VISWASS SCHOOL & COLLEGE OF NURSING

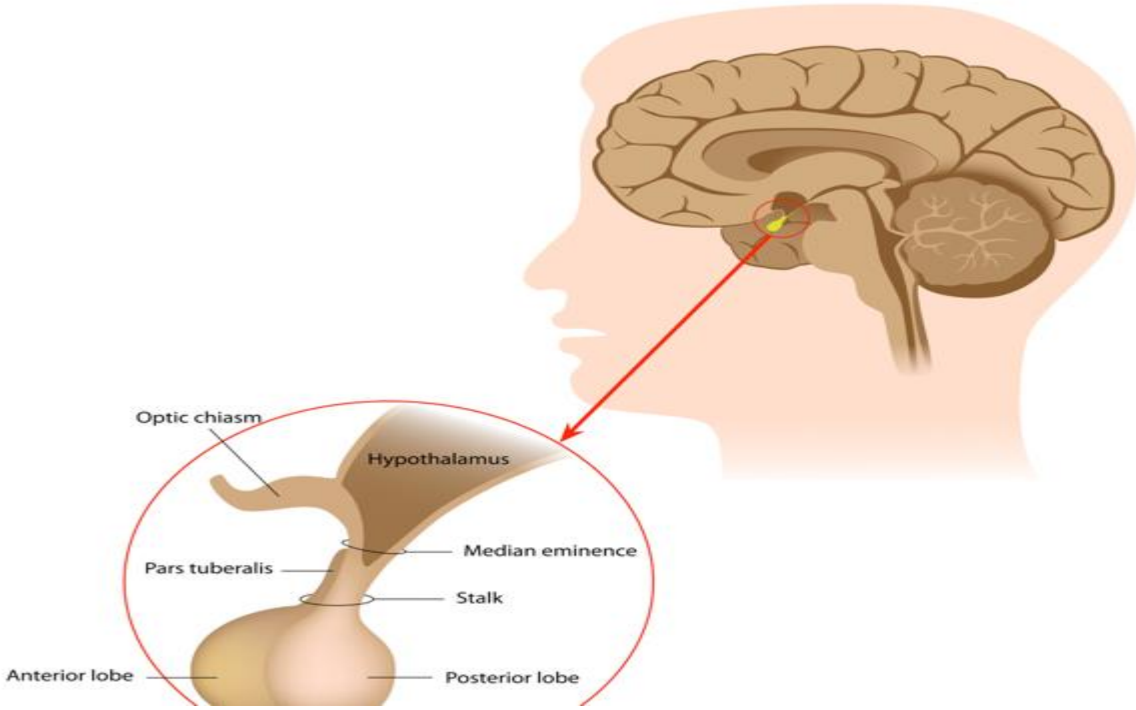
GNM 1ST YEAR
ANATOMY AND PHYSIOLOGY
UNIT-9
ENDOCRINE SYSTEM
SHORT QUESTIONS AND ANSWERS

PREPARE BY: MS. AMRITA SINGH,
DEPARTMENT OF NURSING, VISWASS

1.Structure and function of hypothalamus.(5)

Hypothalamus:

- The **hypothalamus** is a portion of the brain that contains a number of small nuclei with a variety of functions.
- One of the most important functions of the hypothalamus is to link the nervous system to the endocrine system via the pituitary gland.
- The hypothalamus is located below the thalamus and is part of the limbic system.
- In the terminology of neuroanatomy, it forms the ventral part of the diencephalon.
- All vertebrate brains contain a hypothalamus.
- In humans, it is the size of an almond.
- The hypothalamus is responsible for the regulation of certain metabolic processes and other activities of the autonomic nervous system.
- It synthesizes and secretes certain neurohormones, called releasing hormones or hypothalamic hormones, and these in turn stimulate or inhibit the secretion of hormones from the pituitary gland.
- The hypothalamus controls body temperature, hunger, important aspects of parenting and attachment behaviours, thirst, fatigue, sleep, and circadian rhythms.



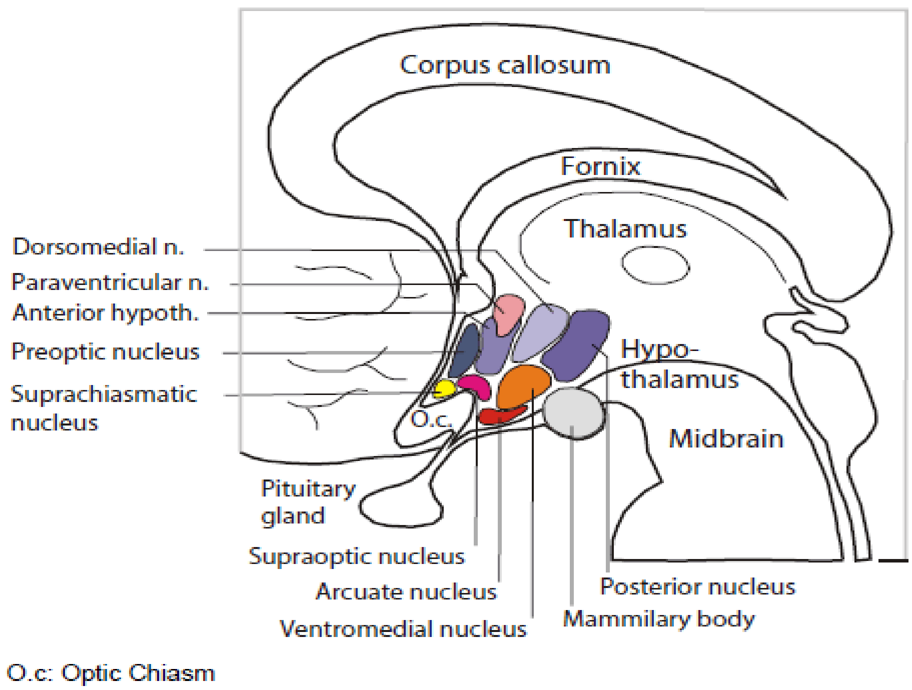
Structure:

- The hypothalamus is a divided into 3 regions (supraoptic, tuberal, mammillary) in a parasagittal plane, indicating location anterior-posterior; and 3 areas (periventricular, medial, lateral) in the coronal plane, indicating location medial-lateral.
- Hypothalamic nuclei are located within these specific regions and areas.
- It is found in all vertebrate nervous systems.
- In mammals, magnocellular neurosecretory cells in the paraventricular nucleus and the supraoptic nucleus of the hypothalamus produce neurohypophysial hormones, oxytocin and vasopressin.
- These hormones are released into the blood in the posterior pituitary.
- Much smaller parvocellular neurosecretory cells, neurons of the paraventricular nucleus, release corticotropin-releasing hormone and other hormones into the hypophyseal portal system, where these hormones diffuse to the anterior pituitary.
- The hypothalamus is highly interconnected with other parts of the central nervous system, in particular the brainstem and its reticular formation.

- As part of the limbic system, it has connections to other limbic structures including the amygdala and septum, and is also connected with areas of the autonomous nervous system.
- The hypothalamus receives many inputs from the brainstem, the most notable from the nucleus of the solitary tract, the locus coeruleus, and the ventrolateral medulla.

Most nerve fibres within the hypothalamus run in two ways (bidirectional).

- Projections to areas caudal to the hypothalamus go through the medial forebrain bundle, the mammillotegmental tract and the dorsal longitudinal fasciculus.
- Projections to areas rostral to the hypothalamus are carried by the mammillothalamic tract, the fornix and terminal stria.
- Projections to areas of the sympathetic motor system (lateral horn spinal segments T1-L2/L3) are carried by the hypothalamospinal tract and they activate the sympathetic motor pathway.



Function:

- The hypothalamus has a central neuroendocrine function, most notably by its control of the anterior pituitary, which in turn regulates various endocrine glands and organs.

- Releasing hormones (also called releasing factors) are produced in hypothalamic nuclei then transported along axons to either the median eminence or the posterior pituitary, where they are stored and released as needed.

