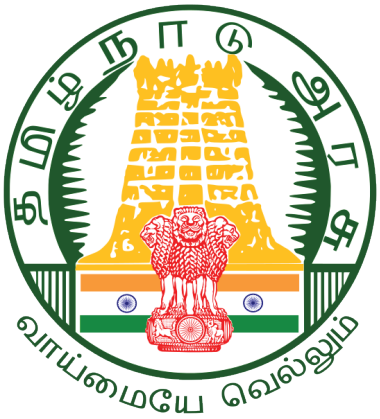


GOVERNMENT OF TAMILNADU

Department of Employment and Training

Course : TNPSC Group-II Mains Material

Subject : Biology

Topic : State Govt. Endocrine System

Commissioner,

Department of Employment and Training

தமிழ்நாடு அரசு
வாய்மையே வெல்லும்

ENDOCRINE SYSTEM

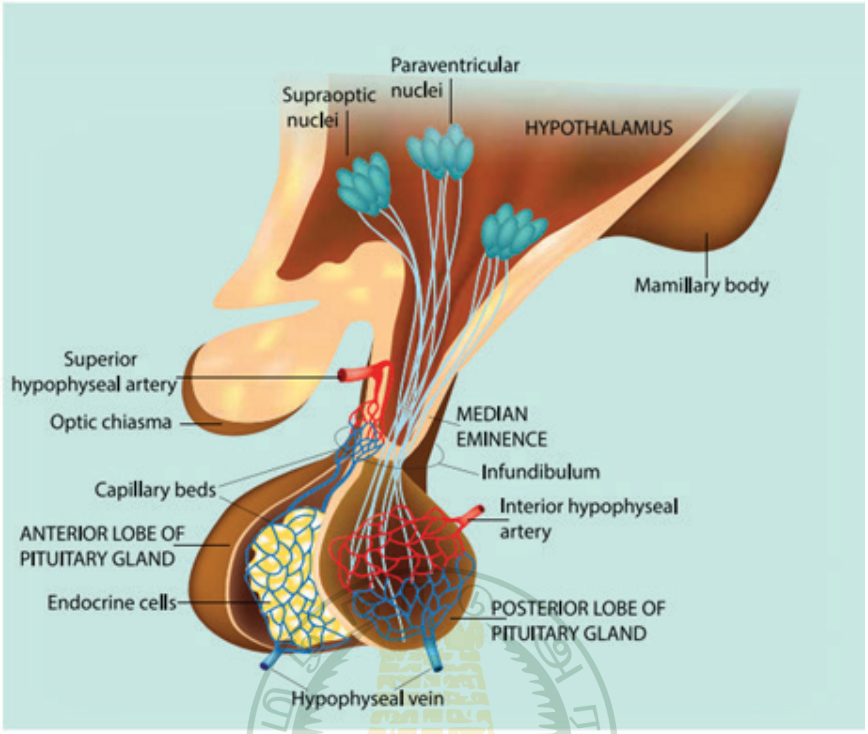
ENDOCRINOLOGY

- The branch of biology which deals with the study of the endocrine glands and its physiology is known as 'Endocrinology'.
- Endocrinology word coined by the Italian physician **Nicola Pende** (1880–1970).

Exocrine Gland	Endocrine Gland
• Gland with ducts.	• Ductless glands and lack ducts.
• Secrete enzymes.	• They release their hormone to the surrounding tissue fluid.
• The secretions are released to the outer surface of the body or to some internal organ through a duct. E.g., Salivary gland, Liver, Pancreas, Sweat glands & Gastric gland.	• The secretions are directly poured into the circulating blood and reach the organ. E.g., Pituitary, Thyroid, Parathyroid, Adrenals & Sex glands (testis & ovaries).
• Largest Exocrine Gland is Liver	• Largest Endocrine Gland is Thyroid gland
• Smallest Exocrine is Goblet Cell	• Smallest Endocrine is Pituitary gland

1. HYPOTHALAMUS

- Supreme Commander of Endocrines. Though pituitary gland is known as master endocrine glands that controls the other endocrine glands, but it is in turn controlled by the hypothalamus.
- Hypothalamus is a small cone shaped structure that projects downward from the brain ending into the pituitary stalk.



