

Chapter-14

Endocrine system

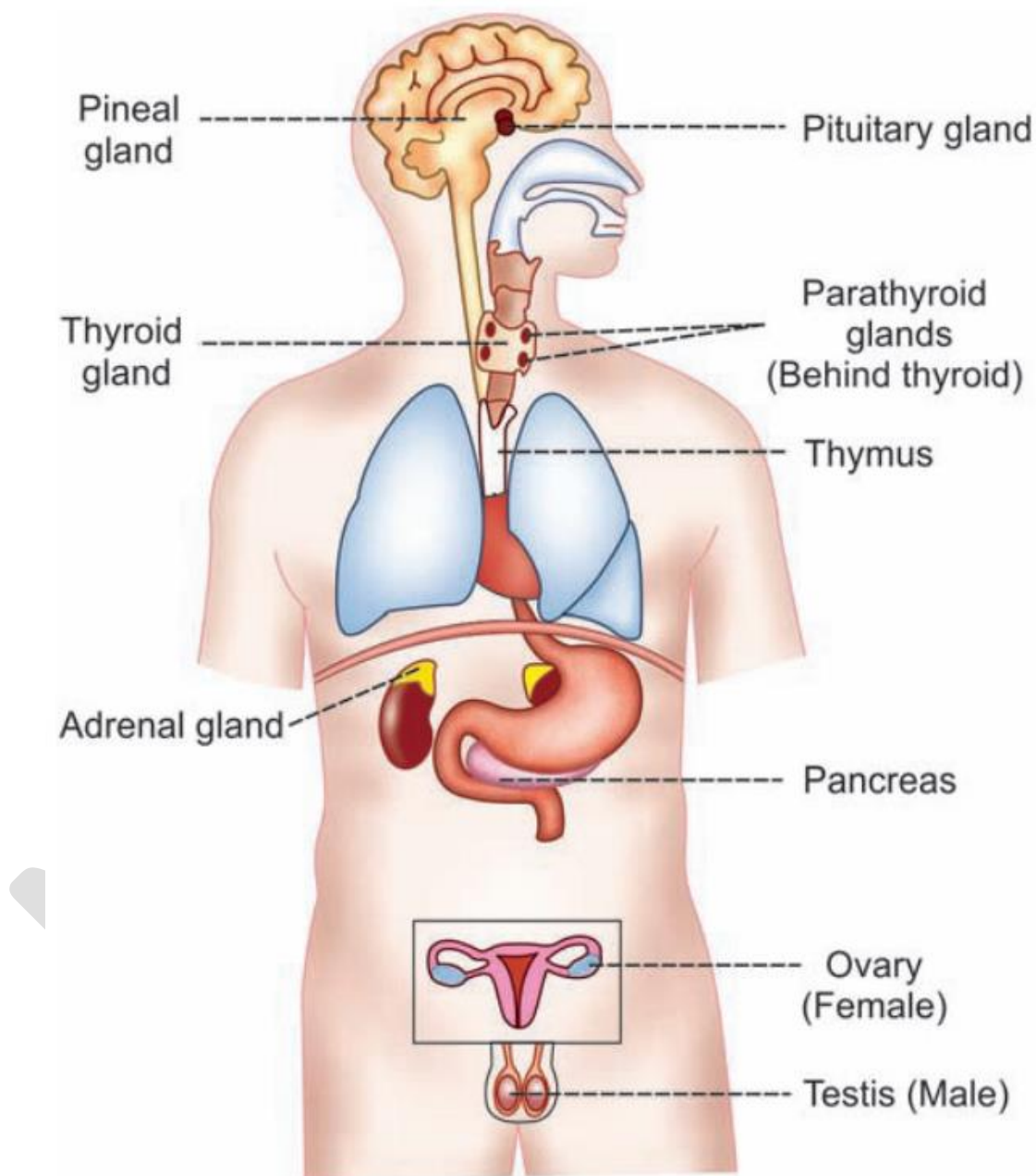
Endocrine system (Hormones and their functions)

- **Pituitary gland**
- **Adrenal gland**
- **Thyroid and parathyroid gland**
- **Pancreas and gonads**

By Noteskarts.com

Endocrine system

Introduction—Endocrine system is defined as the complex glandular structure (cell modification or aggregation) which secrete the hormones and neurotransmitter in the body and regulate the body physiology and major participate in the defensive mechanism of the body.



