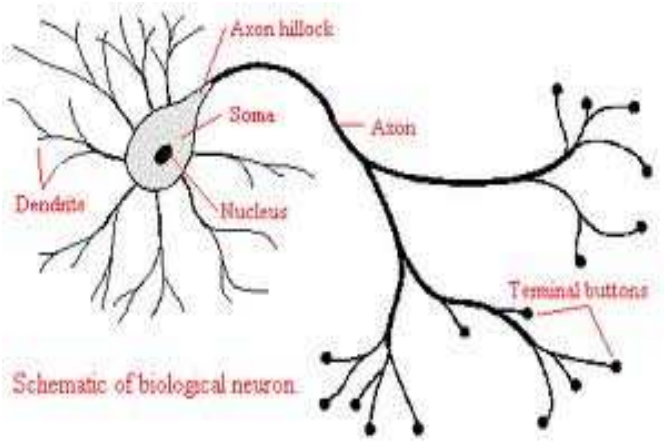
RABBIT- FUNCTIONAL ANATOMY - III

Nervous System

Very Short Answer Questions



1. Name the meninges covering the brain of rabbit.

Ans. The brain & spinal cord of rabbit are covered by three meninges.

1) Outer meninx – Duramater --- tough, fibrous double-layered
2) Middle meninx – Arachnoidmater --- delicate and avascular
3) Inner meninx – Piamater ---- highly vascular

2. What is corpus callosum?

Ans. The two cerebral hemispheres are internally connected together by broad transverse nerve fibres called corpus callosum.

3. Distinguish between pituitary gland and pituitary body.

Ans. In the Diencephalon, ventrally has a rounded projections of infundibulum bears pituitary gland or hypophysis.

Both infudibulum and hypophysis together form pituitary body.

4. What is optic chiasma? Where is it located?

Ans. On the ventral side of Diencephalon of forebrain two optic nerves cross and form optic chiasma. This is present in front of the infundibulum.

5. What do you know about arbor vitae?

Ans. The white matter of cerebellum is branched, tree-like appearance. Hence it is called arbor vitae.

6. What do you call the opening present between II and III ventricles and the duct present between III and IV ventricles?

Ans. a) The two Paracoels or I & II ventricles communicate with each other and with the diocoel by a transverse passage known as Foramen of Monro.

b) Iter or aqueduct of sylvius connects the III ventricle with IV ventricle.

7. What is a choroids plexus? Where do you find them?

Ans. Non-nervous, highly vascularised part in the brain is known as choroids plexus. It is formed by Piamater.

Two types of plexus are present in the brain of rabbit, they are:

1) Anterior choroid plexus --- epithalamus and piamater of diocoel or III ventricle of Diencephalon.
2) Posterior choroid plexus -- at the roof of Myelocoel or IV ventricle

8. Give the names of three sensory cranial nerves of rabbit.

Ans. There are only three sensory cranial nerves in Rabbit. They are---

a) Olfactory (I), b) Optic (II) and c)Auditory VIII) cranial nerves.

9. Name the largest and smallest cranial nerves of rabbit.?

Ans. Vagus nerve is the longest cranial nerve in the rabbit.

Pathetic or trochlear nerves are the smallest cranial nerves in rabbit.

10. What is brachial plexus? Name the nerves arising from it.?

Ans. Ventral rami of 5^{th} to 8^{th} cervical spinal nerves and 1^{st} thoracic spinal nerve from the brachial plexus.

It gives off Radial, Ulnar and Median nerves to forelimb.

11. What is lumbosacral plexus? Name the nerves arising from it.?

Ans. Ventral rami of 4^{th} to 7^{th} lumbar and first three sacral spinal nerves form Lumbosacral plexus.

It gives off Femoral, Obturator and Sciatic nerves to hindlimb.

12. What is the difference between somatic nervous system and autonomous nervous system with respect to the number of neurons in the motor pathway?

Ans.

Somatic nervous system	**Autonomous nervous system**
1. Voluntary control	1. Involuntary control
2. One motor neuron pathway.	2. Two motor neuron pathway.
3. Acetylcholine is the neurotransmitter.	3. Acetylcholine or norepinephrine is the neurotransmitter.
4. Skeletal muscle is effector.	4. Smooth muscle,cardiac muscle and glands are effectors.

13. Why is the sympathetic division called the thoracolumbar division?

Ans. The preganglionic sympathetic neurons have their cell bodies in the gray matter of thoracic and lumbar regions of the spinal cord.

So Sympathetic region is called 'thoracolumbar division'

14. Why is the parasympathetic division called the craniosacral division?

Ans. Cell bodies of preganglionic nerurons of parasympathetic division are located in the brain and in the sacral region of the spinal cord.

So the parasympathetic division is called as craniosacral division.

15. Distinguish between trunk ganglia and collateral ganglia of sympathetic nervous system.

Ans.

Trunk ganglia	**Collateral ganglia**
1. Each Sympathetic chain bears anterior Cervical ganglion, Posterior cervical ganglion, 12 thoracic, 6 or 7 lumbar and 3 or 4 sacral ganglia are present.	1. Ganglia lie outside sympathetic chain close to large abdominal arteries. 2. Coeliac ganglion,Anterior mesenteric and posterior mesenteric ganglia are present.
3. Post ganglinonic axons innervate organs anterior to the diaphragm.	3. post ganglionic axons innervate organs posterior to the diaphragm.

16. What are terminal ganglia of parasympathetic nervous system?

Ans. The parasympathetic ganglia which are present close or within the wall of the visceral organs are called terminal ganglia.

E.g. Ciliary ganglion, pterygopalatine ganglion, submandibular ganglion & Otic ganglion

17. What are cholinergic neurons and adrenergic neurons?

Ans. i) **Cholinergic neurons**: The neurons which release the neurotransmitter Acetyl chline are known as cholinergic neurons

Eg., a) Preganglionic neurons of all the sympathetic and parasympathetic.

b) All postganglionic neurons of parasympathetic.

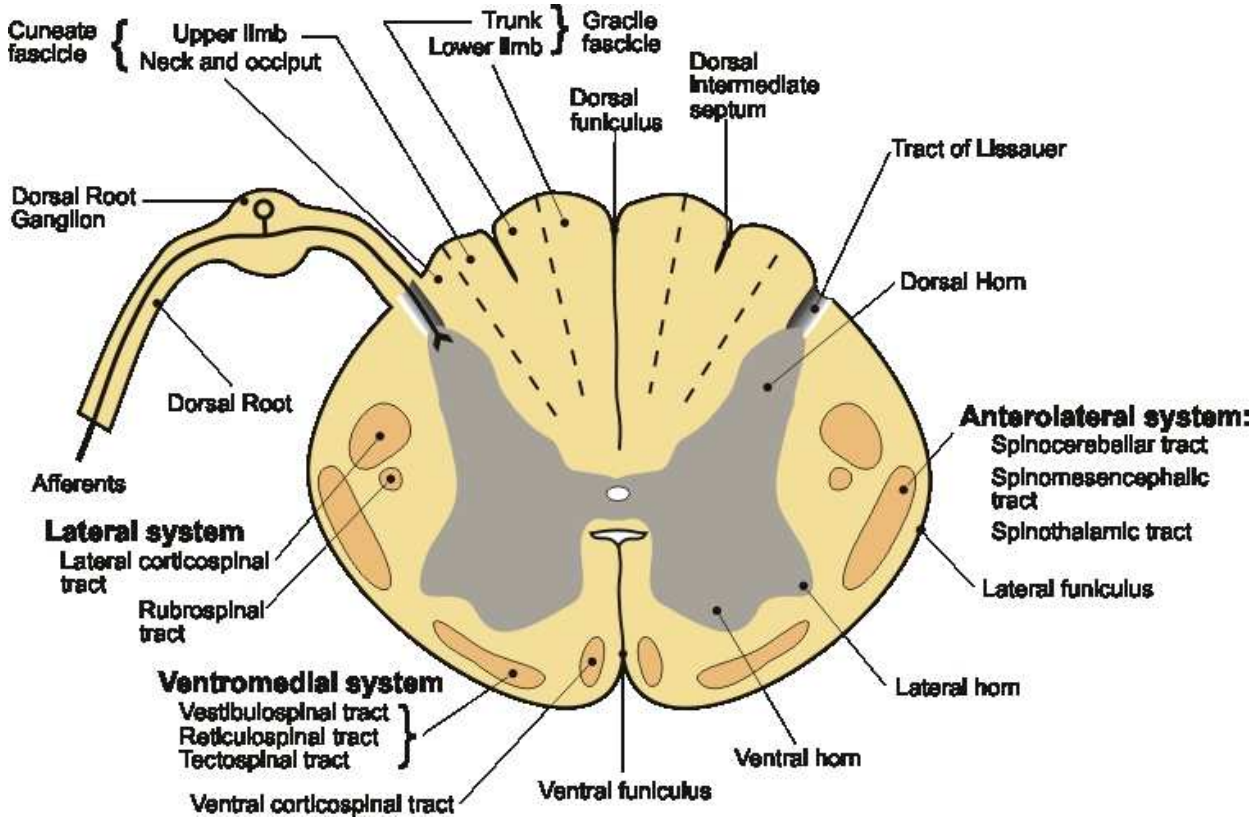
c) Sympathetic postganglionic neurons that innervate sweat glands

ii) **Adrenergic neurons**: The neurons which release neurotransmitter as Norpeinephrine are known as adrenergic neurons.

E.g., Most of sympathetic postganglionic neurons

Short Answer Questions

1. Describe the T.S. of spinal cord.



Ans. Spinal cord is a part of central nervous system.

- ► Medulla oblongata of brain continues as spinal cord which comes out through foramen magnum of cranium.
- ► The spinal cord lies in the neural canal of the vertebral column.
- ► It is covered by 3 meninges like duramater, arachnoid membrane and piamater.
- ► Spinal cord is a subcylindrical structure, showing convex dorsally and flattened ventrally.
- ► Spinal cord exhibits a brachial swelling near the forelimbs and a lumbar swelling near the hind limbs.
- ► It extends up to the middle of the lumbar region and later tapers down as a non-nervous Filum terminale.
- ► A dorsal sulcus and a deep ventral fissure divide the spinal cord into symmetrical right and left longitudinal halves.
- ► It has a narrow central canal. It is continuous with the IV ventricle of the brain. Central canal is lined by ependyma and filled with cerebrospinal fluid.
- ► Spinal cord has outer white matter with medullated nerve fibres, and inner grey matter with cell bodies, dendrites and non medullated axons.
- ► Grey matter is 'H' shaped or butterfly shaped, with dorsal horns and ventral horns.
- ► Grey horns divide the white mater into dorsal, lateral and ventral funiculi.

► Dorsal funiculus has sensory fibres; ventral funiculus has motor fibres and the lateral funiculi have both sensory and motor fibres.

2. Describe the sensory cranial nerves of rabbit.

Ans. Sensory cranial nerves of rabbit are (1) Olfactory nerves, (2) Optic and (3) Auditory.

1) **Olfactory nerves (I):** These are **sensory** nerves and receive the sensory impulses from olfactory epithelium. They arise from the olfactory epithelium and end in olfactory lobes.
2) **Optic nerves (II):** These are **sensory** nerves. They arise from retina and end in mid brain. Optic nerves of both sides cross on the ventral side of diencephalon and form **optic chiasma**. They receive the sensory impulses from retina.
3) **Auditory nerves (VIII):** These are **sensory** nerves. They arise from internal ear and end in medulla. They receive sensory impulses from internal ear. Each nerve divides into two branches.

   a. Vestibular : receives impulses from utriculus, sacculus and semicircular canals.

   b. Cochlear : receives from cochlea.

3. Describe the motor cranial nerves of rabbit.

Motor cranial nerve	**Origin**	**Takes motor impulses to**
III)Oculomotor	Crura cerebri	Anterior,superior and inferior recti muscles and inferior oblique muscles of eyeballs.
IV)Pathetic	Between midbrain and cerebellum	Superior oblique muscles of eyeballs.
VI)Abducens	Pon varolii	Posterior rectus muscles of eye balls and nictitating membrane.
XI)Spinal accessory	Medulla oblongata	Muscles of pharynx, larynx, neck and shoulders.
XII)Hypoglossal	Medulla oblongata	Tongue and Hyoid apparatus.

4. Describe the mixed cranial nerves of rabbit.

Ans. Mixed cranial nerves in rabbit are

1) **Trigeminal (V):** They originate from Gasserian ganglion on pons varolii. Each has three branches…..
   a) **Ophthalmic superficialis**: Sensory nerve. It receives sensory impulses from conjunctiva, iris, cornea, ciliary body, lacrimal glands, upper eyelids, olfactory epithelium of nasal sac.
   b) **Maxiallary:** Mixed nerve. It receives sensory impulses from soft palate, teeth of upper jaw, the vibrissae, lower eye lids, upper lip, sides of snout and mucosa of nasal sac.

It takes motor impulses to lacrimal glands.

c) **Mandibular:** it is mixed. It receives sensory impulses from skin of temporal region, teeth of lower jaw, external ear, lower lip and anterior region of tongue. It takes motor impulses to muscles of lower jaw, sublingual and submaxillary salivary glands.

2) **Facial nerves (VII):** They originate from Pons varolii. Each has 3 branches.

a) Palatine: Sensory. Receives sensory impulses from roof of buccal cavity.

b) Chorda tympani: Sensory. Receives sensory impulses from the taste buds at the anterior part of tongue.

c) Hyomandibular: Motor. Takes motor impulses to muscles of lower jaw, neck, pinna, face, hyoid apparatus & salivary glands.

3) Glossopharyngeal nerves (IX): They originate from medulla. It is divided into two branches.

a) Lingual: It is mixed. It receives sensory impulses from the posterior third of the tongue. It takes motor impulses to sublingual and submaxillary salivary glands.

b) Pharyngeal: It is mixed. It receives sensory impulses from the pharynx. It takes motor impulses to parotid glands and muscles of tongue.

4) , **Vagus(X)** : Originate in medulla and pss through vagus ganglion and has the following branches.

a) Superior laryngeal : Sensory. Receives impulses from larynx.

b) Recurrent laryngeal : Motor. Takes impulses to larynx.

c) Cardiac depressor : Sensory. Receives impulses from aortic arch

d) Cardiac : Motor. Takes impulses to heart.

e) Pneumogastric : Mixed. It receives the impulses from lungs, oesophagus and stomach and takes impulses to muscles f lungs, oesophagus and stomach.

5. Explain the formation of a spinal nerve and its division into three branches.?

- In rabbit the spinal nerves arise from the spinal cord and emerge out of the neural canal through inter vertebral foramina.
- In rabbit there are 37 pairs of spinal nerves because the spinal cord does not extend in the tail.
- A spinar nerve is formed by the union of two roots arise form the horns of grey matter. They are a dorsal root, which is sensory and the ventral root which is motor. So the spinal nerves are mixed nerves.
- Just after coming out from inververtebral foramina, each spinal nerve divides into three branches or rami.

1)Dorsal branch or ramus dorsalis: It goes to the skin and muscles of dorsal part of the body.

2)Ventral branch or ramus ventralis: It innervates the skin and muscles of lateroventral parts of the body.

3)Visceral branch or ramus communicans : It joins the sympathetic system and supply to the visceral organs.

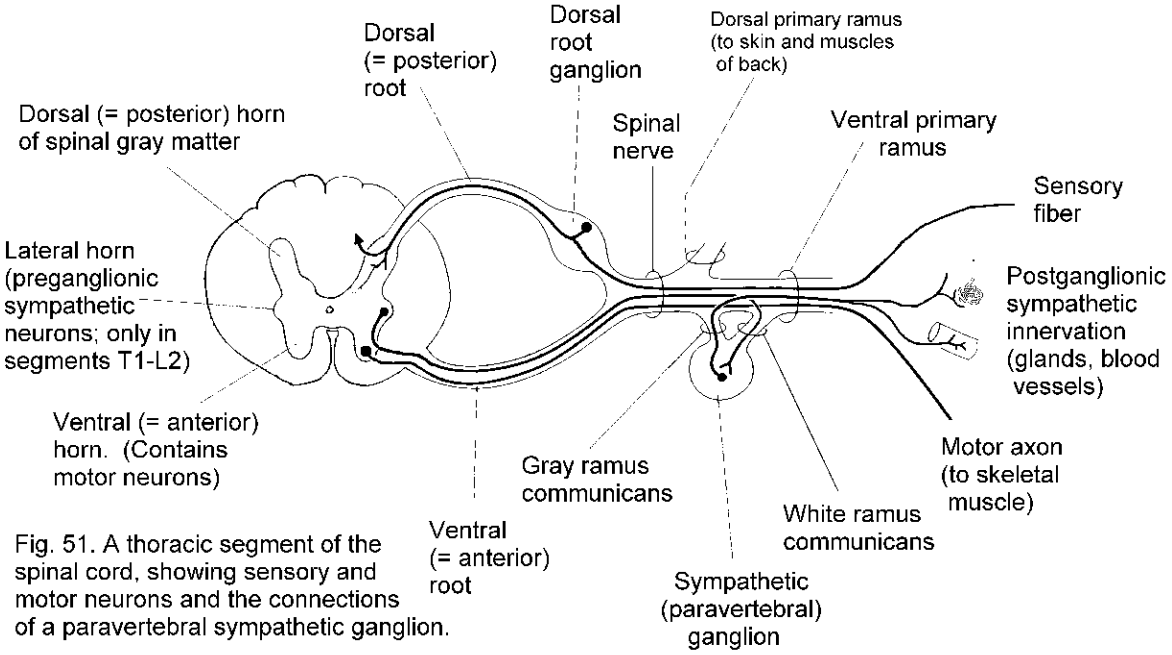


Fig. 51. A thoracic segment of the spinal cord, showing sensory and motor neurons and the connections of a paravertebral sympathetic ganglion.

