



Synthesis
NEET(UG)/ JEE-MAIN/ ADVANCED

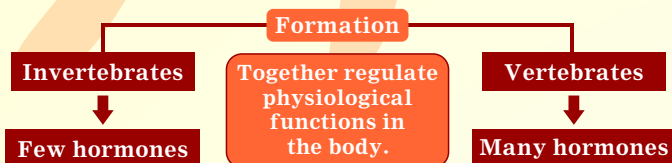
CHEMICAL COORDINATION AND INTEGRATION

1 INTRODUCTION

Significance :
Nerve fibers do not innervate all cells of the body.
Cellular functions require continuous regulation.
The endocrine system integrates with the neural system for coordination.

2 ENDOCRINE GLANDS AND HORMONES

Endocrine glands (Ductless glands) secrete hormones.

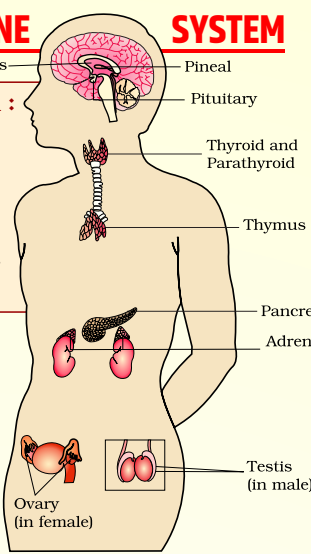


- **Hormones :**
- Released into the blood and transported to target organs.
- Non-nutrient chemicals.
- Act as intercellular messengers.
- Produced in trace amounts.

3 HUMAN ENDOCRINE SYSTEM

- **Endocrine Glands Location :**
- **Head :** Hypothalamus, Pineal, Pituitary.
- **Thorax :** Thyroid, Parathyroid, Thymus.
- **Abdomen :** Pancreas, Adrenal, Testes (in males), Ovaries (in females).

• **Other organs with diffused endocrine tissues & cells :**
Gastrointestinal tract, heart, liver, kidneys



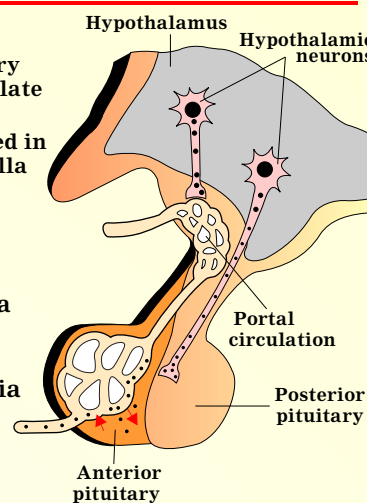
4(a): Types of Hypothalamic Hormones

Hormone Type	Example	Target	Released Hormone
Releasing Hormone	GnRH	Pituitary	Gonadotrophins
Inhibiting Hormone	Somatostatin	Pituitary	?

4 HYPOTHALAMUS AND PITUITARY GLAND

- **Hypothalamus:**
- Contains neurosecretory cells (nuclei) that regulate the pituitary gland.
- Pituitary gland enclosed in a bony cavity called Sella Turcica.

- **Connections:**
- Connected to the anterior pituitary via portal circulation.
- Connected to the posterior pituitary via a stalk (not through portal circulation).



4(b): Anterior Pituitary (Adenohypophysis)

Hormone	Basic Function
Growth Hormone (GH)	Growth of the body
Thyroid Stimulating Hormone (TSH)	Synthesis and secretion of thyroid hormones by the thyroid gland
Adrenocorticotrophic Hormone (ACTH)	Synthesis and secretion of steroid hormones from the adrenal cortex
Follicle Stimulating Hormone (FSH)	Males : Regulates spermatogenesis Females : Stimulates growth and development of ovarian follicles
Gonadotrophins (stimulate gonadal activity)	-
Luteinizing Hormone (LH)	Males: Stimulates the synthesis and secretion of androgens Females: Induces ovulation of fully mature Graafian follicle, maintains corpus luteum
Prolactin	Regulates growth of mammary glands and milk production
Melanocyte Stimulating Hormone (MSH)	Acts on melanocytes of skin & regulates pigmentation

- **Acromegaly :** Serious complications of hypersecretion of GH in middle age.
- Can lead to premature death if unchecked.
- Hard to diagnose in early stages as it often goes undetected for years.
- External changes on face & body become noticeable in later stages.