Hypothalamus and pituitary gland

- It interlinks both the nervous system and endocrine system.
- Hypothalamus contains groups of neurosecretory cells. It produces neurotransmitters which regulate the secretions of the pituitary.

Functions of Hypothalamus

1. Homeostasis (Maintenance of constant internal environment of the body by different coordinating system).
2. Blood pressure.
3. Body temperature.
4. Cardio & fluid electrolyte balance of the body.
    - As the part of limbic system, it influences various emotional responses.
    - The hormones produced by the hypothalamus act either as a **releasing hormone** or as an **inhibitory hormone**.

Hormone

- The word hormone is derived from the Greek word **"hormon"** meaning "to excite".
- English physiologists **W. M. Bayliss** and **E. H. Starling** introduced the term hormone in 1909. They first discovered the hormone secretin in intestine.

Pituitary Gland (Hypophysis) Master Endocrine Gland

- It Size is 1 cm in diameter, and shape is Pea shape, weight is 0.5 gm. It located in the sella turcica, a bony cavity of the sphenoid bone at the base of brain and connected to the hypothalamic region of the brain by a stalk called infundibulum.
- The pituitary consists of two lobes, 1. Anterior glandular adenohypophysis, 2. Posterior neural neurohypophysis (pars nervosa).

Anterior Glandular Adenohypophysis

- Originates from the embryonic invagination of pharyngeal epithelium called Rathke's pouch.
- Anatomically the adenohypophysis has three lobes or zones namely. 1. Pars inter-media, 2. Pars distalis, 3. Pars tuberalis.

Hormones of Adenohypophysis

1. Growth Hormone (GH) (Somatotropic Hormone (STH)/Somatotropin)

- It is a Peptide hormone, it promotes growth of all the tissues and metabolic process of the body. It influences the metabolism of carbohydrates, proteins and lipids and increases the rate of protein biosynthesis in the cells.
- It stimulates chondrogenesis (cartilage formation), steogenesis (bone formation). Helps in the retention of minerals like nitrogen, potassium, phosphorus, sodium etc., in the body. Increases the release of fatty acid from adipose tissue.
- Decreases the rate of glucose utilization for energy by the cells. Thus, it conserves glucose for glucose dependent tissues, such as the brain.

Hypo Secretion of Growth Hormone

- **Dwarfism** due to hyposecretion of growth hormone (GH) in children, skeletal growth and sexual maturity is arrested. They attain a maximum height of 4 feet only.

Hyper Secretion of Growth Hormone

- **Gigantism** due to hypersecretion of growth hormone in children. Overgrowth of skeletal structure occurs (up to 8 feet) and the visceral growth is not appropriate with that of limbs.
- **Acromegaly** due to excessive secretion of growth hormone in adults.

Symptoms

- Over growth of hand bones, feet bones, jaw bones, malfunctioning of gonads and enlargement of viscera, tongue, lungs, heart, liver, spleen and endocrine gland like thyroid, adrenal etc.,

2. Thyroid Stimulating Hormone (TSH)/ Thyrotropin

- Glycoprotein hormone. Stimulates the thyroid gland to secrete Tri-iodothyronine (T3) and thyroxine (T4).
- TSH secretion is regulated by negative feedback mechanism. It's release from the anterior pituitary is induced by the thyrotropin releasing hormone (TRH).
- When thyroxine level in the blood increases, TRH acts on both the pituitary and hypothalamus to inhibit TSH secretion.

3. Adreno Cortico Tropic Hormone (ACTH)

- It is a polypeptide tropic hormone. It stimulates the adrenal cortex to secrete glucocorticoids and mineralocorticoids.
- Stimulates melanin synthesis in melanocytes, induces the release of fatty acids from adipose tissues and stimulates insulin secretion. ACTH secretion is regulated by negative feedback mechanism.