6. Describe the spinal nerves of various regions of rabbit.

Ans. In rabbit the 37 pairs of spinal nerves are divisible into five groups, based on the regions of backbone.

1. Cervical (neck) - 8 pairs
2. Thoracic - 12 pairs
3. Lumbar - 7 pairs
4. Sacral - 4 pairs
5. Caudal or Coccygeal - 6 pairs

- First cervical spinal nerve leaves the neural canal through an aperture between skull and atlas.
- Ventral branch of the 3rd cervical spinal nerve gives off an auricular nerve to the pinna.
- The ventral branches of 4th, 5th and 6th cervical spinal nerves in the neck form cervical plexus. It gives off a Phrenic nerve to the muscles of diaphragm.
- Ventral rami of 5th to 8th cervical spinal nerves and 1st thoracic spinal nerve from the brachial plexus.
  It gives off Radial, Ulnar and Median nerves to forelimb.
- Ventral rami of 4th to 7th lumbar and first three sacral spinal nerves form Lumbosacral plexus.
  It gives off Femoral, Obturator and Sciatic nerves to hind limb.
- Before emerging out form the intervertebral foramina, lumbar, sacral and caudal nerves extend back along with the filum terminale and form a thick bundle of nerves known as 'Cauda equina'

7. Distinguish between somatic nervous system and autonomic nervous system.

Ans.

Somatic nervous system	Autonomous nervous system
1. Special senses and somatic senses sensory input.	1. Mainly form interceptors as a sensory input.
2. Voluntary control	2. Involuntary control.
3. One - neuron pathway.	3. Two - neuron pathway.
4. Acetylcholine is the neurotransmitter.	4. Acetylcholine or norepinephrine as neurotransmitter.
5. Skeletal muscle is effector.	5. Smooth muscle, cardiac muscle and glands are effectors.

8. Describe the sympathetic nervous system of rabbit.

Ans. Autonomic nervous system operates without conscious control. .

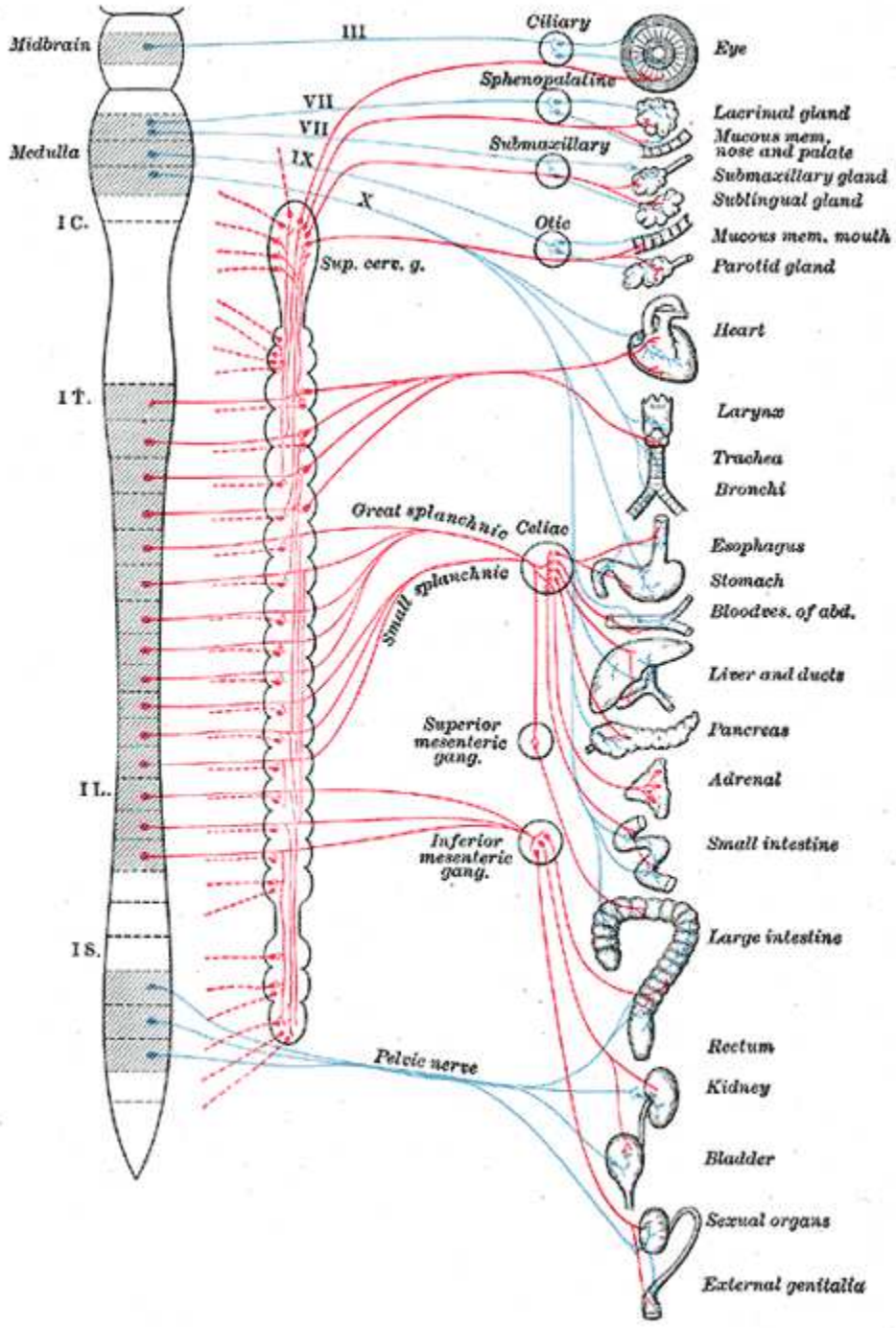
Motor part of ANS has two divisions like

(1) Sympathetic division

(2) Parasympatheitc division.

A) **Sympathetic division:** Preganglionic sympathetic neurons have their cell bodies in the grey mater of thoracic and the lumbar regions of spinal cord. So this division is known as Thracolumbar division.

- One pair of sympathetic chains/trunks of ganglia extends from the base of skull to posterior end of body.
- Each of them has a series of Trunk galglia.
- Each chain ahs an anterior cervical ganglion, a posterior cervical ganglion, 12 thoracic ganglia, 6 or 7 lumbar ganglia and 3 or 4 sacral ganglia.
- Along with these ganglia, 3 collateral ganglia are present outside the sympathetic chain. They are coeliac ganglion, anterior mesenteric ganglion and posterior mesenteric ganglion.
- Postganglionic axons from sympathetic trunk ganglia innervate orgns anterior to the diaphragm, whereas postganglionic axons from collateral ganglia innervate organs posterior to diaphragm..


Midbrain
Medulla
I C.
I T.
I L.
I S.
III
VII
VII
IX
X
Sup. cerv. g.
Ciliary
Sphenopalatine
Submaxillary
Otic
Great splanchnic
Celiac
Small splanchnic
Superior mesenteric gang.
Inferior mesenteric gang.
Pelvic nerve
Eye
Lacrimal gland
Mucous mem. nose and palate
Submaxillary gland
Sublingual gland
Mucous mem. mouth
Parotid gland
Heart
Larynx
Trachea
Bronchi
Esophagus
Stomach
Bloodves. of abd.
Liver and ducts
Pancreas
Adrenal
Small intestine
Large intestine
Rectum
Kidney
Bladder
Sexual organs
External genitalia

9. Describe the parasympathetic nervous system of rabbit.

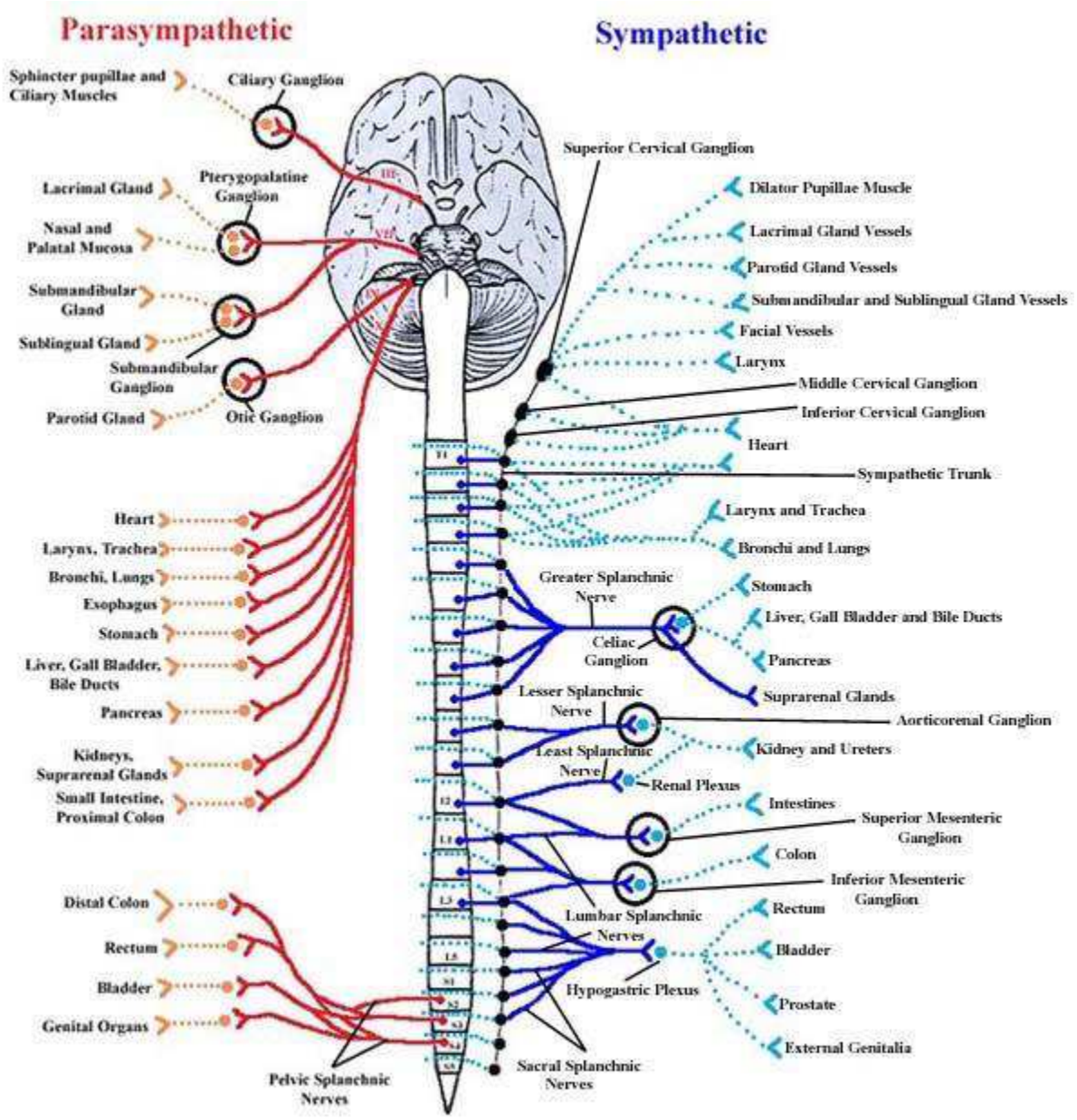
Ans. **Parasympathetic nervous system:**

- Cell bodies of preganglionic neurons of the parasympathetic division are located in the brain and in the sacral nerve region of spinal cord. So it is known as Craniosacral division.
- The axons of parasympathetic preganglionic neurons that emerge from the brain occur in III, VII, IX and X cranial nerves.
- The axons of parasympathetic preganglionic nurons that emerge from sinal cord occur in 2^{nd}, 3^{rd} and 4^{th} sacral spinal nerves. These fibres are known as Craniosacral outflow.
-
- The ganglia of this system are located close to or within the wall of visceral organs. So they are called as Terminal ganglia. They are Ciliary ganglion, pterygopalatine ganglion, submandibular ganglion, and optic ganglion.

10. Explain the physiological effects of the sympathetic and parasympathetic divisions of the autonomic nervous system. ?

Ans.

Sympathetic stimulation	**Parasympathetic stimulation**
1. Increases the heartbeat.	Decrease the heartbeat.
2. Dilates pupil	Constricts pupil.
3. Dilates bronchi	Constricts bronchi
4. Constricts blood arterioles.	Dilates blood arterioles.
5. Increase the blood pressure.	Decrease the blood pressure.
6. Decreases gastrointestinal motility.	Increases gastrointestinal motility.
7. Contraction of sphincters.	Relaxation of sphincters.
8 Inhibits secretion of digestive enzymes.	Stimulates secretion of digestive enzymes.
9 Relaxation of wall of urinary bladder and contraction of sphincter.	Contraction of wall of urinary bladder and relaxation of sphincter.
10. Contracts a rector pili muscles	No known effect.

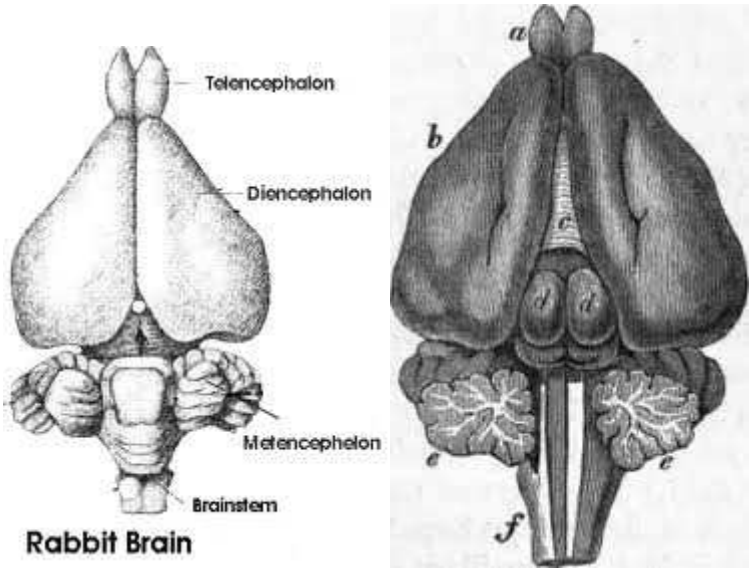

Parasympathetic
Sympathetic
Sphincter pupillae and Ciliary Muscles
Ciliary Ganglion
Lacrimal Gland
Pterygopalatine Ganglion
Nasal and Palatal Mucosa
Submandibular Gland
Sublingual Gland
Submandibular Ganglion
Parotid Gland
Otic Ganglion
Heart
Larynx, Trachea
Bronchi, Lungs
Esophagus
Stomach
Liver, Gall Bladder, Bile Ducts
Pancreas
Kidneys, Suprarenal Glands
Small Intestine, Proximal Colon
Distal Colon
Rectum
Bladder
Genital Organs
Pelvic Splanchnic Nerves
Superior Cervical Ganglion
Dilator Pupillae Muscle
Lacrimal Gland Vessels
Parotid Gland Vessels
Submandibular and Sublingual Gland Vessels
Facial Vessels
Larynx
Middle Cervical Ganglion
Inferior Cervical Ganglion
Heart
Sympathetic Trunk
Larynx and Trachea
Bronchi and Lungs
Greater Splanchnic Nerve
Stomach
Liver, Gall Bladder and Bile Ducts
Celiac Ganglion
Pancreas
Suprarenal Glands
Lesser Splanchnic Nerve
Aorticorenal Ganglion
Kidney and Ureters
Least Splanchnic Nerve
Renal Plexus
Intestines
Superior Mesenteric Ganglion
Colon
Inferior Mesenteric Ganglion
Lumbar Splanchnic Nerves
Rectum
Bladder
Hypogastric Plexus
Prostate
External Genitalia
Sacral Splanchnic Nerves

Long Answer Questions

1. Describe the structure and functions of the brain of rabbit.?

Ans. The nervous system of Rabbit shows 3 sub-divisions.

1) **Central nervous system :** It includes Brain and Spinal cord.
2) **Peripheral nervous system :** It includes cranial and spinal nerves.
3) **Autonomous nervous system :** It includes sympathetic and parasympathetic nervous system.



