# ENDOCRINE SYSTEM AND HORMONAL CO - ORDINATION

**Introduction :** Endocrine system formed of all endocrine glands of body. Though different endocrine glands are different in embryonic origin and are isolated from one another but these interact with one another so collectively form an endocrine system. Endocrine system along with nervous system, controls and coordinates the body functions and maintains a homeostais. So both are collectively form neuro-endocrine system. The study of these two systems is called neuro-endocrinology.

The nervous system achieves functional co-ordination and integration for quick responses of body, like a high-speed service. Contrarily, the endocrine system achieves co-ordination and integration for slow responses of body, like a low speed service.

**Glands of body :** A cell, a tissue or an organ which secretes certain useful chemical compounds is called a gland. Animals have three types of glands.

(i) **Exocrine gland (Gr., *ex* = out + *krinein* = to secrete) :** These glands have ducts for discharging their secretions. Therefore, they called duct glands. *ex* – Liver, Sweat gland, Sebaceous gland, Gastric glands and some intestinal glands.

(ii) **Endocrine glands ( Gr., *endo* = within + *krinein* = to secrete)** : These glands lack ducts and pass secretions into the surrounding blood directly. Therefore they called ductless glands. *ex* – Thyroid, parathyroid, adrenal, pituitary, pineal body and thymus.

(iii) **Heterocrine glands :** These glands consist of both exocrine and endocrine tissue. The exocrine discharge its secretion by a duct and the endocrine tissue discharge its secretion into the blood. Pancreas and gonads are heterocrine glands. These are also called mixed glands.

## 11.1 HORMONES AND THEIR MECHANISM

Hormones are informational molecules secreted by the endocrine cells in one part of the body and carried by blood to another part where they stimulate or inhibit specific physiological process. In other words the hormones are chemical messengers or informational molecules that regulate the biological processes and metabolism. Hormones organs called target organs. Targate cells have receptor proteins for specific hormone.

**Discovery :** First hormone discovered was secretin. It was discovered by two English physiologists : William M Bayliss and Ernest H. Starling in 1903.

**Nomenclature :** Term hormone was coined by starling (1905) from Greek work Hormaein means to excite. It is a mishomer because a number of hormones are known to have inhibitory effect (*e.g.* Somatostatin)

(i) **Properties of hormones**

(a) These are secreted by endocrine gland (biogenic in origin).

(b) Their secretions is released directly into blood (except local hormones *e.g.* gastrin).

(c) These are carried to distantly located specific organs, called target organ.

(d) These have specific physiological action (excitatory or inhibatory). These co-ordinate different physical, mental and metabolic activities and maintain homeostasis.

(e) The hormones have low molecular weight *e.g.* ADH has a molecular weight of 600–2000 daltons.

(f) These act in very low concentration *e.g.* around$10^{-10}$ molar.

(g) Hormones are non antigenic.

(h) These are mostly short-lived. So have a no camulative effect.

(i) Some hormones are quick acting *e.g.* adrenalin, while some acting slowly *e.g.* ostrogen of ovary.

(j) Some hormones secreted in inactive form called Prohormone *e.g.* Pro-insulin.

(k) Hormones are specific. They are carriers of specific information to their specific target organ. Only those target cell respond to a particular hormone for which they have receptors.

(ii) **Classification of hormones**

(a) **On the basis of chemical nature :** On the basis of chemical composition hormones are classified into three categories.

(1) **Amine hormones :** These are derived form tyrosine amino acid and have amino $(-NH_2)$ group *e.g.* Thyroxine, Epinephrine, Nor-epinephrine.

(2) **Steroids :** These are fat soluble and have sterol group. These are derived from cholesterol *e.g.* hormones of adrenal cortex (cartisol, cartisone, carticasterone, aldasterone) testes (testosterone etc.) and ovaries (estrone, estradiol, progesterone etc.)

(3) **Proteinous and peptide hormones :** These are formed of 3 – 200 amino acids interlinked by peptide bonds and are water soluble *e.g.*

(i) Proteinous hormones like STH, TSH, FSH, LH etc. Out of these FSH and LH are glycoproteins.

(ii) Long peptide hormones like insulin and glucagon, ACTH, Paratharmone.

(iii) Short peptide hormones like oxytocin, ADH, MSH. These hormones formed of a few amino acids.

(b) **On the basis of mode of action**

(1) **Quick acting hormones :** These hormones initiate immediate response from their target cells. There receptor is always located on the outer surface of plasma membrane of target cell because these are large sized. Hormone receptor complex activates a membrane enzyme adenyl cyclase which

hydrolise ATP into cyclic AMP. Which acts as secondary messenger, c-AMP activates an inactive enzyme system by cassade effect. So their mode of action is called second messenger hypothesis. *e.g.* These includes proteinous, peptide and amine hormones.

(2) **Short acting hormones :** These hormones intiate response after some time. These are small sized so are diffusable through the plasma membrane of their target cell. These bind their proteinous receptor present in the cytosol. These always operate through de-novo synthesis of m-RNA by activation of certain genes. So their mechanism of action is called m-RNA hypothesis. *e.g.* These include steroid hormones of testes, ovary and adrenal cortex.

(iii) **Differences between hormone and enzymes :** Though both hormones and enzymes regulate the body functions, but they have following differences.

| S.No. | Characters | Enzymes | Hormones |
|---|---|---|---|
| **1.** | Chemistry | Always proteinaceous | May be proteinaceous, or amine or steroids. |
| **2.** | Molecular weight | Macromolecules with high molecular weights. | Have low molecular weights. |
| **3.** | Diffusibility | Non-diffusible through cell membrane. | Diffusible through cell membrane. |
| **4.** | Site of action | Either act intracellularly or carried by some duct to another site. | Generally carried by blood to a target organ. |
| **5.** | Mode of action | Always act as biocatalysts and increase the rate of metabolic physiological process. | May be excitatory or inhibitatory in their physiological action. |
| **6.** | Reversibility | These catalyze reversible reactions. | Hormone controlled reactions are not reversible. |
| **7.** | Effect of concentration | Reaction rate increase with increase in their concentration upto a limit. | Deficiency or excess of hormone causes metabolic disorders and diseases. |
| **8.** | Speed | Act quickly | Some are quick acting, while some are slow acting with a lag period. |
| **9.** | Consumption | Not used in metabolic functions. | Used up in metabolic functions. |

(iv) **Difference between hormone and vitamin :** Though both hormones and vitamins are similar in being organic (compounds; required in micro-amount and regulate the metabolic functions, but two also differ in a number of characters.

| S.No. | Characters | Hormones | Vitamins |
|---|---|---|---|
| **1.** | Source | Synthesized in the endocrine cells of body. | Taken along with food from outside. |
| **2.** | Chemistry | Steroids or proteinous or amino acid derivatives. | Simple organic compounds like amines, esters, organic acids etc. |
| **3.** | Action | Either excitatory or inhibatory. Do not act as co-enzymes. | These generally act as co-enzymes for enzyme activity. |
| **4.** | Cause of disorders | Both excess as well as deficiency of hormones. | Generally avitaminosis (deficiency of vitamins) leads to deficiency diseases. |

(v) **Differences between nervous and hormonal informations :** Both hormonal and nervous system control and coordinate the body functions and work in co-ordination to maintain a steady state condition, called homeostasis. But two types of controls differ in some important characters.

| S.No. | Characters | Nervous control | Hormones control |
|---|---|---|---|
| **1.** | Speed of action | Always quick acting. | May be quick acting or acting with a long period. |
| **2.** | Mode of transmission of informations | As electrochemical nerve impulses. | As chemical messengers. |
| **3.** | Path of transmission | Through nerve fibres. | Through blood. |
| **4.** | Direction of the informations | Towards a specific direction (effector organ or CNS). | Released in general blood circulation from where taken by specific receptor. |
| **5.** | Suitability | For quick reactions like reflexes. | For long-term changes *e.g.* maintenance of pregnancy. |
| **6.** | Durability | Short time effect. | Long lasting. |

(vi) **Release of hormones :** Hormones are released from endocrine glands by three types of stimuli.

(a) **Specific metabolic :** The presence of a specific metabolite in the blood elicits the hormone to deal with it. For instance excess of glucose in the blood causes the release of insulin from the pancreas.

(b) **Other hormone :** The presence of a specific hormone in the blood induces the release of another hormone. For example TSH stimulate thyroid gland to release thyroxine hormone.

(c) **Neuronal impulse :** Neurons of autonomic system stimulate hormone release from some glands. For example adrenaline and nor-adrenaline are released from adrenal medulla on the arrival of nerve impulses during anxiety, stress and danger.

(vii) **Mechanism of hormone action :** The hormones act in two ways –

On cell surface and within a cell.

(a) **On cell surface :** The molecules of hormones that are amino acid derivatives, peptides or proteins are large and insoluble in lipid, and can not enter the target cell. Therefore they act at the cell surface. They bind to specific receptor molecules located on the surface of cell membrane. The hormone receptor complex may acts in one of the two ways –

(1) **Formation of cAMP :** Mechanism of formation of cAMP was discovered by E.W. Sutherland in 1950. The hormone receptor complex causes the release of an enzyme adenyl cyclase. From the receptor site. This enzyme hydrolise the ATP into c-AMP. The c-AMP activates the existing enzyme system of the cell. This accelerates the metabolic reactions in cell. The hormone is called first messenger and the c-AMP is termed the second messenger. *e.g.* Adrenaline causes the secretion of glucose from the liver cell from this mechanism.

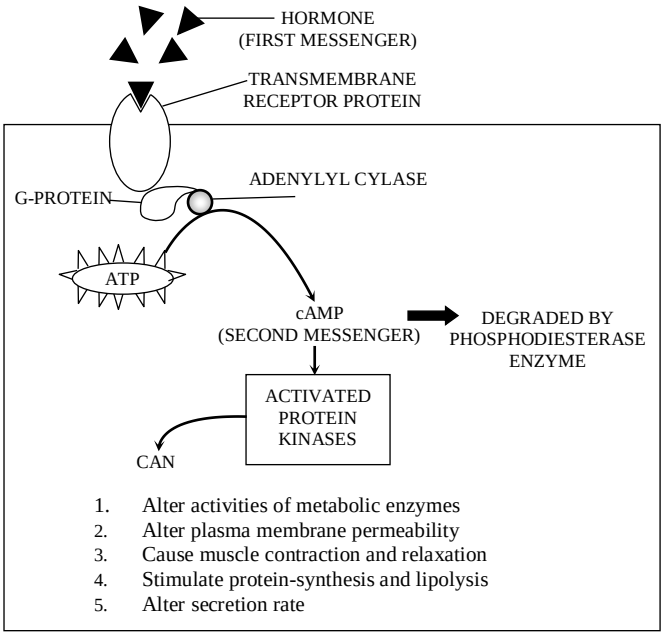


***Fig. – Mechanism of Hormone action on cell surface***

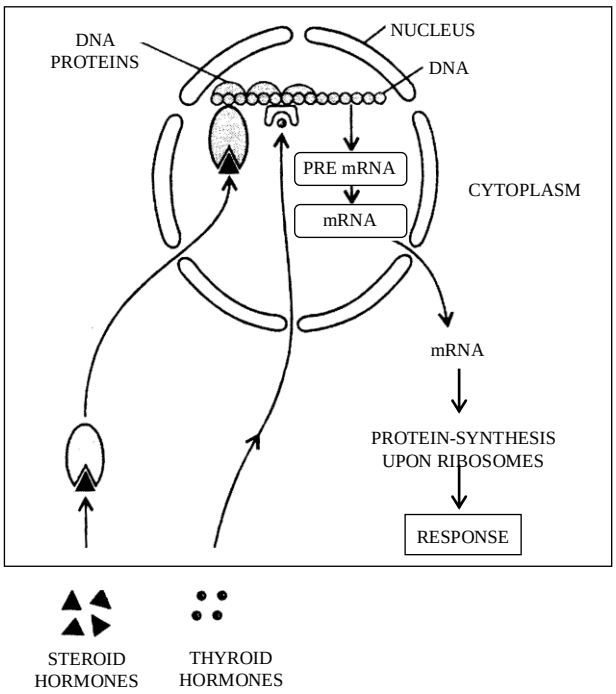


***Fig. – Mechanism of cell surface within a***

(2) **Change in membrane permeability :** The receptor proteins of some hormones are large transmembrane intrinsic protein acting as ion channels for facilitated diffusion of $Na^+$, $K^+$, $Ca^{2+}$ etc. On binding with specific hormone these receptor proteins undergo conformational changes, so that the membrane permeability for ions is altered, resulting into important changes in metabolism.

For example insulin promotes the entry of glucose from blood into the muscles cells by increasing the permeability of sarcolemma to glucose.

(b) **Within a cell :** The steroid hormones act within the cell. Their small, lipid soluble molecules pass through the cell membrane and bind to specific receptor molecules present in the cytoplasm. The receptor molecules carry them into the nucleus. Here, the receptor hormone complex binds to a specific receptor site

on the chromosome and activates certain genes that were previously repressed. The activated gene transcribe m-RNA which directs the synthesis of enzyme (protein molecule) in the cytoplasm. The enzyme molecule promote the metabolic reactions in the cell.

(viii) **Feedback control of hormone secretion :** The secretion of hormones is depends on age, daily routine, health of body. Physiological conditions of body etc. Besides the above factors hormone secretion is also depends on its own amount circulating in the blood. Decrease and increase in the circulating amount of a hormone has a directly inverse effect on the secretion of hormone. This is known as the "pull and push" or "feed-back control" mechanism of hormonal secretion.

Several types of feedback mechanisms are found in the body. Most of these are of negative feedback, but some are of positive feedback. Some negative feedback mechanisms are direct, while others are indirect.

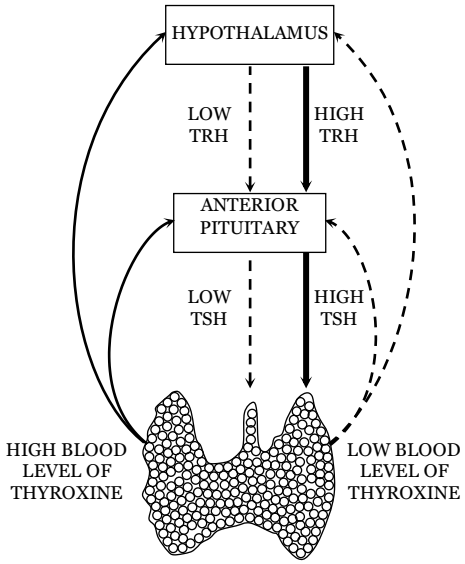

***Fig. – Feed back control of hormone secretion***

(a) **Negative feedback control**

(1) **Direct feedback control :** Thyroid stimulating hormone (T.S.H.) stimulates the thyroid gland to secrete thyroxine hhormone. A high amount of thyroxine in the blood exerts an inhibitory effect on pituitory to secrete less T.S.H.. This eventually results a decrease in thyroxine. This is called "Direct feedback control".

**Thyroxine hormone :** A high amount of thyroxine in the blood exerts an inhibitory effect correction. This eventually results a decrease in thyroxine. This is call "direct feedback control".

(b) **Positive feedback control :** Oxytocin released by posterior pituitary gland stimulate contraction of uterus during child birth. As the contraction of uterus progresses, more and more of oxytocin is released. Thigh is called positive feed back control.

(1) Origin of different endocrine glands

| Endocrine glands | Weight | Origin |
|---|---|---|
| Pituitary | 0.5 gm | Ectoderm |
| Pineal | 5.0 mg | Ectoderm |
| Thymus (up to 12 yrs.) | 20.0 gm | Mesoderm |
| Thyroid | 25.0 gm | Endoderm |
| Parathyroid | 20.0 mg | Endoderm |
| Adrenal cortex | 4.0 gm | Mesoderm |
| Adrenal medulla | 1.0 gm | Ectoderm |
| Testes | – | Mesoderm |
| Ovary | – | Mesoderm |
| Pancrease | 60.0 gm | Endoderm |

(2) **Functions of some important hormones**

- MSH controls skin colour.
- Pituitary controls other endocrine glands.
- Thymosine secreted by the thymus gland provides immunity to the infants.

- Thyroid is the largest gland. Its hormone thyroxine controls oxidative metabolism.
- Normally, family planning pills consists of estrogen and progesterone.
- The Leydig cells secrete testosterone.
- Steroid sex hormones are secreted by the gondas. The hormones control the process of reproduction and secondary sexual characters.
- Adrenal gland is found attached to the kidney as cap. This gland secretes adrenalin and non-adrenalin hormones.
- Oxytocin controls parturition.
- Prolactin controls growth is mammary glands and secretion of milk in woman.
- FSH controls spermatogenesis.
- LH controls secretion of androgen from the Leydig cells in man and helps in the release of ovum from the ovary in woman.

(3) **Number of hormones secreted by different endocrine glands**

| **Endocrine-glands** | **Number of secreted hormones** | |
|---|---|---|
| Pituitary – Anterior | – | 7 |
| Pituitary – Posterior | – | 2 |
| Pineal body | – | 2 |
| Thymus | – | 3 |
| Thyroid | – | 2 |
| Parathyroid | – | 1 |
| Islets of Langerhans | – | 3 |
| Adrenal cortex | – | 46 |
| Adrenal medulla | – | 2 |
| Testes | – | 1 |
| Ovary | – | 3 |
| Placenta | – | 2 |
| Kidneys | – | 2 |
| Stomach | – | 1 |
| Duodenum | – | 5 |
| Ileum | – | 2 |

(4) **Discovery & Terms**

- Term 'endocrine' was first used by Bernard.
- Thomas Addison is called as father of endocrinology.
- Walter canon stated that the hormones maintain homeostasis in the body.
- Von Euler coined the term 'prostaglandin'
- Kendall for the first time prepared the crystals of thyroxine.
- Harrington and Barger studied the molecular structure of thyroxine.

- Term 'thyroxine' was coned by Whartson.
- Sutherland discovered cAMP.
- Parathormone was first isolated by Collip.
- Potts discovered the structure of PTH.
- Axelord studied the structure of epinephrin and nor-epinephrin.
- Endocrine structures of the pancreas were discovered by langerhans.
- Structure of insulin was studied by Sanger. He was given Nobel prize in 1958. He was rewarded Nobel prize in 1980 for gene structure.
- Human insulin was synthesized by Tsan.
- Glucagon was discovered by Kimball and Murlin.
- Term ' Secretin' was coined by Beylis and Starling.
- Adrenalin gland was discovered by Eustachian.

## 11.2 Pituitary Gland (Hypophysis)

Pituitory is known as hypophysis cerebri, its name pituitary was given by vesalius. Muller,s gland of amphioxus and subneural gland of hardmania is homologous to pituitary of vertebrates. Weight to pituitary is 0.5 gm. Removal of pituitary is knows as hypophysectomy.

(i) **Position and origin :** Pituitary gland is the smallest (about 1 to 1½ cm in diameter) endocrine gland of the body. It is pea-shaped, ovoid, radish brown gland situated at the base of the brain in a cavity, the sell turcisa of sphenoid bone. It is connected by a short stalk called Infundibulum, to the ventral wall (Hypothalamus) of diencephalon. That is why it is also called hypophysis cerebri. It weight about 0.5 to 1 gm. It controls most of the endocrine glands. Hence, it is also called leader of endocrine orchestra or master gland. Pituitary gland is closely related with hypothalamus. Hence, it is also called hypothalamo-hypophyseal gland, pituitary is ectodermal in origin.

**Parts and component**

(1) **Adenohypophysis**

(i) Pars distalis
(ii) Pars tuberalis } **Anterior lobe**
(iii) Pars intermedia

(2) **Neurohypophysis**

(i) Pars nervosa } **Posterior lobe**
(ii) Infundibulum

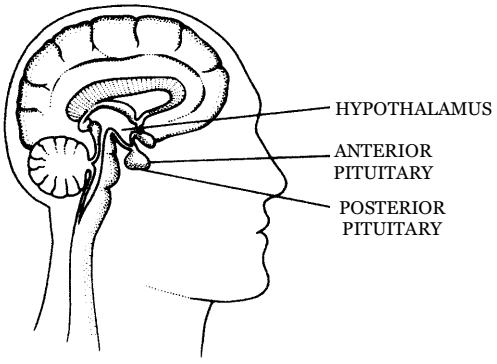


***Fig. – Location of pituitary***

(ii) **Structure of pituitary gland :** Pituitary gland is comprised of two main lobes – Adenohypophysis and Neurohypophysis. Adenohypophysis is arises as hypophysial or Rathke's pouch from dorsal wall of embyronic stomodeum. It is the anterior lobe of pituitary. The neurohypophysis (Pars nervosa or Posterior lobe) form as an outgrowth from the infundibulum of the floor of hypothalamus.

The anterior lobe includes three lobes – Pars tuberalis, Pars distalis and pars intermedia. The posterior lobe includes pars nervosa and infundibulum. The pars nervosa has the axons of the neurosecretory cells found in the hypothalamus. The axons form end knows which are called as Herring bodies. There are special pituicytes in between the Herring bodies which are called neuroglial cells.

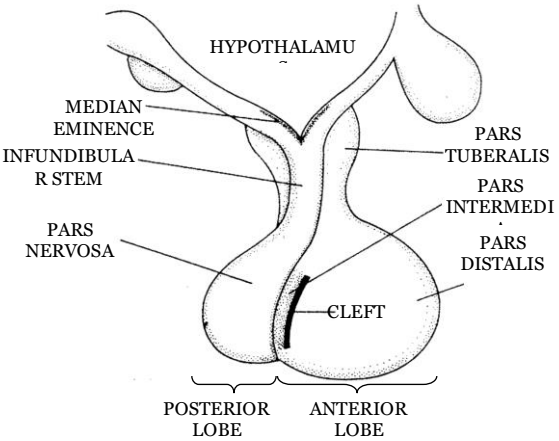


***Fig. – Structure of pituitary***

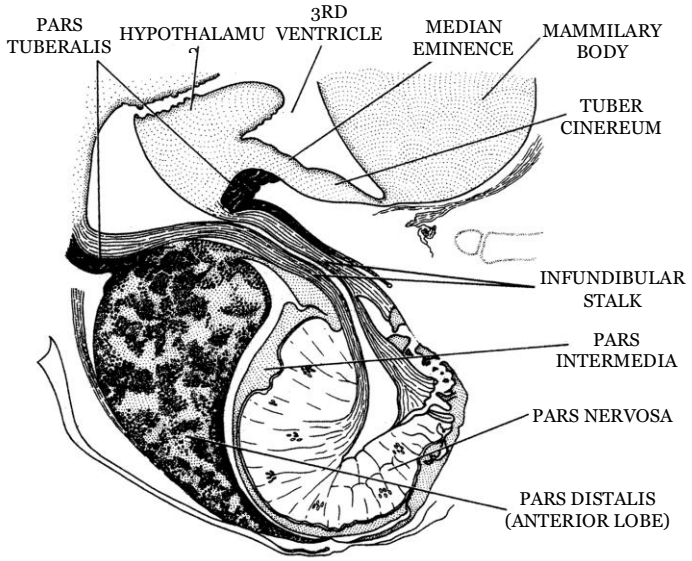


***Fig. – Gross structure of pituitary***

In pituitary following types of cells are found –

(1) **Chromophase cells :** Found in adenohypophysis of pituitary. These are not stained by acid and base dye. Pigment granules are absent. These are colourless may change into chromophils.

(2) **Chromophil cells :** Found in adenohypophysis of pituitary. These are stained by acid and base dye. Pigment granules are filled in these cells. These may be two types –

(i) **Acidophils :** It is also known as α-cells.

(ii) **Basophils :** It is also known as cyanophils.

(3) **Pituecyte cells :** These cells found in neurohypophysis of pituitary.

(4) **Herring bodies :** These are the bodies which store neurosecretory.

(iii) **Blood supply to pituitary :** A pair of posterior hypophysial arteries and a pair of anterior hypophysial arteries provide blood to

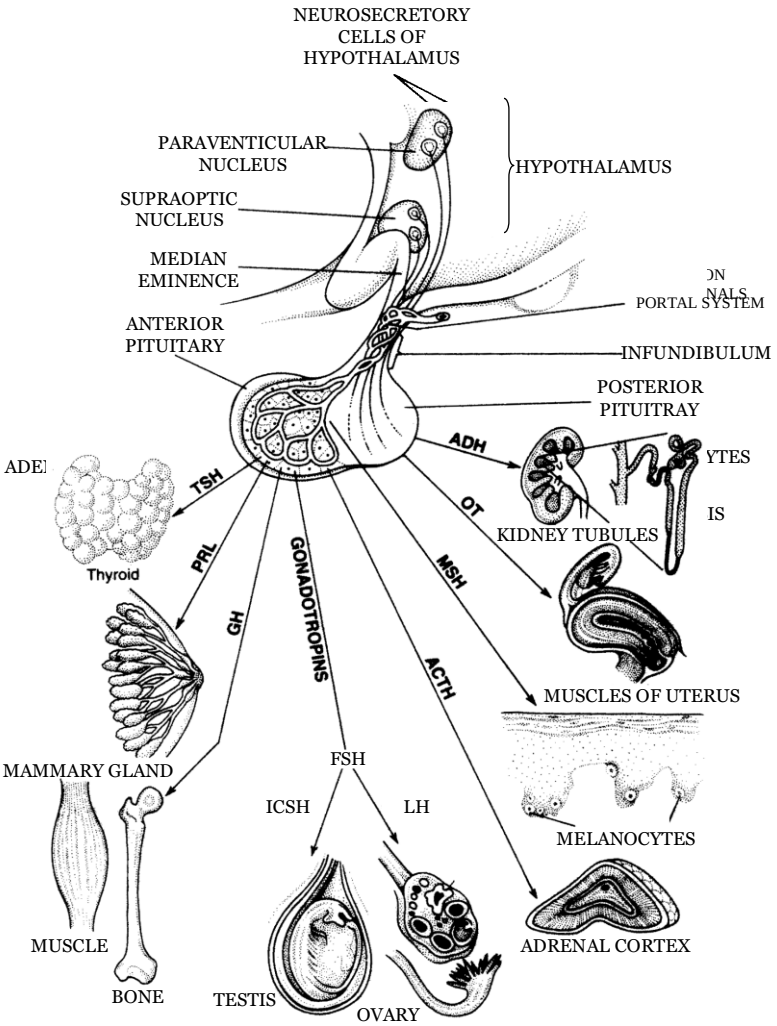


***Fig. – Diagram to show the hormones of adenohypophysis and their target tissues and organs***

the pituitary gland. Posterior arteries supply blood to the pars nervosa, and anterior arteries supply blood to the hypothalamus and pars distalis. Adenohypophysis has dual blood supply be means of a "circle of willis". The anterior hypophysial artery which bring blood into this circle bigureates in to two branches outside the lobe. One branch supplies the adenohypophysis and other supplies the hypothalamus. The veins that drain the blood from hypothalamus. Than run into the pars distalis through pars tuberalis and divide into capillaries. Those veins are therefore, called portal hypophysial veins. These constitute a hypothalamo – hypophysial portal system.

(iv) **Hormones of adenohypophysis :** Adenohypophysis secrets seven hormones which are proteinous in nature. These hormones controlled by the controlling factors. Secreted by the hypothalamus. These are 10 main controlling factors. Out of them 7 are releasing factor (RF) and 3 are inhibiting factor (IF). Complete failure of adenohypophysis (ant. pituitary) is leads to simmonds syndroms. Various hormones of adenohypophysis are as follows –

(a) **Somatotropin (STH) or Growth Hormone (GH)**

(1) **Functions of growth hormone :** Molecules of this hormone are polypeptides of 191 amino acid monomers. It is the major hormone in the secretion of anterior pituitary. It is the most important stimulant of proper normal growth of body. It promotes biosynthesis of DNA, RNA and proteins in all body cells. thus, it acts as an anabolic growth factor. Obviously, it stimulates cellular growth and proliferation, growth and repair of bones, muscles and connective tissue. In the liver cells it promotes, glycogenesis, deamination and gluconeogenesis. For production of energy (ATP) in cells, it retards utilization of glucose, and promotes mobilization of fat from adipose tissues for this purpose. The overall effect of growth hormone; is, thus, an increase in body proteins and carbohydrates reserve, but decrease in body fat.

According to modern scientists, the anabolic effects of growth hormone in man are indirect, instead of being direct. This hormone triggers synthesis of certain special, insulin-like growth factors (IGFs) in cells of many tissues, such as liver, muscles, cartilages, bones, etc. These growth factors are called somatomedins. These are secreted into blood, or act as local hormones in tissues. These promote protein systhesis in cells. Unlike insulin, these promote the use of fatty acids for energy and save glucose for fertilization by nerve cells even at times of fasting and hunger. Remember that African pigmys remain dwarf simply because somatomedins are not synthesized in their bodies.

(2) **Control of the secretion of growth hormone :** Secretion of growth hormone is controlled by two hormonal factors secreted by cells of hypothalamus. One of these factors, called GH-release hormone (GHRH) promotes secretion of growth hormone, while the other called GH-inhibatory hormone (GHIH) retards the secretion of growth hormone by the anterior pituitary. GHRH is also called somatocrinin and GHIH is called somatostatin. Under negative feedback, amounts of glucose, fatty acids and amino acids in blood affect the secretion of GH by anterior pituitary increase in a few minutes. Conversely, increasing blood levels of glucose and fatty acids, or decreasing level of amino acid promote secretions of GHIH by hypothalamus which retards secretion of GH by anterior pituitary in minutes. After termination of growth period at about the age of 22 in adolescence, secretion of growth hormone starts decreasing with age, remaining only about 25% in old age.

(3) **Effects of hyposecretion of growth hormone**

(i) **Nanism or ateliosis** : Hyposecretion (undersecretion) of growth hormone is childhood results into a blunted growth of body. Growth of all organs is retarded. Growth of bones at their epiphysial ends stops. Hence, the bones do not grow in length, so that the body remains a dwarf. This pituitary dwarfism is called nanism or ateliosis.

Growth of these dwarfs can be normalised if growth hormone is given as a drug to these from the beginning in childhood. Synthetic human growth hormone (hGH) is now being manufactured on commercial scale by DNA-recombinant technique.

(ii) **Midgets :** Unlike the thyroid cretinism, the development of brain is normal in pituitary dwarfs, but like thyroid cretinism, the pituitary dwarfs are also infertile. The dwarfs of circuses are pituitary dwarfs. these are called midgets.

(iii) **Pituitary myxodema :** Undersecretion of growth hormone during adolescence (between 13 to 22 years of age) restricts body height, so that the person remains short-statured. Undersecretion after growth period (about the age of 22) causes pituitary myxoedema whose symptoms are almost similar to those of thyroid myxoedema. These include old age symptoms, such as reduced BMR and protein synthesis, graying and falling of hair, pallor and dryness of skin, reduced BP and low body temperature, insomnia, and weakness of muscles, vision and wisdom. Due to accumulation of mucus under the skin, the body becomes puffy, but weak. Genitalia weaken, causing sexual debility. Hence, the person becomes disheartened.

(4) **Effects of hypersecretion of growth hormone (N P)**

(i) **Proportionate gignatism :** Hypersecretion (oversecretion of growth hormone during growth period (childhood and adolescence) causes excessive growth (hypergrowth) of all body parts, resulting into a symmetrically giant body. This is called proportionate gigantism.

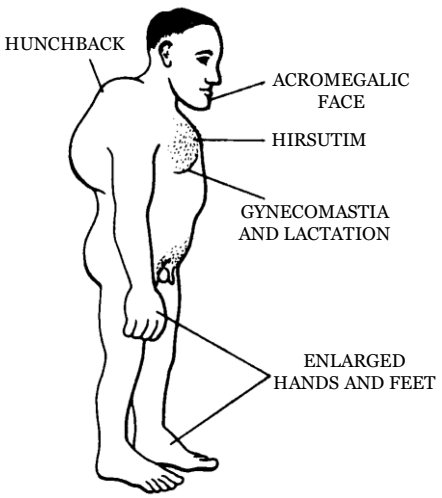

***Fig. – A typical case of***

(ii) **Disproportionate gignatism or acromegaly :** The concerned person may attain a height of 8 feet or ever more. Oversecretion of growth hormone after growth period also causes gigantism, but in this the long bones do not grow in length due to closed hypophyses at their ends, but the bones of hands, feet, lower jaw and rib cage thicken. Simultaneoulsy, eyelids, lips, tongue, nose, chin, etc also enlarge. Soles, palms and forehead become wrinkled. Skin thickens and becomes wrinkled. Skin thickens and becomes coarse and fluffy (hirsutism). Consequently, the body becomes ugly like a gorilla. This is called disproportionate gigantism or acromegaly. It is common in men and rare in women.

