

CHEMICAL COORDINATION AND INTEGRATION

ENDOCRINE GLANDS AND HORMONES

- ☐ Endocrine glands lack ducts and are hence, called ductless glands.
- ☐ Their secretions are called hormones

HORMONES

- ☐ **hormones produced and released into the blood and transported to a distantly located target organ**
- ☐ **Hormones are intercellular messengers**
- ☐ **Produced in trace amounts**

HUMAN ENDOCRINE SYSTEM

- ☐ Hypothalamus
- ☐ Pituitary,
- ☐ Pineal,
- ☐ Thymus
- ☐ Thyroid,
- ☐ Parathyroid,
- ☐ Adrenal,
- ☐ Pancreas,
- ☐ gonads (testis in males and ovary in females)
- ☐ **In addition to these, some other organs, e.g., gastrointestinal tract, liver, kidney, heart also produce hormones.**

☐ **THE HYPOTHALAMUS**

- ☐ **Located in the basal part of forebrain**
- ☐ **It contains neurosecretory cells called nuclei which produce hormones.**
- ☐ **These hormones regulate the synthesis and secretion of pituitary hormones**

HORMONES OF HYPOTHALAMUS

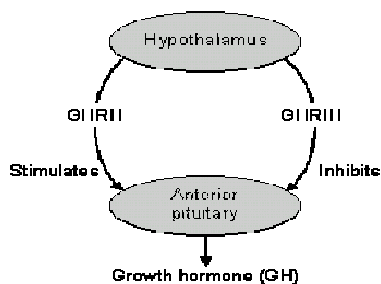
- ☐ 1. Releasing hormones - stimulate secretion of pituitary hormones
- ☐ 2. Inhibiting hormones - inhibit secretions of pituitary hormones Eg:- Somatostatin
- ☐ 3. Oxytocin
- ☐ 4. Vasopressin
- ☐ These hormones originating in the hypothalamic neurons, pass through axons and are released from their nerve endings.

1. RELEASING HORMONES

- ☐ Eg:- Thyrotrophin releasing hormone (TRH) stimulates the pituitary gland for the synthesis and secretion of thyroid stimulating hormone (TSH)
- ☐ Eg:- Gonadotrophin releasing hormone (GnRH) stimulates the pituitary gland for the synthesis and release of gonadotrophins

2. INHIBITING HORMONES

- ☐ Somatostatin from the hypothalamus inhibits the release of growth hormone from the pituitary



OXYTOCIN

Stimulates a vigorous contraction of uterus at the time of child birth,

*Stimulates milk ejection from the mammary gland

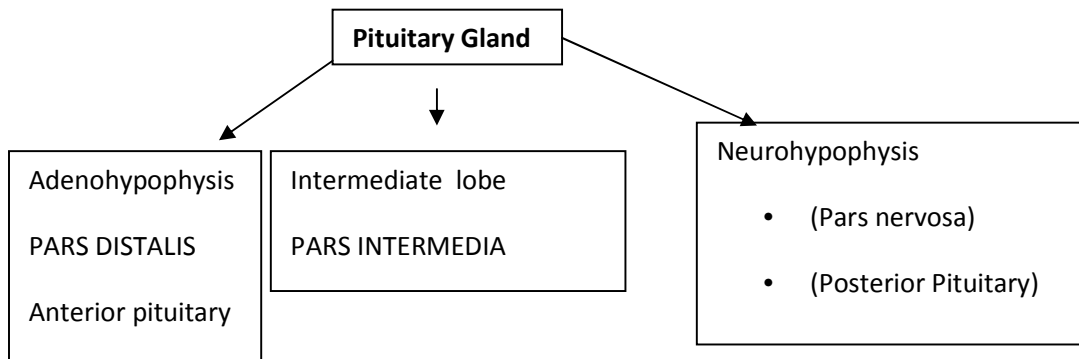
VASOPRESSIN

- ☐ Stimulates reabsorption of water by the distal tubules and thereby reduces loss of water through urine (diuresis). Hence, it is also called as **anti-diuretic hormone (ADH)**.