NOTE

4(c): Posterior Pituitary (Neurohypophysis)

Hormone	Basic Functions
Oxytocin	<ul style="list-style-type: none">• Acts on smooth muscles and stimulates their contraction• Stimulates vigorous contractions of uterus at childbirth• Milk ejection from mammary glands
Vasopressin (ADH/Anti-diuretic Hormone)	<ul style="list-style-type: none">• Acts at kidneys & stimulates reabsorption of water & electrolytes• Reduces loss of water through urine (Diuresis)

4(d): Disorders of Pituitary Gland

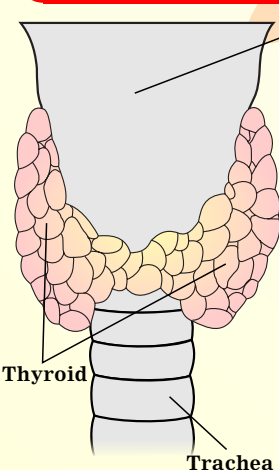
Disease	Age	Cause	Symptoms
Pituitary Dwarfism	-	Hyposecretion of GH	Stunted growth
Gigantism	-	Hypersecretion of GH	Abnormal growth of the body
Acromegaly	Middle age	Hypersecretion of GH	Severe disfigurement, especially of the face
Diabetes Insipidus	-	Hyposecretion of ADH	Diminished ability of the kidney to conserve water leading to dehydration

5 PINEAL GLAND

Location : Dorsal side of the forebrain | **Hormone released :** Melatonin

- **Functions :** Regulates 24-hour diurnal rhythm (sleep-wake cycle).
- Influences body metabolism, temperature, pigmentation, menstrual cycle, and defense capabilities.

6 THYROID AND PARATHYROID GLAND



- **Thyroid Gland**
- **Location and Features :**
- Located on the sides of the trachea.
- Bilobed structure, connected by a thin flap called the isthmus.
- Contains follicular cells, which help in hormone synthesis.
- Iodine is essential for the normal synthesis of thyroid hormones

- **Major Functions :**
- Regulates Basal Metabolic Rate (BMR).
- Controls metabolism of carbohydrates, proteins, and fats.
- Maintains water and electrolyte balance.
- Aids in the development and maturation of the Central Nervous System (CNS).
- Supports the process of Red Blood Cell (RBC) formation (Erythropoiesis).
- Regulates the menstrual cycle.

Number	Hormones	Hormone	Type	Function
1	T ₄ (Thyroxine) or Tetraiodothyronine	Thyroid	Protein Hormone	Reduces blood Ca ²⁺ levels.
2	T ₃ (Triiodothyronine)			

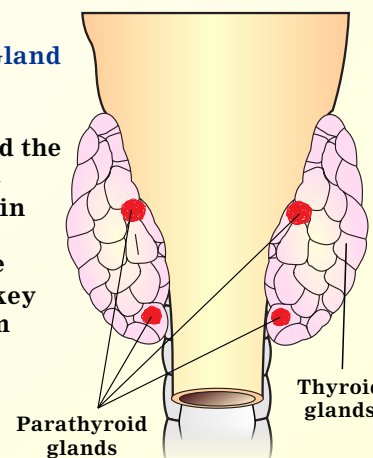
Number	Hormone	Type
4	Parathyroid Hormone (PTH)	Peptide Hormone

- **Major Functions :**
- Increases blood calcium levels (Hypercalcemic Effect).
- Acts on bones and stimulates the process of bone resorption (Dissolution/Demineralization).
- Stimulates calcium reabsorption by the renal tubules.
- Increases calcium absorption from digested food.