(iii) **Kyphosis :** In some cases, the backbone bends and thickens, causing hunchback condition (kyphosis). Breasts enlarge and mammary gland may yield milk. The patients often complain of headache, sexual disorders, muscular pain, and impaired vision and memory.

(iv) **Diabetes mellitus :** Hypersecretion of growth hormone raises blood glucose level (*hyperglycemia*) which may cause diabetes mellitus.

(v) **Ketosis :** Increased breakdown of fat may release ketone bodies, mainly acetoacetic acid, in blood, causing ketosis.

(b) **Prolactin (PRL), Lactogenic, Luteotropic (LTH), or Mammotropic (MTH) Hormone :** It is secreted by the lactotroph cells of anterior pituitary. Its molecules are polypeptides of 198 amino acid monomers. Its secretion by anterior pituitary is enhanced by prolactin-release hormone (PRH) and suppressed by prolactin inhibitory hormone (PIH) of hypothalamus. PIH is also called dopamine. In humans, it may act as a mild growth hormone, but its main physiological effect is to activate growth of breasts during pregnancy and secretion of milk by mammary glands after childbirth. That is why, it is often referred to as "maternity hormone". In some other mammals, and probably in women also, it stimulates corpus luteum of ovaries to continue secreting progesterone hormone during pregnancy.

(1) **Hypersecretion :** Prolactin hormone is secreted both in males as well females in males it influence sexual behaviour. Its hypersecretion may hinder menstruation.

(2) **Hyposecretion :** May cause impotency. In pigeons and doves, it stimulates the epithelial cells of crop in both and females to secrete "pigeon milk" for nutrition of newly hatched infants.

(c) **Follicle-stimulating hormone (FSH) or Gametokinetic factor :** It is a glycoprotein whose molecules consists of a polypeptide of 204 amino acid residues. It stimulates growth of seminiferous tubules and spermatogenesis in men, and growth of ovarian follicles and oogenesis in women. In women, it also stimulates secretion of female sex hormones (estrogens) by the cells of ovarian follicles. Under the negative feedback regulation, the principal male (testosterone) and female (estradiol) hormones retard secretion of FSH. In women, the effect of FSH on ovaries considerably decreases after the age of 40. Consequently oogenesis, secretion of estrogens and mestruation decline and ultimately stop. Termination of mesntruation is called menopause.

(d) **Luteininzing hormone (LH), or Interstitial cell-stimulating hormone (ICSH) :** This is also a glycoprotein whose molecules contain a polypeptide of 204 amino acid residues. In men it stimulates the growth and function of the interstitial cells of testes (cells of Leydig), which secrete the male hormones (androgens) to regulate the development of secondary sexual characteristics. In women, it stimulates the last stages of oogenesis, ovulation, development of corpus luteum and secretion of progesterone by the corpus luteum.

Both FSH and LH are secreted by the gonadotroph cells of anterior pituitary. Since both of these stimulate growth and activities of gonads, these are called gonadotropic hormones. These also activities the accessory genital organs. Secretion of these hormones begins only two to three years before puberty (age of sexual maturity – 12 to 14 years). Obviously their secretion is initiated by a "Genetic biological clock", located in hypothalamus. Further, the secretion of FSH in women is also regulated by a "Clock", located hypothalamus. Further, the secretion of FSH in women is also regulated by a "Clock of menstrual cycle". Under the regulation of both these clocks a gonadotropin-release hormone (GnRH) is secreted by hypothalamus and influences the activities of pituitary gonadotroph cells. Synthetic

hormones of this category and their antegonists are now used to respectively activate or retard the activities of gonads.

(e) **Adrenocorticotropin or Adrenocorticotropic hormone (ACTH) :** It is secreted by corticotroph cells of anterior pituitary. Its molecules are 39 amino acid polypeptides. Its secretion or prompted by a corticotropin-release hormone (CRH) of hypothalamus. Its role is to intensity synthesis of adrenal cortical hormones, particularly the glucocorticoids. Secretion of ACTH is stimulated by low blood level of glucose, shock conditions and presence of a compound called interleukin-1 (IL-1) secreted by macrophages. Under a direct negative feedback regulation, the concentrations of glucocorticoids in blood affect the secretion of both ACTH and CRH. Hyposecretion of ACTH leads to rheumatic arthritis.

(f) **Thyrotropin or Thyroid-stimulating hormone (TSH) :** It is also a glycoprotein secreted by thyrotroph cells of anterior pituitary. The polypeptide of its molecule has 201 amino acid residues. Its secretion is stimulated by a hypothalamic thyrotropin-release hormone (TRH). It promotes growth and function of thyroid gland. Under the negative feedback regulation, the secretion rate of hypothalamic TRH depends on blood levels of TSH, thyroxine and glucose, and on metabolic rates of body cells.

(g) **Melanocyte-stimulating hormone (MSH) or Melanotropin :** It was formerly called intermedin secreted by pars intermedia. This may be the condition in other vertebrates, but in humans, it is secreted by remmant cells of this lobe, which become a part of pars distalis. Its molecule is a small peptide of 13 amino acid residues. Its secretion is controlled by two hypothalamic hormones, *viz* MSH-release hormone (MSHRH) and MSH-inhibitory hormone (MSHIH). In lower vertebrates, the target cells of this hormone are the melanophores melanin is antagonistic to melanocyte stimulating hormone affects spreading of the melanin granules in these cells so that skin colour derkens in fish and amphibian but in birds and mammals of the role of MSH in uncertain. In man, it is probably responsible for bronzing of skin, moles and freckles.

(h) **Metabolic hormone (MH) :** It influence carbohydrate and fat metabolism of body. The hormone which influence carbohydrate metabolism is known as diabetogenic hormone. The hormone which influence fat metabolism is known as ketogenic hormone.

(v) **Hormones of neurohypophysis and their functions :** The hering bodies of neurohypophysis contain two hormones – vasopressin and oxytocin – which are released from axon terminals by exocytosis and diffuse into adjacent blood capillaries when needed. These are secreted by paraventricular nucleus and supra-optic nucleus respectively both vasopressin and oxytocin are protenous in nature.

(a) **Vasopressin :** The principal role of this hormone is to promote reabsorption of water from the distal convoluted tubules of nephrons and collecting ducts reducing excretion of water in urine (diuresis). That is why, it is also called antidiuretic hormone (ADH). Its release into blood is controlled by as "osmoregulatory centre" located in hypothalamus. Another effect of vasopressin is to increase blood pressure by contracting blood vessels (vasoconstriction) in several tissues; hence the name vasopressin.

**Effect of vasopressin**

(1) Vasoconstriction of the blood vessels of skin by this hormone retards secretion of sweat glands.

(2) It also stimulates contraction of intestinal smooth muscles.

(3) When vasopressin is released in excessive amounts, the urine becomes concentrated and blood is diluted, increasing BP. The osmo-regulatory centre, then, issues motor impulses to check release of vasopressin.

(4) When vasopressin is released in smaller amounts, diuresis increases; urine becomes diluted and blood becomes concentrate, amounts, diuresis increase; urine becomes diluted and blood becomes concentrated, decreasing BP.

(5) In acute diuresis, quantity of urine may increase to about 20 litres instead of normal 1 to 2 litres per day. This condition is called polyurea or diabetes insipidus (passing of water; tasteless urine). It causes dehydration of body and thirst.

Patients may die soon if water is not available. Synthetic ADH, called pitressin is used for antidiuresis.

Under the control of hypothalamic osmo-regulatory centre, secretion of ADH increases with increase is osmotic pressure in ECF, and decreases with decrease in osmotic pressure in ECF. Contrarily, drinking of tea, coffee and wine, decreases ADH secretion, causing diuresis and dehydration. That is why, one feels thirsty after drinking wine and suffers from headache the next morning. This is called hangover.

ADH is also secreted more in kangaru rat (Dipodomys). Kangaru rat never drink water throughout the life. ADH is secreted less in alcoholic condition. Patient feel thirsty, dehydration may appear and RBC count and protein in blood increases. ADH secretion increases in stress and emotional conditions.

(b) **Thy oxytocin (Child birth hormone) :** This hormone stimulates contraction of uterine muscles, inducing labour pains for child birth (parturition) when secretion of progesterone hormone from the placenta declines, making the end of pregnancy. As the sensory impulse of increasing labour pain reaches hypothalamus, more and more oxytocin is released from posterior pituitary under a positive feedback regulation. Possibly oxytocin is released at this time by posterior pituitary of both mother and the fetus. At actual childbirth, it dilates the cervix (vaginal stretching). After childbirth, it helps in normalization of the uterus and contracts breast muscles and lactic ducts to facilitate release of milk (lactation) during sucking oxytocin stimulates milk ejection so has a galactogogic effect. Remember, the milkmen inject synthetic oxytocin, called pitocin, into their cows and she buffaloes to get more milk. Release of oxytocin increases in women during coitus for intensifying uterine contractions, so that male's semen may easily ascend along the fallopian tubes to facilitate fertilization of ova. Role of oxytocin in men and nonpregnant women is unknown. Possibly, it increases affection for children and passion and pleasure during coitus.

**Master gland :** As is clear from above account, the pituitary gland plays most important regulatory role in the body. Besides regulating growth, sex and general behaviour, it also regulates the

secretory activities of other principal endocrine glands and cells. Most appropriately, therefore, pituitary has been referred to as "The Master Gland" of body, or the "Chief Executive of Endocrine System", or "The Leader of Endocrine Orchestra".

## 11.3 HYPOTHALAMUS

(i) **Position and Structure :** Hypothalamus is the floor of diencephalon. It is formed of masses of grey matter, called hypothalmic nuclei, containing neurosecretory cells. It is connected with anterior pituitary lobe by blood capillaries of hypophyseal portal system and with the posterior pituitary lobe by axons of its neurons, both passing through the pituitary stalk.

(ii) **Hormones of hypothalamus :** Neurosecretory cells of hypothalamus secrete neurohormones called releasing factors (RF) or inhibiting factors (IF). These neurohormones are carried by hypophyseal portal system to adenohypophysis (primary target organ) and stimulate or inhibit the release of trophic hormones from adenohypophysis. These neurohormones are proteinous in nature and formed of 3 – 20 amino acids.

**Neurohormones of Adenohypophysis**

| Neurohormones | Physiological effects |
|---|---|
| (1) TSH-RF | |
| (Thyroid Stimulating Hormone – Releasing Factor) | Increased ACTH secretion from adenohypophysis. |
| (2) ACTH-RF | |
| (Adrenocorticotrophic Hormone-Releasing Factor) | Increased ACTH secretion from adenohypophysis. |
| (3) STH-RF | |
| (Somatotrophic Hormone-Releasing Factor) | Increased STH secretion from adenohypophysis |
| (4) SOMATOSTATIN (GROWTH INHIBITING HORMONE) | Decreased STH secretion from adenohypophysis. |
| (5) GTH-RF | |
| (Gonadotrophic Hormone-Releasing Factor) | |
| (i) FSH-RF | |
| (Follicular Stimulating Hormone-Releasing Factor) | Increased FSH secretion from adenohypophysis. |
| (ii) LH-RH (In female) | |
| (Luteinising Hormone – Releasing Factor) | Increased LH secretion from adenohypophysis. |
| or ICSH-RF (In male) | |

| | |
|---|---|
| (Interstitial Cells stimulating Hormone-Releasing Factor) | |
| (6) Prolactin-Releasing hormone (P-RH) | Increased secretion of prolactin or leutotrophic hormone. |
| (7) Prolactin-Inhibiting hormone (P-IH) | Increased secretion of prolactin or leutotrophic hormone. |
| (8) MSH-RF | |
| (Melanophore Stimulating Hormone-Releasing Factor) | Increased MSH secretion from intermediate pituitary lobe. |
| (9) MIF | |
| (Melanophore Inhibiting Factor) | Decreased MSH secretion from intermediate pituitary lobe. |

(iii) **Hypothalamo – pituitary complex :** Pituitary gland is closely related with hypothalamus. Both together form hypothalamo-pituitary complex.

The hypothalmic-pituitary (hypothalamo-hypophyseal) system is a direct proof of coordination between the hormonal and nervous system. It regulates most of the physiological activities of body and maintains homeostasis inside the body. These neurosecretory cells are known to synthesize two more hormones : Oxytocin and Vasopressin, which are stored in their axons extending in the posterior lobe of pituitary gland.

## Important tips

- The word 'endocrine' derives from a Greek word meaning 'I separate within'.
- 'Chemical messengers' called the hormones.
- Huxlex called hormones as 'chemical messengers'. Hormones are also known as 'autocoids'.
- The word 'hormone' is derived from a Greek work meaning 'I excite or arouse.'
- The work 'hormone' was first used in reference to secretin and gastrin.
- The father of endocrinolgy is Thomas Addison. The first endocrine disease reported was Addison's disease (1855) caused by the destruction of adrenal cortex.
- Pancreas is a mixed gland (heterocrine), with exocrine and endocrine parts.
- When some hormones work together to control a process, this is called synergism, e.g., FSH and LH.
- When two hormones work against each other to control a process, this is called antagonism, e.g., Insulin and Glucagon, Calcitonin and Parathormone.
- There are some hormone – like substances, but not the products of endocrine glands. They are parahormones, e.g., Prostaglandins and Pheromones.

- Hormones are not present in food but are synthesized in body.
- Protein hormones act at membrane level and change the permeability of plasma membrane.
- Steroid hormones enter nucleus and inavtivate or activate the function of some gene.
- Although thyroxine is not a steroid hormone but it is lipid soluble and acts as gene level like steroid hormones.
- Water soluble hormones act through extracellular receptors.
- Lipid soluble hormones act through intracellular receptors.
- Insulin receptor is a heterotetrameric protein consisting of $2\alpha$ subunits and two $\beta$ subunits.
- One signaling molecules activates many mediators and one molecule of mediator activates hundreds of other molecules.
- In this way a signal is amplified hundred folds.
- Insulin activates $\rightarrow$ about 100 molecules of protein kinase A (about 100 molecules of enzyme phosphorylase kinase).
- Pituitary gland is called "Master gland" or "The leader of Endocrine Orchestra".
- All hormones of anterior pituitary control secretion of other endocrine glands except for somatotrophic hormone which is directly responsible for the growth of body.
- Secretion of hormones is regulated by feed back control mechanism.
- Hormones secreted at nerve endings are called neurochoromones or neurohumors.
- Sutherland received Noble prize in 1971 for his contribution in field of understanding of mechanism of hormone action.
- Secondary messengers are intermediate compounds that amplify a hormonal signal.
- Due to amplification of signals single molecule of adrenaline may lead to release of about 100 million molecules of sugar.
- Amplification of signals is the reason why small amount of hormones can trigger many metabolic reactions.
- Heart muscles use cAMP as secondary messenger for adrenaline and cGMP as secondary messenger for acetylcholine.
- By using two opposite signals within a cell sympathetic and parasympathetic nervous system achieve opposite actions.
- Cells have receptors for insulin and glucagons which also have antagonistic effects.
- Although thyroxine is not a steroid hormone but it is lipid soluble and acts at gene level like steroid hormones.
- Action of protein hormones is faster and not long lasting.
- Action of steroid hormones is slow, wide spread and long lasting.
- The level of hormones in our blood can be measured by radio immuno assay (RIA).

- Endocrine glands with ducts are pancreas, ovaries and testes.
- Primary targate organ of hypothalamus is pituitary glands.
- In amphibious and reptiles pineal gland is considered third vestigeal eye.
- In human pituitary, the intermediate lobe is functional in embryo but is rudimentary in adult.
- One neuron-one hormone hypothesis is followed by pituicytes.
- Growth hormone is the only hormone of anterior pituitary that has direct effect on body cells.
- Median eminance is a part of post pituitary.
- **Myosisthemia gravis :** Abnormal neuromuscular excitation due to hypersecretion of thymosine.
- Histologically, pituitary gland is formed of 5 types of endocrine cells :

  **Somatotropes :** 30 to 40% and secrete growth hormone or STH.

  **Corticotropes :** About 20% and secrete ACTH.

  **Thyrotropes :** Secrete TSH

  **Lactotropes :** Secrete prolactin

  **Gonadotropes :** Secrete FSH and LH in female, and FSH and ICSH in male.
- Hormones are also called autocoids or chemical messengers or information molecules.
- Local hormones are also called para-hormones or tissue hormones.
- First discovered hormone was secretin but first isolated hormone was insulin and was isolated from pancreas of dogs by Banting and McLeod.
- Thyroxine hormone is derived from tyrosine amino acid while oxytocin and ADH ar short chain peptide hormones.
- **Pheromones :** These are intra-specific chemical messengers released by an animal into air to initiate specific response in another animal of same species. These may be signals of food, mate etc. These are also called ectohormones. Term pheromone was coined by Karlson and Butenandt (1959).
- **Feedback inhibition :** In this, end product sends certain inhibatory signals (called negative feedback) when end product is at required level.
- **Endocrinologist :** Scientist involved in the study of endocrine glands.
- **Ecdysone :** A steroid hormone secreted by prothoracic glands present in the prothorax of insects the cockroach and controls moulting or ecdysis.
- **Corpora cardiaca :** A part of rod-like endocrine glands found in insects on the sides of oesophagas and secrete growth hormone which controls the growth of nymphs.
- **Juvenile hormone :** Secreted by a pair of rounded endocrine glands called corpora allata, present just behind corpora cardiaca. These secrete juvenile hormone in the nymphal stage and checks the appearance of adult characters.
- Baldness in human beings is a sex-influenced character. It is more common in males as the autosomal gene of baldness acts as dominant in the presence of testosterone (male hormone) but

acts as recessive in the presence of oestrogens (female hormones).

- Level of hormones in our blood can be measured by Radio Immune Assay (RIA).
- Hormone receptors are always proteinous and are located either on cell membrane of target cells or in cytosol.
- Spleen does not secrete any hormone.
- Basal metabolic rate (BMR) – minimum energy required during rest or sleep (160 Kcal/day).
- Thyroid gland is only endocrine gland that stores its secretory product.
- Adrenal gland is also known as 4 S gland – it controls

  (i) Stress condition (ii) Sugar metabolism (iii) Salt metabolism (iv) Sex organs development
- During continuous stress size of adrenal gland (mainly adrenal cortex) increases.
- Removal of adrenal cortex is called adrenectomy and leads to death.
- Adrenaline is given to asthma patients as it relaxes muscles of respiratory tract causing easy breathing.
- **Pheochromocytomas :** It is due to tumours of chromaffin cells of adrenal medulla. Hypersecretion of adrenaline causes high blood pressure, high levels of sugar in the blood and urine, high metabolic rate, nervousness and sweating.

## 11.4 THYROID GLAND

The name "thyroid" was introduced by Thomas Wharton (1656). It is derived from Greek "Thyreos" a shield.

(i) **Location :** This is the largest endocrine gland of our body. It is located in our neck upon the ventral aspect of larynx (sound box or Adam's apple) and a few anteriomost tracheal rings. It is a dark brown and H-shaped bilobed gland.

(ii) **Origin :** It is endodermal in origin and arises in the embryo as a midventral process from the floor of the tongue in pharyngeal region between the first and second pharyngeal pouches. Later, the duct-like connection (thyroglossal duct) of the process degenerates, so that the process is separated from the tongue and becomes endocrine. Probably, the gland is homologous to the endostyle of lower chordates.

(iii) **Structure of thyroid gland :** In adult human beings, thyroid gland measures about 5 cm in length and 3 cm in width. It's average weight is 25 grams. It is somewhat larger in women. In old age, it becomes somewhat smaller as age advances. Its two lobes are connected by a narrower isthmus formed of nonglandular connective tissue. A small, conical pyramidal lobe is often found extended forwards from the isthmus. The whole gland is enveloped by a fibrous capsule. Thin septa or

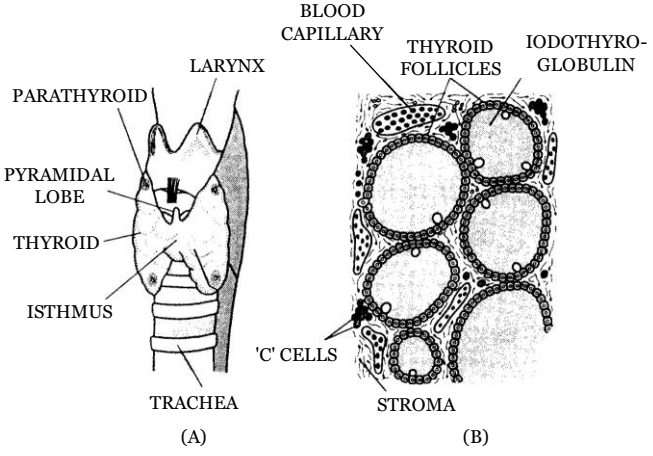


***Fig. – (A) Thyroid gland, (B) Follicles suspended in stroma of a lobule***

trabeculae, extending inwards from the capsule, divide the gland into a number of lobules. Each lobule, in turn, consists of a large number of small and hollow, spherical follicles (acini) embedded in a small amount of a loose connective tissue that forms the stroma of the gland.

The wall of each thyroid consists of a single-layered cuboidal epithelium suspended from a basal lamina, while its cavity is filled with a yellowish, jelly-like and iodinated colloid glycoprotein substance, called iodothyroglobulin. Besides containing a dense network of blood capillaries, the stroma contains small clusters of specialized parafollicular or 'C' cells. The latter are remnants of ultimobranchial bodies derived from the fifth pharyngeal (branchial) pouches in the embryo.

(iv) **Synthesis and storage of iodothyroglobulin :** Synthesis of a glycoprotein thyroglobulin (TGB) – occurs continuosly in the follicular cells under genic control. The cells keep extruding thyroglobulin in follicular cavity by excytosis. Each molecule of thyroglobulin contains about 500 amino acid momoners of which 123 monomers are of tyrosine at fixed places. Soon as the molecules of iodine and thyroglobulin come out of follicular cells, these interact in such a way that 15 tyrosine monomers of each thyroglubulin molecule at fixed places become iodinated. Certain tyrosine monomers bind with single atoms of iodine, formine monoiodotyrosine (MIT or $T_1$). Other tyrosine monomers bind with two atoms of iodine, forming diiodotyrosine (DIT or $T_2$). This is called organification of thyroglobulin. Molecules of iodothyroglobulin keep accumulating in follicular cavity, forming the jelly-like colloid. Within the collodi, molecules of iodothyroglobulin undergo conformational changes and may even interact with each other. This results in a coupling of most of the iodinated tyrosine monomers in pairs. This coupling may occur between the iodinated tyrosine monomers in pairs. This coupling may occur between the iodinated tyrosine monomers of the same or different molecules of iodothyroglobulin. It results in the formation of several groups of complexes of tetraiodothyronine (thyroxine – $T_4$) and some of triiodothyronine ($T_3$) in the colloid. Each $T_4$ complex obviously contains two throsine monomers and four atoms of iodine, whereas each triiodothyronine complex contain two tyrosine monomers and three atoms of iodine. $T_4$ and $T_3$ are actually the iodinated hormones secreted by thyroid. Obviously, the colloid acts as a reservoir of these hormones.

E.C. Kendall (1914) was the first to obtain thyroxine in pure form and to coin its name. Later, Harrington and Barger (1927) worked out its molecular structure.

Lysosomes fuse with these vesicles and their enzymes hydrolyze the molecules of iodothyroglobulin. Consequently, $T_4$ and $T_3$ become free and, being lipid-soluble, these diffuse through the plasma membrane into ECF and thence, into the blood. In blood, most of the $T_4$ and $T_3$ molecules bind with molecules of a transport protein different binding protein named thyroxine-binding prealbumin (TBPA).

The daily output of thyroid glands is about 80μg (0.08mg) of $T_4$ and about 4μg of $T_3$. Since, however $T_3$ is several times more potent, most of the $T_4$ molecules also change into $T_3$ molecules by losing one iodine atom as these diffuse from blood into ECF. This deiodination of $T_4$ is maximum in the liver.

As described in a preceding account, the rate of thyroid secretion is controlled by pituitary gland and the hypothalamus of brain respectively under direct and indirect negative feedback regulation. Rate of thyroid secretion increases during winters and in pregnant women.

(v) **Synthesis and secretion of iodinated hormones**

**Iodides and Iodine :** An adult human body contains about 5 to 6 milligram of iodine and most of it is found in thyroid gland. Thus, the thyroid is a reservoir or iodine. For secreting the iodinated hormones in normal amounts, the thyroid daily utilizes about 150 micrograms (0.15 milligram) of iodine. Obviously, a person must daily obtain 150μg of iodine from food. We can obtain this from diary products, drinking water, seafood, *etc.* If obtained more than this, we excrete the excess iodine in urine.

Iodine of food is absorbed and circulated in blood in the form of iodide ions ($I^-$). Follicular cells of thyroid very actively obtain these ions from blood by active transport. That is why, the concentration of $I^-$ in these cells normally remains about 50 to 250 times more than in blood. These cells possess peroxidase enzyme in abundance. Perosicase continuosly oxidizes iodide ions into molecular iodine ($2I^- \rightarrow I_2$). Iodine is, then, released by follicular cells into follicular cavity.

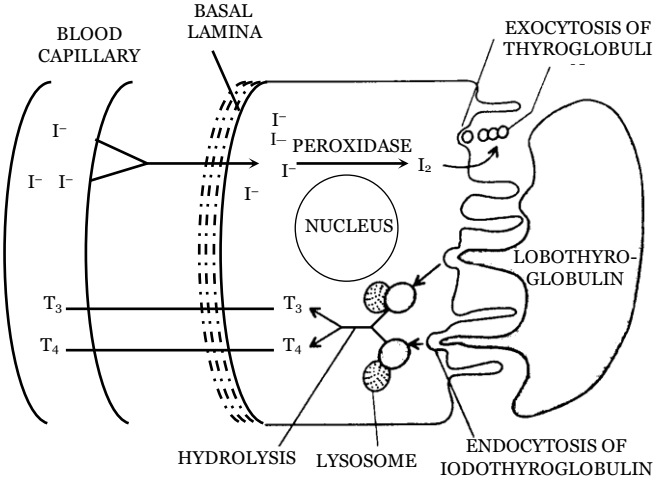


***Fig. – Working mechanism of follicular cells of thyroid***

(vi) **Hormones of thyroid :** Thyroid gland secretes two iodinated hormones. Thyroxine and Thyrocalcitonin (TCT) and one non iodinated hormone thyrocalcitonin. Secretion of thyroid gland is regulated by TSH of anterior pituitary lobe. Thyroxine was first isolated by Kandall (1914) but was first crystalized by Kendall (1919). Its molecular structure was given by Harrington and Berger (1927).

(a) **Thyroxine :** It is an iodine containing (6% iodine) amine hormone which is derived from tyrosine amino acid. Chemically thyroxine is tetraidothyronine though also found as tri-iodothyronine. Secretion of thyroxine is inversely proportional to the blood level of thyroxine (feed back mechanism). These hormones perform following functions :

(1) These regulate Basal Metabolic Rate (BMR) of the body as control rate of cell respiration and energy production in mitochondria hence the "Temp. of life". So these control physical, mental and sexual growth of body. It is called calorigenic effect.

Enhancement of BMR by these hormones results in an increase in protein synthesis in cells, rate of heartbeat, food absorption in intestine, glycogenesis, deamination and gluconeogenesis in liver cells, synthesis and actions of other hormones, conversion of carotene to vitamin A in liver cells, and many other processes. These hormones also increase irritability and regulate cholesterol level in blood. Considering all these effects in totality, these hormones are necessary for healthy life and growth and development of body.

(2) In 1912 Gudernatsch discovered that metamorphosis in frog's tadpole begins only when adequate amount of thyroxine is secreted by the thyroid of the tadpole. It was also found that hyposecretion of thyroxine retards and hypersecretion enhances the rate of metamorphosis.

In the hilly tracts of North America from whose soil all iodine has been washed away by rain water, the tadpoles of *Ambystoma* probably never metamorphose. Therefore, these tadpoles grow to a

large size and attain sexual maturity, *i.e.* these become paedogenetic larvae. This phenomenon is called neoteny. The neotenic larvae of *Ambystoma* are called *Axolotl* larvae.

Addition of thyroxine or iodine is pond water naturally induces and enhances metamorphosis in the tadpoles.

(3) Functions of osmo-regulation and regulation of moulting have been ascribed to these thyroid hormones in cold-blooded vertebrates (fishes, amphibians and reptiles).

(4) These control working by renal tubules of kidney so control urine output.

(5) These help in homeothermy in warm blooded animals.

(b) **Thyrocalcitonin (TCT) :** It is a long peptide hormone secreted by parafollicular by cells of thyroid gland (C-cells). It secretion is regulated by increased plasma level of calcium by feedback mechanism. TCT lower calcinum level in blood to normal by :

Increasing calcium deposition in the bones, so checks osteoporosis and stimulates excretion of calcium in urine. Its prevent hypercalcaemia. Decreasing reabsorption of calcium from urine, so increasing excretion of $Ca^{2+}$. So it prevent hypercalcaemia.

(vii) **Irregularities of thyroid gland**

(a) **Hypothyroidism :** (Decreased section of thyroxine from thyroid gland). It leads to the following diseases :

(1) **Cretirusm :** It is disease of infants, called certin. It is characterised by Decreased BMR (50% than normal); stunted growth; retarded mental development so low I.Q., delayed puberty; decreased body temperature, heart rate, pulse rate, blood pressure and cardiac output; reduced urine output; decreased sugar level in blood, pigeon's chest (chest bulging forward in sternal region). Cretinism can be congenital (absence of thyroid due to genetic defect) of indemic (absence of iodine in diet). It can be corrected by thyromin administration.

(2) **Myxoedema :** It occurs due to deficiency of thyroxine in adults like certinism, it also has low (BMR) (by 30 – 40%); low body temperature, reduced heart rate, pulse rate, blood pressure and cardiac output, low sugar and iodine level in blood etc. But the peculiar feature of myxoedema is that face and hands become swollen due to deposition of albuminous myxomatous tissue. It can also be corrected by thyroxine administration.

(3) **Endemic or simple goitre or colloid goitre :** It occurs due to deficiency of iodine in drinking water. It is non-genetic (sporadic goitre is a genetic disease). It is characterized by enlargement of thyroid gland due to increase in number and size of acinal cells of thyroid gland. It is more common in people of hilly region. To prevent goitre, the table salt is being iodised these days.

(4) **Hashimoto's disease :** It is called auto-immune thyroiditis and occurs due to age factor, injury-surgery, wrong treatment or injection thyroid gland causing hyposecretion of thyroxine. When thyroxine secretion falls upto minimal limit, the antibodies are formed which destroy the thyroid gland.

(b) **Hypersecretion of thyroid hormones (Hyperthyroidism or thyrotoxicosis) :** This may also be a genetic defect, but usually it is provided by chronic infections (influenza, rheumatism, tonsilitis, tuberculosis, measles, whooping cough, etc.) pregnancy, intake of large doses of iodine, over-eating, etc. It results into a considerable increase in glucose and oxygen consumption by cells and the rate of oxidative metabolism in the mitochondria. Consequently, the BMR (basal metabolic rate) may increase severalfolds (hypermetabolism). The cells fail to store all catabolic energy into ATP. Consequently, the extra energy is liberated as heat. Instead of causing growth of body, this energy, thus, overheats the body, causing nervous tension and excitement, restlessness and anxiety, muscular weakness (thyrotoxic myopathy), fatigue and tremors, high temperature, palpitation of heart, copious sweating, diarrhoea, insomania, trembling of limbs and body, weight loss, heat intolerance, warm and soft skin, increased appetite, etc.

Under his "Sodium pump theory of thermogenesis". Edelman has recently (1974) hypothesized that overheating of body in hyperthyroidism is not because cells fail to trap the excess catabolic energy in ATP, but because the excess ATP formed in this condition is utilized in considerably accelerating the $Na^+$–$K^+$ pump, relesing more heat that overheats the body.

(1) **Goitre :** Hyperthyroidism may be simply because of overactive cells of a normal gland, or because of an enlargement of the gland, causing goitre.

(2) **Exophthalmic goitre :** Such a goitre is called exophthalmic goitre, because it is usually accompanied with some asymmetrical protrusion (Exophthalmos) of the eyeballs, imparting an angry, frightened, or staring look to the patient. Protrusion of eyeballs is due to accumulation of mucus in eye orbits.

