

Chemical co ordination and Integration

chapter-19

Endocrine Glands and Hormones

- E.H starling :- Gave the term Hormone
- Thomas Addison :- Father of endocrinology.

Endocrine Glands

- Do not show presence of ducts
- i.e.. Ductless glands.

Hormone :-

They pour their secretion directly into the blood.
Their secretion are known as hormone.

Definition of Hormone

- A chemical produced by endocrine gland release into the blood & transport to a distantly located target organ.
- Hormone are non-nutrients chemicals that act as intercellular messenger & are produced in trace amounts.

* Difference b/w Nervous and Endocrine coordination.

S.NO.	Nervous coordination	Endocrine coordination
1.	Information passes as electrical impulse along the axons. (chemical across synapses.	Information passes as chemical substance through blood stream.
2.	Fast transmission.	Slow transmission.
3.	Response short lived.	Response long lasting.

Human Endocrine System

The Hypothalamus

→ Part of Brain
→ Master of master gland

- Basal part of diencephalon, forebrain etc.
- Has several groups of neurosecretory cells called nuclei
- Nuclei produce hypothalamic hormones.
- Synthesis & secretion of pituitary hormone is regulated by hypothalamic hormone.
- Hormone released by hypothalamus, however are of two types :-
 - ① Releasing Hormone (stimulate pituitary hormone secretions).
 - ② Inhibiting Hormones (inhibit pituitary hormone secretion)

① Releasing Hormone

- a) Gonadotrophin Releasing Hormone (GnRH) :-
 - Pituitary synthesis and release of gonadotrophs is stimulated by a hypothalamic hormone.
- b) Thyrotrophin Releasing Factor (TRF) :-
 - Hypothalamus also secrete TRF.

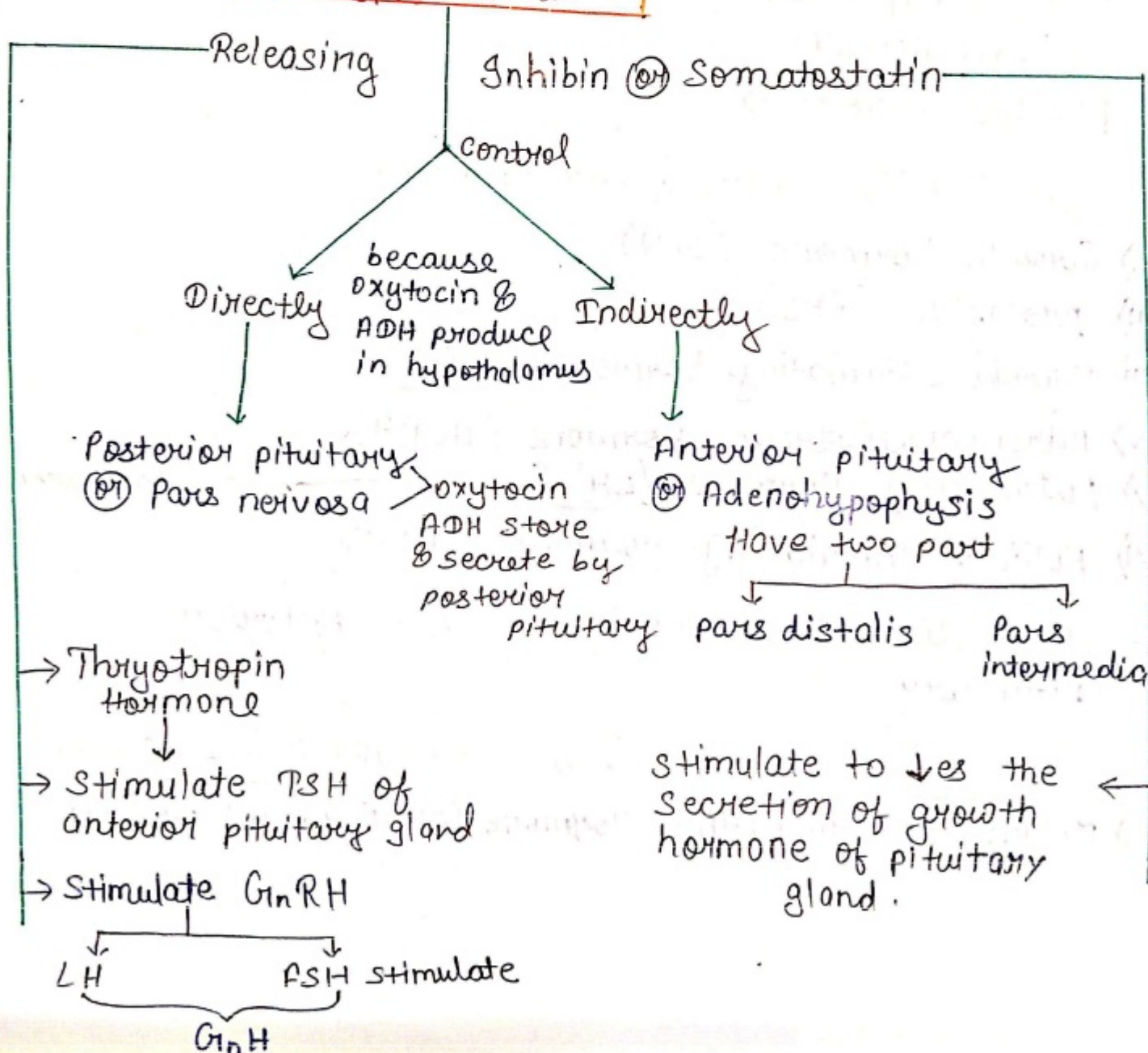
② Inhibiting Hormones

- a) Somatostatin (or) Growth inhibiting hormone (GHIH) :-
 - The release of growth hormone from the pituitary is inhibited by this hormone.