Number	Hormone	Type
1	Thymosins	Peptide Hormones

- **Thymus Gland : Location & Features :**
- Located between the lungs, behind the sternum (ventral side of the aorta).
- Degenerates with age, leading to weaker immune responses.

- **Parathyroid Gland**
- **Location & Features :**
- Located behind the thyroid gland.
- Thyrocalcitonin (TCT) & Parathormone (PTH) play a key role in calcium homeostasis.

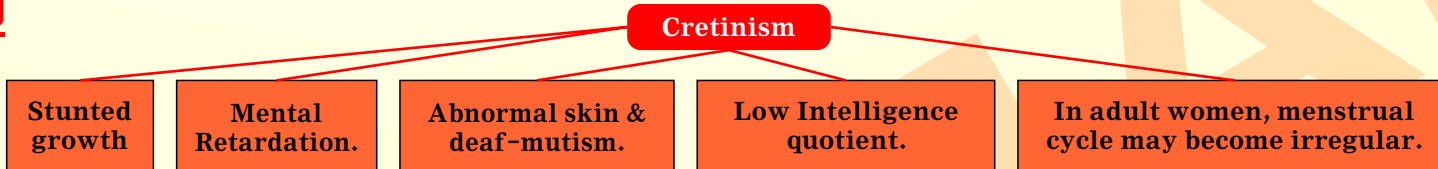


- **Major Functions :** Helps in the differentiation of T-Lymphocytes, thus providing cell-mediated immunity.
- Enhances antibody production, thereby promoting humoral immunity.

7 DISORDERS OF THE THYROID GLAND

- **Hypothyroidism Causes :**
- Iodine deficiency during pregnancy & after birth.

- **Diseases :**
- **Goitre** → Enlargement of the thyroid gland.



- **Hypothyroidism Causes :**
- Cancer of the thyroid gland.
- Development of nodules in the thyroid gland.

- **Diseases :** Exophthalmic Goitre or Graves' Disease → Enlargement of the thyroid gland.
- Protrusion of the eyeballs.
- Increased BMR and weight loss.



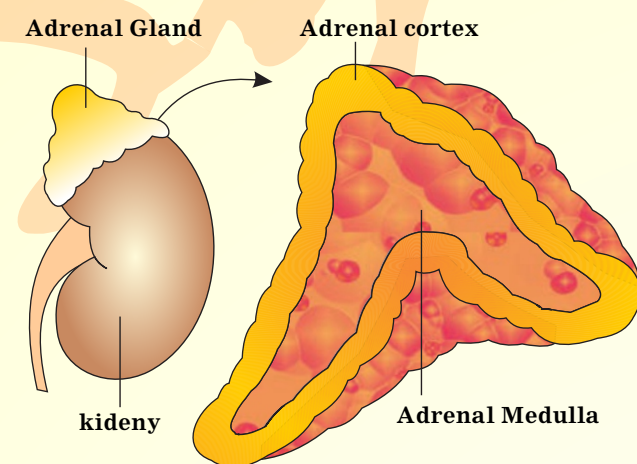
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8 ADRENAL GLAND

Location and Features

A pair of glands located on the upper part of the kidneys.



Hormones of the Adrenal Medulla

Hormone

Adrenaline / Epinephrine & Noradrenaline / Norepinephrine

Function

- Increases alertness, pupil dilation, sweating.
- Increases heart rate and contraction strength.
- Stimulates glycogen breakdown, increasing blood glucose levels.
- Increases breakdown of lipids and proteins.

