THE ENDOCRINE SYSTEM

A **hormone** is a mediator molecule that is released in one part of the body but regulates the activity of cells in other parts of the body. Although a large variety of hormones are produced, nearly all of them can be classified chemically as either amino acid based or steroids.

the body contains two kinds of glands: exocrine glands and endocrine glands. **Exocrine glands** secrete their products 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.

**Endocrine glands** secrete their products (hormones) into the interstitial fluid surrounding the secretory

cells rather than into ducts.

THE PITUITERY GLAND

Structure: The pituitary gland is a pea-shaped structure that measures 1–1.5 cm (0.5 in.) in diameter and lies in the hypophyseal fossa of the sella turcica of the sphenoid bone. It attaches to the hypothalamus by a stalk, the **infundibulum** and has two anatomically and functionally separate portions: the anterior pituitary and the posterior pituitary. The **anterior pituitary (anterior lobe),** also called the **adenohypophysis,** accountsfor about 75% of the total weight of the gland. The anteriorpituitary consists of two parts in an adult: The **pars distalis** is the larger portion, and the **pars tuberalis** forms a sheatharound the infundibulum. The **posterior pituitary (posterior lobe),** also called the **neurohypophysis,** also consists of twoparts: the **pars nervosa,** the larger bulbar portion, and the infundibulum.A third region of the pituitary gland called the *pars**intermedia* atrophies during human fetal development and ceasesto exist as a separate lobe in adults.

Types of Anterior Pituitary Cells:

Five types of anterior pituitary cells—somatotrophs, thyrotrophs, gonadotrophs, lactotrophs, and corticotrophs—secrete seven hormones:

**1. Somatotrophs** secrete **human growth hormone (hGH)** or **somatotropin.** Human growth hormone in turn stimulates several tissues to secrete **insulinlike growth factors,** hormones that stimulate general body growth and regulate aspects of metabolism.

**2. Thyrotrophs** secrete **thyroid-stimulating hormone (TSH)** or **thyrotropin**  TSH controls the secretions and other activities of the thyroid gland.

**3. Gonadotrophs** secrete two **gonadotropins: follicle-stimulating hormone (FSH)** and **luteinizing hormone (LH)** FSH and LH both act on thegonads. They stimulate secretion of estrogens and progesteroneand the maturation of oocytes in the ovaries, and they stimulatesperm production and secretion of testosterone in the testes.

**4. Lactotrophs** secrete **prolactin (PRL),** which initiates milk production in the mammary glands.

**5. Corticotrophs** secrete **adrenocorticotropic hormone**

**(ACTH)** or **corticotropin** which stimulates the adrenal cortex to secrete glucocorticoids such as cortisol. Some corticotrophs, remnants of the pars intermedia, also secrete **melanocyte-stimulating hormone (MSH).**

**POSTERIOR PITUITERY:**

**2 types of hormones** are released from posterior part of pituitery. Oxytocin and vasopressin(ADH).

Oxytocin:

oxytocin affects two target tissues: the mother’s uterus and breasts. During delivery, oxytocin enhances contraction of smooth muscle cells in the wall of the uterus; after delivery, it stimulates milk ejection from the mammary glands.

Oxytocin facilitates the transport of sperm into the female genital tract.

**ADH:**

[**Antidiuretic hormone (ADH)**](javascript:;) prevents wide swings in water balance, helping the body avoid dehydration and water overload.

ADH causes the kidneys to return more water to the blood, thus decreasing urine volume.

ADH also decreases the water lost through sweating and causes constriction of arterioles, which increases blood pressure. This hormone’s other name, vasopressin, reflects this effect on blood pressure.

ADH increases blood sugar level and result glycogenolysis. It diminishes BMR.

THYROID GLAND

Structure: The butterfly-shaped [**thyroid gland**](javascript:;) is located in the anterior neck, on the trachea just inferior to the larynx . Its two lateral lobes are connected by a median tissue mass called the isthmus. A small, pyramidal-shaped lobe sometimes extends upward from the isthmus. Microscopic spherical sacs called **thyroid follicles** make up most of the thyroid gland. The wall of each follicle consists primarily of cells called **follicular cells,** most of which extend to the lumen (internal space) of the follicle. A **basement membrane** surrounds each follicle. The follicular cells produce two hormones: **thyroxine** which is also called **tetraiodothyronine** or **T4** because it contains four atoms of iodine, and **triiodothyronine** or **T3,** which contains three atoms of iodine. A few cells called **parafollicular cells** or **C cells** lie between follicles. They produce the hormone **calcitonin** which helps regulate calciumhomeostasis.

