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CHEMICAL COORDINATION AND REGULATION

SYLLABUS

Endocrine glands and hormones; Human endocrine system-Hypothalamus, Pituitary, Pineal, Thyroid, Parathyroid, Adrenal, Pancreas, Gonads; Mechanism of hormone action (Elementary Idea); Role of hormones as messengers and regulators, Hypo-and hyperactivity and related disorders (Common disorders e.g. Dwarfism, Acromegaly, Cretinism, goiter, exopthalmic goiter, diabetes, Addison's disease).(Imp: Diseases and disorders mentioned above to be dealt in brief.)

KEY CONCEPTS

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.
* **Glands of body :** 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 discharges its secretion into the blood. Pancreas and gonads are heterocrine glands. These are also called mixed glands.

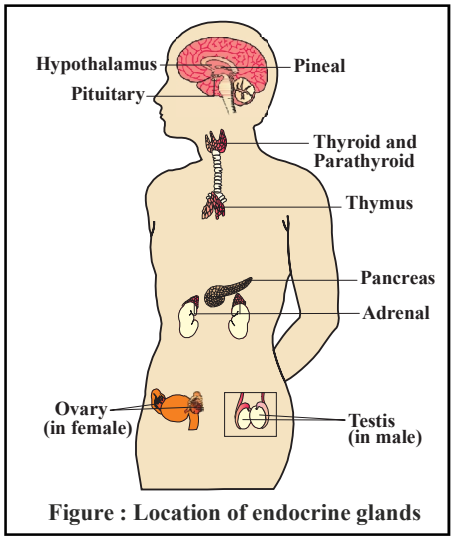


Figure : Location of endocrine glands

HORMONES

* Hormone is a chemical produced by endocrine glands and released into the blood and transported to a distantly located target organ has current scientific definition : Hormones are non-nutrient chemicals which act as intercellular messengers and are produced in trace amounts.

* First hormone discovered was secretin. It was discovered by two English physiologists : William M Bayliss and Ernest H. Starling in 1903.
* Term hormone was coined by starling (1905) from Greek word Homone means to excite. It is a mishomer because a number of hormones are known to have inhibitory effect (e.g., Somatostatin).

Properties of hormones :

(1) These are secreted by endocrine gland (biogenic in origin).
(2) Their secretions is released directly into blood (except local hormones e.g., gastrin).
(3) These are carried to distantly located specific organs, called target organ.
(4) These have specific physiological action (excitatory or inhibitory). These co-ordinate different physical, mental and metabolic activities and maintain homeostasis.
(5) The hormones have low molecular weight e.g., ADH has a molecular weight of 600-2000 daltons.
(6) These act in very low concentration e.g., around 10^{-10} molar.
(7) Hormones are non antigenic.
(8) These are mostly short-lived. So have a no cumulative effect.
(9) Some hormones are quick acting e.g., adrenalin, while some acting slowly e.g., oestrogen of ovary.
(10) Some hormones secreted in inactive form called Prohormone e.g., Pro-insulin.
(11) Hormones after their action destroyed in liver and kidney.

THE HYPOTHALAMUS

* The hypothalamus is the basal part of diencephalon, forebrain.
* It contains several groups of neurosecretory cells called nuclei which produce hormones. These hormones regulate the synthesis and secretion of pituitary hormones.
* The hormones produced by hypothalamus are of two types, the **releasing hormones** (which stimulate secretion of pituitary hormones) and the **inhibiting hormones** (which inhibit secretions of pituitary hormones).
* **Hypothalamic hormone** called Gonadotrophin releasing hormone (GnRH) stimulates the pituitary synthesis and release of gonadotrophins.
* **Somatostatin** from the hypothalamus inhibits the release of growth hormone from the pituitary.
* Hormones originating in the hypothlamic neurons, pass through axons and are released from their nerve endings.
* Hormones reach the pituitary gland through a portal circulatory system and regulate the functions of the anterior pituitary.
* The posterior pituitary is under the direct neural regulation of the hypothalamus.

THE PITUITARY GLAND

* The pituitary gland is located in a bony cavity called sella tursica and is attached to hypothalamus by a stalk called **infundibulum**.
* It is divided anatomically into an adenohypophysis and a neurohypophysis.

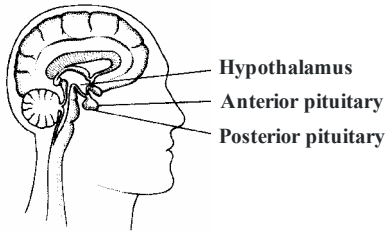


Figure : Location of pituitary gland

* Adenohypophysis consists of two portions, **pars distalis and pars intermedia.**

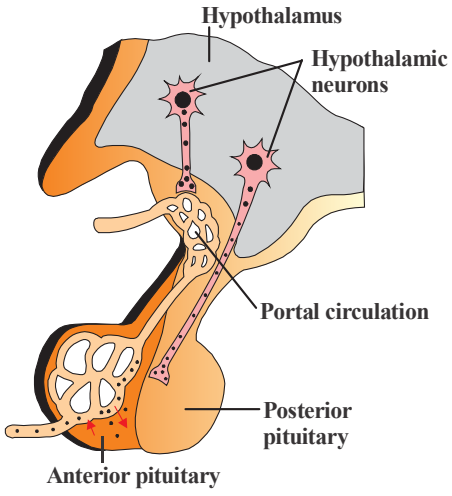


Figure : Diagrammatic representation of pituitary and its relationship with hypothalamus.

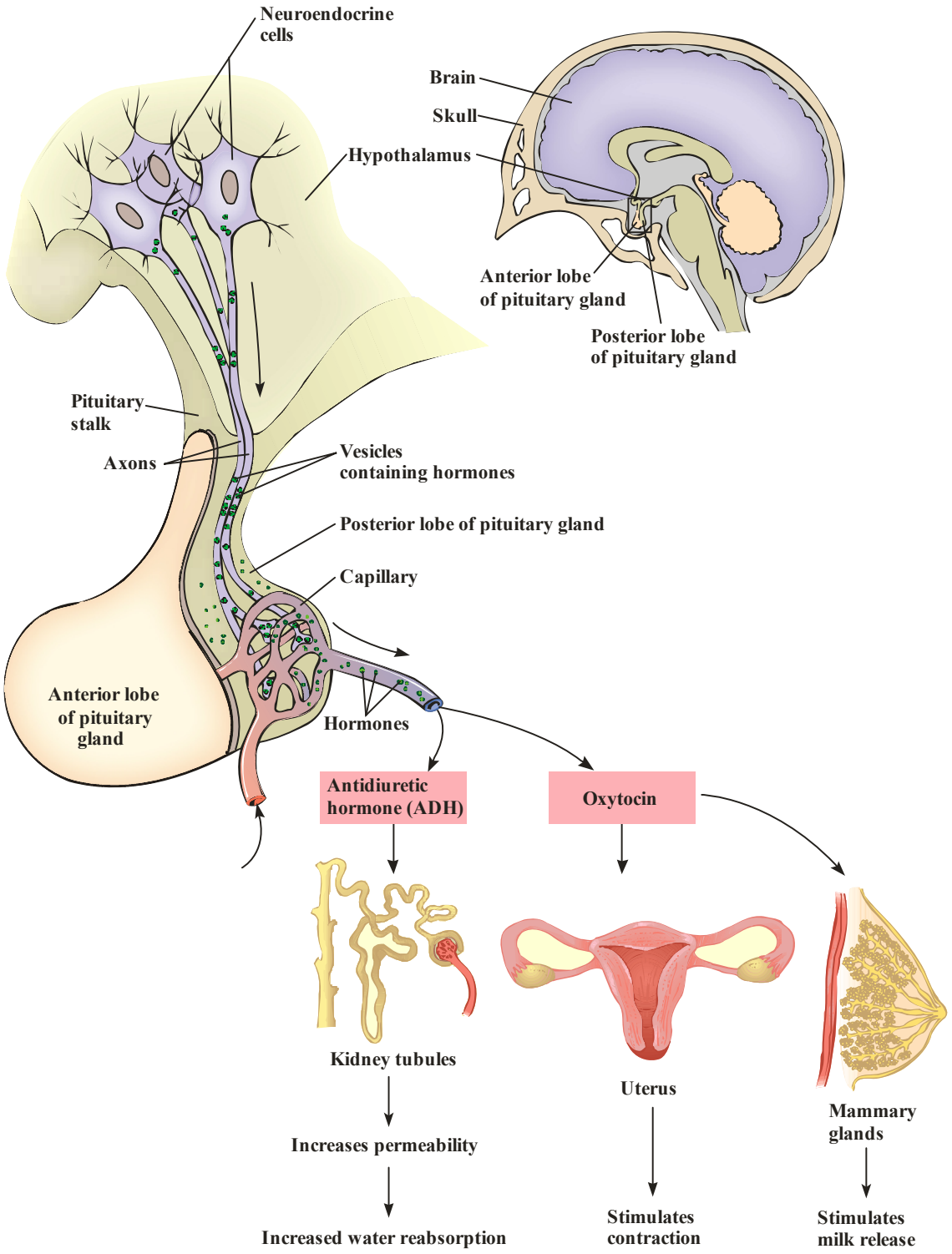


Figure : Synthesis and secretion of posterior pituitary hormones

Neuroendocrine cells in the hypothalamus manufacture hormones that are later secreted by the posterior lobe of the pituitary gland. The axons of these neurons extend into the posterior lobe. The hormones are packaged in vesicles that are transported through the axons and stored in the axon ends. When needed, the hormones are secreted, enter the blood, and are transported by the circulatory system.

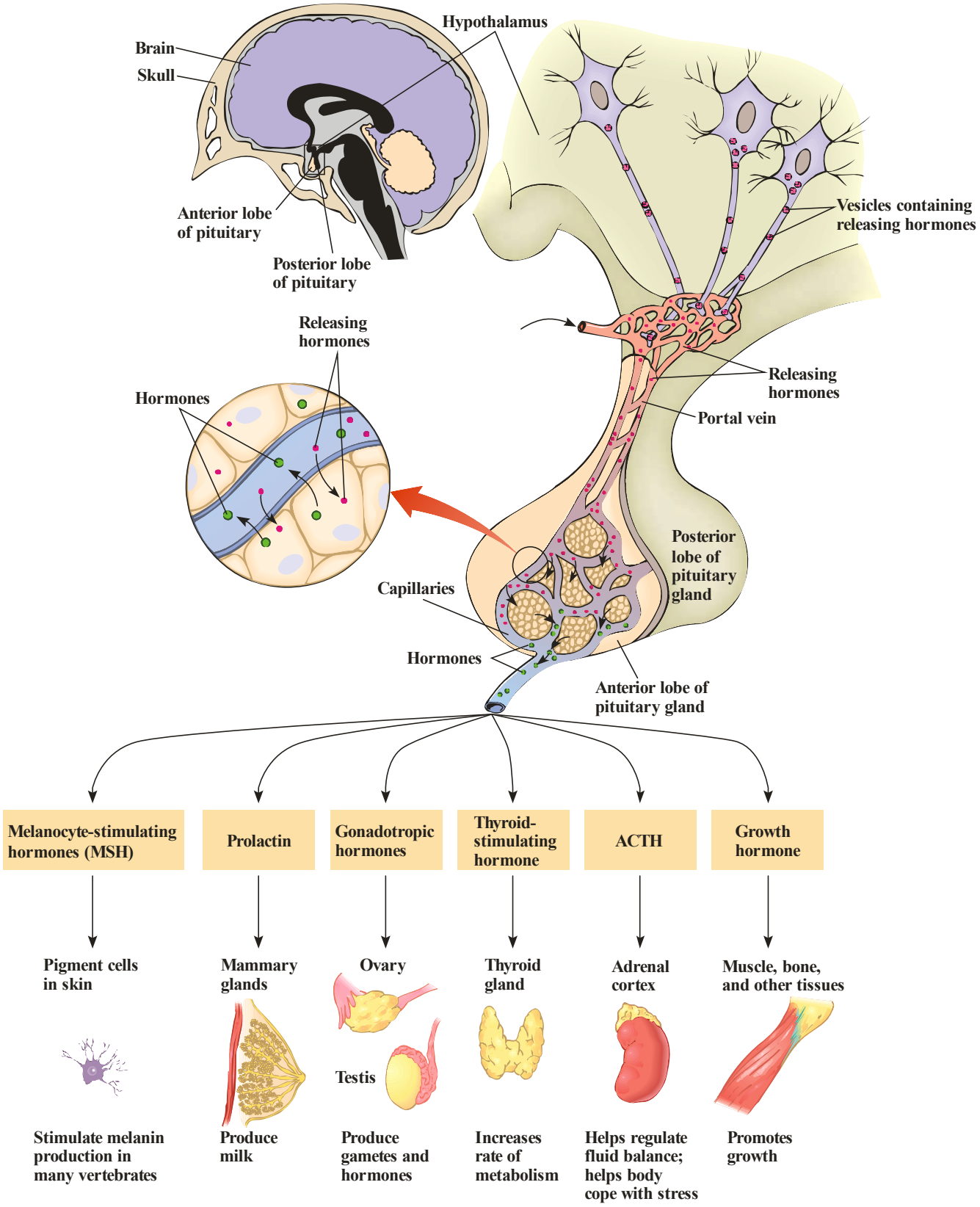


Figure : Synthesis and secretion of anterior pituitary hormones.
The hypothalamus secretes several specific releasing and inhibiting hormones that are transported to the anterior lobe of the pituitary gland by way of portal veins. These regulatory hormones stimulate or inhibit the release of specific hormones by cells of the anterior lobe. The anterior lobe secretes hormones that act on a wide variety of target tissues. (ACTH, adrenocorticotropic hormone)

* The pars distalis region of pituitary, commonly called anterior pituitary, produces growth hormone (GH), prolactin (PRL), thyroid stimulating hormone (TSH), adrenocortico-trophic hormone (ACTH), luteinizing hormone (LH) and follicle stimulating hormone (FSH).
* Pars intermedia secretes only one hormone called melanocyte stimulating hormone (MSH).
* In humans, the pars intermedia is almost merged with pars distalis.
* **Neurohypophysis (pars nervosa)** also known as posterior pituitary, stores and releases two hormones called **oxytocin** and **vasopressin**, which are actually synthesised by the hypothalamus and are transported axonally to neurohypophysis.
* Over-secretion of GH stimulates abnormal growth of the body leading to **gigantism** and low secretion of GH results in stunted growth resulting in **pituitary dwarfism**.
* Prolactin regulates the growth of the mammary glands and formation of milk in them.
* TSH stimulates the synthesis and secretion of thyroid hormones from the **thyroid gland**. ACTH stimulates the synthesis and secretion of steroid hormones called **glucocorticoids** from the adrenal cortex.
* LH and FSH stimulate gonadal activity and hence are called **gonadotrophins**.
* In males, LH stimulates the synthesis and secretion of hormones called **androgens** from testis.
* In males, FSH and androgens regulate spermatogenesis.
* In females, LH induces ovulation of fully mature follicles (graafian follicles) and maintains the corpus luteum, formed from the remnants of the graafian follicles after ovulation. FSH stimulates growth and development of the ovarian follicles in females.
* MSH acts on the melanocytes (melanin containing cells) and regulates pigmentation of the skin.
* Oxytocin acts on the smooth muscles of our body and stimulates their contraction. In females, it stimulates a vigorous contraction of uterus at the time of child birth, and milk ejection from the mammary gland.
* **Vasopressin** acts mainly at the kidney and stimulates resorption of water and electrolytes by the distal tubules and thereby reduces loss of water through urine (diuresis). Hence, it is also called as **anti-diuretic hormone (ADH).**
* 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".

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.

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.

Pituitary myxoedema :

* 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 disability. Hence, the person becomes disheartened.

Proportionate gigantism :

* 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.

Disproportionate gigantism 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 epiphyseal plate 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.

