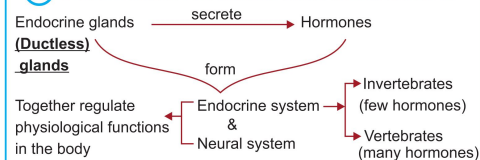


Chemical Coordination and Integration

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.

2 ENDOCRINE GLANDS AND HORMONES



HORMONES

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

3 HUMAN ENDOCRINE SYSTEM

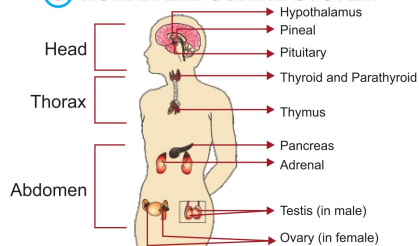


Fig. : Location of endocrine glands

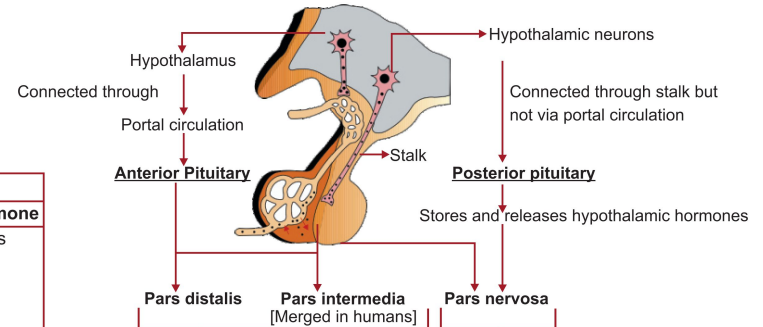
- Other organs with diffused tissues and cells:** gastrointestinal tract, heart, liver and kidneys

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

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

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	
Follicle stimulating hormone (FSH)		Male – Regulates spermatogenesis along with androgens Female – Stimulates growth and development of ovarian follicles	
Gonadotrophins (stimulate gonadal activity)			
Luteinising hormone (LH)		Male – Stimulates the synthesis and secretion of androgens Female – Induces ovulation of fully mature Graafian follicle, maintains corpus luteum	
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	

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)

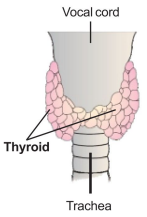
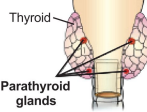
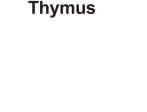
ACROMEGALY

Serious complications of hypersecretion of GH in middle age can lead 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.

DISORDERS

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 face
Diabetes insipidus	–	Hyposecretion of ADH	Diminished ability of the kidney to conserve water leading to water loss and dehydration

6 GLANDS OF THORACIC REGION

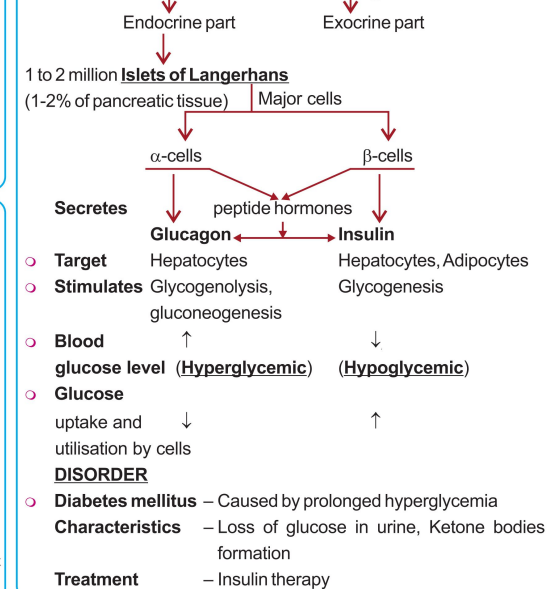
Thyroid 	Location/Feature <ul style="list-style-type: none"> Side of trachea Bilobed structure connected through a thin flap of connective tissue called isthmus Consists of follicles made up of follicular cells enclosing a cavity, in stromal tissue Iodine is essential for the normal rate of hormone synthesis in the thyroid gland 	Number 1	Hormones T_4 (thyroxine) or tetraiodothyronine T_3 (triiodothyronine)	Basic functions <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
Parathyroid 	Location/Feature <ul style="list-style-type: none"> Back side of the thyroid gland Thyroid and parathyroid play a significant role in calcium homeostasis 	Number 4	Hormones Thyrocalcitonin (TCT) (Protein hormone) Parathyroid hormone/ PTH (peptide hormone)	Basic functions <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 	Location/Feature <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 	Number 1	Hormones Thymosins (peptide hormones)	Basic functions <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.