Portal circulatory system

- Hormones pass through a portal circulatory system to reach the pituitary gland and control the functions of anterior pituitary. i.e... Indirect control.
- The posterior pituitary is under the direct neural regulation of the Hypothalamus.
- Hypothalamus is connected to posterior pituitary by axons of neurosecretory cells.

Hypothalamus



The Pituitary Gland → Master gland

- Located in a bony cavity called sella turcica of sphenoid bone.
- Attached to the hypothalamus by a stalk is the pituitary gland.
- Present below the hypothalamus.
- Anatomically, pituitary is divided into an adenohypophysis and a neurohypophysis.
- Adenohypophysis consists of two portions
 - i) pars distalis
 - ii) pars intermedia

i) Pars distalis produced six Hormone.

- i) Growth hormone (GH)
 - ii) prolactin (PRL)
 - iii) Thyroid stimulating hormone (TSH)
 - iv) Adrenocorticotrophic Hormone (ACTH)
 - v) Luteinizing Hormone (LH)
 - vi) Follicle stimulating Hormone (FSH)
- } Gonadotropin

→ Pars distalis commonly known as Anterior Pituitary.

ii) Pars intermedia (median lobe) produced 1 Hormone

- i) Melanocyte stimulating Hormone (MSH) @ Intermedian

Oxytocin and Vasopressin (ADH)

- Actually synthesised by the Hypothalamus.
- Transport axonally to neurohypophysis are stored.
- Released by neurohypophysis (pars nervosa/posterior pituitary)
- neurohypophysis is also known as posterior pituitary

① Growth Hormone (GH)

- In child GH ↓ :- dwarfism (or) nanism (or) midgate
- In child GH ↑ :- Gigantism
↳ Gorilla like appearance
- In adults GH ↓ :- Simed disease
- In adults GH ↑ :- Acromegaly

↓
Enlargement of lower jaw.

- If Acromegaly unchecked, can lead to serious complication & cause death.

② Prolactin [PRL]

- Function → i) Growth of the mammary gland.
ii) Formation of milk.
- PRL is only active in female.

③ TSH (Thyroid stimulating Hormone)

- Synthesis and secretion of thyroid Hormone from the thyroid gland is stimulated by TSH.

④ Adrenocorticotrophic Hormone (ACTH)

- Synthesis and secretion of steroid hormone called Glucocorticoids from the adrenal cortex is stimulated by ACTH.

LH and FSH

- called gonadotrophins as they stimulate gonadal activity.

⑤ LH

- In male
 - LH acts at the Leyding cell of testis & stimulate synthesis & secretion of androgens [testosterone]
 - ↳ Responsible for secondary sexual character of male.

- In female
 - induces ovulation of fully mature follicles (graafian follicles)
 - maintain the corpus luteum.
 - Formed from the remnants of the graafian follicle after ovulation.

⑥ FSH

- In male
 - FSH & androgens regulate spermatogenesis in males. i.e.. sperm formation.
- In female
 - FSH stimulate growth & development of the ovarian follicles ~~or~~ Follicles.

> MSH

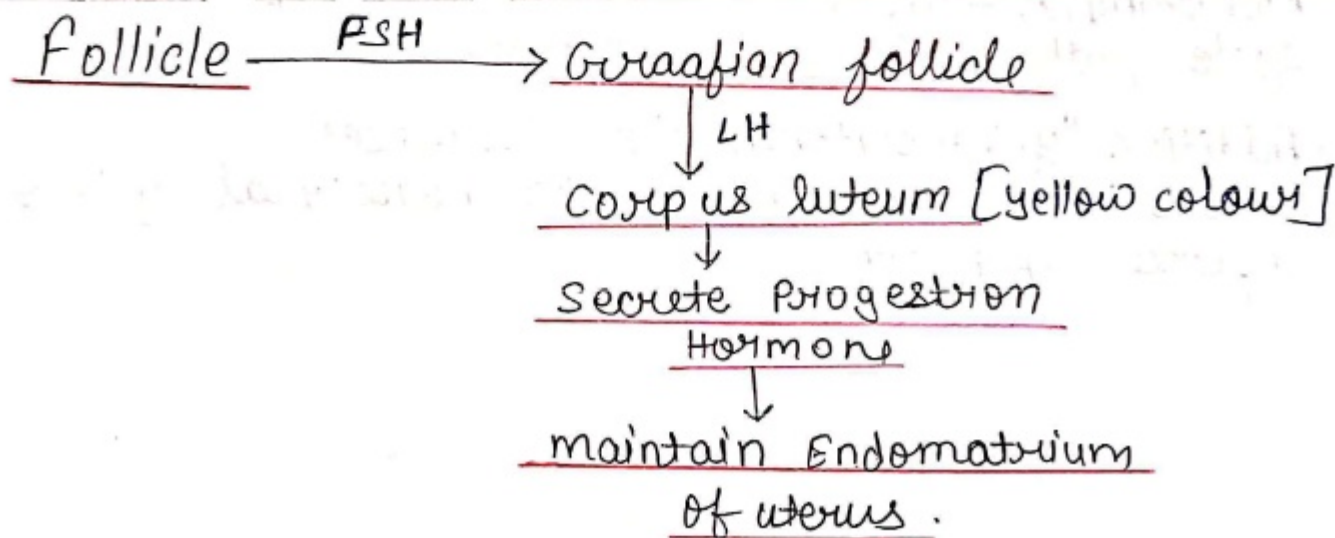
- Regulated pigmentation of the skin.
- MSH acts on the melanocytes (melanin containing cells).
- smooth muscles of human body are acted upon by oxytocin which also stimulates their contraction.

