



CHEMICAL COORDINATION AND INTEGRATION

1 INTRODUCTION

Significance: As the nerve fibres do not innervate all cells of the body and the cellular functions require continuous regulation hence the role of endocrine system is integrated with neural system

3 HUMAN ENDOCRINE SYSTEM

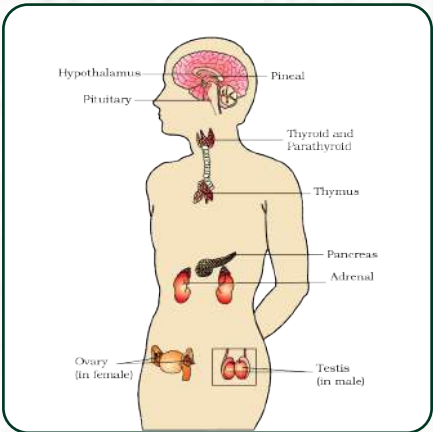
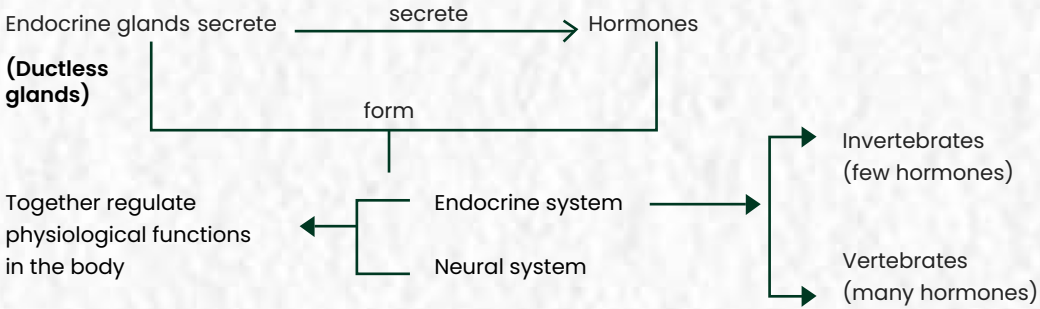


Fig.: Location of endocrine glands

• **Other organs with diffused tissues and cells:** gastrointestinal tract, heart, liver and kidneys

2 ENDOCRINE GLANDS AND HORMONES



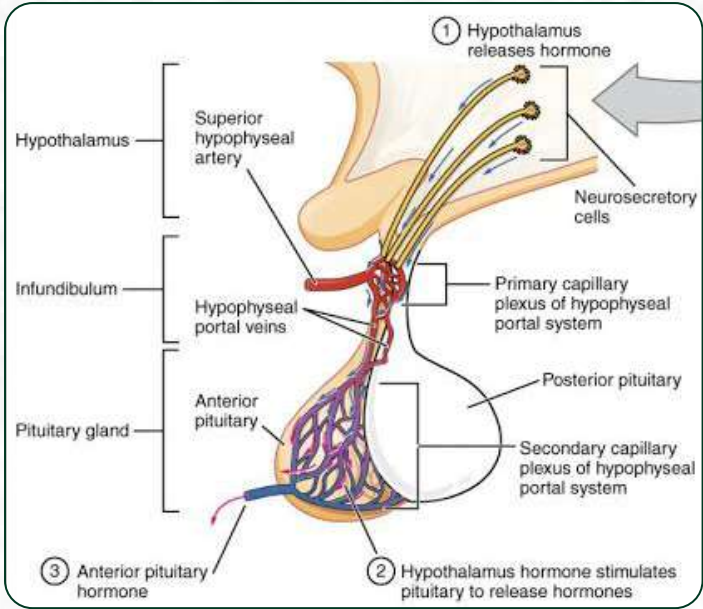
HORMONES

- Released into blood and transported to target organ
- Act as intercellular messengers
- Non-nutrient chemicals
- Produced in trace amounts

4 HYPOTHALAMUS AND PITUITARY GLAND

- Hypothalamus contains several groups of neurosecretory cells called nuclei which produce hormones that regulate synthesis and secretions from pituitary gland enclosed in bony cavity, **Sella tursica**.