- Anterior pituitary

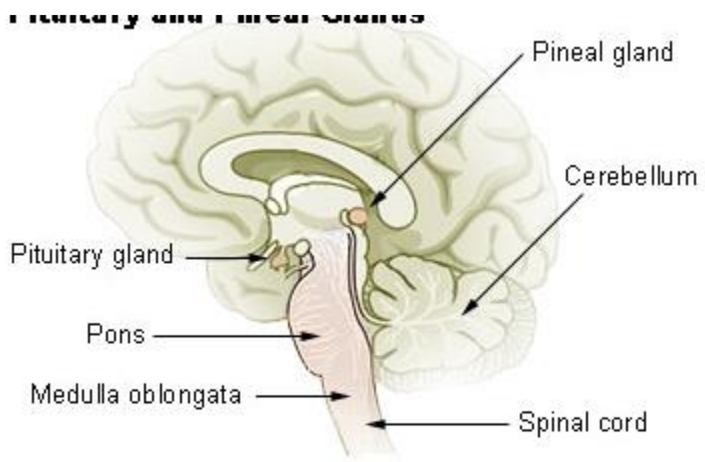
- In the hypothalamic–adenohypophyseal axis, releasing hormones, also known as hypophysiotropic or hypothalamic hormones, are released from the median eminence, a prolongation of the hypothalamus, into the hypophyseal portal system, which carries them to the anterior pituitary where they exert their regulatory functions on the secretion of adenohypophyseal hormones.
- These hypophysiotropic hormones are stimulated by parvocellular neurosecretory cells located in the periventricular area of the hypothalamus.
- After their release into the capillaries of the third ventricle, the hypophysiotropic hormones travel through what is known as the hypothalamo-pituitary portal circulation.
- Once they reach their destination in the anterior pituitary, these hormones bind to specific receptors located on the surface of pituitary cells.
- Depending on which cells are activated through this binding, the pituitary will either begin secreting or stop secreting hormones into the rest of the bloodstream.

2.Structure and function of Pineal gland.(5)

Pineal gland:

- The pineal gland is a small endocrine gland located within the brain.
- Its main secretion is **melatonin**, which regulates the circadian rhythm of the body.
- It is also thought to produce hormones that inhibit the action of other endocrine glands in the body.
- The pineal gland produces melatonin, a serotonin-derived hormone which modulates sleep patterns in both circadian and seasonal cycles.
- The shape of the gland resembles a pine cone from which it derived its name.
- The pineal gland is located in the epithalamus, near the center of the brain, between the two hemispheres, tucked in a groove where the two halves of the thalamus join.

- The pineal gland is one of the neuroendocrine secretory circumventricular organs in which there does not exist the blood–brain barrier at the capillary level.



Structure

- The pineal gland is a midline brain structure that is unpaired.
- It takes its name from its pine-cone shape.
- The gland is reddish-gray and about the size of a grain of rice (5–8 mm) in humans.
- The pineal gland, also called the pineal body, is part of the epithalamus, and lies between the laterally positioned thalamic bodies and behind the habenular commissure.
- It is located in the quadrigeminal cistern near to the corpora quadrigemina.
- It is also located behind the third ventricle and is bathed in cerebrospinal fluid supplied through a small **pineal recess** of the third ventricle which projects into the stalk of the gland.

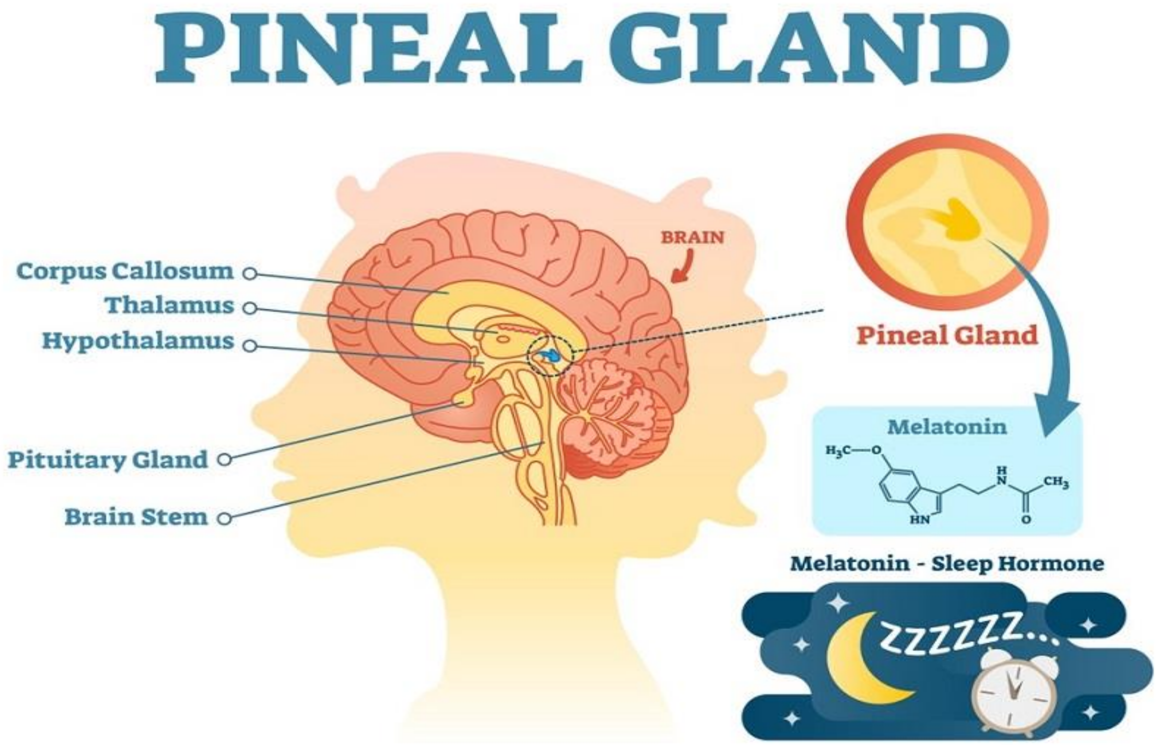
Blood supply

- Unlike most of the mammalian brain, the pineal gland is not isolated from the body by the blood–brain barrier system;
- it has profuse blood flow, second only to the kidney, supplied from the choroidal branches of the posterior cerebral artery.

Nerve supply

- The pineal gland receives a sympathetic innervation from the superior cervical ganglion.
- A parasympathetic innervation from the pterygopalatine and otic ganglia is also present.
- Further, some nerve fibers penetrate into the pineal gland via the pineal stalk (central innervation).

➢ Also, neurons in the trigeminal ganglion innervate the gland with nerve fibers containing the neuropeptide PACAP.



Function

➢ The primary function of the pineal gland is to produce melatonin.

➢ Melatonin has various functions in the central nervous system, the most important of which is to help modulate sleep patterns.

➢ Melatonin production is stimulated by darkness and inhibited by light.

➢ Light sensitive nerve cells in the retina detect light and send this signal to the suprachiasmatic nucleus (SCN), synchronizing the SCN to the day-night cycle.

➢ Nerve fibers then relay the daylight information from the SCN to the paraventricular nuclei (PVN), then to the spinal cord and via the sympathetic system to superior cervical ganglia (SCG), and from there into the pineal gland.

➢ The compound pinoline is also claimed to be produced in the pineal gland; it is one of the beta-carbolines.

Regulation of the pituitary gland

- The pineal gland influences the pituitary gland's secretion of the sex hormones, follicle-stimulating hormone (FSH), and luteinizing hormone (LH.
- The pineal gland contains receptors for the regulatory neuropeptide, endothelin-1, which, when injected in picomolar quantities into the lateral cerebral ventricle, causes a calcium-mediated increase in pineal glucose metabolism.

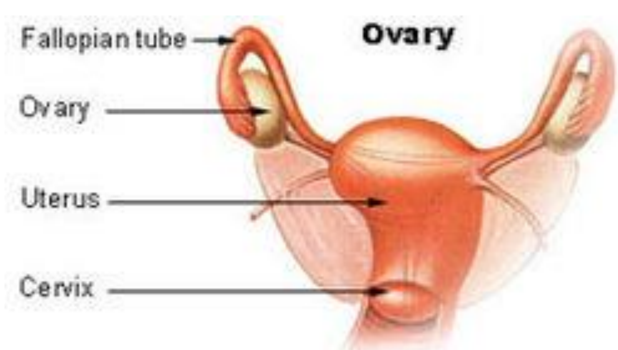
Regulation of bone metabolism

- the pineal-derived melatonin regulates new bone deposition. Pineal-derived melatonin mediates its action on the bone cells through MT2 receptors.