Major endocrine gland

Hormones are non-nutrient chemicals which act as intercellular messengers and are produced in trace amounts. Most hormones enter interstitial fluid and then the bloodstream. In endocrine system we have discussed about two types of glands.

1. **Exocrine glands**—Exocrine glands secrete their products (enzymes) into ducts, that carry the secretions into body cavities, into the lumen of an organ, or to the outer surface of the body. Exocrine glands include sudoriferous (sweat), sebaceous (oil), mucous, and digestive glands
2. **Endocrine gland**—Endocrine glands secrete their products (Hormone) into the interstitial fluid surrounding the secretory cells rather than into ducts, so it is also called as ductless glands. From the interstitial fluid, hormones diffuse into blood capillaries and blood carries them to target cells throughout the body. It is depending upon the heart for distribution of products.

Functions and Importance of Hormones—

Pituitary gland.

Introduction—Pituitary gland or hypophysis is a small endocrine gland located in a depression called 'sella turcica' present in the sphenoid bone at the base of skull. It is connected with the hypothalamus by the pituitary stalk or hypophyseal stalk. Pituitary gland is divided into two divisions.

1. Anterior pituitary or adenohypophysis— It secretes many hormones and regulates the other endocrine gland's function, so it is also known as master gland. Adenohypophysis consists of two portions, pars distalis and pars intermedia. The pars distalis region of pituitary, commonly called anterior pituitary, produces.

- Growth/somatotropic hormone (GH/STH)— GH is responsible for the general growth of the body. 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.
- Thyroid stimulating hormone (TSH)— TSH stimulates the synthesis and secretion of thyroid hormones from the thyroid gland.

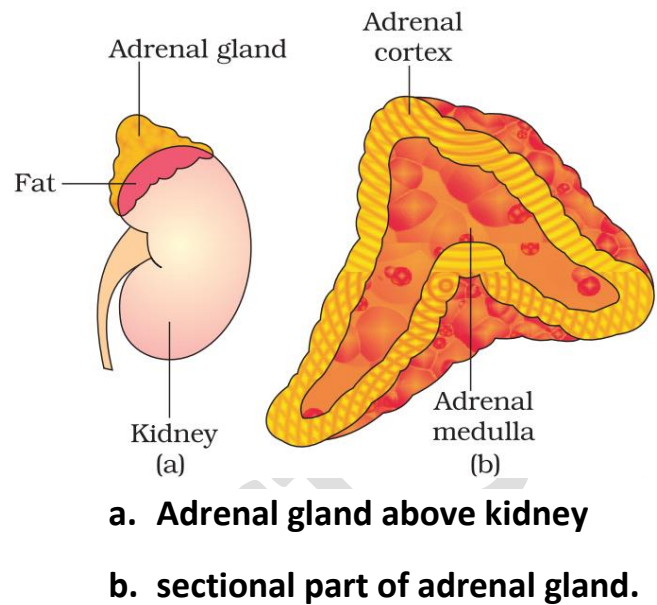
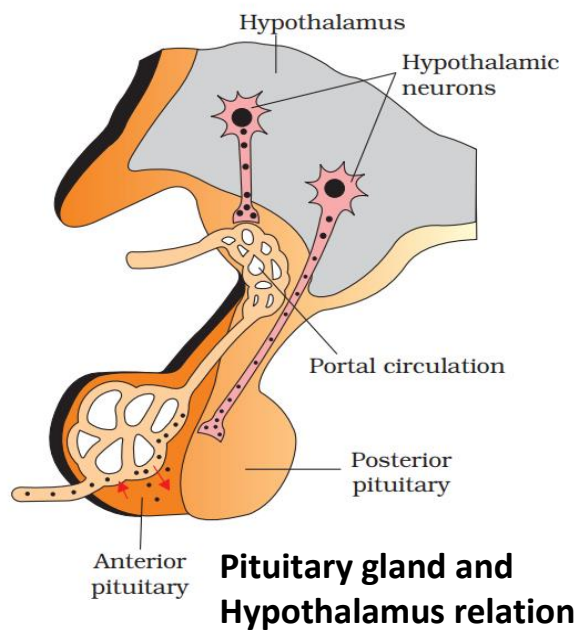
- Adrenocorticotrophic hormone (ACTH)— ACTH stimulates the synthesis and secretion of steroid hormones called glucocorticoids from the adrenal cortex
- Prolactin (PRL)— Prolactin regulates the growth of the mammary glands and formation of milk in them.
- Follicle stimulating hormone (FSH) and luteinizing hormone (LH)— 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.