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

Ketosis :

* Increased breakdown of fat may release ketone bodies, mainly acetoacetic acid, in blood, causing ketosis.

THE PINEAL GLAND

* The pineal gland is located on the dorsal side of forebrain. Pineal secretes a hormone called **melatonin.**
* Melatonin plays a very important role in the regulation of a 24-hour (diurnal) rhythm of our body. For example, it helps in maintaining the normal rhythms of sleep-wake cycle, body temperature. In addition, melatonin also influences metabolism, pigmentation, the menstrual cycle as well as our defense capability.
* 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. Melatonin also is a potent antioxidant. Melatonin causes atrophy of gonads in several animals.

THYROID GLAND

* The thyroid gland is composed of two lobes which are located on either side of the trachea . Both the lobes are interconnected with a thin flap of connective tissue called **isthmus.**

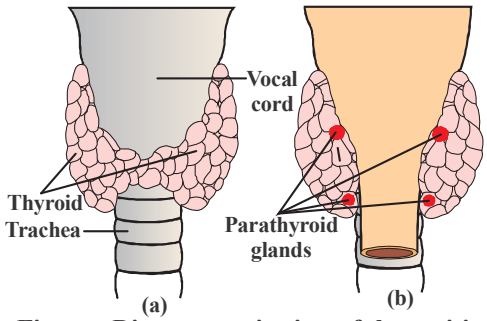


Figure : Diagrammatic view of the position of Thyroid and Parathyroid (a) Dorsal side (b) Ventral side

* The thyroid gland is composed of follicles and stromal tissues. Each thyroid follicle is composed of follicular cells, enclosing a cavity. These follicular cells synthesise two hormones, **tetraiodothyronine or thyroxine (T_4) and triiodothyronine (T_3).**

* Iodine is essential for the normal rate of hormone synthesis in the thyroid.
* Deficiency of iodine in our diet results in hypothyroidism and enlargement of the thyroid gland, commonly called **goitre.**
* 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 150mg of iodine from food. We can obtain this from dairy 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. Peroxidase continuosly oxidizes iodide ions into molecular iodine ($^- \rightarrow I_2$). Iodine is, then, released by follicular cells into follicular cavity.
* Thyroid hormones play an important role in the regulation of the basal metabolic rate. These hormones also support the process of red blood cell formation. Thyroid hormones control the metabolism of carbohydrates, proteins and fats. Maintenance of water and electrolyte balance is also influenced by thyroid hormones.
* Thyroid gland also secretes a protein hormone called **thyrocalcitonin (TCT)** which regulates the blood calcium levels.
* **Cretinism :** It is disease of infants, called cretins. 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) or endemic (absence of iodine in diet). It can be corrected by thyroxin administration.
* **Myxoedema :** It occurs due to deficiency of thyroxine in adults like cretinism, 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.
* **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.
* **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.
* **Simple goitre :** Hyperthyroidism may be simply because of overactive cells of a normal gland, or because of an enlargement of the gland, causing goitre.
* **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.
* **Grave's or Basedow's disease :** Enlargement of the gland is usually due to a diffused growth.
* **Plummer's disease or Toxic Adenoma :** It is due to formation of one or more hypersecretoy nodules plummer's diseases or Toxic Adenoma in the gland.

PARATHYROID GLAND

* In humans, four parathyroid glands are present on the back side of the thyroid gland, one pair each in the two lobes of the thyroid gland. The parathyroid glands secrete a peptide hormone called **parathyroid hormone (PTH)**. The secretion of PTH is regulated by the circulating levels of calcium ions.

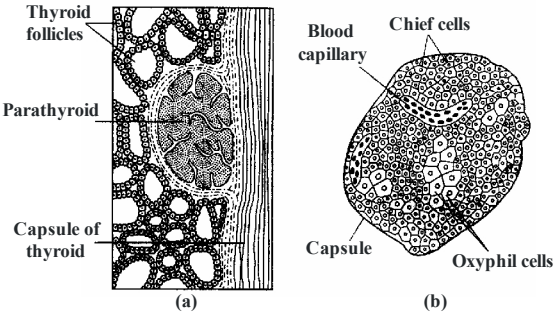


Fig : (a) Parathyroid gland embedded in the surface of thyroid. (b) Ultrastructure of a parathyroid

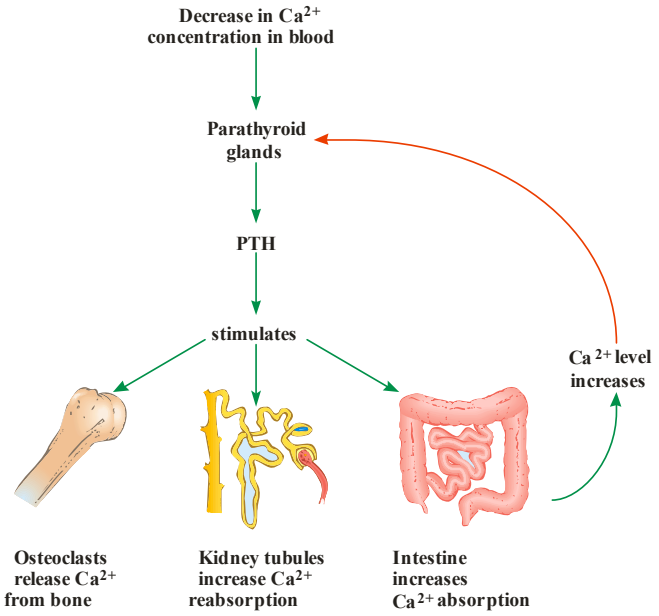
* Parathyroid hormone (PTH) increases the Ca^{2+} levels in the blood. PTH acts on bones and stimulates the process of bone resorption (dissolution/demineralisation).

* PTH also stimulates reabsorption of Ca^{2+} by the renal tubules and increases Ca^{2+} absorption from the digested food. It is, thus, clear that PTH is a hypercalcemic hormone, i.e., it increases the blood Ca^{2+} levels. Along with TCT, it plays a significant role in calcium balance in the body.

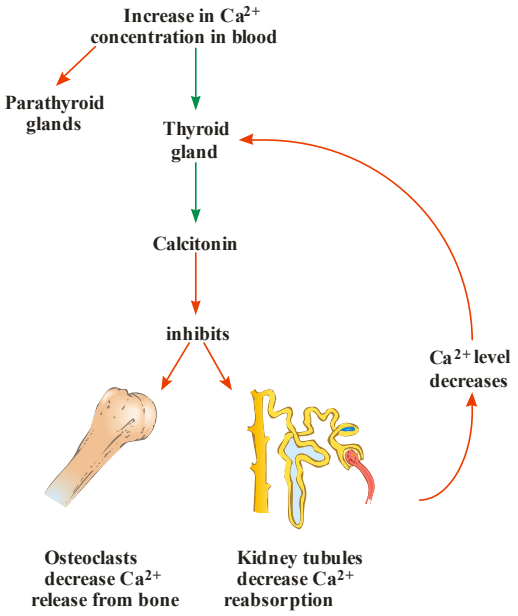
* **Hypoparathyroidism (Hyposecretion of parathormone)**

(i) 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.

(ii) 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 laryngeal, thoracic, and phrenic muscles, which help in breathing, causes death, because the patient fails to breathe (asphyxia).



(a) Calcium concentration too low. When calcium concentration decreases below the normal range, the parathyroid glands secrete parathyroid hormone (PTH). PTH stimulates homeostatic mechanisms that restore appropriate calcium concentration.



(b) Calcium concentration too high. When calcium concentration increases above its set point, the parathyroid glands are inhibited. The thyroid gland secretes calcitonin, which inhibits Ca^{2+} release from bone and decreases Ca^{2+} reabsorption in the kidneys.

Figure : Regulation of calcium homeostasis

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

* **Hyperparathyroidism (Hypersecretion of parathormone)**

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

(ii) **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.

(iii) **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.

THYMUS

* The thymus gland is a lobular structure located on the dorsal side of the heart and the aorta.

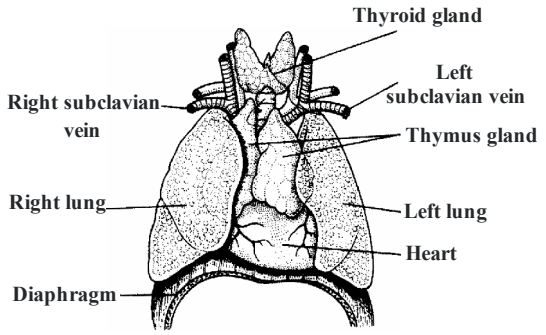


Figure : Location of thymus gland

* This gland secretes the peptide hormones called thymosins. Thymosins play a major role in the differentiation of T-lymphocytes, which provide cell-mediated immunity. In addition, thymosins also promote production of antibodies to provide humoral immunity.

* Thymus is degenerated in old individuals resulting in a decreased production of thymosins. As a result, the immune responses of old persons become weak.

ADRENAL GLAND

* Our body has one pair of adrenal glands, one at the anterior part of each kidney.

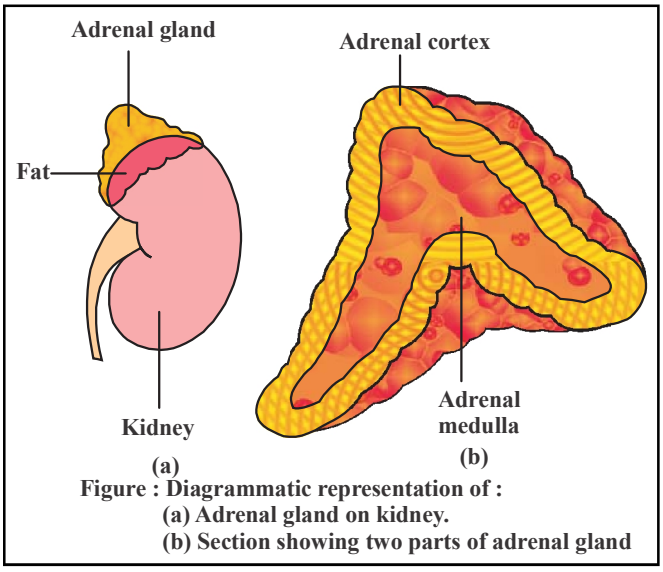


Figure : Diagrammatic representation of :
(a) Adrenal gland on kidney.
(b) Section showing two parts of adrenal gland

* The gland is composed of two types of tissues. The centrally located tissue is called the adrenal medulla, and outside this lies the adrenal cortex.

* The adrenal medulla secretes two hormones called **adrenaline or epinephrine and noradrenaline or norepinephrine**. These are commonly called as **catecholamines.**

* Adrenaline and noradrenaline are rapidly secreted in response to stress of any kind and during emergency situations and are called emergency hormones or hormones of Fight or Flight.

* These hormones increase alertness, pupilary dilation, piloerection (raising of hairs), sweating etc. Both the hormones increase the heart beat, the strength of heart contraction and the rate of respiration.

* Catecholamines also stimulate the breakdown of glycogen resulting in an increased concentration of glucose in blood. In addition, they also stimulate the breakdown of lipids and proteins.

* The adrenal cortex can be divided into three layers, called **zona reticularis (inner layer), zona fasciculata (middle layer) and zona glomerulosa (outer layer).**

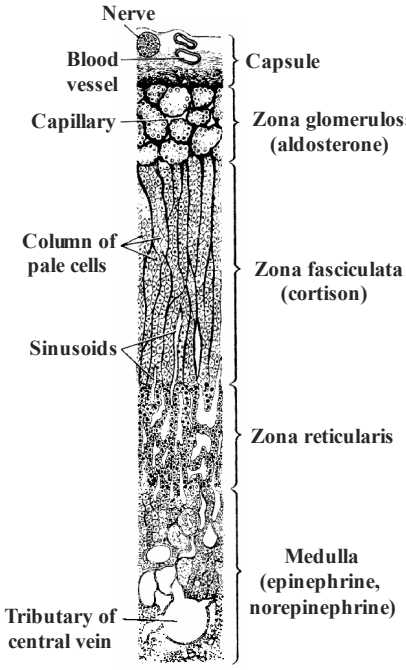


Fig : Adrenal gland with a part cut to show cortex and medulla

* The adrenal cortex secretes many hormones, commonly called as **corticoids.**
* The corticoids, which are involved in carbohydrate metabolism are called glucocorticoids. In our body, cortisol is the main **glucocorticoid.**
* Corticoids, which regulate the balance of water and electrolytes in our body are called **mineralocorticoids.**
* Aldosterone is the main mineralocorticoid in our body.
* Glucocorticoids stimulate, gluconeogenesis, lipolysis and proteolysis; and inhibit cellular uptake and utilisation of amino acids.
* Cortisol is also involved in maintaining the cardio-vascular system as well as the kidney functions.
* Glucocorticoids, particularly cortisol, produces antiinflamatory reactions and suppresses the immune response.
* Cortisol stimulates the RBC production.
* Aldosterone acts mainly at the renal tubules and stimulates the reabsorption of Na^+ and water and excretion of K^+ and phosphate ions.

Thus, aldosterone helps in the maintenance of electrolytes, body fluid volume, osmotic pressure and blood pressure.

* Small amounts of androgenic steroids are also secreted by the adrenal cortex which play a role in the growth of axial hair, pubic hair and facial hair during puberty.
* **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 described by Thomas Addison in 1849, 1855. It is maintained in following symptoms :

(i) Owing to low aldosterone and gluco-corticoides 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.

(ii) 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.

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

(iv) 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.

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

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

(vii) 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.

(viii) As increase in H+ concentration in blood may cause acidosis.

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

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

(ii) 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.

(iii) 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 (nocturia), etc. Similarly, excessive loss of H^+ in urine may cause alkalosis.

(iv) 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).

PANCREAS

* Pancreas is a composite gland which acts as both exocrine and endocrine gland.
* The endocrine pancreas consists of **'Islets of Langerhans'**. There are about 1 to 2 million Islets of Langerhans in a normal human pancreas representing only 1 to 2 per cent of the pancreatic tissue. The two main types of cells in the Islet of **α-cells** and **β-cells**. The α-cells secrete a hormone called **glucagon**, while the β-cells secrete **insulin.**

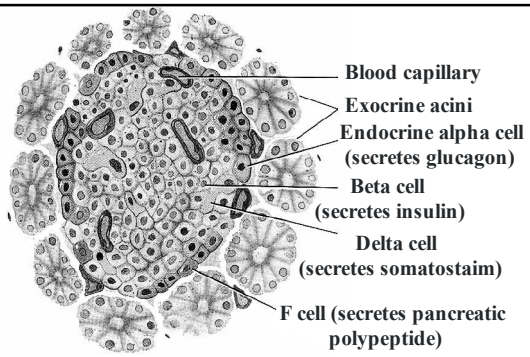


Fig : T.S. of pancreas

* Glucagon is a peptide hormone, and plays an important role in maintaining the normal blood glucose levels. Glucagon acts mainly on the liver cells (hepatocytes) and stimulates glycogenolysis resulting in an increased blood sugar (hyperglycemia).
* Glucagon reduces the cellular glucose uptake and utilisation. Thus, glucagon is a hyperglycemic hormone.
* Insulin is a peptide hormone, which plays a major role in the regulation of glucose homeostasis. Insulin acts mainly on hepatocytes and adipocytes (cells of adipose tissue), and enhances cellular glucose uptake and utilisation.
* Insulin also stimulates conversion of glucose to glycogen (glycogenesis) in the target cells.
* Prolonged hyperglycemia leads to a complex disorder called **diabetes mellitus** which is associated with loss of glucose through urine and formation of harmful compounds known as ketone bodies.

TESTIS

* A pair of testis is present in the scrotal sac (outside abdomen) of male individuals.
* Testis performs dual functions as a primary sex organ as well as an endocrine gland.
* Testis is composed of seminiferous tubules and stromal or interstitial tissue.