4. Follicle Stimulating Hormone (FSH)

- It is a glycoprotein polypeptide hormone. It regulates the functions of the gonads (ovary and testis).
- In males, FSH along with androgens acts on the germinal epithelium of seminiferous tubules and stimulates the production and release of sperms (spermatogenesis).
- In females, FSH acts on the ovaries and brings about the development and maturation of graffian follicles.

5. Luteinizing Hormone (LH)/Interstitial Cell Stimulating Hormone (ICSH)

- Glycoprotein hormone. It promotes synthesis and release of ovarian hormones. In males, ICSH acts on the interstitial cells of testis to produce the male sex hormone, testosterone. In females, LH along with FSH matures the ovarian follicles.
- LH independently induces ovulation. It maintains the corpus luteum.

6. Luteotropic Hormone (LTH)

- Prolactin is also called the hormone of maternity. Luteotropin or Lactogenic hormone or prolactin or mammotropin. It is Protein hormone.
- It stimulates milk secretion after the child birth in females. High prolactin secretion during lactation suppresses LH secretion and ovulation since it induces the corpus luteum hence, named as luteo tropic hormone.

Hormones of Neurohypophysis

1. Vasopressin/Antidiuretic Hormone (ADH) (Pitressin)

- It is Peptide hormone. It promotes reabsorption of water and electrolytes by distal tubules of nephron and thereby reduces loss of water through urine. Hence, it is called as anti-diuretic hormone. It cause constriction of blood vessels when released in large amount and increases blood pressure.
- ADH deficiency disease: **Diabetes insipidus.** Its symptom of Diabetes insipidus induces the production of large amount of urine (Poly-urea). Poly-dipsia–excessive thirst.

2. Oxytocin (Quick Birth/Birth Hormone/Milk Ejecting Hormone/Pitocin)

- It is an Peptide hormone. It stimulates vigorous contraction of the smooth muscles of uterus during child birth and ejection of milk from the mammary glands.
- Vasopressin and oxytocin are composed of nine amino acids and are almost identical and they differ in only two amino acids and yet they have dramatically different physiological effects.

3. Pineal Gland (3rd Eye of the Man)

- It is also called as Epiphysis Cerebri/Conarium/Biological Clock and it is Located Behind the third ventricle of brain and is formed of parenchymal cells and interstitial cells. It secretes the two hormones namely, 1. Melatonin, 2. Serotonin.

1. Melatonin (Sleep Hormone)

- Plays a central role in the regulation of circadian rhythm of our body Maintains the normal sleep wake cycle.
- Melatonin is secreted at night, Light falling on the retina of eye decreases melatonin production.
- Circadian rhythm is the 24–hour cycle of biological activities associated with natural periods of light and darkness, E.g., sleep wake cycle, body temperature, appetite etc.
- Regulates the timing of sexual maturation of gonads and Influences metabolism, pigmentation, menstrual cycle and defence mechanism of our body.

2. Serotonin

- Serotonin is a chemical nerve cells produce. It sends signals between your nerve cells. It is found mostly in the digestive system, although it's also in blood platelets and throughout the central nervous system.
- It helps to Reduce depression, Regulate anxiety, Heal wounds, Stimulate nausea, Maintain bone health.