:: In rabbit, brain is present in cranium of skull. It has three main regions

a)Forebrain b)Midbrain c) Hindbrain

I) FOREBRAIN/PROSENCEPHALON: It consists of olfactory lobes, cerebral hemispheres and a diencephalon.

A) **OLFACTORY LOBES:** One pair of club-shaped lobes present at anterior most part of brain.

- Each lobe has an olfactory bulb and an olfactory tract.
- Olfactory tracts are separated from hippocampal lobe by rhinal fissure.
- Cavity of these lobes are rhinocoels / olfactory ventricles.
- These are concerned with sense of smell.

B) CEREBRAL HEMISPHERES / CEREBRUM :

- One pair of cerebral hemispheres forms the cerebrum. They are narrow anteriorly and broad posteriorly.
- A longitudinal median fissure separates two cerebral hemispheres.
- An oblique Sylvian fissure separates each hemisphere into an anterior Frontal lobe and a posterolateral Temporal lobe.
- Parietal lobe is the posteromedian lobe of each hemisphere.
- A longitudinal Rhinal fissure separates hippocampal lobe from olfactory tract.
- Hippocampal sulcus demarcates the hippocampal lobe from other lobes.

- Corpus callosum is broad transverse band of nerve fibes that joins two hemispheres internally.
- Cavities are known as Paracoels/Lateral ventricles/I & II ventricles.
- Paracoels and diocoel are connected by a transverse foramen of Monro.
- Roof and dorsolateral wall of paracoel are thick and form Neopallium. It is smooth in rabbit.
- Floor and ventrolateral walls of paracoel form Corpus striatum.
- Anterior commissure is a transverse band of nerve fibres that joins corpora striata.
- It is concerned with voluntary movements, thinking, reasoning, intelligence, memory etc.,

C) DIENCEPHALON / THALAMENCEPHALON :

- Small posterior part of forebrain.
- Its cavity is Diocoel/ 3rd ventricle.
- Roof of diocoel is Epithalamus. Epithalamus and piamater form anterior choroid plexus.
- A pineal stalk arises from epithalamus and terminates as a Pineal gland/epiphysis.
- Floor of diocoel is Hypothalamus. It has a median rounded projection, Infundibulum.
- Infundibulum has pituitary gland/Hypophysis.
- Optic chiasma is formed by the crossing of optic nerves in front of infundibulum.
- Corpus mamillare is present behind the infundibulum.
- Optic thalami are the thickened lateral walls of diencephalon and joined by Median commissure.
- Diencephalon provides perception of touch, pressure, pain and temperature.
- Hypothalamus controls and integrates the activities of ANS and pituitary gland and temperature.

II) MIDBRAIN / MESENCEPHALON::

- It has four optic lobes collectively known as corpora quadrigemina.
- Superior colliculi are larger anterior lobes and concerned with sight.
- Inferior colliculi are smaller posterior lobes and concerned with hearing.
- Dorsal walls of superior colliculi are connected by a transverse band, Posterior commissure.
- Midbrain has a narrow longitudinal Iter/Aqueduct of Sylvius.
- It connects III & IV ventricles.
- Floor is formed by thick tracts of nerve fibres , Crura cerebri .

III) HINDBRAIN /RHOMBENCEPHALON : It includes metencephalon and myelencephalon.

A) **METENCEPHALON :** It has Pons varolii and cerebellum

i) **PONS VAROLII**: It connects right and left halves of the cerebellum anteroventrally.

ii) **CEREBELLUM** : It consists of a median lobe, Vermis and two lateral lobes.

Each lateral lobe has a ventrolateral extension, Flocculus.

White matter is known as Arbor vitae (tree like) .

-- Cerebellum coordinates the voluntary muscular movements initiated by cerebrum.

-- It regulates posture and balance.

B) MYELENCEPHALON / MEDULLA OBLONGATA

- Last part of brain. It is anteriorly broad and psoteriorly tapers into spinal cord.
- Ventricle is known as Myelocoel / 4th ventricle.
- Piamater projects as posterior choroid plexus.
- Medulla oblongata and pons Varolii control the involuntary activities in the body like Heartbeat, breathing, vomiting, swallowing etc.,

2. Describe the autonomic nervous system of rabbit.

Ans. Autonomic nervous system operates without conscious control. . Motor part of ANS has two divisions like

(1) Sympathetic division (2) Parasympatheitc division.

A) **Sympathetic division:** Preganglionic sympathetic neurons have their cell bodies in the grey mater of thoracic and the lumbar regions of Spinal cord. So this division is known as Thoracic columbar division.

- ❖ One pair of sympathetic chains/trunks of ganglia extends from the base of skull to posterior end of body.
- ❖ Each of them has a series of Trunk ganglia.
- ❖ Each chain ahs an anterior cervical ganglion, a posterior cervical ganglion, 12 thoracic ganglia, 6 or 7 lumbar ganglia and 3 or 4 sacral ganglia.
- ❖ Along with these ganglia, 3 collateral ganglia are present outside the sympathetic chain. They are Coeliac ganglion, Anterior mesenteric ganglion and posterior mesenteric ganglion.
- ❖ Postganglionic axons from sympathetic trunk ganglia innervate orgns anterior to the diaphragm, whereas postganglionic axons from collateral ganglia innervate organs posterior to diaphragm..

B) **Parasympathetic nervous system:**

- ❖ Cell bodies of reganglionic neurons of the parasympathetic division are located in the brain and in the sacral nerve region of spinal cord. So it is known as Craniosacral division.
- ❖ The axons of parasympathetic preganglionic neurons that emerge from the brain occur III, VII, IX and X cranial nerves.
- ❖ The axons of parasympathetic preganglionic nurons that emerge from sinal cord occur in 2nd, 3rd and 4th sacral spinal nerves. These fibres are known as Craniosacral outflow.
- ❖ The ganglia of this system are located close to or within the wall of visceral organs. So they are called as Terminal ganglia. They are Ciliary ganglion, pterygopalatine ganglion, submandibular ganglion, and optic ganglion.

NEUROTRANSMITTERS OF ANS:

I) **Cholinergic neurons**: The neurons which release the neurotransmitter Acetyl choline are known as cholinergic neurons

Eg., a)Preganglionic neurons of all the sympathetic and parasympathetic.
b) All postganglionic neurons of parasympathetic.
c) Sympathetic postganglionic neurons that innervate sweat glands

II) **Adrenergic neurons**: The neurons which release neurotransmitter as Norpeinephrine are known as adrenergic neurons.

E.g., Most of sympathetic postganglionic neurons.

Physiological effect of ANS : The effects of sympathetic and parasympathetic nervous system are usually antagonistic (like accelerator and brake). In general, nerve impulses from sympathetic division increase the activity, whereas impulses from parasympathetic division decrease the activity of the organs. The balance between sympathetic and parasympathetic activity is regulated by hypothalamus activity of the sympathetic division and release of hormones by the adrenal medulla brings about fight or flight response. The parasympathetic division enhances "rest and digest" activities.

The effects of sympathetic and parasympathetic divisions

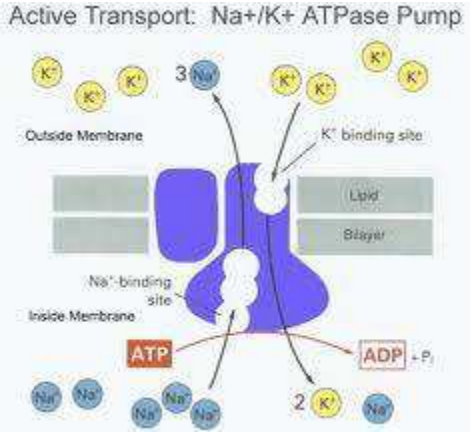
Sympathetic Stimulation	**Parasympathetic Stimulation**
Increases heart beat	Decreases heart beat
Dilates pupil	Constricts pupil
Dilates bronchi	Constricts bronchi
Mainly constricts blood arterioles	Mainly dilates blood arterioles
Increases blood pressure	Decreases blood pressure
Dilates coronary arterioles	Constricts coronary arterioles
Dilates skeletal muscle arterioles	No known effect
Contracts arrector pili muscles	No known effect
Decreases gastrointestinal motility, contraction of sphincters.	Increases gastrointestinal motility, relaxation of sphincters.
Inhibits secretion of digestive enzymes	Stimulates secretion of digestive enzymes.
Relaxation of wall of urinary bladder and contraction of sphincter.	Contraction of wall of urinary bladder and relaxation of sphincter.

Propagation of Nerve Impulse

Very Short Answer Questions

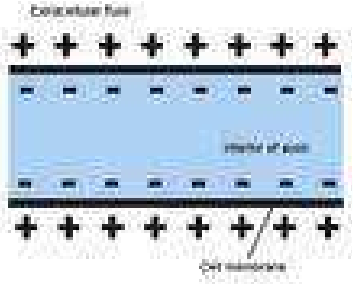
1. What is sodium-potassium pump?

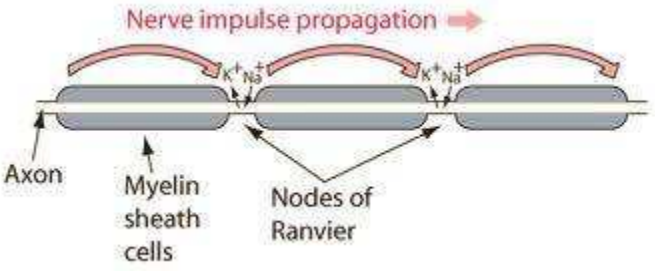
Ans. The Na^+ and K^+ gradients between axoplasm and ECF are maintained by the Na^+/K^+ ATPase (sodium-potassium pump). It transports 3 Na^+ into ECF and 2 K^+ ions into the axoplasm.



2. What is the value of resting membrane potential? Name the instruments used to measure it.

Ans. The value of resting membrane potential is about –70 mV.
Voltmeter or oscilloscope is the instrument used to measure it.





3. Distinguish between depolarization and hyper polarization.

Ans. Depolarized means the membrane potential becomes less negative in inner side. It reaches to +45 mV.

Hyperpolarized means membrane potential becomes more negative in inner side. It may reach to – 90 mV.

4. What is an action potential?

Ans. The local voltage change across the cell wall as a nerve impulse is transmitted is called action potential.

5. What is threshold potential?

Ans. The momentary change in electrical potential on the membrane of a neuron that occurs when it is stimulated, resulting in the transmission of an electrical impulse is termed as Action potential or nerve impulse.

6. Justify the statement "action potential are all-or-none events".

Ans. When the depolarization is just equal to or above the threshold potential;
an action potential of equal amplitude is initiated.
Hence the action potential is an all-or- none phenomenn.

7. What is an absolute refractory period?

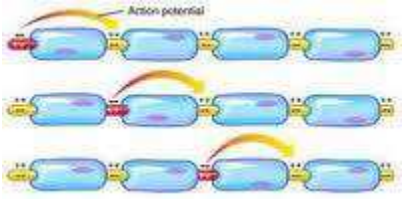
Ans. A few milliseconds after initiation of an action potential it is impossible to trigger a second action potential. This period is known as 'absolute refractory period'.

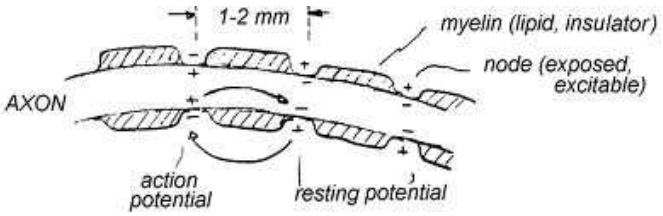
8. What is a relative refractory period?

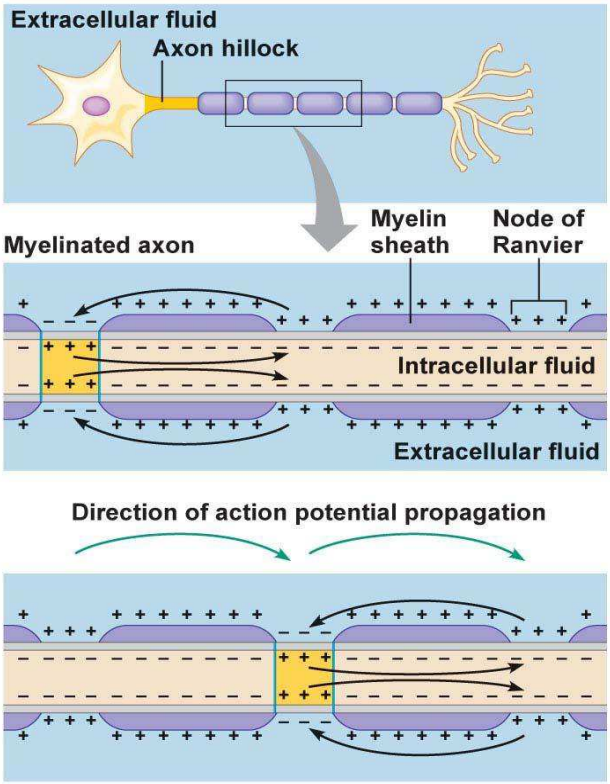
Ans. The time during which a second action potential can be initiated by a larger than normal stimulus is called relative refractory period.

9. What is saltatory conduction?

Ans. In a myelinated axon, the voltage – gated Na and K channels are concentrated at nodes of Ranvier.
So depolarization travels from one node to another node by leaping (saltations). This mechanism is called saltatory conduction.
It is about 50 times faster than the continuous conduction.







10. Distinguish between excitatory and inhibitory postsynaptic potential.

Ans.Excitatory neurotransmitters depolarize the postsynapticmembrane. These potentials are called as excitatory postsynaptic potential. (EPSPs)

Inhibitory neurotransmitters cause hyperpolarization of postsynaptic membrane. These potentials are called inhibitory postsynaptic potentials.(IPSP)

11. Distinguish between temporal summation and spatial summation.

Ans. Integration of the inputs is known as Summation.

The summation of Successive inputs from a single pre synaptic bouton is called temporal summation.

The summation of inputs from several pre synaptic boutons is called spatial summation.

12. Give two examples for inhibitory neurotransmitters.

Ans. Gamma amino butyric acid (GABA) and glycine are inhibitory neurotransmitters.

Short Answer Questions

1. Explain resting membrane potential.

- The axoplasm and extra cellular fluid are electrically neutral.

- ❖ Just inside the axolemma anions are present in the axoplasm. Cations are present in the ECF just outside the axolemma.
- ❖ They tend to move back toward each other. This tendency of oppositely charged ions to flow back towards each other called a potential. It is measured by voltmeter or oscilloscope.
- ❖ The membrane potential of a neuron that is not transmitting signals is known as Resting potential.
- ❖ The concentration of Na^+ in ECF is ten times to its concentration in the axoplasm.
- ❖ The concentration of K^+ in the axoplasm is thirty times to its concentration in the ECF.
- ❖ The Na^+ and K^+ gradients are maintained by the Na^+ / K^+ ATP ase (Sodium-Potassium pump) . It ransports 3 Na into ECF and 2 K in to the cell.
- ❖ The principle anion in the axoplasm is non-diffusible proteins, sulphate, phosphate and other organic anions. The principal anion in ECF is Cl.
- ❖ At the resting potential, the voltage-gated Na^+ channels are in resting state. Voltage gated K channels are closed.
- ❖ Resting potential about –70 mV, negative on the inner side of axolemma. At resting phase, the axolemma is polarized. If the inner side becomes less negative is called depolarized. If the inner side becomes more negative is called hyperpolarized.

2. Explain action potential.

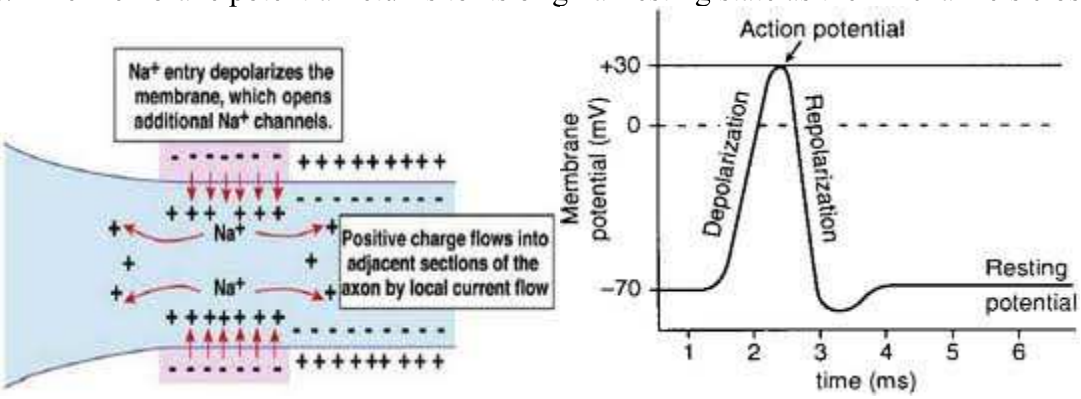
► The momentary change in electrical potential on the membrane of a neuron occurs when it is stimulated, resulting in the transmission of en electrical impulse is known as action potential or nerve impulse.

