Chemical Coordination and Integration

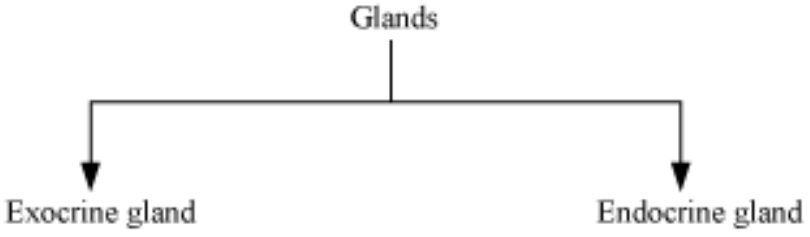
Hormones

- Hormones are chemical messengers that regulate the physiological processes in living organisms.
- These act upon specific target cells/tissues and organs.

Differences between Hormonal Control and Nervous Control

Hormonal Control	**Nervous Control**
Transmitted chemically through blood	Transmitted electro-chemically through nerve fibres
Transmitted slowly	Transmitted rapidly
Affects different organs	Affects specific organs
Is not affected by previous experience	Is affected by previous experience
Has both long lasting and short lasting effects	Has short lasting effect

Glands



- **Exocrine glands –** Glands that discharge their secretions into ducts

Examples: salivary gland in buccal cavity, sebaceous gland in skin

- **Endocrine gland–** Glands that do not discharge their secretions into ducts, but directly into blood

These are also called ductless glands. Examples: pituitary gland, thyroid gland, adrenal gland, etc.

Human Endocrine System

- Pituitary, pineal, thyroid, adrenal, pancreas, parathyroid, thymus, and gonads are the organised endocrine glands in our body.
- In addition, GI tract, liver, kidney, heart also produce hormones.

Human endocrine system

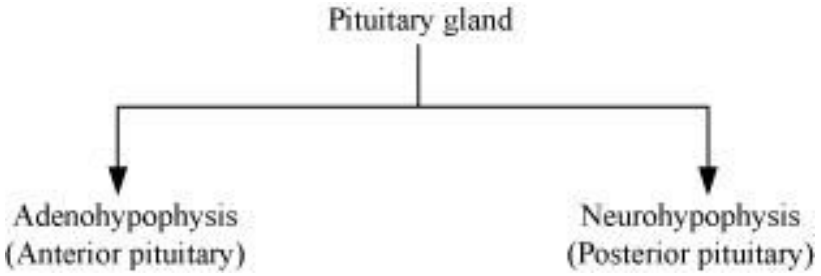
- **Hypothalamus:**
    - Contains neurosecretory cells that produce hormones
    - Hormones regulate the synthesis and secretion of pituitary glands.
    - Two types of hormones are released.
        - **Releasing hormones –** Stimulate pituitary gland to release hormones
        - **Inhibiting hormones –** Inhibit pituitary gland from releasing hormones
- **Pineal gland**
    - It secretes a hormone called melatonin.
    - It also regulates the rhythm of body.
- **Thyroid gland**
    - It secretes two hormones:
        - **Tetraiodothyronine or thyroxin (T4)**
        - **Triiodothyronine (T3)**

Deficiency of iodine results into

- **Hypothyroidism.** The disease is known as **goitre**
- **Creatinism**

- **Myxodema**
- High level of iodine results into **hyperthyroidism.**
- Thyroid hormone plays a role in carbohydrate, fat, and protein metabolism in the body.
- It also secretes thyrocalcitonin, which lowers the calcium level in blood plasma.
- **Parathyroid gland:** It regulates calcium level in body. It increases the reabsorption of calcium ions by renal tubules and digested food.

- **Pituitary gland**



- **(i). Adenohypophysis** is further divided into two regions:
- **Pars distalis (anterior pituitary):**
    - **Growth hormone –** It is involved in growth and development of the body. Low secretion of growth hormone results in dwarfism and acromegaly (extra growth of bones in jaws, hands or feet)
    - **Prolactin –** It helps in growth of mammary gland and milk formation.
    - **Thyroid stimulating hormone –** It helps in secretion of thyroxine from thyroid glands.
    - **Adreno-corticotrophic hormone –** It helps in secretion of glucocorticoid hormone from adrenal cortex.
    - **Gonadotrophic hormone –** It includes the following.
        - **Luteinizing hormone –** It helps in secretion of androgen from testis. It also induces ovulation from Graafian follicles.