TYPES OF HYPOTHALAMIC HORMONES			
	Example	Target	Released hormone
Releasing hormone	GnRH	Pituitary	Gonadotrophins
Inhibiting hormone	Somatostatin	Pituitary	X



Adenohypophysis

Neurohypophysis

Hormones of Pituitary		Basic function
Growth hormone (GH)		Growth of body
Thyroid stimulating hormone (TSH)		Synthesis and secretion of thyroid hormones by thyroid gland
Adrenocorticotrophic hormone (ACTH)		Synthesis and secretion of steroid hormones from adrenal cortex
Gonadotrophins (stimulate gonadal activity)	Follicle stimulating hormone (FSH)	Male Regulates spermatogenesis along with androgens Female-Stimulates growth and development of ovarian follicles
	Luteinising hormone (LH)	Male-Stimulates the synthesis and secretion of androgens Graafian follicle, maintains corpus luteum.
		Female Induces ovulation of fully mature Graafian follicle and maintains corpus luteum.

Hormones released	Basic functions
Oxytocin	<ul style="list-style-type: none">• Acts on smooth muscles and stimulates their contraction• Stimulates vigorous contractions of uterus at the time of child birth• Milk ejection from mammary glands
Vasopressin/ADH Anti-diuretic hormone	<ul style="list-style-type: none">• Acts at kidney and stimulates resorption of water and electrolytes by the distal tubules• Reduces loss of water through urine (Diuresis)



Prolactin	Regulates the growth of the mammary glands and formation of milk in them
Melanocyte stimulating hormone (MSH) by pars intermedia	Acts on the melanocytes of skin and regulates pigmentation of skin

DISORDERS

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

ACROMEGALY

Serious complications of hypersecretion of GH in middle age can leads to premature death if unchecked. The disease is hard to diagnose in early stages and often goes undetected for many years, until changes in external features become noticeable.

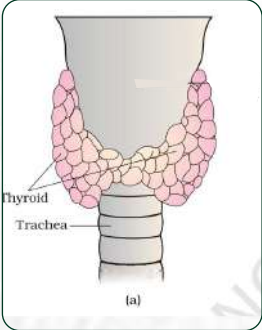
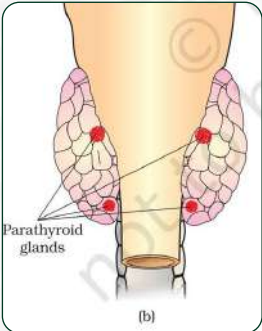
5

PINEAL GLAND

- Location: Dorsal side of forebrain
- Hormone released: Melatonin
- Basic functions:
- Regulate 24 hours diurnal rhythm of our body (sleep wake cycle)
- Influence body metabolism, temperature, pigmentation, menstrual cycle and defense capabilities

6

GLANDS OF THORACIC REGION

Thyroid	Location/Feature	Number	Hormones	Basic functions
	<ul style="list-style-type: none">• Side of trachea• bilobed structure connected through a thin flap of connective tissue called Isthmus• Consists of follicles made up of follicular cells enclosing a cavity in stromal tissue• Iodine is essential for the normal rate of hormone synthesis in the thyroid gland	1	T_4 (thyroxine) or tetraiodothyronine T_3 (triiodothyronine)	<ul style="list-style-type: none">• Regulate basal metabolic rate (BMR)• Control metabolism of carbohydrates, proteins and fats• Maintain water and electrolyte balance• Regulate development and maturation of CNS• Support process of RBC formation (erythropoiesis) and regulates menstrual cycle
			Thyroid calcitonin (TCT) (Protein hormone)	Regulates blood Ca^{2+} levels
Parathyroid 	<ul style="list-style-type: none">• Back side of the thyroid gland• Thyroid calcitonin and parathormone play a significant role in calcium homeostasis	4	Parathyroid hormone PTH (peptide hormone)	<ul style="list-style-type: none">• Increase level of Ca^{2+} (hypercalcemic)• Acts on bones and stimulates the process of bone resorption dissolution/demineralisation)• Stimulates the reabsorption of Ca^{2+} by the renal tubules.• Increases Ca^{+2} absorption from digested food
Thymus	<ul style="list-style-type: none">• Lobular structure located between lungs behind sternum on ventral side of aorta• Degenerates in old age so immune responses become weak	1	Thymosins (peptide hormones)	<ul style="list-style-type: none">• Play a role in differentiation of T-lymphocytes, thus provide cell mediated immunity.• Promote production of antibodies thereby providing humoral immunity