Layers of the Adrenal Cortex

Layer	Main Hormone	Function
Zona Glomerulosa (Outer Layer)	Aldosterone	Regulates sodium and water reabsorption and controls blood pressure.
Zona Fasciculata (Middle Layer)	Cortisol	Stimulates gluconeogenesis, lipolysis and proteolysis.
Zona Reticularis (Inner Layer)	Androgenic Steroid	Aids in the growth of axial, pubic and facial hair during puberty.

9 PANCREAS AND GLUCOSE HOMEOSTASIS

Components and Functions

Endocrine Part

Maintains Glucose Homeostasis

Exocrine Part

Secretes Digestive Enzymes

Islets of Langerhans

α -cells : Secrete Glucagon
 β -cells : Secrete Insulin

Functions of Pancreatic Hormones

Hormone	Target Cells	Function
Glucagon	Hepatocytes	Stimulates Glycogenolysis & Gluconeogenesis
Insulin	Hepatocytes, Adipocytes	Stimulates Glycogenesis

Diabetes Mellitus

- Cause : Prolonged hyperglycemia (high blood sugar levels).
- Characteristics: Loss of glucose in urine, formation of ketone bodies.
- Treatment: Insulin therapy.

Disorder of Adrenal Gland

Disorder	Cause	Characteristic
Addison's Disease	Underproduction of adrenal cortex hormones	Alters carbohydrate metabolism, causing acute weakness and fatigue.

Effects on Blood Glucose Levels

Hormone	Glucagon	Insulin
Effect	Increases Blood Glucose (Hyperglycemic Effect).	Decreases Blood Glucose (Hypoglycemic Effect).

10 GONADS – PRIMARY SEX ORGANS

Form gametes & secrete hormones.

Comparison of Male and Female Gonads

Parameter	Male (Testis)	Female (Ovary)
Location	Scrotal sac (outside abdomen)	Inside the abdomen
Structure Responsible	Leydig cells (Interstitial cells)	Ovarian follicles and corpus luteum
Steroid Hormone	Androgens (mainly Testosterone)	Estrogen and Progesterone

Functions of Hormones

Testosterone (Male)

- Development & maturation of male accessory sex organs.
- Stimulates spermatogenesis.
- Influences male sexual behavior (Libido).
- Stimulates muscular growth, facial and axillary hair, aggressiveness, and low-pitched voice.
- Produces anabolic effects on protein & carbohydrate metabolism.

Estrogen (Female)

- Growth and activities of female secondary sex organs.
- Stimulates the development of growing follicles.
- Regulates sexual behavior.
- Development of secondary sexual characters like mammary gland growth, high-pitched voice, etc.

Progesterone (Female)

- Supports pregnancy.
- Stimulates the formation of alveoli (stores milk and helps in milk secretion).

11 HORMONES OF HEART, KIDNEY, AND GASTROINTESTINAL TRACT

Tissue	Organ	Hormone	Basic Function
Atrial Wall	Heart	ANF (Atrial Natriuretic Factor)	When blood pressure increases, it dilates blood vessels to reduce blood pressure.
Juxtaglomerular Cells (JG cells)	Kidney	Erythropoietin	Stimulates erythropoiesis (RBC formation).
Endocrine cells in the GIT	Stomach (Gastric Glands)	Gastrin	Stimulates secretion of HCl and pepsinogen for digestion.
GIP (Gastric Inhibitory Peptide)	-	-	Inhibits gastric secretions and motility.
Cholecystokinin (CCK)	-	-	Stimulates the pancreas and gallbladder to secrete digestive enzymes and bile juice.
Secretin	-	-	Stimulates the pancreas to secrete water and bicarbonates.
Growth Factors	-	-	Essential for normal growth, repair and regeneration of tissues.

Note: All these given hormones are peptide hormones.

12 MECHANISM OF HORMONE ACTION

Key Points

Hormone receptors are located only in the target tissue.

Each receptor is specific to only one hormone.

Most intracellular receptors are present inside the nucleus.

Steroid hormones and iodothyronines enter the target cell.