3)Write down the structure and function of Ovary.(5)

Structure & function of Ovary:

- Ovaries are the female gonads and they lie in a shallow fossa on the lateral walls of the pelvis.
- The ovaries also secrete hormones that play a role in the menstrual cycle and fertility.
- They are 2.5-3.5 cm long, 2cm wide and 1cm thick.
- Each is attached to the upper part of the uterus by the ovarian ligament and to the back of the broad ligament by a broad band of tissue, the mesovarium.
- Blood vessels and nerves pass to the ovary through the mesovarium.



Structure:

The ovaries have two layers of tissue.

Medulla:

This lies in the centre and consists of fibrous tissue, blood vessels and nerves.

Cortex:

- this surrounds the medulla.
- It has a framework of connective tissue, or stroma, covered by germinal epithelium.
- It contains ovarian follicles in various stages of maturity, each of which contains an ovum.
- Before puberty the ovaries are inactive but the stroma already contains immature follicles, which the female has from birth.
- During the child bearing years, about every 28 days, one or more ovarian follicle matures, ruptures and release its ovum into the peritoneal cavity.
- This is called ovulation and it occurs during most menstrual cycles.

Blood supply, lymph drainage and nerve supply

Arterial supply:

This is by the ovarian arteries, which branch from the abdominal aorta just below the renal arteries.

Venous drainage:

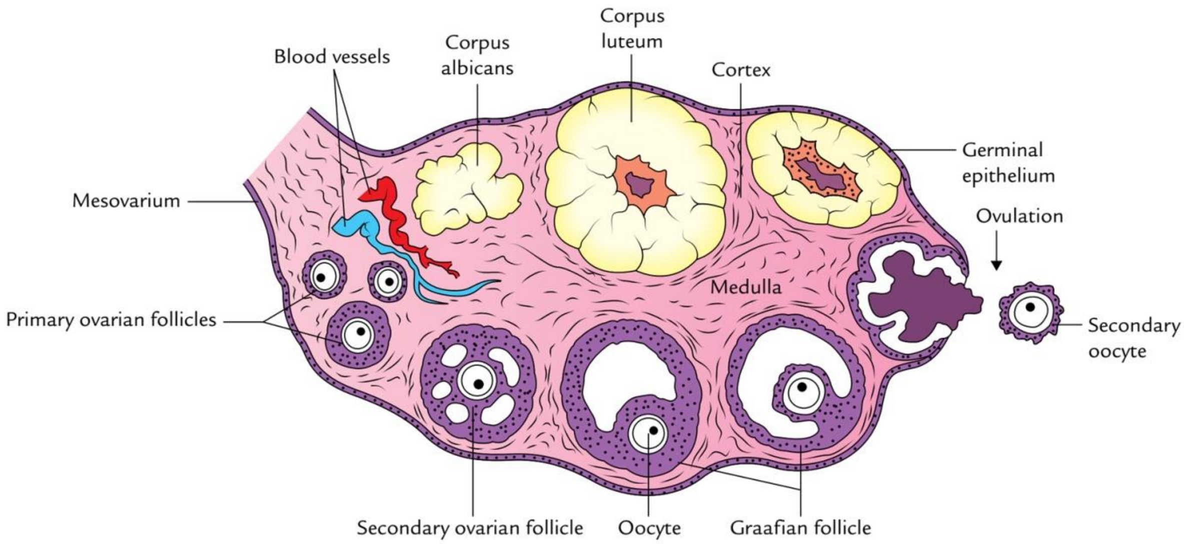
This is into a plexus of veins behind the uterus, from which the ovarian veins arise. The right ovarian veins opens into the inferior vena cava and the left into the left renal vein.

Lymph drainage:

This is to the lateral aortic and preaortic lymph nodes. The lymph vessels follow the same route as the arteries.

Nerve supply:

The nerves are supplied by parasympathetic nerves from the sacral outflow and sympathetic nerves from the lumber outflow.



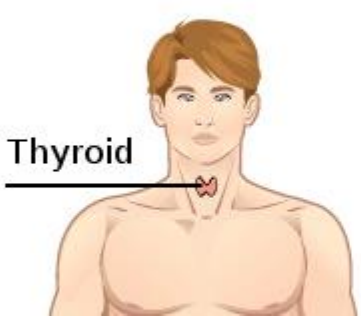
Functions:

- At puberty, the ovary begins to secrete increasing levels of hormones. Secondary sex characteristics begin to develop in response to the hormones. The ovary changes structure and function beginning at puberty.
- Gamete production: The ovaries are the site of production and periodical release of egg cells, the female gametes. In the ovaries, the developing egg cells (or oocytes) mature in the fluid-filled follicles. Typically, only one oocyte develops at a time, but others can also mature simultaneously.
- Hormone secretion: At maturity, ovaries secrete estrogen, testosterone, inhibin, and progesterone. In women, fifty percent of testosterone is produced by the ovaries and adrenal glands and released directly into the blood stream.
- Ovarian aging: As women age, they experience a decline in reproductive performance leading to menopause. This decline is tied to a decline in the number of ovarian follicles. Although about 1 million oocytes are present at birth in the human ovary, only about 500 (about 0.05%) of these ovulate, and the rest are wasted.

4)Write down the structure and function of thyroid gland.(5)

Thyroid gland:

- **thyroid gland**, is an endocrine gland in the neck consisting of two connected lobes.
- The lower two thirds of the lobes are connected by a thin band of tissue called the thyroid isthmus.
- The thyroid is located at the front of the neck, below the Adam's apple.
- Microscopically, the functional unit of the thyroid gland is the spherical thyroid follicle, lined with follicular cells (thyrocytes), and occasional parafollicular cells that surround a lumen containing colloid.
- The thyroid gland secretes three hormones: the two thyroid hormones – triiodothyronine (T_3), and thyroxine (T_4), and a peptide hormone, calcitonin.
- The thyroid hormones influence the metabolic rate and protein synthesis, and in children, growth and development.
- Calcitonin plays a role in calcium homeostasis.
- Secretion of the two thyroid hormones is regulated by thyroid-stimulating hormone (TSH), which is secreted from the anterior pituitary gland.
- TSH is regulated by thyrotropin-releasing hormone (TRH), which is produced by the hypothalamus.
- The thyroid gland develops in the floor of the pharynx at the base of the tongue at 3-4 weeks gestation; it then descends in front of the pharyngeal gut, and ultimately over the next few weeks, it migrates to the base of the neck.
- During migration, the thyroid remains connected to the tongue by a narrow canal, the thyroglossal duct.
- At the end of the fifth week the thyroglossal duct degenerates, and over the following two weeks the detached thyroid migrates to its final position.



Structure

- The thyroid gland is a butterfly-shaped organ composed of two lobes, left and right, connected by a narrow isthmus.

- It weighs 25 grams in adults, with each lobe being about 5 cm long, 3 cm wide, and 2 cm thick, and the isthmus about 1.25 cm in height and width.

- The gland is usually larger in women than in men, and increases in size during pregnancy.

- The thyroid is near the front of the neck, lying against and around the front of the larynx and trachea.

- The thyroid cartilage and cricoid cartilage lie just above the gland, below the Adam's apple.

- The isthmus extends from the second to third rings of the trachea, with the uppermost part of the lobes extending to the thyroid cartilage and the lowermost around the fourth to sixth tracheal rings.

- The infrahyoid muscles lie in front of the gland and the sternocleidomastoid muscle to the side.

- Behind the outer wings of the thyroid lie the two carotid arteries.

- The trachea, larynx, lower pharynx and esophagus all lie behind the thyroid.

