*C*
(a)	Placenta	Insulin	Vasopressin
(b)	Ovary	Insulin	Calcitonin
(c)	Placenta	Glucagon	Calcitonin
(d)	Ovary	Glucagon	Growth hormone

25. 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

26. Which of the following statements is correct in relation to the endocrine system?

(a) Adenohypophysis is under direct neural regulation of the hypothalamus

(b) Organs in the body like gastrointestinal tract, heart, kidney and liver do not produce any hormones

(c) Non-nutrient chemicals produced by the body in trace amount that act as intercellular messenger are known as hormones

(d) Releasing and inhibitory hormones are produced by the pituitary gland

27. One reason for the division of the ANS is that

(a) sympathetic signals are transmitted from the spinal cord to the periphery through two successive neurons, in contrast to one neuron for parasympathetic signals

(b) sympathetic fibres alone innervate organs in the abdominal cavity

(c) sympathetic fibres alone arise from the spinal cord

(d) the effects of the two divisions on the organs are usually antagonistic

28. According to the accepted concept of hormone action, if receptor molecules are removed from target organs, then the target organ will

(a) not respond to the hormone

(b) continue to respond to hormone without any difference

(c) continue to respond to the hormone but in the opposite way

(d) continue to respond to the hormone but will require higher concentration

29. A person entering an empty room suddenly finds a snake right in front, on opening the door. Which one of the following is likely to happen in his neurohormonal control system?

(a) Sympathetic nervous system is activated releasing epinephrine and norepinephrine from adrenal medulla

(b) Neurotransmitters diffuse rapidly across the cleft and transmit a nerve impulse

(c) Hypothalamus activates the parasympathetic division of brain

(d) Sympathetic nervous system is activated releasing epinephrine and norepinephrine from adrenal cortex

30. Match the following columns.

	Column I		Column II
A.	Somatotropin	1.	Antidiuretic hormone
B.	Vasopressin	2.	Oversecretion of thyroid hormones
C.	Grave's disease	3.	Excess growth hormone
D.	Gigantism	4.	Prolactin
		5.	Growth hormone

	A	B	C	D		A	B	C	D
(a)	5	1	2	3	(b)	1	2	3	4
(c)	4	5	2	1	(d)	2	3	4	5

31. Match the following columns.

	Column I		Column II
A.	Hypothalamus	1.	Relaxin
B.	Anterior pituitary	2.	Oestrogen
C.	Testis	3.	FSH and LH
D.	Ovary	4.	Androgens
		5.	Gonadotropin releasing hormone

	A	B	C	D		A	B	C	D
(a)	5	3	4	2	(b)	5	3	1	4
(c)	1	2	4	3	(d)	3	5	4	2

ANSWERS

SESSION 1

1 (d)	**2** (d)	**3** (d)	**4** (a)	**5** (c)	**6** (a)	**7** (a)	**8** (d)	**9** (a)	**10** (d)
11 (c)	**12** (d)	**13** (d)	**14** (d)	**15** (c)	**16** (c)	**17** (c)	**18** (a)	**19** (d)	**20** (b)
21 (b)	**22** (a)	**23** (d)	**24** (a)	**25** (d)	**26** (b)	**27** (d)	**28** (a)	**29** (a)	**30** (c)
31 (a)	**32** (b)	**33** (b)	**34** (a)	**35** (b)	**36** (b)	**37** (d)	**38** (c)	**39** (b)	**40** (a)
41 (c)	**42** (a)	**43** (c)	**44** (c)	**45** (a)	**46** (a)	**47** (a)	**48** (b)	**49** (c)	**50** (d)
51 (d)	**52** (c)	**53** (d)	**54** (c)	**55** (d)	**56** (c)	**57** (c)	**58** (c)	**59** (b)	**60** (c)
61 (d)	**62** (b)	**63** (a)	**64** (b)	**65** (c)	**66** (a)	**67** (a)	**68** (d)	**69** (a)	**70** (b)
71 (c)	**72** (d)	**73** (b)	**74** (c)	**75** (b)	**76** (c)	**77** (d)	**78** (b)	**79** (c)	**80** (d)
81 (b)	**82** (a)	**83** (d)	**84** (a)	**85** (b)	**86** (a)	**87** (d)	**88** (b)	**89** (a)	**90** (a)
91 (d)	**92** (b)	**93** (b)	**94** (c)	**95** (a)	**96** (a)	**97** (b)	**98** (c)	**99** (b)	**100** (d)
101 (c)	**102** (a)	**103** (d)	**104** (a)	**105** (b)	**106** (c)	**107** (c)	**108** (c)	**109** (b)	**110** (c)
111 (b)	**112** (c)	**113** (a)	**114** (b)	**115** (c)	**116** (c)	**117** (c)	**118** (a)	**119** (c)	

SESSION 2

1 (c)	**2** (b)	**3** (b)	**4** (a)	**5** (d)	**6** (d)	**7** (a)	**8** (d)	**9** (c)	**10** (a)
11 (c)	**12** (a)	**13** (b)	**14** (d)	**15** (a)	**16** (c)	**17** (c)	**18** (d)	**19** (a)	**20** (a)
21 (b)	**22** (a)	**23** (a)	**24** (d)	**25** (a)	**26** (c)	**27** (d)	**28** (a)	**29** (a)	**30** (a)
31 (a)									