Functions:

1. Thyroid hormones increase **basal metabolic rate (BMR),** the rate of oxygen consumption under standard or basal conditions(awake, at rest, and fasting), by stimulating the use ofcellular oxygen to produce ATP. When the basal metabolicrate increases, cellular metabolism of carbohydrates, lipids, andproteins increases.
2. A second major effect of thyroid hormones is to stimulate synthesis of additional sodium-potassium pumps (Na\_/K\_ATPase), which use large amounts of ATP to continually eject sodium ions (Na\_) from the cytosol into the extracellular fluid and potassium ions (K\_) from the extracellular fluid into the cytosol. As cells produce and use more ATP, more heat is given off, and body temperature rises. This phenomenon is called the **calorigenic effect.** In this way, thyroid hormones play an important role in the maintenance of normal body temperature. Normal mammals can survive in freezing temperatures, but those whose thyroid glands have been removed cannot.
3. In the regulation of metabolism, the thyroid hormones stimulate protein synthesis and increase the use of glucose and fatty acids for ATP production. They also increase lipolysis and enhance cholesterol excretion, thus reducing blood cholesterol level.
4. Together with human growth hormone and insulin, thyroid hormones accelerate body growth, particularly the growth of the nervous and skeletal systems. Deficiency of thyroid hormones during fetal development, infancy, or childhood causes severe mental retardation and stunted bone growth.

Calcitonin:

It can decrease the level of calcium in the blood by inhibiting the action of osteoclasts, the cells that break down bone extracellular matrix.

Hypothyroidism:

It produces Cretinism in young and Myxoedema and Goitre in adults.

Cretinism:

1. Mental growth retarded along with low sexual activities.
2. Growth of the child diminishes.
3. Loss of appetite.
4. Continuous dribbling of saliva.
5. Pot belly.

Myxoedema:

1. Mongolism like facial appearance.
2. Diminishes BMR.
3. Swelling of the face.
4. Scaliness of the skin occur.
5. Coarse voice.

Goitre:

Due to low synthesis of thyroxin TSH level increases and it increase the size of the thyroid gland. This hypoactive state of thyroid gland with its elevation in size is known as goitre.

Hyperthyroidism:

Grave’s disease:

It is associated to external protrusion of eyeball and this is known as grave’s disease. General symptoms are-

1. Elevation of blood sugar and heart rate.
2. A high state of excitability.
3. Intolerance to heat.
4. Excessive sweating.
5. Extreme fatigue but inability to sleep.
6. Tremor of hands and feet.
7. Tachycardia.

ADRENAL GLAND

Structure:

The paired adrenal glands are pyramid-shaped organ which lies superior to each kidney in the retroperitoneal space. They are also often referred to as the suprarenal glands. Each adrenal gland is structurally and functionally two endocrine glands. The inner adrenal medulla, is part of the sympathetic nervous system. The outer adrenal cortex, encapsulating the medullary region and forming the bulk of the gland. Each region produces its own set of hormones. The adrenal cortex produces steroid hormones that are essential for life. Complete loss of adrenocortical hormones leads to death due to dehydration and electrolyte imbalances in a few days to a week, unless hormone replacement therapy begins promptly. The adrenal medulla produces three catecholamine hormones—norepinephrine, epinephrine, and a small amount of dopamine.

Adrenal cortex:

The adrenal cortex is subdivided into three zones, each of which secretes different hormones.The outer zone, is the **zona glomerulosa,** secrete hormones called **mineralocorticoids** because they affect mineral homeostasis. The middle zone, or **zona fasciculata** secrete mainly **glucocorticoids**, so named because they affect glucose homeostasis. The cells of the inner zone, the **zona reticularis,** They synthesize small amounts of weak **androgens,**steroid hormones that have masculinizing effects.

Mineralocorticoids:

**Aldosterone** is the major mineralocorticoid. It regulates homeostasis of two mineral ions, namely sodium ions

(Na\_) and potassium ions (K\_), and helps adjust blood pressure and blood volume. The **renin–angiotensin–aldosterone** or **RAA pathway** controls secretion of aldosterone.

Glucocorticoids:

The glucocorticoids, which regulate metabolism and resistance to stress, include **cortisol (hydrocortisone), corticosterone,** and **cortisone.**

Glucocorticoids have the following effects:

**1. *Protein breakdown.*** Glucocorticoids increase the rate of protein breakdown, mainly in muscle fibers, and thus increase the liberation of amino acids into the bloodstream. The amino acids may be used by body cells for synthesis of new proteins or for ATP production.