2.THE PITUITARY GLAND

- ☐ located in a bony cavity called sella tursica
- ☐ Attached to hypothalamus by a stalk

THE PITUITARY GLAND



ANTERIOR PITUITARY HORMONES(Pars distalis)

- ☐ Growth hormone (GH),
- ☐ Prolactin (PRL),
- ☐ Thyroid stimulating hormone (TSH),
- ☐ Adrenocorticotrophic hormone (ACTH),
- ☐ Luteinizing hormone (LH) and
- ☐ Follicle stimulating hormone (FSH)

HORMONES OF PARS INTREMEDIA

- ☐ Melanocyte stimulating hormone (MSH)

HORMONES OF POSTERIOR PITUITARY

- ☐ Stores and releases two hormones called **oxytocin** and **vasopressin**, which are actually synthesised by the hypothalamus and are transported axonally to neurohypophysis.

PITUITARY HORMONES

1.GROWTH HORMONE (GH)- Growth of the body

GIGANTISM-Over-secretion of GH stimulates abnormal growth of the body leading to gigantism

DWARFISM-Low secretion of GH results in stunted growth resulting in pituitary dwarfism

2,PROLACTIN

- ☐ Prolactin regulates the growth of the mammary glands and production of milk in them

3.THYROID STIMULATING HORMONE (TSH)

- ☐ TSH stimulates the synthesis and secretion of thyroid hormones from the thyroid gland

4.ADRENOCORTICOTROPIC HORMONE (ACTH)

- ☐ ACTH stimulates the synthesis and secretion of steroid hormones called glucocorticoids from the adrenal cortex.

5.GONADOTROPHINS

- ☐ Luteinizing hormone (LH) and Follicle stimulating hormone (FSH) stimulate gonadal activity and hence are called gonadotrophins.

MALE	FEMALE
Stimulates the synthesis and secretion of hormones called androgens from testis	Induces ovulation and maintains the corpus luteum
FSH and androgens regulate spermatogenesis	Stimulates growth and development of the ovarian follicles in females.

1.MELANOCYTE STIMULATING HORMONE (MSH)

MSH acts on the melanocytes (melanin containing cells) ®ulates pigmentation of skin

THE PINEAL GLAND

- ☐ Located on the dorsal side of forebrain.

Pineal secretes a hormone called **melatonin**

MELATONIN

- ☐ regulates a 24-hour (diurnal) rhythm of our body.
- ☐ melatonin also influences
- ☒ metabolism
- ☒ pigmentation
- ☒ the menstrual cycle
- ☒ defence capability

THYROID GLAND

- ☐ Located on either side of the trachea.
- ☐ Composed of two lobes
- ☐ Both are interconnected with isthmus.
- ☐ The thyroid gland is composed of follicles which contains follicular cells
- ☐ These follicular cells synthesise 3 hormones,

1. Tetraiodothyronine or thyroxine (T4)

2. Triiodothyronine (T3)

3. Thyrocalcitonin

GOITRE

- ☐ Iodine is essential for the synthesis of thyroid hormones.
- ☐ Deficiency of iodine results in **hypothyroidism** and **enlargement of the thyroid gland**, commonly called **goitre**.

HYPOTHYROIDISM-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.

HYPERTHYROIDISM-Due to cancer of the thyroid glands, the secretion of the thyroid hormones is increased to high levels leads to hyperthyroidism which adversely affects the body physiology.

FUNCTIONS OF THYROID HORMONES

- ❑ Regulates the basal metabolism
- ❑ Support the process of red blood cell formation.
- ❑ Control the metabolism of carbohydrates, proteins and fats.
- ❑ Maintenance of water and electrolyte balance

THYROCALCITONIN

- ❑ Thyrocalcitonin (TCT) -regulates the blood calcium levels. (Decreases the calcium level in blood)

PARATHYROID GLAND

- ❑ Four parathyroid glands are present on the back side of the thyroid gland, one pair each in the two lobes of the thyroid gland
- ❑ Secrete a peptide hormone called **parathyroid hormone (PTH)**.
- ❑ Parathyroid hormone (PTH) **increases the Ca^{2+}** levels in the blood by three ways.
- ❑ 1.Stimulates the process of bone reabsorption (dissolution/demineralisation).
- ❑ 2.Stimulates reabsorption of Ca^{2+} by the renal tubules
- ❑ 3. Increases Ca absorption from the digested food.
- ❑ Along with TCT, PTH plays a significant role in calcium balance in the body.