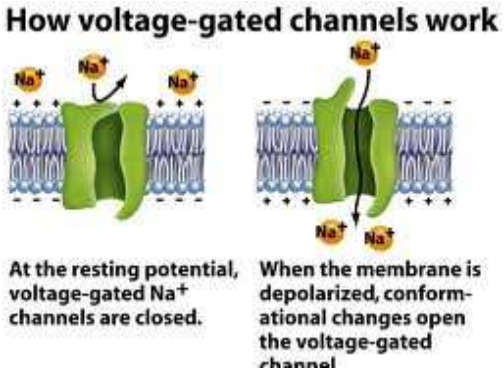
A) Depolarizing phase: when the depolarization reaches the threshold level (-55mV), voltage gated Na channels are activated.

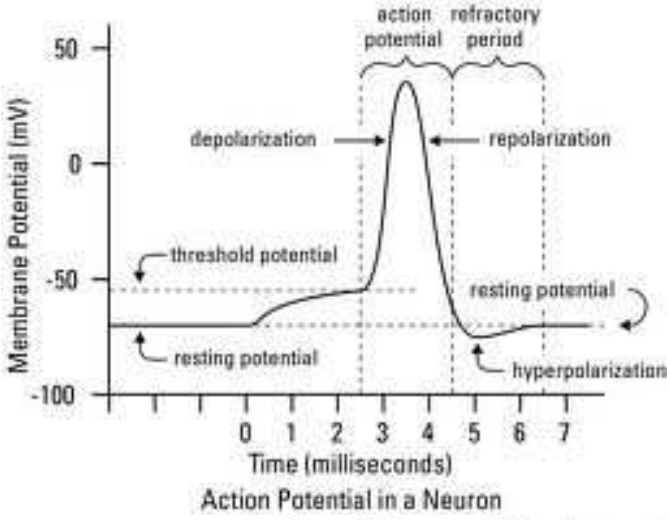
Due to rapid influx of Na the membrane potential shoots rapidly upto +45 mV. When **t**he depolarization is just equal to or above the threshold potential, an action potential of equal amplitude is initiated. Hence the action potential is an all-or-non-principle.

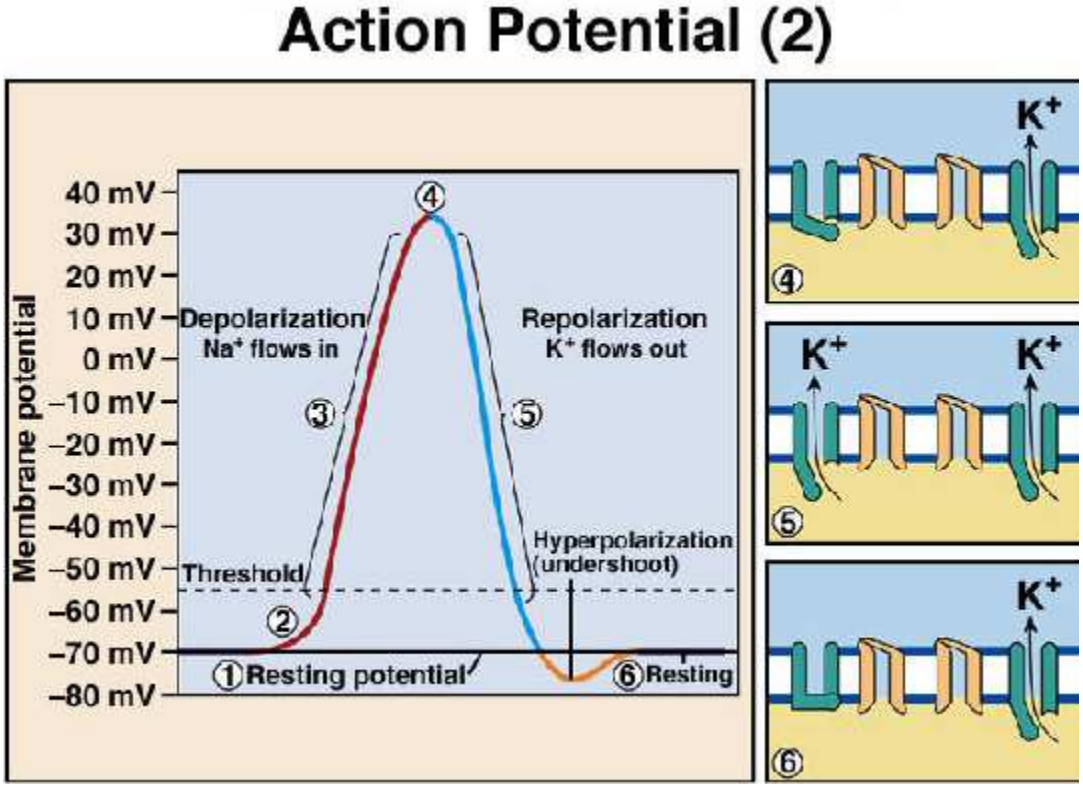
B) **Repolarizing phase:** The membrane potential rises to its peak, the voltage gated Na^+ channels are inactivated and voltage-gated K^+ channels open. The efflux of K repolarizes the axolema.

C) **Hyperpolarizing phase (Undershoot):** The membrane potential briefly becomes even more negative (–90 mV) than it normally is at rest. It is due to more outward movements of K ions. The membrane potential returns to its original resting state as the K^+ channels close.









3. Give an account of synaptic transmission.

- Synapse is the space between two neurons. It is generally present between the terminal knob of one neuron and dendrite of the next neuron. The space between two neurons is synaptic cleft.
- The parts in a synapse are Presynaptic terminal, synaptic cleft and postsynaptic membrane.
- Neurotransmitter is synthesized by presynaptic neuron and stores in presynaptic vesicles of synaptic terminals.

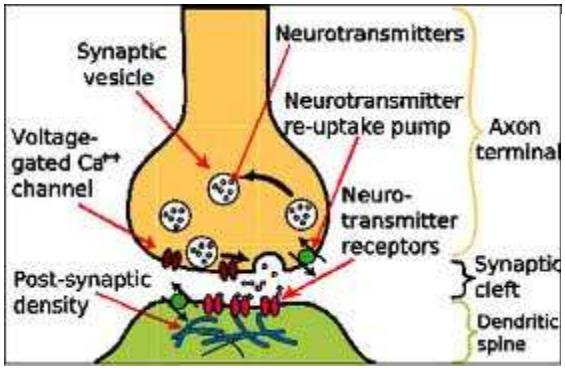
Transmission of impulse through synapse occurs in the following manner……..

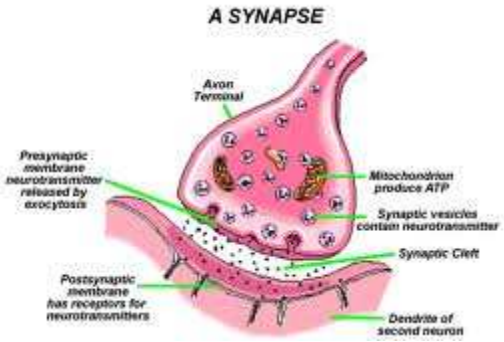
- Action potential depolarizes the terminal membrane of presynaptic region to open voltage-gated calcium channels in that membrane.
- Calcium ions diffuse into the terminal. The rise in Ca concentration in terminal causes the fusion of synaptic vesicles with terminal membrane to release the neurotransmitter by exocytosis.
- Neurotransmitter diffuses across the synaptic cleft.
- Postsynaptic membrane has ligand-gated channels. Neurotransmitter binds with receptor of these channels and causes Postsynaptic potential.
- Excitatory neurotransmitters depolarize the postsynapticmembrane. These potentials are called as excitatory postsynaptic potential. (EPSPs)
- Inhibitory neurotransmitters cause hyperpolarization of postsynaptic membrane. These potentials are called inhibitory postsynaptic potentials.(IPSP)
- Neurotransmitter is degraded by an enzyme present in synaptic cleft.
- If the sum of EPSPs exceeds the sum of IPSPs and the threshold is reached, an action potential is generated in the initial segment of the axon of the postsynaptic neuron.

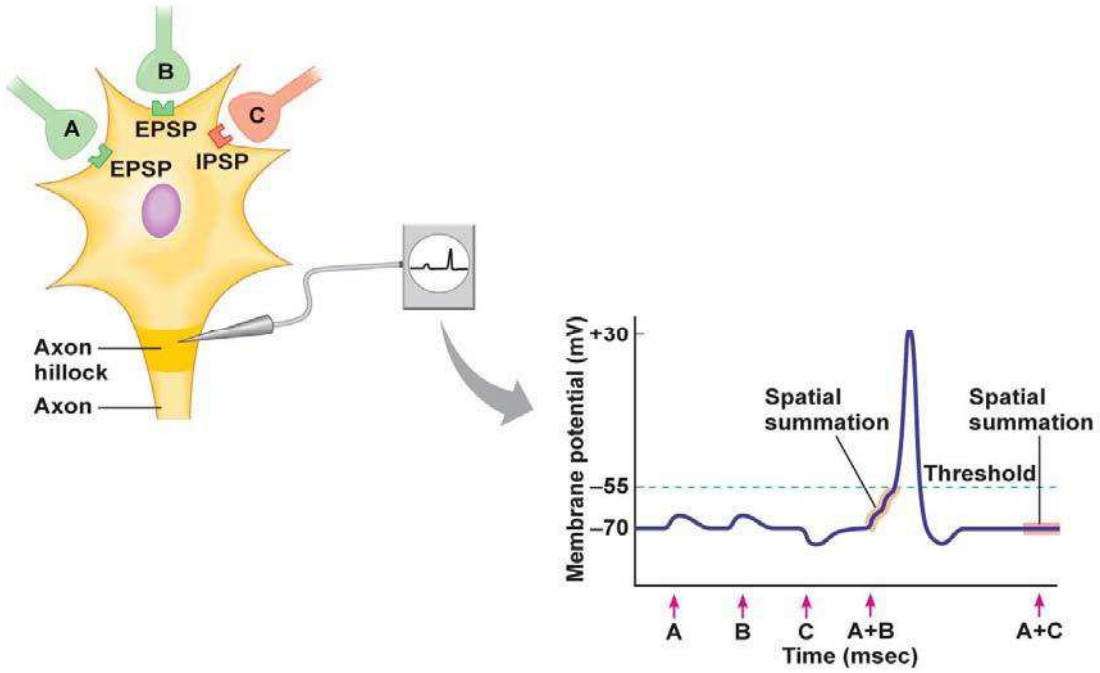
SUMMATION OF POSTSYNAPTIC POTENTIALS

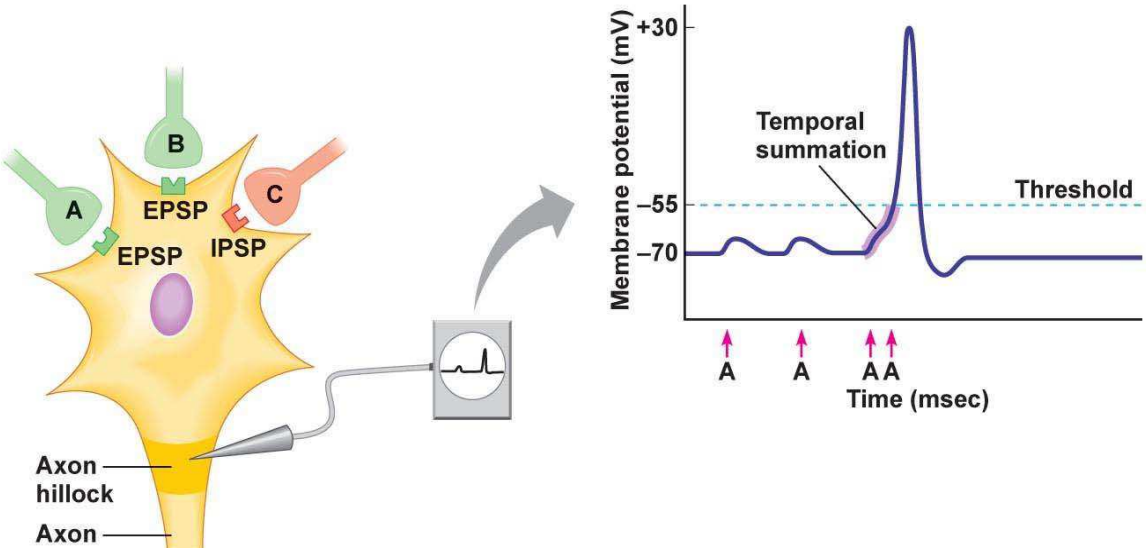
- Unlike action potentials, postsynaptic potentials are graded. Their magnitude varies with a number of factors like the amount of neurotransmitter.
- A typical neuron receives input from many synapses.
- Integration of the inputs is known as Summation.
- The summation of Successive inputs from a single pre synaptic bouton is called temporal summation.

The summation of inputs from several pre synaptic boutons is called spatial summation.









Long Answer Questions

1. Explain the impulse transmission through a nerve fibre.

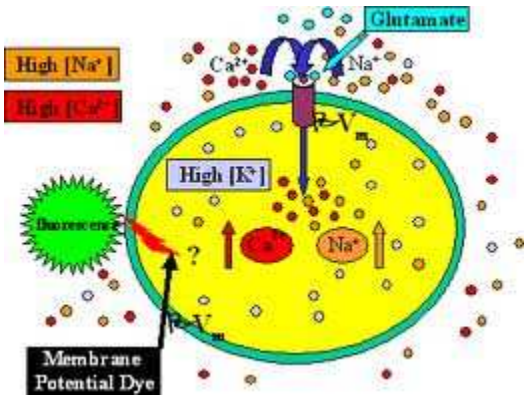
Ans. Nerve impulse is the combination of mechanical, chemical or electrical disturbances occur in a neuron because of stimulus..

The propagation of an impulse along nerve fibre is called transmission. In this process both physical and chemical changes are involved. The entire process is divided into stimulation, excitation, conduction and response.

A) RESTING POTENTIAL:

- The axoplasm and extra cellular fluid are electrically neutral.

- Just inside the axolemma anions are present in the axoplasm. Cations are present in the ECF just outside the axolemma.
- They tend to move back toward each other. This tendency of oppositely charged ions to flow back towards each other called a potential. It is measured by voltmeter or oscilloscope.
- The membrane potential of a neuron that is not trnsmiting signals is known as Resting potential.
- The concentration of Na^+ in ECF is ten times to its concentration in the axoplasm.
- The concentration of K^+ in the axoplasm is thirty times to its concentration in the ECF.
- The Na^+ and K^+ gradients are maintained by the Na^+ / K^+ ATP ase (Sodium-Potassium pump). It ransports 3 Na into ECF and 2 K in to the cell.
- The principle anion in the axoplasm is non-diffusible proteins, sulphate, phosphate and other organic anions. The principal anion in ECF is Cl.
- At the resting potential, the voltage-gated Na^+ channels are in resting state. Voltage gated K channels are closed.
- Resting potential about –70 mV, negative on the inner side of axolemma. At resting phase, the axolemma is polarized. If the inner side becomes less negative is called depolarized. If the inner side becomes more negative is called hyperpolarized.



B) **ACTION POTENTIAL** :

- The momentary change in electrical potential on the membrane of a neuron occurs when it is stimulated, resulting in the transmission of en electrical impulse is known as action potential or nerve impulse.
- **A) Depolarizing phase:** when the depolarization reaches the threshold level (-55mV), voltage gated Na channels are activated.
- Due to rapid influx of Na the membrane potential shoots rapidly upto +45 mV. When the depolarization is just equal to or above the threshold potential, an action potential of equal amplitude is initiated. Hence the action potential is an all-or-non-principle.
- B) **Repolarizing phase:** The membrane potential rises to its peak, the voltage gated Na^+ channels are inactivated and voltage-gated K^+ channels open. The efflux of K repolarizes the axolema.
- C) **Hyperpolarizing phase (Undershoot) :** The membrane potential briefly becomes even more negative (–90 mV) than it normally is at rest. It is due to more outward movements of K ions. The membrane potential returns to its original resting state as the K^+ channels close.

C) **Refractory periods:**

► For a few milliseconds after initiation of an action potential, it is impossible to trigger a second action potential. This period is known as the **absolute refractory period**.

► The **relative refractory period** is the time during which a second action potential can be initiated by a larger than normal stimulus.

D) PPOPAGATION OF ACTION POTENTIALS: At the site where an action potential is initiated, Na^+ influx during the depolarizing phase creates an electrical current that depolarizes the neighbouring region of the axolemma.

The depolarization in the neighbouring region is large enough to reach the threshold, causing the action potential to be generated there.

This process is repeated many times as the action potential travels along the length of the axon.