> Oxytocin

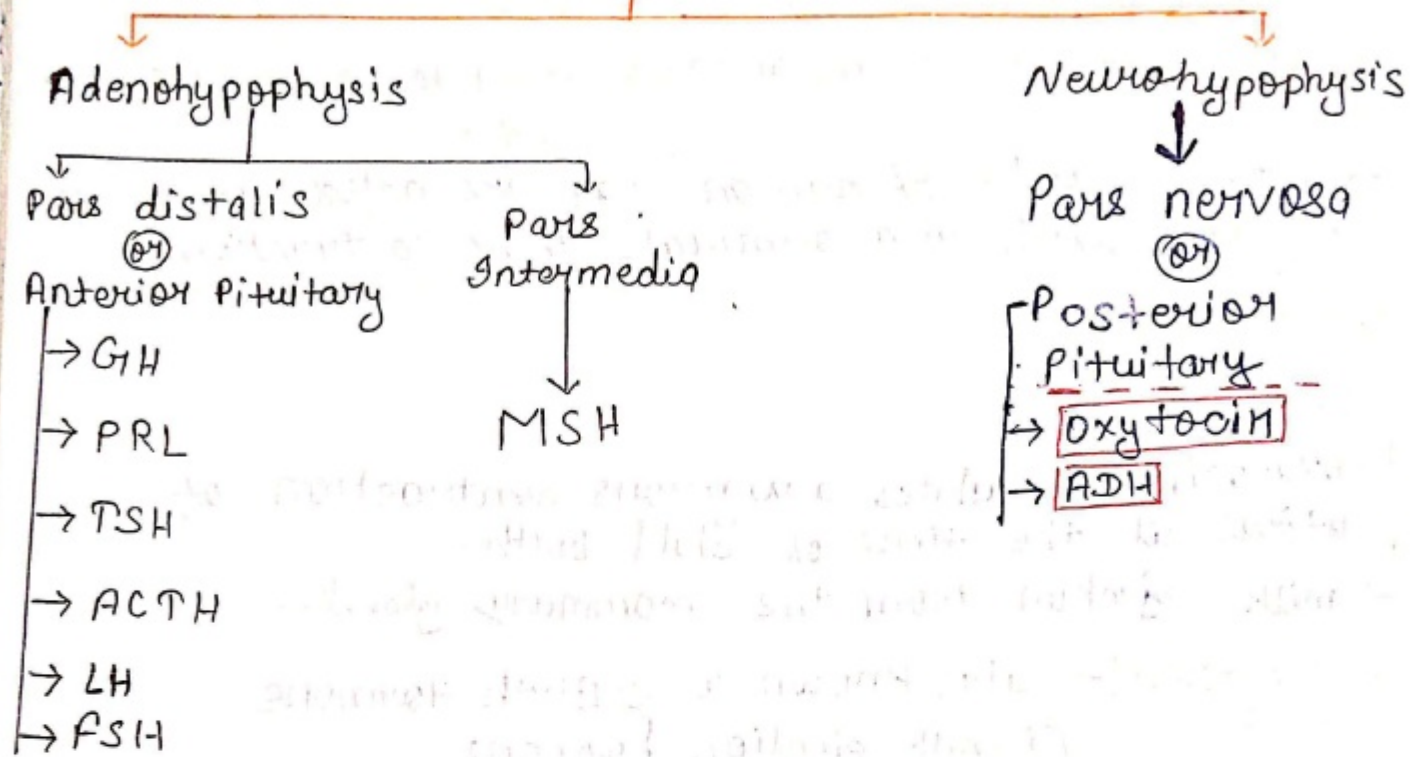
- In female
- oxytocin stimulates a vigorous contraction of uterus at the time of child birth.
- milk ejection from the mammary gland.
- Oxytocin! — also known as ① Birth hormone
② milk ejection hormone

> Vasopressin

- acting mainly at the kidney & stimulating reabsorption of water & electrolytes by the distal tubules.
- Reducing loss of water through urine (diuresis)
- also called Antidiuretic hormone (ADH)
- low secretion of ADH → Disease diabetes insipidus