2. THYROID GLAND

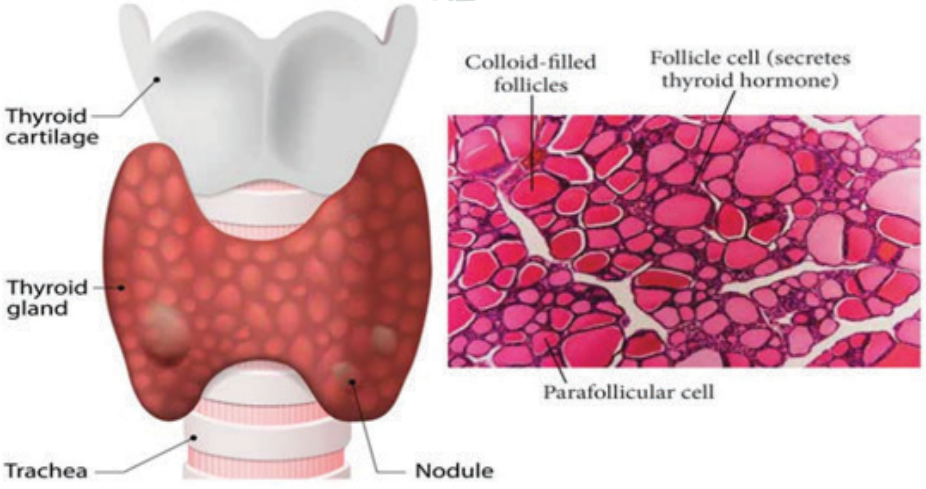
- Butterfly shape, largest endocrine gland, and it located larynx on each side of upper trachea.
- **Isthmus**: Thyroid two lateral lobes connecting median tissue mass and each lobe is made up of many lobules. The lobules consist of follicles called acini (acinus in singular).
- Hormones of the thyroid gland are often called the major metabolic hormones.
- Thyroid gland requires "120 µg" of iodine every day for the production of thyroxine. The follicular cells of thyroid gland secrete two hormones. 1. Tri-iodothyronine (T3), 2. Thyroxine or tetra-iodothyronine (T4).
- The parafollicular cells or 'C' cells of thyroid gland secrete a hormone called thyrocalcitonin.
- Iodine is essential for the normal synthesis of thyroid hormones.

1. Thyroxine (or) Tetraiodothyronine

- It regulate the basal metabolic rate (BMR) and body heat production and stimulate protein synthesis and promotes growth.
- It is essential for the development of skeletal and nervous system and plays an important role in maintaining blood pressure. Reduce serum cholesterol levels, Optimum levels of thyroxine in blood is necessary for gonadial functions.

2. Thyrocalcitonin (TCT)

- It is an polypeptide hormone and it regulate the blood calcium and phosphate levels, reduce the blood calcium level and oppose the effects of parathyroid hormone.
- First Crystallizations of Thyroxine Hormone – Edward C. Kendal (1914).
- Charles Harrington and George Barger identified the molecular structure of thyroxine in 1927.



Structures of thyroid gland

1. Simple Goiter (Endemic Goiter)

- Hyposecretion of thyroxine. Its symptoms Enlargement of thyroid gland, Fall in serum thyroxine level, Increased TSH secretion.

2. Cretinism:

- Hypothyroidism in infants, causes cretinism.
- Its symptoms is Low bmr, Slow pulse rate, Subnormal body temperature, Elevated blood cholesterol levels, A cretin shows retarded skeletal growth, absence of sexual maturity, Retarded mental ability, thick wrinkled skin, Protruded enlarged tongue, bloated face, thick and short limbs occur.

3. Myxedema (Gull's Disease):

- Hyposecretion of thyroid in adults.
- Its symptoms is Decreased mental activity, Memory loss, Slowness of movement, Speech and general weakness of body, Dry coarse skin, Scarce hair, puffy appearance, Disturbed sexual function, Low bmr, poor appetite and subnormal body temperature.

4. Grave's Disease (Thyrotoxicosis or Exophthalmic Goiter):

- Caused due to hyper secretion of thyroid.
- Its symptoms is Enlargement of thyroid gland, Increased BMR (50–100%), Elevated respiratory and Excretory rates, Increased heartbeat, High Blood Pressure, Increased body temperature, Protrusion of eyeball, Weakness of eye muscles and Weight loss.

Parathyroid Gland

- In human, four tiny parathyroid glands are found in the posterior wall of the thyroid glands. It composed of two types of cells and chief cells-secrete parathyroid hormone (PTH).
- Oxyphil cells-functions of oxyphil cells are not known.
- The parathyroid gland secretes parathormone and calcitonin.