NOTE—Pars intermedia secretes the only one hormone melanocyte stimulating hormone (MSH). MSH acts on the melanocytes (melanin containing cells) and regulates pigmentation of the skin.

2. Posterior pituitary or neurohypophysis— Also known as pars nervosa and it release two hormone-

- Oxytocin— 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— Vasopressin acts mainly at the kidney and 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).

NOTE— Hypothalamus release the both type (stimulating as well as inhibitory) Hormone through the portal circulatory system and regulate the functions of Pituitary gland, so it called as master of master gland.



Adrenal gland.

Introduction— 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 the adrenal medulla, and outside this lies the adrenal cortex.

Adrenal medulla— Adrenal medullary hormones are the amines derived from catechol and so these hormones are called catecholamines.

1. Adrenaline or epinephrine.
 2. Noradrenaline or norepinephrine.
 3. Dopamine.
- 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, pupillary dilation, piloerection (raising of hairs), sweating etc. Both the hormones increase the heartbeat, 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.

Adrenal cortex—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.

- 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.
- 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.

Applied physiology.

Pheochromocytoma— It is a condition characterized by hypersecretion of catecholamines.

Thyroid gland

Introduction—Thyroid gland situated at the roof of the neck on either side of the trachea. It has two lobes and both the lobes are interconnected with a thin flap of connective tissue called isthmus.

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). In between the follicles, the parafollicular cells are present. These cells secrete calcitonin. Iodine is essential for the normal rate of hormone synthesis in the thyroid.

Stages of synthesis of thyroid hormones— five stages.

- **Thyroglobulin synthesis.**
- **Iodide trapping.**
- **Oxidation of iodide.**
- **Transport of iodine into follicular cavity.**
- **Iodination of tyrosine.**
- **Coupling reactions.**

Functions of thyroid hormone.

- Thyroid hormones play an important role in the regulation of the basal metabolic rate.
- It also supports 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.

Disorder related to thyroid gland.

- **Hyperthyroidism**— Increased secretion of thyroid hormone is called hyperthyroidism. It is caused by- Graves' disease, Thyroid adenoma.
- **Hypothyroidism**— decreased secretion of thyroid hormone is called hypothyroidism. It leads to myxoedema in adults and cretinism in children.
- **Goitre**— Goitre means enlargement of thyroid gland. It occurs both in hypothyroidism and hyperthyroidism.
 - Goitre in hyperthyroidism— Also called as toxic goitre. It is the enlargement of thyroid gland with increased secretion of thyroid hormone, caused of thyroid tumor.
 - Goitre in hypothyroidism— Also known as non-toxic goitre/hypothyroid goitre. It is the enlargement of thyroid gland without increase in hormone secretion

Parathyroid gland.

Introduction— 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. Each parathyroid gland is made up of chief cells, which secrete a peptide hormone called parathyroid hormone (PTH)/parathormone. The secretion of PTH is regulated by the circulating levels of calcium ions.