(3) **Grave;s or Basedow's disease :** Enlargement of the gland is usually due to a diffused growth.

(4) **Plummer's disease or Toxic Adenoma :** It is due to formation of one or more hypersecretoy nodules Plummer's disease or Toxic Adenoma in the gland.

**Thyrocalcitonin (Calcitonin) :** This is a noniodinized hormone secreted by the parafollicular cells (clear or C cells) of thyroid stroma. It retards bone dissolution and stimulates excretion of calcium in urine. Thus, it lowers calcium level in ECF. Its role is discussed with the role of parathyroid hormone.

## 11.5 PARATHYROID GLAND

(i) **Position and structure :** These are four in number which are wholly are partially embedded in the dorsal surface of the thyroid gland two glands in each lobe of thyroid gland. Each is oval shaped, small sized (5×5 mm) and yellow coloured. Histologically, a parathyroid gland is formed of masses of polygonal cell arranged in cords. Endocrine cell are two types principal or chief and oxyphil cells. Parathyroid is endodermal in origin.

(ii) **Hormones of parathyroid :** Active hormone secreted by parathyroids is parathormone (PTH), also called Collip's Hormone (Phillips

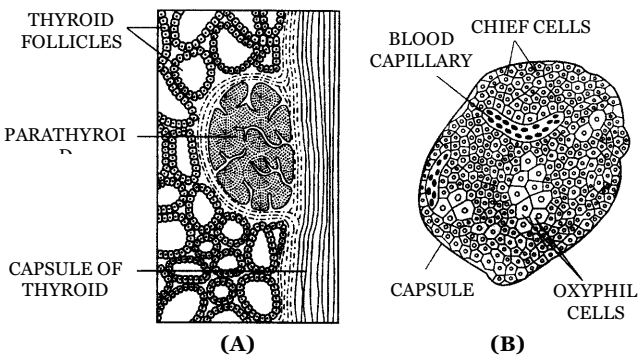


***Fig. – (A) Parathyroid gland embedded in the surface of thyroid, (B) Ultrastructure of a parathyroid***

collip, 1925). It was discovered and purified by Collip in 1925. Its crystals wave first prepared by Craig and Ras mussen in 1960. Its molecular structure was worked out by potts and his associates in 1971. The latter is a protein of 84 amino acid monomer. It is a polypeptide hormone. Parathyroids are present in all vertebrates except fishes. Its secretion is stimulated by low level of calcium in blood than normal level through feedback control.

**Functions of parathormone :** Parathormone is essential for survival, because it significantly contributes to "homeostatis" by regulating the amount of calcium and phosphate ions in ECF. Our body requires an optimum calcium level (10.0 to 11.5 mg per 100mL.) in ECF (total 1000 to 1120 grams in a 70 kg man), because calcium is a key element in many physiological functions like proper permeability of cell membranes, muscular activities, nerve impulse conduction, heartbeat, blood coagulation, bone formation, fertilization of ova, etc. Calcium is most abundant of all minerals found in the body and about 99% of calcium and phosphorous are contained in the bones.

Maintenance of proper calcium level under 'homeostasis' is, in fact, a combined function of parathormone, thyrocalcitonin and vitamin $D_3$ (cholecalciferol). Parathormone promotes absorption of calcium from food in the intestine and its reabsoption from nephrons in the kidneys. Simultaneously, it accelerates elimination of phosphates in urine (phosphaturic action). Thus, calcium level tends to rise in the ECF due to the effect of parathormone. This calcium is, then, utilized by bone-forming cells – osteoblast – in bone formation under the influence of vitamin $D_3$. Bones are asymmetrical when first formed. Their unnecessary parts are, therefore, dissolved by bone-eating cells called osteoclasts. This process also proceeds under the influence of parathormone. It results in release of calcium and phosphate in blood.

The above process of bone-remodelling or reshaping, *i.e.* laying of new bone (by stimulating osteoblast activity), and dissolution of asymmetrical parts of newly laid bones (by stimulating osteoclast activity) continues in the body throughout life under the influence of vitamin $D_3$ and parathormone to serve as a mechanism of $Ca^{2+}$ homeostatis. Role of vitamin $D_3$ and parathormone in this process is obviously synergetic. Contrary to this, thyrocalcitonin of thyroid gland retards bone dissolution and accelerates excretion of calcium in urine. Its role is, thus, antagonistic to that of parathormone. In healthy people, parathormone and thyrocalcitonin are, therefore, in a state dynamic equilibrium.

Vitamin $D_3$, is a steroid hormone which is first synthesized in an inactive form in skin cells from 7-dehydrocholesterol under the influence of ultraviolet (UV) rays of sunlight. Skin cells release it in blood. Liver cells take it from blood, change in into 25-hydroxycholecalciferol and release back into blood. Finally, the cells of proximal convoluted tubules of nephrons in the kidneys change 25-hydroxycholecalciferol into 1-25-dihydroxycholecalciferol under the influence of parathormone. This last compound is released in blood as active vitamin $D_3$ named as cholecalciferol (calcitriol).

In addition to its role in bone-remodelling, $D_3$ also stimulates absorption of $Ca^{2+}$ and $Mg^{2+}$ in intestine. Similarly, parathormone also plays an additional role of stimulating excretion of $Na^+$, $K^+$ and $HCO^-_3$, but retarding the excretion of $Mg^{2+}$.

(iii) **Irregularities of parathormones**

(a) **Hypoparathyroidism (Hyposecretion of parathormone)**

(1) It is rare, However, in undersecretion of parathormone, the level of calcium in ECF falls (hypocalcemia), and that of phosphates rises (hyperphosphatemia). This causes neuromuscular hyperexcitability, excessive perspiration, gooseflesh (raising of hairs and prickly sensation in skin), cooling of hands and feet, painful muscular spasms and convulsions, and trembling.

(2) Sometimes some skeletal muscles, usually of hands and feet, fail to relax after a contraction, and remain in "sustained contraction". This is called "Tetany". Tetany of larygneal, thoracic, and phrenic muscles, which help in breathing, causes death, because the patient fails to breathe (asphyxia).

(3) Childhood hypoparthyroidism retards growth, particularly of bones, teeth, hair and brain. Vitamin D is administered to such children.

(b) **Hyperparathyroidism (Hypersecretion of parathormone) :**

(1) **Osteoporosis :** Oversecretion of parathormone is rare and occurs usually due to overgrowth of one or more parathyroid glands. It causes demineralization bones which, therefore, become soft, weak, distorted and fragile. This is called osteoporosis.

(2) **Hypercalcemia :** Simultaneously, due to a sharp rise in calcium level in blood and ECF (hypercalcemia) and a sharp fall in phosphate level (hypophosphatemia), muscles and nerves are weakened.

(3) **Hypercalciurea :** Calcium is excreted in urine (hypercalciurea), thirst increases owing to copius urination, appetite is lost, constipation and headache become common, and often, kidney stones are formed. The only treatment so far known is removal of extra part of the glands by operation.

**Feedback control of secretion of parathormone and thyrocalcitonin :** Secretion of these two hormones is continuously regulated by a direct negative feedback. As $Ca^{2+}$ levels tends to fall, secretion of parathormone increases, but that of thyrocalcitonin decreases. Contrarily, the secretion of parathormone decreases and that of thyrocalcitonin increases when $Ca^{2+}$ level tends to rise in blood.

## 11.6 Adrenal gland

Adrenal gland was first reported by Eustachius.

(i) **Origin and position :** The adrenals are paired glands placed on the top of the kidneys as cap. Hence, they are also called suprarenal glands.

Adrenals have a dual origin, they are originated from ectoderm and mesoderm both.

(ii) **Structure :** Each adrenal is a small ( 5 cm long, 3 cm broad and 1 cm thick), triangular and yellowish cap like structure. Its weight in humans is about 4 to 6 gm. Each gland has two parts – Outer cortex and inner medulla.

(a) **Outer cortex :** The cortex is derived from mesoderm and forms about 80% part of the gland. Outside the cortex a thin connective tissue capsule is present. Cortex consists of fatty,

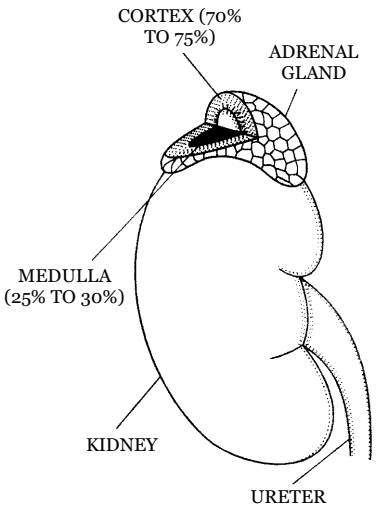


***Fig. – Adrenal gland with a part cut to show cortex and medulla***

cholesterol rich cells. These cells distinguish the cortex into three zones or regions.

(1) **Zona glomerulosa :** It is the outer part of the cortex (15% of the gland), which consists of small polyhedral cells. It secrets mineralocorticoids *e.g.* Aldosterone.

(2) **Zona fasciculata :** It is the middle part of the cortex (50% of the gland). Which consists of large polyhedral cells. This part secrets gluco-corticoids. *e.g.* Cartison, carticosterone.

(3) **Zona Reticularis :** It is the inner part of the cortex (7% of the gland). In which the parallel cell cords of the zona fasciculata branched to form a loose anastomasing network. It secrets sex hormones.

(b) **Inner medulla :** The medulla is derived from ectoderm and forms about 20% part of the gland. Adrenal medulla is reddish brown in colour and colourless of rounded groups of short cords of relatively large and granular cells. These cells are modified postganglionic cells of sympathetic nervous system. These are called chromaffin cells or phaeochromocytes. Adrenal medulla secrets adrenalin and nor-adrenalin which are collectively called as catecholamines.

(iii) **Hormones of adrenal cortex :** Abut 20 steroids (steriodogenic) compounds have secreted from adrenal cortex. These are called adrenocorticoids (cortiosteroids). Only few of them are biologically active as hormone. these hormones or steroid in nature. The letter, however account about 80% of the secretion of adrenal cortex and are classified in to three categories.

(a) **Mineralo-corticoids :** The principal mineralocorticoid is aldosterone. It is also called salt-retaining hormone. It promotes reabsorption of sodium ions from kidney and excretion of potassium ions in urin. It also reabsorb $Cl^-$ ions from kidney. Thus aldosterone has a important contribution in homeostasis by controling osmatic pressure of ECF (Extra cellular fluid).

Remember that doctors administer saline drip to the patients who lose excessive water and salts due to diarrhoea, cholera, etc. Aldosterone also helps in maintaining acid-base equilibrium and blood *pH* (7.35) by promoting reabsorption of $HCO^-_3$ and regulating excretion of $H^+$ by kidneys. It also promotes absorption of water and salt in intestine, mainly in colon.

(b) **Gluco-corticoids :** These include two main hormones – cortisol and carsicasterone. Cartisol is most abundant (about 95%) and most important. These hormones play an important role in carbodydrate, fat and protein metabolism as follows –

(1) Cortisol retards glucose consumpiton and protein synthesis, but promotes breakdown of proteins and fats in the cells of such parts of body as are concerned with normal (non-emergent) activities and defense. These parts include skin, alimentary tract, bones, lymph nodes, adipose tissue, muscles, *etc.* Consequently, levels of glucose, FFAs and amino acids in blood pressure is elevated. This effect of cortisol in antagonistic to that of insulin.

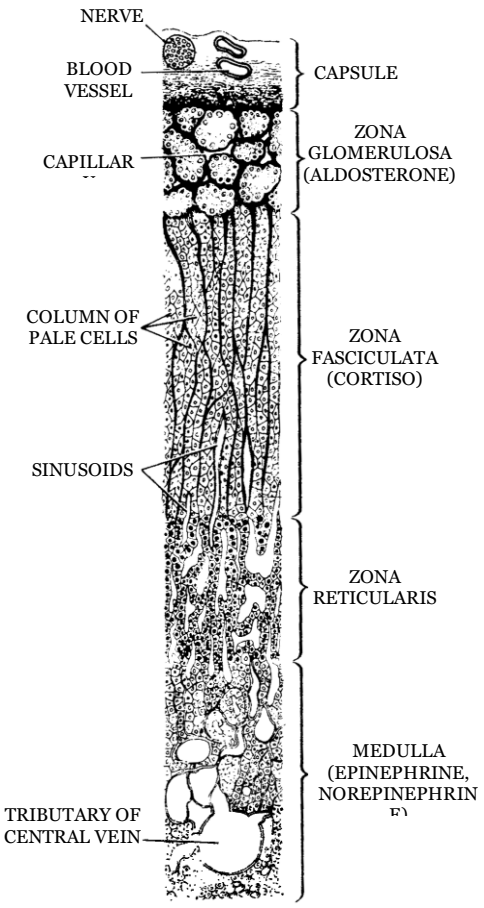


***Fig. – Adrenal gland with a part cut to show cortex and medulla***

(2) Effects of glucocorticoids upon liver are anabolic. These promote intake of glucose, FFAs and amino acids by cells of liver. Then, these intensify deamination of amino acids, synthesis of urea, synthesis of glucose from fatty acids and amino acids (gluconeogenesis), and synthesis of glycogen from glucose (glycogenesis) in liver cells.

(3) Cortisol is anti-inflammatory. It retards the migratory movements and phagocytic activities of white blood corpuscles (WBCs), suppressing "inflammation reactions" which constitute the normal defense mechanism of body against toxic substances. Simultaneously, it reduces the number of mast cells, reducing secretion of histamine. This is also an anti-inflammatory effect. It also demotes synthesis of collage fibres which usually form at the sites of inflammation in normal defense. That is why, cortisol is usually injected as a drug for treatment of diseases that are caused by deposition of collagen fibres, such as arthritis or rheumatism.

(4) Cortisol is also "immunosuppressive". It suppressess synthesis of antibodies, retarding the normal immune reactions of body against antigens and attack of micro-organisms. In fact, it induces atrophy of thymus gland and other lymphoid tissues, so that the productions of lymphocytes is inhibited. That is why, it is used for treatment of allergy. Also, it is used in transplantation surgery to suppress the formation of antibodies in the body of recipients so that the latter may accept the transplanted organs.

(5) Cortisol increases RBC count, but decreases the WBC count of blood. It also elevates blood pressure (BP).

(c) **Sex hormones :** The zona reticularis of adrenal cortex secrets androgen and estrogen in small quantity. These hormones regulates the development of sex organs, secondary sexual characters and promote growth and protein metabolism.

(d) **Role of adrenal cortex in stress reaction :** Adrenal glands provide the body with an emergent "chemical defence mechanism" in stress conditions that threaten the physical integrity and chemical constancy of the body. After the "Fight or Flight" reaction, the body remains in a state of shock for some time just like a country after a war. Heartbeat, cardiac output, blood pressure and glucose and salt concentrations in ECF considerably go down in this "shock condition". For example, excessive bleeding in an accidental injury immediately sends the body into shock condition. the injured must be made to recline and his / her legs must be elevated by putting a few pillows under the feet and hips. This increases venous flow of blood towards the heart, so that the cardiac output is maintained.

Whereas the hormones of adrenal medulla elevate $O_{2-}$ consumption, BMR, respiration and tension to increase alertness and responsivity to prepare the body for violent stress-reactions, those of adrenal cortex, particularly aldosterone and cortisol, serve to maintain the body in living condition and recoup it from the severe after-effects of stress reactions. An increased output of cortisol is actually "life-saving" in shock conditions. It inhibits the normal defence mechanisms and mobilises help from all parts of the body in order to keep the body alive. In case the stress reaction is very strong and the shock is very severe, the life-saving mechanism fails, and the body succumbs to the resultant large scale muscle wasting and severe exhaustion. That is how a person sometimes dies mainly due to stress and shock, even when bitten by a non-poisonous snake. In a person succumbing to death, breathing becomes noisy, fretful and intermittent at short and then gradually longer intervals.

Adrenal glands are large in fetus, but these mainly secrete sex hormones. By the time of child-birth, these become small and their secretions remain minimal for a few days after birth. Obviously, the "chemical defence system" is very weak in newly born infants. The latter can, therefore, easily succumb to stress conditions. That is why, infants are provided extra care in maternity homes.

As is clear from above account, adrenal cortex is very necessary for survival, but adrenal medulla is not so necessary, because its deficiency can be compensated by sympathetic nervous system.

(e) **Control of adrenal cortex secretions :** Secretion of glucocorticoids and sex hormones by adrenal cortex is regulated by a hormone, corticotropin or adrenocorticotropic hormone (ACTH), secreted by the anterior lobe of pituitary gland. Secretion of ACTH from pituitary is, in turn, regulated by a "corticotropin-release hormone (ACTHRH)" of hypothalamus. A "feedback control mechanism" operates between hypothalamus, pituitary and adrenal cortex. A decrease in cortisol level in blood stimulates the hypothalamus and pituitary. Hence secretion of ACTHRH from hypothalamus and of ACTH from pituitary and, therefore, of glucocorticoids and sex hormones from adrenal cortex increases. When cortisol level in the blood rises, the control mechanism operates in reverse direction. This "feedback control" is very efficient and quick. It even observes a daily (circadian) rhythm because amount of ACTH and cortisol in blood is maximum during morning hours and minimum at midnight.

Secretion of mineralcorticoids is only nominally under the control of ACTH. Although adrenal glands themselves regulate secretion of mineralocorticoids according to $Na^+$, water and $K^+$ levels in ECF, by feedback, but this regulation is mainly provided by the kidneys. As the blood pressure goes down due to decreased amount of salt and water in blood, certain cells of afferent arterioles that supply glomeruli secrete an enzyme named renin. Reaching in blood, renin covers a plasma protein, angiotensinogen into angiotensin I. the latter is taken from blood by liver cells which release it back into the blood after converting it into angiotensin II. The latter is a hormone which stimulates adrenal cortex to secrete more aldosterone.

(iv) **Hormones of adrenal medulla :** The chromaffin cells of adrenal medulla synthesize two hormones adrenalin or epinephrine (80%) and nor-adrenalin or non-epinephrine (20%). These hormones are proteinous in nature and derived from amino acid tyrosine. Which is first hydroxylated and decarboxylated to form dopamine and than the latter is hydroxylated again to finally form norepinephrine. Epinephrine is derived by methylation of norepinephrine.

$$\text{Tyrosine} \xrightarrow[\text{Decarboxylation}]{\text{Hydroxylation}} \text{Dopamine} \xrightarrow{\text{Hydroxylation}} \text{Norepinephrine} \xrightarrow{\text{Methylation}} \text{Epinephrine}$$

The molecular structure of dopamine, norepinephrine and epinephrine, includes a 6-carbon ring connected to two hydroxyl groups (– *OH*). This is called catechol ring, and these compounds are called catecholamines for this reason.

Epinephrine (adrenalin) was first extracted by Abel (1899) who coined this name for it. It was, however, extracted in pure form by Jokichi and Takamine (1900). Its molecular structure was worked out by Aldrich in 1901. Stolz (1904) and Dakin (1905) synthesized it in their laboratories. Norepinephrine was discovered by Ulf von Euler (1946). Effects of these hormones were studied by Axelrod (1965). For their discoveries. Euler and Axelrod won Nobel Prize in 1970.

Chromaffin cells store adrenaline and noradrenaline in secretory granules and release these by exocytosis when required. In blood, both hormones circulate in original active form. these retard the activity level of some of their target cells, but increase the activity level of most of their target cells. In

their action mechanism, these affect the metabolic processes either by modifying the ion permeability of the plasma membrane of target cells, or by inducing formation cAMP.

(a) **Function of epinephrine**

(1) Epinephrine causes constriction of the blood vessels (vasoconstriction) which supply blood to those peripheral and abdominal organs (skin and organs of digestive, excretory and reproductive systems) that normally remain active while we are resting or sleeping. Obviously, the activities of these organs are retarded, but the blood pressure (BP) increases.

(2) Reduced supply of blood causes a pale skin (pallor), but arrector pilli muscles of skin contract, causing gooseflesh.

(3) Mouth becomes dry due to poor secretion of saliva.

(4) Food digestion is retarded because of reduced gut peristalsis due to relaxation of the smooth muscles of gut wall, as well as, because of poor secretion of digestive glands.

(5) Kidneys produce small volume of urine, and muscles or urinary bladder relax.

(6) In pregnant women, the muscles of uterus contract, increasing the possibility of abortion.

(7) Epinephrine causes dilation of blood vessels (vasodilation) which supply brain, skeletal muscles, heart, lungs, liver, adipose tissues, sensory organs, etc. Due to increased blood supply, these organs become very active, inducing alarm reaction. Obviously, the blood pressure, increased due to effect of norepinephrine, is reduced to some extent.

(8) Pupils dilate due to contraction of radial dilatory muscles of iris. Secretion of tear by lacrimal glands increases.

(9) Epinephrine causes relaxation of the smooth muscles of trachea, bronchi and bronchioles. These organs, therefore dilate, so that breathing becomes easier and faster. Remember that epinephrine is used in treatment of asthma for this reason.

(10) Contractions of cardiac muscles intensify, increasing both rate and force of heartbeat, pulse rate, arterial pressure and cardiac output.

(11) Due to an increase in adhesiveness of blood platelets, the time of blood clotting is considerably reduced.

(12) The spleen contracts, releasing its reserve of blood corpuscles whose number in blood, therefore, increases.

(13) In islets of Langerhans in pancreas, secretion of insulin hormone decreases, but that of glucagon increases. Glucagon causes glycogenolysis, *i.e.* breakdown of glycogen into glucose in liver and skeletal muscles. Consequently, skeletal muscles become more active and liver cells release more glucose into the blood. Simultaneously, desgradation of fat (lipolysis) also occurs in adipose tissues, so that free fatty acids (FFA) increase in blood.

(14) Because of an increase in blood levels of $O_2$ glucose, FFA, etc the basal metabolic rate of all body cells considerably increases and renders the whole body highly active and irritable.

(15) External genitalia become flaccid, but ejaculation becomes early and forceful.

Since the rate and force of the activities of most internal organs increase in a few seconds under the effects of epinephrine and norepinephrine, the various changes can be detected by a lie detector polygraph to ascertain the emotional state of a person.

**Difference between Adrenal cortex and Adrenal medulla**

| S.No. | Adrenal cortex | Adrenal medulla |
|---|---|---|
| 1. | It is external firm region of the adrenal gland. | It is central soft region of the adrenal gland. |
| 2. | It is pale yellowish-pink in colour. | It is dark reddish-brown in colour. |
| 3. | It is enclosed by a fibrous capsule. | It is not enclosed by a fibrous capsule. |
| 4. | It forms about 80% of the adrenal capsule. | It forms just 20% of the adrenal gland. |
| 5. | It develops from the mesoderm. | It develops from the ectoderm (neural crests). |
| 6. | It consists of 3 concentric regions : Outer zona glomerulosa, middle zona fasiculata and inner zona reticulars. | It is not differentiated into regions. |
| 7. | It is essential for life, its destruction causes death. | It is not essential for life, its destruction does not cause death. |
| 8. | It secretes 3 groups of hormones : mineralocorticoids, glucocorticoides and sexocortocoids. | It secretes 2 similar hormones nor adrenaline and adrenaline. |
| 9. | It is stimulated to release its hormones by the adrenocorticortrophic hormone from the anterior pituitray. | It is stimulated to secrete its hormones by nerve impulses reaching via sympathetic nerve fibres. |
| 10. | There is no cooperation between adrenal cortex and sympathetic nervous system. | Adrenal medulla and sympathetic nervous system function as an integrated system called sympatheticoadrenal system. |
| 11. | It causes many deficiency / excess disorders. | It is not known to cause any disorder. |

**Significance of adrenal medullary hormones**

**Relationship between adrenal medulla and sympathetic nervous system :** Our routine in voluntary activities like food digestion, respiration, heartbeat and blood circulation, thermoregulation, peristalsis of tubular organs, secretion of glands, excretion, etc are continuously and automatically done by our internal (visceral) organs without the conscious control of our brain. These are, therefore, called involuntary activities, these activities occur under the control of autonomic nervous system and their co-ordinated regulation is controlled by the hypothalamus of brain. The autonomic nervous system controls these activities by affecting the activity levels of cardiac muscles, smooth muscles of visceral organs and blood vessels, and the glands. The autonomic nervous system comprises two control systems, having antagonistic effects of these organs. These are sympathetic and parasympathetic systems. Obviously, the motor nerve fibres of both these systems, originating from central nervous

system (CNS), innervate most of the internal organs. The motor fibres of parasympathetic system stimulate those organs which remain more active while we are at rest or sleeping. contrarily, the motor fibres of sympathetic system stimulate those organs which remain more active when we are awake and doing work.

The fibres of sympathetic system, innervating the organs, the postganglionic motor fibres. At their terminals, these release norepinephrine, a neurotransmitter which triggers an alteration in the activities of concerned organs. The adrenal medulla is also innervated by fibres of sympathetic system, but these are preganglionic fibres of this system. At their terminals these fibres release acetylcholine which stimulates chromaffin cells to release their hormones – epinephrine and norepinephrine. Circulating in blood, these hormones reach into the internal organs and not only increase the effects of sympathetic stimulation, but also prolong these effects about ten-fold. That is why, the sympathetic system and adrenal medulla are collectively considered as sympathoadrenal system, and the hormones of adrenal medulla are called sympathomimetic amines. Besides this, the medullary hormones, especially epinephrine, increase the basal metabolic rate (BMR) of all body cells, increasing the activity and irritability level of whole body. Since, however, the effects of sympathetic system and adrenal medullary hormones are complementary, a retarded efficiency of any one of these is compensated by the other.

Modern scientists have discovered that cells resembling chromaffin cells occur in small groups near the thoracic and abdominal ganglia of sympathetic system. These groups have been named paraganglia.

**Alarm or stress reaction :** Physico-chemical changes continuously occur in the external and internal environments of our body during our daily routine life, and our body keeps on maintaining homeostasis and functional equilibrium by counteracting the effects of these changes by alterations and co-ordinated regulations of the activities of various organs by sympathetic system under hypothalamic control. However, the emergency or stress conditions such as fear, anger, intense pain, accident and injury, burning, intense cooling or heating of body, sudden invasion of micro-organisms, poisoning, emotional upsets due to insult, restlessness, mental tension, anxiety, exertion, surgery, etc tend to disturb homeostasis and functional equilibrium to such an extent that the very survival of body in endangered.

As the sensory impulses of such strong stimuli called stressors, reach the brain, directly or through spinal cord, motor impulses or required responses are issued by hypothalamus to all organs, including adrenal medulla through the spinal cord. Consequently, norepinephrine is released simultaneously in all organs by sympathetic fibres, and a large amount of both epinephrine and norepinephrine is poured into blood by adrenal medulla. This "mass release" of these hormones prepares the whole body, within seconds, for a violent physical reaction called alarm or stress reaction, and often referred to as general adaptation syndrome (GAS). In this reaction, the concerned person either boldly faces the emergency, or tries somehow to escape from it. That is why, it is called "Fight or Flight reaction".

(iv) **Effects of irregularities of adrenal secretion**

(a) **Hyposecretion :** This may be a genetic defect. Undersecretion of adrenocorticoids (hypocorticism) causes Addison's disease which is relatively rare and occurs in both men and women

between the ages of 20 to 40 years. This disease was first discribed by Thomas Addison in 1849, 1855. It is maintained in following symptoms –

(1) Owing to low aldosterone level in blood, considerable amount of sodium ions and water is excreted in urine, leading to dehydration, low blood pressure, and weakness, all symptoms of a peculiar, Addinosonean anaemia which is different from common pernicious anaemia resulting from entirely different causes like diarrhoea, cholera, etc.

(2) Owing to low cortisol level, glucose level also falls in blood (hypoglycemia). This sharply reduces BMR in body cells. Due to hypoglycemia and hyperkalemia (increased $K^+$ level in blood) efficiency of brain, liver, skeletal and cardiac muscles, etc declines. Body temperature also falls. Heartbeat may even stop, causing death.

(3) Decreased cortisol level induces gastro-intestinal disorders, resulting in loss of appetite, nausea, vomiting, diarrhoea, abdominal pain and restlessness.

(4) Due to a sharp decline in body's chemical defense and resistance, sensitivity to cold, heat, infection, poisoning and other adverse condition increases. Acute hypocorticism is catastrophic and resistance, sensitivity to cold, heat, infection, poisoning and other adverse conditions increases. Acute hypocorticism is catastrophic and threatens life. Complete destruction of removal of adrenals causes death in a short time, principally because of loss of excessive sodium in urine.

(5) Addison's disease also causes an increase in the number of WBCs, resulting into eosinophilia, lymphocytosis, leucocytosis, etc.

(6) Undersecretion of sex hormones causes impotence in males and disorders or menstrual cycle in females.

(7) Excessive deposists of melanin, particularly in the skin of open parts of body like face, hands, feet, neck, teats, etc cause deep bronzing of skin in these parts.

(8) As increase in $H^+$ concentration in blood may cause acidosis.

(b) **Hypersecretion :** Oversecretion of adrenocorticoids (hypercorticism) causes following disorders and diseases –

(1) Glucose level rises in blood (hyperglycemia). This may lead to diabetes mellitus.

(2) Irregular deposits of fat, particularly in thoracic parts and face, imparts asymmetrical shape to the body. the face becomes red and rounded (moon face), shoulders swell (buffalo humps) and abdomen dilates and often shows lines of stretching. All these are symptoms of Cushing's disease (Cushing, 1932). Patients may die from brain haemorrhage, cardiac arrest, pneumonia, etc.

(3) Retention of sodium and water is the ECF increases blood pressure, causing severe hypertension and associated symptoms like severe headache. Fluids may accumulate at placed in connective tissue, causing edema, liver cirrhosis, etc.

(4) Excessive loss of potassium in urine causes potassium deficiency (hypokalemia). This leads to muscular weakness and convulsions and nervous disorders, and may even cause tetany and paralysis,

copious and frequent urination (polyuria) and thirst, bed urination (nicturia), etc. Similarly, excessive loss of $H^+$ in urine may cause alkalosis.

(5) Excessive mobilization of materials from all parts of body had widespread deteriorating effects. For instance, mobilization of proteins from all cells causes tissue wasting. similarly, mobilization from bones renders the bones weak and fragile (osteoporosis).

*Fig. – A girl showing pseudohermaphroditis*

(6) Excessive secretion of male hormones (androgens) in a female fetus before complete formation of ovaries results into pseudohermaphroditism due to masculinization of external genitals, and causes abnormal development of muscles, hair on face (beard and moustache), early sexual maturation, hoarse voice and absence of menstruation. The clitoris grows to penis size, while vagina and uterus remain underdeveloped. This is known as adrenogenital syndrome. The resultant females are sterile. Oversecretion of androgens after complete formation of ovaries and fallopian tubes causes only a moderate enlargement of clitoris. Oversecretion of androgens in girls after birth causes a gradual masculinization manifested in overgrowth of clitoris, under development of mammary glands and uterus and disturbed menstruation. Oversecretion of androgens in male children causes excessive development of penis (marcogenitosomia) and other secondary sexual organs and characteristics, but atrophy of testes so that there is no spermatogenesis. Early erections are noted. Due to the anabolic effects of androgens, both in girls and body, growth is accelerated, muscles are well-developed and strong, and bones mature early.

(7) Excessive secretion of female hormones in adult males cause enlarged mammary glands (gynaecomastia) and retards growth of beard. Contrarily, excessive secretion of androgens in females in masculinizing and causes hirsutism (increased facial and body hair and muscle growth, clitorial enlargement, etc.)

Prolonged undersecretion of catecholamines by adrenal medulla causes low blood pressure and depression. Regular treatment with antidepressant drugs, like cocaine, amphitamines, ephedrine, tyramine, etc., which stimulate the sympathetic nervous system, is required. Contrarily, the oversecretion of catecholamines causes high blood pressure and hypertension. Antihypertensives (transquilizers), like disulphiram, reserpine, guanethidine, etc are useful, because these retard the effects of sympathetic nervous system.

## 11.7 Pancreas

(i) **Location, origin :** Pancreas (Gr. pankreas = sweet bread; Fr., pan = all + kreas = flesh) is a flattened and pinkish mixed gland situated in the concavity formed by duodenum just behind the stomach. It measures about 15 cm in length and 4 to 5 cm in breadth. It forms by fusion of two bilateral endodermal processes of embyronic intestine (duodenum of future adult).