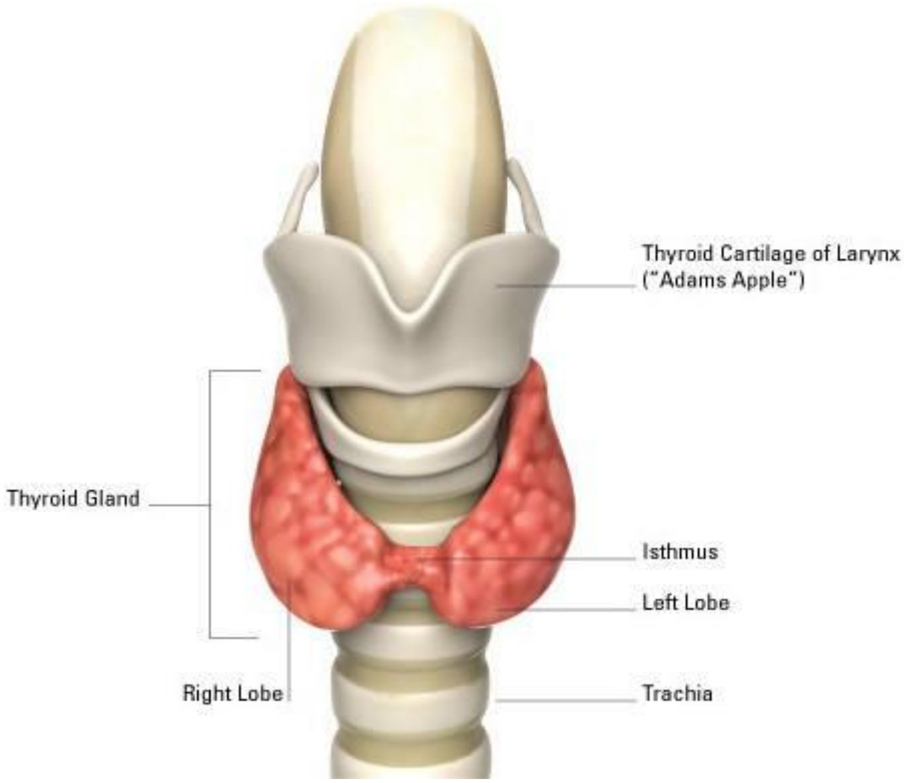
- In this region, the recurrent laryngeal nerve and the inferior thyroid artery pass next to or in the ligament.

- Typically, four parathyroid glands, two on each side, lie on each side between the two layers of the thyroid capsule, at the back of the thyroid lobes.

- The thyroid gland is covered by a thin fibrous capsule, which has an inner and an outer layer.

- The inner layer extrudes into the gland and forms the septae that divides the thyroid tissue into microscopic lobules.
- The outer layer is continuous with the pretracheal fascia, attaching the gland to the cricoid and thyroid cartilagesvia a thickening of the fascia to form the posterior suspensory ligament of thyroid gland, also known as Berry's ligament.

- This causes the thyroid to move up and down with the movement of these cartilages when swallowing occurs.



Blood, lymph and nerve supply

- The thyroid is supplied with arterial blood from the superior thyroid artery, a branch of the external carotid artery, and the inferior thyroid artery, a branch of the thyrocervical trunk, and sometimes by an anatomical variant the thyroid ima artery,[5] which has a variable origin.
- The superior thyroid artery splits into anterior and posterior branches supplying the thyroid, and the inferior thyroid artery splits into superior and inferior branches.
- The superior and inferior thyroid arteries join together behind the outer part of the thyroid lobes.
- The venous blood is drained via superior and middle thyroid veins, which drain to the internal jugular vein, and via the inferior thyroid veins.
- The inferior thyroid veins originate in a network of veins and drain into the left and right brachiocephalic veins.
- Both arteries and veins form a plexus between the two layers of the capsule of the thyroid gland.

- Lymphatic drainage frequently passes the prelaryngeal lymph nodes (located just above the isthmus), and the pretracheal and paratracheal lymph nodes.
- The gland receives sympathetic nerve supply from the superior, middle and inferior cervical ganglion of the sympathetic trunk.
- The gland receives parasympathetic nerve supply from the superior laryngeal nerve and the recurrent laryngeal nerve.

Functions:

- The primary function of the thyroid is the production of the iodine-containing thyroid hormones, triiodothyronine (T_3) and thyroxine (T_4) and the peptide hormone calcitonin.
- The thyroid hormones are created from iodine and tyrosine.
- T_3 is so named because it contains three atoms of iodine per molecule and T_4 contains four atoms of iodine per molecule.
- The thyroid hormones have a wide range of effects on the human body.
- These include:

- Metabolic:
  - ✓ The thyroid hormones increase the basal metabolic rate and have effects on almost all body tissues.
  - ✓ Appetite, the absorption of substances, and gut motility are all influenced by thyroid hormones.
  - ✓ They increase the absorption in the gut, generation, uptake by cells, and breakdown of glucose.
  - ✓ They stimulate the breakdown of fats, and increase the number of free fatty acids.
  - ✓ Despite increasing free fatty acids, thyroid hormones decrease cholesterol levels, perhaps by increasing the rate of secretion of cholesterol in bile.

- Cardiovascular:
  - ✓ The hormones increase the rate and strength of the heartbeat.
  - ✓ They increase the rate of breathing, intake and consumption of oxygen, and increase the activity of mitochondria.
  - ✓ Combined, these factors increase blood flow and the body's temperature.

- Developmental:

  - ✓ Thyroid hormones are important for normal development.
  - ✓ They increase the growth rate of young people, and cells of the developing brain are a major target for the thyroid hormones T_3 and T_4.
  - ✓ Thyroid hormones play a particularly crucial role in brain maturation during fetal development and first few years of postnatal life.

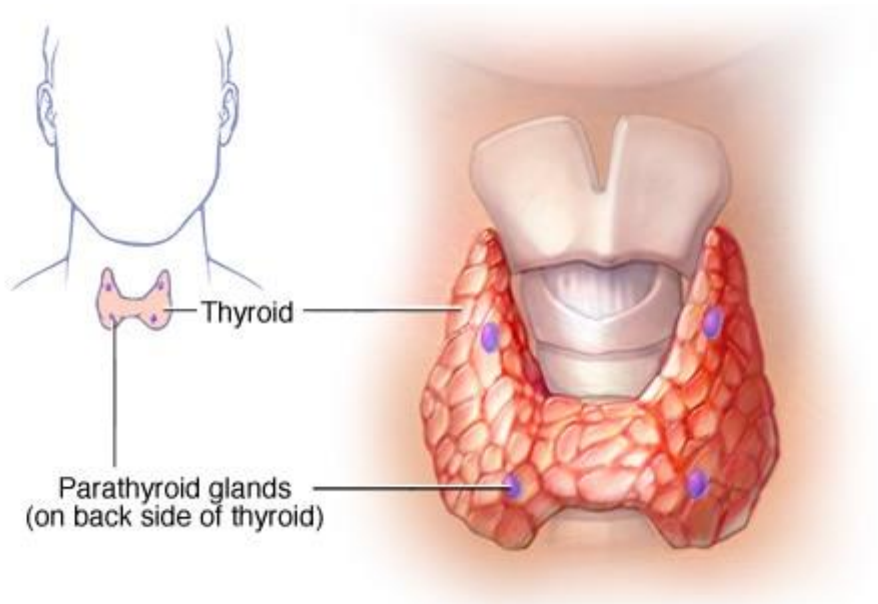
- ➢ The thyroid hormones also play a role in maintaining normal sexual function, sleep, and thought patterns.
- ➢ Increased levels are associated with increased speed of thought generation but decreased focus.
- ➢ Sexual function, including libido and the maintenance of a normal menstrual cycle, are influenced by thyroid hormones

5) Structure and function of Parathyroid gland.(5)

Parathyroid gland:

- ➢ **Parathyroid glands** are small endocrine glands in the neck of humans and other tetrapods.
- ➢ Humans usually have four parathyroid glands, located on the back of the thyroid gland in variable locations.
- ➢ The parathyroid gland produces and secretes parathyroid hormone in response to a low blood calcium, which plays a key role in regulating the amount of calcium in the blood and within the bones.
- ➢ Parathyroid glands share a similar blood supply, venous drainage, and lymphatic drainage to the thyroid glands.
- ➢ Parathyroid glands are derived from the epithelial lining of the third and fourth pharyngeal pouches, with the superior glands arising from the fourth pouch and the inferior glands arising from the higher third pouch.