DISORDERS OF THYROID GLAND

• Hypothyroidism Cause

- Iodine deficiency in diet during pregnancy and after birth

1. Goitre: Enlargement of thyroid gland

2. Cretinism: Stunted growth, mental retardation, low intelligence quotient abnormal skin and deaf-mutism

3. In adult women, menstrual cycle can become irregular

• Hyperthyroidism Cause

- Cancer of the thyroid gland
- Development of nodules of the thyroid gland

1. Exophthalmic goitre or Graves' disease:

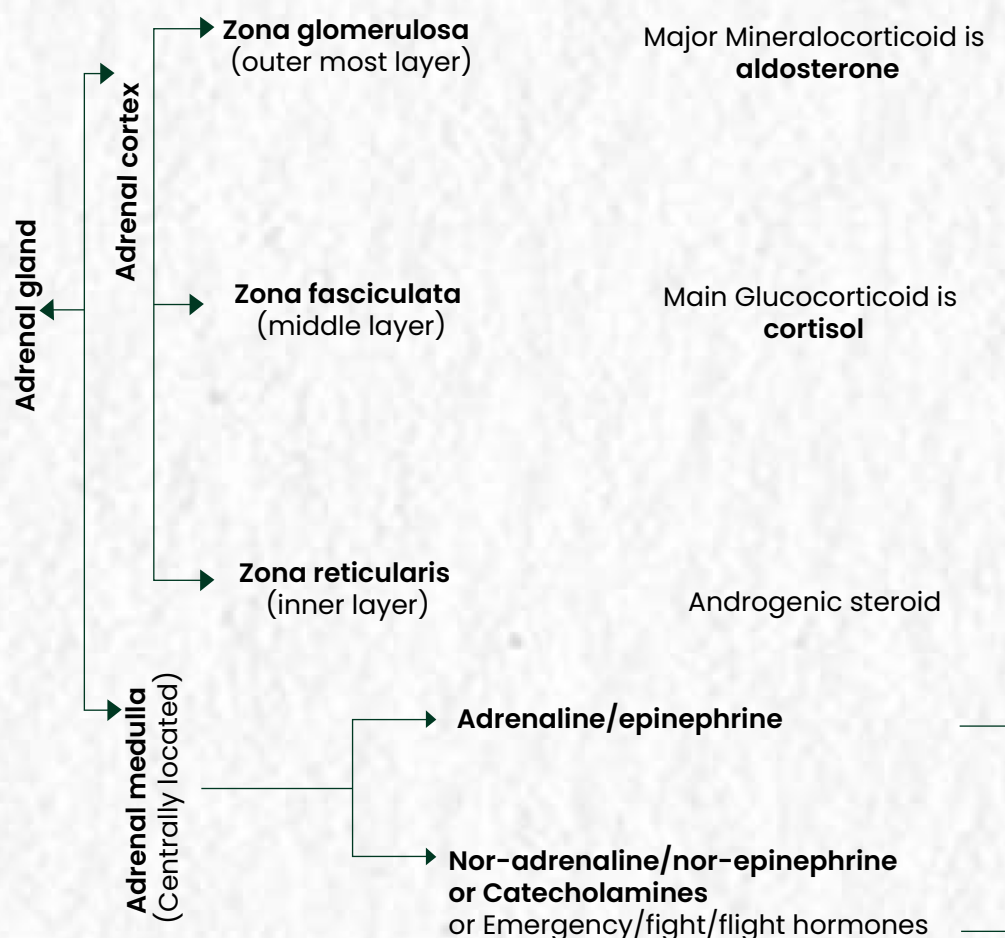
- Enlargement of thyroid gland
- Protrusion of eyeballs
- Increase in BMR and weight loss.