Pituitary gland

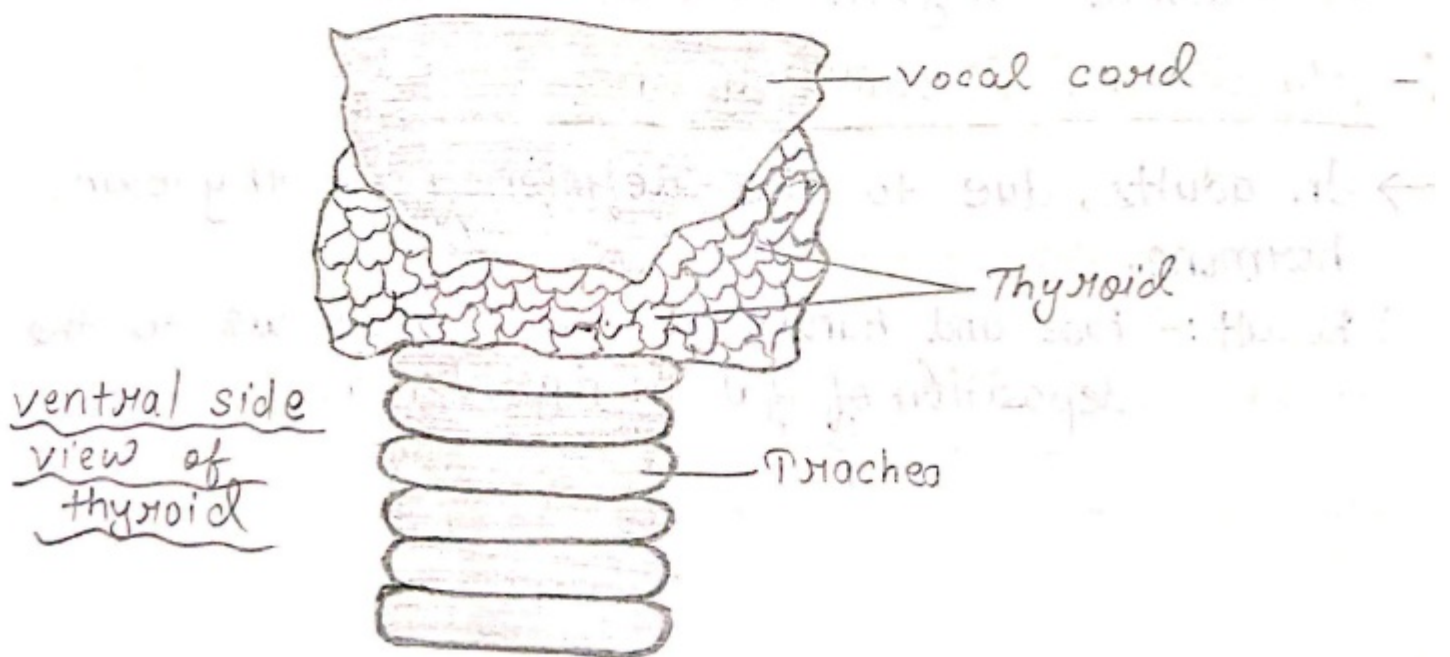


The Pineal Gland

- located on dorsal side of forebrain.
- Pineal & pituitary glands originate ectodermally.
- Secretes a hormone called Melatonin.
- Important Role of melatonin Hormone.
 - ↳ controlling the human body's 24 hour (diurnal) Rhythm.
- For example: - maintain the usual sleep wake cycle patterns, body temperature etc.
- Additionally, melatonin also influences metabolism, pigmentation, the menstrual cycle & defence capability.

Thyroid Gland

- Largest endocrine gland
- Located on either side of the trachea
- Composed of two lobes.
- Isthmus:- A thin flap of connective tissue, interconnect both the lobes.
- 'C' cells (or) parafollicular cell are contained in the stroma.
- Two hormones tetraiodothyronine (or) thyroxine (T_4) and triiodothyronine (T_3) synthesised by these follicular cells.
- Thyroid hormones are instrumental in regulating the basal metabolic rate (BMR).
- Key role of thyroxine is to regulate metabolism
- Thyroid hormone assist process of creating Red blood cell formation.
- Regulate the carbohydrates, proteins & fats
- Also influence the metabolism of water maintenance and the electrolyte balance.



:- Thyroid Disorders.

:- Goitre (simple)

- Deficiency of iodine in human diet.
- Results in Hypothyroidism and enlargement of the thyroid gland.
- Lower intake of iodine.

• To prevent Goitre, table salt is iodised [NaCl]

:- Cretinism

- Defective development and maturation of the growing baby lead to stunted growth, mental retardation, low intelligence, abnormal skin, deaf mutism etc. ↓

which result from hypothyroidism during pregnancy.

- Hypothyroidism may cause menstrual cycle to become irregular in adult women.

:- Myxoedema (or) Gull's disease

- In adults, due to the deficiency of thyroxine hormone.
- Result:- Face and hands become swollen due to the deposition of fat in myxoedema.

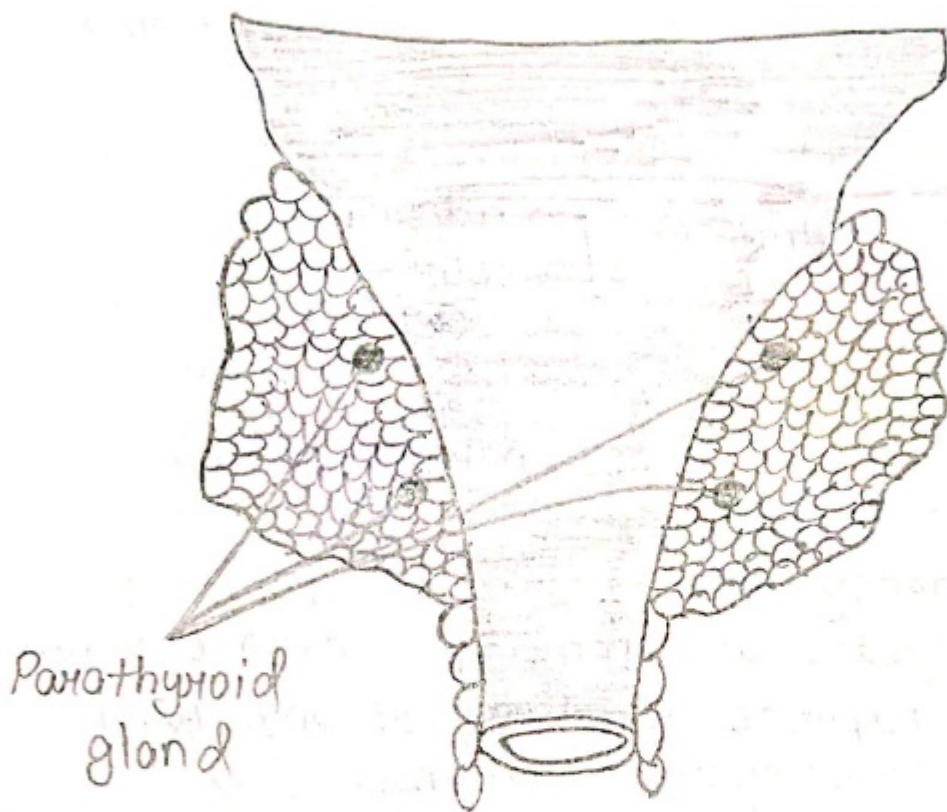
→ PTH hyposecretion (hypoparathyroidism) leads to hypocalcaemia.