- The relative position of the inferior and superior glands, which are named according to their final location, changes because of the migration of embryological tissues.
- Hyperparathyroidism and hypoparathyroidism, characterized by alterations in the blood calcium levels and bone metabolism, are states of either surplus or deficient parathyroid function.



Structure

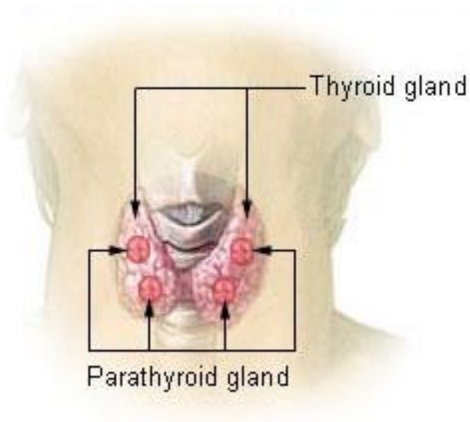
- The parathyroid glands are two pairs of glands usually positioned behind the left and right lobes of the thyroid.
- Each gland is a yellowish-brown flat ovoid that resembles a lentil seed, usually about 6 mm long and 3 to 4 mm wide, and 1 to 2 mm anteroposteriorly.
- There are typically four parathyroid glands.
- The two parathyroid glands on each side which are positioned higher are called the superior parathyroid glands, while the lower two are called the inferior parathyroid glands.
- Healthy parathyroid glands generally weigh about 30 mg in men and 35 mg in women.
- These glands are not visible or able to be felt during examination of the neck.
- Each parathyroid vein drains into the superior, middle and inferior thyroid veins. The superior and middle thyroid veins drain into the internal jugular vein, and the inferior thyroid vein drains into the brachiocephalic vein.

Lymphatic drainage

- Lymphatic vessels from the parathyroid glands drain into deep cervical lymph nodes and paratracheal lymph nodes.

Variation

- The parathyroid glands are variable in number: three or more small glands, and can usually be located on the posterior surface of the thyroid gland.
- Occasionally, some individuals may have six, eight, or even more parathyroid glands.
- Rarely, the parathyroid glands may be within the thyroid gland itself, the chest, or even the thymus.



<u>Function</u>

- The major function of the parathyroid glands is to maintain the body's calcium and phosphate levels within a very narrow range, so that the nervous and muscular systems can function properly.
- The parathyroid glands do this by secreting parathyroid hormone (PTH).
- Parathyroid hormone (also known as parathormone) is a small protein that takes part in the control of calcium and phosphate homeostasis, as well as bone physiology.
- Parathyroid hormone has effects antagonistic to those of calcitonin.

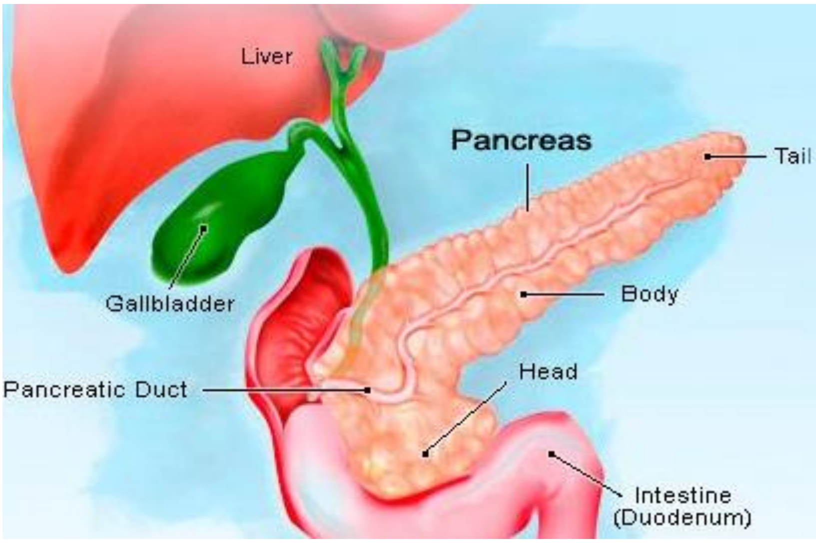
- Calcium. PTH increases blood calcium levels by directly stimulating osteoblasts and thereby indirectly stimulating osteoclasts (through RANK/RANKL mechanism) to break down bone and release calcium. PTH increases gastrointestinal calcium absorption by activating vitamin D, and promotes calcium conservation (reabsorption) by the kidneys.

- **Phosphate.** PTH is the major regulator of serum phosphate concentrations via actions on the kidney. It is an inhibitor of proximal tubular reabsorption of phosphorus. Through activation of vitamin D the absorption (intestinal) of Phosphate is increased.

6.Structure and function of Pancreas.(5)

Pancreas:

- The pancreas is a creamy pink gland weighing about 60g.
- It is about 12-15cm long and is situated in the epigastric and left hypochondriac regions of the abdominal cavity.
- It consist of a broad head, a body and a narrow tail.
- The head lies in the curve of the duodenum, the body behind the stomach, and the tail infront of the left kidney, just reaching the spleen.
- The abdominal aorta and the inferior venacava lie behind the gland.
- The pancreas is both an exocrine and endocrine gland.



Exocrine pancreas:

- This consists of a large number of lobules made up of small acini, the walls of which are composed of secretory cells.
- Each lobule is drained by a tiny duct and these eventually unite to form the pancreatic duct, which extends along the whole length of the gland and opens into the duodenum.

- Just before entering the duodenum the pancreatic duct joins the common bile duct to form the hepatopancreatic ampulla.
- The duodenal opening of the ampulla is controlled by the hepatopancreatic sphincter at the duodenal papilla.
- The function of the exocrine pancreas is to produce pancreatic juice containing enzymes, some in the form of inactive precursors, which digest carbohydrates, proteins and fats.
- As in the alimentary tract, parasympathetic stimulation increases the secretion of pancreatic juice and sympathetic stimulation depresses it.

Endocrine pancreas;

- Distributed throughout the gland, in close proximity to the capillary networks, are groups of specialised cells called the pancreatic islets.
- The islets have no ducts, so the hormones diffuse directly into the blood.
- The endocrine pancreas secrets the hormones insulin and glucagon, which are principally concerned with control of blood glucose levels.

Blood supply;

The splenic and mesenteric arteries supply the pancreas, and venous drainage is given by veins of the same names that joints other veins to form the portal vein.

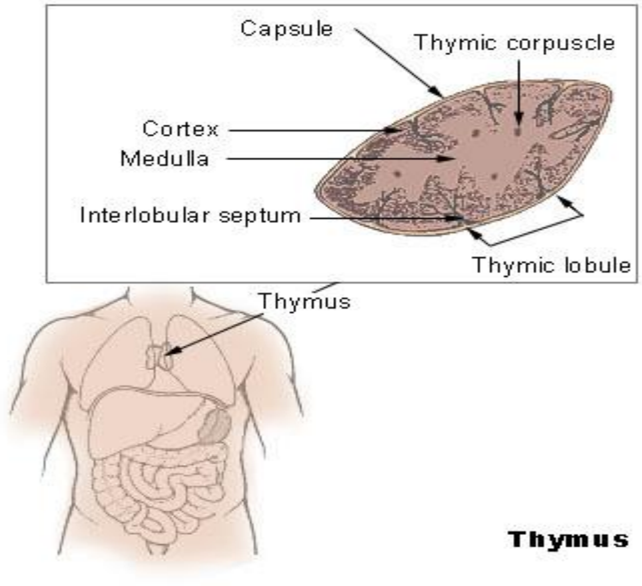
Function:

- A healthy pancreas produces chemicals to digest the food we eat.
- The exocrine tissues secret a clear, watery, alkaline juice that contains several enzymes. these breakdown food into small molecules that can be absorbed by the intestine.
- The endocrine portion, secret insulin and other hormones.
- Pancreatic beta cells release insulin when blood sugar levels rise.
- When blood sugar falls, pancreatic alpha cells release the hormone glucagon.
- Glucagon causes glycogen to be broken down into glucose in the liver.
- The glucose then enters the bloodstream, restoring blood sugar levels to normal.