(ii) **Structure :** About 98% part of the gland is exocrine and formed of hollow pancreatic acini or lobules embedded in a connective tissue stroma. In the stroma, there are numerous (approximately 1 to 2 million in human pancreas) small (0.1 to 0.2 mm in diameter) clusters of endocrine cells, called islets of Langerhans after the name of their discoverer, Paul Langerhans (1869).

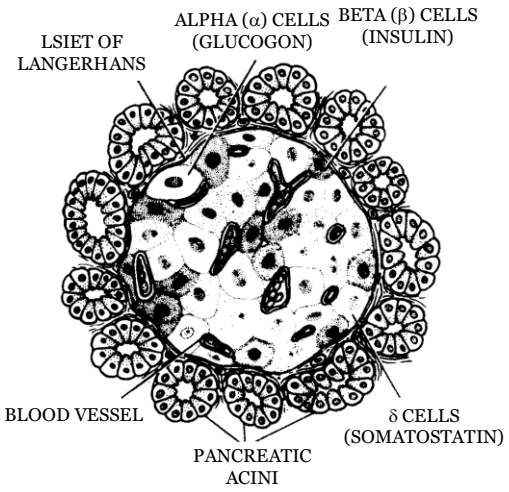


***Fig. – T.S. of pancreas***

Each islet of Langerhans contains hundreds of small cells and several blood capillaries and sinusoids. Its cell are distinguished into four types –

(a) Beta (β) cells (about 70%) in the middle of the islet.

(b) Alpha (α) cells (about 20%) in cortical zone of the islet.

(c) Scattered delta (δ) or gamma cells (about 5%)

(d) The remaining F or PP cells (about 5%).

(iii) **Hormones of pancreas and their role :** The β and α cells of islets of Langerhans respectively secrete insulin and glucagon hormones which are important regulation of carbohydrate protein and fat metabolism in the body.

(a) **Insulin :** In 1889, Minkowski and Mehring discovered that pancreas is related with the disease of diabetes mellitus in humans. Normal concentration of glucose in blood is about 100 mg (0.1 gm) per 100 ml. It increases somewhat after a carbohydrate rice food. Then, the secretion if insulin increases. It increases the permeability of all cells for glucose several times, except that of brain cells and red blood corpuscles (RBCs). The brain cells and RBCs are already highly permeable to glucose. After taking more glucose from blood, the cells utilize it for energy-production. Consequently, the basal metabolic rate (BMR) and RNA and protein synthesis increases in cells. Simultneously, glycogenesis (synthesis of glycogen from glucose) in liver and muscles and lipogenesis (synthesis of fat) in adipose tissues also increase. Thus, acting as an anabolic hormone, insulin contributes to proper growth and repair of body and maintenance of food reserve in between the meals.

In 1923, two Canadian scientists, Banting and Best succeeded in preparing a pure extract of insulin from the pancreatic islets of a new born calf with the help of Macleod, Banting and Macleod won the 1923 Nobel prize for this work. Later, Abel (1926) succeeded in preparing pure crystals of insulin. F. Sanger (1955) worked out the molecular structure of bovine insulin and won the 1958 Nobel Prize. He discovered that insulin is a small protein whose molecule consists of two polypeptide chains, α and β, joined by disulphide linkages and respectively formed of 21 and 30 amino acid residues. Insulin is the first protein to be crystallized in pure form, first protein whose molecular structure was worked out, the first protein to be synthesized in laboratory in 1964, and also the first protein to be

commercially manufactured by means of DNA recombinant technique. Even the human insulin was also synthesized by Tsan in 1965.

(1) **Hypoinsulinism :** In insulin deficiency, body cells fail to obtain glucose from blood. Hence, glucose level of blood rises, a condition called hyperglycemia. When glucose level rises further, glucose starts passing out in urine. This condition is called glycosuria. Ultimately, when glucose level in blood rises to 300 to 500 mg per ml, the person concerned suffers from diabetes mellitus in which the urine becomes sweat.

Diabetes mellitus has been known to Greeks as a human disease since 1500 B.C. in England, it was known as a "pissing evil" due to copious urination in it. Modern scientists have discovered that diabetes mellitus is of two types – I and II. The type I diabetes is usually found in young people, in some of which it is hereditary. About 10% of diabetes patients suffer from this type. Other patients suffer from diabetes of type II, usually found in people of over 40 years of age or obesse persons. Diabetics excrete large volumes of urine. This is called polyuria. It results into dehydration which, in turn, causes increased thrist (polydipsa) and hunger (polyphagia). Being unable to utilize glucose for energy-production ("starving in midst of plenty"), the cells utilize their proteins for it, causing "body wasting". The body, therefore, becomes very weak. Nervous system may be damaged and often cataract occurs. Lipolysis in adipose tissues increases, elevating blood level of free fatty acids (FFA). Accelerated, but incomplete, oxidation of fatty acids for energy, especially in liver, results into the formation of ketone bodies – acetone, acetoacetic acid and β-hydroxybutyrate– , causing ketosis. Since the ketone bodies are sweet, acidic and poisonous, their increased amount in blood causes acidosis. Hence, patients may anytime become unconscious (coma condition) and finally die.

Regular injections of insulin must be given to chronic patients of diabetes. Balanced diet, exercise, and regular intake of insulin tablets (*eg* dionyl) may keep diabetes in control. Certain drugs, like glyburide, which stimulate insulin secretion are now available.

(2) **Hyperinsulinism :** Oversecretion of insulin enhances glucose intake by most body cells and glycogenesis in liver and muscles, causing a persistent decrease in blood glucose level (Hypoglycemia) since brain cells and cells of retina and germinal epithelium mainly depend on glucose for energy, nervous efficiency, fertility and vision sharply decline. Poor supply of glucose to the brain stimulates sympathetic nervous system, causing unnecessary excitement and feeling of anxiety, sweating, weakness, fatigue and muscular convulsions. Continued excess of insulin in blood causes "coma (insulin shock)" and death. Injections of cortisol, adrenaline, growth hormone and glucagon help in treatment of hyperinulinism, because these hormones retard glucose utilization in cells and mobilize glucose and fatty acids respectively from liver and adipose tissues. Injections of glucose also give relief to the patients.

(b) **Glucagon :** This is secreted by the alpha cells of islets of Langerhans. It was discovered by Kimball and Murlin (1923). Like insulin, it is also a small protein. Its molecule consists of a single polypeptide chain of 29 amino acid residues. Its function is to elevate glucose level in blood when glucose is deficient. For this, glucagon intensifies glycogenolysis, deamination and gluconeogenesis, and inhibits glycogenesis in liver cells. It also intensifies lipolysis in adipose tissues. Thus, it is promoter of catabolic

metabolism. When, during excessive physical labour and stress, glucose consumption in the body increases and blood glucose level falls, glucagon is secreted to normalize the glucose level.

The secretion of insulin and glucagon is regulated by a "limit-control feedback" or "push and pull feedback" control system. When sugar level in blood increases, insulin is secreted and secretion of glucagon is inhibited. When, due to the effect of insulin, blood sugar level falls, secretion of insulin is inhibited and that of glucagon is stimulated. Besides this, certain amino acids (*e.g.* orginine and leucine), gastro-intestinal hormones, acetylcholine, etc enhance insulin secretion. Contrarily, diazoxide, phenytoin, alloxan, etc inhibit insulin secretion by destroying the β cells of islets of Langerhans.

(c) **Somatostatin and Pancreatic polypeptide :** Modern physiologists have postulated that the δ and F (PP) cells of pancreas respectively secrete somatostatin (SS) and pancreatic polypeptide (PP). Somatostatin resembles the growth hormone inhibitory hormone (GHIH) secreted by hypothalamus. Its molecule is a small peptide of 14 amino acid residues. Acting as a paracrine hormone, it serves to retard secretory activities of α and β cells. Besides this, it also slows down food digestion, absorption of digested nutrients and assimilation of nutrients in cells. Thus, it prolongs utilization of every feed. pancreatic polypeptide (PP) also acts as a local, paracrine hormone. It retards secretion of pancreatic enzymes and somatostatin. It also inhibits motility of stomach, duodenum and gall bladder.

**Difference between diabetes mellitus and diabetes insipedus**

| S.No. | Diabetes mellitus | Diabetes insipidus |
|---|---|---|
| **1.** | It is due to deficiency of insulin. | It is due to deficiency of ADH. |
| **2.** | The blood sugar becomes high and glucose appears in urine. | The blood glucose is normal and glucose does not appear in urine. |
| **3.** | There is high blood cholesterol and ketone body formation. | There is no such phenomenon. |

## Important tips

- A molecule of insulin consists of two polypeptide chains – α-chain (21 amino acids) and β-chain (30 amino acids) which are joined by disulphide bodns.
- Human insulin was prepared for the first time byTsan in 1965.
- Insulin is effective only when it is given by injection.
- If insulin is taken orally, it is digested.
- Chemicals, alloxan and streptozotocin selectively destroy beta cells of islets of Langerhans.
- Insulin is zinc containing polypeptide hormone.
- Cobalt chloride selectively destroys alpha cells of islets of Langerhans.
- Atrial natriuretic factor (ANF) : A polypeptide hormone secreted by cardiocytes of atria in response to increased venous return. It promotes the excretion of ions and water so regulating the blood volume.
- **Humulin :** Genetically engineered human insulin is called humulin.
- **Acidosis :** Decrease in pH of blood e.g. in diabetes mellitus.
- **Insulin stock :** Quick fall of sugar level upto 43 mg/100 ml of blood when insulin is injected after

exercise or delayed meal. It causes unconsciousness and may lead to death.

- Prostaglandins were discovered from human semen in 1930.
- The seminal vesicles are the chief source of prostaglandins in semen.
- The commonest prostaglandins are $PGA_1$, $PGA_2$, $PGE_1$, $PGE_2$ etc.

## 11.8 THYMUS GLAND

(i) **Origin and position :** The thymus gland is located in the upper part of the thorax near the heart. It is endodermal in origin, arising in the embryo from the epithelium of outer part of third branchial pauches.

(ii) **Structure :** Structurally, it is like lymph gland enveloped by a thin, loose and fibrous connective tissue capsule. Septa, extending inwards from the capsule, divide the two lobes of the gland into a number of small lobules. Each lobule is distinguished into a cortical parenchyma containing numerous lymphocytes, and a medullary mass of large, irregularly branched and interconnected epithelial cells (reticular cells), a few lymphocytes and some phagocytic cells called macrophages or Hassal's corpuscles.

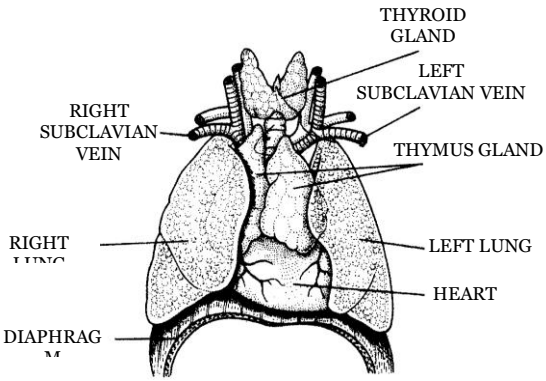

*Fig. – Location of thymus gland*

(iii) **Function of thymus glands**

(a) Thymus is haemopoietic, as well as, an endocrine gland. Thymus is the "seedbed" of "thymic lymphocytes (T-lymphocytes). Certain "stem cells", originating in yolk sac and liver in early embryo, but only in bone marrow in late embryo, migrate into the thymus and proliferate to form a large number of lymphocytes.

(b) The major function of thymus is to secrete thymosin hormone, thymic humoral factor (THF), thymic factor (TF), thymopoietin. These compounds induce, not only the proliferation of lymphocytes, but also their differentiation into a variety of clones differently specialized to destroy different specific categories of antigens and pathogens likely to get into the body. This is called maturation of lymphocytes. Thus, the thymus brings forth competent T-lymphocytes for cellular immune defense system of body, and maintains a sufficient supply of these lymphocytes in general blood circulation and peripheral lymphoid organs and tissues for future use.

(c) As is clear from above account, thymus is essential in neonatal (newly born) infant and postnatal child for normal development of lymphoid organs and cellular immunity. That is why, the thymus, small at birth, progressively grows in size about three or four-folds upto about the age of puberty. By this time lymphoid organs and tissues are well-developed. The thymus, therefore, starts gradually diminishing in size and its tissue is progressively infiltrated by yellowish adipose tissue. This is known as the "immunity theory of ageing". By the old age, the thymus is reduced to quite a thin, yet functional chord of tissue.

### 11.9 Pineal gland (Epiphysis)

(i) **Origin, position and structure :** This is a small, whitish and somewhat flattened ectodermal gland situated at the tip of a small, fibrous stalk that arises from dorsal wall of diencephalon, *i.e.* the roof (epithalamus) of third ventricle of the brain. Due to its location, it is also called epiphysis cerebri. It is covered over by a thin capsule formed of the piamater of the brain. Septa from this membrane extend into the gland, dividing in into lobules having two types of branched cells, viz the large and modified nerve cells, called pinealocytes, and interstitial or neuroglial cells forming the supporting tissue. In the pineal gland starts degenerating after the age of about 7 years because of deposition of granules of calcium salts (brain sand) in it.

(ii) **Function of pineal body :** Hormone, though the function of the gland is still the subject of current research, it is known to secrete one hormone, melatonin. Melatonin concentration in the blood appears to flow a diurnal (day-night) cycle as it arises in the evening and through the night and drops to a low around noon. Melatonin lightens skin colour in certain animals and regulates working of gonads (testes and ovaries). Light falling on the retina of the eye decreases melatonin production, darkness stimulates melatonin synthesis. Girls blind from birth attain puberty earlier than normal, apparently because there is no inhibitory effect of melatonin on ovarian function.

Serotonin, a neurotransmitter found in other locations in the brain, is also found in the pineal gland. Research evidence is accumulating to support the idea that the pineal gland may be involved in regulating cyclic phenomena in the body.

### 11.10 Gonads

The gonads are the sex glands, the testes and the ovary. Testes is the male gonad and ovary is the female gonads. They develop from the mesoderm of the embryo. They produce gametes (sperm and ova). Besides producing gametes, the gonads secrete sex hormones from the onset of puberty (sexual maturity) to control the reproductive organs and sexual behaviour.

The sex hormone were discovered by Adolf Butenononal in 1929 and 1931. He won the 1939 Nobel prize jointly with Leopold Ruzicka.

(i) **Testes**

(a) **Location and structure :** In testes between the siminiferous tubules, special types of cells are present called interstitial cells or cells of leydig. These cells secrete male hormones (androgens) derived from cholesterol. The main androgen is testosterone other less important androgens include androstenedione and dehydroepiandrosterone. It is a

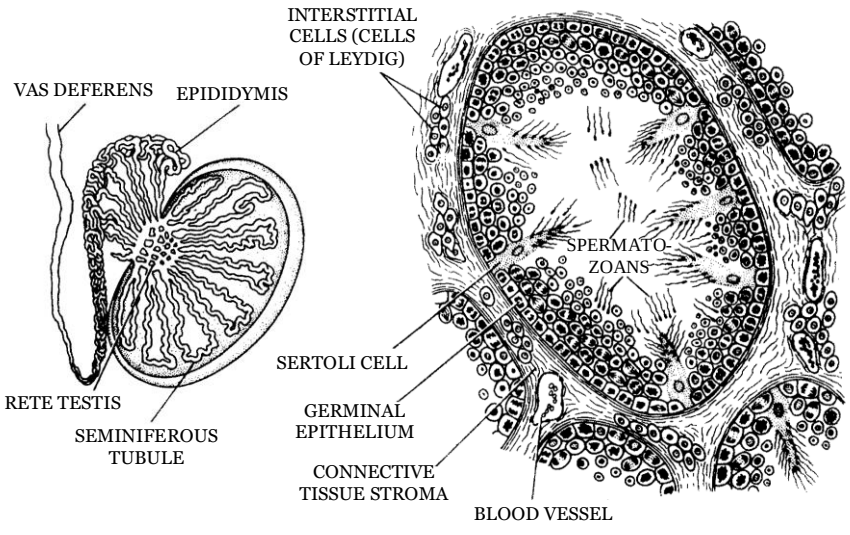


***Fig. – Ultrastructure of testes***

masculinizing hormone. From puberty to the age of about twenty year *i.e.* adolescence or the period of sexual maturation or attainment of adult hood.

(b) **Function**

(1) It stimulates the male reproductive system to grow to full size and become functional.

(2) It stimulates the formation of sperms (spermatogenesis) in the seminiferous tubules.

(3) It stimulates the development of male accessory sex characters such as hair on the face (beard and moustaches), growth and distribution of hair on the body, deepening of voice, broadening of shoulders, enlarged and stronger bones and muscles. It also maintains these characters.

(4) It also determines the male sexual behaviour sex urge, aggressive behaviour.

(5) Under its effect protein anabolism increases.

(6) Grythropoisis in bone marrow increases.

(7) In brief, testosterone determines libido. It is also required, together with the follicle stimulating hormone (FSH) of pituitary, for initiation and completion of spermatogenesis. All androgens are also secreted in traces from adrenal glands in both boys and girls.

(c) **Development of testis :** Under the effect of chorionic gonadotropic hormone, secreted by placenta during pregnancy, the testes of eight to nine months old fetus start secreting testosterone. The latter regulates differentiation and development of urinogenital system, accessory genital organs and external genitalia in the embryo. During childhood *i.e.* from birth to puberty (age of 11 to 13 years), testes remain quiescent, so that androgens are not secreted. At puberty, the gonadotropic hormones (FSH and ICSH) of pituitary reactivate the testes which, therefore, start producing sperms and resume secreting androgens. Upto the age of about 40 years, androgens are secreted in sufficient amounts. thereafter, their secretion starts gradually declining, but the capability of reproduction still continues for many years.

(d) **Castration :** Surgical removal of testes is called castration or orchidectomy. Castration, or deficient secretion of testosterone (hypogonadism) before puberty (due to congenital defects or injury to testes) retards growth of genitalia, muscles and bones, as well as, the development of sexual characteristics. Consequently, the affected person develops into a sterile neuter or eunuch (eunuchoidism). Eunuchs are relatively taller with longer limbs, but lean and weak in constitution. Their genitals are of child-size. Beard and moustache do not usually grow. Aggressiveness is reduced. In brief, the libido is diminished in eunuchs.

Castration or hypogonadism after puberty preserves the libido, but diminishes its overall efficiency (demasculinization). Muscular strength, hair growth, spermatogenesis, sex urge and potency sharply decline. sometimes, the person becomes impotent.

Castration is widely used in animal husbandry and domestication. Castrated cattle, horses and fowls are respectively called steers, geldings and capons. Castration makes these docile.

(ii) **Ovary :** Primordial ovarian follicles are formed in the primitive ovaries of female fetuses as early as about 16 weeks of gestation, but these do not secrete hormones. Even in early childhood, upto the age of 7 or 8 years, ovaries remain quiescent. Thereafter, the pituitary starts secreting gonadotropins (FSH and LH) under whose influence puberty in girls sets in at about the age of 11 to 13 years; ovaries become active and menstrual cycle begins, so that the girls attain sexual maturity.

Reproductive period, *i.e.* ovarian function and menstrual cycles in women normally cease at about the age of 45 to 55 years. This is called menopause. It usually results in a rise in urinary excretion of gonadotropins of the pituitary gland.

(a) **Ovarian hormone :** Under the influence of FSH and LH. They secretes three female sex hormone, estrogen, progesteron and relaxin. They derived from cholesterol.

(1) **Estrogens :** These are secreted by the cells of the Graafian (ovarian) follicle surrounding the maturing ovum in the ovary. They stimulate the female reproductive tract to grow to full size and become functional. They also stimulate the differentiation of ova (oogenesis) in the ovary. They also stimulate the development of accessory sex characters such as enlargement of breasts; broadening of pelvis; growth of pubic and axillary hair; deposition of fat in the thighs, and onset of menstruation cycle. Graafian follicle cells are stimulated to secrete estrogens by luteinising hormone (LH) from the anterior lobe of the pituitary gland. Rise of blood-estrogens level above normal inhibits the secretion of LH from the anterior pituitary. This negative feedback prevents the oversecretion of estrogens.

(2) **Progesterone :** It is secreted by the corpus luteum. The latter is a yellowish body formed in the empty Graafian follicle after the release of the ovum. Its hormone suspends ovulation during pregnancy, fixes the foetus to the uterine wall, forms placenta, and controls the development of the foetus in the uterus. Ovulation, formation of corpus luteum and secretion of progesterone are stimulated by the luteinsing hormone (LH) from the anterior pituitary.

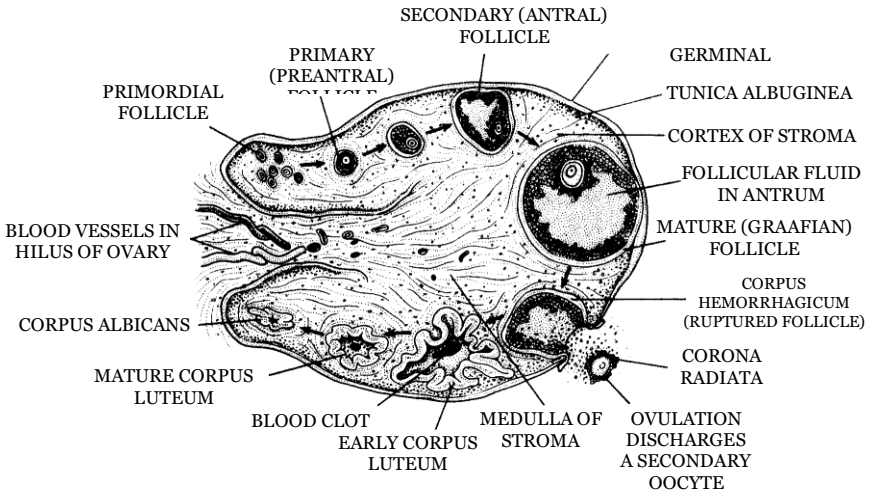


***Fig. – V.L.S. of ovary***

(3) **Relaxin :** It is produced by the corpus luteum at the end of the gestation period. It relaxes the cervix of the uterus and ligaments of the pelvic girdle for easy birth of the young one.

(b) **Regulation of ovarian hormone :** Secretion of estrogens is regulated by the gonadotropins of pituitary. Undersecretion of estrogens (hypogonadism) before puberty due to congenital defects or damage to ovaries, causes female eunuchoidism. Accessory genitals and breasts remain underdeveloped, pelvis remains narrow and buttocks flat. Secondary sexual characteristics also do not develop. Hypogonadism in adulthood reduces fertility and disturbs menstrual cycles. Oversecretion (hypersecretion of hypergonadism) of estrogens also disturbs menstrual cycles and may even cause cancer.

**Hormonal sexual abnormalities**

**True hermaphroditism :** All higher animals and some higher plants are unisexual (dioecious) organisms with separate male and female individuals. Occasionally, bisexual (hermaphrodite or monoecious) individuals, displaying characteristics of both male and female sexes, are seen in these

organisms. This aberrant sexuality develops mainly due to genetic abnormalities, or hormonal disbalances. Bisexuals produced due to genetic abnormalities are regarded true hermaphrodites.

**Pseudohermaphroditism :** Bisexuals produced due to hormonal disbalances are regarded pseudohermaphrodites or intersexes. An intersex can be defined as an individual genetically belonging to one sex (*i.e.* having normal XY or XX sex chromosomes), but phenotypically displaying certain characteristics of the other sex. Obviously, intersexes possess normal glands (testes or ovaries), but their accessory reproductive organs (genital ducts and glands, etc.), external genitalia (copulatory organs) and secondary sexual characteristics (stature, voice, hair, breasts, body phsiology, etc.) and behaviour are ambiguous or at variance from their genetic (gonadal) sex. Obviously, these are sterile individuals (eunuchs).

Male intersexes develop when secretion of male hormones (androgens) is insufficient during embryonic development due to defective testes. Female intersexes, on the other hand, develop when the female fetus is exposed to a coipous supply of androgens mainly from adrenal glands.

**Psychological sex abnormalities :** In human beings, psychological disbalances produce homosexual, transvestite and trans-sexual individuals. These individuals are physically normal, yet they display unusual behaviour. For example, homosexuals prefer having sex with others of the same sex. Transvestites prefer to dress in attirement of opposite sex in pursuit of sexual excitement. Trans-sexuals possess desire to belong to the opposite sex and many even prefer to undergo operations for this.

**Freemartin :** When male and female twin (fraternal twins) are produced in cattle, the male calf is normal, but the female calf is usually sterile, having masculanized reproductive organs. What happens in this case is that the twins share a common placenta, establishing a vascular connection between these. When male hormones of male calf circulate in female fetus, these supress sexual development in this fetus. Hence, the female calf circulate in female fetus, these supress sexual development in this fetus. Hence, the female calf prossesses rudimentary genital organ. Such calves are called freemartins.

(1) Testosterone exerts a feed back inhibitor effect of pituitary LH(ICSH) secretion.

(2) Estrogen supress the production of pituitary FSH.

(3) Menarche is the starting of menstruation in girls at about $13\frac{1}{2}$ years.

(4) **Progesterone :** Also called anti-abortion hormone.

(5) **Gravidex test :** Involve testing of HCG of placenta in the urine to test the pregnancy.

(6) **Contraceptive pills :** Contain oestrogens and progesterone so called combined pills. These check ovulation and so pregnancy in female.

(7) **Adiposogenital syndrome :** Also called hypothalmic eunuchoidism characterized by hypogonadism in male caused by genetic inability of hypothalamus to secrete gonadotrophin releasing hormones.

**Hormonal Contraception**

**Female contraception :** As already described, gonads are stimulated to produces sex cells (gametes) and secrete sex hormones by the gonadotropic hormones (FSH and LH) of anterior pituitary. The anterior pituitary is, in turn, stimulated to secrete gonadotropins by the gonadotropin-releasing hormone (GnRH) of hypothalamus. In women, FSH promotes oogenesis and secretion of female hormones (estrogens). LH promotes ovulation, formation of corpus luteum and secretion of progesterone from it. A negative feedback regulation operates between GnRH and gonadotropins, on one hand, and between gonadotropins and female hormones on the other. Hence, high concentration of female hormones retards secretion of FSH, LH and GnRH due to which oogenesis does not occur, and pregnancy is out of question. Thus, this negative feedback regulation is contraceptive. That is why, women who do not want pregnancy take oral contraceptive pills of estrogens or progesterone for first 21 days during menstruation cycle. Contraceptive pills of mixtures of estrogens and progesterone are more effective. The most popular contraceptive pills contain synthetic ethinyl estradiol and synthetic progesterone (*e.g.* norethindrone). In a modern method, a capsule of synthetic progesterone, like levonor gestrel, is implanted under the skin. The capsule serves for contraception for about five years.

Abortion is also now permissible in many countries to check population growth. Since progesterone is necessary to maintain early pregnancy, drugs, like mifepristone (RU-486), which inhibit the effects of progesterone are administered for abortion.

**Male contraception :** In men, LH stimulates cells of Leydig to secrete male hormones (androgens) of which testosterone is the principal hormone. Testosterone, in turn, inhibits LH secretion, but not FSH secretion by anterior pituitary. FSH and testosterone stimulate spermatogenesis. It has been found that large doses of testosterone can inhibit secretion of gonadotropin-release hormone (GnRH) by thalamic cells, thereby inhibiting secretion of both LH and FSH by pituitary. Hence systematically administered injections of testerone have been suggestes as a means of male contraception.

Recently, the cells of Sertoli in seminiferous have been found to secrete a protein factor named inhibin which directly inhibits secretion of FSH by pituitary. Hence, use of inhibin as a male contraceptive is now being explored.

## 11.11 Gastro-intestinal mucosa placenta skin, kidney and heart

(i) **Gastro-intestinal mucosa :** Inner most layer of the wall of the alimentary canal is called mucosa. Certain cell of the mucosa of the stomach and intestine secrete important hormones. Gastro-intestinal mucosa is endodermal in origin.

(a) **Stomach :** The mucosa of the pyloric stomach near the duodenum secretes a hormone called gastrin. Presence of food in the stomach provides a stimulus for gastrin secretion. Gastrin stinmulates the gastric glands to produce the gastric juice. It also stimulates the stomach movements.

(b) **Intestine :** The intestinal mucosa secretes six hormones : secretin, cholecystokinin, enterogastrone, enterocrinin, duopcrinin and villikinin. Entry of acidic food from the stomach into the duodenum serves as a stimulus for the release of these hormones.

(1) **Secretin :** It is produced by the small intestinal mucosa. It causes the release of sodium bicarbonate solution from the pancreas for pancreatic juice and from the liver for bile. It also inhibits the secretion and movements of stomach.

(2) **Cholecystokinin-pancreozymin (CCK-PZ) :** This hormone is secreted by the mucosa of entire small intestine. The actions of cholecystokinin and pancreozymin were discovered independently. But it has been discovered that both hormones have similar effects and hence it is considered one hormone. As the name suggest CCK-PZ has two main functions. The word cholecystokinin is derived from three roots : Chol meaning bile, Cyst meaning bladder, and kinin meaning to remove. The word pancreozymin is derived from pancreas and Zymin, which means enzyme producer. This hormone stimulates the gall bladder to release the bile and also stimulates the pancreas to release its enzymes.

(3) **Enterogastrone :** It is secreted by the duodenal mucosa. It shows gastric contractions and stops the secretion of gastric juice.

(4) **Enterocrinin :** It is secreted by duodenal mucosa. It stimulates crypts of Lieberkuhn to secrete the enzymes in the intestinal juice.

(5) **Duocrinin :** It is secreted by the duodenal mucosa. It stimulates the release of viscous mucus from Brunner's glands into the intestinal juice.

(6) **Villikinin :** It is secreted by the mucosa of the entire small intestine. It accelerates the movements of villi to quicken absorption of food.

(ii) **Placenta :** When the early embryo reaches into the uterus from fallopian tube, it becomes implanted with uterine wall by a placenta for support and nutrition. The cells of placenta secrete two steroid hormones (estradiol and progesterone) and two protein hormones (human chorional gonadotropin-HCG and human placental stomato mammotropin-HCS). Early placenta secretes so much of chorional gonadotropin that the latter starts being exerted in mother's urine just after about two weeks of pregnancy. Its presence in urine is used for pregnancy test. It serves to maintain the corpus luteum, and to stimulate it for secretion. Due to its effect, the corpus luteum continues secreting estrogens, progesterone and relaxin. It also serves to maintain pregnancy by preventing contraction of uterine wall. After about three months of pregnancy, secretion of progesterone by the placenta increases. Hence, importance of corpus luteum decreases, and it starts degenerating. If therefore, ovaries are surgically removed at this stage, pregnancy remains unaffected, *i.e.* there is no abortion and the fetus grows and develops normally.

The placental somatomammotropin was formerly known as placental lactogen. Reaching into mother's body, its serves as a mid growth hormone and promote growth of milk glands.

**Relaxin hormone :** This hormone has been obtained from corpus luteum ovaries and from the placenta. It is a polypeptide. During pregnancy it causes relaxation of the ligaments of pubic

symphysis, and towards the termination of pregnancy, softens and widens the opening (cervix) of uterus for easy child birth (parturition). A temporary structure with endocrine function is placenta.

(iii) **Skin :** Vitamins of *D* group are synthesized in skin cells under the effect of ultraviolet (UV) rays of sunlight from cholesterol-derived compounds. Cholecalciferol ($D_3$) is the main *D* vitamin. It circulates in blood. Liver cells convert it into hydroxycholecalciferol (calcidiol) by hydroxylation and release back into blood. Certain cells of proximal convoluted tubules of nephrons in the kidneys convert calcidiol into dihydroxycalciferol (calcitriol) by further hydroxylation and release back into blood. Calcitriol is an important regulator of $Ca^{2+}$ homeostasis. It promotes absorption of $Ca^{2+}$ and phosphorus in intestine and bone-formation. It is therefore, required for growth of body and bone healing. Its deficiency in childhood causes thin, weak and curved bones, a condition called rickets. Its deficiency after growth period, causes weak, porous and fragile bones. This called osteomalacia.

(iv) **Kidney :** Whenever the rate of ultrafiltration in kidneys decreases due to low blood pressure (BP), the cells of juxtamedullary complexes secrete into blood a compound named renin. The latter is a proteolytic enzyme. It acts upon a large plasma-protein formed in liver and called angiotensinogen, separating a small protein from it called angiotensin-I. Besides their function of excretion, the kidneys secrete three hormones, *viz* calcitriol, renin and erythropoetin. Calcitriol is the active form of vitamin $D_3$ as already described. While the blood flows in blood capillaries of liver, an angiotensin-converting enzyme (ACE) converts angiotensin-I into angiotensin-II which acts as a hormone. This hormone accelerates heartbeat and constricts arterioles increasing blood pressure. Consequently, the rate of ultrafiltration increases. Simultaneously, it stimulates adrenal cortex to secrete aldosterone, and enhances water and sodium reabsorption from nephrons. These factors also increase the volume of ECF, elevating blood pressure.