→ **Hypocalcaemic tetany**:- This includes skeletal muscle failure to relax and the condition.

Thymus

- Location:- lungs behind sternum on the ventral side of aorta.
- Major role:- development of immune system
- Hassall's corpuscles which are phagocytic in nature are found in the medulla.
- Thymosins are peptide hormones secreted by thymus gland.
- Major role:- Differentiating T-lymphocytes
Provide
cell-mediated immunity.
- Antibody:- Provide humoral immunity.

In old people - thymus is degenerated resulting in reduced thymosins production. As a result, old people's immune responses become weak.



Dorsal side view of the position of
thyroid and parathyroid.

ADRENAL GLAND

- A pair of adrenal gland.
- Each adrenal gland is located on the anterior part of each kidney.
- Adrenal gland is composed of two types, the outer tissue is called adrenal cortex and centrally located tissue is called the adrenal medulla.

I. Adrenal medulla:-

Secrete two hormones —

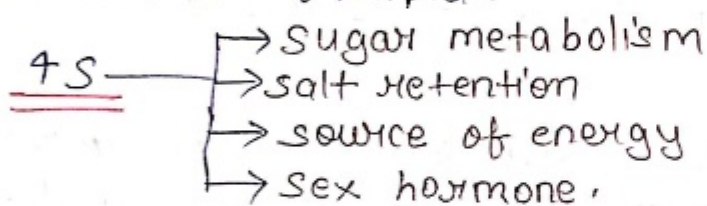
- adrenaline
- epinephrine
- noradrenaline
or
norepinephrine

- Also called catecholamines.
- Called emergency hormones or hormones of Fight or Flight, adrenaline and noradrenaline
- Secreted in response to stress of any kind and during emergency situations.
- Adrenal gland is also referred to as the gland for fight, flight and fright or Triple 'F' gland or life-saving gland or emergency gland.
- Alertness, pupillary dilation, piloerection (raising of hairs), sweating etc. increased by catecholamines.
- Heart beat, the strength of heart contraction and the rate of respiration are increased by both the hormones.
- Blood pressure is also increased by adrenaline.

- Catecholamines also stimulate the breakdown of glycogen resulting in an increased concentration of glucose in blood. In addition, they also stimulate the breakdown of lipids and proteins.

-: Adrenal Cortex :-

- Adrenal cortex is divided into three layers called zona reticularis (inner layer), zona fasciculata (middle layer) and zona glomerulosa (outer layer).
- Many hormones are secreted by the adrenal cortex, usually called corticoids.
- Hormones of adrenal cortex are synthesised from cholesterol or lipid.



Zona Glomerulosa

- Mineralocorticoids are released.
- Mineralocorticoids which regulate the balance of water and electrolytes in our body.
- Main mineralocorticoid in our body is aldosterone.
- Aldosterone raises blood levels of both Na^+ and water.
- Aldosterone primarily works at the renal tubules and induces Na^+ and water reabsorption and excretion of K^+ and phosphate ions.
- Aldosterone thus assists in the maintenance of electrolytes, volume of blood fluid, osmotic pressure and blood pressure.

Zona Fasciculata

- Glucocorticoids are released by this zone. involved in carbohydrate metabolism.
- * → Cortisol is the main glucocorticoid in human body.
- Gluconeogenesis, lipolysis and proteolysis are stimulated by glucocorticoids and inhibit cellular uptake and utilisation of amino acids.
- Maintaining the cardio-vascular system as well as the kidney functions.
- Anti-inflammatory reactions and suppresses the immune response.
- In allergic reaction, glucocorticoids is produced.
- RBC production is stimulated by cortisol.

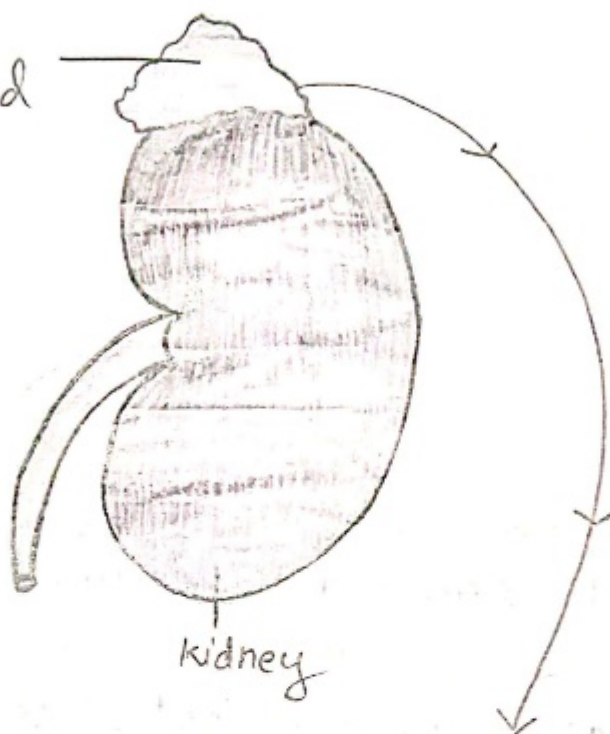
Note:-

- # → Addison's disease is caused by the underproduction (Hyposecretion) of hormones by the adrenal cortex which alters carbohydrate metabolism resulting in acute weakness and fatigue.