* The **Leydig cells or interstitial cells**, which are present in the intertubular spaces produce a group of hormones called androgens mainly testosterone.

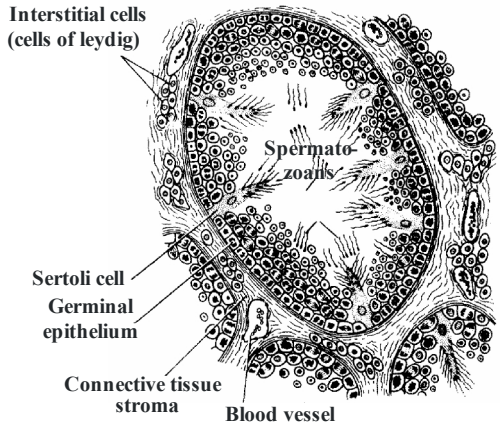


Figure : Testes

* **Androgens** regulate the development, maturation and functions of the male accessory sex organs like epididymis, vas deferens, seminal vesicles, prostate gland, urethra etc. These hormones stimulate muscular growth, growth of facial and axillary hair, aggressiveness, low pitch of voice etc. Androgens play a major stimulatory role in the process of spermatogenesis (formation of spermatozoa). Androgens act on the central neural system and influence the male sexual behaviour (libido). These hormones produce anabolic (synthetic) effects on protein and carbohydrate metabolism.

OVARY

* Females have a pair of ovaries located in the abdomen.
* Ovary is the primary female sex organ which produces one ovum during each menstrual cycle.
* In addition, ovary also produces two groups of steroid hormones called estrogen and progesterone.
* Ovary is composed of ovarian follicles and stromal tissues.
* The estrogen is synthesised and secreted mainly by the growing ovarian follicles. After ovulation, the ruptured follicle is converted to a structure called **corpus luteum**, which secretes mainly progesterone.

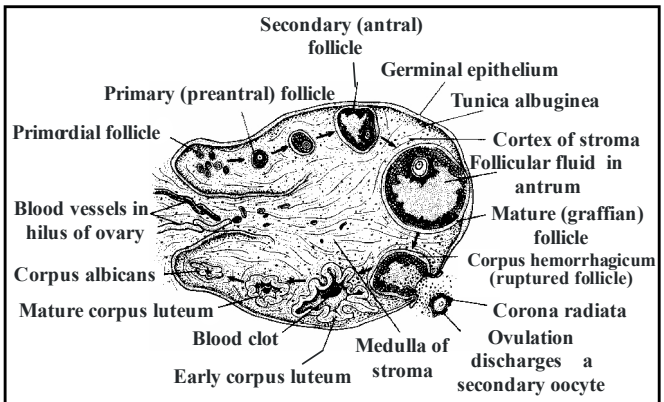


Figure : Ovary

* Estrogens produce wide ranging actions such as stimulation of growth and activities of female secondary sex organs, development of growing ovarian follicles, appearance of female secondary sex characters (e.g., high pitch of voice, etc.), mammary gland development.
* Progesterone supports pregnancy. Progesterone also acts on the mammary glands and stimulates the formation of alveoli (sac-like structures which store milk) and milk secretion.

MECHANISM OF HORMONE ACTION

* Hormones produce their effects on target tissues by binding to specific proteins called hormone receptors located in the target tissues only.
* Each receptor is specific to one hormone only and hence receptors are specific.
* Hormone-Receptor complex formation leads to certain biochemical changes in the target tissue. Target tissue metabolism and hence physiological functions are regulated by hormones.
* On the basis of their chemical nature, hormones can be divided into groups :

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

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

(iii) Iodothyronines (thyroid hormones)

(iv) Amino-acid derivatives (e.g., epinephrine).

* Hormones which interact with membrane-bound receptors normally do not enter the target cell, but generate **secondary messengers** (e.g., cyclic AMP, IP_3, Ca^{++} etc) which in turn regulate cellular metabolism. (Figure a).
* Hormones which interact with intracellular receptors (e.g., steroid hormones, iodothyronines, etc.) mostly regulate gene expression or chromosome function by the interaction of hormone-receptor complex with the genome. Cumulative biochemical actions result in physiological and developmental effects (Figure b)

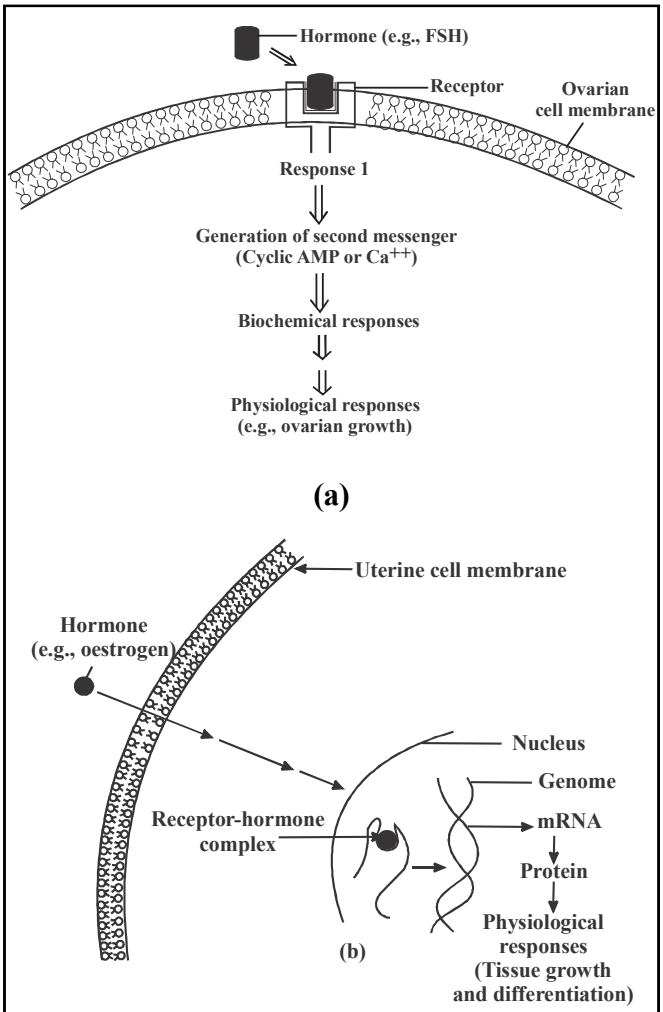


Figure : Diagramatic representation of the mechanism of hormone action : (a) Protein hormone (b) Steroid hormone

CONCEPT REVIEW

* Hormones can be grouped as fatty acid derivatives, steroids, amino acid derivatives, or peptides and proteins.
* Prostaglandins and the juvenile hormone of insects are **fatty acid derivatives.**
* Hormones secreted by the adrenal cortex, ovary, and testis, as well as the molting hormone of insects are **steroid hormones.**
* Thyroid hormones and epinephrine are **amino acid derivatives.**
* Antidiuretic hormone (ADH) and glucagon are examples of **peptide hormones**. Insulin is a small protein.
* Hormone secretion is typically regulated by **negative feedback mechanisms**, in which a hormone is released in response to some change in a steady state and triggers a response that counteracts the changed condition; this process restores homeostasis.
* Steroid hormones and thyroid hormones are hydrophobic molecules that pass through the plasma membrane and combine with receptors within the target cell; the hormone-receptor complex may activate or repress transcription of messenger RNA coding for specific proteins.
* Peptide hormones are hydrophilic and do not enter target cells. They combine with receptors on the plasma membrane of target cells. Many hormones bind to **G protein-linked receptors** that act via **signal transduction**. An extracellular hormone signal is transduced into an intracellular signal by the receptor.
* Most peptide hormones are first messengers that carry out their actions by way of **second messengers**, such as **cyclic AMP (cAMP)** or calcium ions. The G protein-linked receptor activates a **G protein**. The G protein either stimulates or inhibits an enzyme that affects the second messenger. For example, G proteins stimulate or inhibit **adenylyl cyclase**, the enzyme that catalyzes the conversion of ATP to cAMP.
* Many second messengers stimulate the activity of **protein kinases**, enzymes that phosphorylate specific proteins that affect the activity of the cell.

* **Inositol trisphosphate (IP_3) & diacylglycerol (DAG)** are second messengers that increase calcium concentration and activate enzymes. Calcium ions bind with calmodulin, which activates certain enzymes.
* **Receptor tyrosine kinases** are **enzyme-linked receptors** that bind growth factors, including insulin and nerve growth factor.
* **Signal amplification** occurs as each hormone-receptor complex stimulates the production of many second messenger molecules. Second messengers, in turn, activate protein kinase molecules that activate many protein molecules.
* Nervous and endocrine regulation are integrated in the **hypothalamus**, which regulates the activity of the **pituitary gland.**
* The neurohormones **oxytocin** and **antidiuretic hormone** (ADH) are produced by the hypothalamus and released by the **posterior lobe** of the pituitary. Oxytocin stimulates contraction of the uterus and stimulates ejection of milk by the mammary glands. ADH stimulates reabsorption of water by the kidney tubules.
* The hypothalamus secretes **releasing hormones** and **inhibiting hormones** that regulate the hormone output of the **anterior lobe** of the pituitary gland.
* The anterior lobe of the pituitary gland secretes growth hormone, prolactin, and several **tropic hormones** that stimulate other endocrine glands. **Prolactin** stimulates the mammary glands to produce milk.
* **Growth hormone (GH)** is an anabolic hormone that stimulates body growth by promoting protein synthesis. GH stimulates the liver to produce **insulin-like growth factors (IGFs),** which promote skeletal growth and general tissue growth.
* The **thyroid gland** secretes thyroid hormones: **thyroxine**, or T_4, and **triiodothyronine**, or T_3. Thyroid hormones stimulate the rate of metabolism.
* Regulation of thyroid secretion depends mainly on a negative feedback system between the anterior pituitary gland and the thyroid gland.
* Hyposecretion of thyroxine during childhood may lead to **cretinism**; during adulthood it may result in **myxedema**. **Goiter**, an abnormal enlargement of the thyroid gland, is associated with both hyposecretion and hypersecretion. The most common cause of hyperthyroidism is **Grave's disease**, an autoimmune disease.
* The **parathyroid glands** secrete parathyroid hormone (PTH), which regulates the calcium level in the blood. Parathyroid hormone increases calcium concentration by stimulating calcium release from bones, increasing calcium reabsorption by kidney tubules, and increasing calcium reabsorption from the intestine.
* **Calcitonin**, secreted by the thyroid gland, acts antagonistically to parathyroid hormone.
* The **islets of Langerhans** in the pancreas secrete insulin and glucagon. Insulin and glucagon secretion are regulated directly by glucose concentration.
* Insulin stimulates cells to take up glucose from the blood and so lowers blood glucose concentration.
* Glucagon raises blood glucose concentration by stimulating conversion of glycogen to glucose (glycogenolysis) and by stimulating production of glucose from other nutrients (gluconeogenesis).
* In **diabetes mellitus**, either insulin deficiency or insulin resistance results in decreased use of glucose, increased fat mobilization, increased protein use, and electrolyte imbalance.
* The **adrenal glands** secrete hormones that help the body cope with stress.
* The **adrenal medulla** secretes epinephrine and norepinephrine, hormones that help the body respond to danger by increasing the heart rate, metabolic rate, and the strength of muscle contraction. These hormones also reroute blood to organs needed for fight or flight.
* The **adrenal cortex** secretes sex hormones; mineralo-corticoids, such as aldosterone; and glucocorticoids, such as cortisol. Aldosterone increases the rate of sodium reabsorption and potassium excretion by the kidneys. Cortisol promotes gluconeogenesis.
* During stress, the adrenal cortex ensures adequate fuel supplies for the rapidly metabolizing cells.

IMPORTANT POINTS

* Thymus grows to the maximum size at puberty and then diminishes gradually.
* Gland responsible for calcium metabolism is parathyroid.
* The no. of hormones secreted from anterior pituitary is 6.
* Spleen does not secrete any hormone.
* Leydig cells secrete androgens.
* Secretion of estrogen is under the control of FSH.
* Pituitary gland is under the control of hypothalamus.
* Follicle stimulating hormone (FSH) is secreted by anterior pituitary.
* FSH and LH are gonadotropin hormones.
* Addisons disease is due to defect in adrenals.
* Failure or reduced insulin production causes diabetes mellitus.
* Pineal gland produces melatonin.
* Hormone having stimulatory effect on heart is adrenaline.
* Blood calcium is increased by administration of parthormone.
* Thyroxine is not secreted by pituitary.
* Androgen is male hormone.
* Pituitary gland occurs in brain.
* Secretin hormone is secreted by duodenum and stimulates pancreas.
* Thymus becomes inactive after puberty.
* Hormone controlling metabolism is thyroxine from thyroid.
* ADH is not secreted by anterior pituitary.
* Mensuration is caused by abrupt decrease of LH.
* Volume of urine to be excreted by kidney is well regulated by ADH.
* ANF = Decrease blood pressure
  MSH = Pigmentation
  GIP = Inhibits gastric secretion
  TCT = Regulates blood calcium level
* Pineal gland is located in brain.
* Thyroid gland is the largest endocrine gland in the body.
* Endostyle of lower vertebrates like Herdmania, Amphioxus is homologous of thyroid gland.
* Thyroid is the only endocrine gland in the body which stores its hormone in its inactive state.
* The oxidation of iodine is promoted by the enzyme peroxidase.
* 21 October is Iodine deficiency day
* Thyroxine stimulates the metamorphosis of tadpole larva in amphibians.

* **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 (Aldosterone) and Glucocorticoids (cortisol)	Deficiency	Adrenal cortex
Conn's disease	Mineralocorticoids	Excess	Adrenal cortex
Cushing's disease	Corticosteroid	Excess	Adrenal cortex

* Table : Consequences of Endocrine Malfunction

Hormone	Hyposecretion	Hypersecretion
Growth hormone	Pituitary dwarfism	Gigantism if malfunction occurs in childhood; acromegaly in adult.
Thyroid hormones	Cretinism (in children); myxedema, a condition of prounounced adult hypothyroidism; dietary iodine deficiency leads to hyposecretion and goiter.	Hyperthyroidism; increased metabolic rate, nervousness, irritability; goiter, can be caused by Grave's disease.
Parathyroid hormone	Spontaneous discharge of nerves; spasms; tetany; death	Weak, brittle bones; kidney stones.
Insulin	Diabetes mellitus	Hypoglycemia
Hormones of adrenal cortex	Addison's disease	Cushing's disease

* Table : Some Endocrine Glands and Their Hormones

Gland	Hormone	Target tissue	Principal actions
Hypothalamus	Releasing and inhibiting hormones	Anterior lobe of pituitary	Regulate secretion of hormones by the anterior pituitary
Posterior pituitary (storage and release of hormones produced by hypothalamus)	Oxytocin Antidiuretic hormone (ADH)	Uterus Mammary glands Kidneys (collecting ducts)	Stimulates contraction Stimulates ejection of milk into ducts. Stimulates reabsorption of water.
Anterior pituitary	Growth hormone (GH) Prolactin Thyroid-stimulating hormone (TSH) Adrenocorticotropic hormone (ACTH) Gonadotropic hormones (follicle-stimulating hormone [FSH]; luteinizing hormone [LH])	General Mammary glands Thyroid gland Adrenal cortex Gonads	Stimulates growth of skeleton and muscle Stimulates milk production Stimulates secretion of thyroid hormones Stimulates secretion of adrenal cortical hormones Stimulate gonad function and growth
Thyroid gland	Thyroxine (T_4) and triiodothyronine (T_3) Calcitonin	General Bone	Stimulate metabolic rate; regulate energy metabolism Lowers blood-calcium level
Parathyroid glands	Parathyroid hormone	Bone, kidneys digestive tract	Regulates blood-calcium level
Pancreas	Insulin Glucagon	General Liver, adipose tissue	Lowers blood glucose concentration Raises blood glucose concentration
AdrenalMedulla	Epinephrine and norepinephrine	Muscle; blood vessels; liver; adipose tissue	Help body cope with stress; increase metabolic rate; raise blood glucose level; increase heart rate and blood pressure
Adrenal Cortex	Mineralocorticoids Glucocorticoids	Kidney tubules General	Maintain sodium and potassium balance. Help body cope with long-term stress; raise blood-glucose level.
Pineal gland	Melatonin	Hypothalamus	Important in biological rhythms
Ovary	Estrogens Progesterone	General; uterus Uterus; breast	Develop and maintain sex characteristics in female; stimulate growth of uterine lining Stimulates development of uterine lining
Testis	Testosterone	General; reproductive structures	Develops and maintains sex characteristics in males; promotes spermatogenesis

QUESTION BANK

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

SECTION - 1 (VOCABULARY BUILDER)

Choose one correct response for each question.