1. Parathyroid Hormone or Parathormone (PTH)

- PTH is a hypercalcemic hormone. It is a peptide hormone involved in controlling the calcium and phosphate homeostasis.
- The secretion of PTH is controlled by calcium level in the blood. It increases the blood calcium level by stimulating osteoclasts to dissolve the bone matrix.
- As a result calcium and phosphate are released into the blood.
- PTH enhances the reabsorption of calcium and excretion of phosphates by the renal tubules and promotes activation of vitamin D to increase calcium absorption by intestinal mucosal cells.

2. Calcitonin

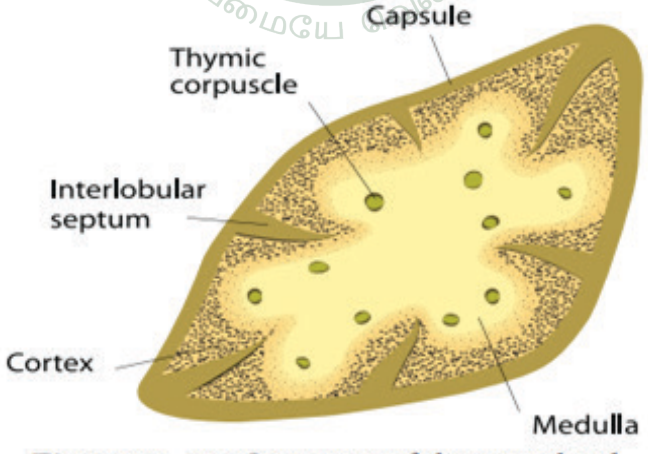
- Calcitonin reduces calcium levels in the blood by two main mechanism. That is,
  1. When bone is broken down, the inhibition of the osteoclasts by calcitonin directly reduces the amount of calcium released into the blood.
  2. It can also decrease the resorption of calcium in the kidneys, again leading to lower blood calcium levels.

3. THYMUS GLAND

- Thymus gland is partially an endocrine and partially a lymphoid organ. It located just above the heart and aorta, behind the sternum.
- It is covered by fibrous capsule and anatomically, it is divisible into an outer cortex and an inner medulla.
- It secretes 4 hormones: 1. Thymulin, 2. Thymosin, 3. Thymopoietin, 4. Thymic Humoral Factor (THF).
- Production of immuno competent 'T' lymphocytes which provides cell mediated immunity.
- Thymus Gland secretes the Thymosin hormone. It has a stimulatory effect on the immune function and stimulate the production and differentiation of lymphocytes.