7

ADRENAL GLAND

- **One pair** located on anterior part of kidneys

Hormone



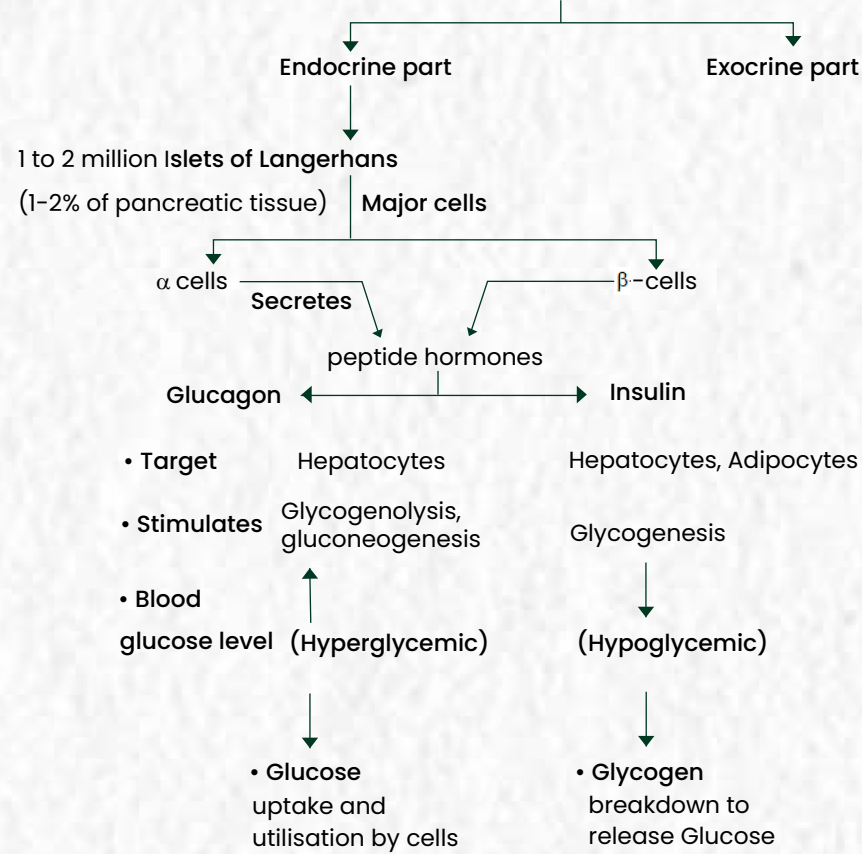
Functions:-

- Stimulates gluconeogenesis, lipolysis and proteolysis
- Inhibit cellular uptake and utilisation of amino acids, maintains the cardiovascular system and the kidney functions
- Produces anti-inflammatory reactions and suppresses immune response
- Stimulate glomerular filtration rate
- Stimulates reabsorption of Na^+ and H_2O and excretion of K^+ and PO_4^{3-} ions, thus helps in maintenance of electrolytes, body fluid volume osmotic pressure and blood pressure.
- Play a role in growth of axial hair, pubic hair and facial hair during puberty.
- Increase alertness, pupillary dilation, piloerection, sweating
- Increase heart beat, the strength of heart contraction and the rate of respiration
- Stimulate breakdown of glycogen resulting in an increased concentration of glucose in blood.
- Increase breakdown of lipids and proteins