Zona Reticularis

- Gonadocorticoids (sex corticoids) are released from this region.
- The adrenal cortex also secretes small amounts of androgenic steroids which plays a role in the growth of axial hair, pubic hair and facial hair during puberty.

Adrenal gland



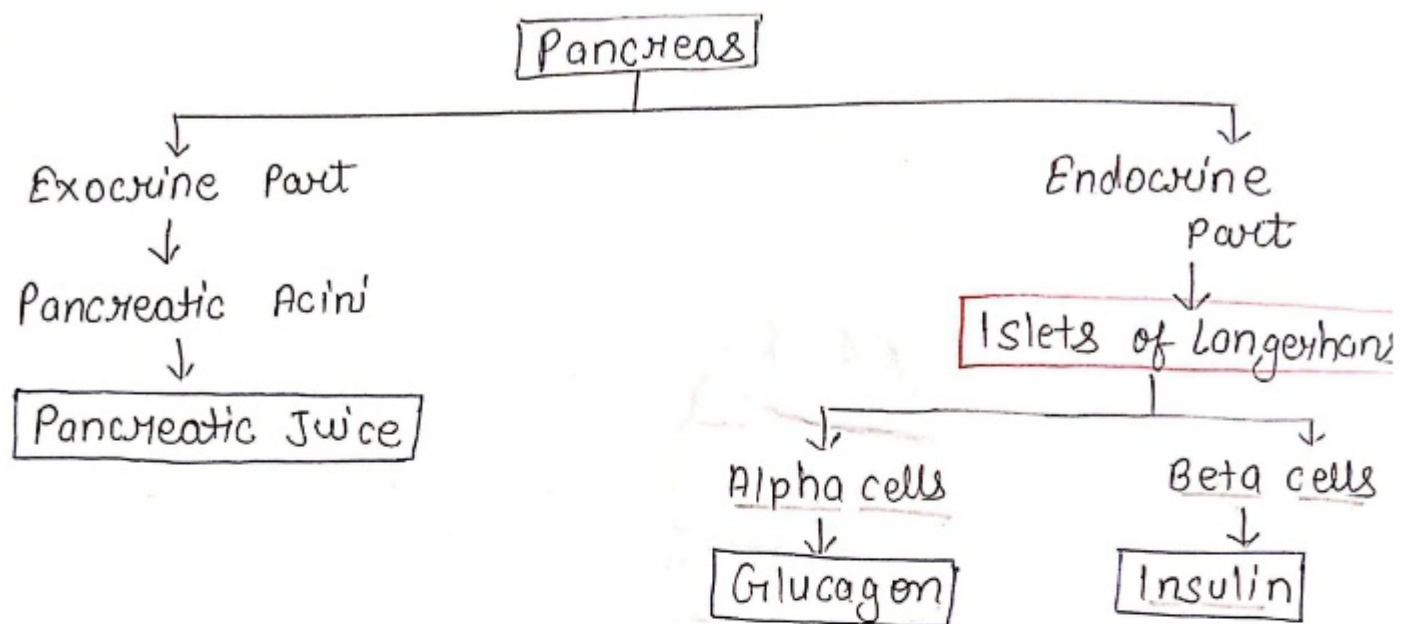
Kidney

Adrenal cortex



Adrenal gland

PANCREAS



- Heterocrine gland
- acts as a both endocrine and exocrine gland.
- Only 1 to 2% of the pancreatic tissue.
- 1 to 2 million Islets of Langerhans.
- Endocrine pancreas comprises of 'Islets of Langerhans'.
- Alpha-cells and Beta-cells are the two main types of cells.
- A peptide hormone, glucagon plays an important role in maintaining the normal blood glucose level by acting mainly on the liver cells (hepatocytes) and stimulates glycogenolysis resulting in an increased blood sugar (hyperglycaemia).
- Cellular glucose uptake and utilisation is reduced by glucagon which means it is a hyperglycaemic hormone.

→ A peptide hormone, which plays a major role in the regulation of glucose homeostasis in insulin.

→ Insulin acts primarily on hepatocytes and adipocytes (cells of adipose tissue) and enhances cellular glucose uptake and utilisation.

→ Resulting in decreased blood glucose levels (hypoglycaemia).

→ Glucose to glycogen (glycogenesis) in the target cell (insulin).

Diabetes mellitus

→ Insulin and glucagon jointly maintain the glucose homeostasis in blood, hyperglycaemia leading to a complex disorder.

→ Associated with loss of glucose through urine and formation of harmful compounds known as ketone bodies.