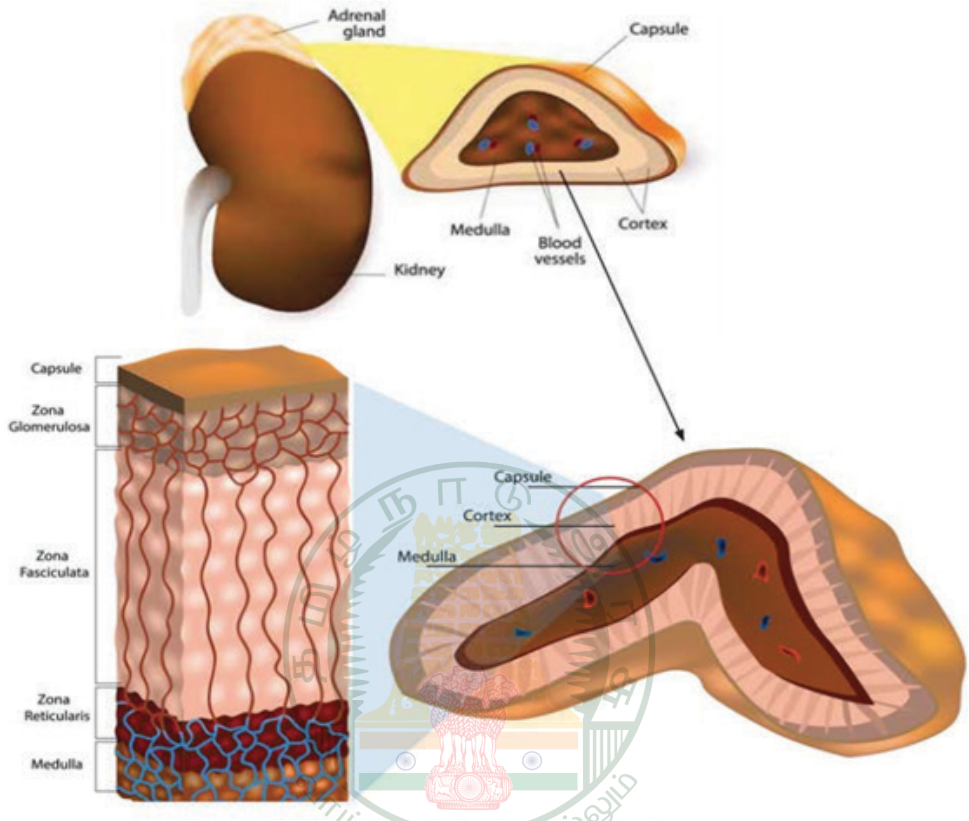
Degeneration of Thymus Gland

- Thymosin level decreases, as a result the immunity of old age people becomes weak and causes sickness.



Structure of thymus gland

4. ADRENAL GLAND (SUPRARENAL GLANDS/COCK HAT GLAND)



Structure of adrenal gland

- A pair of adrenal glands are located at the anterior end of the kidneys.
- Its Outer region is Cortex and Inner region is Medulla and Histological of the adrenal cortex has three distinct zones. Zona Glomerulosa (Outer thin layer–15%): It Secretes Mineralocorticoids (Aldosterone).

1. Zona Fasciculata (Middle widest layer–75%): It secretes lucocorticoids such as cortisol, corticosterone.
2. Zona Reticularis (Inner layer–10%): It secretes the adrenal androgen, trace amount of Oestrogen.

Aldosterone

- It maintains mineral metabolism by favouring re-absorption of sodium and water and excretion of potassium and phosphate ions.
- It maintains electrolyte balance, body fluid volume, osmotic pressure and blood pressure.

Hormones of Adrenal Medulla

- Central part of adrenal gland and is composed of ovoid and columnar cells.
  1. Adrenalin (Epinephrine), 2. Nor Adrenalin (Nor Epinephrine).
- These both are catecholamines and it also called as 3F hormone (fight, flight & fright).

1. Epinephrine (Adrenaline)

- It promotes the conversion of glycogen to glucose in liver and muscles and it increases heart beat, blood pressure and the rate of respiration by dilation of bronchi and trachea.
- It causes dilation of the pupil in eye and decreases blood flow through the skin.

2. Nor-Epinephrine (Nor-Adrenalin)

- Most of its actions are similar to those of epinephrine.