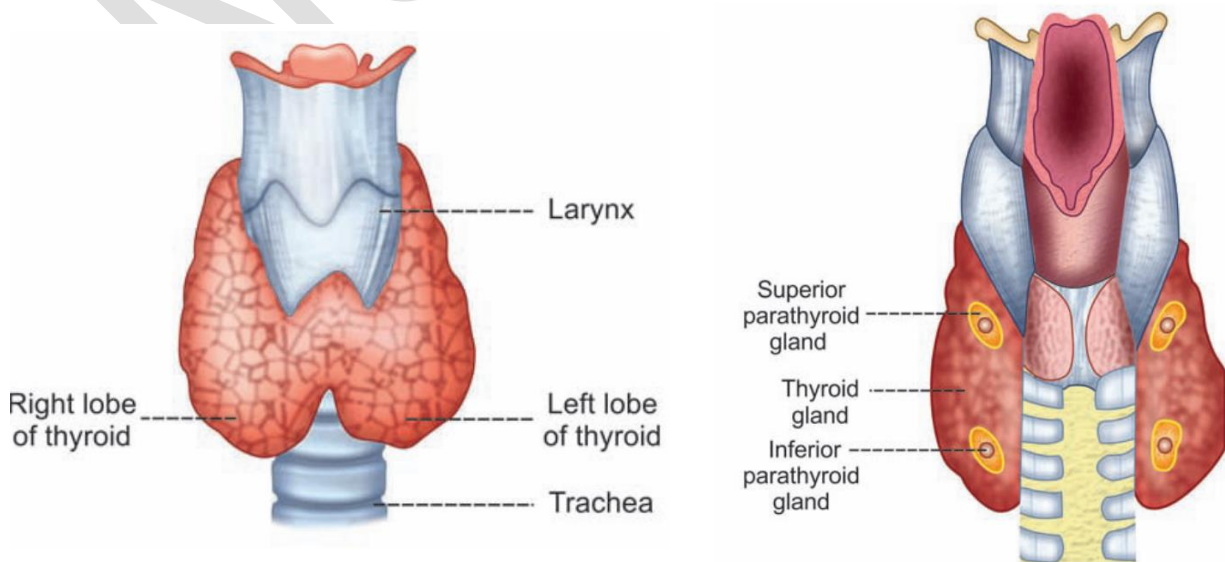
Functions of parathyroid hormone.

- 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 hypercalcaemic hormone, i.e., it increases the blood Ca^{2+} levels.

NOTE—Both PTH and TCT plays a significant role in calcium balance in the body.

Disorder related to parathyroid gland.

- Hypoparathyroidism— less secretion of PTH is called hypoparathyroidism. It leads to hypocalcaemia (decrease in blood calcium level)
- Hyperparathyroidism— Hyper secretion of PTH is called hyperparathyroidism. It leads in hypercalcemia (Increase in blood calcium level).



Pancreas.

Introduction— 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 Langerhans are called α -cells and β -cells. The α -cells secrete a hormone called glucagon, while the β -cells secrete insulin.

1. Glucagon.

- Glucagon is a peptide hormone, and plays an important role in maintaining the normal blood glucose levels.

Thyroid gland

Parathyroid gland

- Glucagon acts mainly on the liver cells (hepatocytes) and stimulates glycogenolysis resulting in an increased blood sugar (hyperglycaemia).
- Glucagon reduces the cellular glucose uptake and utilisation. Thus, glucagon is a hyperglycaemic hormone.

2. Insulin.

- Insulin is a peptide hormone, which plays a major role in the regulation of glucose homeostasis. Insulin acts mainly on hepatocytes and adipocytes 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 levels (hypoglycaemia).
- Insulin also stimulates conversion of glucose to glycogen (glycogenesis) in the target cells. The glucose homeostasis in blood is thus maintained jointly by the two – insulin and glucagon.

NOTE— Prolonged hyperglycaemia 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.

Gonads.

In gonads we discuss about both testis and ovary.

1. **Testis**— It 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 intratubular spaces produce a group of hormones called androgens mainly testosterone

Function of androgens.

- 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.
2. **Ovary**— **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.

Functions of estrogen.

- Estrogen produces 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.
- Estrogen also regulates female sexual behaviour

Function of progesterone

- 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.