For Q.1-Q.5

Match the column I with column II.

Q.1

	Column I	Column II
(a)	PRL	(i) Gonadotropins
(b)	TSH	(ii) Glucbcorticoids
(c)	ACTH	(iii) Thyroid hormone
(d)	LH and FSH	(iv) Mammary glands

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

Q.2

	Column I	Column II
(a)	Protein hormones	(i) Epinephrine
(b)	Steroid hormones	(ii) Testosterone, progesterone
(c)	Iodothyronines hormones	(iii) Thyroid
(d)	Amino acid derivatives hormones	(iv) Insulin and glucagon

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

Q.3

	Column I	Column II
(a)	Gastrin	(i) Inhibit gastric secretion.
(b)	Secretin	(ii) Acts on gall bladder.
(c)	CCK	(iii) Stimulate secretion of water and bicarbonate ions.
(d)	GIP	(iv) Secretion of HCl

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

Q.4

	Column I (Endocrine gland)	Column II (Hormones)
a.	Pineal	i. Epinephrine
b.	Thyroid	ii. Melatonin
c.	Ovary	iii. Estrogen
d.	Adrenal medulla	iv. Tetraiodothyronine

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

Q.5

	Column I	Column II
(a)	T_4	(i) Hypothalamus
(b)	PTH	(ii) Thyroid
(c)	GnRH	(iii) Pituitary
(d)	LH	(iv) Parathyroid

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

SECTION - 2 (BASIC CONCEPTS BUILDER)

For Q.6 to Q.21 :

Choose one word for the given statement from the list.

Androgenic, Adrenal, Sella turcica, Hypothalamus, Pituitary; Two, Nerve, Interstitial cells, Intertubular spaces, Testosterone, Continuously, Scrotal sac, Gastric, Iodine, Hypothyroidism, Goitre, Stimulates, Pepsinogen, Axons, Nerve, Pituitary, Portal, Anterior, CNS, Libido, Anabolic, Specific, Target tissue, Hormones, Dorsal, Epinephrine, Heart, Norepinephrine, Graafian follicle, Emergency, Catecholamines, Cell membrane receptors, Nuclear receptors, Corpus luteum, Progesterone, Immune, LH

Q.6 The ____ fibres do not innervate all cells of the body and cellular functions need to be ____ regulated, A special kind of coordination and integration has to be provided. This function is carried out by ____.

Q.7 The thymus gland is a lobular structure located on the ____ side of the ____ and aorta. The thymus plays a significant role in the development ____ system.

Q.8 Hormones originating in the hypothalamic neurons, pass through ____ and are released from their ____ endings. These hormones reach the ____ gland through a ____ circulatory system and regulate the functions of the ____ pituitary.

Q.9 A pair of testis are present in the ____ of humans (male).

Q.10 Gastrin acts on ____ gland and _____ the secretion of HCl and ____.

Q.11 Small amount of ____ steroids are secreted by ____ cortex which play a role in the growth of axial hair, pubic hair and facial hair during puberty.

Q.12 Each receptor is ____ to one hormone only and hence, receptors are ____. Hormone receptor complex formation leads to certain biochemical changes in the ____.

Q.13 Hormones released by the neurosecretory cells in hypothalamus regulate the ____ gland. Mainly the neurosecretory hormones are of ____ types.

Q.14 Androgens act on the _____ and influence the male sexual behaviour called ____ These hormones produce ____effect on protein and carbohydrate metabolism.

Q.15 In females the ____ induces the ovulation of fully mature follicle called ____ and maintain the ____ formed from remnants of the Graafian follicle after ovulation.

Q.16 ____ is essential for the normal rate of hormone synthesis in the thyroid. Deficiency of iodine in our diet results in ____ and enlargement of the thyroid gland, commonly called ____.

Q.17 The pituitary gland is located in a bony cavity called ____ and is attached to ____ by a stalk.

Q.18 The hydrophilic hormones interact with ____. While the hydrophobic hormones interact with ____.

Q.19 The adrenal medulla secretes two hormones called adrenaline or ____ and noradrenaline or _____. These are commonly called as ____ Adrenaline and noradrenaline are rapidly secreted in response to stress of any kind and during ____ situations and are called emergency hormones or hormones of fight or flight.

Q.20 The estrogen is synthesised and secreted mainly by growing ____. After ovulation the ruptured follicle is converted to a structure called ____ which secretes ____.

Q.21 The Leydig cells or ____ cells which are present in ____ Spaces produce a group of hormone called androgens mainly ____.

For Q.22-Q.26

Select target gland from the list :
[Adrenal Cortex, Pituitary Gland, Thyroid Gland, Pineal Gland, Testis and Ovaries]

Q.22 Hypothalamic hormones ____.

Q.23 Thyrotrophin (TSH) ____.

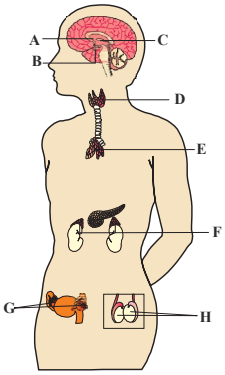
Q.24 Corticotrophin (ACTH) ____.

Q.25 Gonadotrophins (LH, FSH)____.

Q.26 Melanotrophin (MSH) ____.

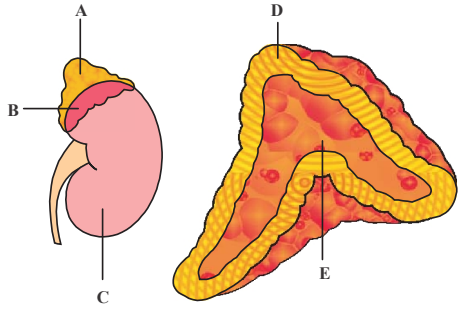
SECTION - 3 (ENHANCE DIAGRAM SKILLS)

Q.27 Identify different endocrine glands in human (A to H).



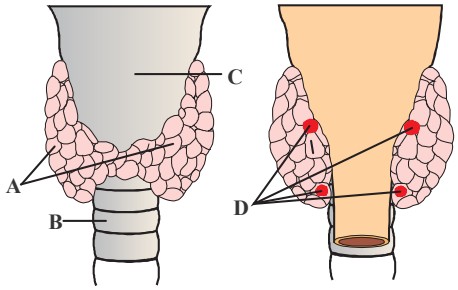
(A) A-Pineal, B-Hypothalamus, C-Pituitary, D-Thyroid and Parathyroid, E-Thymus, F-Adrenal, G-Ovary, H-Testis
(B) A-Hypothalamus, B-Pituitary, C-Pineal, D-Thyroid and parathyroid E-Thymus, F-Adrenal, G-Ovary, H-Testis
(C) A-Hypothalamus, B-Pineal, C-Pituitary, D-Thyroid and Parathyroid, E-Thymus, F-Adrenal, G-Testis, H-Ovary
(D) A-Hypothalamus, B-Pineal, C-Pituitary, D-Thyroid and Parathyroid, E-Adrenal, F-Thymus, G-Testis, H-Ovary

Q.28 Identify A to E in the following figure.



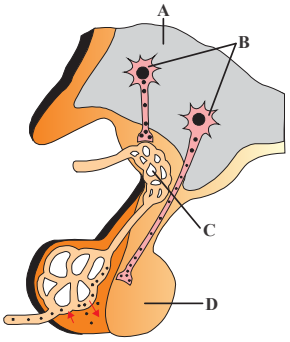
(A) A-Adrenal gland, B-Fat, C-Kidney, D-Adrenal cortex, E-Adrenal medulla
(B) A-Fat, B-Adrenal gland, C-Kidney, D-Adrenal cortex, E-Adrenal medulla
(C) A-Fat, B-Adrenal gland, C-Kidney, D-Adrenal medulla, E-Adrenal cortex
(D) A-Adrenal gland, B-Fat, C-Kidney, D-Adrenal medulla, E-Adrenal cortex

Q.29 Identify A, B, C and D in the given diagram.



(A) A-Thyroid, B-Trachea, C-Vocal cord, D-Parathyroid glands
(B) A-Trachea, B-Thyroid, C-Vocal cord, D-Parathyroid glands
(C) A-Trachea, B-Vocal cord, C-Thyroid, D-Parathyroid glands
(D) A-Parathyroid glands, B-Thyroid, C-Vocal cord, D-Trachea

Q.30 Identify A to D in the given figure.



(A) A-Hypothalamic neuron, B-Hypothalamus, C-Portal circulation, D-Posterior pituitary
(B) A-Hypothalamus, B-Hypothalamic neuron, C-Portal circulation, D-Posterior pituitary
(C) A-Hypothalamus, B-Hypothalamic neuron, C-Posterior pituitary, D-Portal circulation
(D) A-Hypothalamus, B-Hypothalamic neuron, C-Posterior pituitary, D-Neurohypophysis

SECTION - 4 (ENHANCE PROBLEM SOLVING SKILLS)

Choose one correct response for each question.

PART - 1 : ENDOCRINE GLANDS AND HORMONES

Q.31 I. Non-nutrient
II. Intercellular messenger
III. Produced in trace amount
IV. Intracellular messenger
Select the correct properties of hormones –
(A) I, II and III (B) II, III and IV
(C) I, II and IV (D) I, III and IV

Q.32 All the following tissues in mammals except one consists of a central 'medullary' region surrounded by a cortical region. Mark the wrong entry
(A) Ovary (B) Adrenal
(C) Liver (D) Kidney

Q.33 Heterocrine glands are the glands, which
(A) work as exocrine glands.
(B) work as endocrine glands.
(C) have dual (exo and endocrine) mode of function.
(D) are present in the hypothalamus region of brain.

Q.34 Identify which of the following are endocrine glands?
I. Liver II. Gastric gland
III. Pituitary gland IV. Thyroid
(A) I and II (B) III and IV
(C) I and IV (D) II and IV

Q.35 Proinsulin is a –
(A) hormone (B) vitamin
(C) prohormone (D) enzyme

PART - 2 : HUMAN ENDOCRINE SYSTEM

Q.36 GnRh (Gonadotropin Releasing Hormone) stimulates the –
(A) pituitary to release the gonadotropin.
(B) pituitary for synthesis and release of gonadotropin.
(C) testis to release the gonadotropin
(D) hypothalamus to release the gonadotropin.

Q.37 PTH is a –
(A) hypercalcemic (B) hypocalcemic
(C) endocalcemic (D) exocalcemic

Q.38 Pineal gland secretes
(A) FSH (B) LH
(C) Melatonin (D) GH

Q.39 Leydig cells produce a group of hormones called
(A) Androgens (B) Estrogens
(C) Aldosterone (D) Gonadotropins

Q.40 The thyroid gland is composed of
(A) follicles (B) stromal tissue
(C) trachea (D) Both (A) and (B)

Q.41 Pituitary gland is divided into
(A) adenohypophysis and neurohypophysis.
(B) adenohypophysis and pars distalis.
(C) adenohypophysis and pars intermedia.
(D) adenohypophysis and anterior pituitary.

Q.42 Which of following do not belongs to the hormones of anterior pituitary origin –
(A) Growth hormone
(B) Follicle stimulating hormone
(C) Oxytocin
(D) Adrenocorticotrophic hormone

Q.43 Islets of Langerhans have ___ cells which secrete ____ hormone. This hormone reduces the blood glucose level by converting glucose into glycogen. Islets of Langerhans have ___ cells which secrete ____ hormone. This hormone increase the blood glucose by converting glycogen to glucose.
(A) α, glucagon, α, insulin
(B) α, insulin, β, glucagon
(C) β, insulin, α, glucagon
(D) α, glucagon, β, insulin

Q.44 In males, LH stimulates the synthesis and secretion of hormones called –
(A) gonadotropins (B) androgens
(C) testosterone (D) oxytocin

Q.45 Diurnal rhythm of our body is maintained by
(A) thyroid gland (B) pineal gland
(C) pituitary gland (D) hypothalamus

Q.46 Secretion of PTH is regulated by the circulating levels of ____ in blood.
(A) Na^+ (B) I^-
(C) Ca^{2+} (D) Fe^{2+}

Q.47 Corpus luteum secretes a hormone called
(A) Prolactin (B) Progesterone
(C) Aldosterone (D) Testosterone

Q.48 Insulin is
(A) hypoglycemic hormone
(B) decreases the blood sugar
(C) act on adipose tissue and hepatocytes
(D) All of the above

Q.49 Mary is about to face an interview. But during the first five minutes before the interview she experiences sweating, increased rate of heart beat, respiration etc. Which hormone is responsible for her restlessness?
(A) Estrogen and progesterone
(B) Oxytocin and vasopressin
(C) Adrenaline and noradrenaline
(D) Insulin and glucagon

Q.50 Functions of oxytocin is/are
(A) smooth muscle contraction.
(B) contraction of uterus.
(C) milk ejection.
(D) All of the above.

Q.51 Adrenal gland is present at the
(A) lateral side of each kidney.
(B) dorsal side of each kidney.
(C) posterior side of each kidney.
(D) anterior side of each kidney.

Q.52 Cortisol is secreted from
(A) Pancrease (B) Thyroid
(C) Adrenal (D) Thymus

Q.53 Glucagon is –
(A) peptide hormone
(B) increases the blood sugar
(C) hyperglycemic hormone
(D) All of the above

Q.54 T_3 and T_4 hormones are synthesised by –
(A) follicles (B) stromal tissue
(C) isthmus (D) Both (A) and (C)

Q.55 Diabetic patients are successfully treated by
(A) glucagon therapy
(B) insulin therapy
(C) combination of glucagon and insulin therapy
(D) All of the above

Q.56 Hypothalamus is the
(A) anterior part of diencephalon.
(B) posterior part of diencephalon.
(C) interior part of diencephalon.
(D) basal part of diencephalon.

Q.57 Pars intermedia is a part of
(A) neurohypophysis
(B) adenohypophysis
(C) posterior lobe of pituitary
(D) hypothalamus

Q.58 Estrogen –
(A) stimulate the growth of ovarian follicle.
(B) stimulate the appearance of secondary sex characters.
(C) stimulate the growth of mammary gland.
(D) All of the above

Q.59 Hypothalamus releases two types of hormones mainly
(A) Stimulating hormones; Releasing hormones
(B) Stimulating hormones; Inhibiting hormones
(C) Exocrine hormones; Inhibiting hormones
(D) Exocrine hormones; Stimulating hormones

Q.60 Corticoids are the hormones, which are secreted by
(A) kidney (B) adrenal cortex
(C) adrenal medulla (D) hypothalamus

Q.61 Gigantism & dwarfism are the disease related to
(A) prolactin hormone of mammary gland.
(B) growth hormone of adenohypophysis.
(C) luteinising hormone of pituitary gland.
(D) thyroid stimulating hormone of thyroid.