Disorders

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

Pancreas: A composite gland whose main hormones maintain glucose homeostasis

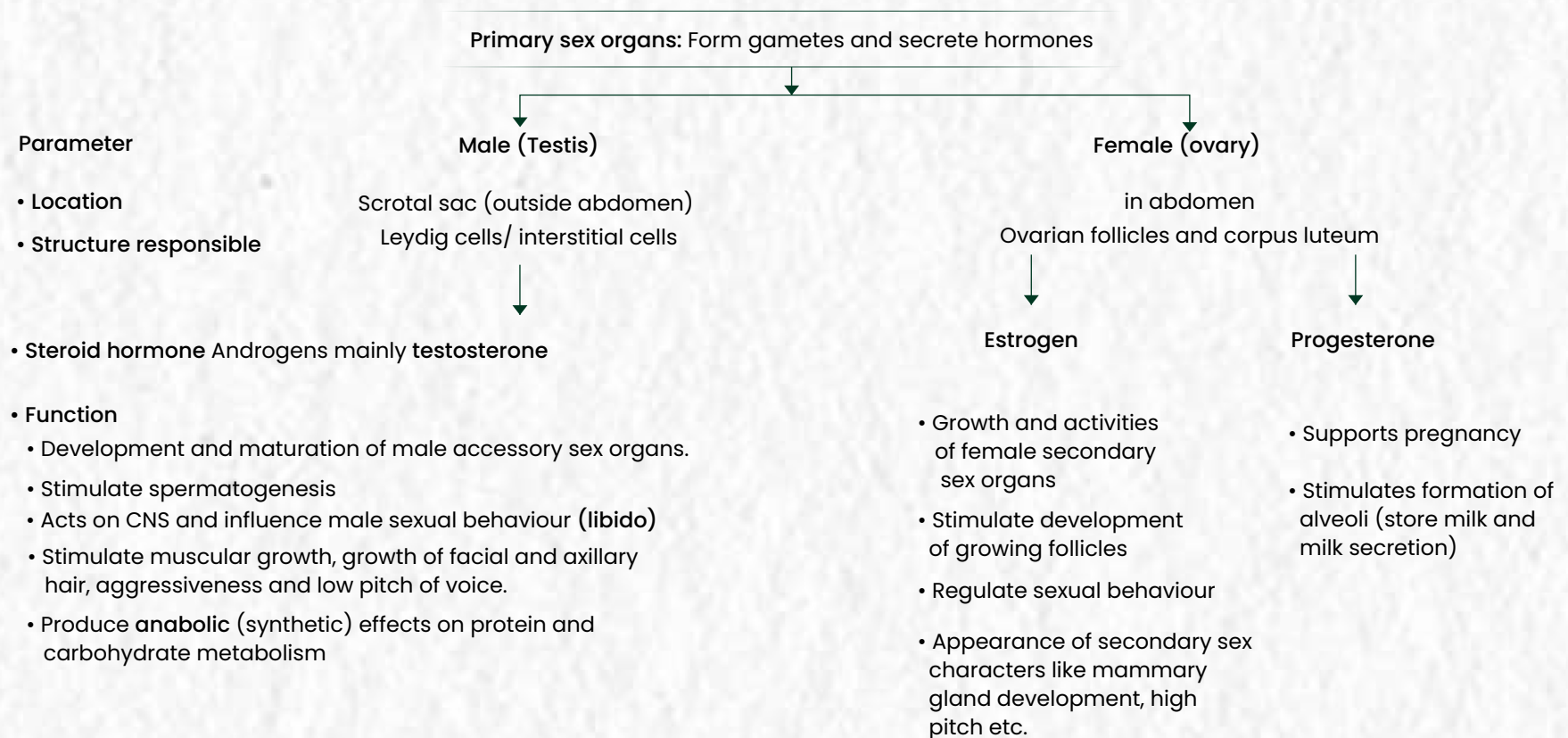


DISORDER

- **Diabetes mellitus** - Caused by prolonged hyperglycemia

Characteristics - Loss of glucose in urine, Ketone bodies formation

Treatment - Insulin therapy





10

HORMONES OF HEART, KIDNEY AND GASTROINTESTINAL TRACT

Tissue	Organ	Hormone	Basic function
• Atrial wall	Heart	• ANF	• When blood pressure increases, it dilates blood vessels to reduce blood pressure
• Juxtaglomerular cells (JG cells)	Kidney	• Erythropoietin	• Stimulates erythropoiesis
• Endocrine cells in different parts of gastro-intestinal tract	GIT	• Gastrin	• Acts on gastric glands and stimulates secretion of HCl and pepsinogen
		• GIP/gastric inhibitory peptide	• Inhibits gastric secretions and motility
		• cholecystokinin	• Acts on exocrine part of pancreas and gall bladder to stimulate secretion of pancreatic enzymes and bile juice
		• Secretin	• Acts on exocrine part of pancreas and stimulates secretion of water and bicarbonates
• Non-endocrine tissue		• Growth factors	• Essential for normal growth, repair and regeneration of tissues