A) Addison's Disease

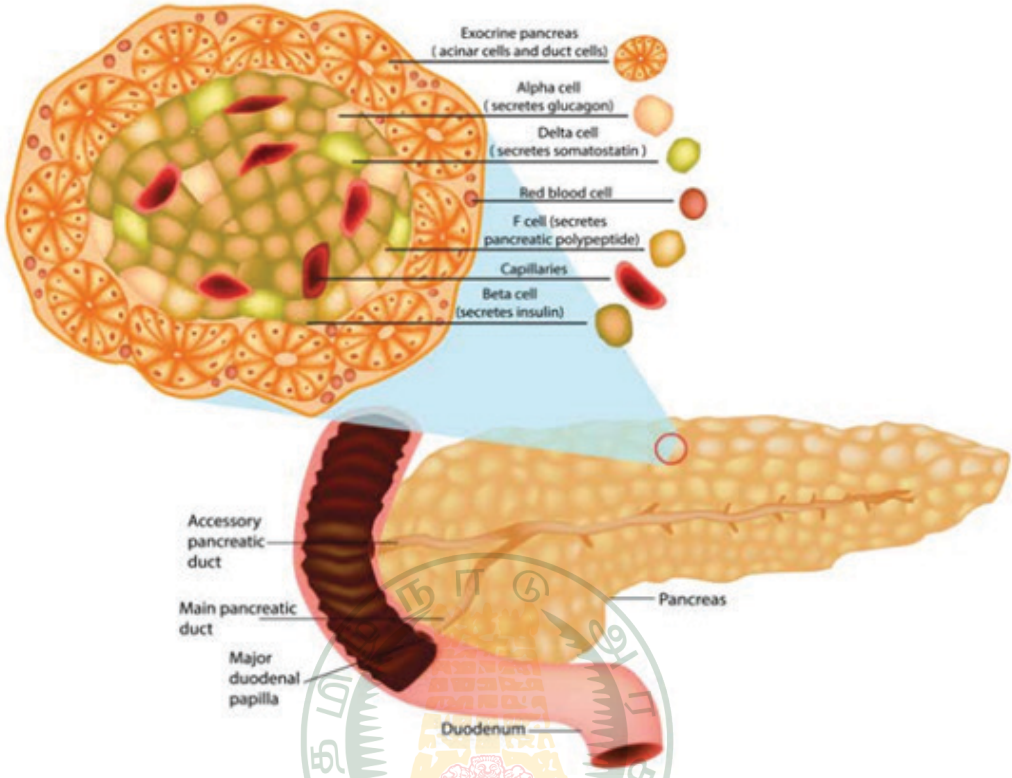
- Caused due to hyposecretion of glucocorticoids and mineralocorticoids from the adrenal cortex.
- Its symptoms is Muscular weakness, low BP., loss of appetite, vomiting, hyper pigmentation of skin, low metabolic rate, subnormal temperature, reduced blood volume, weight loss.
- Reduced aldosterone secretion increases urinary excretion of NaCl. and water and decreases potassium excretion leading to dehydration.

B) Cushing's Syndrome

- Excess secretion of cortisol lead to Cushing's syndrome, it was first described by Harvey Cushing (1932).
- Its symptoms is Obesity of the face and trunk, redness of face, hand, feet, thin skin, excessive hair growth, Loss of minerals from bone (osteoporosis), systolic hypertension.
- Suppression of sexual function like atrophy of gonads are the other symptoms of Cushing's syndrome.

5. PANCREAS (HETEROCRINE GLAND)

- Pancreas is a composite gland which performs both exocrine and endocrine functions. It is located just below the stomach as a leaf like structure.
- Pancreas is an elongated, yellowish gland situated in the loop of stomach and duodenum.
- The pancreas is composed of two major tissues such the acini and islets of Langerhans.
- Acini secretes digestive enzymes and the islets of Langerhans secretes hormones like insulin and glucagon.
- Pancreas can be classified into Acini cells (Enzymes) and Islets of Langerhans (1. Alpha Cells–Glucagon, 2. Beta Cells–Insulin, 3. Delta Cells–Somatostatin, 4. F Cells – Pancreatic peptide).
- Human pancreas has one to two million islets of Langerhans. Islets of Langerhans (Islands of Pancreas).



Structure of Islets of Langerhans (pancreas)

Functions of Pancreatic Hormones

- A balance between insulin and glucagon production is necessary to maintain blood glucose concentration.

1. Insulin (Hypoglycemic Hormone)

- It is an Peptide hormone. Insulin helps in the conversion of glucose into glycogen which is stored in liver and skeletal muscles. It promotes the transport of glucose into the cells and it decreases the concentration of glucose in blood.

Type-1 Insulin Dependent Diabetes Mellitus (IDDM)

- IDDM accounts for 10 to 20% of the known diabetics. The condition also occurs in children (juvenile onset diabetes) and young adults, the onset is usually sudden and can be life threatening.
- This is caused by the destruction of β–cells of the pancreas. It is characterized by abnormally elevated blood glucose levels (hyperglycemia) resulting from inadequate insulin secretion.
- Causes: Genetic inheritance and environmental factors (Infections due to virus, acute stress) are the cause for this condition.