The propagation of this cycle of events along the nerve fibre is called a nerve impulse.

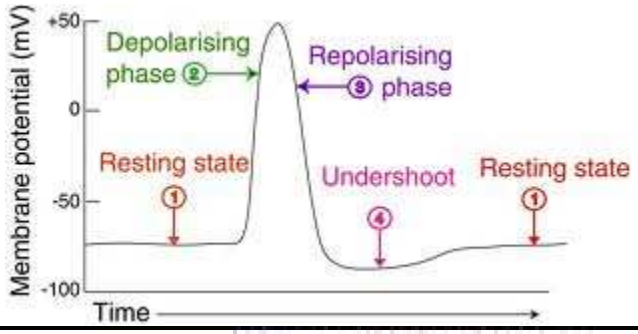
The action potential move only towards the synaptic terminals.

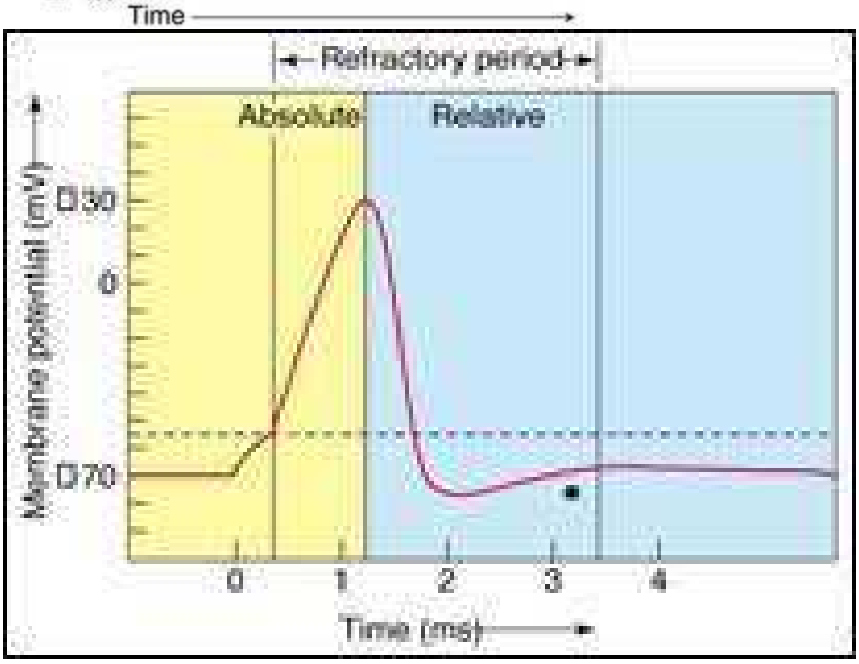
E) CONDUCTION SPEED:

i) The speed of conduction of impulse is directly proportional to diameter of axon.

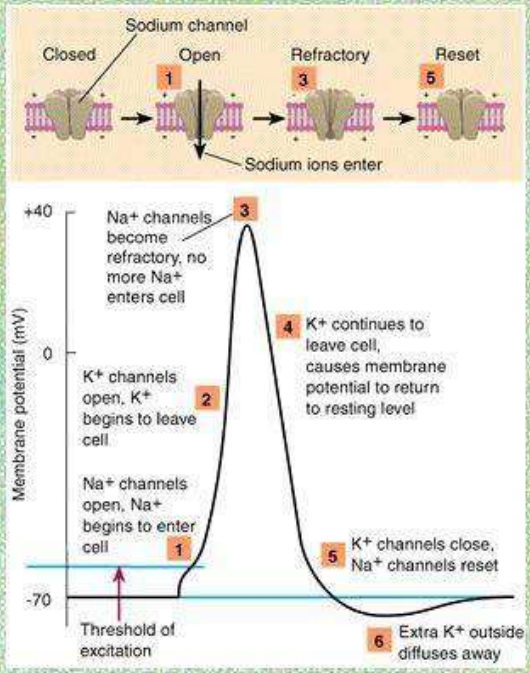
ii) If diameter is more, resistance to the flow of electrical current is less. It causes more speed of conduction of impulse.

iii) If diameter of axon is less, resistance to the flow of electrical current is more. It causes less speed of conduction of impulse.

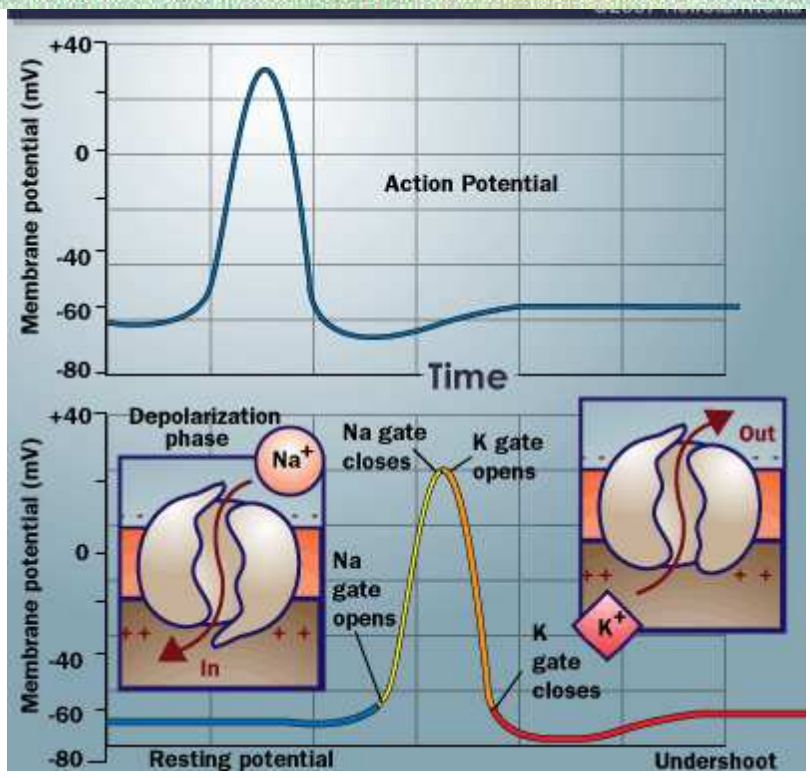




The basis of the absolute refractory period



- Na^+ channels actually have 3 voltage gated configurations
  - Closed (at rest)
    - Ions cannot pass
    - Ready to open
  - Open (during action potential)
    - Ions can pass through
  - Inactive or refractory (just after action potential
    - Ions cannot pass
    - Will not open



Endocrine System of Rabbit

Very Short Answer Questions

1. Distinguish between autocrine and paracrine signaling.

Ans. Action of some chemical messengers on neighboring cells is known as paracrine signaling.

Action of chemical messenger on the same cell that secreted it is called autocrine signaling.

2. Give two examples for lipid-soluble hormones.

Ans. Lipid soluble hormones are steroid and thyroid hormones.

Steroid hormones are corticosteroids, oestrogen, rogesterone and testosterone.

3. How do adenohypophysis and neurohypophysis develop?

Ans. Adenohypophysis develops an outgrowth of ectoderm called the Rathke's pouch in the roof of the buccal cavity.

Neurohypophysis (posterior lobe) develops from the terminal region of an ectodermal outgrowth of hypothalamus.

Both of them belong to pituitary gland.

4. Distinguish between diabetes insipidus and diabetes mellitus.

Ans.

Diabetes insipidus	**Diabetes mellitus**
1. It is caused by deficiency of Anti Diuretic Hormone (ADH).	1. It is caused by deficiency of Insulin.
2. Large quantities of urine are excreted.	2. Urine along with glucose is sent out side.

5. Name the "fight-or-flight hormones".

Ans. The epinephrine or adrenaline and norepinephrine or non-adrenaline hormone produced by adrenal medulla is called as "fight-or-flight hormones".

6. Name the hormone that contributes to the setting of body's biological clock.

Ans. Melatonin of Pineal gland contributes to setting of body's biological clock.

7. Name the cells that secrete testosterone. Name the hormone that stimulates these cells.?

Ans. Interstitial cells of Leydig cells in testis secrete testosterone.

Interstitial cell stimulating hormone (ICSH) of pituitary gland stimulates leydig cells to secrete testosterone.

Short Answer Questions

1. Compare the actions of nervous system and endocrine system.?

Ans.

Nervous system	**Endocrine system**
1. Electrical and chemical mode of communication.	1. Chemical only

2. Neurotransmitters mediate 3. Close to site of release. 4. Muscle and gland cells & neurons are the target cells	2. Hormones mediate 3. far from site of release. 4. all body cells are target cels

2. Explain the various chemical classes of hormones.

Ans. The hormones are chemically classified into three classes. They are :
(1) Peptide & protein hormones, (2) Steroid and (3) Amine hormones.

1) <u>Peptide hormones and protein hormones:</u>

These hormones are polymers of amino acids.

Peptide hormones consist of chains of 3 to 49 amino acids.

E.g. Anti Diuretic Hormone and Oxytocin.

Protein hormones having 50 to 200 amino acids.

E.g. hGH, TSH and Insulin.

2) <u>Steroid hormones</u> : These are derived from cholesterol.

E.g. Corticosteroids, Oestrogens, Progesterone and Testosterone.

3) <u>Amine hormones</u> : These are derived from a single amino acid.

The catecholamines (epinephrine, norepinephrine) and thyroid hormones are derived from the amino acid tyrosine.

Melatonin is derived from the amino acid tryptophan.

3. Explain the transport of hormones and mechanism of hormone action.?

Ans. Water-soluble hormones circulate in the water blood plasma in a free form.

Lipid soluble hormones circulate in the blood mainly bound to plasma proteins which increase their solubility in blood.

<u>Mechanism of Hormone action ::</u>

The hormones are travel in the body through the blood. It affects only the specific target cells.

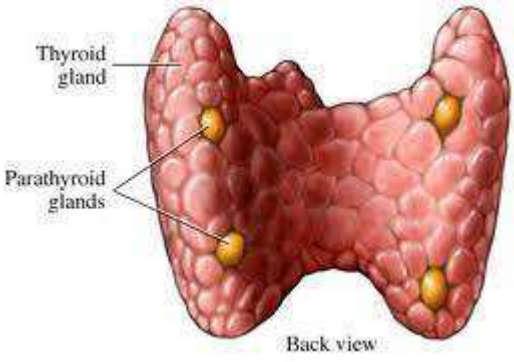
Some hormones affect many cells of different types of the cells of the receptors.

E.g. Growth hormone and thyroxine.

Lipid-soluble hormones diffuse through lipid bilayer of the plasma membrane. They bind to intracellular hormone receptors.

Water-soluble hormones are lipid-insoluble and cannot diffuse through lipid bilayer of the plasma membrane. They bind to receptors on the target cell membrane. It causes the production of many molecules of second messenger e.g., cyclic AMP inside the cell. It causes various intracellular effects b y activating a cascade of enzymes.

4. Describe the thyroid gland.



Ans. **Thyroid gland:**

- ❖ Thyroid gland is the largest endocrine gland present ventral to larynx.
- ❖ It is homologous to endostyle of protochordates.
- ❖ It has right and left lobes connected by isthamus.
- ❖ Each lobe has many follicles.
- ❖ Follicular cells produce two hormones.
  - i) Thyroxine or Tetraiodothyronine (T_4)
  - ii) Triidothyronine or T_3
- ❖ Parafollicular cells produce Calcitonin.

ROLE OF HORMONES:

- ❖ I) Thyroid hormones increase basal metabolic rate by stimulating the use of cellular oxygen to produce ATP.
  II) Thyroid hormones stimulate protein synthesis.
  III) Along with growth hormone and insulin, thyroid hormones accelerate body growth mainly the growth of nervous tissue.
  IV) Thyroxine is essential for metamorphosis in amphibians.
- ❖ Calcitonin is hypocalcaemic hormone which lowers the amount of blood calcium and phosphates by inhibiting bone resorption by osteoclasts and by accelerating uptake of calcium and phosphates into bone matrix.

5. Explain the role of pancreas as an endocrine gland.?

- ► The pancreas is a mixed gland present in the loop of duodenum.
- ► Exocrine part has acini and produce digestive enzymes.
- ► Islets of Langerhans are present among the acini.
- ► Each islet has 4 types of cells which secrete hormones in the following manner……

1) **Alpha cells:** secrete glucagon. It is hyperglycemic hormone. It Stimulates glycogenolysis and gluconeognesis in hepatocytes and increases glucose level.
2) **Beta cells:** secrete insulin. It is a hypoglycemic hormone. It accelerates facilitated diffusion of glucose into body cells. It accelerates glycogenesis, lipogenesis and slows dwn glycogenolysis and gluconeogenesis nd thus brings and brings down sugar level in the blood.
3) **Delta cells:** Secrete somatostatin which inhibits secretion of insulin and glucagon.
4) **F cells:** secrete pancreatic polypeptide. They inhibit somatostatin secretion, gallbladder contraction and secretion enzymes by pancreas.

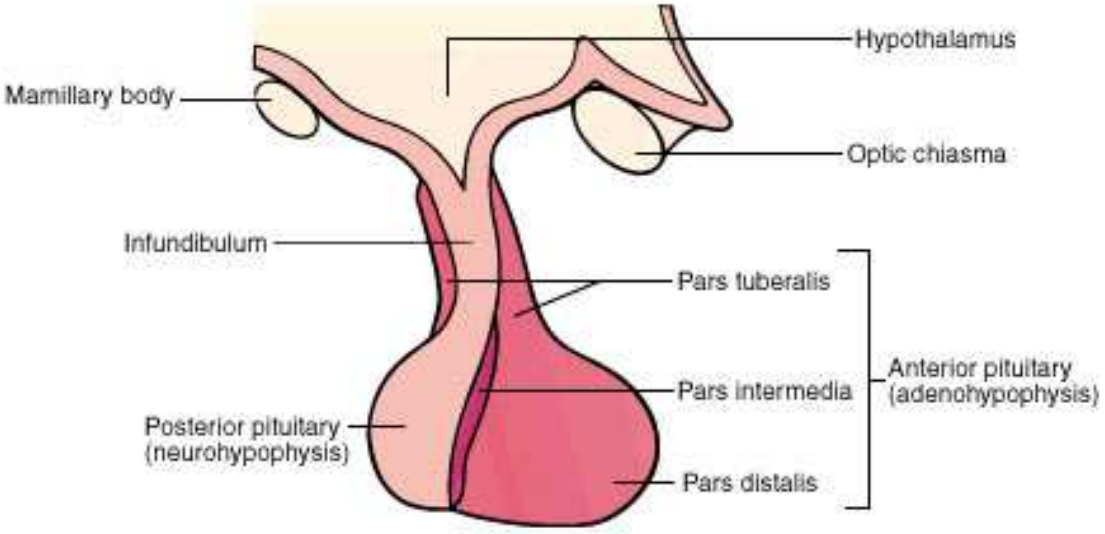
6. Write short notes on gastrointestinal hormones.

Ans. The mucosa layer of stomach and duodenum secrete some hormones which help in the process of digestion.

i) **Gastrin:** When food reaches the stomach, pyloric stomach produces gastrin hormone. It stimulates the gastric glands to secrete gastric juice and increases gastric motility.
ii) **Cholecystokinin:** Mucosa of duodenum secretes it. It stimulates gall bladder to release bile juice and secretion of pancreatic juice rich in enzymes.
iii) **Secretin:** It is secreted by duodenal mucosa. It stimulates the pancreas to release pancreatic juice.
iv) **Enterogastrone:** It is secreted by the walls of the duodenum. It inhibits the secretion of gastric juice.
v) **Enterocrinin:** It activates the intestinal glands to secrete intestinal juice.

Long Answer Questions

1. **Give a detailed account of the pituitary gland.?**



Ans. **Pituitary gland or hypophysis :** It is present in sella tursica of basisphenoid bone.
It has two parts. (a) Adenohypophysis and (b) Neurohypophysis.

a) **Adenohypophysis :** It deveos as an outgrowth of ectoderm from the roof of bucaal cavity as Rathke's pouch. It has three parts. Pars intermedia, Pars anterior, Pars tuberalis. (The last two parts will form anterior lobe).

b) **Neurohypophysis :** It develops as an ectodermal outgrowth of hypothalamus . It has Pars nervosa (posterior lobe) .

HORMONES SECRETED FROM PITUITARY GLAND:

i) ADENOHYPOPHYSIS: It secretes 7 protein hormones. They are….

a)Growth hormone(GH) or Somatotropin: It stimulates the cells in the liver, skeletal muscle, cartilage, bone and other tissues to secrete
Insulin-like growth factors (IGFs) which help the cells to grow and multiply.

b) Thyroid – stimulating Hormone (TSH). It stimulates the thyroid gland to secrete thyroid hormones.

c) **Adrenocorticotropic hormone (ACTH) :** It stimulates the cortex of adrenal gland to secrete glucocorticoids

d) Follicle-stmulating Hormone (FSH): In females, FSH initiates the development of ovarian follicles. In males, FSH stimulates spermatogenesis in the seminiferous tubules**.**

e) Luteinizing Hormone (LH): In females, LH stimulates ovulation, formation of corpus luteum and secretion of progesterone. In males, this hormone is known as interstitial cell stimulating hormone
(ICSH) which stimulates Leydig cells to secrete testosterone.

f) Prolactin (PRL): It maintains milk secretion by mammary glands.