THYMUS GLAND

- ❑ Secretes the peptide hormones called **Thymosins**.
- ❑ A lobular structure located on the dorsal side of the heart and the aorta.
- ❑ **Function in immunity**

- ☐ Helps in the differentiation of T lymphocytes, which provide cell-mediated immunity.
- ☐ Increase the production of antibodies to provide humoral immunity.
- ☐ **Degenerates with aged individuals resulting in a decreased production of thymosins. As a result, the immune responses of old persons become weak**

ADRENAL GLAND

- ☐ **One pair of adrenal glands, one at the anterior part of each kidney.**
- ☐ Two PARTS
- ☐ **Adrenal medulla & Adrenal cortex**

ADRENAL medulla

- ☐ Secretes 2 hormones
- ☐ 1. Adrenaline or Epinephrine
- ☐ 2. Noradrenaline or Norepinephrine.
- ☐ Commonly called as Catecholamines

Catecholamines

- ☐ **Called as emergency hormones or hormones of Fight or Flight.**
- ☐ Because they are secreted in stress of any kind and during emergency situations

Effects of catecholamines (Adrenaline & Noradrenaline)

- ☐ Increase alertness,
- ☐ Pupillary dilation,
- ☐ Piloerection (raising of hairs),
- ☐ Sweating etc.
- ☐ Increase the heart beat, and the rate of respiration.
- ☐ Stimulate the breakdown of glycogen.
- ☐ stimulate the breakdown of lipids and proteins.

ADRENAL cortex

- ☐ Consists of 3 layers
- ☐ zona reticularis (inner layer),
- ☐ zona fasciculata (middle layer)
- ☐ Zona glomerulosa (outer layer)
- ☐ **The adrenal cortex secretes many hormones, commonly called as corticoids.**

CORTICOID HORMONES

- ☐ **1.Glucocorticoids**
- ☐ **2.Mineralocorticoids**
- ☐ **3.Androgenic steroids**
- ☐ **1.Glucocorticoids**
- ☐ The corticoids, which are involved in carbohydrate metabolism are called glucocorticoids
- ☐ In our body, cortisol is the main glucocorticoid

Function of GLUCOCORTICIDS (CORTISOL)

- ☐ Stimulate, gluconeogenesis, lipolysis and proteolysis;
- ☐ Inhibit cellular uptake and utilisation of amino acids.
- ☐ Involved in maintaining the cardio-vascular system as well as the kidney functions.
- ☐ Cortisol, produces anti- inflammatory reactions and suppresses the immune response.
- ☐ Stimulates the RBC production of RBC

MINERALOCORTICIDS

- ☐ Regulate the balance of water and electrolytes in our body are called Mineralocorticoids.
- ☐ Aldosterone is the main mineralocorticoid in our body.
- ☐ **MINERALOCORTICIDS (ALDOSTERONE)**

- ☐ Aldosterone acts mainly at the renal tubules and stimulates the reabsorption of Na^+ and water. Thus, aldosterone helps in the maintenance of electrolytes, body fluid volume, osmotic pressure and blood pressure.

ANDROGENIC STEROIDS

- ☐ Androgenic steroids are secreted by the adrenal cortex
- ☐ Play a role in the growth of axial hair, pubic hair and facial hair during puberty.

PANCREAS

- ☐ Pancreas is a mixed (composite) gland which acts as both exocrine and endocrine gland.
- ☐ The endocrine pancreas consists of **Islets of Langerhans**.

ISLETS OF LANGERHANS

- ☐ The two main types of cells in the Islet of Langerhans
- ☐ α -cells and β -cells.
- ☐ The α -cells *secrete* **glucagon**,
- ☐ the β -cells secrete **insulin**.

GLUCAGON

- ☐ Glucagon is a peptide hormone
- ☐ **Maintain the normal blood glucose levels.**
- ☐ 1.Stimulates glycogenolysis (breakdown of glycogen into glucose) resulting **hyperglycemia**.
- ☐ 2.Stimulates gluconeogenesis which also contributes to hyperglycemia.
- ☐ 3.Reduces the cellular glucose uptake and utilisation.
- ☐ Thus, glucagon is a **hyperglycemic hormone**.