        - **Follicle stimulating hormone –** It maintains the growth and development of Graafian follicle.

- **Pars intermedia:** It secretes melanocyte-stimulating hormone (MSH), which maintains skin pigmentation.

- **(ii). Neurohypophysis (posterior pituitary): –** It contains pars nervosa region. Pars nervosa region secretes two hormones:
    - **Oxytocin –** It helps in contraction of uterus and milk ejection.
    - **Vasopressin (Anti-diuretic hormone) –** It stimulates reabsorption of water by distal convoluted tubules.Deficiency causes Diabetes Insipidus.

- **Thymus**
    - This gland is degenerated with the age.
    - Thymus produces a hormone called **thymosins.**
    - Thymosins produce T-lymphocytes that protect the body against infectious agents. It provides cell-mediated immunity and also humoral immunity.

- **Adrenal gland**
    - It is divided into:
        - **Adrenal medulla –** It secretes adrenaline (epinephrine) and noradrenaline (norepinephrine). These are collectively called as catecholamines. These hormones are also called emergency hormones.
        - **Adrenal cortex –** It secretes hormone called corticoids.
            - Corticoid such as glucocorticoid regulates carbohydrate metabolism. Example includes cortisol.

        - Corticoid such as mineralocorticoid maintains the sodium potassium level in blood and tissue. Example includes aldosterone.

    - **Hyposecretion** : Less secretion from adrenal cortex.
    - Disease caused is called **Addison's disease.**
    -
    - **Hypersecretion:** Excess of secretion from adrenal cortex
    - Disease caused is called **Cushing's Syndrome.**

- **Pancreas**

- The islets of Langerhans have two types of cells:

    - **α – cells –** secrete glucagon

    1. **β – cells –** secrete insulin

- **Insufficient Secretion of Insulin**
- **Disease caused: Diabetes mellitus**
- **Over- Secretion of insulin**
- **Disease caused: Hypoglycemia**

- **Hyperglycemia –** Increased blood glucose level

    - Glucagon is a hyperglycaemic hormone.
    - **Hypoglycaemia –** Decreased blood glucose level
    - Insulin is a hypoglycaemic hormone.

    - Diabetes mellitus – Abnormal high glucose level in blood, which results in release of sugar in urine and formation of toxic ketone bodies

- **Testis**

    - **Leydig cells (Interstitial cells) –** Secrete androgens, mainly testosterone

    - Testosterone plays a role in spermatogenesis and development of male secondary sexual characters.

- **Ovary**

    - It secretes two hormones.

- **Estrogen –** Secreted by Graafian follicle, it regulates the development of female secondary sexual characters.

- **Progesterone –** Secreted by corpus luteum, it acts on mammary glands and helps in milk secretion.

Non-Endocrine Hormones

Hormone secreted by heart:

- **Atrial natriuretic factor (ANF) –** Secreted by atrial wall of heart, it decreases the blood pressure.

Hormone secreted by kidney:

- **Erythropoietin –** Stimulates erythropoiesis i.e., formation of RBCs

Hormones secreted by gastro-intestinal tract

- **Gastrin –** Stimulates gastric gland to secrete hydrochloric acid and pepsinogen
- **Secretin –** Stimulates secretion of HCO_3^- ions and water
- **Cholecystokinin (CCK) –** Stimulates secretion of bile juice and pancreatic juice
- **Gastric inhibitory peptide (GIP) –** Inhibits gastric secretion and mobility

Mechanism of hormone action:

Hormone
↓
Binds to hormone receptors in target tissues
↓
Hormone receptor complex
↓
Biochemical change in target tissue

Based on chemical nature, hormones are of four types:

SL NO	Nature	Example
1	Protein (peptide)	Insulin, glucagon
2	Steroids	Testosterone, estrogen, cortisols
3	Iodothyronines	Thyroid hormones
4	Amino acid derivatives	Epinephrine