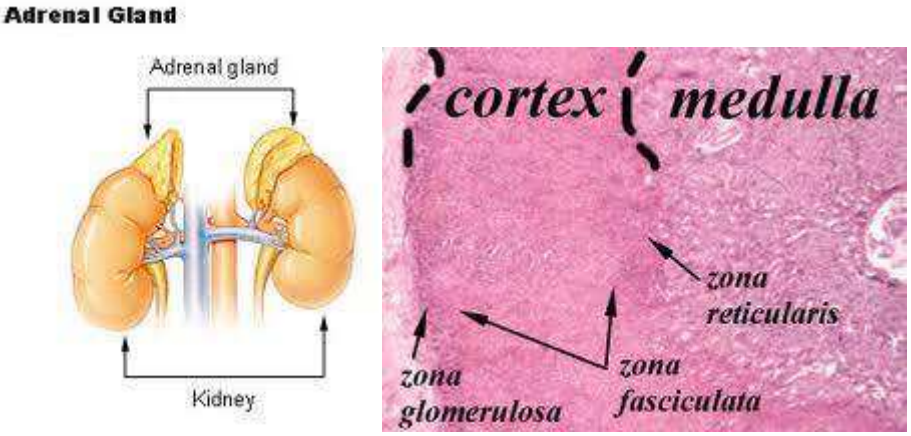
g)Melanocyte –stimulating Hormone (MSH) : secreted by cells of Pars intermedia. It increases skin pigmentation in lower vertebrates by stimulating the dispersion of melanin granules in melanocytes.

Hormones of neurohypophysis : Neurosecretory cells of hypothalamus secrete hormones which enter into neurohypophysis. They are

a) **Oxytocin :** It increases the contraction of smooth muscles in the wall of uterus during parturition. After parturition, it stimulates ejection of milk.

b) **Vasopressin or Antidiuretic hormone (ADH):** It causes the kidneys to reabsorb more water into the blood. ADH causes constriction of arterioles. It increases blood pressure.

2. Describe the adrenal gland in detail.



Ans. **Adrenal glands (suprarenal):** Adrenal glands are present anterior to kidneys. It has outer cortex and central medulla.

Adrenal Cortex : It is influenced by ACTH of pituitary gland.

► Adrenal cortex has three zones.

A)outer Zona glomerulosa -- secretes mineralocorticoids
B)middle Zona fasciculate -- secretes glucocorticoids and sex hormones.
C)inner Zona reticularis --- secretes sex hormones.

1) Mineralocorticoids : They regulate homeostasis of minerals. Aldosterone increases reabsorption of Na and water and secretion of K and H.

2) Glucocorticoids: Cortisol, corticosterone and cortisone .
Cortisol is more abundant. They regulate carbohydrate, protein and fat metabolism. They have anti-inflammatory effect and help combat stress.

3) Sex corticoids: androgens and female sex hormones.

.

Adrenal Medulla: It is a modified sympathetic ganglion. It has chromaffian cells without axons.

► Chromaffian cells secrete two major hormones Epinephrine or adrenaline and norepinephrine or noradrenaline.

► About 80% of cells secrete epinephrine. The remaining 20 % secrete norepinephrine.

► These hormones are responsible for 'fight-o r-flight' response. They increase cardiac output and blood pressure. They increase blood flow to the heart, liver, skeletal muscles and adipose tissue.

► They dilate lungs, and increase blood levels of glucose and fatty acids.

Endocrine Disorders in Human Being

Very Short Answer Questions

1. **What is the reason for disproportionate gigantism in case of acromegaly**?

Ans. Hypersecretion of hGH (growth hormone) during adulthood causes disproportionate gigantism called acromegaly.

2. What is diabetes insipidus?

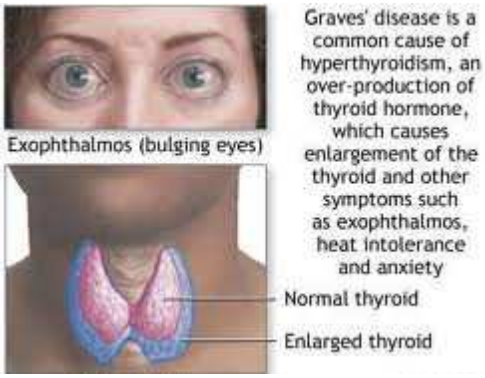
Ans. It is caused by deficiency of Anti Diuretic Hormone (ADH) or inability of secrete ADH. Symptom is excretion of large volumes of urine, resulting in dehydration and thirst.

3. Name the hormonal disorder that causes face to become puffy? Why does it happen?

Ans. Hypothyroidism during the adult stage produces myxoedema disorder. It causes the facial tissues to swell and look puffy.

4. What is Grave's disease?

Ans. Over secretion of thyroid gland produce the thyroxin hormone causes the Grave's disease. It is an autoimmune disorder. The patients show a peculiar oedema behind the eyes leads to exophthalmos.



5. What is the reason for protrusion of eyeballs in Grave's disease?

Ans. Grave's disease patient often has a peculiar edema behind the eyes called exophthalmos. It causes the eyes to protrude.

6. Why does thyroid gland enlarge in case of endemic goitre?

Ans. Enlargement of thyroid gland is called endemic goitre or simple goitre. It causes by the hypothyroidism or hyperthyroidism or normal secretion of thyroid hormone or euthyroidism.

In some places in the world, dietary iodine intake are inadequate causes the endemic goiter.

7. What is tetany? Hyposecretion of which hormone is responsible for it?

Ans. Neurons and muscle fibres to depolarize and produce action potentials spontaneously or sustained contraction of skeletal muscle is called tetany.

Hypoparathyroidism leads to tetany.

8. Name the disease that occurs due to the hypersecretion of cortisol.

Ans. Hypersecretion of Cortisol by the adrenal cortex produces Cushings syndrome.

9. Differentiate between type-I and type-II diabetes mellitus.

Ans.

Type-I	**Type-II**

1. It is caused by lack of insulin secretion or little secretion of insulin.	1. It is more common than type-I.
2. It is insulin-dependent diabetes mellitus (IDDM)	2. It is non-insulin-dependent diabetes mellitus (NIIDDM)
3. It is called juvenile diabetes.	3. It is called Age onset or adult onset diabetes.
4 It is most commonly in younger people.	4. It is often who are overweight.

10. What is insulin shock?

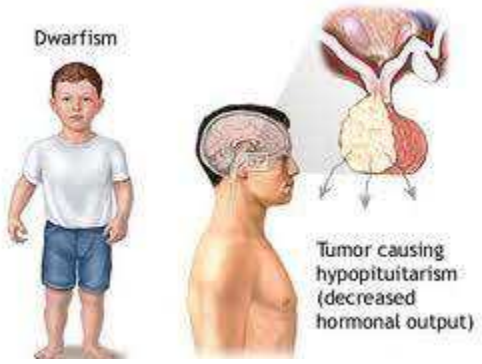
Ans. Intake of overdose of insulin is called insulin shock. It is due to severe hypoglycemia. Death can occur quickly unless blood glucose level is raised.

Short Answer Questions

1. Describe various pituitary gland disorders.

Ans. Pituitary gland causes the following disorders.

1) **Pituitary dwarfism:** Hyposecretion of hGH (Height Growth Hormone) during the growth years slows down bone growth. The epiphysis plates are lost before normal height is reached. Other organs of the body also fail to grow.

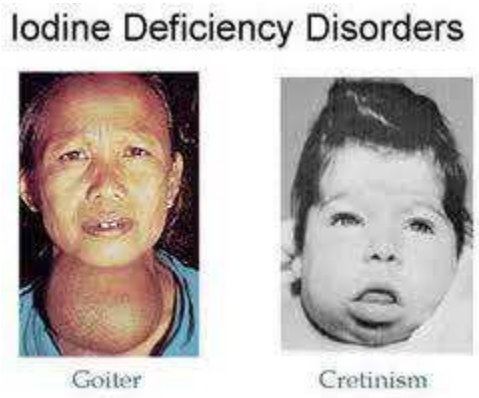


2) **Gigantism:** Hypersecretion of hGH during childhood causes gigantism. Abnormal increase in the length of long bones. The gigantism person grows to be very tall.
3) **Acromegaly:** Hypersecretion of hGH during adulthood causes disproportionate gigantism called acromegaly. Eyelids, lips, tongue and nose enlarge.
4) **Diabetes insipidus :** Due to defects in Anti Diuretic hormone (ADH) receptors or inability to secrete ADH. Symptoms of diabetes insipidus are excretion of large volumes of urine, resulting in dehydration and thirst.

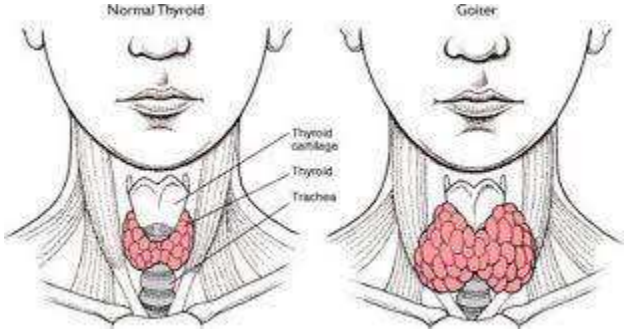
2. Write short notes on thyroid gland disorders.

Ans. Thyroid gland disorders are following types.

1) **Hypothyroidism:** In children cretinism is due to hypothyroidism. They will be mentally retarded, dwarf and sterile.
In adult persons hypothyroidism causes myxoedema that causes the facial tissues to swell and look puffy. That person suffering from slow heart rate, low body temperature, sensitivity to cold, dry hair and skin, muscular weakness, general lethargy and tendency to gain weight.



2) **Hyperthyroidism:** It causes Grave's disease. It is an autoimmune disorder, in which person produces antibodies for TSH receptors. The thyroid gland enlarged in size is called goitre. Grave's patient often has a peculiar edema behind the eyes, called exophthalmos(eyes protrude)
3) **Endermic Goitre:** Enlargement of thyroid gland is called endemic goitre or simple goitre. It may be associated with hyper or hypo secretion of thyroid gland produces the hormone. However the low levels of thyroid hormone in the blood accelerates secretion of TSH, causes the enlargement of thyroid gland. It occurs in the places where dietary intake of iodine is less.



3. Give an account of disorders that occur due to hypo-parathyroidism and due to hyperparathyroidism?

Ans. 1) **Hypothyroidism:** In children cretinism is due to hypothyroidism. They will be mentally retarded, dwarf and sterile. In adult persons hypothyroidism causes myxoedema, that causes the facial tissues to swell and look puffy. That person suffering from a slow heart rate, low body temperature, sensitivity to cold, dry hair and skin, muscular weakness, general lethargy and tendency to gain weight.
2) **Hyperthyroidism:** It is common that hyperthyroidism causes Grave's disease. It is an autoimmune disorder, in which person produces antibodies for TSH receptors. The thyroid gland enlarged in size is called goitre. Grave's patient often has a peculiar edema behind the eyes, called exophthalmos.

4. Explain Cushing's disease and Addison's disease.

Ans. These are caused by disorders of Adrenal gland.
1) **Cushing disease :**



It is also known as Cushing's syndrome.

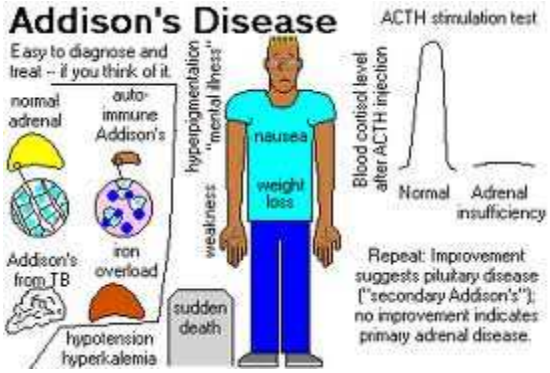
Hypersecretion of cortisol by the adrenal gland cortex produces cushing's syndrome.

A tumor of the adrenal gland secretes the cortisol or a tumor in pituitary, which secrete adrenocorticotropoic hormone (ACTH).

The conditions are by break down of muscle proteins and redistribution of body fat, resulting in spindly arms and legs accompanied by a rounded moon face, buffalo hump on the back and pendulous or hanging abdomen.

The facial skin is flushed and the skin covering the abdomen develops stretch marks,

2) Addison's disease :



Undersecretion of glucocorticoids and aldosterone causes Addison's disease.

Symptoms are mentally lethargy, anorexia, nausea and vomiting, weight loss, hypoglycemia and muscular weakness.

Loss of aldosterone leads to elevated K^+ and decrease Na^+ in the blood.

The skin have a bronzed appearances is the characteristic feature.

5. Write about the symptoms are types of diabetes mellitus.?

Ans. Diabetes mellitus is the most common endocrine disorder. Because glucose is not transported into body cells.

Blood glucose level is high and is excreted through the urine, called glucosuria or glycosuria.

The Hallmark of diabetes mellitus are three "Polys".

1) Polyuria – excessive urine production due to inability of the kidneys.
2) Polydipsia – excessive thirst
3) Polyphagia – excessive eating or hunger.

Diabetes mellitus is divided into two types, type-I and type-II.

Type-I diabetes caused by lack of insulin secretion or little secretion of insulin. It is also known as insulin-dependent diabetes mellitus (IDDM). Insulin injections are required preventing death. It is commonly in young people and called juvenile diabetes. Regularly intake the injections.

Type-II diabetes disease called non-insulin-dependent diabetes mellitus (NIDDM). It is common in older people and overweight persons. Some times called age onset or adult onset diabetes.

Over injection of too much insulin causes hyperinsulinism. Hypoglycemia decreases blood glucose level. Severe hypoglycemia leads to mental disorientation, convulsions, unconsciousness and shock. Insulin shock is caused by intake of the overdose of the insulin.

Immunology

Very Short Answer Questions

1. Distinguish between active immunity and passive immunity.

Ans.

Active immunity	Passive immunity
1. Immunity developed due to Antigenic stimulus.	1. Immunity developed by the organisms as a result of transfer of antibodies from an immune individual.

2. Distinguish between natural active and artificial active immunities.

Ans.

Natural active immunity	Artificial active immunity
1. This is the immunity developed by the host in response to natural infection e.g. Small pox	1. This immunity has been acquired by the host in response to artificial inoculation of antigen. E.g. Vaccination.

3. Distinguish between natural passive and artificial passive immunity.

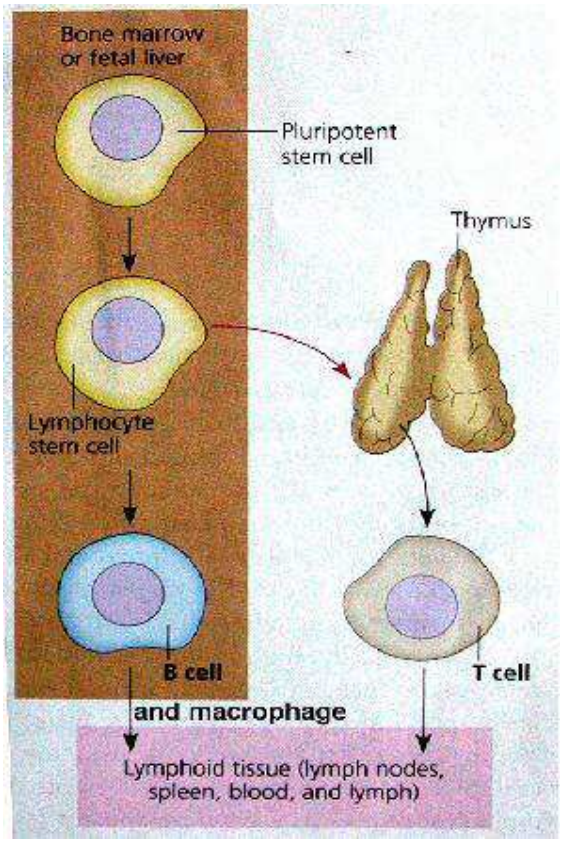
Ans.

Natural passive immunity	Artificial passive immunity
1. Immunity obtained by the transfer of antibodies from mother to child.	1. Immunity developed by the transfer of antibodies from an immunized donor to non-immunized individual. e.g Injection of ATS

4. Distinguish between humoral and cell mediated immunities.

Ans.

Humoral immunity	Cell Mediated immunity
1. Immunity developed due to B-lymphocytes. 2. Antibodies are released into humors of the body. 3. It protects against extracellular bacteria & foreign macromolecule	1. Immunity developed due to T-lymphocytes. 2. No antibodies are produced. 3. Protects against intracellular bacteria, viruses and cancer cells.