Erythropoetin (EPO) controls formation of enthrocytes (red blood corpuscles-RSCs) in red bone marrow. That is why, its secretion increases on decrease in blood volume, or RBC count, or haemoglobin deficiency (anaemia). Contrarily, its secretion decreases when RBC count tends to increase due to blood transfusion or other reasons.

(v) **Heart :** When volume of ECF and blood pressure (BP) increase due to retention of more *NaCl* in the body, certain cardiac muscle cells of the atria of heart secrete an atrial natriuretic peptide (ANP) which acts as a hormone. The effect of ANP is to promote copious urination (diuresis) and excretion of *NaCl* (natriuresis) to normalise ECF volume and BP. It also inhibits the effect of vasoconstrictor hormones and secretion of renin, aldosteone and vasopressin hormones.

**List of hormones their chemical nature and functions**

| Name of endocrine gland | Name of hormone and its chemical nature | Functions |
|---|---|---|
| (1) Neurosecretory cells of Hypothalamus (Supraoptic Nucleus and Paraventricular Nucleus) | (1) Oxytocin and vasopressin nanopeptide. | (i) Milk ejection and parturition (oxytocic effect).<br>(ii) Vasoconstriction and antidiuretic (vasotocin) effects. |
| | (2) Gonadotropin releasing hormones | Stimulates FSH and LH sysnthesis. |
| | (3) Other releasing hormones *e.g.* TSHRH, MSHRH, ACTHRH, GHRH etc. Proteinaceous | Stimulate TSH, MSH, ACTH GH secretions from pituitary. |
| (2) Pituitary | | |
| (a) Neurohypophysis (Pass Nervosa) | Store and release Oxytocin and Vasopressin. | Hormone release is related to physiological state and requirements. |
| (b) Adenohypehypsis (contains diverse cell types) | Proteincaceous or glycoprotein | Affect growth, development differential pubertal changes and other metabolic mechanism. |
| (3) Pineal | Melatonin-derived from the amino acid tyrosine | (1) Antagonist to FSH / LH<br>(2) Regulates biological / circadian rhythms. |
| (4) Thyroid gland (amine hormone) having – $NH_2$ group) | (a) Thyroxine, iodinated amino acid called tyrosine ($T_2$, $T_3$, $T_4$). | (a) Controls basal metabolic rate (BMR). All organ / system of body responds to thyroxine. |
| | (b) Thyrocalcitonin (Peptide) | (b) Facilitates $Ca^{+2}$ absorption |
| (5) Parathyroid gland | Parathormane, Peptide | $Ca^{+2}$ and $PO^{-}{}_4$ metabolism. |
| (6) Thymus | Thymosine (polypeptide) | Anti-FSH and LH; delays puberty |
| (7) Islets of lengerhans | Glucagon Isolated by | (i) Gluconeogenesis / |

| | | |
|---|---|---|
| (= Endocrine pancrease)<br>(i) α-cells<br>(ii) β-cells<br>(iii) δ-cells | Insulin Banting<br>Secretin Polypeptide | Glycogenolys<br>(ii) Glycogenesis<br>(iii) Gastric functions |
| (8) Adrenal gland | | |
| (a) Adrenal medulla<br>(Amine hormone have – $NH_2$) | (a) Catecholamines (epinephrine = adrenaline, and<br>norepinephrine = noradrenaline (derived from tyrosine) | (a) Stresses = emergency = Fright, Fight and Flight Hormone (3F)<br>acclerates cardiac functions muscle activity etc. |
| (b) Adrenal cortex | (b) Mineralcorticoids and glucocorticoids and traces of androgen and estrogen steroids derived from cholesterol | (b) Electrolyte and carbohydrate metabolism. |
| (9) Ovary | | |
| (a) Ganulosa cells steroid, fat soluble have sterol group derived from cholesterol | Estrogen (Steroid)<br>Estrone, estradiol | (a) Secondary sex character primary action on uterine endometrium mitogenic. |
| (b) Corpus luteum | Estrogen and Progesterone (Steroid) | (a) Secreted during luetal phase of menstrual cycle in human female and oestrous cycle of other mammals. Prepares uterine endometrium for receiving blastocytes for implantation. Progesterone is also called pregnancy hormone and is anti-FSH and anti-LH/anti-LTH. |
| (c) Placenta temporary endocrine gland formed during pregnancy | (a) Steroid secreted are estrogen and progesterone | (a) Maintenance of pregnant state, prevents lactogenesis |

| | | |
|---|---|---|
| | (b) Relaxin-Polypeptide | folliculogenesis, and Ovulation.<br>(b) Act on pubic symphysis and enlarges the birth canal to facilitate birth. Acts synergestically with oxytocin during this process (parturition) |
| (10) Testis<br>(i) Sertoli cells<br>(=sustentacular cells) | (i) Inhibin – Polypeptide | Inhibits FHS action and attenuates spermatogenesis decrementally |
| (ii) Leydig cells<br>(=Interstitial cells) | (ii) Estradiol-Steroid Androgens (*e.g.* Testosterone) Steroid androstenedione) | –do–<br>(i) Pubertal changes in male<br>(ii) Secy. sex characters in male<br>(iii) Sex drives<br>(iv) Spermatogenesis |
| (11) Gastro-intestinal hormones<br>(secreted by cells of mucosa of stomach and intestine) also called hormones | | Stimulates gastric juices secretion from gastric gland, movement of sphincters of stomach and increased movement of stomach |
| (a) Pyloric stomach (Argentophil cells) Intestine | Gastrin<br>(i) Secreten<br>(ii) Cholecystokinin (CCK)<br>(iii) Enterogastrone<br>(iv) Duedocrinin<br>(v) Enterokinin<br>(vi) Villikrinin | (i) Stimulates secretion of succus entericus<br>(ii) Bile released from gall bladder<br>(iii) Inhibits gastric secretin<br>(iv) Stimulates secretion of mucous from Brunner's gland<br>(v) Stimulate intestinal gland<br>(vi) Stimulate villi movement |

**Disease caused by hormonal irregularities**

| Disease | Hormone | Quantity | Gland |
|---|---|---|---|
| Dwarfism | GH | Deficiency | Pituitary |
| Gigantism | GH | Excess | Pituitary |
| Acromegaly | GH | Excess | Pituitary |
| Simmond's disease | GH | Deficiency | Pituitary |
| Diabetes incipedus | ADH | Deficiency | Pituitary |
| Cretinism | Thyroxine | Deficiency | Thyroid |
| Simple goitre | Thyroxine | Deficiency | Thyroid |
| Myxaedema | Thyroxine | Deficiency | Thyroid |
| Exophthalamic goitre | Thyroxine | Excess | Thyroid |
| Tetani | Parathyroid | Deficiency | Parathyroid |
| Plummer's disease | Thyroxine | Excess | Thyroid |
| Addison's disease | Mineralocorticoids | Deficiency | Adrenal cortex |
| Conn's disease | Mineralocorticoids | Excess | Adrenal cortex |
| Cushing's disease | Corticosteroid | Excess | Adrenal cortex |
| Diabetes mellitus | Insulin | Deficiency | Pancrease |
| Myasthenia gravis | Thymosine | Excess | Thymus |

## 11.12 Local hormones pheromones and insect endocrine glands

(i) **Local hormones :** Hormones described so far are called circulating hormones, because these circulate in whole body with blood. When stimulated by physical or chemical stimuli, all body cells, except red blood corpuscles (RBCs), secrete certain such compounds which transmit coded informations of metabolic adjustments between neighbouring cells and hence remain ECF instead of diffusing into the blood. These compounds are called local tissue hormones or autocoids. These are short-lived, because various enzymes present in ECF continue degrading these at a fast rate.

Local hormones are of two main categories-paracrine and autocrine. Paracrine hormones affect metabolism of cells located in the neighbourhood of those which secrete them. Autocrine hormones affect metabolism of the every cells which secrete them. Most local hormones are paracrine. These belong to the following categories :

(a) **Eicosanoids :** These are a category of lipids derived from a fatty acid, arachidonic acid, synthesized in the plasma membrane of cells, and released in ECF. These are of four categories, *viz*. Prostaglandins, prostacyclins, thromoboxanes and leukotrienes.

(1) **Prostaglandins (PGs) :** In 1935, Ulf von Euler discovered that human semen contains a very active compound presumably secreted by prostate gland and, hence, named as such. He found that after

the semen is discharged in woman's vagina, this compound contracts uterine muscles to facilitate the sperms to ascend into fallopian tubes and reach ova to fertilize these.

(2) **Prostacyclins :** These are found in walls of blood vessels and induce vasodilation. These also facilitate flow of blood in vessels and prevent thrombosis by inhibiting aggregation of platelets.

(3) **Thromboxanes :** These are secreted by blood platelets. These help in blood clotting by instigating aggregation of platelets at the place of injury. These also instigate vasoconstriction at places of injury to prevent excessive loss of blood.

(4) **Leukotrienes :** These are secreted by eiosinophils of blood and mast cells of connective tissues. These serve as mediators in inflammatory and allergic reactions, induce bronchoconstriction (constriction of bronchioles), constrict arterioles and induce migration of neutrophils and eosinophils towards the places of inflammation. These can cause asthma, arthrites, colitis, etc.

(b) **Neuroregulators :** These are a category of proteins which function as paracrine hormones in nervous tissues. These can be classified in three categories as follows :

(1) **Neurotransmitters :** These are synthesized in nerve cells and are secreted by exocytosis by axon terminals of these cells. These serve to transmit nerve impulses from one neuron to other neighbouring neurons, or muscles, or glands across synapses. About 60 to these have so far been discovered, but the most common of these are acetylcholine, norepinephrine, dopamine, serotonin and histamine.

(2) **Neuromodulators :** In nervous tissues, the neurons secrete such paracrine hormones which modulate (increase or decrease) the excitability of other neighbouring neurons. These hormones are called neuromodulators. The main positive neuromodulators which increase the excitability of other neurons are the amino acids glutamate and aspartate, and polypeptide named '*P*' substance. Contrarily, the main negative modulators which decrease the excitability of neighbouring neurons are the amino acid glycine and gama aminobutyric acid (GABA), polypeptides named enkephalins, endorphins, dynorphins and tachychinins, and the nitric oxide (NO).

(3) **Nerve growth factors :** The supporting glial cells of nervous tissues and cells of muscles, salivary glands and many other tissues secrete such polypeptide paracrine hormones which play important role in growth, development and survival of nerve cells. That is why, these hormones are collectively called neurotrophins.

(ii) **Pheromones :** These are defined as chemicals excreted or released by one animal to the exterior, but evoke a physiological or behavioral response in another animal of the same species. Some pheromones, release on body surface, evoke a response in the recipient when tasted by the latter by licking, but most pheromones are volatile and odorous fatty acids (hydrocarbons) whose air borne molecules are received by recipient animals through olfaction. Certain insect pheromones are well-known examples. For instance, certain insects secrete bombykol or gyplure to attract their mating partners. Some other insects release geranoil to transmit information of food souirce of danger to their fellows.

In mammals, presumably including humans, certain volatile fatty acids secreted in vaginal fluid by females acts as pheromones. These may evoke sex drive in males, or affect menstrual cycle in other females. It has been observed that there is a tendency of synchronized menstrual cycles in female roommates. This "dormitory effect" must be due to pheromones.

**Types of pheromones**

| Type | Example |
|---|---|
| (1) Sex pheromones | Bombycol – sillkmoth<br>Queen substance – Honey bee<br>Civetone – Cat<br>Muskone – Muskdeer |
| (2) Aggregation pheromones | Geradiol – Honey bee |
| (3) Alarm pheromones | Danger signals |
| (4) Marking pheromones | Mark the territory in wild animals |

(iii) **Insect endocrine glands :** The endocrine system of cockroach comprises intercerebral gland cells, corpora cardiaca, corpora allata, and prothoracic glands.

(1) **Intercerebral gland cells :** These cells lie in the brain between the two cerebral ganglia. They secrete a hormone called the brain hormone. This hormone activates the prothoracic glands to secrete their hormone.

(2) **Corpora cardiaca :** These are a pair of rod-like bodies situated on the sides of the oesophagus just behind the brain. They secrete a growth hormone.

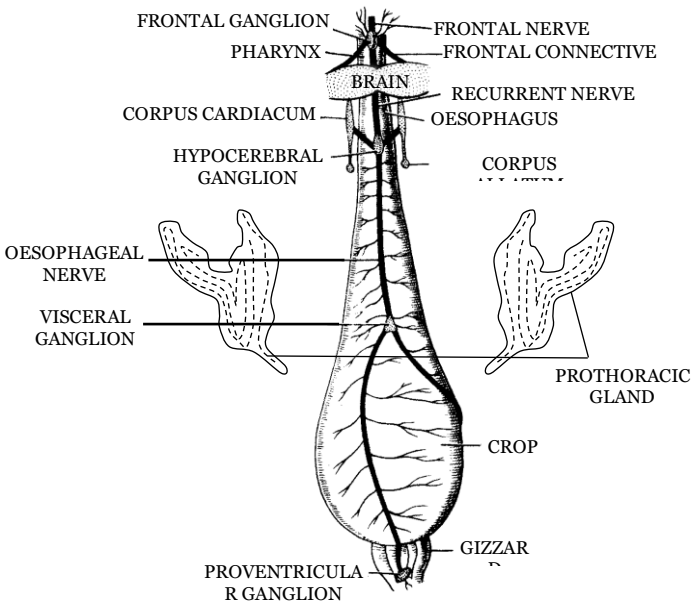


***Fig. – Endocrine glands of cockroach***

(3) **Corpora Allata :** These are a pair of small, rounded bodies lying close behibnd the corpora cardiaca. They secrete a juvenile hormone in the nymphal stages. This hormone causes retention of the nymphal characters and checks the appearance of adult characters. In other words, it keep the insect young, hence its name. In the last nymphal form, corpora allata become inactive, thereby resulting in the absence of juvenile hormone. The absence of this hormone permits the appearance of adult features. In the adult, the corpora allata again become active and secrete a gonadotropic hormone, which regulates egg production and development and functioning of the accessory sex glands.

(4) **Prothoracic glands :** These are fairly large, irregular glands situated in the prothorax. They secrete a hormone called ecdyson, which controls moulting of the nymphs. The prothoracic glands degenerate after metamorphosis.

# ASSIGNMENT

## HORMONES AND MECHANISM OF HORMONAL ACTION

***Basic Level***

1. Who is the "Father of Endocrinology"
   (a) Whittaker (b) Einthoven (c) Pasteur (d) T. Addison
2. Steroid is a
   (a) Thyroid acid (b) Vitamin A (c) Cholesterol (d) Easter and fatty acid
3. The feed back control mechanism is related with
   (a) Bile secretion (b) *HCl* secretion (c) Hormonal secretion (d) Hering breuer reflex
4. All functions of the body are regulated and integrated by
   (a) Respiratory system (b) Digestive system
   (c) Neuroendocrine system (d) Excretory system
5. Which of the following does not secrete any hormone
   (a) Ovary (b) Testis (c) Spleen / Liver (d) Pancreas
6. The name second messenger is given to
   (a) ATP (b) Cyclic AMP (c) GTP (d) Both ATP and AMP
7. Endocrine glands produce or action of endocrine glands is mediated through
   (a) Hormones (b) Enzymes (c) Minerals (d) Vitamins
8. The word "hormone" means
   (a) To move (b) To excite (c) To initiate (d) To increase
9. In which of the following organisms hormones are normally absent
   (a) Monkey (b) Cat (c) Cockroach (d) Bacteria
10. Which one of the following flows directly into blood from the seat of its production to act on an organ away from it
    (a) Enzyme (b) Hormone (c) Blood (d) Lymph
11. Hormones may be
    (a) Amino acid derivatives (b)Peptides (c) Steroids (d) All of these
12. Endocrine glands are those which put their secretions directly into
    (a) Ducts (b) Blood (c) (a) and (b) both (d) None of these
13. Which one is the integration system in our body
    (a) Blood vascular system (b) Endocrine system
    (c) Nervous system (d) Nervous and endocrine systems

14. Which of the following is not necessarily a property of all hormones
(a) Information carrying (b)Secreted in low amounts
(c) Short half-life (d)Protein in nature

15. Which of the following is the largest gland in human body
(a) Pancreas (b) Liver (c) Pituitary (d) Thyroid

16. Which of the following is secreted at ends of nerve fibres
(a) Ascorbic acid (b) Acetic acid (c) Acetyl CoA (d) Acetylcholine

17. Which one of the following is not a gland
(a) Pancreas (b) Pituitary (c) Adrenal (d) Kidney

18. A hormone is
(a) Any glandular secretion (b)An enzyme
(c) A chemical messenger (d)An excretory product

19. Endocrine glands
(a) Do not possess ducts (b) Sometimes do not have ducts
(c) Pour their secretion into blood through ducts (d) Always have ducts

20. Which of the following acts as precursor for steroid hormones
(a) Amino acids (b) Cholesterol (c) Mucoprotein (d) Nucleic acids

21. Find odd one out
(a) Thyroxin (b) Adrenocorticosteroid (c) Ptylin (d) Estradiol

22. Which is not the ductless gland
(a) Testis (b) Ovary (c) Sub-maxillary (d) Pituitary

23. The effect of different hormones on the body can be best said to bring about
(a) Stimulation of organs (b) Release of inherent capacities
(c) Proper growth (d) Co-ordination of functions

24. Hormones influence body parts for bringing about
(a) Proper growth (b) Co-ordination
(c) Stimulation of body parts (d) Proper functioning of body parts

25. Which one does not match with regard to biological activity
(a) Creatinine (b) Renin (c) Gastrin (d) Oxytocin

26. A heterocrine gland is one which
(a) Has two distinct parts
(b) Serves a double function of exocrine and endocrine gland
(c) Produces two types of hormones
(d) Occurs in two places.

27. Hormones are produced by

(a) Exocrine glands (b) Endocrine glands (c) Holocrine glands (d) Apocrine glands

28. An organ where a hormone shows its effect is called

(a) Effector (b) Target (c) Initiator (d) Terminator

29. Cholesterol is required for synthesis of

(a) Insulin (b) Vitamin B (c) Vitamin E (d) Estradiol

30. The releasing hormones are produced by

(a) Testis (b) Pancreas (c) Pituitary (d) Hypothalamus

31. Hormone term was coined by

(a) E.H. Starling (b) G.W. Harris (c) E.H. Schally (d) W.M. Bayliss

32. Which is not ductless gland

(a) Testis (b) Ovary (c) Sub-maxillary (d) Pituitary

33. Which of the following cell does not secrete hormone

(a) Kupffer cell (b) Leydig cell

(c) Lutein cell (d) Parafollicular cells of thyroid

34. Which of the following statements does not hold true for the hormones

(a) They act on target organs usually away from the source glands

(b) They are secreted directly into the blood

(c) They are used again and again like catalysts

(d) They are produced in very minute quantities and are biologically very active

35. Pheromones are chemical messengers produced by animals and released outside the body. The odour of these substances affects

(a) Skin colour (b)Breast

(c) Genitalia (d)Mutual behaviour of members of a species

36. Animal tissues that synthesise hormones are closely associated with and sometimes resemble cells of the

(a) Immune system (b) Embryonic mesoderm (c) Circulatory system (d) Nervous system

37. Endocrine glands are characterized by

(a) Well-developed ducts (b)Absence of ducts (c) Poor blood supply (d) Poor nerve supply

38. One of the following does not secrete hormone

(a) Kidney (b) Stomach (c) Oesophagus (d) Pancreas

39. A male moth finds a mate by means of

(a) Pheromone (b) Ecdysone (c) Brain hormone (d) Thyroxine

40. Who called hormones as 'chemical messengers'

(a) Huxley (b) Addison (c) Starling (d) Bayliss

41. One similarity between enzymes and hormones is that

(a) Both are proteins (b) Both can be used again and again

(c) Both are used in minute amount (d) Both act at a particular *pH*

42. Hormone is

(a) A part of blood (b) A part of digestive juice

(c) Not used again and again (d) Produced in large quantity

43. Steroid hormones are almost similar in structures to

(a) Cholesterol (b) Triglycerides (c) Tyrosine (d) Co-enzyme A

44. Hormones are distributed in the body from their place of origin through

(a) Duct (b) Blood (c) Cytoplasm (d) None of these

45. Endocrine glands and nervous systems are

(a) Interdependent (b) Independent (c) Synchronous (d) Antagonistic

46. What is not true about endocrine gland

(a) They secrete hormone (b) Their secretion is discharged in blood

(c) They are long acting (d) All are proteinaceous

47. Pheromones act as

(a) Sex attractant

(b) Alarm signal

(c) Releaser substance which maintain social organisation in many animals

(d) All of these

***Advance Level***

48. According to the accepted concept of hormone action, if receptor molecules are removed from target organs

(a) The target organ will continue to respond to the hormone without any difference

(b) The target organ will continue to respond to the hormone but will require higher concentration

(c) The target organ will not respond to the hormone

(d) The target organ will continue to respond to the hormone but in the opposite way

49. Who proposed the term 'pheromone'

(a) Bergstroem (b) Karlson

(c) Starling (d) Karlson and Butenandt

50. Pheromone is

(a) A product of endocrine gland (b) Used for animal communication

(c) Messenger RNA (d) Always protein

51. The condition when some hormones work together to control a process in the body, is called

(a) Antagonism (b) Factor hypothesis (c) Feedback mechanism (d)Synergism

52. Rate of hormone synthesis and secretion depends upon

(a) Functional efficiency of the feedback system (b) Amount of excitation in target tissue

(c) Degree of inhibition caused (d) Functional state of the tissue/organ

53. Receptors for protein hormones are located

(a) In cytoplasm (b) On cell surface

(c) In nucleus (d) On endoplasmic reticulum

54. "Pheromones" in insects are secreted from

(a) Exocrine glands (b) Endocrine glands (c) Digestive tract (d) Corpus allata

55. Moulting hormone is secreted by

(a) Corpora cardicum (b) Prothoracic gland

(c) Corpora aceta (d) Neurosecretory hormone

56. Steroid hormones regulate gene activity through

(a) Transcription (b) Binding with specific DNA sites

(c) Removing the repressor molecules (d) The formation of a receptor complex

57. Action of the peptide hormone on a target cell is mediated by

(a) A cytoplasmic receptor (b)Cyclic AMP (c) ATP (d) Epinephrin

58. Which of the following statements is true regarding hormones

(a) All hormones are proteins

(b)Hormones are required and secreted in large quantities

(c) Hormones are informational molecules (d) Most hormones are used locally

59. Broadly defined, a hormone is a molecule that

(a) Moves through the blood stream

(b) Influences development

(c) Alters the activity of certain nonadjacent cells

(d) Has the same chemical activity in a variety of organisms

60. The target cells of a hormone always have
(a) Special receptors to which hormone binds
(b) Special channels through which the hormone moves
(c) Large amount of the hormone stored within vesicles
(d) Undifferentiated cytoplasm

61. Hormones are also known as
(a) Autocoids (b) Chemical messengers (c) Both (d) None of these

62. Which of the following hormone utilize cAMP as a second messenger
(a) Aldosterone (b) Estrogen (c) Progestrone (d) None of these

63. Which of the following enzyme is related with hormonal activity
(a) ATPase (b) Adenyl cyclase (c) Cholinesterase (d) All of these

64. Hormones differ from enzymes in that they are
(a) Found only in animals (b)Found only in plants
(c)Used up in metabolism (d)Not used up in metabolism

65. Hormones are
(a) Chemically steroid
(b) Stored in body in liver any thyroid
(c) Harmful only in excess
(d) Similar so that hormones of one species perform the same function in other species

66. Ecdysone is
(a) A moulting hormone in insects and crustacea (b) Absent in lower vertebrates
(c) Present in molluscs
(d) Controls metamorphosis of echinoderm larvae

67. Juvenile hormone of an insect is
(a) Antagonistic to ecdysone (b)Promotes moulting
(c) Prevents pheromone products (d)Inhibits oogenesis

68. Which of the following is a steroid
(a) Thyroxine (b) Vitamin A (c) Ester and fatty acid (d) Cholesterol

69. Which of the following hormones attach on a specific receptor site on plasma membrane
(a) Glucagon (b) Thyroxine (c) Epinephrine (d) All of these

70. The hormone, that helps in metamorphosis in the insects, is
(a) Juvenile hormone (b) Ecdysone (c) Growth hormone (d) None of these

71. Hormones are not secreted by the following cells

(a) Zona glomerulosa cells of adrenal cortex (b) Thymocytes of post-pubertal male

(c) Sertoli cell (d) Luteal cells of the ovary

72. Identify the correct statement

(a) Target cells fail to respond to a specific hormone if its surface lack the specific receptor for it

(b) Sertoli cells do not secrete any hormone

(c) Leydig cells secrete polypeptide hormones

(d) Biogenic amines are secreted by adrenal cortex

73. Identify the correct statement

(a) Female cockroach secrete pheromone which attract male and leads to copulation

(b) Pheromone production is regulated by ecdysone

(c) Pheromones are produced by male butterflies to attract female

(d) Bombykol acts as alarm signal

## PITUITARY GLAND

***Basic Level***

74. FSH and LH hormones together are called

(a) Emergency hormones (b) Gonadotropic hormones

(c) Neurohormones (d) Outstress hormones

75. Gorilla like man with large head and hands and protruding jaws, is produced due to

(a) Over secretion of thyroxin (b) Over secretion of growth hormone since maturity

(c) Excess of vitamin 'C' in diet (d) Excess secretion of TSH

76. Which one controls the secretion of estrogen

(a) HCG (b) Progesteron (c) LH (d) FSH

77. Which of the following hormones is responsible for hoarseness in voice, beard, mustaches etc. in males

(a) Gonadotropic hormone (b)Adrenaline (c) Thyroid (d) All of these

78. The synthesis of vasopressin is done by

(a) Hypothalamus (b) Kidney (c) Anterior pituitary (d) Posterior pituitary

79. Which of the following secretes leutenizing hormone

(a) Pituitary (b) Thyroid (c) Parathyroid (d) Adrenal

80. Degeneration of anterior pituitary results into

(a) Sterility (b) Extreme weakness (c) Hypoglycaemia (d) All of these

**81.** A person passes much urine and drinks much water but his blood glucose level is normal. This condition may be the result of

(a) A reduction in insulin secretion from pancreas

(b) A reduction in vasopressin secretion from posterior pituitary

(c) A fall in the glucose concentration in urine

(d) An increase in secretion of glucagon

**82.** Which hormone promotes cell division, protein synthesis and bone growth

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

**83.** The other name of anterior pituitary is

(a) Neurohypophysis (b) Pars tuberalis (c) Pars intermedia (d) Adenohypophysis

**84.** Tablets to prevent female contraception contain

(a) LH (b) FSH (c) Progesterone (d) (a) and (b) both

**85.** Gonadotrophic hormones are produced in the

(a) Posterior part of thyroid (b) Adrenal cortex

(c) Adenohypophysis of pituitary (d) Interstitial cells of testis

**86.** Which of the following is not secreted by pituitary gland

(a) ACTH (b) GH (c) FSH (d) Thyroxine

**87.** Function of hypothalamus is

(a) Helps in sleeping (b) Related to hunger and thirst

(c) Temperature regulation (d) All of these

**88.** Which of the following pair of hormones is responsible for the growth and maturation of the graffian follicle

(a) *GH – ADH* (b) *ACTH – LH* (c) *FSH – LH* (d) *FSH – LTH*

**89.** The important function of vassopressin hormone is to

(a) Cause contraction of the uterus and thus help in child birth

(b) Increase reabsorption of water in the kidney tubule

(c) Stimulate the secretion of milk in the mammary glands

(d) Lower the level of blood glucose

**90.** A number of drugs and alcohols suppress ADH secretion. This results in

(a) Loss of thirst (b) Lost of appetite (c) Loss of urine (d) More of urine

**91.** Suggest a suitable word for the fourth place

Darkening of skin : MSH :: Lightening of skin : …….