**2. *Glucose formation.*** These hormones favor glycogen synthesis and also stimilate gluconeogenesis from amino acid.

**3. *Lipolysis.*** Glucocorticoids stimulate **lipolysis,** the breakdown of triglycerides and release of fatty acids from adipose tissue into the blood.

**4. *Resistance to stress.*** Glucocorticoids work in many ways to provide resistance to stress. The additional glucose supplied by the liver cells provides tissues with a ready source of ATP to combat a range of stresses, including exercise, fasting, fright, temperature extremes, high altitude, bleeding, infection, surgery, trauma, and disease.

Androgens:

The major androgen secreted by the adrenal gland is **dehydroepiandrosterone (DHEA).** After puberty in males, the androgen testosterone is also released in much greater quantity by the testes.

After menopause, when ovarian secretion of estrogens ceases, all female estrogens come from conversion of adrenal androgens.

Adrenal medulla:

The two major hormones synthesized by the adrenal medulla are **epinephrine** and **norepinephrine (NE),** also

called *adrenaline* and *noradrenaline,* respectively.

The two hormones exert the same effects. Epinephrine is the more potent stimulator of metabolic activities, bronchial dilation, and increased blood flow to skeletal muscles and the heart, but norepinephrine has the greater influence on peripheral vasoconstriction and blood pressure.

Hypo activity:

Addison’s disease:

1. Muscles become weak and fatigue.
2. Low BMR.
3. Skin become hyper pigmented.

Hyper activity:

Adrenogenital syndrome:

Reversal of sex characteristics are the main feature.

Cushing’s syndrome:

1. Excess fat deposition in abdomen and pubic zone.
2. High blood sugar level.
3. Degeneration in testis and ovary.
4. Loss of minerals from bones.

PANCREAS GLAND

Structure:

The **pancreas** is both an endocrine gland and an exocrine gland. the pancreas is located in the curve of the duodenum, the first part of the small intestine, and consists of a head, a body, and a tail. Roughly 99% of the cells of the pancreas are arranged in clusters called **acini.** The acini produce digestive enzymes. Scattered among the exocrine acini are 1–2 million tiny clusters of endocrine tissue called **pancreatic islets** or **islets of Langerhans.**

**Cell Types in the Pancreatic Islets**

Each pancreatic islet includes four types of hormone-secreting cells:

**1. Alpha** or **A cells** constitute about 17% of pancreatic islet cells and secrete **glucagon.**

**2. Beta** or **B cells** constitute about 70% of pancreatic islet cellsand secrete **insulin.**

**3. Delta** or **D cells** constitute about 7% of pancreatic islet cells and secrete **somatostatin.**

**4. F cells** constitute the remainder of pancreatic islet cells and secrete **pancreatic polypeptide.**

**Glucagon:**

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| **1.** Breakdown of glycogen to glucose (glycogenolysis) |
| **2.** Synthesis of glucose from lactic acid and from noncarbohydrate molecules (gluconeogenesis) |
| **3.** Release of glucose to the blood by liver cells, which causes blood glucose levels to rise |

Insulin:

Insulin’s effects are most obvious when we have just eaten. Its main effect is to lower blood glucose levels, but it also influences protein and fat metabolism. Circulating insulin lowers blood glucose levels by enhancing membrane transport of glucose (and other simple sugars) into body cells, especially muscle and fat cells. Insulin inhibits the breakdown of glycogen to glucose and the conversion of amino acids or fats to glucose; thus, it counters any metabolic activity that would increase plasma levels of glucose.

Hypoglycemia:

It is a condition in which blood sugar level is present below the normal level i.e., below 80mg/100ml. symptoms are: 1. A feeling of fatigue, weakness and hunger.

2. extreme anxiety and irritability.

3. tremors of hands and legs.

Hyperglycemia:

It is a condition in which blood sugar increases above the normal level,i.e., above 120mg/100ml. when the blood sugar exceeds the renal thresh hold (180mg/100ml) sugar appears in the urine.

Glycosuria:

It is a condition when the blood glucose level exceeds 180mg/100ml above the normal blood glucose level. At this time the renal tubule cells are not able to reabsorb all the glucose.

Imbalance in adrenal hormones results in a condition termed as Diabetes mellitus,in which a large volume of urine is passed.