Q.62 Major roles of thymus gland in humans is/are –
(A) differentiation of T-lymphocytes
(B) differentiation of B-lymphocytes
(C) promote production of antibodies
(D) Both (A) and (C)

Q.63 The thyroid gland is composed of ____ lobes which are located on either side of the ____ the lobes are interconnected with a thin flap of connective tissue called ____.
(A) 3, trachea, isthmus (B) 4, trachea, isthmus
(C) 2, trachea, isthmus (D) 1, trachea, isthmus

Q.64 In males, the spermatogenesis is regulated by
(A) FSH (B) androgens
(C) Both (A) and (B) (D) hypothalamus

Q.65 Androgens regulates
(A) development of accessory sex organs.
(B) muscular growth.
(C) maturation of accessory sex organs.
(D) All of the above.

Q.66 The posterior pituitary is under the
(A) direct neural regulation of the adenohypophysis.
(B) direct neural regulation of the hypothalamus.
(C) direct axonal regulation of the adenohypophysis.
(D) direct axonal regulation of the neurohypophysis.

Q.67 Ovary produces
(A) one ovum at each month (B) progesterone
(C) estrogen (D) All of these

Q.68 Islets of Langerhans in a normal human pancreas comprise only
(A) 2-3% of pancreatic tissue
(B) 1-2% of pancreatic tissue
(C) 3-4% of pancreatic tissue
(D) 4-5% of pancreatic tissue

Q.69 Number of parathyroid glands present on the back side of thyroid gland is
(A) 2 (B) 3
(C) 4 (D) 5

Q.70 The steroid responsible for balance of water and electrolytes in our body is
(A) Insulin (B) Melatonin
(C) Testosterone (D) Aldosterone

Q.71 Pineal gland is located on the
(A) ventral side of forebrain.
(B) lateral side of forebrain.
(C) dorsal side of forebrain
(D) back side of forebrain.

Q.72 Glucocorticoids are the corticoids which
(A) are involved in protein metabolism
(B) are involved in fat metabolism
(C) are involved in glucose metabolism
(D) All of the above

Q.73 In humans, testis functions as
(A) primary sex organ
(B) secondary sex organ
(C) endocrine gland
(D) Both (A) and (C)

Q.74 Oxytocin and vasopressin is stored and released by
(A) anterior lobe of pituitary.
(B) posterior lobe of pituitary.
(C) intermediate lobe of pituitary.
(D) hypothalamus lobe of pituitary.

Q.75 Cretinism, mental retardation, low intelligence quotient, abnormal skin, deaf-mutism, etc. are the results of
(A) hyperthyroidism (B) goitre
(C) hypothyroidism (D) Both (B) and (C)

Q.76 Pancreas acts as
(A) exocrine gland (B) endocrine gland
(C) Both (A) and (B) (D) holocrine gland

Q.77 Immune response of old age person becomes weak due to the degeneration of gland.
(A) thyroid (B) parathyroid
(C) thymus (D) hypothalamus

Q.78 A pair of ovary is located ___ of female (human).
(A) outside the abdomen
(B) inside the abdomen
(C) inside the scrotal sac
(D) inside the inguinal canal

Q.79 Thymosin is responsible for
(A) Raising the blood sugar level
(B) Raising the blood calcium level
(C) Increased production of T lymphocytes
(D) Decrease in blood RBC

Q.80 Resorption of water and electrolytes by distal tubules of kidney & thereby diuresis reducing the loss of water through urine (diuresis) is done by
(A) oxytocin (B) vasopressin
(C) FSH (D) LH

Q.81 Hypothalamus contains several group of neurosecretory cells called –
(A) hormones (B) pituitary gland
(C) nuclei (D) protoplasm

Q.82 Gluconeogenesis, lipolysis and proteolysis processes are stimulated by
(A) glucocorticoids (B) mineralocorticoids
(C) Both (A) and (B) (D) None of the above

Q.83 Somatostatin from hypothalamus gland
(A) activates the release of growth hormone.
(B) inhibits the release of growth hormone.
(C) inhibits the release of enzymes in the digestive tract.
(D) activates the release of enzymes pineal gland.

Q.84 Development of epididymis, vas deferens, seminal vesicles, prostate glands and urethra is controlled by –
(A) estrogen (B) progesterone
(C) androgen (D) pituitary hormone

Q.85 Thymus gland releases ____ hormone.
(A) T_4 (B) T_3
(C) thymosins (D) TCT

Q.86 Pigmentation of skin in humans is maintained by
(A) FSH (B) LH
(C) MSH (D) ACTH

Q.87 Storing and release of vasopressin and oxytocin is done by –
(A) adenohypophysis (B) neurohypophysis
(C) hypothalamus (D) thyroid

Q.88 Cortisol is involved in –
(A) maintaining cardio-vascular system.
(B) kidney functions.
(C) RBC production.
(D) All of the above

PART - 3 : HORMONES OF HEART, KIDNEY AND GASTROINTESTINAL TRACT

Q.89 JGC (Juxtaglomerular cell) secretes
(A) ANF (B) erythropoietin
(C) renin (D) angiotensinogen

Q.90 ANF has exactly opposite function of which of hormone secreted.
(A) PTH (B) estrogen
(C) aldosterone (D) androgen

Q.91 'GIP' stimulates the release of
(A) glucagon (B) insulin
(C) calcitonin (D) thyrocalcitonin

Q.92 CCK acts on
(A) pancreas (B) gall bladder
(C) Both (A) and (B) (D) liver

Q.93 Gastrointestinal hormones are
(A) steroidal in nature
(B) proteinaceous in nature
(C) glycoproteinaceous in nature
(D) Both (A) and (B)

Q.94 Erythropoietin
(A) stimulates erythropoiesis
(B) inhibits erythropoiesis
(C) inhibits platelets formation
(D) stimulates platelets formation

Q.95 Cholecystokinin is secreted by
(A) large intestine (B) small intestine
(C) liver (D) spleen

Q.96 Which hormone acts on the exocrine part of pancreas and stimulates secretion of water and bicarbonate ions?
(A) Gastric (B) Secretin
(C) CCK (D) GIP

Q.97 'ANF' is a hormone, which
(A) is secreted when BP is increased
(B) decreases BP
(C) causes vasodilation
(D) All of the above

Q.98 GIP (Gastric Inhibitory Peptide)
(A) inhibits the gastric secretion and motility.
(B) inhibits the gastric secretion only.
(C) activate the gastric secretion and motility.
(D) activate the gastric secretion only.

Q.99 'ANF' is secreted by
(A) venous wall of heart (B) atrial wall of heart
(C) Both (A) and (B) (D) None of these

Q.100 Gastroinhibitory polypeptide is released/secreted by
(A) small intestine (B) spleen
(C) hypothalamus (D) pineal gland

PART - 4 : MECHANISM OF HORMONE ACTION

Q.101 Receptor hormone complex is formed when, the binding of
(A) hormone to its respective receptor takes place.
(B) enzyme to its respective receptor takes place.
(C) Both (A) and (B)
(D) Protiens to ER takes place

Q.102 Lipid soluble hormone works by interacting with
(A) intracellular receptors
(B) intercellular receptors
(C) enzymes
(D) producing enzymes

Q.103 Hormones which interact with intracellular receptors are –
I. Steroid hormones II. ACTH
III. Iodothyronines IV. MSH
(A) I and III (B) II and IV
(C) II and III (D) I and IV

Q.104 In the mechanism of action of a protein hormone, one of the second messengers is
(A) Cyclic AMP (B) Insulin
(C) T_3 (D) Gastrin

Q.105 Hormones produce their effect on target tissue by binding to specific proteins called as –
(A) target proteins (B) activator proteins
(C) inhibitor proteins (D) hormone receptors

Q.106 Steroid hormones typically alters the activity of target cells by
(A) activating primary messenger
(B) activating secondary messenger
(C) interacting with intracellular receptors
(D) None of the above

Q.107 Hormone which interact with membrane bound receptors normally
(A) enters into the cell membrane.
(B) don't enter into the cell.
(C) generate secondary messenger.
(D) Both (B) and (C)

Q.108 Some hormone need the secondary messenger, because –
(A) they need activator
(B) they can't cross cell membrane
(C) they can cross cell membrane
(D) they need a prosthetic group

Q.109 Intracellular receptors are mostly
(A) cytoplasmic receptors
(B) membrane receptors
(C) nuclear receptors
(D) ER receptors

Q.110 Which of them are the secondary messengers?
I. Cyclic AMP II. IP_3 III. Ca^{2+}
(A) I and II (B) II and III
(C) I and III (D) I, II and III

EXERCISE - 2 (LEVEL-2)

Choose one correct response for each question.

Q.1 A chemical released from an epithelial cell gland that enters the blood to affect the activity of another cell some distance away.
(A) hormone (B) neurohormone
(C) pheromone (D) exocrine gland secretion

Q.2 The hormone and target involved in elevating blood glucose by glycogenolysis and gluconeogenesis.
(A) insulin and pancreas
(B) glucagon and liver
(C) TSH and thyroid
(D) ACTH & adrenal cortex

Q.3 Incorrect about endocrine glands?
(A) they secrete hormones
(B) they have ducts
(C) their product is typically transported by the blood.
(D) they are typically regulated by negative feedback.

Q.4 A chemical produced by one cell that has a specific regulatory effect on another cell is the definition of a –
(A) neurohormone (B) hormone
(C) exocrine gland secretion (D) pheromone

Q.5 A cell secretes a product that diffuses through the interstitial fluid and acts on nearby cells. This is an example of –
(A) neuroendocrine secretion
(B) autocrine regulation
(C) paracrine regulation
(D) classical endocrine control

Q.6 Which of the following is/are true of steroid hormones?
(A) hydrophilic
(B) secreted by the posterior pituitary.
(C) typically work through G proteins and cyclic AMP.
(D) typically bind with receptor in nucleus and affect transcription.

Q.7 Which of the following is not a correct pair?
(A) neurohormone; brain hormone.
(B) calcium; calmodulin.
(C) posterior lobe of pituitary; releasing hormone.
(D) anterior lobe of pituitary; growth hormone.

Q.8 Growth hormone –
(A) is regulated mainly by calcium level.
(B) stimulates the liver to produce insulin-like growth factors.
(C) is a catabolic hormone.
(D) stimulates metabolic rate.

Q.9 Parathyroid hormone –
(A) increases glucose level in blood.
(B) helps body cope with stress.
(C) increases permeability of kidney tubules to water.
(D) increases calcium concentration in blood.

Q.10 An action of cortisol is –
(A) decreases glucose level in blood
(B) helps body cope with stress
(C) increases permeability of kidney tubules to water.
(D) promotes uptake of amino acids.

Q.11 Which of the following is not a correct pair?
(A) thyroid gland; calcitonin
(B) islets of Langerhans; glucagon
(C) posterior lobe of pituitary; oxytocin
(D) anterior lobe of pituitary; cortisol

Q.12 Which of the following occurs in diabetes mellitus?
(A) decreased use of glucose
(B) decreased fat metabolism
(C) decreased protein use
(D) increased concentration of thyroid-releasing hormone

Q.13 Insulin resistance is associated with –
(A) low insulin secretion by the islets of Langerhans.
(B) type 1 diabetes.

(C) impaired function of receptors on target cells.
(D) hypoglycemia.

Q.14 Aldosterone –
(A) is released by posterior pituitary
(B) is an androgen
(C) secretion is stimulated by an increase in thyroid-stimulating hormone.
(D) increases sodium reabsorption

Q.15 Which of the following is an action of epinephrine and norepinephrine?
(A) decreases glucose use.
(B) increases cardiac output.
(C) constricts blood vessels in brain
(D) reduces inflammation.

Q.16 Activity of the anterior lobe of the pituitary gland is controlled by
(A) the hypothalamus
(B) releasing hormones
(C) releaseinhibiting hormones
(D) all of the above

Q.17 Glucagon is secreted by –
(A) Leydig cells (B) Islets of langerhans
(C) Corpus luteum (D) Glisson's capsule

Q.18 A hormone with seat of activity in liver-changing glucose into glycogen is produced by –
(A) Pituitary (B) Thymus
(C) Parathyroid (D) Pancreas

Q.19 Estrogen is secreted by –
(A) Liver (B) Spleen
(C) Ovaries (D) Pituitary

Q.20 Androgens are secreted by –
(A) Pituitary (B) Testes
(C) Ovaries (D) Thyroid

Q.21 Ovulation in mammals occurs mainly under the influence of –
(A) TSH and ACTH (B) FSH and LH
(C) TSH and STH (D) MTH and ACTH

Q.22 Which gland is both exocrine as well as endocrine
(A) Pituitary (B) Mammary gland
(C) Thyroid (D) Pancreas

Q.23 Chemical structure of man's insulin was studied by –
(A) Banting (B) Kendal
(C) Tsan (D) Starling

Q.24 Over secretion of glucagon causes –
(A) Tetany (B) Diabetes insipidus
(C) Acromegaly (D) Glycosuria

Q.25 Glucagon is secreted by –
(A) β (beta) cells of islets of langerhans
(B) α (alpha) cells of islets of langerhans
(C) β cells of pancreas
(D) Adrenal cortex

Q.26 Insulin by chemical nature is –
(A) Carbohydrate (B) Protein
(C) Steroid (D) Lipid

Q.27 If ovaries from a pregnant woman are removed in 4th month of pregnancy then –
(A) Development of embryo becomes abnormal
(B) Abortion occurs after some time
(C) Embryo develops normally till birth
(D) None

Q.28 Leydig cells are meant for –
(A) Formation of sperm
(B) To produce progesterone
(C) To produce testosterone
(D) Nutrition of sperm

Q.29 Secretion of estrogen is controlled by –
(A) HCG (B) Progesterone
(C) LH (D) F.S.H.

Q.30 Immediate cause of induction of ovulation in human female is large in plasma surge of –
(A) Progesterone (B) LH
(C) FSH (D) Estradiol

Q.31 Bombycol is a pheromone secreted by the body of –
(A) Wasp (B) House fly
(C) Spider (D) Silk moth

Q.32 Stimulation of uterine contraction during child birth is brought about by –
(A) Adrenaline (B) Progesterone
(C) Oxytocin (D) Prolactin

Q.33 Role of thymus in homosepiens is chiefly concerned
(A) Reproduction (B) Immunology
(C) Calcium balance (D) Blood coagulation

Q.34 Hyposecretion of aldosterone causes –
(A) Gull's disease (B) Grave's disease
(C) Cushing's disease (D) Addison's disease

Q.35 Hormones produced by adrenal cortex and gonads (sex hormone) are chemically –
(A) Proteinous (B) Steroids
(C) Glycoprotein (D)Phenolic compound

Q.36 Melatonin is a hormone produced by –
(A) Adrenal gland (B) Pituitary gland
(C) Pineal gland (D) Thymus gland

Q.37 Cushing's disease is caused by –
(A) Disturbance in fat metabolism
(B) Excess of ACTH secretion by the pituitary
(C) Under secretion of insulin
(D) None of the above

Q.38 Carbohydrate metabolism is governed by :
(A) Thyroxine (B) Insulin
(C) Glucocorticoids (D) All

Q.39 Which of the following does not secrete any hormone :
(A) Testes (B) Spleen
(C) Stomach (D) Intestine

Q.40 In diabetes disease the urine contains :
(l) Salt (B) Fat
(C) Protein (D) Sugar

Q.41 Which has no role in secretion of hormone :
(A) Rickets and mongolism
(B) Diabetes mellitus and cretinism
(C) Gigantism and exophthalmia
(D) Cretinism and diabetes

Q.42 Which gland prepares you for flight, fright and fight during adverse conditions :
(A) Thyroid (B) Parathyroid
(C) Pituitary (D) Adrenals

Q.43 Which hormone secretion is under nervous control –
(A) Adrenal cortex (B) Anterior pituitary
(C) Posterior pituitary (D) Pineal body

Q.44 Which one of the following does not match is biological category of chemical substance
(A) Gastrin (B) Renin
(C) Oxytocin (D) Creatinine

Q.45 Sex hormone will work without the help of –
(A) Gonadotropins (B) Placenta
(C) Pituitary (D) Insulin