7 DISORDERS OF THYROID GLAND

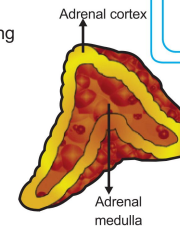
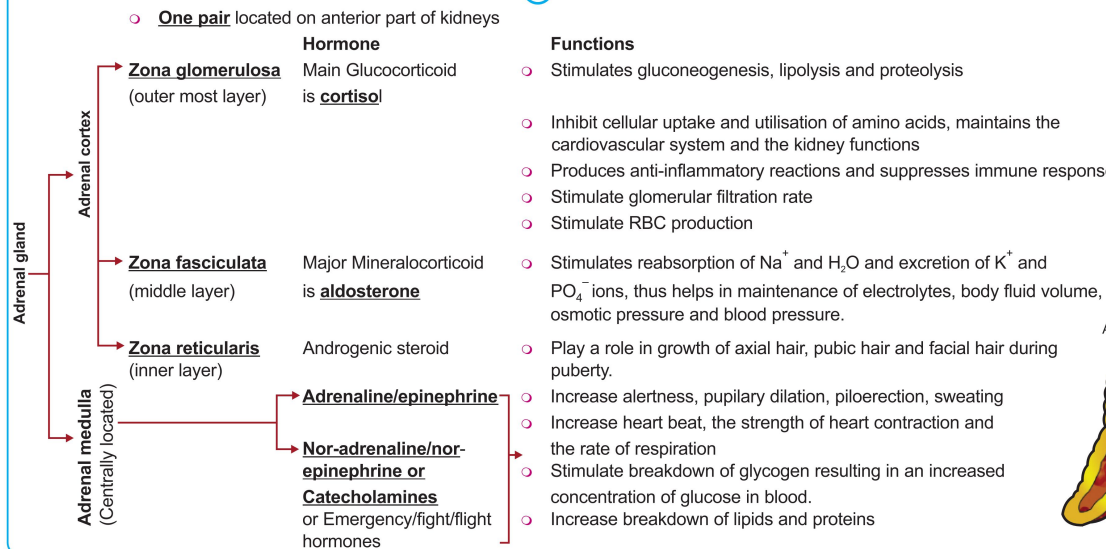
Hypothyroidism Cause <ul style="list-style-type: none"> Iodine deficiency in diet during pregnancy and after birth 	Hyperthyroidism Cause <ul style="list-style-type: none"> Cancer of the thyroid gland Development of nodules of the thyroid gland
<ol style="list-style-type: none"> Goitre: Enlargement of thyroid gland Cretinism: Stunted growth, mental retardation, low intelligence quotient abnormal skin and deaf-mutism In adult women, menstrual cycle can become irregular 	<ol style="list-style-type: none"> Exophthalmic goitre or Graves' disease: <ul style="list-style-type: none"> Enlargement of thyroid gland Protrusion of eyeballs Increase in BMR and weight loss.

9 PANCREAS

Pancreas: A **composite** gland whose main hormones **maintain glucose homeostasis**



8 ADRENAL GLAND



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

10 GONADS → Primary sex organs: Form gametes and secrete hormones

Parameter	Male (Testis)	Female (ovary)
Location	Scrotal sac (outside abdomen)	in abdomen
Structure responsible	Leydig cells/ interstitial cells	Ovarian follicles and corpus luteum
Steroid hormone	Androgens mainly testosterone	Estrogen and Progesterone
Function	<ul style="list-style-type: none"> Development and maturation of male accessory sex organs. Stimulate spermatogenesis Acts on CNS and influence male sexual behaviour (libido) Stimulate muscular growth, growth of facial and axillary hair, aggressiveness and low pitch of voice. Produce anabolic (synthetic) effects on protein and carbohydrate metabolism 	<ul style="list-style-type: none"> Growth and activities of female secondary sex organs Stimulate development of growing follicles Regulate sexual behaviour Appearance of secondary sex characters like mammary gland development, high pitch etc. Supports pregnancy Stimulates formation of alveoli (store milk and milk secretion)

11 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
		○ Growth factors	○ Essential for normal growth, repair and regeneration of tissues
○ Non-endocrine tissue			

All these given hormones are peptide hormones.

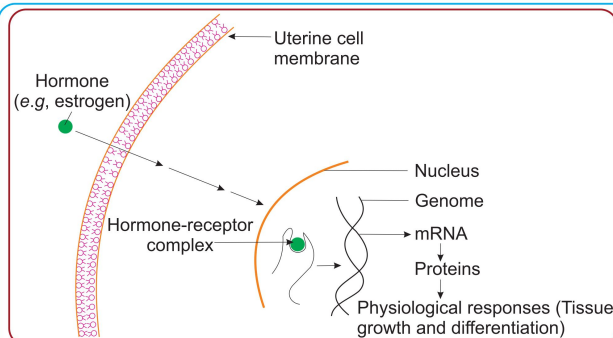


Fig: Mechanism of action of a steroid hormone

12 MECHANISM OF HORMONE ACTION

- 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

Classification of Hormones

Based on chemical nature

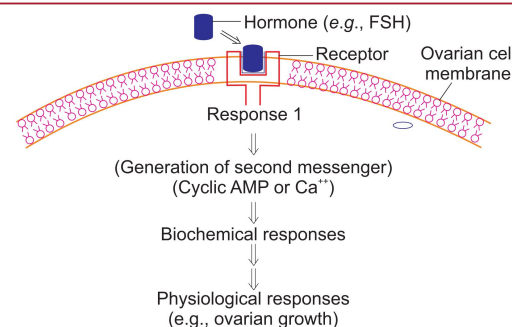


Fig: Mechanism of action of a protein hormone

Steroids – Cortisol, testosterone, estradiol, progesterone
Iodothyronines – Thyroid hormones

Bind to ↓

Intracellular/Nuclear receptors

Genome and regulate gene expression and chromosome functions

Interact with

Hormone receptor complex

Generate

Second messengers cAMP, IP₃, Ca⁺² etc

- Brings biochemical changes in target tissue

Cumulative effect

Results in physiological and developmental effects

Amino acid derivatives – Epinephrine
Peptide, Polypeptide, Protein – Insulin, glucagon, pituitary and hypothalamic hormones etc.

Bind to ↓

Extracellular/Membrane bound receptors