5. Distinguish between primary lymphoid organs and secondary lymphoid organs.?

Ans.

Primary lymphoid organs	**Secondary lymphoid organs**
1. Lymphoid progenitors differentiate into mature or immunocompetent lymphocytes.	1. Immunocompetent lymphocytes transform into functional cells .
2. These are the major sites of lymphopoiesis. e.g. Bursa of Fabricius, Bone marrow, Thymus	2. These organs trap antigens and make it available for mature lymphocytes. e.g. Spleen, Lymph nodes.

6. What are immuno competent cells?

Ans. Mature lymphocytes which are capable of recognizing a specific antigen and mounting an immune response is called immunocompetent cells.

7. What are natural killer cells?

Ans. Natural killer cells are large, granular lymphocytes that destroy the infected cells .

8. Name the three types of antigen presenting cells.

Ans. 3 types of antigen presenting cells are

a) Activated Macrophages b)Dendritic cells c) B lymphocytes.

9. What are complement proteins?

Ans. Complement is a group of serum proteins . They are activated in a cascade fashion. They activate inflammation, cause cytolysis and opsonization.

10. What are interleukins?

Ans. They are the cytokines secreted by leucocytes. They primarily affect the growth and differentiation of various cells of immune system.

11. What are interferons?

Ans. These are the cytokines secreted by certain cells that induce an antiviral state in other cells. They help to regulate immune response.

12. Distinguish between F_c end and F_{ab} end of an antibody.

Ans.

F_c end	**F_{ab} end**
1. It is one end of antibody to which antigen binds.	1. It is the end interacts with Phagocytes or one of the Complement molecules.

13. What are haptens?

Ans. Small molecules are called haptens. E.g. Penicillin. These are antigenic but incapable by themselves of inducting a specific immune response until they combine with carrier molecule like protein.

14. What are cytokines?

Ans. These are low molecular-weight proteins that mediate interactions among cells of immune system.

15. Distinguish between primary immune deficiency and secondary immune deficiency.?

Ans.

Primary immune deficiency	**Secondary immune deficiency**
1. Immune deficiency caused due to defective genes or defect in immune system	1. Immune deficiency caused due to the factors other than genetic factor. Like chemical or biological agents. e.g. Infections, drugs, malnutrition, ageing.

16. What is the most commonly used screening test for HIV?

Ans. The most commonly used screening test is ELISA (Enzyme Linked Immuno Sorbent Assay) for HIV.

17. What is opsonization?

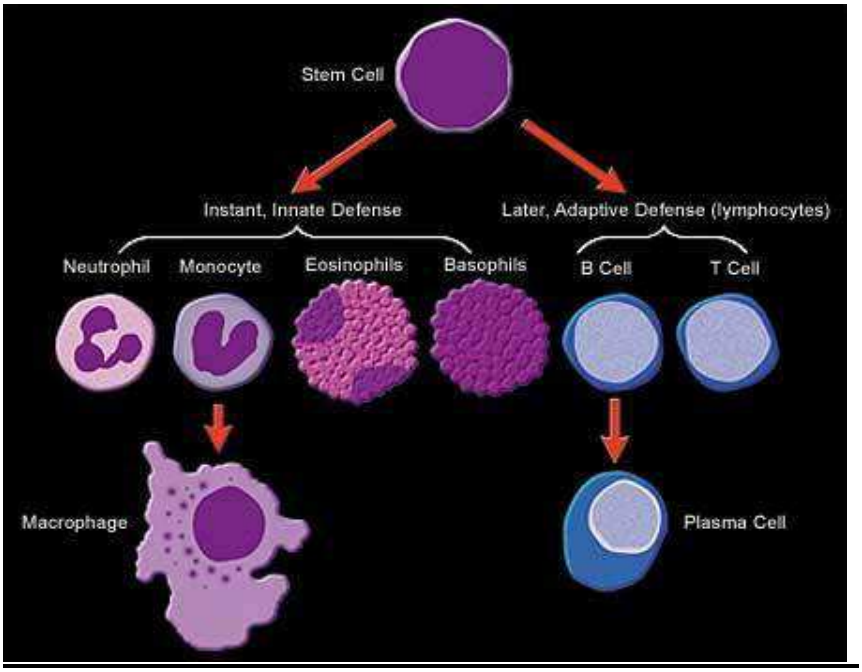
Ans. Particulate antigens more susceptible to phagocytosis by promoting adherence of antigen with the phagocyte is called opsonization.

18. Which hepatitis virus is not infective by itself? It requires which other virus to be come infective?

Ans. Hepatitis-D (Delta Hepatitis) virus cannot survive independently. It requires Hepatitis-B virus to be come infective.

19. What is hypersensitivity?

Ans. Exaggerated immune response that causes damage to the host tissues is known as hypersensitivity.



Short Answer Questions

1. Explain the different types of immunities.

Ans

1) Basing on the nature and type of response immunity is of two types.

(i) Innate immunity (ii) Acquired immunity or Adaptive immunity.

i) Innate immunity : Inborn resistance to diseases. It comprises four types of defensive barriers, anatomic, physiological, phagocytic and inflammatory

ii) Acquired immunity or Adaptive immunity: Immunity developed by an organism either by the entry of pathogen or by artificial inoculation. It has specificity, diversity and memory.

Acquired immunity is again classified into Active and Passive.

A) Active immunity: It is a type of acquired immunity in which the individual develop immunity as a result of antigenic stimulus

Active immunity is of two types.

a) Natural active acquired immunity : The immunity developed by the host in response to natural infection (antigen)
e.g.,., small pox .

b) Artificial active acquired immunity: The immunity acquired by the host in response to the artificial inoculation of antigen.
E.g. Vaccination.

B) Passive immunity: It is immunity developed by the organism as a result of transfer of antibodies from an immune individual..

Passive immunity is of two types.

a) Natural passive acquired immunity: The immunity obtained by the transfer of antibodies from mother to child.

e.g. Antibodies transfer from mother to child though colostrums (first milk and antibodies, released by the mother after the child birth).

b) Artificial passive acquired immunity: It is due to the transfer of antibodies from an immunized donor (man or suitable animal) to non-immunized individual.

e.g. Injection of ATS to man.

2) **Humoral immunity and cell mediated immunity.**

Humoral immunity: It is the immunity caused by B-lymphocytes which produce antibodies into humors.

Cell mediated immunity: It is the immunity caused by the T-lymphocytes.

2. Write notes on cells of immune system.

Ans. The cells involved in immune responses are …. (1) Lymphoid cells (2) MNPs (3) Granulocytes (4) Mast cells (5)Dendritic cells

1) LYMPHOID CELLS:

- Lymphocytes form 99% of cells in lymph. They are of 3 types ….

a) **B –lymphocytes:** Mature B cells synthesize and display membrane-bound antibody molecules to bind with antigen and known as B cell receptors (BCR). B cells act as antigen presenting cells also.

b) **T – lymphocytes**: They also have membrane receptors from antigen (TCR).

- T – Cells are of two types based on membrane glycoprotein molecules known as CD markers….

I)T helper cells (T_H) --- with CD 4 markers --- $CD4^+$ cells.

ii)T cytotoxic cells (T_C) cells ----with CD8 markers --- $CD8^+$cells

c) **Natural Killer cells (NK cells**): These are large, granular lymphocytes without the surface markers. They exhibit cytotoxic activity against tumour cells and virus-infected cells.

2) MONONUCLEAR PHAGOCYTES (MNP):

- Monocytes and macrophages contribute this system.
- Monocytes of blood enter into tissues and differentiate into wandering macrophages or fixed macrophages.
- These are of several types based on the location.

a)Histiocytes -- in connective tissue
b)Alveolar macrophages --- in lungs
c)Kupffer cells --- in liver
d)Microglial cells --- in brain
e)Osteoclasts --- in bone.

Activated macrophages act as Antigen-presenting cells.

3) GRANULOCYTES : These are of 3 types …

Type of granulocytes	**character**
1.Neutrophils	Phagocytic. These are Polymorpho— Nuclear leucocyte (PMN)
2.Eosinophils	Less phagocytic
3.Basophils	Non – phagocytic. They release histamine and bradykinin.



4) MAST CELLS:

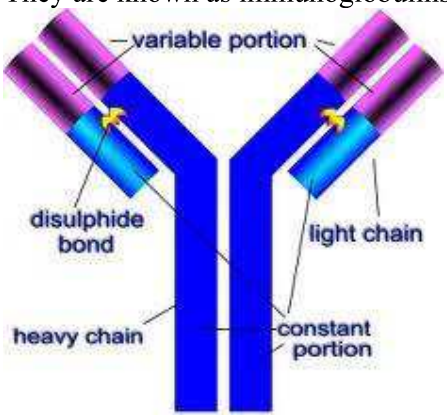
- They release inflammatory mediators like histamine and bradykinin.

5) DENDRITIC CELLS:

- ❖ Their membrane extensions resemble the dendrites of nerve cells.
- ❖ They express high levels of class II MHC molecules.
- ❖ They are most potent Antigen presenting cells.

3. Explain the structure of antibody.

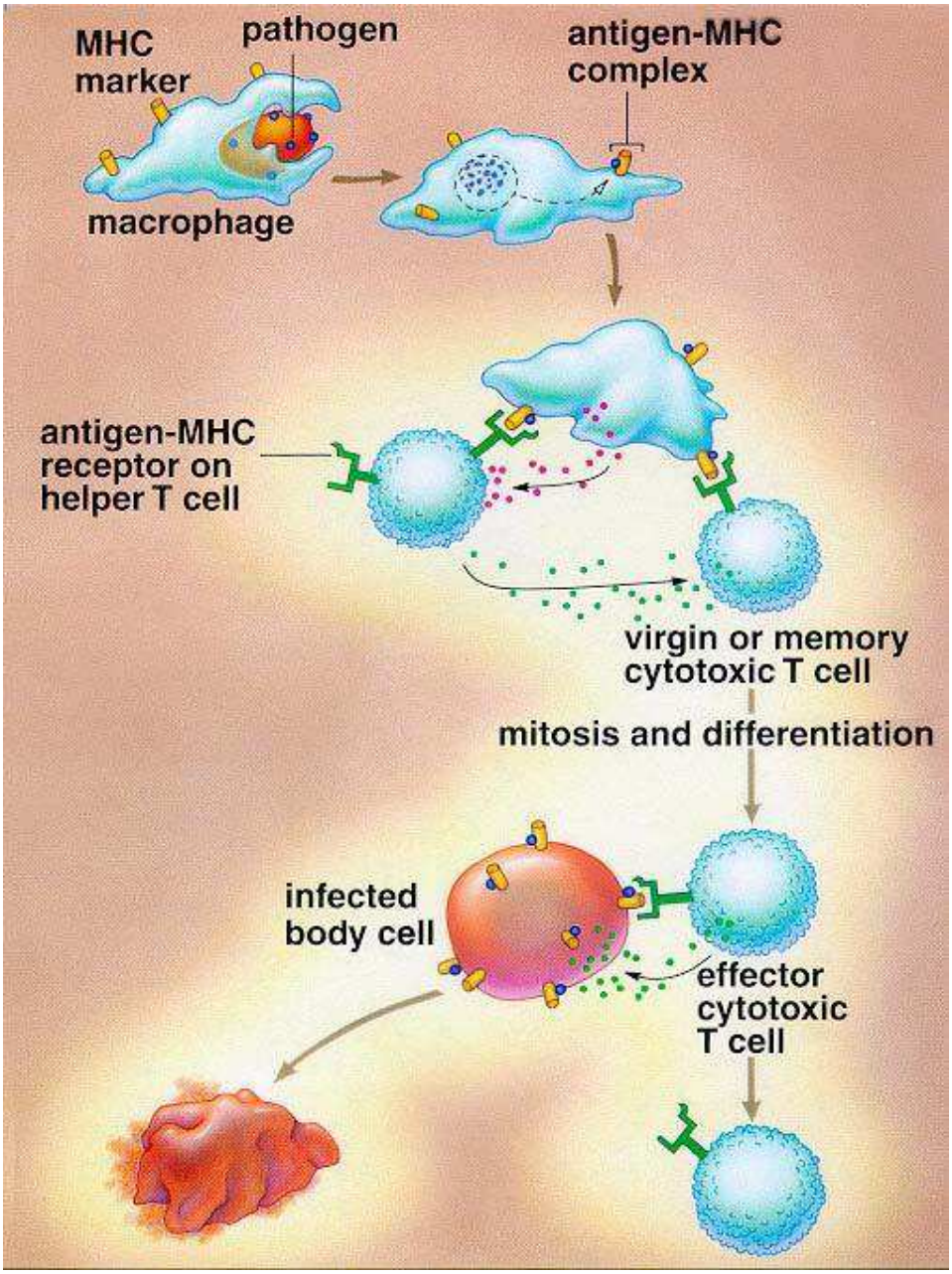
- ► Antibodies are antigen binding proteins.
- ► They are known as immunoglobulins.



- ► The antibody consists of four chains of polypeptides -- two identical light (L) chains and two identical heavy (H) chains linked by disulphide and other bonds to form Y – shaped molecule.
- ► Each arm of 'Y' is called F_{ab} fragment with antigen binding site. It includes a light chain and part of a heavy chain.
- ► The stem of 'Y' is called F_C fragment. It includes a part of each heavy chain. It binds to complement rotein or R_C receptors like phagocytes, mast cells etc.
- ► The ends of the two arms of Y are called variable (V) regions.
- ► The stem of antibody and lower parts of arms constitute the constant region.
- ► Based on the type of heavy hain constant region, there are 5 classes of antibodies – Ig M, IgG, Ig D, Ig A and Ig E.
- ► Membrane bound antibodies are present on the cell membrane of immunocompetent B cells.
- ► The secreted antibodies are circulating in the body fluids.

4. Explain the mechanism of cell-mediated immunity.

- ► Antigen presenting cell engulfs exogenous antigens and process the antigen and displays antigenic fragment on its membrane bound to class II MHC molecule.
- ► T_H cell recognizes and interacts with the antigen class-II MHC molecule complex.
- ► Activated T_H cells secrete interleukins-2.
- ► T_C cells bind to antigen-class-I MHC molecule complex on altered self cells.
- ► Interleukins-2 causes proliferation and differentiation of antigen activated T_C cell into a clone of effectors CTLs.
- ► CTLs attaché to target cells and release perforins and granzymes.
- ► Perforins form pores on the target cell membrane.
- ► Granzymes enter the target cells and initiate reactions that fragment target-cell DNA.
- ► T_C cells remain as long-lived memory T cells.



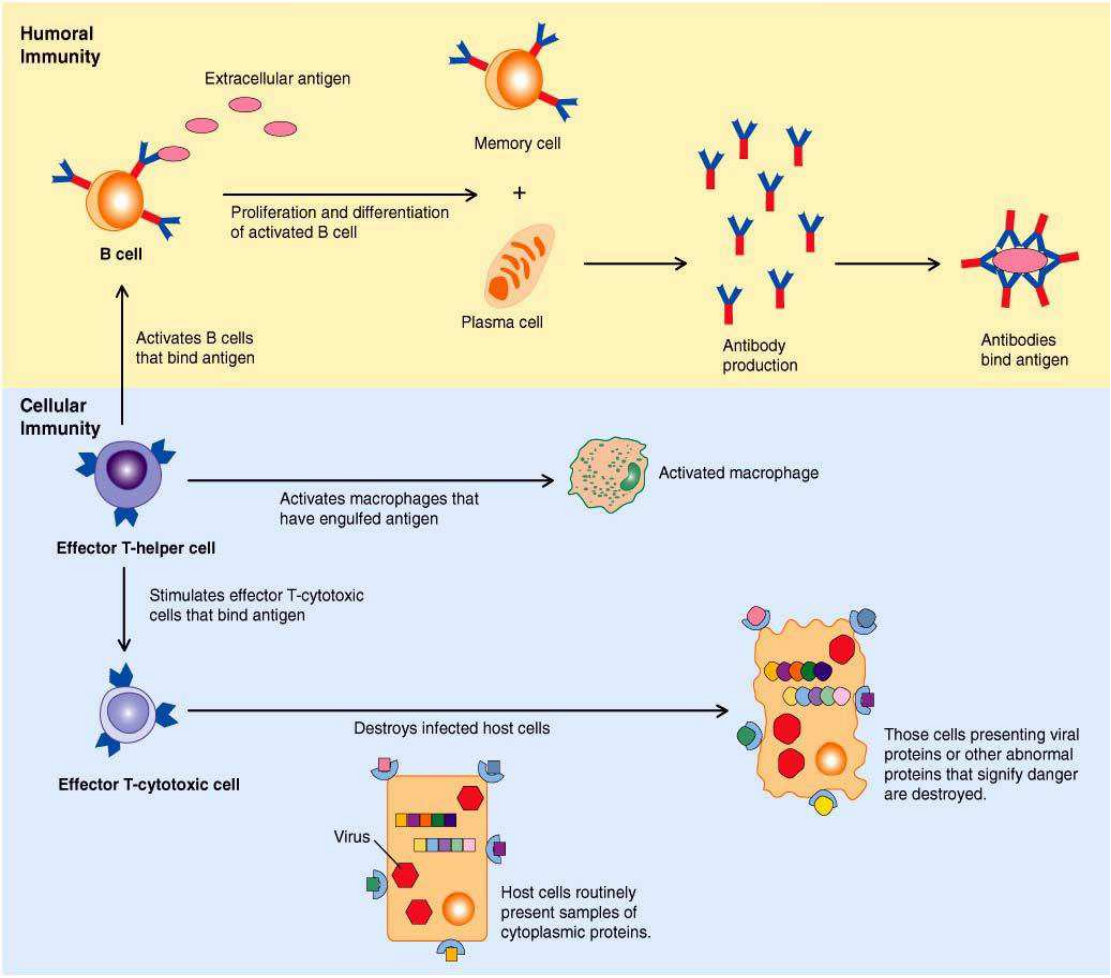
5. Explain the mechanism of humoral immunity.