Testis

- In male individual, a pair of testes is present outside the abdomen in the scrotal sac.
- Primary sex organ. scrotal sac
- The function of a primary sex organ as well as an endocrine gland testes which is comprised of seminiferous tubules and stromal or interstitial tissue.
- intertubular spaces, the Leydig cells or interstitial cells secrete a group of hormones called androgens, mainly testosterone.
- By the stimulation of LH from anterior pituitary, male hormones known as androgens are secreted by Leydig cells.
- Testosterone is the main hormone or androgen which is responsible for the puberty in males.
- The development, maturation and functions of the male accessory sex organs like epididymis, vas deferens, seminal vesicles, prostate gland, urethra etc. are regulated by the androgens.
- Muscular growth, growth of facial and axillary hair, aggressiveness, low pitch of voice i.e. ...
(secondary sexual character)

In male by androgen

- In the process of spermatogenesis (formation of spermatozoa).

male sexual behaviour (libido)

Action on the CNS (central neural system)
androgens influence.

→ An anabolic (synthetic) effect on protein and carbohydrate metabolism is produced by these hormones.

OVARY

→ A pair of ovaries is located in the abdomen of females.

→ Primary sex organ in female.

→ Ovary also produces two groups of steroid (lipid or cholesterol) hormones called estrogen and progesterone.

→ Composed of ovarian follicles and stromal tissue.

→ Estrogen is synthesised and secreted mainly by the growing ovarian follicles.

→ 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 is produced by estrogen.

→ FSH controls the secretion of estrogen.

→ Progesterone which also acts on the mammary glands stimulates the formation of alveoli (sac-like structures which store milk) and milk secretion by pregnancy is supported by progesterone.

For the growth and development of the foetus, Progesterone is responsible.

Also, it is responsible for the implantation of blastocyst (embryo) in uterus, and also in the formation of the placenta.

& maintain endometrium of uterus.

Note:-

① Progesterone is anti-abortion hormone.

② Testes and ovaries are called gonads which are heterocrine glands.

*Hormones of Heart, kidney and Gastrointestinal tract.

→ Some tissues which are not endocrine glands also secrete hormones.

→ The atrial wall of our heart secretes a very important peptide hormone called atrial natriuretic factor (ANF), which decreases blood pressure, when blood pressure is increased.

→ ANF is secreted which causes dilation of the blood vessels. This results in lowering of blood pressure.

→ A peptide hormone called erythropoietin which stimulates erythropoiesis (formation of RBC) is produced by the juxtaglomerular cells of kidney.

→ Gastrin, secretin, cholecystokinin (CCK) and gastric inhibitory peptide (GIP) are the four major peptide hormones secreted by endocrine cells present in different parts of the gastrointestinal tract.

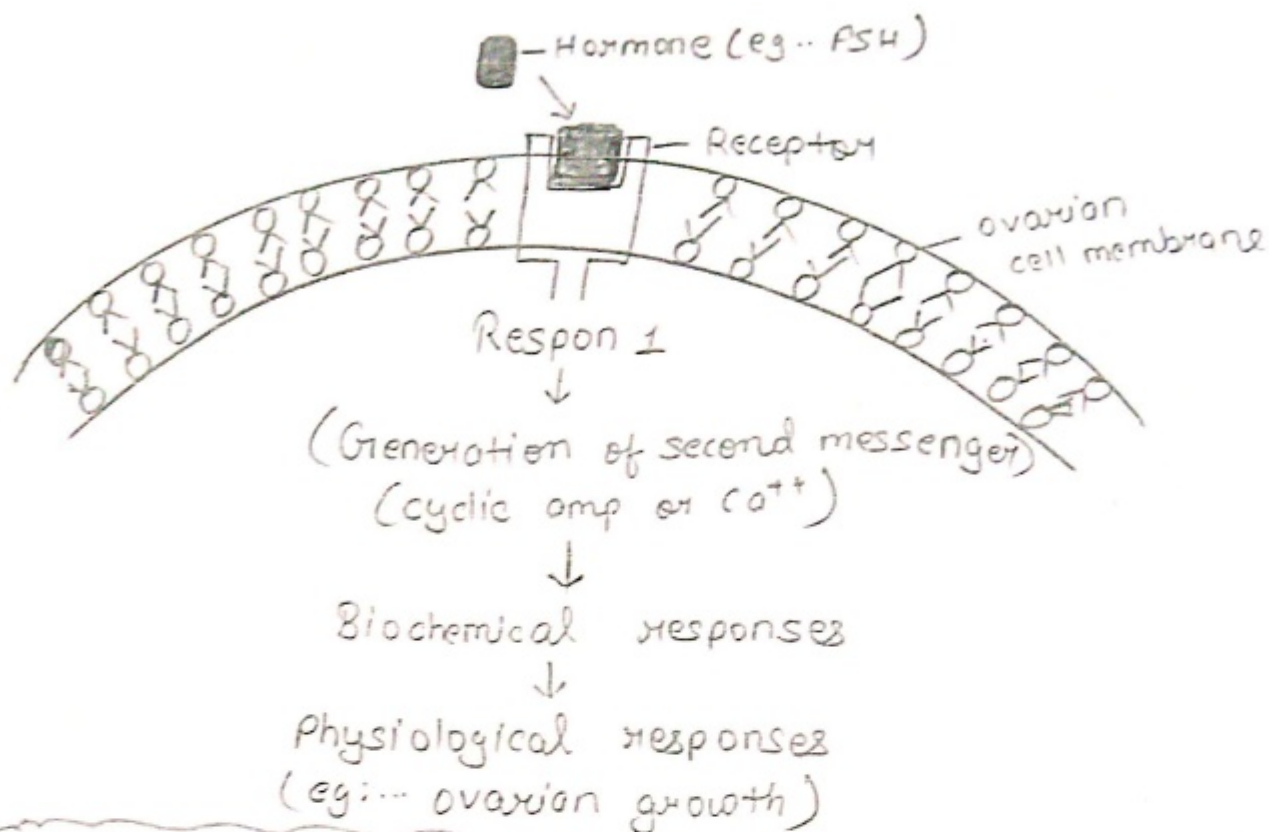
- ① Gastrin acts on the gastric glands and stimulates the hydrochloric acid and pepsinogenic secretion.
 - ② Secretin acts on the exocrine pancreas and stimulates water and bicarbonate ion secretion (HCO_3^-).
 - ③ CCK acts on both pancreas and gall bladder, and stimulates the pancreatic enzyme and bile juice secretion, respectively.
 - ④ GIP inhibits gastric secretion and motility. GIP also is known as enterogastrone.
- Hormones called growth factors are secreted by several other non-endocrine tissue which are essential for the normal growth of tissue and their repairing/regeneration.