Q.46 Hypophysectomy leads to –
(A) Heart attack
(B) Increased digestion
(C) Death
(D) Regression of reproductive function

Q.47 Which of the following is not a steroid hormone–
(A) Androgen (B) Aldosterone
(C) Estrogen (D) Relaxin

Q.48 Which of following is not a protein hormone –
(A) Relaxin (B) HCG
(C) Placental lactogen (D) Estradiol

Q.49 Secretin stimulates the activity of :
(A) Liver (B) Gastric gland
(C) Pancreas (D) Gall-bladder

Q.50 Adrenaline hormone causes :
(A) Increase in blood pressure
(B) Increase in heart beat
(C) Both of them
(D) None of them

Q.51 Main similarity between hormone and enzyme is
(A) Both act at particular pH
(B) Both are protein
(C) Both are required in small amount
(D) Both can be used again and again

Q.52 Largest amount of iodine is found in :
(A) Adrenals (B) Liver
(C) Thyroid (D) Testes

Q.53 'ANF' is
(A) steroidal in nature
(B) peptide hormone
(C) glucocorticoid hormone
(D) mineralocorticoid hormone

Q.54 A hormone responsible for normal sleep-wake cycle is
(A) Epinephrine (B) Gastrin
(C) Melatonin (D) Insulin

Q.55 I. GH II. PRL
III. TSH IV. ACTH
V. LH VI. Oxytocin.
Which of the above hormones are released by anterior lobe of pituitary?
(A) I, II, III and VI (B) III, IV, V and VI
(C) I, II, V and VI (D) I, II, III, IV, and V

Q.56 One of the following conditions is not linked to deficiency of thyroid hormones
(A) Cretinism (B) Goitre
(C) Myxedema (D) Exophthalmosis

Q.57 Hormones are called chemical signals that stimulate specific target tissues. Their specificity is due to the presence of signal receiving 'receptors' only in the respective target tissues. Where are these receptors present in case of hormones of protein nature?
(A) Extra cellular matrix (B) Blood
(C) Plasma membrane (D) Nucleus

Q.58 Blood calcium level is a resultant of how much dietary calcium is absorbed, how much calcium is lost in the urine, how much bone dissolves releasing calcium into the blood and how much calcium from blood enters tissues. A number of factors play an important role in these processes. Mark the one which has no role.
(A) Vitamin D (B) Parathyroid hormone
(C) Thyrocalcitonin (D) Thymosin

Q.59 Prolonged hyperglycemia leads to
(A) diabetes insipidus
(B) diabetes mellitus
(C) increase in ketone bodies
(D) Both (B) and (C)

Q.60 I. Sleep-wake cycle II. Body temperature
III. Pigmentation IV. Metabolism
V. Defence capability
All of the above written activities are influenced/ regulated by –
(A) pineal gland (B) parathyroid gland
(C) thymus gland (D) adrenal gland

EXERCISE - 3 (LEVEL-3)

Choose one correct response for each question.

Q.1 Control of hormone secretion by a negative feedback mechanism generally includes –
(i) no change in hormone secretion.
(ii) decrease in hormone secretion.
(iii) change that maintains homeostasis.
(iv) increase in hormone secretion.
Choose the correct option –
(A) (ii), (iii) (B) (i), (iii)
(C) (ii), (iv) (D) (i), (ii)

Q.2 Small hydrophobic hormones that hormone-receptor complexes in the cytoplasm of target cells.
(i) steroids (ii) cAMP
(iii) thyroid hormone (iv) prolactin
(v) often result in altered gene express
Choose the correct option –
(A) (i), (ii), (iii) (B) (i), (iii), (v)
(C) (i), (ii), (iv) (D) (i), (ii)

Q.3 Increased skeletal growth results directly and/or indirectly from the activity of –
(i) aldosterone (ii) growth hormone
(iii) hormones produced in the hypothalamus.
(iv) progestins. (v) epinephrine
Choose the correct option –
(A) (ii), (iii) (B) (i), (iii)
(C) (ii), (iv) (D) (i), (ii)

Q.4 The activity of the anterior pituitary is controlled by –
(i) the hypothalamus. (ii) ADH.
(iii) epinephrine (iv)releasing hormones.
(v) inhibiting hormones.
Choose the correct option –
(A) (i), (ii), (iii) (B) (i), (iii), (v)
(C) (i), (ii), (iv) (D) (i), (iv), (v)

Q.5 Normal individuals have a fasting glucose level of 100 mg/l 00 ml blood. A person with a fasting level of 300 mg/100 ml blood –
(i) is hypoglycemic
(ii) is hyperglycemic
(iii) has too much insulin
(iv) probably has cells not using enough glucose
Choose the correct option –
(A) (ii), (iii) (B) (i), (iii)
(C) (ii), (iv) (D) (i), (ii)

Q.6 Diabetes mellitus is an adult with ample numbers of functioning beta cells probably –
(i) suffers from type I DM.
(ii) suffers from type II DM.
(iii) indicates that not enough insulin is being secreted.
(iv) indicates that insulin is not active on target cells.
(v) is unusual since this condition normally occurs in children.
(A) (ii), (iii) (B) (i), (iii)
(C) (ii), (iv) (D) (i), (ii)

Q.7 The hormone and target tissue that are involved in raising glucose concentration in blood by glycogenolysis and gluconeogenesis are –
(A) insulin and pancreas.
(B) glucagon and liver.
(C) thyroid stimulating hormone and thyroid gland.
(D) adrenocorticotropic hormone and adrenal cortex.

For Q.8-Q.9 :
(A) Statement- 1 is True, Statement-2 is True, Statement-2 is a correct explanation for Statement -1
(B) Statement -1 is True, Statement -2 is True ; Statement-2 is NOT a correct explanation for Statement - 1
(C) Statement - 1 is True, Statement- 2 is False
(D) Statement -1 is False, Statement -2 is False

Q.8 **Statement 1 :** Failure of secretion of somatotropin from an early age causes dwarfism in the patient.
Statement 2 : Somatotropin hormone stimulates the body growth and elongation of long bones.

Q.9 **Statement 1 :** Females have less stature than males after puberty.
Statement 2 : This happens because of the presence of hcG in the blood of females.

Q.10 I. Hypothyroidism causes irregularity of menstrual cycle.
II. Hyperthyroidism adversely affects the body physiology.
III. Hypothyroidism cause cretinism.
IV. Hypothyroidism causes goitre.
Which of the above statements are correct?
(A) III and IV (B) I, II and IV
(C) I, II and III (D) All of these

Q.11 I. Increased alertness
II. Pupillary dilation
III. Raising of hairs
IV. Sweating
All of the above written physiological processess are regulated by
(A) adrenaline (B) norepinephrine
(C) Both (A) and (B) (D) Thymosin

Q.12 Identify the four major hormones of GI tract. Out of the list given below.
I. Gastrin II. Secretin
III. Cholecystokinin IV. ACTH
V. MSH VI. GIP
(A) I, II, III and IV (B) II, III, IV and V
(C) III, IV, V and VI (D) I, II, III and VI

Q.13 Choose the correct code –
a. Epinephrine i. Increase in muscle growth
b. Testosterone ii. Decrease in blood pressure
c. Glucagon iii. Decrease in liver glycogen content
d. Atrial natriuretic factor iv. Increase heart beat
(A) a-ii, b-i, c-iii, d-i (B) a-iv, b-i, c-iii, d-ii
(C) a-i, b-ii, c-iii, d-iv (D) a-i, b-iv, c-ii, d-iii

Q.14 Significant role of calcium balance in the body is maintained by
(A) PTH and FSH (B) PTH and TCT
(C) TCT and FSH (D) TCT and GH

Q.15 I. Glucagon II. Epinephrine
III. Steroid hormone IV. Idothyronine
Among the given hormones which needs secondary messenger.
(A) I and III (B) III and IV
(C) I and II (D) IV and I

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

Choose one correct response for each question.

Q.1 Which of the following statements is correct in relation to the endocrine system ?**[NEET 2013]**
(A) Releasing and inhibitory hormones are produced by the pituitary gland.
(B) Adenohypophysis is under direct neural regulation of the hypothalamus.
(C) Organs in the body like gastrointestinal tract, heart, kidney and liver do not produce any hormones.
(D) Non-nutrient chemicals produced by the body in trace amount that act as intercellular messenger are known as hormones.

Q.2 Select the answer which correctly matches the endocrine gland with the hormone it secretes and its function/deficiency symptom : **[NEET 2013]**

	Endocrine gland	Hormone	Function/deficiency symptoms
(A)	Corpus luteum	Testosterone	Stimulates spermatogenesis
(B)	Anterior pituitary	Oxytocin	Stimulates uterus contraction during child birth
(C)	Posterior pituitary	Growth Hormone (GH)	Oversecretion stimulates abnormal growth
(D)	Thyroid gland	Thyroxine	Lack of iodine in diet results in goitre

Q.3 A pregnant female delivers a baby who suffers from stunted growth, mental retardation, low intelligence quotient and abnormal skin. This is the result of : **[NEET 2013]**
(A) Over secretion of pars distalis
(B) Deficiency of iodine in diet
(C) Low secretion of growth hormone
(D) Cancer of the thyroid gland

Q.4 Identify the hormone with its correct matching of source and function – **[AIPMT 2014]**
(A) Oxytocin - posterior pituitary, growth and maintenance of mammary glands.
(B) Melatonin - pineal gland, regulates the normal rhythm of sleepwake cycle.
(C) Progesterone - corpus-luteum, stimulation of growth and activities of female secondary sex organs.
(D) Atrial natriuretic factor - ventricular wall increases the blood pressure.

Q.5 Fight-or-flight reactions cause activation of – **[AIPMT 2014]**
(A) The parathyroid glands, leading to increased metabolic rate.
(B) The kidney, leading to suppression of reninangiotensin-aldosterone pathway.
(C) The adrenal medulla, leading to increased secretion of epinephrine & norepinephrene.
(D) The pancreas leading to a reduction in the blood sugar levels.

Q.6 A chemical signal that has both endocrine and neural roles is : **[AIPMT 2015]**
(A) Calcitonin (B) Epinephrine
(C) Cortisol (D) Melatonin

Q.7 Which one of the following hormones is not involved in sugar metabolism ? **[RE-AIPMT 2015]**
(A) Aldosterone (B) Insulin
(C) Glucagon (D) Cortisone

Q.8 Which one of the following hormones through synthesised elsewhere is stored and released by the master gland ? **[RE-AIPMT 2015]**
(A) Luteinizing hormone
(B) Prolactin
(C) Melanocyte stimulating hormone
(D) Antidiuretic hormone

Q.9 Which of the following pairs of hormones are not antagonistic (having opposite effects) to each other? **[NEET 2016 PHASE 1]**
(A) Parathormone - Calcitonin
(B) Insulin - Glucagon
(C) Aldosterone - Atrial Natriuretic Factor
(D) Relaxin - Inhibin

Q.10 Graves' disease is caused due to – **[NEET 2016 PHASE 2]**
(A) Hyposecretion of thyroid gland.
(B) Hypersecretion of thyroid gland.
(C) Hyposecretion of adrenal gland.
(D) Hypersecretion of adrenal gland.

Q.11 Name a peptide hormone which acts mainly on hepatocytes, adipocytes and enhances cellular glucose uptake and utilization. **[NEET 2016 PHASE 2]**
(A) Insulin (B) Glucagon
(C) Secretin (D) Gastrin

Q.12 The posterior pituitary gland is not a 'true' endocrine gland because – **[NEET 2016 PHASE 2]**
(A) It is provided with a duct
(B) It only stores and releases hormones
(C) It is under the regulation of hypothalamus
(D) It secretes enzymes

Q.13 A decrease in blood pressure/volume will not cause the release of – **[NEET 2017]**
(A) Renin (B) Atrial Natriuretic Factor
(C) Aldosterone (D) ADH

Q.14 Hypersecretion of Growth Hormone in adults does not cause further increase in height, because
(A) Growth Hormone becomes inactive in adults. **[NEET 2017]**
(B) Epiphyseal plates close after adolescence.
(C) Bones loose their sensitivity to Growth Hormone in adults.
(D) Muscle fibres do not grow in size after birth.

Q.15 A temporary endocrine gland in the human body is **[NEET 2017]**

(A) Pineal gland (B) Corpus cardiacum
(C) Corpus luteum (D) Corpus allatum

Q.16 Which of the following is an amino acid derived hormone? **[NEET 2018]**

(A) Estradiol (B) Ecdysone
(C) Epinephrine (D) Estriol

Q.17 Which of the following hormones can play a significant role in osteoporosis? **[NEET 2018]**

(A) Estrogen and Parathyroid hormone.
(B) Progesterone and Aldosterone.
(C) Aldosterone and Prolactin.
(D) Parathyroid hormone and Prolactin.

Q.18 How does steroid hormone influence the cellular activities? **[NEET 2019]**

(A) Changing the permeability of the cell membrane.
(B) Binding to DNA and forming a genehormone complex.
(C) Activating cyclic AMP located on the cell membrane.
(D) Using aquaporin channels as second messenger.

Q.19 Which of the following glucose transporters is insulin-dependent? **[NEET 2019]**

(A) GLUT I (B) GLUT II
(C) GLUT III (D) GLUT IV

Q.20 Match the following hormones with the respective disease

(a) Insulin	(i) Addison's disease
(b) Thyroxin	(ii) Diabetes insipidus
(c) Corticoids	(iii) Acromegaly
(d) Growth Hormone	(iv) Goitre
	(v) Diabetes mellitus

Select the correct option. **[NEET 2019]**

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

ANSWER KEY

EXERCISE-1 (SECTION-1&2)

(1) (C) **(2)** (C) **(3)** (C) **(4)** (D)
(5) (C)
(6) Nerve, continuously, hormones
(7) Dorsal, heart, immune
(8) Axons, nerve, pituitary, portal, anterior
(9) Scrotal sac
(10) Gastric, stimulates, pepsinogen
(11) Androgenic; adrenal
(12) Specific, specific, target tissue
(13) Pituitary; two
(14) CNS, libido, anabolic
(15) LH, Graafian follicles, corpus luteum
(16) Iodine, hypothyroidism, goitre
(17) Sella turcica; hypothalamus
(18) **Cell membrane receptors; nuclear receptors**
(19) Epinephrine, norepinephrine, catecholamines, emergency
(20) Graafian follicle, corpus luteum, progesterone
(21) Interstitial cells, intertubular spaces, testosterone
(22) Pituitary Gland **(23)** Thyroid Gland
(24) Adrenal Cortex **(25)** Testis and Ovaries
(26) Pineal Gland

EXERCISE - 1 [SECTION-3 & 4]

Q	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51
A	B	A	A	B	A	C	C	B	C	B	A	C	A	D	A	C	C	B	B	C	B	D	C	D	D
Q	52	53	54	55	56	57	58	59	60	61	62	63	64	65	66	67	68	69	70	71	72	73	74	75	76
A	C	D	A	B	D	B	D	B	B	B	D	C	C	D	B	D	B	C	D	C	D	D	B	C	C
Q	77	78	79	80	81	82	83	84	85	86	87	88	89	90	91	92	93	94	95	96	97	98	99	100	101
A	C	B	C	B	C	A	B	C	C	C	B	D	C	C	B	C	B	A	B	B	D	A	B	A	A
Q	102	103	104	105	106	107	108	109	110																
A	A	A	A	D	C	D	B	C	D																

EXERCISE - 2

Q	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
A	A	B	B	B	C	D	C	B	D	B	D	A	C	D	B	D	B	D	C	B	B	D	C	D	B
Q	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50
A	B	C	C	D	B	D	C	B	D	B	C	B	D	B	D	A	D	C	D	D	D	D	D	C	C
Q	51	52	53	54	55	56	57	58	59	60															
A	C	C	B	C	D	D	C	D	D	A															

EXERCISE - 3

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

EXERCISE - 4

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

SOLUTIONS

EXERCISE-1

(1) (C) **(2)** (C) **(3)** (C) **(4)** (D)

(5) (C)

(6) Nerve, continuously, hormones

(7) Dorsal, heart, immune

(8) Axons, nerve, pituitary, portal, anterior

(9) Scrotal sac

(10) Gastric, stimulates, pepsinogen

(11) Androgenic; adrenal

(12) Specific, specific, target tissue

(13) Pituitary; two

(14) CNS, libido, anabolic

(15) LH, Graafian follicles, corpus luteum

(16) Iodine, hypothyroidism, goitre

(17) Sella turcica; hypothalamus

(18) **Cell membrane receptors; nuclear receptors**

(19) Epinephrine, norepinephrine, catecholamines, emergency

(20) Graafian follicle, corpus luteum, progesterone

(21) Interstitial cells, intertubular spaces, testosterone

(22) Pituitary Gland **(23)** Thyroid Gland

(24) Adrenal Cortex **(25)** Testis and Ovaries

(26) Pineal Gland

(27) (B) **(28)** (A) **(29)** (A) **(30)** (B)

(31) **(A).** Properties of hormones are

(i) They have low molecular weight.