(a) ADH (b) Myxodema (c) Melatonin (d) FSH

**92.** The activity of adrenal cortex is governed by a pituitary hormone breviated as

(a) HCG (b) FSH (c) ACTH (d) TSH

93. The urine of a man is very dilute and the quantity of urine is too much and dehydration has started in his body and he is very thirsty by the cause of
(a) Hypersecretion of ADH (b)Hyposecretion of ADH
(c) (a) and (b) both (d) None of these

94. "Water drinkers" is the name given to persons who have
(a) Undersecretion of ADH (b)Oversecretion of ADH
(c) Absence of ADH (d) None of these

95. Pituitary gland is made up of
(a) Pars distalis and pars nervosa (b) Pars intermedia
(c) Pars intermedia and pars distalis (d) Pars distalis**,** pars intermedia and pars nervosa

96. FSH (follicle stimulating hormone) is produced by
(a) Adrenal cortex (b)Anterior pituitary lobe
(c) Middle pituitary lobe (d)Posterior pituitary lobe

97. Which of the following pituitary hormone is a direct action hormone
(a) MSH (b) ICSH (c) ACTH (d) TSH

98. The function of oxytocin is to help in
(a) Growth (b) Lactation (c) Child birth (d) Gametogenesis

99. Posterior lobe of pituitary gland is also known as
(a) Hypophysis (b) Adenohypophysis (c) Neurohypophysis (d) Pars intermedia

100. The process of spermatogenesis and sperm formation is under the regulatory influence of
(a) FSH (b) ADH (c) LH (d) LTH

101. The hormones of posterior pituitary are oxytocin and vasopressin; but later is better known as
(a) Antidiuretic hormone (b)Growth hormone
(c) Corticotrophic hormone (d) Neurohypophyseal

102. A person suffering from diabetes insipidus will pass what amount of urine per day
(a) 1 litre (b) ½ litre (c) 3 litres (d) 1.5 litres

103. High increase in oxytocin level in a pregnant lady results in
(a) Increased synthesis of milk (b) Decrease is haemoglobin %
(c) Abortion (d) High blood pressure

104. A gorrilla like man has huge hands and legs. This is due to the abnormal secretion of
(a) Pituitary FSH (b) Pituitary LH (c) Pituitary GH (d) Thyroid

105. The hormone that stimulates the secretion of glucocorticoids
(a) FSH (b) ACTH (c) Cortisol (d) LH

106. Somatostatin is secreted by
(a) Hypothalamus (b) Pituitary (c) Pineal (d) Thyroid

107. At menopause there is a rise in urinary excretion of
(a) LH (b) STH (c) FSH (d) MSH

**108.** In man, there is an enlargement of hand and feet and the nose and lower jaw are lengthened. These are the symptoms of the disease

(a) Myxoedema (b) Cretinism (c) Acromegaly (d) Gigantism

**109.** Addison's disease is caused by under secretion of

(a) ACTH (b) Insulin (c) Cortin (d) Adrenalin

**110.** Continued secretion of milk is maintained by

(a) Prolactin (b) Progesterone (c) Estrogen (d) Relaxin

**111.** Vasopressin is concerned with

(a) General metabolism (b) Regulation of heart beat (c)Urine formation (d) Child birth

**112.** Inadequate production of STH in early life may result in

(a) Gigantism (b) Acromegaly (c) Sterility (d) Dwarfism

**113.** The hormone that maintains the secretory activity of the corpus luteum as well as the increase in the size of the mammary glands is

(a) Estrogen (b) Luteinizing (c) Luteotrophin (d) Gonadotrophin

**114.** ACTH (Adrenoeorticotripic hormone) is secreted by

(a) Adrenal medulla (b) Adrenal cortex (c) Thymus (d) Pituitary

**115.** Hormones of pituitary gland are

(a) All proteins

(b) All steroids

(c) Some steroids and some proteins

(d) Complex substances formed from proteins, steroids and carbohydrates

**116.** Pituitary gland is under the control of

(a) Pineal gland (b) Hypothalamus (c) Adrenal gland (d) Thyroid gland

**117.** Hypersecretion of growth hormone by pituitary results in

(a) Dwarfism (b) Gigantism (c) Cretinism (d) Myxoedema

**118.** If there is deficiency of ADH (antidiuretic hormone), its effect would be

(a) The volume of urine will increase (b) The volume of urine will decrease

(c) The *pH* of urine will change from 4.8 to 8.0 (d) Secretion of urochrome will take place

**119.** Hypersecretion of GH from pituitary in the adult causes a disease called

(a) Gigantism (b) Acromegaly (c) Cushing's disease (d) Addison's disease

**120.** Hypophysis is an alternative name for

(a) Thyroid gland (b) Pituitary gland (c) Thymus gland (d) Pineal gland

121. Which hormone stimulates the secretion of milk during sucking of milk by baby

(a) Oxytocin (b) Relaxin (c) Prolactin (d) Progesteron

122. FSH is a

(a) Catecholamine (b) Glycoprotein (c) Polypeptide (d) Steroid

123. Complete failure of adenohypophysis of pituitary causes

(a) Addison's disease (b) Cushing's disease (c) Dwarfism (d) Simmond's disease

124. Adenohypophyseal hormone that stimulates the gonads in males and females are called

(a) Prolactin (b) Luteotropic hormone

(c) Follicle stimulating hormone (d) Gonadotropins

125. The pituitary hormone which controls the growth and maturation of ovaries and testes

(a) Gonadotropic hormones (b) Progesterone

(c) Androgen (d) Estrogen

126. Midgets are due to the deficiency of

(a) Pituitary (b) Thyroid (c) Pancreas (d) Adrenal

127. The hormone that have influence on other endocrine glands of the body such as thyroid, gonad etc. are secreted by

(a) Posterior pituitary (b) Anterior pituitary (c) Pars intermedia (d) Pars tuberalis

128. The posterior lobe of the pituitary is

(a) Glandular (b) Neural (c) Ganglionic (d) Vascular

129. The growth of corpus luteum is initiated by

(a) FSH (b) ICSH (c) Gonadotrophic hormone (d)LH

130. Petresssin is also called as

(a) ADH (b) LH (c) NADH (d) FSH

131. Hormones produced by anterior lobe of pituitary

(a) Control calcium level in blood (b) Stimulate thyroid and other endocrine glands

(c) Initiate alarm reaction (d) Regulate water balance in body

132. Pituitary lies in the sella turcica of

(a) Sphenoid bone (b) Ethmoid bone (c) Vomer (d) Nasal bone

133. The number of hormones secreted by anterior pituitary is

(a) 3 (b) 4 (c) 6 (d) 8

134. Hormone which stimulates mammary glands for milk secretion is

(a) ACTH (b) LH (c) Vasopressin (d) LTH

135. The hormone acting on chromatophores is

(a) Calcitonin (b) Oxytocin (c) Intermedin (d) ACTH

136. Tropic hormones are secreted by

(a) Pituitary (b) Thyroid (c) Adrenal (d) All of these

137. Which of the following has no specific target tissue

(a) TSH (b) STH (c) ACTH (d) FSH

138. The abbreviation TSH stands for

(a) Thymine stimulating hormone (b) Thyroid stimulating hormone

(c) Thyroxine stimulating hormone (d) None of these

139. Melanocyte stimulating hormone (MSH) is secreted by pituitary

(a) Anterior lobe (b) Median lobe

(c) Posterior lobe (d) Not any particular lobe

140. MSH of pars intermedia of pituitary is responsible for

(a) Darkening of skin in lower vertebrates

(b) Lighten skin colouration in lower vertebrates

(c) Both (a) and (b) (d) Darkening of skin in human beings

141. Gigantism and acromegaly are due to

(a) Hypothyroidism (b) Hyperpituitarism (c) Hyperthyroidism (d) Hypopituitarism

142. The part of the brain with the greatest influence over the endocrine system is

(a) Cerebral cortex (b) Hypothalamus (c) Medulla oblongata (d) Pons varolii

143. Pituitary gland occurs in

(a) Brain (b) Gonads (c) Pancreas (d) Trachea

144. Hormone responsible for proper growth of body is secreted by

(a) Adrenals (b) Thyroid (c) Posterior pituitary (d) Anterior pituitary

145. Median eminence is a part of

(a) Neurohypophysis (b) Pars intermedia (c) Adenohypophysis (d) Pars distalis

146. Anterior lobe of pituitary secretes

(a) ACTH, TSH and Oxytocin (b) STH, GH and ADH

(c) TSH, ADH and Prolactin (d) FSH**,** GH and LH

147. 'Herring bodies' are found in

(a) Thymus (b) Pituitary (c) Pineal gland (d) Kidney

148. Master gland of our body is

(a) Liver (b) Pituitary (c) Adrenal (d) Sex organ

149. Growth hormone is produced in

(a) Pituitary (b) Adrenal (c) Thyroid (d) Gonad

**150.** FSH is formed by

(a) Posterior pituitary lobe (b)Middle pituitary lobe

(c) Adrenal cortex (d)Anterior pituitary lobe

**151.** Melanocyte stimulating hormone (MSH) is secreted by pituitary's

(a) Anterior lobe (b) Posterior lobe (c) Intermediate lobe (d) None of these

**152.** Diabetes insipidus occurs due to the hyposecretion of

(a) Oxytocin (b) Vasopressin (c) Thymosin (d) Insulin

**153.** Which are identical

(a) ACTH and adrenaline (b)hCG and progesterone

(c) Calcitonin and oxytocin (d) Vasopressin and ADH

**154.** Adrenocorticotrophin hormone is produced by

(a) Adrenal medulla (b) Adrenal cortex (c) Thyroid (d) Pituitary

**155.** STH (somatotrophic hormone) is also known as

(a) TSH (b) LTH (c) ADH (d) GH

**156.** Thick skin, long arms and legs are due to hypersecretion of hormone from

(a) Thyroid (b) Thymus (c) Anterior pituitary (d) Posterior pituitary

**157.** What is the other name of vasopressin

(a) ADH (b) ACTH (c) LH (d) FSH

**158.** The primary target of the hormones of hypothalamus is

(a) Pineal gland (b) Thymus (c) Pituitary (d) Testis

**159.** Dwarfism is due to

(a) Absence of insulin (b) Hyposecretion of GH during childhood

(c) Hyposecretion of GH during adult stage (d) Excessive secretion of adrenaline

**160.** Gigantism and acromegaly are two defects produced due to improper functioning of

(a) Thyroid (b) Pituitary

(c) Thyroid and pituitary (d) Thyroid, pituitary and thymus

**161.** Growth hormone (GH or STH) works properly

(a) With thyroxine (b) Without thyroxine (c) Without adrenaline (d) Without insulin

**162.** Diabetes insipidus can be cured by administration of

(a) ADH (b) Antithistamine (c) Glucagon (d) Insulin

**163.** Uterine contraction at the child birth is stimulated by

(a) Prolactin (b) Progesterone (c) Adrenaline (d) Oxytocin

**164.** Neurohypohysis secretes

(a) Vasopressin and growth hormone (b) Oxytocin and estrogen

(c) Vasopressin and oxytocin (d) Vasopressin and estrogen

**165.** Pars nervosa is a part of

(a) Brain (b) Spinal cord (c) Pituitary gland (d) Pineal gland

**166.** A person was admitted in a hospital with high blood pressure but decreased urine formation and excretion. What hormonal disorder is he suffering from

(a) Polydypsia (b) Polyuria

(c) ADH hypersecretion (d) Hyper secretion of adrenaline

**167.** Hypersecretion of pituitary gland prior to pubertal changes leads to

(a) Nanism (b) Gigantism (c) Mongoloid idiocy (d) Cretinism

**168.** Select the correctly matched pair

(a) Hyperpituitarism after puberty – Acromegaly

(b) FSH – Ovulation hormone

(c) LH – Folliculogenic hormone

(d) LTH – Milk ejection hormone

**169.** Reproductive functions are regressed if the following gland is surgically removed

(a) Pineal (b) Pituitary (c) Adrenal (d) Parathyroid

**170.** Pituitary gland is connected to brain by

(a) Infundibulum (b) Portal vessels (c) Neurosecretory axons (d) Glial cells

**171.** Myometrial muscles of a pregnant utreus can be stimulated by a hormone called

(a) Oxytocin (b) FSH (c) Relaxin (d) $\beta$–endorphin

**172.** In summer season, urine formation and excretion is less because

(a) More uptake of water

(b) Reduced metabolic rate

(c) More ADH is secreted

(d) Higher retention of metabolic water by tissues so as to escape from desiccation

**173.** Excessive secretion of somatotropin leads to a disorder called

(a) Giantism (b) Acromegaly (c) Cretinism (d) Both (a) and (b)

**174.** MSH

(a) Induces color changes in some lower vertebrates

(b) Is a secretion of pars distalis

(c) Is produced by pars intermedia (d) Both (a) and (b)

**175.** Estrous cycle of rat is controlled by

(a) Inhibin (b) FSH and LH (c) LTH (d) Estrogen

**176.** Identify the hormone which is not secreted by pituitary

(a) TSH (b) MSH (c) GH (d) Thymosine

***Advance Level***

**177.** Some hormones check the milk from being secreted by the mammary glands till the birth of young ones even though the glands are all prepared to do so. They are

(a) Progestin and prolactin (b)Prolactin and FSH (c) Estrin and prolactin (d) Estrin and progestin

**178.** Occurrence of diuresis following saline ingestion is due to

(a) Suppression of adrenocorticoid release

(b) Reduction in the rate of water absorption by kidney capillaries

(c) Suppression of ADH release

(d) Reduction of colloidal osmo, pressure of blood

**179.** The hormone that acts during parturition (child birth) but which has more effect on lactation is

(a) Progesterone (b) Prolactin (c) Oxytocin (d) Vasopressin

**180.** The anterior lobe of pituitary affects

(a) Protein metabolism (b) Fat metabolism

(c) Carbohydrate metabolism (d) All of these

**181.** Oestrogen inhibits

(a) Thyroid (b) Secretions of anterior pituitary

(c) Deposition of fat in subcutaneous tissue in feminine body

(d) Secretion of ACTH

**182.** The intermediate lobe of the pituitary gland produces a secretion which causes a dramatic darkening of the skin of many fishes, amphibians and reptiles. It is

(a) Adrenocorticotropic hormone (ACTH) (b) Follicle stimulating hormone (FSH)

(c) Melanocyte stimulating hormone (MSH) (d) Luteinizing hormone (LH)

**183.** Contraction of the uterus, increase in arterial pressure and reduction in urine output are produced by

(a) Oxytocin and ACTH (b) Vasopressin and TSH

(c) ADH and ACTH (d) Oxytocin and vasopressin

**184.** The secretion of following anterior pituitary hormones is controlled by hypothalamus

(a) Thyrotropin (TSH) and cortisol

(b) Follicle stimulating hormone (FSH) and progesterone

(c) Corticotropin (ACTH), growth hormone and vasopressin

(d) Luteinizing hormone (LH)**,** corticotropin (ACTH) and thyrotropin (TSH)

**185.** In an, accident the anterior pituitary of a four year old boy was severely damaged but the boy survived. What is likely to happen

(a) High levels of thyroxin will be released (b)Spermatogenesis will be stimulated

(c) The boy will not grow much in height (d)The growth of mammary glands will be stimulated

**186.** A substance called ADH is

(a) A hormone that promotes glycogenesis in liver cells

(b) An enzyme secreted by cell of intestinal wall; hydrolyses dipeptides into amino acids

(c) A pituitary secretion which promotes reabsorption of water from glomerular filtrate

(d) A high energy compound involved in muscle contraction

**187.** Match the items

| Column 'A' | Column 'B' |
|---|---|
| (i) Acromegaly | A. Luteinising hormone |
| (ii) Vasopressin | B. Oxytocin |
| (iii) Ovulation | C. GH |
| (iv) Child birth | D. FSH |
| (v) Spermatogenesis | E. Diabetes insipidus |

The correct pairing sequence is

(a) C E A B D (b) A B D C E (c) E A C B D (d) C A B E D

**188.** In a pregnant woman having prolonged labour pains, if child birth has to be hastened *i.e.* to aid parturition, it is advisable to administer a hormone that can

(a) Activate the smooth muscles (b)Increase the metabolic rate

(c) Release glucose into the blood (d)Stimulate the ovary

**189.** The correct set of a single endocrine gland hormone is

(a) Oxytocin, prolactin, ACTH (b)Oxytocin**,** vasopressin**,** ADH

(c) Thyroxin, secretin, ACTH (d)Epinephrin, cortisol, ICSH

**190.** Luteinizing hormone

(a) Stimulates ovulation

(b) Stimulates the egg mother cell to undergo completion of meiotic cycle

(c) Stimulates the corpus luteum to secrete progesterone

(d) All of these

**191.** Hormone prolactin was discovered by

(a) Riddle (b) Hisaw (c) Leonard (d) Hisaw and Leonard

**192.** At cellular level GH affects growth by controlling the production of

(a) *r*-RNA (b) *t*-RNA (c) *m*-RNA (d) None of these

**193.** Hormone released by posterior lobe of pituitary is concerned with

(a) Metabolism of carbohydrates (b)Stimulation of thyroid

(c) Secondary sexual characters (d)Contraction of uterus

194. Hormone present in greatest concentration during ovulation is
(a) FSH (b) LH (c) Prolactin (d) ACTH

195. Gametokinetic factor is
(a) ACTH (b) GH (c) FSH (d) TSH

196. Which of the following secretes with the help of neurosecretory axons
(a) Pineal gland (b) Adrenal cortex (c) Anterior pituitary (d) Posterior pituitary

197. Which hormone acts as a mild growth hormone in human beings
(a) Cortisol (b) Estrogen (c) Progesterone (d) Prolactin

198. Which one of the following is not essentially a part of nervous system
(a) Axon (b) Cyton (c) Intermedin (d) Myelinated fibre

199. The secretion of hormones from anterior pituitary are regulated by
(a) Factors from the brain (b) Factors from the kidney
(c) Factors from the posterior pituitary (d) Factors from the hypothalamus

200. Somatostatin is a hormone secreted by hypothalamus. It inhibits the secretion of
(a) Thyroxine (b) Growth hormone (c) Vasopressin (d) ACTH

201. Which of the following is known as 'vestigial hormone' in man
(a) LH (b) LTH (c) MSH (d) FSH

202. Sella turcica is present in which bone of rabbit
(a) Alisphenoid (b) Orbitosphenoid (c) Basisphenoid (d) Occipital segment

203. Alcohol inhibits the secretion of
(a) ADH (b) Insulin (c) Oxytocin (d) Progesterone

204. Pituitary gland is known as master endocrine gland because it controls
(a) Thyroid gland and hence metabolism
(b) Gonads as well as adrenals and hence sex, appearance and salt metabolism
(c) Growth
(d) Thyroid**,** gonads and adrenals

205. A woman whose pituitary gets damaged can have a baby if she is given
(a) 20 μg of estrogen and progesterone each day for 14 days
(b) Small quantity of estrogen every day for 28 day after evolution
(c) Small quantity of FSH and LH each day and large dose of LH on fifteenth day
(d) Small quantity of FSH and LH each day

206. Which is true
(a) Deficiency of growth hormone leads to cretinism
(b)LH induces mammary glands to produce milk
(c) FSH stimulates testes to produce sperm cells (d) Adrenalin reduces blood pressure

207. Deficiency of pituitary hormone causes a disease
(a) Diabetes insipidus (b) Diabetes mellitus (c) Goitre (d) Acromegaly

208. If a person happens to take large amount of water, the amount of ADH in blood will
(a) Increase (b) Decrease
(c) First increase then decrease (d) Will remain unchanged

209. LH in human female is
(a) Called ovulation hormone (b)Facilitates luteinisation of granulosa cells of ovulated follicle
(c) Helps in milk ejection (d)Both (a) and (b)

210. Identify the glycoprotein hormone
(a) Epinephrine (b) Insulin (c) Cortisol (d) FSH

211. Hypersecretion of adenohypophyseal hormone leads to
(a) Gigantism (b) Nanism (c) Exophthalmic goitre (d) Cushing's syndrome

212. Oxytocin is secreted by
(a) Neurosecretory cells of hypothalamus (b) Pars distalis
(c) Pars intermedia (d) Pars nervosa

213. Identify the milk ejection hormone
(a) Prolactin (b) Vasopressin (c) Oxytocin (d) Vasotocin

214. Select the correct statement
(a) Pituitary is the master of endocrine orchestra is only partially true
(b) LH and oxytocin are secreted by pars distalis
(c) Pars nervosa secrets MSH and FSH
(d) Neurosecretory cells are found in adenohypophysis

215. Which of the hormone is secreted by hypothalamic neurosecetory cells but is stored are released by pars nervosa
(a) Epinephrine and norepinephrine (b)Vasopressin and oxytocin
(c) Melatonin and serotonin (d)Endorphin and encephalin

216. A patient was diagnosed as suffering from polydypsia and polyurea. He can be cured by administration of
(a) Cortisol (b) Aldosterone (c) Vasopressin (d) Androstenedione

217. Removal of corticotroph cells in the pituitary gland leads to
(a) Cushing's disease (b) Addison's disease (c) Alzheimer's disease (d) Schizophrenia

218. Adrenocorticotrophic hormone is secreted by
(a) Adrenal cortex (b) Adrenal medulla (c) Pars distalis (d) Pars nervosa

219. Which hormone's secretion related to changes in temperature in a season
(a) ADH (b) Oxytocin (c) FSH (d) Adrenaline

220. Which hormone is required for androgenesis and its control in Leydig cells of mammalian testes
(a) Gonadotrophins (b) Releasing hormone (c) FSH.RH (d) ICSH

221. Vasopressin has a antidiuretic as well as
(a) Vasodilator role (b) Cardiac inhibitor function
(c) Vasoconstrictor action (d) Cardiac accelerator action

222. ICSH is secreted by
(a) Neurosecretory cells of the hypothalamus (b) Pineal gland
(c) Neurohypophysis (d) Adenohyophyseal cells

223. Oxytocin and vasopression are
(a) Octapeptide (b) Decapeptide (c) Nanopeptide (d) Polypeptide

224. Pars distalis secretes
(a) Vasotocin (b) Serotonin (c) Y-aminobutyric acid (d)Somatostatin

## THYROID AND PARATHYROID

***Basic Level***

225. An organ *X* has a large blood supply. It produces a hormone lack of which causes a disease called as cretinism. The organ is
(a) Testes (b) Pituitary gland (c) Thyroid (d) Thymus

226. The hormone that regulates the calcium level of blood is
(a) Parathormone (b) Thyroxine (c) Insulin (d) Glucagon

227. Which of the following absorbs iodine from blood
(a) Pituitary gland (b) Thyroid gland (c) Adrenal gland (d) Pancreas

228. Thyroxine is
(a) An enzyme (b) A hormone
(c) A vitamin (d) An excretory product

229. Which of the following disease results from endocrine disorder
(a) Pneumonia (b) Typhoid (c) Goitre (d) Jaundice

230. Grave's disease is caused due to
(a) Hypersecretion of thyrocalcitonin (b) Hyposecretion of thyrocalcitonin
(c) Hypersecretion of thyroxine (d) Hyposecretion of thyroxine

231. Parathyroid hormone is a
(a) Protein (b) Carbohydrate (c) Lipid (d) Steroid

232. Which of the following two hormones have antagonistic effects
(a) Parathormone and calcitonin (b) FSH and LH
(c) Oestrogen and progesterone (d) ADH and melatonin

233. Which of the following glands is associated with the consumption of iodized salt
(a) Thyroid (b) Thymus (c) Pituitary (d) Ovary

234. Calcitonin lowers the calcium level in the blood. This is secreted by
(a) Parathyroid (b) Hypothalamus (c) Adrenal (d) Thyroid

235. Tetany (Irregular muscle contraction) and osteoporosis are caused due to the deficiency of
(a) Cortisone (b) Estrogen (c) Insulin (d) Parathormone

236. The other name for autoimmune thyroiditis is
(a) Addison's disease (b) Simmond's disease (c) Hashimoto's disease (d) Cushing's disease

237. The disease caused by deficiency of parathormone is
(a) Cretinism (b) Tetany (c) Hypercalcemia (d) Myxoedema

238. 'Cretinism' is due to less secretion of
(a) Thyroid gland (b) Pituitary gland (c) Parathyroid gland (d) Adrenal gland

239. If a person takes iodine then it will be stored in
(a) Thyroid (b) Liver cells (c) Brain cells (d) Pancreas

240. Which of the following gland plays a key role in metamorphosis of frog's tadpole
(a) Adrenal (b) Thymus (c) Pancreas (d) Thyroid

241. Hypokalaemia means
(a) High level of potassium in blood (b) High level of sodium in blood
(c) Low level of potassium in blood (d) Low level of sodium in blood

242. Which of the following is referred as "suicide gland"
(a) Pineal body (b) Parathyroid (c) Thymus (d) Thyroid

243. Metamorphosis can be accelerated by
(a) $I_2$ (b) $P$ (c) $K$ (d) $Ca$

244. Disease caused by deficiency of iodine is
(a) Goitre (b) Myxodema (c) Cretinism (d) Tetany

245. The hormone which regulates the basal metabolism rate (BMR) in our body or in rabbit is secreted from
(a) Pituitary (b) Thyroid (c) Adrenal cortex (d) Pancreas

246. Calcitonin is thyroid hormone which
(a) Elevates potassium level in blood (b) Lowers calcium level in blood
(c) Elevates calcium level in blood (d) Has no effect on calcium

247. Hormones thyroxin, adrenaline and the pigment melanin are formed from
(a) Tryptophan (b) Glycine (c) Tyrosine (d) Proline

248. Iodine is associated with
(a) Thyroxin (b) Calcitonin (c) Oxytocin (d) Secretin

**249.** Why thyroxine is a harmone not an enzyme

(a) It is secreted in small quantity (b) It is not a polypeptide

(c) It has no special effect (d) It is directly poured into blood

**250.** The hormone which controls the rate of body metabolism is

(a) Thyroxin (b) Insulin (c) ACH (d) HGH

**251.** If thyroid gland is completely removed from a tadpole, it will

(a) Die immediately (b) Turn into a giant frog

(c) Turn into a dwarf frog (d) Remain tadpole throughout its life

**252.** Goitre affects

(a) Metabolism (b) Vision (c) Excretion (d) Speech

**253.** Which disease is caused by the deficiency of thyroxin in the adults

(a) Diabetes incipidus (b) Diabetes mellitus (c) Myxoedema (d) Exopthalmic goitre

**254.** Disease related to thyroxine hormone

(a) Goitre (b) Acromegaly (c) Addison disease (d) Thalasemia

**255.** Table salt is often iodised for certain areas to prevent

(a) Scurvey (b) Goitre (c) Acromegaly (d) Rickets

**256.** Exophthalmic goitre is due to

(a) Hyposecretion of thyroxine (b) Hypersecretion of thyroxine

(c) Hypersecretion thyrocalcitonin (d) Hyposecretion of thyrocalcitonin

**257.** Calcium level is not regulated by

(a) Vitamin D (b) Thyroxine (c) Collip's hormone (d) Calcitonin

**258.** Parathormone is a

(a) Protein (b) Steroid (c) Lipid (d) Carbohydrate

**259.** In India, large scale arrangments and steps are being taken to supplement the mineral deficiency of

(a) Iodine (b) Sodium (c) Potassium (d) Iron

**260.** Hypersecretion of thyroid leads to a disease called

(a) Rickets (b) Cretinism (c) Beri-beri (d) None of these

**261.** Which of the following is not a steroid hormone

(a) Aldosterone (b) Androgen (c) Estrogen (d) Thyroxine

**262.** Increase in BMR is due to

(a) Parasympathetic (b) Sympathetic (c) Thyroxine (d) Adrenaline

**263.** Parathormone is also known as

(a) Collip's hormone (b) Birth hormone

(c) Calciferol (d) Langerhans hormone

264. Blood calcium is decreased by the injection of
(a) Glucagon (b) Thyroxine (c) Parathormone (d) Calcitonin

265. Goitre is swelling of neck due to enlargement of
(a) Larynx (b) Pharynx (c) Thyroid (d) Parathyroid

266. Metabolic rate in an animal increases mainly by giving injections of
(a) Testosterone (b) Thyroxine (c) Insulin (d) Estrogen

267. Hypothyroidism in childhood leads to
(a) Cretinism (b) Addison's disease (c) Sterility (d) Myxoedema

268. In blood, $Ca^{++}$ and $PO_4$ level is controlled by
(a) Thyroid (b) Parathyroid (c) Adrenal (d) Thymus

269. Hormone responsible for regulation of calcium and phosphorus homeostasis is secreted by
(a) Pituitary (b) Parathyroids (c) Thymus (d) Pancreas

270. Parathormone affects the blood level of
(a) Glucose (b) Potassium (c) Calcium (d) None of these

271. If the parathyroid glands of man are removed, the specific result will be
(a) Onset of ageing (b) Disturbance of calcium level in blood
(c) Onset of myoxedema (d) Elevation of blood pressure

272. Parathormone causes
(a) Hypercalcemia (b) Hypocalcemia (c) Hyperglycemia (d) Hypoglycemia

273. Gland responsible for calcium metabolism is
(a) Thymus (b) Thyroid (c) Parathyroid (d) Adrenal

274. Less amount of iodine in water affect metamorphosis of tadpole of frog
(a) Accelerated (b) Delayed (c) Stopped (d) Not affected

275. Which hormone controls growth, mental faculties and tissue differentiation
(a) Glucagon (b) Parathormone (c) Thyroxine (d) Cortisone

276. Hormone that control other endocrine glands
(a) Insulin (b) Thyrotropin (c) Gastrin (d) None of these

277. Deficiency of thyroxine/hypothyroidism in adults results in
(a) Diabetes mellitus (b) Diabetes insipidus (c) Myxoedema (d) Exophthalmic goitre

278. Thyroid is
(a) A bone is thorax
(b) A waste material produced in intestine
(c) An endocrine gland located at the base of the neck
(d) An endocrine gland located near the kidneys.

279. A tadpole with surgically removed thyroid gland can be made to matamorphose if
(a) Given an injection of TSH (b)Given an injection of oxytocin
(c) Given an injection of thyroxine (d)Fed on dried thyroid gland

280. Small amount of iodine is added to common salt so that
(a) Oedema is prevented (b)Common salt is utilised properly in the body
(c) Occurrence of goitre is prevented
(d) Kidney remains efficient in maintaining water balance.

281. Immune disease in which body destroys the ill-functioning thyroid is
(a) Simmond's disease (b) Cretinism (c) Hashimoto's disease (d) Myxoedema

282. The excessive amount of calcium is regulated by
(a) Thyroxine (b) Calcitonin (c) Epinephrine (d) Progesterone

283. Effect of thyroxine on metabolic rate
(a) Decreases (b) No effect (c) Increases (d) Uncertain

284. Thyroxine is secreted by
(a) Thyroid (b) Adrenal (c) Testis (d) Ovary

285. The hormone responsible for the regulation of metabolism of calcium and phosphorous is secreted by
(a) Thyroid (b) Parathyroid and thyroid both
(c) Thymus (d) Pancreas

286. Substance responsible for metamorphosis
(a) Estrogen (b) Thyroxin (c) Propandiol (d) Glucagon

287. Proper development of the bone depends on
(a) Epinephrin (b) Thyroxin (c) Parathormone (d) Vasopressin

288. Cretinism is due to
(a) Excess growth hormone (b) Absence of insulin
(c) Excess adrenalin (d) Hyposecretion of thyroid in childhood (Thyroxin)

289. Parathormone induces
(a) Increase in serum calcium level (b) Decrease in serum potassium level
(c) Increase in blood sugar level (d) Decrease in blood sugar level

290. 'Exopthalmic goitre' is caused due to
(a) Hypofunction of the thyroid (b) Hyperfunction of the thyroid
(c) Hypofunction of the parathyroid (d) Hyperfucntion of the parathyroid

291. Identify the iodinated derivative of tyrosine
(a) Melanin (b) Melatonin (c) Thyroxine (d) Serotonin

**292.** Low heart beat, body temperature and retarded sexual and neural development are indications of

(a) Thyroxine deficiency (b)Deficient calcitonin level

(c) Parathormone deficiency (d) Melatonin deficiency

**293.** Osteoporosis is due to

(a) Hypersecretion of parathormone (b) Hypersecretion of thyrocalcitonin

(c) Hyposecretion of parathormone (d) Hyposecretion of calcitonin

**294.** What will happen if the parathyroid gland is removed

(a) Muscular tetany occurs (b)Neurological disorder (c)Amnesia (d) Anorexial nervosa

**295.** Hypocalcemia will result if the following endocrine gland is surgically removed

(a) Parathyroid (b) Thymus (c) Adrenal (d) Islets of Langerhans

**296.** Parathormone stimulates

(a) Demineralisation of bones (b) Calcification of bones

(c) Reduced uptake of $Ca^{+2}$ by intestinal villi

(d) Increased excretion of $Ca^{+2}$ in faces and urine

**297.** Identify the hormone which is a modified (=iodinated) amino acid

(a) Epinephrine (b) Norepinephrine (c) Acetylcholine (d) Thyroxine

***Advance Level***

**298.** If parathyroid gland of a child is removed, which activity is disturbed

(a) Growth (b) Calcium concentration

(c)Potassium concentration (d) None of these

**299.** Man with thick lips, dirt deposited on tongue, low heart beating rate, with excess amount of cholesterol in blood, is supposed to be suffering from which abnormality

(a) Cretinism (b) Hashimoto disease (c) Myxoedema (d) Addison's disease

**300.** Parathormone is secreted during

(a) Increased blood calcium level (b) Decreased blood calcium level

(c) Increased blood sugar level (d) Decreased blood sugar level

**301.** A man has an I.Q. equivalent to that of a boy 5 years old, this is due to deficiency of which hormone

(a) Thyroxin (b) Adrenaline (c) Aldosterone (d) Somatotropin

**302.** A person appears fat, short and stocky and has stupid look and protruding tongue due to the hormonal deficiency of

(a) Parathyroid (b) Thyroid (c) Adrenal (d) Pineal

**303.** Which of the following statement is not false

(a) Hormone produced in thyroid stimulates metabolism

(b) Hormone produced in ovary affects the uterine contraction

(c) Hormone produced in small intestine stimulates heart

(d) Hormone produced in adrenal cortex stimulates heart beat

**304.** Which of the following radioactive isotopes is used in the detection of thyroid cancer
(a) Iodine – 131 (b) Carbon – 14 (c) Uranium – 238 (d) Phosphorus – 32

**305.** Which endocrine gland stores its secretion in the extracellular space before discharging it into the blood
(a) Adrenal (b) Pancreas (c) Testis (d) Thyroid

**306.** Similarity between the secretion of thyroid and adrenal is that both the secretions
(a) Are proteins (b) Are steroid
(c) Increase glucose metabolism (d) Control mineral metabolism

**307.** Thyrotropin-Releasing Factor (TRF) is produced by
(a) Cerebrum (b) Optic lobe (c) Cerebellum (d) Hypothalamus

**308.** When the thyroid secretion is too much, the gland itself gets enlarged, conversely, if the secretion is too little, the gland gets
(a) Enlarged (b) Reduced (c) Disappeared (d) None of these

**309.** Hypoparathyroidism results to
(a) Upset in metabolism (b) Improper genodial function
(c) Convulsions and tetany (d) Nervousness and wasting

**310.** Thyroxin was isolated by
(a) William Buemont (b) Best and Sterling (c) F. Senger (d) None of these

**311.** High incidence of goitre is seen in the mountaineous region because of
(a) Deficiency of iodine in water (b)Deficiency of iodine in food
(c) Presence of antagonistic agents (d)(a) and (b) both

**312.** Energy releasing process in the body cells is initiated by
(a) Pituitary (b) Thyroid (c) Parathyroid (d) Adrenal

**313.** Which of the following statements is correct
(a) Secretion of thyroid gland is directly proportional to the blood level of thyroxine
(b) Thyroid gland is ectodermal in origin
(c) Parafollicular cells of thyroid secrete thyroxine
(d) Lower temperature**,** high altitude and pregnancy**,** all stimulate secretion of thyroxine

**314.** Almost all the active thyroid hormone entering the circulation is in the form of
(a) Triiodothyronine (b) Thyroxine (c) Thyrotropin (d) Thyroglobulin

**315.** Physiologically active thyroxine exists in which of the following forms
(a) Bound to albumin (b) Unbound (c) Bound to globulin (d) All of these

**316.** If thyroxine is added in a beaker which has some small tadpoles then
(a) All tadpoles die (b) They metamorphose very fast
(c) They develop small body (d) They develop a giant body

**317.** Which one opposes parathormone
(a) ADH (b) Insulin (c) Thyroxine (d) Thyrocalcitonin

**318.** Which is true of thyrocalcitonin

(a) Produced by parathyroid, decreases *Ca* in ECF

(b)Produced by thyroid**,** decreases *Ca* in ECF

(c) Produced by parathyroid, increases *Ca* in ECF (d) Produced by thyroid, increases *Ca* in ECF.