Hormones acting through extracellular receptors do not enter the target cell.

CLASSIFICATION OF HORMONES (BASED ON CHEMICAL NATURE)

1. Mechanism of Action of Steroid Hormones

Examples

Steroids – Cortisol, Testosterone, Estradiol, Progesterone.

Iodothyronines – Thyroid hormones.

Mechanism

- These bind to intracellular/nuclear receptors.
- Regulate gene expression and chromosome functions.
- Forms a hormone-receptor complex that interacts with DNA.
- Results in mRNA synthesis and protein formation.
- Leads to physiological responses such as tissue growth and differentiation.

2. Mechanism of Action of Steroid Hormones

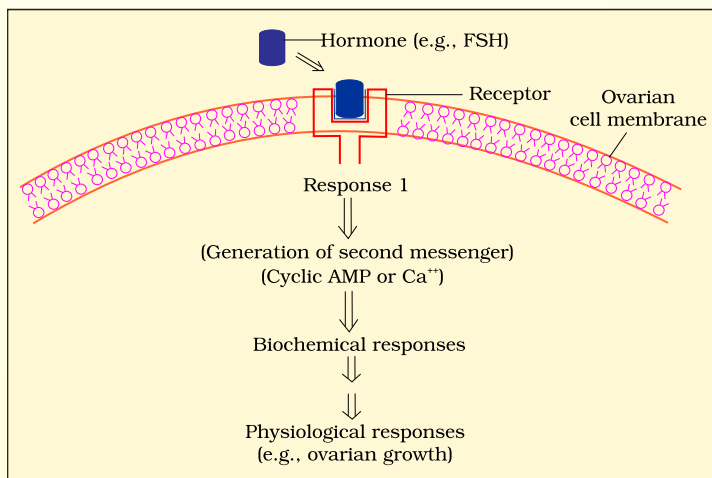
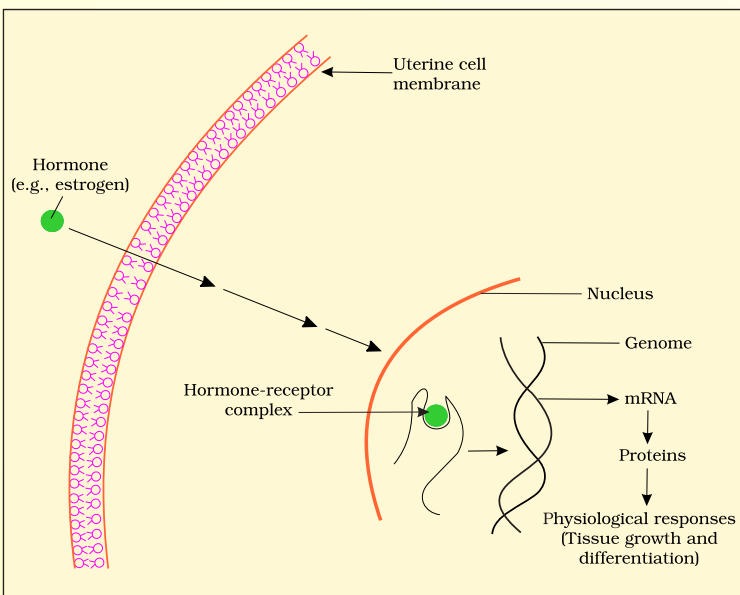
Examples

Amino acid derivatives – Epinephrine.

Peptides, Polypeptides, and Proteins – Insulin, Glucagon, Pituitary & Hypothalamic hormones

Mechanism

- These bind to extracellular/membrane-bound receptors.
- Forms a hormone-receptor complex that generates a second messenger.
- Second messengers include cAMP, IP₃, Ca²⁺.
- Brings biochemical changes in the target tissue.
- Results in physiological & developmental effects such as ovarian growth.



Motivational
Syn-टेक्स

Like hormones, negative energy is also more effective even in small quantities, so always remain positive.