(ii) They are soluble in water and blood.

(iii) They are non-nutrient.

(iv) They can act in very low concentration.

(v) They are intercellular messenger.

(32) (C) **(33)** (C)

(34) **(B).** Endocrine glands are also called holocrine glands or ductless gland. e.g., thyroid, parathyroid, adrenals, pituitary, etc.

(35) **(C).** The hormones that are produced in inactive form called prohormone.

e.g., Proinsulin → Insulin

(inactive form) (active form)

(36) **(B).** (Gonadotropin Releasing Hormone) from hypothalamus stimulates the pituitary for synthesis and release of gonadotropins. On the other hand somatostatin from hypothalamus inhibits the release of growth hormone from pituitary.

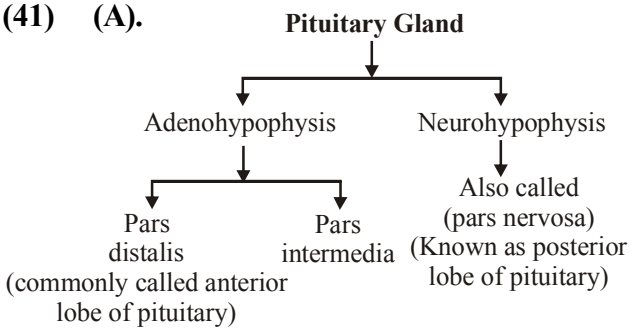
(37) **(A).** PTH is the hypercalcemic hormone because it increases the Ca^{2+} level in blood.

(38) **(C).**

(39) **(A).** The Leydig's cells present in the connective tissue between seminiferous tubules produce a group of hormones called androgens mainly testosterone.

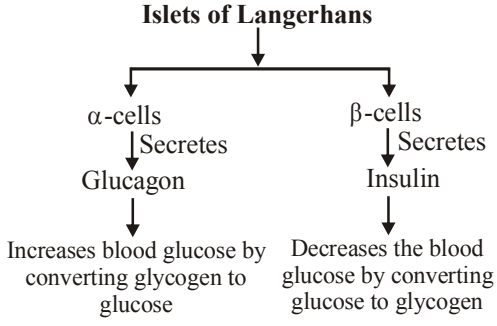
(40) **(D).** The thyroid gland is composed of follicles and stromal tissues. Each thyroid follicle is composed of follicular cells enclosing a cavity. These follicle cells synthesise two hormones tetraiodothyronine or thyroxine and triiodothyronine.

(41) **(A).**



(42) **(C).** The anterior lobe of the pituitary gland secrete the following hormones: thyroid stimulating hormone, adrenocorticotropic hormone, growth hormone, prolactin or mammotrophic or luteotropic hormone and gonadotropic hormones [FSHand LH]. Oxytocin is secreted by the posterior lobe of pituitary gland.

(43) **(C).**



(44) **(B).** In males, LH stimulates the synthesis and secretion of hormones called androgens from testis. In males, FSH and androgens regulate spermatogenesis. In females, LH induces ovulation of fully mature follicles (Graafian follicles) and maintains the corpus luteum, formed from the remnants of the Graafian follicles after ovulation.

(45) **(B).**

(46) **(C).** The parathyroid glands secrete a peptide hormone called Parathyroid Hormone (PTH). The secretion of PTH regulated by the circulating levels of calcium ions in the blood.

(47) **(B).** Corpusluteum of the ovary secretes progesterone, and relaxin. Prolactin is secreted by anterior lobe of pituitary gland. Aldosterone is a principal mineralocortioid secreted by the Adrenal cortex and testosterone is secreted by the Leydig's cells in the testes.

(48) **(D).** Insulin is a peptide hormone, which plays a major role in the regulation of glucose homeostasis. Insulin acts mainly on hepatocytes and adipocytes (cells of adipose tissue) and enhances cellular glucose uptake and utilisation. As a result there is a rapid movement of glucose from blood to hepatocytes and adipocytes resulting in decreased blood glucose level (hypoglycemia), Insulin also stimulates conversion of glucose to glycogen (glycogenesis) in target cells.

(49) **(C).** Medulla of adrenal glands secrete two hormones adrenaline and noradrenaline. During emergency, adrenaline is released and causes dilation of blood vessels, so that the blood flow is increased. It also increases heart beat so that more oxygen is consumed and it also increases blood glucose levels. Therefore, it is also known as emergency hormone, Norepinephrine (= Noradrenaline) causes increased activity of the heart, inhibition of gastrointestinal tract, dilation of the pupils of the eyes and so forth. Because of the role of their hormones, the adrenal glands are also called 'glanad of emergency'.

(50) **(D).** Oxytocin acts on the smooth muscles of our body and stimulates their contraction. In females, it stimulates a vigorous contraction of uterus at the time of child birth and milk ejection from the mammary gland.

(51) **(D).** Our body has one pair of adrenal glands, one at the anterior part of each kidney. The gland is composed of two types of tissues. The centrally located tissue is called adrenal medulla and outside this lies the adrenal cortex.

(52) **(C).** Adrenal or suprarenal glands are paired structures located on the top of the kidneys. The cells of zona fasciculata of adrenal cortex secretes mainly glucocorticoids. Glucocorticoids include three main hormones: cortisol (= hydrocortisone), corticosterone and cortisone. They effect carbohydrate metabolism, however, they also affect the metabolism of proteins and fats.

(53) **(D).** Glucagon is a peptide hormone, which plays an important role in maintaining the normal blood glucose level. Glucagon acts mainly on the liver cells (hepatocytes) and stimulates glycogenolysis resulting in an increased blood sugar (hyperglycemia).

In addition, this hormones stimulates the process of gluconeogenesis which also contributes to hyperglycemia. Glucagon reduces the cellular glucose uptake and utilisation. Thus, glucagon is hyperglycemic hormone.

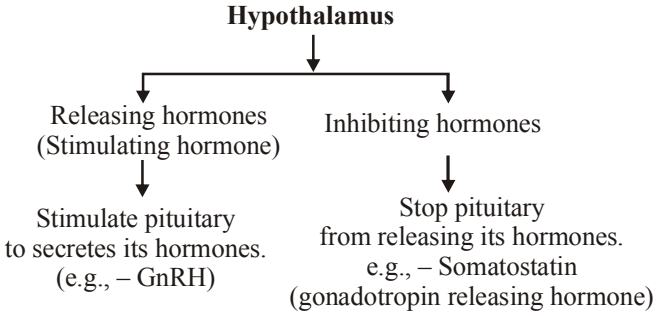
(54) (A) **(55)** (B)

(56) **(D).** Hypothalamus is a part of forebrain and basal part of diencephalon. It regulates a wide spectrum of body functions. It contains several group of neurosecretory cells called nuclei, which produce hormones. These hormones regulate the synthesis and secretion of pituitary hormones.

(57) **(B).** Pars intermedia is almost merged with the pars distal is commonly called anterior lobe of pituitary.

(58) **(D).** Estrogen produces wide ranging actions such as stimulation of growth and activities of female secondary sex organs, development of growing ovarian follicle, appearance of female secondary sex characters (e.g., high pitch voice, etc.), mammary glands development. Estrogen also regulate the female sexual behaviour.

(59) **(B).**



(60) **(B).** The adrenal cortex can be divided into three layers, called zona reticularis (inner layer), zona fasciculata (middle layer) and zona glomerulosa (outer layer). The adrenal cortex secretes many hormones, commonly called as corticoids.

(61) **(B).** Over secretion of GH stimulates abnormal growth of the body leading to gigantism and low secretion of GH results in stunted growth resulting in dwarfism

(62) (D) **(63)** (C) **(64)** (C)

(65) **(D).** Androgens regulate the development, maturation and functions of the male accessory sex organs like epididymis, vas deferens, seminal vesicles, prostate gland, etc. These hormones stimulate muscular growth, growth of facial and axillary hair, aggressiveness, low pitch of voice, etc. Androgens play a major stimulatory role in process of spermatogenesis (formation of spermatozoa).

(66) **(B).** The hormones of pituitary (posterior part) are synthesised in the hypothalamus; packaged in secretory granules and are transported down the axons to be stored for release by posterior lobe. The posterior pituitary is under the direct neural regulation of the hypothalamus.

(67) (D) **(68)** (B)

(69) **(C).** In human four parathyroid glands are present on the back side of the thyroid gland, one pair each in the two lobes of the thyroid gland.

(70) **(D).** Aldosterone is a major mineralocorticoid, secreted by adrenal cortex. It regulates mineral metabolism and controls the sodium and potassium ratio in the extracellular and intracellular fluids. Therefore, it is called salt-balancing hormone.

(71) **(C).** The pineal gland is located on the dorsal side of the forebrain. Pineal gland secretes a hormone called melatonin. Melatonin plays a very important role in regulation of 24 hour (diurnal) rhythm of our body.

(72) **(D).** The corticoids which are involved in carbohydrate metabolism are called glucocorticoids. In our body, cortisol is the main glucocorticoids.

Glucocorticoids stimulate, gluconeogenesis lipolysis and proteolysis. So, they are involved in carbohydrate, fat and protein metabolism.

(73) **(D).** Testis perform dual functions i.e. as primary sex organs as well as an endocrine gland. Testis is composed of seminiferous tubules and stromal or interstitial tissue.

(74) **(B).** Neurohypophysis (pars nervosa) also known as posterior lobe of pituitary, stores and releases two hormones called oxytocin and vasopressin. Which are actually synthesised by hypothalamus and are transported axonally to neurohypophysis.

(75) **(C).** Hypothyroidism during pregnancy causes defective development and maturation of the growing baby leading to stunted growth (cretinism), mental retardation, low intelligence quotient, abnormal skin, deaf-mutism, etc. In adult women, hypothyroidism may cause menstrual cycle to become irregular.

(76) (C) **(77)** (C)

(78) **(B).** Females have a pair of ovaries located in the abdomen. Ovary is the primary female sex organ, which produces one ovum during each menstrual cycle. In addition ovary also produces two group of steroid hormones called estrogen and progesterone. Ovary is composed of ovarian follicle and stromal tissue.

(79) **(C).** Thymus secretes a hormone named thymosin which stimulates the development and differentiation of T-cells increasing resistance to infections. It also hastens attainment of sexual maturity.

(80) **(B).** Vasopressin released by posterior lobe of pituitary acts mainly at the kidney and stimulates, reabsorption of water and electrolytes by the distal tubules and thereby reduces the loss of water through urine (diuresis). Hence, it is also called Anti-Diuretic Hormone (ADH).

(81) **(C).**

(82) **(A).** Glucocorticoids stimulate, gluconeogenesis, lipolysis and proteolysis and inhibit cellular uptake and utilisation of amino acids.

(83) **(B).**

(84) **(C).** Development of accessory sex organs like epididymis, vas deferens, seminal vesicle, prostate gland and urethra is the prime function of androgens.

(85) **(C).** Thymus gland secretes the peptide hormones called thymosins. Thymosin plays a major role in the differentiation of T-lymphocytes, which provides cell-mediated immunity. In addition, thymosins also promote the production of antibodies to provide humoral immunity.

(86) **(C).** MSH released by pars intermedia, acts on the melanocytes (melanin containing cells) and regulates pigmentation of skin.

(87) **(B).**

(88) Cortisol is involved in maintaining the cardiovascular system as well as kidney function. Glucocorticoids, particularly cortisol, produces anti-inflammatory reactions and suppresses the immune response. Cortisol stimulates the RBC production.

(89) **(C).** The juxtaglomerular cells of kidney produce a peptide hormone called renin, which increase blood pressure through angiotension-II.

(90) **(C).**

(91) **(B).** GIP (Gastro Inhibitory Polypeptide) inhibits gastric acid secretion and stimulates insulin release.

(92) **(C).** **Cholecystokinin** is a peptide hormone of the gastrointestinal system responsible for stimulating the digestion of fat and protein. Cholecystokinin, previously called pancreozymin, is synthesised by I-cells in the mucosal epithelium of the small intestine and secreted in the duodenum, the first segment of the small intestine, and causes the release of digestive enzymes and bile from the pancreas and gall bladder, respectively. It also acts a hunger suppressant. Recent evidence has suggested that it also plays a major role in inducing drug tolerance to opioide like morphine and heroin and is partly implicated in experiences of pain hypersensitivity during opioid withdrawal.

(93) **(B).** There are bunch of hormones, neuropeptides and neurotransmitters that affect gastrointestinal function. The GI (gastrointestinal) endocrine system diffuses and its endocrine cells are distributed differentially in the mucosal epithelium along the length of digestive tract. Gastrointestinal hormones are proteinaceous in nature.

(94) **(A).** Erythropoietin or EPO, is a glycoprotein hormone that controls erythropoiesis or red blood cell production. It is a cytokine

(protein signaling molecule) for erythrocyte (red blood cell) precursors in the bone marrow. Human EO has a molecular weight of 34 kDa.

When exogenous EPO is used as a performance-enhancing drug, it is classified as an erythropoiesis-stimulating agent (ESA). Exogenous EPO can often be detected in blood, due to slight differences from the endogenous protein.

(95) (B). Cholecystokinin (CCK) and gastro inhibitory polypeptide (GIP) both are secreted by small intestine. Whereas gastrin by G-cells of pyretic gland and duodenum and secretin by duodenal and jejunum mucosa.

(96) (B). Secretin, a digestive hormone secreted by the wall of the upper part of the small intestine (the duodenum) acts on the exocrine pancreas and stimulates secretion of water and carbonateion. Secretin is a polypeptide made up of 27 amino acids. It was discovered in 1902 by British physiologists Sir William M Bayliss and Ernest H Starling.

(97) (D).

(98) (A). Gastric inhibitory polypeptide (GIP), also known as the glucose-dependent insulinotropic peptide is a member of the secretin family of hormones. It has traditionally been called gastrointestinal inhibitory peptide or gastric inhibitory peptide and was believed to neutralise stomach acid to protect the small intestine from acid damage, reduce the rate at which food is transferred through the stomach and inhibit the GI motility and secretion of acid.

(99) (B). The atrial wall of our heart secretes a very important peptide hormone called Atrial Natriuretic Factor (ANF), which is peptide in nature. ANF decreases blood pressure. When blood pressure is increased, ANF is secreted which causes dilation of the blood vessels. This reduces the blood pressure.

(100) (A).

(101) (A). Binding of a hormone to its receptors leads to the formation of hormone receptor complex. Each receptor is specific to one hormone only and hence the receptors are specific.

(102) (A).

(103) (A). Hormones which interact with intracellular receptors (e.g., steroid hormones and iodothyronines) mostly regulate gene expression or chromosome function by interaction of hormone receptor complex with the genome.