7)Structure and function of Thymus gland.(5)

Thymus gland:

- The **thymus** is a specialized primary lymphoid organ of the immune system.
- Within the thymus, T cells mature.
- T cells are critical to the adaptive immune system, where the body adapts specifically to foreign invaders.
- The thymus is composed of two identical lobes and is located in the anterior superior mediastinum, in front of the heart and behind the sternum.
- Each lobe of the thymus can be divided into a central medulla and a peripheral cortex which is surrounded by an outer capsule.
- The cortex and medulla play different roles in the development of T cells.
- Cells in the thymus can be divided into thymic stromal cells and cells of hematopoietic origin (derived from bone marrow resident hematopoietic stem cells).
- Developing T cells are referred to as thymocytes and are of hematopoietic origin.
- Stromal cells include epithelial cells of the thymic cortex and medulla, and dendritic cells.
- The thymus provides an environment for development of T cells from precursor cells.
- The cells of the thymus provide for development of T cells that are functional and self-tolerant.
- Therefore, one of the most important roles of the thymus is the induction of central tolerance.
- The thymus is largest and most active during the neonatal and pre-adolescent periods.
- By the early teens, the thymus begins to decrease in size and activity and the tissue of the thymus is gradually replaced by adipose tissue (fat).
- Nevertheless, residual T lymphopoiesis continues throughout adult life.



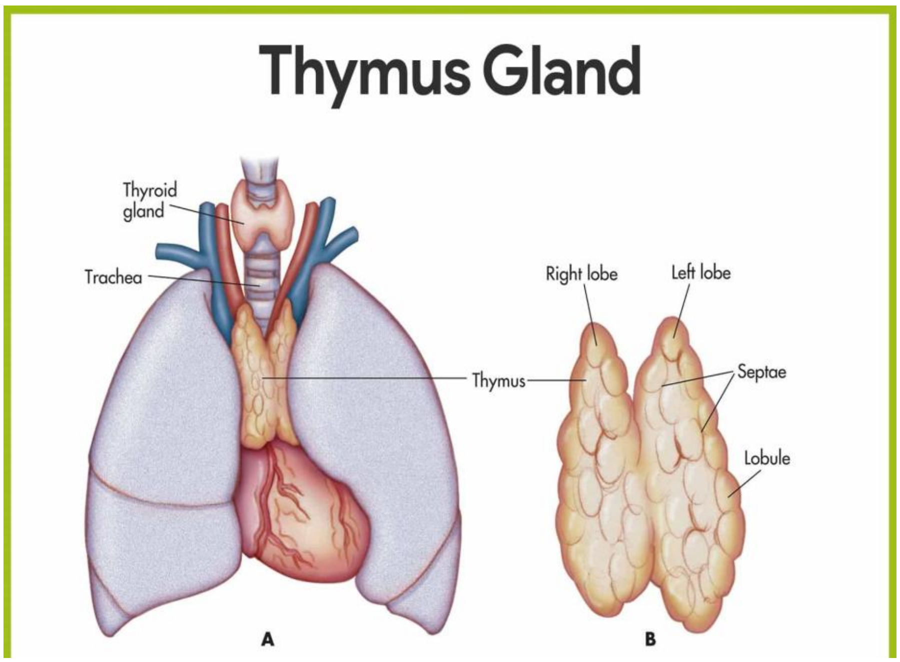
Structure:

- In children, the thymus is pinkish-gray, soft, and lobulated on its surfaces.
- At birth it is about 4–6 cm long, 2.5–5 cm wide, and about 1 cm thick.
- It increases in size until puberty, where it may have a size of about 40–50 g, following which it decreases in size in a process known as involution.
- The thymus is made up of two lobes that meet in the upper midline, and stretch from below the thyroid in the neck to as low as the cartilage of the fourth rib.
- The lobes are covered by a capsule.
- The thymus lies beneath the sternum, rests on the pericardium, and is separated from the aortic arch and great vessels by a layer of fascia.
- The left brachiocephalic vein may even be embedded within the thymus.
- In the neck, it lies on the front and sides of the trachea, behind the sternohyoid and sternothyroid muscles.

Blood and nerve supply:

- The arteries supplying the thymus are branches of the internal thoracic, and inferior thyroid arteries, with branches from the superior thyroid artery sometimes seen.

- The branches reach the thymus and travel with the septa of the capsule into the area between the cortex and medulla, where they enter the thymus itself; or alternatively directly enter the capsule.
- The veins of the thymus end in the left brachiocephalic vein, internal thoracic vein, and in the inferior thyroid veins.
- Sometimes the veins end directly in the superior vena cava.
- Lymphatic vessels travel only away from the thymus, accompanying the arteries and veins.
- These drain into the brachiocephalic, tracheobronchial and parasternal lymph nodes.
- The nerves supplying the thymus arise from the vagus nerve and the cervical sympathetic chain.
- Branches from the phrenic nerves reach the capsule of the thymus, but do not enter into the thymus itself.



Function:

T cell maturation;

- The thymus facilitates the maturation of T cells, an important part of the immune system providing cell-mediated immunity.

- T cells begin as hematopoietic precursors from the bone-marrow, and migrate to the thymus, where they are referred to as thymocytes.
- In the thymus they undergo a process of maturation, which involves ensuring the cells react against antigens ("positive selection"), but that they do not react against antigens found on body tissue ("negative selection").
- Once mature, T cells emigrate from the thymus to provide vital functions in the immune system.
- Each T cell has a distinct T cell receptor, suited to a specific substance, called an antigen.
- Most T cell receptors bind to the major histocompatibility complex on cells of the body.
- In order to be properly functional, a mature T cell needs to be able to bind to the MHC molecule ("positive selection"), and not to react against antigens that are actually from the tissues of body ("negative selection").
- Positive selection occurs in the cortex and negative selection occurs in the medulla of the thymus.
- After this process T cells that have survived leave the thymus, regulated by sphingosine-1-phosphate.
- Further maturation occurs in the peripheral circulation. Some of this is because of hormones and cytokines secreted by the thymus including thymulin, thymopoietin, and thymosins.

Positive selection;

- T cells have distinct T cell receptors.
- These distinct receptors are formed by process of V(D)J recombination gene rearrangement stimulated by RAG1 and RAG2 genes.
- This process is error-prone, and some thymocytes fail to make functional T-cell receptors, whereas other thymocytes make T-cell receptors that are autoreactive.
- [1] If a functional T cell receptor is formed, the thymocyte will begin to express simultaneously the cell surface proteins CD4 and CD8.

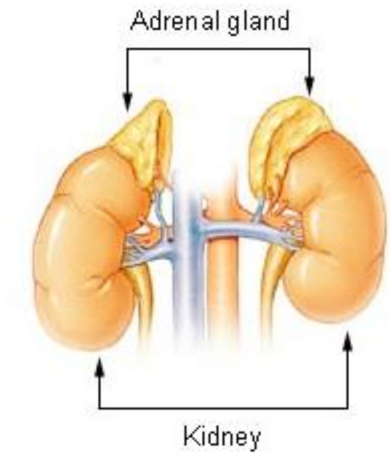
Negative selection;

- T cells that attack the body's own proteins are eliminated in the thymus, called "negative selection".
- Epithelial cells in the medulla and dendritic cells in the thymus express major proteins from elsewhere in the body.

8)Structure and function of Adrenal gland.(5)

Adrenal gland:

- The **adrenal glands** (also known as **suprarenal glands**) are endocrine glands that produce a variety of hormones including adrenaline and the steroids aldosterone and cortisol.
- They are found above the kidneys.
- Each gland has an outer cortex which produces steroid hormones and an inner medulla.
- The adrenal cortex itself is divided into three zones: the zona glomerulosa, the zona fasciculata and the zona reticularis.
- The adrenal cortex produces three main types of steroid hormones: mineralocorticoids, glucocorticoids, and androgens. Mineralocorticoids (such as aldosterone) produced in the zona glomerulosa help in the regulation of blood pressure and electrolyte balance.
- The glucocorticoids cortisol and cortisone are synthesized in the zona fasciculata; their functions include the regulation of metabolism and immune system suppression.
- The innermost layer of the cortex, the zona reticularis, produces androgens that are converted to fully functional sex hormones in the gonads and other target organs.
- The production of steroid hormones is called steroidogenesis, and involves a number of reactions and processes that take place in cortical cells.
- The medulla produces the catecholamine which function to produce a rapid response throughout the body in stress situations.