**319.** $Ca^{2+}$ level is controlled by

(a) Thyroid (b) Hypothalamus

(c) Pituitary (d) Thyroid and parathyroids

**320.** Which hormone produces calorigenic effect in the body

(a) Adrenalin (b) FSH (c) Growth hormone (d) Thyroxine

**321.** While dwarfs and cretins are somewhat of the same height, the main difference is that

(a) Dwarf have normal intelligence while cretins do not

(b) Cretins are mentally deranged

(c) The head of cretin is especially large (d) The dwarf have elongated chin

**322.** Restlessness, intolerance to temperature and increased metabolism is due to

(a) Thyrotoxicosis (b) ACTH deficiency

(c) Pituitary deficiency (d) Calcitonin deficiency

**323.** Which of the following are called as antithyroid substances

(a) Thiocynate (b) Propylthiouracil

(c) High concentrations of inorganic iodides (d) All of these

**324.** All the following are characterised by hypothyroidism except

(a) Weight gain (b) Heat intolerance

(c) Decreased metabolic rate (d) Bradycardia

**325.** Parathormone deficiency produces muscle cramp or tetany as a result of

(a) Enhanced blood glucose (b) Enhanced blood $Ca^{2+}$

(c) Lowered blood $Ca^{2+}$ (d) Enhanced blood $Na^{+}$

**326.** Main content of thyroxine is

(a) Iodine 65**%** by weight (b)Iodine 35% by weight

(c) Iodine 50% by weight (d)Variable concentration

**327.** Thyroid gland of vertebrates is considered to be homologous to the following part of lower chordates

(a) Nerve cord (b) Neural gland (c) Endostyle (d) Gill pouches

**328.** Parafollicular cells of thyroid secrete

(a) Parathormone (b) Thyroglobin (c) Calcitonin (d) Thyroxine

**329.** Thyroxine is accumulated in the extracellular spaces of thyroid gland in the form of

(a) Thyroglobulin (b) Thyroalbumin (c) Triodothryonine (d) Monoiodothyronine

330. Which of the following statements is correct
(a) Basal metabolic rate is regulated by corticoids
(b) Thyroxine is secreted into extracellular space before being discharged into the blood
(c) Methionine is iodinated to form thyroxine
(d) Excessive secretion of thyroxine in children leads to disorder called cretinism

331. Identify the correctly matched pair
(a) Isthmus – connection between two thyroid lobes
(b) Site of $T_2$ accumulation – Thymus
(c) T-cell proliferation – Parathyroid
(d) Parathormone – Thyroid gland

## ADRENAL GLAND

***Basic Level***

332. Adrenal gland is associated with
(a) Pharynx (b) Pancreas (c) Kidney (d) Brain

333. Which of the following hormone is responsible for the emotional state such as fear, anger, pain etc. and causes rise in blood pressure and rate of heart beat
(a) Insulin (b) Adrenalin (c) Progesterone (d) Thyroxin

334. Nor epinephrine is secreted from
(a) Zona glomerulosa (b) Zona fasciculata (c) Zona reticularis (d) Medulla of adrenal

335. Adrenal cortex produces
(a) Aldosterone (hormone) (b)Pepsin (enzyme) (c) Progesterone (hormone) (d)*HCl*

336. Cushing's syndrome and myxoedema are associated with these glands respectively
(a) Thyroid, adrenal (b) Adrenal**,** thyroid (c) Parathyroid, thyroid (d) Adrenal, pituitary

337. When an animals is angry and wants to flight; the hormone that is secreted is
(a) Adrenalin (b) Androgen (c) Corticosterone (d) Gluco-corticoids

338. Cause of Addison's disease is
(a) Hyposecretion of aldosterone hormone (b) Hypersecretion of aldosterone hormone
(c) Hyposecretion of cortisone hormone (d) Hypersecretion of cortisone hormone

339. Which of the following hormones is a derivative of amino acid
(a) Estrogen (b) Epinephrine (c) Progesterone (d) Prostaglandin

340. Conn's disease is caused by the over-secretion of
(a) ADH (b) ACTH (c) Aldosterone (d) Oxytocin

341. Sympathin was the previous name of
(a) Adrenaline (b) Thyroxin
(c) Nor-adrenaline / Nor-epinephrine (d) None of these

342. Which gland is concerned with salt equilibrium in body
(a) Anterior pituitary (b) Pancreas (c) Adrenal (d) Thyroid

343. The hormone responsible for the sodium metabolism is
(a) Aldosterone (b) ACTH (c) Vasopressin (d) None of these

344. The mineralcorticoid hormone of the adrenal cortex which causes the *Na* retention and *K* excretion is
(a) Corticosol (b) Corticosterone (c) Progesterone (d) Aldosterone

345. Epinephrin is
(a) Nephrostomal part of mesoderm (b) Clusters of glomeruli in mammalian kidney
(c) Hormone of the adrenal gland (d) Frontal lobe of nephridia

346. Which of the following is an emergency hormone
(a) Pituitary (b) Prolactin (c) Progesterone (d) Adrenalin

347. Conn's syndrome is characterised by
(a) Muscular weakness (b) Hypertension (c) Retention of sodium (d) All of these

348. The gland which acts to resist stress
(a) Adrenal (b) Parathyroid (c) Pineal (d) Thyroid

349. Which one of the following hormone is antiinflammatory
(a) Secretin (b) Epinephrin (c) Glucoprotein (d) Glucocorticoid

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

351. Which of the following is not under direct control of pituitary gland with respect to the regulation of its secretory function
(a) Adrenal cortex (b) Adrenal medulla (c) Thyroid (d) Testis

352. Which of the following endocrine glands functions under nervous control
(a) Cortex of adrenal glands (b) Medulla of adrenal glands
(c) Anterior pituitary glands (d) Posterior pituitary gland

353. Adrenal cortex secretes androgen, it is
(a) Testosterone (b) Andosterone (c) Progesterone (d) Aldosterone

354. Blood pressure is controlled by
(a) Adrenal (b) Thyroid (c) Thymus (d) Corpus luteum

355. The hormone having a stimulatory effect on the heart is
(a) Adrenaline (b) Gastrin (c) Glucagon (d) Thyroxin

356. Gland of emergency is
(a) Pituitary (b) Thyroid (c) Pancreas (d) Adrenal

357. Cortisone is produced by
(a) Thyroid (b) Parathyroid (c) Adrenal (d) Thymus

**358.** Which one of the following hormone controls the water and mineral metabolism

(a) Progesterone (b) Insulin

(c) Succus entericus (d) Deoxycorticosterone

**359.** If adrenal cortex function is impaired, it results in decreased concentration of one of the following in the blood

(a) Ammonium salts (b) Sodium salts (c) Glucose (d) Calcium salts

**360.** Young boys at puberty start growing facial hairs. This is an example of

(a) Secondary sexual characters (b) Appearance of primitive characters

(c) Metamorphosis (d) Protective colouration

**361.** Adrenaline increases

(a) Heart beat (b) Blood pressure (c) (a) and (b) both (d) None of these

**362.** Which of the following hormone is released in excess quantity during excitement

(a) Cortisone (b) Serotonin (c) Adrenaline (d) Nor-adrenaline

**363.** Which of the following is a salt balancing hormone

(a) Mineralocorticoid (b) Glucocorticoid (c) Somatotropin (d) Follitropin

**364.** Norepinephrine functions as both hormone and

(a) Fuel for cellular respiration (b) Neurotransmitter

(c) Ions to promote action potential (d) Solutes to promote osmotic flow

**365.** An androgen secreted by adrenal cortex is

(a) Testosterone (b) Aldosterone (c) Androsterone (d) Progestrone

**366.** Adrenaline causes

(a) Hypoglycemia (b) Hyperglycemia (c) Diabetes insipidus (d) Diabetes mellitus

**367.** A woman started developing male characters. It may be due to

(a) Damage to posterior pituitary (b) Damage to mammary glands

(c) Over production of estrogens (d) Over production of adrenal androgens

**368.** Adrenal medulla develops from

(a) Ectoderm (b) Mesoderm

(c) Endoderm (d) Ectoderm and mesoderm

**369.** Facial hairs occurs in some women due to effect of

(a) UV radiation (b) Temperature (c) Hormones (d) Pollution

**370.** Which of the following is a mineralocorticoid

(a) Aldosterone (b) Androgen (c) Progesterone (d) Testosterone

**371.** Which of the following is called '4S' gland

(a) Pancreas (b) Adrenal (c) Thyroid (d) Parathyroid

372. Hyperglycemia is induced by all the following hormones except
(a) Epinephrine (b) Aldosterone (c) Glucagon (d) Thyroxine

373. Androgens are secreted by
(a) Thyroid (b) Parathyroids (c) Pituitary (d) Adrenals

374. Both ectoderm and mesoderm contribute in the development of
(a) Thyroid (b) Pancreas (c) Adrenal (d) Pituitary

375. Triple 'F' or gland for flight, fight and fright / life saving gland is
(a) Thyroid (b) Thymus (c) Pituitary (d) Adrenal

376. The hormone which reduces the sodium loss through urine and sweat is
(a) Calcitonin (b) Aldosterone (c) Parathormone (d) Vasopressin

377. Impairment of adrenal cortex causes decreased concentration of
(a) Calcium (b) Sodium (c) Ammonium (d) Glucose

378. Endocrine gland for combating emergency is
(a) Adrenal cortex (b) Adrenal medulla (c) Pancreas (d) Parathyroid

379. Addison's disease is due to under secretion of
(a) Adrenaline (b) Corticoids (c) ACTH (d) Insulin

380. Function of ACTH is to
(a) Stimulate pituitary (b)Stimulate the adrenal cortex to produce hormones
(c) Suppress the activity of adrenal cortex (d)Stimulate thyroid

381. Epinephrine is secreted from
(a) Adrenal medulla and decreases heart beat (b) Adrenal medulla and increases heart beat
(c) Pancreas and increases heart beat (d) Pancreas and decreases heart beat

382. Hormone connected with increased rate of glycogenesis, blood pressure and heart beat is
(a) Insulin (b) Glucagon (c) Adrenaline (d) FSH

383. Stimulated blood flow and higher blood sugar level results when the following hormone rises in concentration
(a) Glucagon (b) Vasopressin (c) Oxytocin (d) Epinephrine

384. What happens when hypersecretion of adrenal cortex hormone occurs
(a) Cushing's syndrome (b) Parkinson's disease (c) Alzheimer disease (d) Diabetes insipidus

385. Uptake of sodium from the glomerular filtrate in the distal convoluted tubule back into the blood is facilitated by
(a) Insulin (b) Cortisol (c) Aldosterone (d) Prostaglandin

**386.** Identify the correct statement

(a) Prolactin is necessary for transformation of spermatid into sperm

(b) Melationin and inhibin are antistress hormone

(c) Cortisol and aldosterone are emergency hormone

(d) Adrenaline is also called fright fight and flight hormone

**387.** Which of the following has the same relationship as LH has to testosterone in male

(a) ACTH to crotisol (b) TSH and calcitonin

(c) Melatonin and puberty (d) Serotonin and high blood pressure

**388.** Which of the following is mesodermal in origin

(a) Neurohypophysis (b) Pineal gland (c) Adrenal cortex (d) Adrenal medulla

**389.** All adrenal cortex hormones are

(a) Peptide (b) Polypeptide (c) Steroid (d) Catecholamines

**390.** Aldosterone

(a) Is a male hormone (b) Inhibits spermatogenesis

(c) Maintains proper ratio of $Na^+$ and $K^+$ in blood (d) Stimulates lipid metabolism

**391.** Adrenal medullary hormones are

(a) Under the control of sympathetic nervous system

(b) Called stress hormones

(c) Also called fright and flight hormone (d) All of these

**392.** Identify the hormone that acts as cardiac accelerator

(a) Acetylcholine (b) Epinephrine (c) Erythropoietin (d) Oxytocin

**393.** Identify the extra testicular source of androgen

(a) Adrenal cortex (b) Epididymis (c) Prostate (d) Seminal vesciles

**394.** Zona reticularis of adrenal cortex secretes

(a) Cortisol (b) Corticosterone

(c) Aldosterone (d) Androgen and estrogen

**395.** Identify the pair that does not match

(a) Cardiac accelerator – Acetyl choline (b) Gluconeogenic hormone – glucagon

(c) Controller of basal metabolic rate – Thyroxine (d) Folliculogenic hormone – FSH

**396.** Zona fasciculata of adrenal cortrex secretes

(a) Androgen (b) Cortisol (c) Aldosterone (d) Estrogen

***Advance Level***

**397.** The main function of nor-adrenaline is

(a) Contraction of arteries (b)To stop contraction of arteries

(c) Relaxation (d) None of these

**398.** When a normal heart is injected with physiological concentration of adrenalin, it shows

(a) Decreased rate (b) Systolic arrest

(c) Sustained increased rate (d) First increased rate than normal rate

**399.** The secretion of aldosterone by adrenal cortex is directly controlled by

(a) Plasma $K^+$ concentration (b)Plasma *Ca* concentration

(c) Level of blood angiotensin (d) (a) and (c) are correct

**400.** The functioning of adrenal medulla gland is similar to those of nerves because

(a) Adrenal medulla and nervous system are derived from embryonic mesoderm

(b) Adrenal medulla and nerves secrete similar chemicals such as adrenaline and noradrenaline

(c) Adrenal medulla does not secrete any hormone

(d) Adrenal medulla is made up of nervous tissue

**401.** The adrenal cortical hormone that reduces inflamation and produces healing response is

(a) Corticosterone (b) Deoxycorticosterone (c) Corticostone (d) Aldosterone

**402.** Manifestation of masculinity pattern in females due to hormonal effects is known as

(a) Maculinity (b) Virilism (c) Castration (d) Epitaxis

**403.** Insulin was isolated from dog by

(a) M. Bayliss (b) E.H. Sterling (c) Banting and Best (d) Von Mering

**404.** When mammary glands of male develop similar to that of female, then this condition is known as

(a) Gonochorism (b) Gynaecomastia (c) Faminism (d) Gynaecism

**405.** Aldosterone helps in the

(a) Conservation of sodium and water and elimination of potassium

(b) Elimination of sodium, potassium and water

(c) Conservation of sodium, potassium and water

(d) Conservation of potassium and water and elimination of sodium

**406.** Chromaffin cells are found in

(a) Thyroid (b) Adrenal cortex (c) Adrenal medulla (d) Pancreas

**407.** Which pair is tyrosine derivatives

(a) Calcitonin and insulin (b) FSH and GH

(c) Thyroxine and adrenaline (d) Insulin and Glucagon

**408.** Which of the endocrine gland is taken as the extension of sympathetic nervous system

(a) Pineal gland (b) Neurohypophysis (c) Adrenal cortex (d) Adrenal medulla

**409.** Patient on examination found suffering from adrenal tumour. He is likely to develop

(a) Addison's disease (b) Tetany (c) Diabetes mellitus (d) Gynecomastia

**410.** Epinephrine and norepinephrine together known as

(a) Steroids (b) Pheromones (c) Catecholamines (d) All of these

411. Which hormones possesses anti-insulin effect
(a) Cortisol (b) Calcitonin (c) Oxytocin (d) Aldosterone

412. Gluconeogenesis is controlled by
(a) Corticosterone (b) Thyroxine (c) Cortisol (d) All of these

413. When a person suffers from a marked fall in blood pressure, it is helpful to administer to him the following hormone
(a) Insulin (b) Thyroxine (c) GH (d) Adrenaline

414. Life-saving hormones are secreted by
(a) Adrenals (b) Pituitary (c) Thyroid (d) Pineal

415. At the time of interview, the heartbeat often becomes faster due to
(a) Release of adrenaline (b) Hypersecretion of renin
(c) Release of antidiuretic hormone (d) Release of corticotrophin

416. The fight, flight and fright hormone is called
(a) Insulin (b) Adrenaline (c) Oxytocin (d) Glucogon

417. Hormone produced in allergic reaction is
(a) Glucocorticoid (b) Mineralocorticoid (c) Norepinephrine (d) Epinephrine

418. What happen when blood potassium level rises
(a) Aldosterone production is increased (b) Aldosterone synthesis is blocked
(c) Cortisol synthesis is accelerated (d) More androgen and estrogen is secreted

419. Adrenal cortex produces aldosterone when stimulated by
(a) Pituitary
(b) Hypothalamus
(c) A peptide called angiotensin present in the blood plasma
(d) Thyroid

420. A patient who excretes large quantity of sodium in urine has
(a) Diseased adrenal medulla (b) Diseased adrenal cortex
(c) Diseased pancreas (d) Diseased thymus

421. Zona glomerulosa or glomerular area of adrenal cortex is involved in
(a) Water and electrolyte balance (b) Carbohydrate metabolism
(c) Steroid and hormone secretion (d) Blood pressure

422. Besides testes, androgens are also produced by
(a) Thyroid (b) Thymus (c) Adrenal medulla (d) Adrenal cortex

423. Which endocrine secretion shall remain unaffected following hypophysectomy
(a) Adrenaline and noradrenaline (b) Thyroxine
(c) Aldosterone (d) Testosterone

424. Aldosterone was isolated and crystallised by
(a) Scharrer and Scharrer (b)Baylis and Starling
(c) Turner and Gorbman (d)Simpson and Tait

425. Which of the following is both ectodermal and mesodermal in origin
(a) Pituitary gland (b) Adrenal gland (c) Thyroid gland (d) Both (a) and (b)

426. A person showed symptoms of pigmentation of skin, great muscular weakness and hypoglycemia. He is a case of
(a) Addison's disease (b) Caushing's syndrome (c) Alkaptoneuria (d) Grave's disease

427. A mentally disturbed patient showed excessive facial and body hairs, hyperglycemia and reddening of the face and neck. He is an example of
(a) Cushing's syndrome (b) Turner's syndrome
(c) Cri-du-chat syndrome (d) Patau's syndrome

428. Sympathetic nerve endings secrete
(a) Acetylcholine (b) Epinephrine
(c) *Y*-aminobutyric acid (d) 5'-hydroxytryptamine

429. Liver and muscle cells contain receptors for
(a) FSH (b) LH (c) LTH (d) Adrenaline

430. Which of the following is a catecholamine
(a) Epinephrine (b) Aldosterone (c) Cortisol (d) Androgen

## PANCREAS AND THYMUS AND PINEAL BODY

***Basic Level***

431. Which of the following is both exo and endocrine gland
(a) Thyroid (b) Pancreas (c) Pyer's patches (d) Thymus

432. Mammalian thymus is mainly concerned with
(a) Regulation of body growth (b) Regulation of body temperature
(c) Immunological function (d) Secretion of thyrotropin

433. Glucagon hormone is secreted by
(a) Pituitary (b) Adrenal
(c) Beta cells of islets of Langerhans (d) Alpha cells of islets of Langerhans

434. Which of the following hormone governs the metabolism of carbohydrates
(a) Corticoids (b) Glucagon
(c) Insulin (d) Glucagon and insulin

435. Diabetes is due to
(a) $Na^+$ deficiency (b) Hormonal deficiency (c) Enzyme deficiency (d) Iodine deficiency

436. Which one of the following pair is the matching pair of the part and the hormone it secretes
(a) Thyroid – Epinephrin (b) Alpha cells of pancreas – Glucagon
(c) Anterior pituitary – Adrenalin (d) Stomach epithelium – Secretin

437. Hormone involved in the discharge of pancreatic juice in mammals is
(a) Secretin (b) Gastrin (c) Cholecytokinin (d) Enterogasterone

438. "Islets of Langerhans" are found in
(a) Pituitary (b) Pancreas (c) Spleen (d) Stomach

439. The rise of blood sugar above the normal level is known as
(a) Hyperglycemia (b) Hypoglycemia (c) Glucosuria (d) Glycolysis

440. Beta and alpha cells secrete the following hormones in respective order
(a) Insulin and glucagon (b) Glucagon and insulin
(c) Testosterone and progesteron (d) Adrenalin and nor-adrenalin

441. Which of the following is related to the production of lymphocytes and antibodies
(a) Thymus (b) Hypothalamus (c) Thyroid (d) Leydig cells

442. Which endocrine gland becomes inactive in old age
(a) Adrenal (b) Pineal (c) Thymus (d) Pituitary

443. Insulin is produced by
(a) Alpha cells (b) Beta cells (c) Adrenal cortex (d) Testis

444. Insulin is secreted by
(a) Pituitary (b) Pancreas (c) Gonads (d) Thymus

445. The secretion of glucagon causes
(a) Increase in blood glucose (b) Decrease in blood glucose
(c) Increase in liver glycogen (d) Decrease in plasma $Ca^{++}$

446. Diabetes mellitus is due to lack of
(a) Starch in blood (b) Trypsin in pancreatic juice
(c) ADH reaching in kidneys (d) Insulin in blood

447. Which endocrine gland is responsible for immunity
(a) Pineal (b) Thymus (c) Pituitary (d) Adrenal

448. An overdose of intravenous insulin may lead to the death of an individual due to
(a) An excessive increase of blood glucose (b) An excessive decrease of blood glucose
(c) An inhibition of glucagon secretion (d) An over production of histamine

449. A disease characterised by raised levels of blood glucose as well as increased fat and protein metabolism is
(a) Diabetes (b) Cancer
(c) Ulcer (d) Enlargement of pancreas

**450.** The hormone glucagon

(a) Has the opposite effect as that of insulin (b) Is produced in the beta cells of pancreas

(c) Converts glucose into glycogen (d) Is used in the treatment of diabetes mellitus

**451.** Failure of insulin production results in

(a) Addison's disease (b) Cushing's disease (c) Diabetes insipidus (d) Diabetes mellitus

**452.** According to recent knowledge, the pineal body is considered as

(a) A vestigial organ (b) An organ of intelligence

(c) An endocrine gland (d) An organ of involuntary action

**453.** Which hormone is secreted more in dark condition

(a) Insulin (b) Adrenalin (c) Thyroxine (d) Melatonin

**454.** Hypersecretion of glucagon causes

(a) Glycosuria (b) Diabetes insipidus (c) Tetany (d) Acromegaly

**455.** Hormones of islets of Langerhans have effect on

(a) Calcium (b) Glucose level (c) Blood volume (d) None of these

**456.** Which of the following endocrine glands is a modified lymph gland

(a) Thymus (b) Pituitary (c) Pineal (d) Thyroid

**457.** A hormone which seat of activity in liver, converting glucose to glycogen is produced in

(a) Pancreas (b) Pituitary (c) Parathyroids (d) Thymus

**458.** Insulin is a hormone secreted by

(a) Adrenals and regulates heartbeat (b) Thyroid and regulates growth

(c) Islets of Langerhans and regulates blood glucose level

(d) Pituitary and regulates reproduction

**459.** Glucagon produced by alpha-cells of islets of Langerhans which

(a) Converts glucose to glycogen (b) Converts glycogen to glucose

(c) Decrease concentration of glucose in blood (d) None of these

**460.** Pineal is

(a) An exocrine gland (b) An endocrine gland (c) A digestive gland (d) A fat body

**461.** Pineal gland produces

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

**462.** According to one of the theories of ageing, the decline and disappearance of which gland by late middle age is the primary cause of ageing

(a) Thyroid (b) Parathyroid (c) Thymus (d) Posterior pituitary

**463.** The endocrine gland which degenerates in adult human being is

(a) Pancreas (b) Pineal (c) Pituitary (d) Thyroid

**464.** Diabetes mellitus means

(a) Increase of sugar in blood (b) Increase of sugar in urine

(c) Decrease of sugar in blood (d) (a) and (b) both

**465.** An endocrine gland which atrophies in the adult humans is

(a) Thyroid (b) Parathyroids (c) Thymus (d) Pineal

**466.** Insulin is

(a) Vitamin (b) Proteinaceous hormone

(c) Amine hormone (d) Steroid

**467.** Hassall corpuscles are found in

(a) Pituitary gland (b) Thymus gland (c) Thyroid gland (d) Adrenal gland

**468.** The disease diabetes mellitus is the result of

(a) Undersection of insulin (b) Undersection of thyroxine

(c) Undersection of oestrogen (d) None of these

**469.** Glucagon hormone

(a) Has opposite effect to that of insulin (b) Converts glucose to glycogen

(c) Given to diabetic patients (d) Is formed by β-cells of pancreas

**470.** Pineal body develops from

(a) Dorsal part of diencephalon (b) Ventral part of diencephalon

(c) Ventral side of cerebellum (d) Lateral side of cerebrum

**471.** In case stoppage of functioning of islets of Langerhans what hormone will be in short supply and what will be its effect

(a) Adrenaline – heart beat increases (b) Insulin – blood glucose level rises

(c) Thyroxine – retardation of growth (d) Cortisone – tetany

**472.** (1) Pancreas secrete hormone called

(2) Islets of Langerhand produce hormone for controlling diabetes mellitus. It is

(a) Insulin (b) Pepsin (c) Renin (d) Trypsin

**473.** Removal or absence of thymus in early life shall bring about

(a) Lack of lymphocytes (b)Lack of antibodies (c) Lack of lymph nodes (d)All of these

**474.** Action of insulin was first demonstrated by

(a) Banting and Best (b) Darwin (c) Lamarck (d) Watson and Crick

**475.** Identify the endocrine gland associated with brain

(a) Pineal (b) Thyroid (c) Thymus (d) Parathyroid

**476.** Glycogenolysis is triggered by a hormone called

(a) Insulin (b) Glucagon (c) FSH (d) LH

**477.** Identify the grave disorder of carbohydrate metabolism

(a) Alkaptoneuria (b) Gray is disease (c) Diabetes mellitus (d) Diabetes insipidus

**478.** Polypeptide hormones are secreted by

(a) Adrenal cortex (b) Islets of Langerhans (c) Corpus luteum (d) Leydig cells

**479.** Destruction of β-cells of islets of Langerhans would cause

(a) Glycosuria (b) Diabetes insipidus (c) Hyperemia (d) Diabetes mellitus

**480.** The pineal gland of all anamniota is

(a) Neurosensory (b) Photosensory (c) Strictly endocrine (d) (b) and (c) both

***Advance Level***

**481.** Glucagon and insulin are

(a) Antagonistic secretions

(b) Secreted by same cells and perform similar function

(c) Secreted by different cells and perform antagonistic function

(d) None of these

**482.** The function of glucagon hormone is

(a) To increase glycogenesis

(b) To decrease blood sugar level

(c) To release glucose from liver cells and glycogenolysis promotion

(d) To increase the absorption of glucose and fatty acids through cell

**483.** A man suffering from diabetes mellitus drinks water more frequency, as he has to

(a) Eliminate extra glucose from blood (b) Eliminate extra insulin from blood

(c) Eliminate extra salt from blood (d) Eliminate extra protein from blood

**484.** If the pancreatic duct of a healthy dog is blocked an hour after it had its food, which one of the following functions of the pancreas will be affected

(a) Carbodydrate digestion (b) Neutralization of chyme

(c) Break down of protein (d) Maintenance of normal blood sugar level

**485.** Insulin is secreted by β-cells of islets of Langerhans. Which is not correct concerning insulin

(a) It is rich in cysteine, leucine and glutamic acid

(b) Oestrogen stimulates the secretion of insulin

(c) Two chains of insulin are linked by disulphide bridges

(d) The functional nature of insulin is same as that of proinsulin

**486.** The structure of insulin consists of two polypeptide chains *A* and *B*. These two polypeptide chains

(a) Have equal number of amino acids

(b) Chain *A* has 21 amino acids**,** while chain *B* has 30 amino acids

(c) Chain *A* has 30 amino acids, while chain *B* has 21 amino acids

(d) Chain *A* has 11 amino acids, while chain *B* has 40 amino acids

**487.** The source of somatostatin is same as that of

(a) Thyroxine and calcitonin (b) Insulin and glucagon

(c) Somatotropin and prolactin (d) Vasopresin and oxytocin

**488.** Serotonin hormone is secreted by

(a) α-cells (b) β- cells (c) δ- cells (d) None of these

**489.** Daily rythms are usually associated with

(a) Pineal (b) Pituitary (c) Thymus (d) Hypothalamus

**490.** Which one affects liver, muscle and adipose tissue

(a) Androgen (b) Insulin (c) Progesterone (d) Glucagon

**491.** Blood sugar level can be decreased by

(a) Insulin given from mouth (b) Glucagon given through mouth

(c) Intraveinal injection of insulin (d) Intraveinal injection of glucagon

**492.** Which hormone has the anti-insulin effect

(a) Calcitonin (b) Cortisol (c) Oxytocin (d) Aldosterone

**493.** If thymus gland is removed from the newborn baby, the cells which will not be formed are

(a) Monocytes (b) *T*-lymphocytes (c) B-lymphocytes (d) Eosinophils

**494.** Glucagon characteristically increases all the following except

(a) Gluconeogenesis in the liver (b) Ketogenesis in the liver

(c) Glycogenolysis in muscle (d) Lipolysis in adipose tissue

**495.** Serotonin is secreted by

(a) Pineal gland (b) Mast cells (c) Both of these (d) None of these

**496.** Epiphysis cerebri is another name for

(a) Pituitary (b) Optic lobes (c) Pineal gland (d) Diencephalon

**497.** Pineal gland is absent in

(a) Frog (b) Snake (c) Crocodile (d) Rabbit

**498.** Pineal gland is derived from

(a) Ectoderm (b) Mesoderm (c) Endoderm (d) Both (a) and (c)

**499.** Thymus gland develops from embryonic

(a) Endoderm (b) Ectoderm (c) Mesoderm (d) All of these

**500.** Which gland is often referred in connection with AIDS

(a) Thymus (b) Thyroid (c) Adrenal (d) Pancreas

**501.** Alloxan treatment destroys

(a) STH cells (b) Sertoli cells

(c) Leydig's cells (d) β-cells of islets of Langerhans

**502.** Bacteria do not produce insulin. For insulin production which should be inserted in bacteria

(a) Insulin (b) α-cells (c) Plasmids (d) β-cells

**503.** Hormones involved in carbohydrate metabolism are

(a) Insulin, glucagon, epinephrine and parathormone

(b) Insulin**,** glucagon**,** epinephrine and glucacorticoids

(c) Insulin, glucagon, glucocorticoid and calcitonin

(d) Insulin, glucagon, norepinephrine and melatonin

**504.** The action of insulin include

(a) Converting glycogen to glucose (b) Stimulating gluconeogenesis

(c) Increasing potassium entry into cells (d) Reducing urine formation

**505.** The first hormone artificially produced by culturing bacteria is

(a) Insulin (b) Thyroxine (c) Testosterone (d) Adrenaline

**506.** Insulin increases glucose uptake in all the following structures except

(a) Cardiac muscle (b) Skeletal muscle (c) Intestinal mucosa (d) Adipose tissue

**507.** Which of the following statement is false about diabetes

(a) It is the result of deficiency of insulin

(b) Blood has excess of glucose

(c) Cells fail to pick up glucose from blood

(d) More sugar is burnt in the body of a diabetic than of a normal person

**508.** Thymosine is

(a) Secreted by thymus gland (b) Anti FSH

(c) Anti LH (d) All of these

**509.** Thymosine

(a) Stimulates lymphocytes to neutralise and destroy non-self material that has entered the body

(b) Programmed *T* lymphocytes

(c) Stimulates proliferation of β-lymphocytes

(d) Accelerates pubertal changes

**510.** Identify the chemical which is used for experimental induction of diabetes mellitus

(a) Sodium oxide (b) Dinitrophenol (c) Alloxan (d) Actinomycin D

**511.** Which of the hormone is not secreted after puberty

(a) Inhibin (b) Estrogen (c) Thymosine (d) Erythropoietin

**512.** Identify the hormone that stimulates glycogenolysis and gluconeogenesis

(a) Glucagon (b) Insulin (c) Melatonin (d) Serotonin

**513.** Steroid hormones are not produced by

(a) Ovary (b) Adrenal cortex (c) Pineal gland (d) Placenta

**514.** Which of the following hormone is not controlled by hypothalamic releasing factors

(a) Insulin (b) FSH (c) LH (d) LTH

**515.** Consider the following statements :

Assertion (A) **:** Insulin is not given orally.