(104) (A). The molecules of hormones that are amino acid derivatives, peptides or proteins are large and insoluble in lipids, and cannot enter the target cell. Therefore, they act at the cell surface. They bind to specific receptor molecules located on the surface of the cell membrane. The hormone-receptor complex activates G protein associated with the cytoplasmic C-terminal which initiate the release of an enzyme adenyl cyclase from the receptor site. Adenyl cyclase enzyme forms in the cell, cyclic adenosine monophosphate (cAMP) from ATP. The cAMP activates the existing enzyme system of the cell. This accelerates the metabolic reactions in the cell. The hormone is called the first messenger and the cAMPis termed the second messenger.

(105) (D). Hormones produce their effects on target tissue by binding to specific proteins called hormone receptors which are located in the target tissue only. Hormone receptors present on the cell membrane of the target cells are called membrane bound receptors and receptors present inside the target cell are called intracellular receptors. Intracellular receptors are mostly nuclear receptors (present in the nucleus).

(106) (C). Steroid hormones are the lipid soluble hormones. They are also categorised as hydrophobic hormones. They directly pass

through the cell membrane and interact with intracellular receptors present inside the cell (generally into the nucleus). Generally the steroid hormone is derived from the cholesterol ring.

(107) (D). Hormones which interact with membrane bound receptor normally do not enter the target cell, but generate secondary messengers (e.g., cyclic AMP, IP_3, Ca^{2+}, etc.) which in turn regulate cellular metabolism.

(108) (B). The hormones which are proteinaceous in nature generally can't pass through the cell membrane. So, they generate the secondary messenger which regulate the further changes in target cell.

(109) (C).

(110) (D). Cyclic AMP, IP_3 and Ca^{2+} are all the secondary messenger.

EXERCISE-2

(1) (A).

(2) (B). (B) is correct because glucagon acts on the liver to promote the breadown of stored glycogen to glucose as well as the formation of glucose (i.e., gluconeogensis) from noncarbohydrate sources (e.g., amino acids); these actions result in the elevation of glucose levels in the blood.

(3) (B) **(4)** (B) **(5)** (C) **(6)** (D)

(7) (C) **(8)** (B)

(9) (D). The sole purpose of the parathyroid glands is to control calcium within the blood in a very tight range between 9.0 and 10.1 . In doing so, parathyroids also control how much calcium is in the bones, and therefore, how strong and dense the bones are.

(10) (B). Cortisol, a glucocorticoid (steroid hormone), is produced from cholesterol in the two adrenal glands located on top of each kidney. It is normally released in response to events and circumstances such as waking up in the morning, exercising, and acute stress.

(11) (D) **(12)** (A) **(13)** (C)

(14) (D). Aldosterone is produced in the cortex of the adrenal glands, which are located above the kidneys.Aldosterone affects the body's ability to regulate blood pressure. It sends the signal to organs, like the kidney and colon, that can increase the amount of sodium the body sends into the bloodstream or the amount of potassium released in the urine. The hormone also causes the bloodstream to re-absorb water with the sodium to increase blood volume. All of these actions are integral to increasing and lowering blood vessels. Indirectly, the hormone also helps maintain the blood's pH and electrolyte levels.

(15) (B) **(16)** (D)

(17) (B). Glucagon is a hormone that is involved in controlling blood sugar (glucose) levels. It is secreted into the bloodstream by the alpha cells, found in the islets of Langerhans, in the pancreas.

(18) (D)

(19) (C). Estrogens, in females, are produced primarily by the ovaries, and during pregnancy, the placenta. Follicle-stimulating hormone (FSH) stimulates the ovarian production of estrogens by the granulosa cells of the ovarian follicles and corpora lutea.

(20) (B). Androgen, any of a group of hormones that primarily influence the growth and development of the male reproductive system. The predominant and most active androgen is testosterone, which is produced by the male testes.

(21) (B)

(22) (D). The liver and pancreas are both exocrine and endocrine glands; they are exocrine glands because they secrete products—bile and pancreatic juice—into the gastrointestinal tract through a series of ducts, and endocrine because they secrete other substances directly into the bloodstream.

(23) (C) **(24)** (D) **(25)** (B)

(26) **(B).** Insulin is a small peptide (protein) consisting of fifty-one amino acids synthesized and stored within the pancreas, an organ situated behind the stomach.Insulin is a polypeptide hormone formed, after elimination of C peptide by hydrolysis, of two chains of 21 and 30 amino acids, connected by two disulfide bridges. It is secreted by the beta cells of the islets of Langerhans of the pancreas and exerts an hypoglycemic action.

(27) (C) **(28)** (C)

(29) **(D).** The synthesis and secretion of estrogens is stimulated by follicle-stimulating hormone (FSH), which is, in turn, controlled by the hypothalamic gonadotropin releasing hormone (GnRH). High levels of estrogens suppress the release of GnRH providing a negative-feedback control of hormone levels.

Progesterone production is stimulated by luteinizing hormone (LH), which is also stimulated by GnRH.

(30) (B)

(31) **(D).** Bombykol is a pheromone released by the female silkworm moth to attract mates.

(32) (C) **(33)** (B)

(34) **(D).** Addison's disease can develop due to damages adrenal cortex. Adrenal glands won't be able to produce enough of the steroid hormones cortisol and aldosterone.

(35) (B)

(36) **(C).** Melatonin is a hormone made by the pineal gland , a small gland in the brain. Melatonin helps control your sleep and wake cycles.

(37) **(B).** Cushing disease is a condition in which the pituitary gland releases too much adrenocorticotropic hormone (ACTH).

(38) (D)

(39) **(B).** **Spleen :** An abdominal organ involved in the production and removal of blood cells in most vertebrates and forming part of the immune system.

(40) (D)

(41) **(A).** **Mongolism -** A congenital disorder caused by having an extra 21st chromosome; results in a flat face and short stature and mental retardation.

Gigantism is a rare condition that causes abnormal growth in children. This change is most notable in terms of height, but girth is affected as well. It occurs when your child's pituitary gland makes too much growth hormone, which is also known as somatotropin.

Cretinism is a condition of severely stunted physical and mental growth due to untreated congenital deficiency of thyroid hormone (congenital hypothyroidism) usually due to maternal hypothyroidism.

(42) (D)

(43) **(C).** The Posterior Lobe of the Pituitary Gland (or neurophpophysis) stores and releases hormones secreted by the hypothalamus section of the brain including:

ADH (Antidiuretic hormone) stimulates the smooth muscles, blood vessels and the intestine. ADH increases the kidney's permeability to water allowing the body to re-absorb water that would otherwise escape in urine.

OT (Oxytocin) stimulates the smooth muscles of the uterus during pregnancy, causing it to contract during labour. It also stimulates the lacteals (milk ducts) in the breast.

(44) (D) **(45)** (D)

(46) **(D).** Hypophysectomy is the surgical removal of the hypophysis (pituitary gland).When the procedure is performed before sexual maturity, the reproductive tract remains undeveloped and non-functional. There is also a general lack of growth. If performed after sexual maturity, there will be a loss of reproductive function along with atrophy of gonads and accessory reproductive structures.

(47) **(D).** Hormones can be grouped into three main types:

1. amines: these are simple molecules
2. proteins and peptides: which are made from chains of amino acids
3. steroids: which are derived from cholesterol.

Steroid hormones are secreted by three endocrine organs: the testes, which produce testosterone; the ovaries, which produce estrogen; and the adrenal cortex, which produces steroid hormones such as cortisol and aldosterone. Protein hormones include insulin and growth hormone.

(48) (D)

(49) **(C).** Secretin:a hormone released into the bloodstream by the duodenum (especially in response to acidity) to stimulate secretion by the liver and pancreas.

(50) **(C).** Epinephrine, more commonly known as adrenaline, is a hormone secreted by the medulla of the adrenal glands. Strong emotions such as fear or anger cause epinephrine to be released into the bloodstream, which causes an increase in heart rate, muscle strength, blood pressure, and sugar metabolism.

(51) (C) **(52)** (C)

(53) **(B).** Atrial Natriuretic Factor (ANF) is made up of peptide.

(54) **(C).** Melatonin is a hormone secreted by pineal gland. Immediately above the optic chiasma (in the brain) in a nucleus,are present melatonin receptors that react to this hormone and synchronize the nucleus to the 24 hrs day/night rhythm, thus informing the brain when it is day and when it is night.

(55) **(D).** Hormones released by anterior lobe of pituitary are

(i) GH (Growth hormone)
(ii) PRL (Prolactin)
(iii) TSH (Thyroid Stimulating Hormone)
(iv) ACTH (Adrenocorticotrophic Hormone)
(v) LH (Luteinising Hormone)
(vi) FSH (Follicle Stimulating Hormone).

(56) **(D).** Hypothyroidism is a disorder caused due to deficiency of thyroid hormone. It may lead to cretinism, myxoedema, simple goitre, Hashimoto's disease. Exopthalamic goitre is thyroid enlargement in which thyroid secretes excessive amount of thyroid hormone. It is caused due to hypersecretion of thyroid hormone.

(57) **(C).** Hormones of protein nature binds to specific receptor molecules located on the plasma membrane to form the hormone receptor complex.

(58) **(D).**

(59) **(D).** Prolonged hyperglycemia leads to a complex disorder called diabetes mellitus, which is associated with loss of glucose through urine and formation of harmful compounds known as ketone bodies. Diabetic patients are successfully treated with insulin therapy.

(60) **(A).** Pineal gland helps in maintaining the normal rhythms of sleep-wake cycle, body temperature. In addition melatonin also influences metabolism, pigmentation, the menstrual cycle as well as our defence capability.

EXERCISE-3

(1) **(A).** (ii) is correct because the secretion of the hormone from the source cell is reduced in negative feedback; (iii) is correct because homeostasis is maintained with negative feedback.

(2) **(B).** (i) and (iii) are correct because steroids and thyroid hormones are soluble in the cell membrane and enter the cytoplasm where they bind to receptors inside the cell; (v) is correct because the hormone-receptor complexes formed after hormone binding affect the transcription of genes; (ii) and (iv) are not correct because these hormones bind to membrane-associated receptors and initiate rapid responses inside cells without altering gene expression

(3) (A) **(4)** (D) **(5)** (C) **(6)** (C)

(7) (B)

(8) **(A).** The somatotropin (STH), also called growth hormone (GH) is secreted by the anterior lobe of pituitary gland. Somatotropin stimulates body growth by stimulating retention of proteins and calcium in the body, synthesis and deposition of proteins in tissues, growth and elongation of long bones, and proportionate growth of muscles and visceral organs. The failure of secretion of growth hormone from an early age stops the growth of long bones and of the body prematurely; this makes the patient dwarf and this condition is called dwarfism.

(9) **(C).**

(10) **(D).** Due to cancer of the thyroid gland or due to development of nodules the rate of synthesis and secretion of the thyroid hormones is increased to abnormal high levels leading to a condition called hyperthyroidism which adversely affects the body physiology.

(11) **(C).** Adrenal medulla releases two hormones adrenaline and noradrenaline. In the stress conditions, these hormones increase alertness, pupillary dilation, piloerection (raising of hairs), sweating etc. Both of these hormones increase the heart beat. Catecholamines (adrenaline and noradrenaline) also stimulate the breakdown of glycogen resulting in an increased concentration of glucose in blood. In addition they also stimulate the breakdown of lipids and proteins.

(12) **(D).** Four major hormones of GI tract are

(i) **Gastrin :** Acts on gastric gland and stimulates the secretion of HCl and pepsinogen.

(ii) **Secretin :** Acts on exocrine pancreas and stimulates secretion of water and bicarbonate ions.

(iii) **CCK (Cholecystokinin) :** Acts on both pancreas and gall bladder and stimulates the secretion of pancreatic enzyme and bile juice.

(iv) **GIP (Gastric Inhibitory Peptide) :** Inhibits gastric secretion and mortality.

(13) **(B).**

(14) **(B).** Parathyroid Hormone (PTH) increases the Ca^{2+} in the blood. PTH acts on bones and stimulates the process of bone resorption (dissolution/demineralisation). PTH also stimulates the reabsorption of Ca^{2+} by the renal tubules and increases Ca^{2+} absorption from the digested food. It is thus clear that PTH is hypercalcemic hormone, i.e., it increases the blood Ca^{2+} level. Along with TCT, it plays a significant role in calcium balance in the body.

(15) **(C).** Glucagon and epinephrine hormone are proteinaceous in nature. They produces the secondary messenger for their action.

EXERCISE-4

(1) **(D).** Hormones are non-nutrient chemicals which act as intercellular messengers and are produced in trace amounts.

(2) **(D).** Growth hormone – Secreted by Anterior pituitary ; Corpus leutum – Progesterone
Oxytocin – Secreted by Posterior pituiatary

(3) **(B).** Iodine is essential for the normal rate of hormone synthesis in the thyroid. Deficiency of iodine in our diet results in hypothyroidism and enlargement of the thyroid gland, commonly called goitre. Hypothyroidism during pregnancy causes defective development and maturation of the growing baby leading to stunted growth (cretinism), mental retardation, low intelligence quotient, abnormal skin, deaf-mutism, etc.

(4) **(B).** Atrial Natriuretic factor is secreted by atrial wall of heart. Oxytocin is synthesised by hypothalamous.

(5) **(C).** In fight or flight reactions, emergency hormones are secreted by adrenal medulla.

(6) **(B).** Hormones epinephrine and norepinephrine are secreted from adrenal medulla. They are emergency hormones released in condition of stress, emergency etc. Epinephrine and norepinephrine are also released by adrenergic nerve fibres of sympathetic nervous system where they act as neurotransmitters.

(7) **(A).** Aldosterone is secreted by adrenal cortex and is responible for regulation of Na^+ & K^+ levels in body.

(8) **(D).** ADH and oxytocin are secreted by hypothalamus & stored in posterior pituitary.

(9) **(D).** Relaxin relaxes the pubic symphysis during parturition while inhibin decreases the secretion of FSH from anterior pituitary.

(10) **(B).** Grave's disease is due to the hypersecretion of thyroid gland.

(11) **(A).** Insulin is a peptide hormone which acts mainly on hepatocytes, adipocytes and enhances cellular glucose uptake and utilisation so it decreases the blood glucose level.

(12) **(B).** Posterior pituitary gland is not a true endocrine gland because it only stores and releases hormones.

(13) **(B).** A decrease in blood pressure / volume stimulates the release of renin, aldosterone, and ADH while increase in blood pressure / volume stimulates the release of Atrial Natriuretic Factor (ANF) which cause vasodilation and also inhibits RAAS (Renin Angiotensin Aldosterone System) mechanism that decreases the blood volume/pressure.

(14) **(B).** Epiphyseal plate is responsible for the growth of bone which close after adolescence so hypersecretion of growth hormone in adults does not cause further increase in height.

(15) **(C).** Corpus luteum is the temporary endocrine structure formed in the ovary after ovulation. It is responsible for the release of the hormones like progesterone, oestrogen etc.

(16) **(C).** Epinephrine is derived from tyrosine amino acid by the removal of carboxyl group. It is a catecholamine.

(17) **(A).** Estrogen promotes the activity of osteoblast and inhibits osteoclast. In an ageing female osteoporosis occurs due to deficiency of estrogen. Parathormone promotes mobilisation of calcium from bone into blood. Excessive activity of parathormone causes demineralisation leading to osteoporosis.

(18) **(B).** Steroid hormones directly enter into the cell and bind with intracellular receptors in nucleus to form hormone receptor complex. Hormone receptor complex interacts with the genome.

(19) **(D).** GLUT-IV is insulin dependent and is responsible for majority of glucose transport into muscle and adipose cells in anabolic conditions. Whereas GLUT-I is insulin independent and is widely distributed in different tissues.

(20) **(C).**

- Insulin deficiency leads to diabetes mellitus.
- Hypersecretion or hyposecretion of thyroxine can be associated with enlargement of thyroid gland called goitre.
- Deficiency of corticoids (Glucocorticoid + mineralocorticoid) leads to Addison's disease.
- Growth hormone hypersecretion in adults leads to Acromegaly.