All these given hormones are peptide hormones.

11

MECHANISM OF HORMONE ACTION

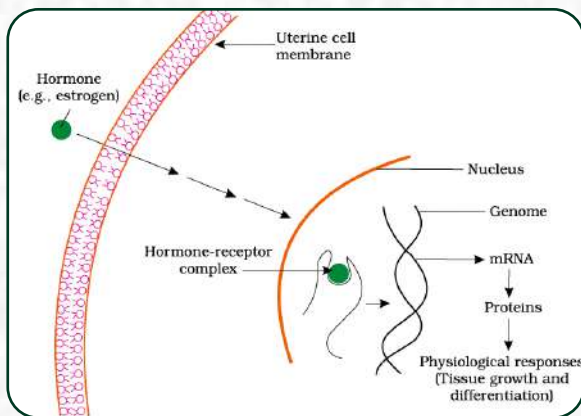


Fig.: Mechanism of action of a steroid hormone

- Hormone receptors are located in the target tissue only.
- Each receptor is specific to one hormone only.
- Most intracellular receptors are present in the nucleus.
- Steroid hormones and iodothyronines enter the target cell.
- Hormones acting through extracellular receptors do not enter the target cell.

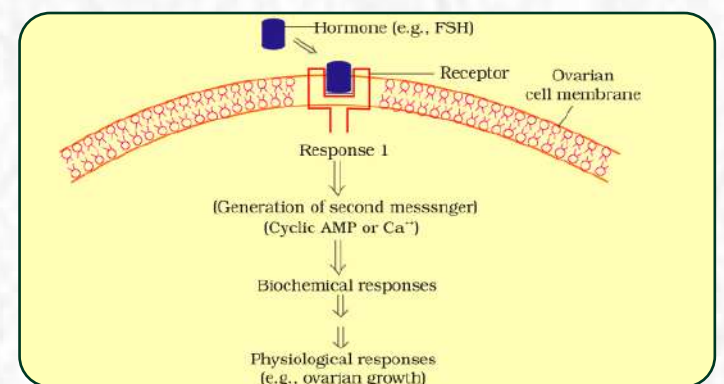


Fig.: Mechanism of action of a steroid hormone

Classification of Hormones

Based On Chemical Nature

Steroids—Cortisol, testosterone, estradiol, progesterone

Iodothyronines—Thyroid hormones

Bind to

Intracellular Nuclear receptors

Amino acid derivatives—Epinephrine

Peptide, Polypeptide, Protein—Insulin, glucagon, pituitary and hypothalamic hormones etc.

Bind to

Extracellular/Membrane bound receptors

Genome and regulate gene expression and chromosome functions

Interact with

Hormone receptor complex

Generate

Second messengers cAMP, IP₃, Ca²⁺ e.t.c.

Brings biochemical changes in target tissue

Cumulative effect

Results in physiological and developmental effects