Reason (R) **:** Insulin is a macromolecule and is not absorbed by the mucosa layer of alimentary canal.

Now select your answer from the answer code given below

(a) Both A and R are true and R is the correct explanation of A

(b) Both A and R are true but R is not the correct explanation of A

(c) A is true but R is false

(d) R is true but A is false

**516.** The effect of insulin on glucose transport is to

(a) Permit transport against a concentration gradient

(b)Enhance transport through the intestinal mucosa

(c) Enhance transport into the brain

(d) Enhance transport across the cell membrane

**517.** Identify the straight chain hormone secreted by $\alpha$-cells of the islets of Langerhans

(a) Proinsulin (b) Insulin (c) Glucagon (d) Cortisol

**518.** Pineal gland in reptiles and birds is

(a) Neurosensory (b) Neuroendocrine

(c) Responsive to photoperiod (d) All of these

**519.** Pineal gland has became strictly endocrine in

(a) Snakes (b) Lizards (c) Birds (d) Humans

**520.** Identify the endocrine gland which is a part of mammalian brain

(a) Hypophysis (b) Pineal gland (c) Corpus albecans (d) Both (a) and (b)

**521.** Identify the hormone which is antagonistic to insulin

(a) Glucagon (b) Adrenaline (c) Cortisol (d) All of these

## TESTIS AND OVARY

***Basic Level***

**522.** Progesterone hormone is secreted by

(a) Corpus luteum (b) Corpus callosum (c) Corpus uteri (d) Corpus albicans

**523.** A ruptured follicle in mammalian ovary after the release of ovum which latter gets fertilized, forms

(a) Corpus albicans (b) Corpus callosum (c) Corpus luteum (d) Graafian follicle

524. Estrogens are the hormones produced by
(a) Testis (b) Ovary (c) Pituitary (d) Adrenal cortex

525. Development of secondary sexual characters in females are controlled by
(a) Estrogen (b) Oxytocin (c) Progesterone (d) Androgen

526. Progesterone is
(a) An enzyme for digesting proteins
(b) A hormone to initiate uterine contraction during child birth
(c) An amino acid which may cause alcaptonuria
(d) A hormone concerned with retention and growth of pregnancy

527. Which is not a gonadal hormone
(a) Progesterone (b) Testosterone (c) Adrenalin (d) Estrogen

528. Which part of the ovary in mammals acts as an endocrine gland after ovulation
(a) Stroma (b) Germinal epithelium (c) Graafian follicle (d) Vitelline membrane

529. Function of relaxin hormone is
(a) Relax pubic symphysis (b)Relax ovaries
(c) Relax uterus (d) Relax fallopian tubule

530. Estrogen is secreted by
(a) Corpus albicans (b) Corpus callosum
(c) Corpus luteum (d) Cell of graafian follicles

531. Secretion of the androgen by Leydig cells of testis is under the regulatory influence of
(a) LTH (b) FSH (c) STH (d) ICSH

532. In mammals the relaxin hormone is secreted by
(a) Follicle (b) Placenta (c) Ovary (d) Testis

533. Androgens are secreted by
(a) Ovaries (b) Thyroid (c) Pituitary (d) Testes

534. Leydig's cells secrete
(a) Estrogen (b) Progesterone (c) Testosterone (d) Aldosterone

535. Male hormone is
(a) Adrenalin (b) Testosterone (c) Progesterone (d) Insulin

536. A temporary endocrine gland formed after ovulation in ovary is
(a) Corpus callosum (b) Corpus albicans (c) Corpus leuteum (d) Corpus uteri

537. Ovulation in mammals is caused by
(a) FSH and TSH (b) FSH and LH (c) FSH and LTH (d) LTH and LH

538. Pregnancy hormone is
(a) Oestrogen (b) Androgen (c) Progesterone (d) Gestron

**539.** Breast development during pregnancy is induced by

(a) Estradiol (b) Progesterone (c) Relaxin (d) FSH

**540.** Testosterone, a hormone responsible for the development of secondary sexual characteristics in male is produced by the

(a) Spermatogonia (b) Seminiferous tubules

(c) Anterior lobe of the pituitary (d) Cells that lie between seminiferous tubules

**541.** Release of ova in mammals occurs mainly under the influence of

(a) FSH and LH (b) TSH and STH (c) ACTH and MTH (d) TSH and ACTH

**542.** Occurrence of Leydig's cells and their secretion is

(a) Ovary and Estrogen (b) Liver and Cholesterol

(c) Pancreas and Glucagon (d) Testis and Testosterone

**543.** The high levels of testosterone in the blood would inhibit

(a) ICSH (b) FSH (c) GH (d) Prolactin

**544.** The male hormone, *testosterone* is secreted by

(a) Sperms (b) Seminiferous tubules

(c) Prostate glands (d) Interstitial cells of testes

**545.** Most of the contraceptive pills contain

(a) Estrogen + FSH (b) Progesterone + LH

(c) FSH + LH (d) Estrogen + progesterone

**546.** All the hormone are proteins, peptides and amino acid derivatives except

(a) Hormone of ovary (b) Thyroid hormone

(c) Parathyroid hormone (d) Pancreas hormone

**547.** Graafian follicles are formed by the active division of

(a) Peritoneum (b) Germinative epithelium

(c) Columnar epithelium (sensory) (d) Corpus cavernosa

**548.** Progesterone is a

(a) Carbohydrate (b) Steroid (c) Protein (d) Sterol

**549.** Hormone responsible for the implantation of embryo in uterus and formation of placenta is

(a) Adrenalin (b) Progesterone (c) Estradiol (d) FSH

**550.** The placenta helps in the maintenance of pregnancy by secreting a hormone, knows as

(a) Thyroxine (b) Estrogen (c) Progesteron (d) Testosterone

**551.** Which hormone is secreted at the time of parturition

(a) Progesterone (b) Thyroxin (c) Relaxin (d) Glucocorticoid

**552.** In male, the retard growth of the secondary sexual characters is due to the deficiency of one of the hormones

(a) Progestrine (b) Androsterone (c) Cortin (d) Thyroxin

**553.** Secretion of progesterone by corpus luteum is initiated by

(a) *MSH* (b) *LH* (c) Testosterone (d) Thyroxine

554. In males, the essential hormone for secondary sexual characteristics is
(a) Testosterone (b) Progesterone (c) Estrogen (d) Relaxin

555. In females, the essential hormone for secondary sexual characteristics is
(a) Testosterone (b) Progesterone (c) Estrogen (d) Relaxin

556. Graafian follicle of ovary secretes which hormone
(a) Estrogen (b) Progesterone (c) Relaxin (d) Cortisone

557. Which one of the following cells, found in testes of rabbit secretes male hormone
(a) Leydig's cells (b) Sertoli cells (c) Epithelial cells (d) Spermatocytes

558. Estrogen or estradiol is a excretory product of the hormone of
(a) Testis (b) Pituitary (c) Ovary (d) Pancreas

559. Which of the following is not a protein hormone
(a) Testosterone (b) Growth hormone (c) ACTH (d) FSH

560. Secretion of large quantities of estrogen causes
(a) Growth of fallopian tube (b)Growth of breast due to ducts of mammary gland
(c) Enlargement of female external genitalia (d)All of these

561. Ovarian hormones are
(a) Proteins (b) Steroids only (c) Proteins and steroids (d)None of these

562. At puberty, young boys start growing facial hairs. It represents
(a) Mimicry (b) Metamorphosis
(c) Atavism (d) Secondary sexual trait

563. The major function of corpus luteum is
(a) Excretory (b) Digestive (c) Nervous (d) Endocrine

564. Hormone required for maintenance of corpus luteum is
(a) Progesterone (b) Estrogen (c) FSH (d) LH

565. Secretion of estrogen is controlled by
(a) hCG (b) FSH (c) Progesterone (d) Testosterone

566. An important function of progesterone is
(a) Prepare uterus for pregnancy (b) Implantation of embryo
(c) Maintenance of pregnancy (d) All of these

567. Corpus luteum is a source of
(a) Luteinising hormone (b)Estrogen (c) Progesterone (d) Both (b) and (c)

568. Corpus luteum is part of
(a) Mammalian lung (b) Mammalian ovary (c) Mammalian liver (d) Mammalian brain

569. Hormone found in greatest concentration at the time of ovulation is
(a) LH (b) FSH (c) Prolactin (d) ACTH

570. Hormone secreting structure produced after ovulation is
(a) Corpus albicans (b) Corpus spongiosum (c) Corpus callosum (d) Corpus luteum

571. The hormone which brings about characteristics changes in male at puberty is called
(a) Testosterone (b) Androgen
(c) Follicle stimulating hormone (d) None of these

572. Male sex hormones produced by the testes are synthesised in
(a) Cowper's glands (b) Sertolic cells (c) Interstitial cells (d) Seminiferous tubules

573. Estrone and estriol are hormones of
(a) Testis (b) Ovary (c) Oviduct (d) Uterus

574. Corpus luteum is
(a) Immature ovarian follicle (b) Remains of ruptured follicle after ovulation
(c) Mature Graafian follicle (d) Extra embryonic membrane

575. Ovulation is caused by a sudden increase in the secretion of
(a) FSH (b) LH (c) Estrogen (d) Progesterone

576. Orchidectomy is the removal of
(a) Ovaries (b) Testes (c) Kidneys (d) Spleen

577. Testosterone is synthesized from all the following substances except
(a) Cholesterol (b) Estrogen (c) Androstenedione (d) Pregnenolone

578. Which hormone prepares the human uterine endometerium for implantation of blastocyte
(a) Endorphin (b) Encephalin (c) Progesterone (d) 17 β-estradiol

579. Labour pains during childbirth are due to
(a) Increased weight of the foetus (b) Bursting of amniotic membrane
(c) Contraction of the myometrial muscles (d) Sloughing off of endometrial wall

580. Increased level of androgen in human female leads to
(a) Sterility (b) Mental disorder
(c) Hirsutism (d) No change in the pitch of voice

581. The cells found in the interstitium of seminiferous tubules are called
(a) Leydig cells (b) Sertoli cells (c) Chromafin cells (d) Medullary cells

***Advance Level***

582. Which hormone(s) of the following endocrine glands lacks peptides, amines and sulphur
(a) Hormone of anterior pituitary (b) Hormone of posterior pituitary and pancreas
(c) Hormone of thyroid and adrenal gland (d) Hormone of testes and ovary

583. Correct hormonal sequence in the increase of menstruation is
(a) Estrogen, FSH and progesterone (b) Estrogen, progesterone and FSH
(c) FSH, progesterone and estrogen (d) FSH**,** estrogen and progesterone

**584.** Tick out the wrong statement

(a) Vasopressin is an antidiuretic hormone (b) Sex hormones are protein in nature

(c) LH and ICSH are the same hormones (d) Glucagon is a catabolic hormone

**585.** The name of hormone secreted by the ovary, which facilitates growth of ovarian follicle is

(a) Progesterone (b) LH (c) FSH (d) Estradiol

**586.** A decrease in level of oestrogen and progesterone causes

(a) Loss of endometrium

(b) Growth of dilation of metridium

(c) Release of ova from ovaries

(d) Constriction of uterine blood vessels leading to sloughing of uterine epithelium

**587.** Cholesterol is necessary for the synthesis of

(a) Vitamin *C* (b) Vitamin *B* (c) Estradiol (d) Insulin

**588.** Corpus luteum is not found in

(a) Frog (b) Rat (c) Rabbit (d) Man

**589.** After fertilization the corpus luteum remain in a woman for about

(a) 21 days (b) 28 days (c) 280 days (d) 7 days

**590.** During menstruation the level of progesterone in blood is

(a) Low (b) High (c) Normal (d) Very high

**591.** The most important component of the oral contraceptive pill is

(a) Thyroxine (b) Growth hormone (c) Luteinizing hormone (d)Progesterone

**592.** The role of progesterone hormone is

(a) To thicken uterine wall (b) To increase blood supply to uterine wall

(c) To build up fat and glycogen in uterine wall (d) All of these

**593.** Biological actions of estrogens include all of the following except

(a) Decreased glucose tolerance (b)Increased serum cholesterol

(c) Stimulation of follicular growth (d)Delayed bone loss at menopause

**594.** If ovaries of a lady are removed in fourth month of pregnancy, the result will be

(a) Embryo will develop normally till birth (b) Abortion will occur after sometime

(c) Development of embryo becomes abnormal (d) None of these

**595.** The source of estrogen and progesterone during the first two months of pregnancy is the

(a) Posterior pituitary (b) Ovary (c) Placenta (d) Corpus luteum

**596.** High level of progesterone in the blood suppress the release of

(a) LH (b) FSH (c) ACTH (d) None of these

**597.** Hypophysectomy results in

(a) Heart attack (b) Regression of reproductive functions

(c) Death (d) Poor digestion

**598.** Human male sex hormone or androgen present in urine of males is

(a) Testosterone (b) Andostenedione

(c) Dehydroepiandrosterone (d) Androsterone

**599.** Which ovarian hormone is proteinaceous

(a) Estradiol (b) Relaxin

(c) Human chorionic gonadotropin (d) Both (b) and (c)

**600.** (1) In a pregnant woman having prologed labour pains, childbirth has to be hastened. It is a advisable to administer a hormone that can

(2) Which type of hormone is administered to aid parturition

(a) Activate smooth muscles (b) Increase the metabolic rate

(c) Release glucose in the blood (d) None of these

**601.** Which hormone is secreted by Graafian follicle of the ovary

(a) Relaxin (b) Progesterone (c) Estrogen (d) Cortisone

**602.** If both the ovaries of a rat are removed, which hormone will be deficient

(a) Prolactin (b) Oestrogen

(c) Oxytocin (d) Gonadotrophic hormone

**603.** What is not true about ovarian hormones

(a) Induce myometrial contraction (b)Promote development of secondary sex characters

(c) Have anti FSH and anti LH role (d)Initiate and sustain changes in oviduct and uterus

**604.** Select the incorrect statement

(a) Chemically, steroid, hormones are derivatives of cholesterol

(b) Androgens are catecholamines

(c) Target cells of a hormone have specific receptors to which it responds

(d) Hormones are not species-specific

**605.** Identify the hormone which transforms granulosa cells of ovulated graffian follicle into lutein cells

(a) FSH (b) LH (c) Estrogen (d) Progesterone

**606.** Identify the predominant natural mammalian estrogen

(a) Estrone and 17 $\beta$-estradiol (b) Pregnenolone

(c) Estriol (d) 17 $\alpha$-ketosteroid

**607.** A young woman was diagnosed of having reproductive failure and was given daily doses of FSH and LH and then a large dose of LH of day 14. What is her ailment

(a) Damaged pituitary (b) Amenorrhea

(c) Dysmenorrhea (d) Premenstrual syndrome

## GASTRO – INTERTINAL MUCOSA , PLACENTA KIDNEY

***Basic Level***

**608.** The hormone which makes the gall bladder contract is

(a) Cholesterokinin (b) Cholecytokinin (c) Cholecystokinin (d) Cholegastrokinin

**609.** The hormone released from placenta is

(a) Prolactin (b) FSH

(c) Human chorionic gonadotropin (HCG) (d) Prothrombin

**610.** Which hormone stops the secretion of *HCl* from parietal cells of stomach

(a) Enterogasterone (b) Enterokinase (c) Gastrin (d) Secretin

**611.** Secretin is a

(a) Hormone (b) Enzyme (c) Pheromone (d) Vitamin

**612.** Which part of body secretes the hormone secretin

(a) Ileum (b) Duodenum (c) Stomach (d) Oesophagus

**613.** Cholecystokinin activates

(a) Gastric glands (b) Crypts of Lieberkuhn (c) Gall bladder (d) Liver

**614.** Which one of the following hormones inhibits gastric secretion

(a) Gastrin (b) Secretin (c) Enterogastrone (d) Cholecystokinin

**615.** Hormone villikinin is secreted by

(a) Mucosa of small intestine (b) Mucosa of duodenum

(c) Mucosa of pyloric stomach (d) Mucosa of gall bladder

**616.** Which one of the following is temporary endocrine gland

(a) Pineal (b) Pancreas (c) Placenta (d) Parathyroid

**617.** Secretin stimulates

(a) Pancreas (b) Gall bladder (c) Lungs (d) Gastric glands

**618.** Hormone relaxin is produced by

(a) Anterior pituitary (b) Posterior pituitary (c) Mid pituitary (d) Placenta

**619.** Renin is a hormone secreted by

(a) Gonads (b) Kidneys (c) Skin (d) Lungs

**620.** A hormone promoting RBCs production is secreted by

(a) Kidney (b) Bone marrow (c) Spleen (d) Liver

**621.** Erythropoietin is a hormone secreted by

(a) Brain (b) Kidney (c) Bone marrow (d) Spleen

**622.** The hormone that stimulates the stomach to secrete gastric juice is

(a) Gastrin (b) Enterogastrone (c) Enterokinase (d) Renin

**623.** Secretin

(a) Stimulates secretion of bicarbonate (b) Inhibits movements of stomach

(c) Inhibits secretion of gastric glands (d) All of these

**624.** Identify the correctly matched pair

(a) Zona glomerulosa – insulin (b) Zona fasciculata – epinephrine

(c) Zona reticularis – glucagon (d) Pineal gland – melatonin

**625.** Gastrin

(a) Stimulates gastric glands (b) Is secreted by fundic glands

(c) Is synthesized by cardiac gland (d) Both (a) and (b)

***Advance Level***

**626.** Test of urine of a lady of 4 months pregnancy indicates the presence of

(a) Relaxin (b) More alkalinity

(c) More acidity (d) Chorionic gonadotropin

**627.** Mark the incorrect

(a) Hormone produced by adenohypophysis is FSH (b)Hormone produced in thyroids is $T-4$

(c) Hormone synthesized by neurohypophysis is ADH (d)Hormone produced in placenta is URF

**628.** The recently reported protein angiotensin is secreted by

(a) Liver (b) Kidney (c) Pancreas (d) Placenta

**629.** Cholecystokinin and secretin are

(a) Hormones liberated by mucosa of duodenum and stimulate gall bladder and pancreas respectively

(b) Hormones stimulating liver

(c) Hormones stimulating pancreas

(d) Enzymes

**630.** A polypeptides secreted into the blood by the cells in the stomach wall, stimulates the production of *HCl* by the parietal cells of the stomach is

(a) Gastrin (b) Secretin (c) Pancreozymin (d) Renin

**631.** Which one of the following is both hormone and enzyme

(a) ADH hormone (b) Acetylcholinesterase (c) Angiotensinogen (d) Renin

**632.** Which one of the following flows directly into the blood from seat of its production to act on an organ away from it

(a) Rennin (b) Renin (c) Cholesterol (d) Cholesterase

**633.** Which hormone stops the release of FSH from the pituitary after fertilization

(a) Placental hormone (b) Fertilizin

(c) Estradiol (d) Luteinizing hormone

**634.** Which of the following statement is false

(a) The hormone produced in the ovary affects uterine contraction

(b) The hormone produced in the small intestine stimulates the heart

(c) The hormone produced in thyroid regulats general metabolism

(d) The hormone produced in parathyroid produces tetany

**635.** Secretin is secreted from

(a) Endocrine gland and acts on an endocrine gland

(b)Exocrine gland and acts on an exocrine gland

(c) Endocrine gland and acts on an exocrine gland

(d)Exocrine gland and acts on an endocrine gland

**636.** The peristence of corpus luteum during pregnancy is due to a hormone knowns as

(a) Chorionic gonadotropic hormone (b) FSH

(c)Estrogen (d) Progesterone

**637.** In man, cholecystokinin hormone stimulates the contraction of

(a) Stomach (b) Brunner's gland (c) Salivary glands (d) Gall bladder

**638.** Which hormone is produced in human female if a pregnancy has occurred

(a) Estrogen (b) Progesterone (c) LH (d) HCG

**639.** Function of renin is

(a) To reduce blood pressure

(b)Vasodilation

(c) Degradation of angiotensinogen to angiotensin-II

(d)Stimulation of copious urination

**640.** Placenta secretes following hormones except

(a) Gonadotropin (b) Lactogen (c) Testosterone (d) Progesterone

**641.** The source of estrogen and progesterone during the last seven months of pregnancy is the

(a) Placenta (b) Ovary (c) Corpus luteum (d) Anterior pituitory

**642.** Hormone which stimulates pancreas for secretion of enzymes

(a) Glucagon (b) Pancreozymine (c) Gastrin (d) Insulin

**643.** Renin is

(a) An enzyme present in the gastric juice of mammals

(b) A substance excreted through the kidney

(c) A protein produced by some cells present in cortex of kidney

(d) None of these

**644.** The hormone secretin is produced by

(a) Pancreas and influences the conversion of glycogen to glucose

(b) Adrenal gland and accelerate heart beat

(c) Testis and produces male secondary sex characters

(d) Small intestine and stimulates pancreas

**645.** Renin is produced by

(a) Liver (b) Spleen (c) Juxtaglomerular cells (d) Stomach

**646.** The organ which was considered vestigial till recently but now confirmed to be endocrine gland is

(a) Thymus (b) Pancreas (c) Pineal (d) Pituitary

**647.** Hormonal product of placenta is

(a) hCG and progesterone (b)Calcitonin (c) Relaxin (d) Vasopressin

**648.** Which is gastrointestinal hormone

(a) Prolactin (b) Enterokinase (c) Cholinesterase (d) Secretin

**649.** Cholecystokinin and secretin are secreted by

(a) Stomach (b) Liver (c) Duodenum (d) Ileum

**650.** Pineal gland produces

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

**651.** Identify the polypeptide hormone secreted by placenta which facilitates parturition

(a) Oxytocin (b) Progesterone (c) Relaxin (d) Estrogen

**652.** Which hormone was first isolated in 1902 from the gastro intestinal tract

(a) Insulin (b) Glucagon (c) Secretin (d) Gastrin

**653.** Identify the endocrine gland which secretes steroids as well as protein hormone

(a) Corpus luteum (b) Leydig cells (c) Adrenal cortex (d) Placenta

**654.** Assertion (A) **:** A woman usually does not conceive during the lactation period

Reason (R) **:** The hormone 'prolactin' stimulates (*a*) the growth of milk glands during pregnancy and (*b*) secretion of milk in a postpartum woman.

(a) If both A and R are true and R is the correct explanation of A

(b) If both A and R are ture but R is not the correct explanation of A**.**

(c) If A is true but R is false.

(d) If both A and R are false.

**655.** The best example of stress hormone is

(a) Vasopressin (b) Oxytocin (c) Norepinephrine (d) Calcitonin

**656.** Glycogen is converted into glucose by

(a) Insulin (b) Glucagon

(c) Both insulin and glucagon (d) Galactase

**657.** Insulin promotes

(a) Glycogenesis (b) Glycolysis (c) Gluconeogenesis (d) Glycogenolysis

# ANSWER

## ASSIGNMENT ( BASIC & ADVANCE LEVEL )

| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| d | c | c | c | c | b | a | b | d | b | d | b | d | d | b | d | d | c | a | b |
| 20 | 21 | 22 | 23 | 24 | 25 | 26 | 27 | 28 | 29 | 30 | 31 | 32 | 33 | 34 | 35 | 36 | 37 | 38 | 39 |
| c | c | d | b | a | b | b | b | d | d | a | c | a | c | d | d | b | c | a | a |
| 40 | 41 | 42 | 43 | 44 | 45 | 46 | 47 | 48 | 49 | 50 | 51 | 52 | 53 | 54 | 55 | 56 | 57 | 58 | 59 |
| c | c | a | b | a | d | d | c | d | b | d | a | b | a | b | a | b | c | c | a |
| 60 | 61 | 62 | 63 | 64 | 65 | 66 | 67 | 68 | 69 | 70 | 71 | 72 | 73 | 74 | 75 | 76 | 77 | 78 | 79 |
| c | d | b | c | d | a | a | d | d | b | b | a | a | b | b | d | a | a | a | d |
| 80 | 81 | 82 | 83 | 84 | 85 | 86 | 87 | 88 | 89 | 90 | 91 | 92 | 93 | 94 | 95 | 96 | 97 | 98 | 99 |
| b | a | d | d | c | d | d | c | b | d | c | c | b | a | d | b | a | b,c | c | a |
| 100 | 101 | 102 | 103 | 104 | 105 | 106 | 107 | 108 | 109 | 110 | 111 | 112 | 113 | 114 | 115 | 116 | 117 | 118 | 119 |
| d | c | c | c | b | a | c | c | a | a | c | d | b | d | a | b | b | a | b | b |
| 120 | 121 | 122 | 123 | 124 | 125 | 126 | 127 | 128 | 129 | 130 | 131 | 132 | 133 | 134 | 135 | 136 | 137 | 138 | 139 |
| a | b | d | d | a | a | b | b | d | a | b | a | c | d | c | a | b | b | b | a |
| 140 | 141 | 142 | 143 | 144 | 145 | 146 | 147 | 148 | 149 | 150 | 151 | 152 | 153 | 154 | 155 | 156 | 157 | 158 | 159 |
| b | b | a | d | a | d | b | b | a | d | c | b | d | d | d | c | a | c | b | b |
| 160 | 161 | 162 | 163 | 164 | 165 | 166 | 167 | 168 | 169 | 170 | 171 | 172 | 173 | 174 | 175 | 176 | 177 | 178 | 179 |
| a | a | d | c | c | c | b | a | b | a | a | d | d | d | b | d | a | c | c | d |
| 180 | 181 | 182 | 183 | 184 | 185 | 186 | 187 | 188 | 189 | 190 | 191 | 192 | 193 | 194 | 195 | 196 | 197 | 198 | 199 |
| b | c | d | d | c | c | a | a | b | d | d | c | d | b | c | d | d | c | d | b |
| 200 | 201 | 202 | 203 | 204 | 205 | 206 | 207 | 208 | 209 | 210 | 211 | 212 | 213 | 214 | 215 | 216 | 217 | 218 | 219 |
| c | c | a | d | c | c | a | b | d | d | a | a | c | a | b | c | b | c | a | d |
| 220 | 221 | 222 | 223 | 224 | 225 | 226 | 227 | 228 | 229 | 230 | 231 | 232 | 233 | 234 | 235 | 236 | 237 | 238 | 239 |
| c | d | c | d | c | a | b | b | c | c | a | a | a | d | d | c | b | a | a | d |
| 240 | 241 | 242 | 243 | 244 | 245 | 246 | 247 | 248 | 249 | 250 | 251 | 252 | 253 | 254 | 255 | 256 | 257 | 258 | 259 |
| c | d | a | a | b | b | c | a | d | a | d | a | c | a | b | b | b | a | a | d |
| 260 | 261 | 262 | 263 | 264 | 265 | 266 | 267 | 268 | 269 | 270 | 271 | 272 | 273 | 274 | 275 | 276 | 277 | 278 | 279 |

| d | c | a | d | c | b | a | b | b | c | d | a | c | b | c | b | c | c | c | c |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 280 | 281 | 282 | 283 | 284 | 285 | 286 | 287 | 288 | 289 | 290 | 291 | 292 | 293 | 294 | 295 | 296 | 297 | 298 | 299 |
| c | b | c | a | b | b | c | d | a | b | c | a | a | a | a | b | d | b | c | b |
| 300 | 301 | 302 | 303 | 304 | 305 | 306 | 307 | 308 | 309 | 310 | 311 | 312 | 313 | 314 | 315 | 316 | 317 | 318 | 319 |
| a | b | a | a | d | c | d | a | c | d | d | b | d | b | b | b | d | b | d | d |
| 320 | 321 | 322 | 323 | 324 | 325 | 326 | 327 | 328 | 329 | 330 | 331 | 332 | 333 | 334 | 335 | 336 | 337 | 338 | 339 |
| b | a | d | b | c | a | c | c | a | b | a | c | b | d | a | b | a | a | b | c |
| 340 | 341 | 342 | 343 | 344 | 345 | 346 | 347 | 348 | 349 | 350 | 351 | 352 | 353 | 354 | 355 | 356 | 357 | 358 | 359 |
| c | c | a | d | c | d | d | a | d | a | b | b | b | a | a | d | c | d | b | a |
| 360 | 361 | 362 | 363 | 364 | 365 | 366 | 367 | 368 | 369 | 370 | 371 | 372 | 373 | 374 | 375 | 376 | 377 | 378 | 379 |
| c | c | a | b | c | b | d | a | c | a | b | b | d | c | d | b | b | b | b | b |
| 380 | 381 | 382 | 383 | 384 | 385 | 386 | 387 | 388 | 389 | 390 | 391 | 392 | 393 | 394 | 395 | 396 | 397 | 398 | 399 |
| b | c | d | a | c | d | a | c | c | c | d | b | a | d | a | b | a | d | a | b |
| 400 | 401 | 402 | 403 | 404 | 405 | 406 | 407 | 408 | 409 | 410 | 411 | 412 | 413 | 414 | 415 | 416 | 417 | 418 | 419 |
| a | b | c | b | a | c | c | d | d | c | a | d | d | a | a | b | a | a | c | b |
| 420 | 421 | 422 | 423 | 424 | 425 | 426 | 427 | 428 | 429 | 430 | 431 | 432 | 433 | 434 | 435 | 436 | 437 | 438 | 439 |
| a | d | a | d | b | a | a | b | d | a | b | c | d | d | b | b | a | b | a | a |
| 440 | 441 | 442 | 443 | 444 | 445 | 446 | 447 | 448 | 449 | 450 | 451 | 452 | 453 | 454 | 455 | 456 | 457 | 458 | 459 |
| a | c | b | b | a | d | b | b | a | a | d | a | d | a | b | a | a | c | b | b |
| 460 | 461 | 462 | 463 | 464 | 465 | 466 | 467 | 468 | 469 | 470 | 471 | 472 | 473 | 474 | 475 | 476 | 477 | 478 | 479 |
| d | c | b | d | c | b | b | a | a | a | b | a | d | a | a | b | c | b | b | d |
| 480 | 481 | 482 | 483 | 484 | 485 | 486 | 487 | 488 | 489 | 490 | 491 | 492 | 493 | 494 | 495 | 496 | 497 | 498 | 499 |
| c | c | a | d | b | b | b | d | a | b | c | b | b | c | b | c | d | a | a | a |
| 500 | 501 | 502 | 503 | 504 | 505 | 506 | 507 | 508 | 509 | 510 | 511 | 512 | 513 | 514 | 515 | 516 | 517 | 518 | 519 |
| d | c | b | c | a | c | d | d | a | c | c | a | c | a | a | d | c | d | d | d |
| 520 | 521 | 522 | 523 | 524 | 525 | 526 | 527 | 528 | 529 | 530 | 531 | 532 | 533 | 534 | 535 | 536 | 537 | 538 | 539 |
| d | a | c | b | a | d | c | c | a | d | d | c | d | c | b | c | b | c | b | d |
| 540 | 541 | 542 | 543 | 544 | 545 | 546 | 547 | 548 | 549 | 550 | 551 | 552 | 553 | 554 | 555 | 556 | 557 | 558 | 559 |
| a | d | a | d | d | a | b | b | b | c | c | b | b | a | c | a | a | c | a | d |
| 560 | 561 | 562 | 563 | 564 | 565 | 566 | 567 | 568 | 569 | 570 | 571 | 572 | 573 | 574 | 575 | 576 | 577 | 578 | 579 |

| | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| b | d | d | d | b | d | c | b | a | d | a | c | b | b | b | b | b | c | c | c |
| 580 | 581 | 582 | 583 | 584 | 585 | 586 | 587 | 588 | 589 | 590 | 591 | 592 | 593 | 594 | 595 | 596 | 597 | 598 | 599 |
| a | d | d | b | d | d | c | a | c | a | d | d | b | a | d | a | b | d | b | a |
| 600 | 601 | 602 | 603 | 604 | 605 | 606 | 607 | 608 | 609 | 610 | 611 | 612 | 613 | 614 | 615 | 616 | 617 | 618 | 619 |
| c | b | a | b | b | a | a | c | c | a | a | b | c | c | a | c | a | d | b | a |
| 620 | 621 | 622 | 623 | 624 | 625 | 626 | 627 | 628 | 629 | 630 | 631 | 632 | 633 | 634 | 635 | 636 | 637 | 638 | 639 |
| b | a | d | d | d | d | d | a | a | a | d | b | a | b | c | a | d | d | c | c |
| 640 | 641 | 642 | 643 | 644 | 645 | 646 | 647 | 648 | 649 | 650 | 651 | 652 | 653 | 654 | 655 | 656 | | | |
| a | b | c | d | c | c | a | d | c | d | c | c | d | b | c | b | a | | | |

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