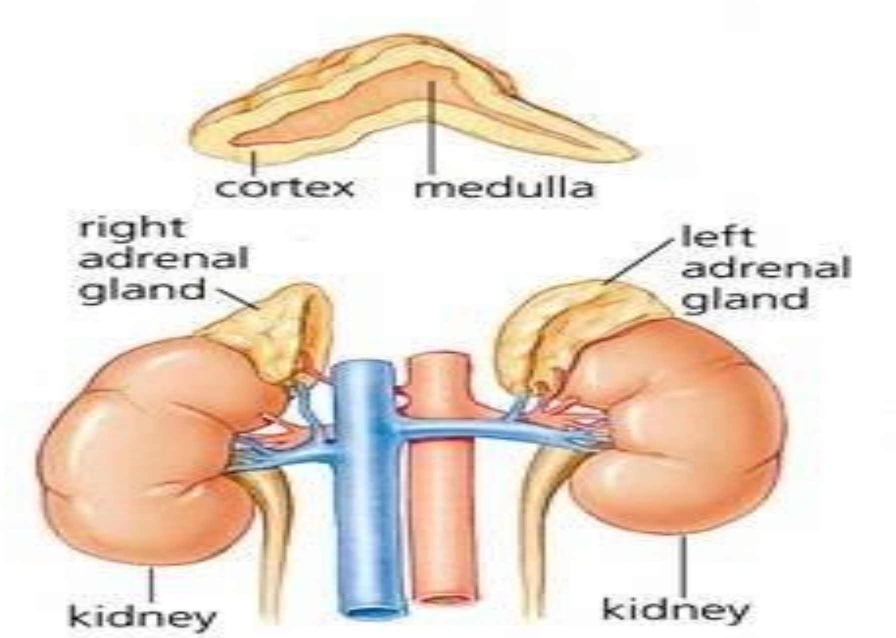
Structure:

- The adrenal glands are located on both sides of the body in the retroperitoneum, above and slightly medial to the kidneys.
- In humans, the right adrenal gland is pyramidal in shape, whereas the left is semilunar or crescent shaped and somewhat larger.
- The adrenal glands measure approximately 3 cm in width, 5.0 cm in length, and up to 1.0 cm in thickness.
- Their combined weight in an adult human ranges from 7 to 10 grams.
- The glands are yellowish in colour.
- The adrenal glands are surrounded by a fatty capsule and lie within the renal fascia, which also surrounds the kidneys.
- A weak septum (wall) of connective tissue separates the glands from the kidneys.
- The adrenal glands are directly below the diaphragm, and are attached to the crura of the diaphragm by the renal fascia.
- Each adrenal gland has two distinct parts, each with a unique function, the outer adrenal cortex and the inner medulla, both of which produce hormones.

Adrenal Cortex;

- Section of human adrenal gland under the microscope, showing its different layers.
- From the surface to the center: zona glomerulosa, zona fasciculata, zona reticularis, medulla.
- In the medulla, the central adrenomedullary vein is visible.

- The adrenal cortex is the outermost layer of the adrenal gland.
- Within the cortex are three layers, called "zones".
- When viewed under a microscope each layer has a distinct appearance, and each has a different function.
- The adrenal cortex is devoted to production of hormones, namely aldosterone, cortisol, and androgens.



Blood supply;

- The adrenal glands have one of the greatest blood supply rates per gram of tissue of any organ: up to 60 small arteries may enter each gland.
- Three arteries usually supply each adrenal gland:

* The superior suprarenal artery, a branch of the inferior phrenic artery
* The middle suprarenal artery, a direct branch of the abdominal aorta
* The inferior suprarenal artery, a branch of the renal artery

- These blood vessels supply a network of small arteries within the capsule of the adrenal glands.
- Thin strands of the capsule enter the glands, carrying blood to them.

Venous blood is drained from the glands by the suprarenal veins, usually one for each gland:

* The right suprarenal vein drains into the inferior vena cava

- The left suprarenal vein drains into the left renal vein or the left inferior phrenic vein.
  - The central adrenomedullary vein, in the adrenal medulla, is an unusual type of blood vessel.
  - Its structure is different from the other veins in that the smooth muscle in its tunica media (the middle layer of the vessel) is arranged in conspicuous, longitudinally oriented bundles.

Function:

- The adrenal gland secretes a number of different hormones which are metabolised by enzymes either within the gland or in other parts of the body.
- These hormones are involved in a number of essential biological functions.

Corticosteroids;

- Corticosteroids are a group of steroid hormones produced from the cortex of the adrenal gland, from which they are named.
- Corticosteroids are named according to their actions:

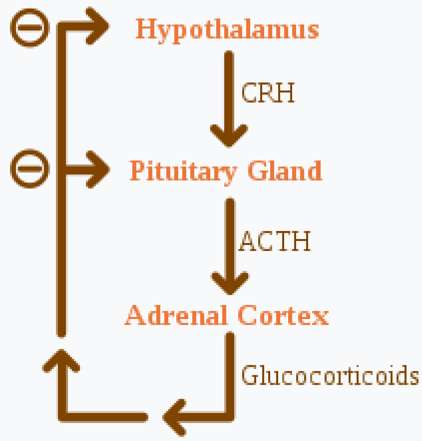
- Mineralocorticoids such as aldosterone regulate salt ("mineral") balance and blood volume.
- Glucocorticoids such as cortisol influence metabolism rates of proteins, fats and sugars ("glucose").

Formation;

- Steroidogenesis in the adrenal glands – different steps occur in different layers of the gland
- All corticosteroid hormones share cholesterol as a common precursor.
- Therefore, the first step in steroidogenesis is cholesterol uptake or synthesis.
- Cells that produce steroid hormones can acquire cholesterol through two paths.
- The main source is through dietary cholesterol transported via the blood as cholesterol esters within low density lipoproteins (LDL).
- LDL enters the cells through receptor-mediated endocytosis.
- The other source of cholesterol is synthesis in the cell's endoplasmic reticulum. Synthesis can compensate when LDL levels are abnormally low.

  In the lysosome, cholesterol esters are converted to free cholesterol, which is

Regulation;