Type-2: Non-Insulin Dependent Diabetes Mellitus (NIDDM)

- This is also called as adult onset diabetes and accounting for 80 to 90% of the diabetic population. It develops slowly, usually milder and more stable.
- Insulin production by the pancreas is normal but its action is impaired. The target cells do not respond to insulin. It does not allow the movement of glucose into cells.
- Causes: The causes are multifactorial which include increasing age (affecting middle aged and older people), obesity, sedentary life style, overeating and physically inactive.

2. Hyperglycemia

- Diabetes mellitus is a chronic metabolic disorder. In Greek **(Diabetes–running through; mellitus–sweet).**
  1. Increase in blood sugar level (Hyperglycemia).
  2. Excretion of excess glucose in the urine (Glycosuria).
  3. Frequent urination (Polyuria).
  4. Increased thirst (Polydipsia).
  5. Increase in appetite (Polyphagia).
  6. Hypoglycemia.

Laboratory Diagnosis

1. Glucometer

- It is a simple and portable medical device used to record the approximate levels of blood glucose. It is a battery-operated digital meter.

2. Benedict's Test

- Benedict's reagent is used to test for the presence of glucose in urine.

3. Glucagon (Hyperglycemic Hormone)

- A **polypeptide hormone.** Glucagon helps in the breakdown of glycogen to glucose in the liver. Glucagon releases glucose from the liver cells and it increases blood glucose levels.
- It is a potent hyperglycaemic hormone that acts on the liver and promotes the breakdown of glycogen to glucose (Glygogenolysis, synthesis of glucose from lactic acid and from non-carbohydrate molecules (Gluconeogenesis).

6. GONADS

Testes

- A pair of testis is present in the scrotal sac of males. The testis functions as a sex organ and also as an endocrine gland.
- The testis is composed of seminiferous tubules and interstitial cells or Leydig cells secrete several male sex hormone androgens-(Testosterone).

- Under the influence of FSH and LH, testosterone initiates maturation of male reproductive organs and the appearance of secondary sexual characters, muscular growth, growth of facial and axillary hair, masculine voice and male sexual behaviour.
- It enhances the total bone matrix and plays a stimulating role in the process of spermatogenesis.

Ovary

- Females have a pair of ovaries located in the pelvic region of the abdomen.
- The ovary is composed of ovarian follicles and stromal tissues and it produces the eggs or ova.
- The ovaries secrete the steroid hormones oestrogen and progesterone.

1. Oestrogen

- Steroid Hormone. It is responsible for the maturation of reproductive organs and the development of secondary sexual characters at puberty.
- Along with progesterone, oestrogens promotes breast development and initiate the cyclic changes during menstrual cycle.

2. Progesterone (Pregnancy Hormone)

- Steroid Hormone. It prepares the uterus for implantation of the fertilized ovum.
- It decreases the uterine contraction during pregnancy and stimulates the development of mammary glands and milk secretion.
- It is responsible for premenstrual changes in the uterus and is essential for the formation of placenta.

Hormones of Heart

- Atrial Natriuretic Factor (ANF). In the heart, cardiocytes on the atrial wall's secretes an important peptide hormone.
- When blood pressure is increased, ANF is secreted and causes dilation of the blood vessels to reduce the blood pressure.

Hormones of Kidney

- Erythropoietin (EPO): It is secreted by the JGA cells of the kidney and It stimulates erythropoiesis (formation of RBC) in bone marrow.
- Renin: It is secreted by juxta glomerular cells (JG cell). It increases blood pressure when angiotensin is formed in blood.
- Calcitriol: It is secreted by proximal tubules of nephron. It is an active form of vitamin D3 which promotes calcium and phosphorus absorption from intestine and accelerates bone formation.

Hormones of Gastro Intestinal Tract

- Gastrin: Gastrin acts on the gastric glands. It stimulates the secretion of HCl and pepsinogen.
- Cholecystokinin (CCK): It is secreted by duodenum in response to the presence of fat and acid in the diet. It acts on the gall bladder to release bile into duodenum and stimulates the secretion of pancreatic enzymes and its discharge.
- Secretin: It acts on acini cells of pancreas to secrete bicarbonate ions and water to neutralize the acidity.