INSULIN

- ☐ Insulin is a peptide hormone,
- ☐ Plays a major role in the regulation of glucose homeostasis.

- ☐ Enhances cellular glucose uptake and utilisation.
- ☐ Insulin 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.**
- ☐ 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.

TESTIS

- ☐ A pair of testis is present in the scrotal sac (outside abdomen) of male
- ☐ Primary sex organ
- ☐ Endocrine gland
- ☐ Composed of

1.Seminiferous tubules and

2. Leydig cells or interstitial cells.

- ☐ **The Leydig cells or interstitial cells, produce male hormones called androgens mainly testosterone.**
- ☐ Regulate the development, maturation and functions of the male accessory sex organs
- ☐ 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).
- ☐ **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 composed of ovarian follicles and stromal tissues.**
- ☐ Ovary produces two groups of steroid hormones
 - 1.Estrogen** and
 - 2.Progesterone**
- ☐ **The estrogen is secreted by the growing ovarian follicles.**
- ☐ **After ovulation, the ruptured follicle is converted to a structure called corpus luteum, which secretes progesterone.**

ESTROGENS

- ☐ 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.
- ☐ Regulate female sexual behaviour.

PROGESTERONE

- ☐ Progesterone supports pregnancy. (maintain the endometrial wall of the uterine wall)
- ☐ Progesterone also acts on the mammary glands and stimulates the formation of alveoli (sac-like structures which store milk) and milk secretion.

HORMONES OF HEART

Atrial Natriuretic Factor (ANF)

- ☐ Decreases blood pressure.
- ☐ When blood pressure is increased, ANF is secreted which causes dilation of the blood vessels. This reduces the blood pressure.

☐ **HORMONES OF KIDNEY**

- The juxtaglomerular cells of kidney produce a peptide hormone called erythropoietin which stimulates erythropoiesis (formation of RBC).

HORMONES	SOURCE	TARGET ORGAN	FUNCTIONS
Gastrin	Stomach	Gastric glands	Stimulate the secretion of HCl and Pepsinogen
Secretin	Small Intestine	Exocrine Pancreas	Secretion of water and bicarbonate ions
Cholecystokinin	Small Intestine	Pancreas Gall bladder	Stimulate the secretion of pancreatic enzymes and bile juice
Enteric Inhibitory Peptide	Small Intestine	Gastric glands	Inhibits gastric secretion and motility

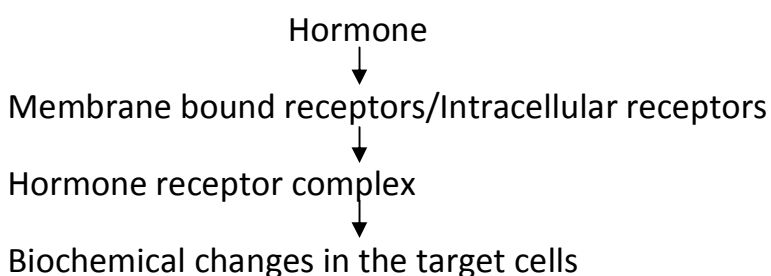
□ CLASSIFICATION OF HORMONES

HORMONES	EXAMPLE
Peptide ,Polypeptide, Protein hormones	Insulin , Glucagon, Pituitary hormones, Hypothalamic hormones etc.
Steroids	Cortisol, Testosterone, Estradiol, Progesterone , estrogen
Iodothyronines	Thyroid hormones
Amino acid derivatives	Adrenaline

- Hormones produced bind with a specific hormone receptors present in the target cells and form **hormone-receptor complex**.

Hormone receptors are two types

1. Membrane bound receptors
2. Intracellular receptors



- **Membrane bound receptors-Action**

Hormones do not enter cell

interact with receptors present in the cell membrane

Generate a second messenger(cyclic AMP, IP3 Ca^{++})

2nd messenger regulate cellular metabolism

- **Egs.** Protein hormones

- **Intracellular receptors-action**

hormone interact with intracellular receptors

interact with chromosome and gene expression.

Result in biochemical actions

- e.g., steroid hormones, iodothyronines, etc