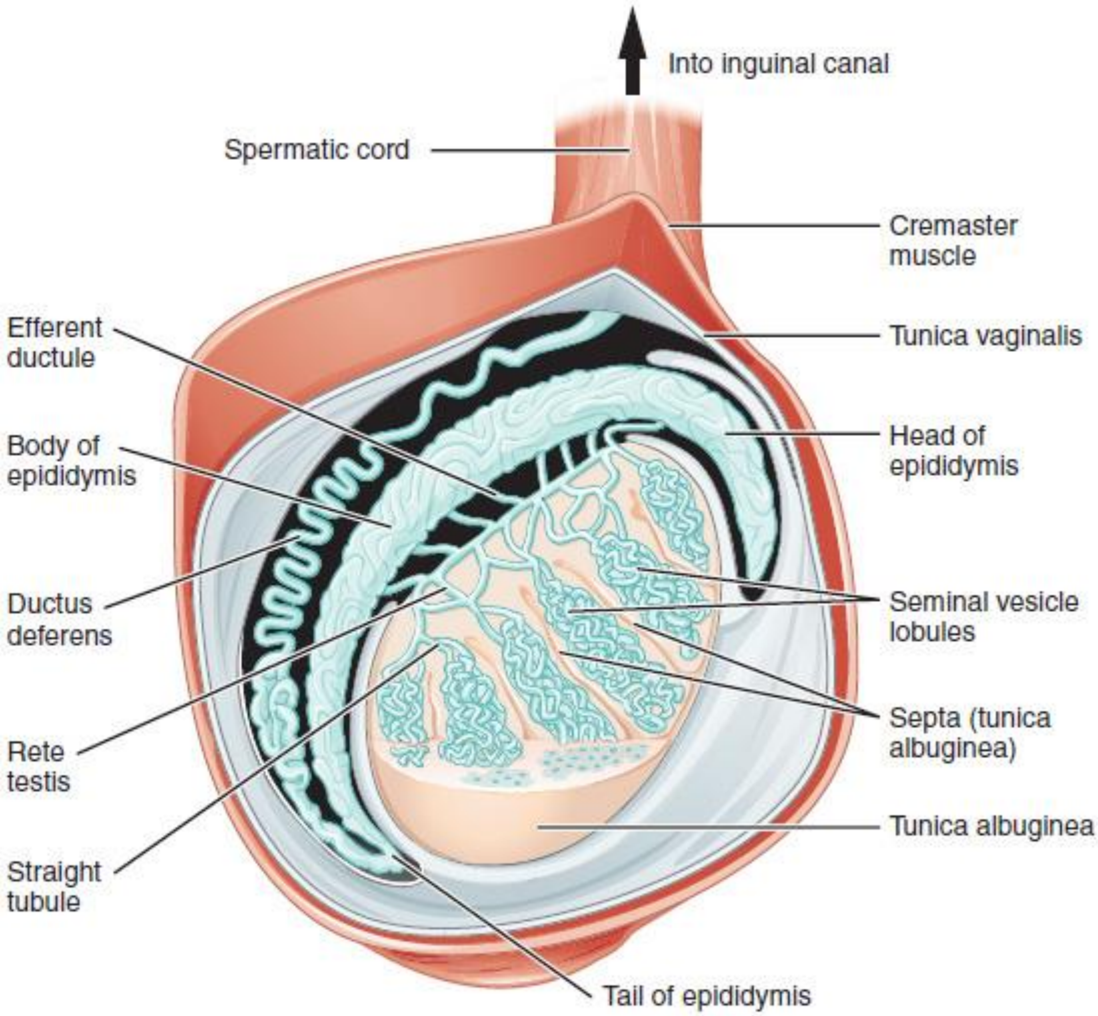
- Glucocorticoids are under the regulatory influence of the hypothalamus-pituitary-adrenal (HPA) axis.
- Glucocorticoid synthesis is stimulated by adrenocorticotropic hormone (ACTH), a hormone released into the bloodstream by the anterior pituitary.
- In turn, production of ACTH is stimulated by the presence of corticotropin-releasing hormone (CRH), which is released by neurons of the hypothalamus.
- ACTH acts on the adrenal cells first by increasing the levels of StAR within the cells, and then of all steroidogenic P450 enzymes.
- The HPA axis is an example of a negative feedback system, in which cortisol itself acts as a direct inhibitor of both CRH and ACTH synthesis.
- The HPA axis also interacts with the immune system through increased secretion of ACTH at the presence of certain molecules of the inflammatory response.

9)Explain about Testis.(5)

<u>Testis:</u>

- **Testicle** or **testis** is the male <u>reproductive gland</u> or <u>gonad</u> in all animals, including humans.
- It is <u>homologous</u> to the female <u>ovary</u>.
- The functions of the testes are to produce both <u>sperm</u> and <u>androgens</u>, primarily <u>testosterone</u>.

- Testosterone release is controlled by the anterior pituitary luteinizing hormone; whereas sperm production is controlled both by the anterior pituitary follicle-stimulating hormone and gonadal testosterone.



Structure

Appearance;

- Males have two testicles of similar size contained within the scrotum, which is an extension of the abdominal wall.

- Scrotal asymmetry is not unusual: one testicle extends farther down into the scrotum than the other due to differences in the anatomy of the vasculature.

Internal structure;

- Transverse section through the left side of the scrotum and the left testis.

Duct system;

- The testes are covered by a tough membranous shell called the tunica albuginea.
- Within the testes are very fine coiled tubes called seminiferous tubules.
- The tubules are lined with a layer of cells (germ cells) that develop from puberty through old age into sperm cells (also known as spermatozoa or male gametes).
- The developing sperm travel through the seminiferous tubules to the rete testis located in the mediastinum testis, to the efferent ducts, and then to the epididymis where newly created sperm cells mature (see spermatogenesis).
- The sperm move into the vas deferens, and are eventually expelled through the urethra and out of the urethral orifice through muscular contractions.

Primary cell types;

Within the seminiferous tubules

- Here, germ cells develop into spermatogonia, spermatocytes, spermatids and spermatozoon through the process of spermatogenesis. The gametes contain DNA for fertilization of an ovum
- Sertoli cells – the true epithelium of the seminiferous epithelium, critical for the support of germ cell development into spermatozoa. Sertoli cells secrete inhibin.
- Peritubular myoid cells surround the seminiferous tubules.

Between tubules (interstitial cells)

- Leydig cells – cells localized between seminiferous tubules that produce and secrete testosterone and other androgens important for sexual development and puberty, secondary sexual characteristics like facial hair, sexual behavior and libido, supporting spermatogenesis and erectile function. Testosterone also controls testicular volume.
- Also present are:
    - Immature Leydig cells
    - Interstitial macrophages and epithelial cells.

Blood supply and lymphatic drainage;

Blood supply and lymphatic drainage of the testes and scrotum are distinct:

- The paired testicular arteries arise directly from the abdominal aorta and descend through the inguinal canal, while the scrotum and the rest of the external genitalia is supplied by the internal pudendal artery (itself a branch of the internal iliac artery).
- The testis has collateral blood supply from 1.
- the cremasteric artery (a branch of the inferior epigastric artery, which is a branch of the external iliac artery), and 2.
- the artery to the ductus deferens (a branch of the inferior vesical artery, which is a branch of the internal iliac artery).
- Therefore, if the testicular artery is ligated, e.g., during a Fowler-Stevens orchiopexy for a high undescended testis, the testis will usually survive on these other blood supplies.
- Lymphatic drainage of the testes follows the testicular arteries back to the paraaortic lymph nodes, while lymph from the scrotum drains to the inguinal lymph nodes.

Layers:

- Many anatomical features of the adult testis reflect its developmental origin in the abdomen.
- The layers of tissue enclosing each testicle are derived from the layers of the anterior abdominal wall.
- Notably, the cremasteric muscle arises from the internal oblique muscle.

The blood–testis barrier

- Large molecules cannot pass from the blood into the lumen of a seminiferous tubule due to the presence of tight junctions between adjacent Sertoli cells.
- The spermatogonia are in the basal compartment (deep to the level of the tight junctions) and the more mature forms such as primary and secondary spermatocytes and spermatids are in the adluminal compartment.
- The function of the blood–testis barrier may be to prevent an auto-immune reaction.
- Mature sperm (and their antigens) arise long after immune tolerance is established in infancy.

- Therefore, since sperm are antigenically different from self tissue, a male animal can react immunologically to his own sperm.
- In fact, he is capable of making antibodies against them.
- Injection of sperm antigens causes inflammation of the testis (auto-immune orchitis) and reduced fertility.
- Thus, the blood–testis barrier may reduce the likelihood that sperm proteins will induce an immune response, reducing fertility and so progeny.

Temperature regulation;

- Spermatogenesis is enhanced at temperatures slightly less than core body temperature.
- The spermatogenesis is less efficient at lower and higher temperatures than 33 °C.
- Because the testes are located outside the body, the smooth tissue of the scrotum can move them closer or further away from the body.
- The temperature of the testes is maintained at 35 degrees Celsius (95 degrees Fahrenheit), i.e. two degrees below the body temperature of 37 degrees Celsius (98.6 degrees Fahrenheit).
- Higher temperatures affect spermatogenesis.
- There are a number of mechanisms to maintain the testes at the optimum temperature.
- The cremasteric muscle is part of the spermatic cord.
- When this muscle contracts, the cord is shortened and the testicle is moved closer up toward the body, which provides slightly more warmth to maintain optimal testicular temperature.
- When cooling is required, the cremasteric muscle relaxes and the testicle is lowered away from the warm body and is able to cool.
- Contraction also occurs in response to stress (the testicles rise up toward the body in an effort to protect them in a fight).
- The cremaster muscle can reflexively raise each testicle individually if properly triggered.

- This phenomenon is known as the cremasteric reflex. The testicles can also be lifted voluntarily using the pubococcygeus muscle, which partially activates related muscles.