Nature of Hormone

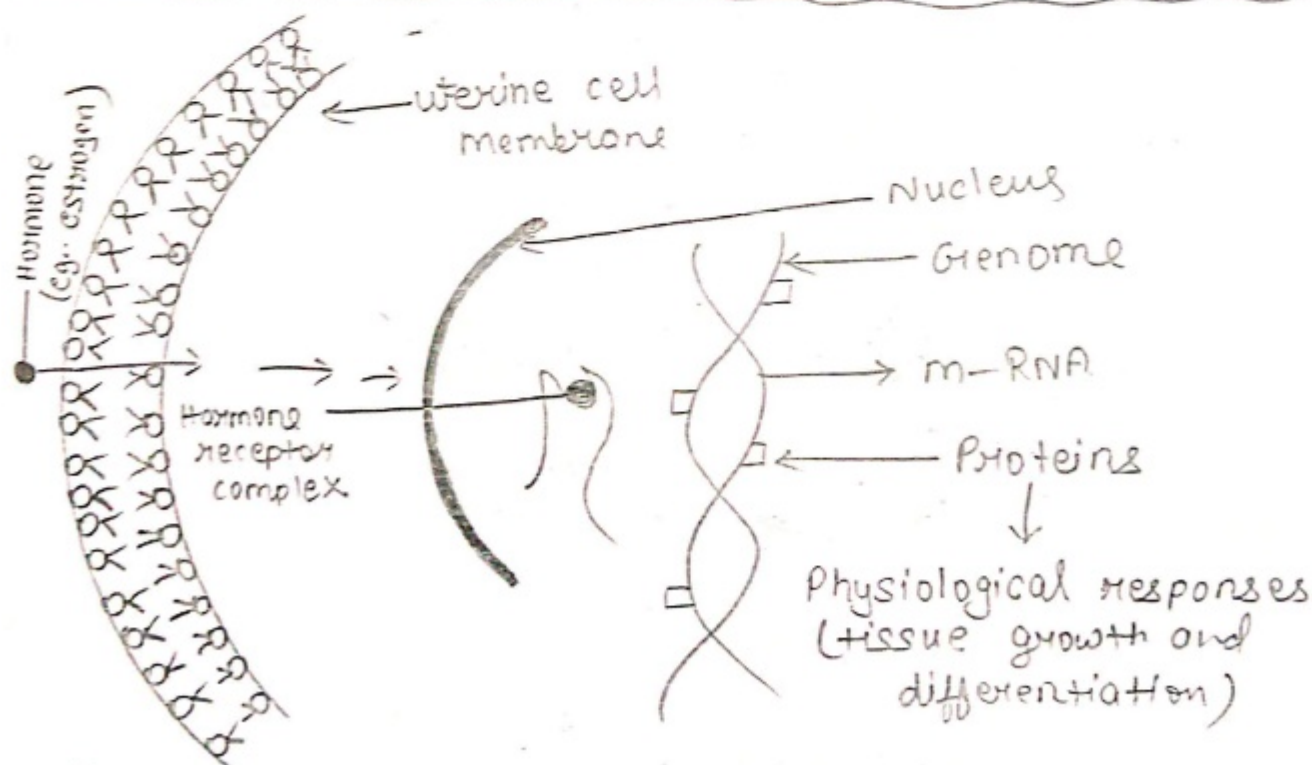
- i) Peptide, polypeptide, protein hormones: Eg, insulin, glucagon, pituitary hormones, hypothalamic hormones TCT, PTH, Thymosin and hormones of GIP.
- ii) Steroids: Eg.. cortisol, testosterone, estradiol, progesterone, aldosterone etc. Steroid hormones are derived from cholesterol or lipid.
- iii) Iodothyronines: Thyroid hormones (Thyroxine)
- iv) Amino-acid derivatives: Eg, epinephrine (derivative of tyrosine).

Mechanism of Hormone Action

- Membrane-bound receptors are the hormone receptors present on the cell membrane of the target cell & while the receptors present inside the target cell are called intracellular receptors, mostly nuclear receptors (present in the nucleus).
- When a hormone binds to its receptor, formation of a hormone-receptor complex takes place.
- Hormone-receptor complex formation results in many biochemical changes in the target tissue.
- Metabolism of the target tissue and therefore its physiological function are regulated by hormones.
- Hormones that interact with membrane-bound receptors do not usually enter the target cell, but produce secondary messengers (e.g., cyclic AMP, cGMP, IP_3 , Ca^{++} etc) that in turn control cellular metabolism.
- Steroid hormones, iodothyronines etc.) mostly regulate gene expression or chromosome function by the interaction of hormone-receptor complex with the genome. Physiological and developmental effects result from cumulative biochemical actions.



Protein hormone of the mechanism of hormone action



Steroid hormone of the mechanism of hormone action