- Antigen binds to B-cell receptor of an immunocompetent B-cell.
- It engulfs and processes the antigen and displays antigenic fragment on its membrane, bound to class – MHC molecule.
- An appropriate T_H cell recognizes and interacts with the antigen class II MHC molecule complex on the B-cell and releases interleukin-2.
- It stimulates the B cell to divide differentiate to produce long lived memory B-cell and effector plasma cells.
- The clone of Plasma cells release antibodies into the blood plasma, lymph and extracellular fluids.

ROLE OF ANTIBODIES;

- A) Neutralizing the antigen by blocking the antigens. They neutralize bacteria toxins, and prevent the attachment of viruses to body cells.
- B) Immobilizing the bacteria by attaching to their flagella.

- C) Precipitation of soluble antigens and agglutination of insoluble antigens by cross-linking the antigens. These antigens are easily phagocytosed by the macrophages.
- Activation of the complement system and phagocytes.
- Opsonization of bacteria.



6. Write note on HIV and AIDS.



Ans. **HIV and AIDS:**

Acquired Immunodeficiency Syndrome (AIDS) is caused by HIV virus.

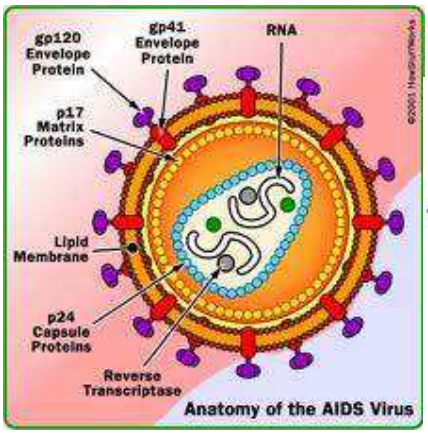
It was first recognized in 1981 in U.S by Centre for Disease Control (CDC). It is two types HIV-1 and HIV-2, HIV-1 is more common type and HIV-2 is less pathogenic than HIV-1-

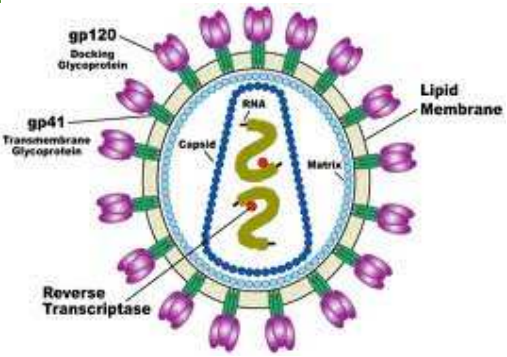
HIV is a retrovirus which uses reverse transcriptase.

a) **Structure of HIV**.

It consists of a **nucleocapsid surrounded by an outer envelope. The envelope is a lipid bilayer derived from host cel membrane.**

** It bers glocoprotien projections composed of gp 120 and gp 41.
** Nucleopsid consists of a protein shell surrounding two identical single stranded RNA molecules and molecules of reverse tanscriptase , protease and integrase.





b) **Transmission of HIV:** Its transmission is through homosexual and heterosexual contact, syringe needles, blood transfusion, from mother to foetus through placenta or through breast-feeding.

c) **Replication of HIV:** Main target cells of HIV are T_H cells, macrophages and dendritic cells. (all with CD_4 receptors). The viral RNA is released into the host cell and is reverse transcribed to from double-stranded DNA. This viral DNA becomes integrated into the DNA of the host cell and forms provirus.

d) **Stages of HIV Infection:** The progression from HIV infections to AIDS takes about 10 years in adults. It occurs in three clinical stages.

1) **Category-A : Asymptomatic or chronic lymphadenopathy (swollen lymph nodes)**
2) **Category-B : Symptomatic** it is characterized by viral infections and certain cancerous conditions of cervix.
3) **Category-C – Clinical AIDS:** Several infections characteristic of AIDS such as yeast, tuberculosis, pneumonia, Kaposi's sarcoma(cancer os skin) appear.

e) Diagnosis: The most commonly used screening test is ELISA test and confirmation test is western blot test.

Nucleic acid tests detect viral RNA by using methods such as PCR.

f) Chemotherapy : Reverse transcriptase inhibitors and protease inhibitors are used in the treatment.

Zidovudine or Azidothymine are used to inhibit reverse transcription.

g) Prophylaxis: Discouraging causal and indiscriminate sexual relation, use of condoms, sterilization of needles and syringes, screening of blood donors

7. What is hepatitis? Explain any two types of viral hepatitis.?

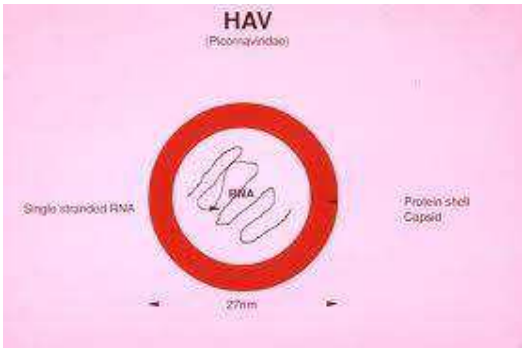
Ans. Hepatitis is an inflammation of liver caused commonly by viruses.

Symptoms of viral hepatitis include

i) anorexia (loss of appetite)

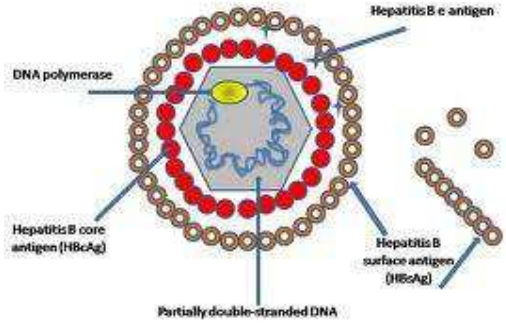
ii)Malaise (discomfort) iii)Nausea, diarrhea, abdominal discomfort, fever, chills, jaundice and cirrhosis (fibrosis of liver)

TYPES OF HEPATITIS



a) **HEPATITIS A** :

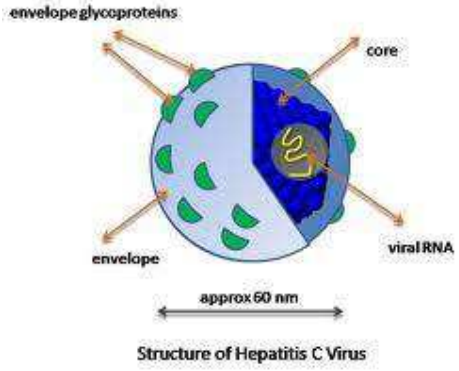
- ► It is caused by hepatitis A virus (HAV).
- ► HAV contains single-stranded RNA but without an envelope .
- ► Infection by faecal-oral route through contaminated food and water.
- ► Incubation period is 2-6 weeks.
- ► No chronic hepatitis A.
- ► Inactivated whole agent vaccine is available.



b) **HEPATITIS B** :

- ► It is caused by hepatitis B virus (HBV).
- ► HBV has double-stranded DNA and is enveloped.
- ► Transmission is parenteral (injection, blood transfusion) or perinatal from mother to child or sexual contact.
- ► Incubation period is 4-26 weeks.
- ► Risk chronic disease is high in infants and low in adults.
- ► Vaccine with a portion of the viral protein coat produced by a genetically engineered yeast.

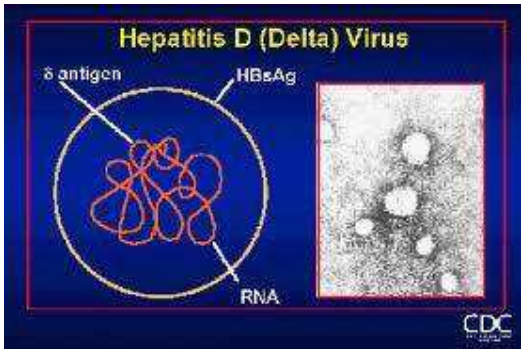
c) HEPATITIS C



Structure of Hepatitis C Virus

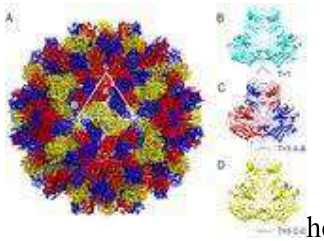
- ► It is caused by hepatitis C virus (HCV).
- ► HCV has a single-stranded RNA with an envelope.
- ► Transmission if parenteral
- ► Incubation period is 2-22 weeks.
- ► Progress to chronic hepatitis.

- ► Vaccine is not available.



d)**HEPATITIS D (DELTA)**

- ► It is caused by hepatitis D virus (HDV).
- ► It has single stranded RNA.
- ► It becomes infective when it is covered by an envelope of HBV.
- ► Incubation period is 6-26 weeks.
- ► Transmission is parenteral.
- ► Chronic form.
- ► HBV vaccine is effective.


hepatitis E virus

e)**HEPATITIS E**

- ► It is caused by hepatitis E virus (HEV).
- ► It contains single-stranded RNA but without an envelope.
- ► Transmission is by faecal-oral route.
- ► Incubation period is 2-6 weeks.
- ► No chronic form
- ► Vaccine under development.

Long Answer Questions

1. Explain the mechanism of cell-mediated and humoral immunities.

Ans. **cell-mediated immunity.**

- ► Antigen presenting cell engulfs exogenous antigens and process the antigen and displays antigenic fragment on its membrane bound to class II MHC molecule.
- ► T_H cell recognizes and interacts with the antigen class-II MHC molecule complex.
- ► Activated T_H cells secrete interleukins-2.
- ► T_C cells bind to antigen-class-I MHC molecule complex on altered self cells.
- ► Interleukins-2 causes proliferation and differentiation of antigen activated T_C cell into a clone of effectors CTLs.
- ► CTLs attach to target cells and release perforins and granzymes.
- ► Perforins form pores on the target cell membrane.
- ► Granzymes enter the target cells and initiate reactions that fragment target-cell DNA.
- ► T_C cells remain as long-lived memory T cells.

2. humoral immunity.

- ✹ Antigen binds to B-cell receptor of an immunocompetent B-cell.

- It engulfs and processes the antigen and displays antigenic fragment on its membrane, bound to class – MHC molecule.
- An appropriate T_H cell recognizes and interacts with the antigen class II MHC molecule complex on the B-cell and releases interleukin-2.
- It stimulates the B cell to divide differentiate to produce long lived memory B-cell and effector plasma cells.
- The clone of Plasma cells release antibodies into the blood plasma, lymph and extracellular fluids.

ROLE OF ANTIBODIES;

- A) Neutralizing the antigen by blocking the antigens. They neutralize bacteria toxins, and prevent the attachment of viruses to body cells.
- B) Immobilizing the bacteria by attaching to their flagella.
- C) Precipitation of soluble antigens and agglutination of insoluble antigens by cross-linking the antigens. These antigens are easily phagocytosed by the macrophages.
- Activation of the complement system and phagocytes.
- Opsonization of bacteria.

2. Write an essay on immunological disorders.

Ans. Immunological disorders are 3 types.

1) **Auto immunity**: Inappropriate immune response against self-antigens is called auto immunity.

2) **Immunodeficiency**: Any deficiency in the immune response is called immunodeficiency.

3) **Hypersensitivity**: Exaggerated immune response that causes damage to the host tissues.

A) **Primary immunodeficiency**: Immunodeficiency resulting from a genetic or developmental defect in the immune system.

It may be due to defective T cells, B cells, Phagocytes or complement system.

B) **Secondary or acquired immunodeficiency**: It results from exposure to various chemical (e.g. drugs) or biological (e.g. HIV) agents.

I)ACQUIRED IMMUNODEFICIENCY SYNDROME (AIDS)



Acquired Immunodeficiency Syndrome (AIDS) is caused by HIV virus.

It was first recognized in 1981 in U.S by Centre for Disease Control (CDC). It is two types HIV-1 and HIV-2, HIV-1 is more common type and HIV-2 is less pathogenic than HIV-1-

HIV is a retrovirus which uses reverse transcriptase.

e) **Structure of HIV.** It consists of a **nucleocapsid surrounded by an outer envelope. The envelope is a lipid bilayer derived from host cell membrane.**

** It bears glycoprotien projections composed of gp 120 and gp 41.

** Nucleocapsid consists of a protein shell surrounding two identical single stranded RNA molecules and molecules of reverse tanscriptase , protease and integrase.

f) **Transmission of HIV:** Its transmission is through homosexual and heterosexual contact, syringe needles, blood transfusion, from mother to foetus through placenta or through breast-feeding.

g) **Replication of HIV:** Main target cells of HIV are T_H cells, macrophages and dendritic cells. (all with CD_4 receptors). The viral RNA is released into the host cell and is reverse transcribed to from double-stranded DNA. This viral DNA becomes integrated into the DNA of the host cell and forms provirus.

h) **Stages of HIV Infection:** The progression from HIV infections to AIDS takes about 10 years in adults. It occurs in three clinical stages.

2) **Category-A : Asymptomatic or chronic lymphadenopathy (swollen lymph nodes)**

2) **Category-B : Symptomatic** it is characterized by viral infections and certain cancerous conditions of cervix.

3) **Category-C – Clinical AIDS :** Several infections characteristic of AIDS such as yeast, tuberculosis, pneumonia, Kaposi's sarcoma(cancer os skin) appear.

e) Diagnosis: The most commonly used screening test is ELISA test and confirmation test is western blot test.

Nucleic acid tests detect viral RNA by using methods such as PCR.

f) Chemotherapy : Reverse transcriptase inhibitors and protease inhibitors are used in the treatment.

Zidovudine or Azidothymine are used to inhibit reverse transcription.

g) Prophylaxis: Discouraging causal and indiscriminate sexual relation, use of condoms, sterilization of needles and syringes, screening of blood donors

II) HEPATITIS;

Hepatitis is an inflammation of liver caused commonly by viruses.

Symptoms of viral hepatitis include i) anorexia (loss of appetite)

ii) Malaise (discomfort) iii)Nausea, diarrhea, abdominal discomfort, fever, chills, jaundice and cirrhosis (fibrosis of liver)

TYPES OF HEPATITIS.

f) **HEPATITIS A** :

- ► It is caused by hepatitis A virus (HAV).
- ► HAV contains single-stranded RNA but without an envelope.
- ► Infection by faecal-oral route through contaminated food and water.
- ► Incubation period is 2-6 weeks.
- ► No chronic hepatitis A.
- ► Inactivated whole agent vaccine is available.

g)HEPATITIS B :

- ► It is caused by hepatitis B virus (HBV).
- ► HBV has double-stranded DNA and is enveloped.
- ► Transmission is parenteral (injection, blood transfusion) or perinatal from mother to child or sexual contact.
- ► Incubation period is 4-26 weeks.
- ► Risk chronic disease is high in infants and low in adults.
- ► Vaccine with a portion of the viral protein coat produced by a genetically engineered yeast.

h) HEPATITIS C

- ► It is caused by hepatitis C virus (HCV).
- ► HCV has a single-stranded RNA with an envelope.
- ► Transmission if parenteral
- ► Incubation period is 2-22 weeks.
- ► Progress to chronic hepatitis.
- ► Vaccine is not available.

i) HEPATITIS D (DELTA)

- ► It is caused by hepatitis D virus (HDV).
- ► It has single stranded RNA.
- ► It becomes infective when it is covered by an envelope of HBV.
- ► Incubation period is 6-26 weeks.
- ► Transmission is parental.
- ► Chronic form.
- ► HBV vaccine is effective.

j) HEPATITIS E

- ► It is caused by hepatitis E virus (HEV).
- ► It contains single-stranded RNA but without an envelope.
- ► Transmission is by faecal-oral route.
- ► Incubation period is 2-6 weeks.
- ► No chronic form
- ► Vaccine under development.