HUMAN ANATOMY & PHYSIOLOGY-II

UNIT 4 NOTES

ENDOCRINE SYSTEM

- CLASSIFICATION OF HORMONES
- MECHANISM OF HORMONE ACTION
- HORMONES & DISORDERS

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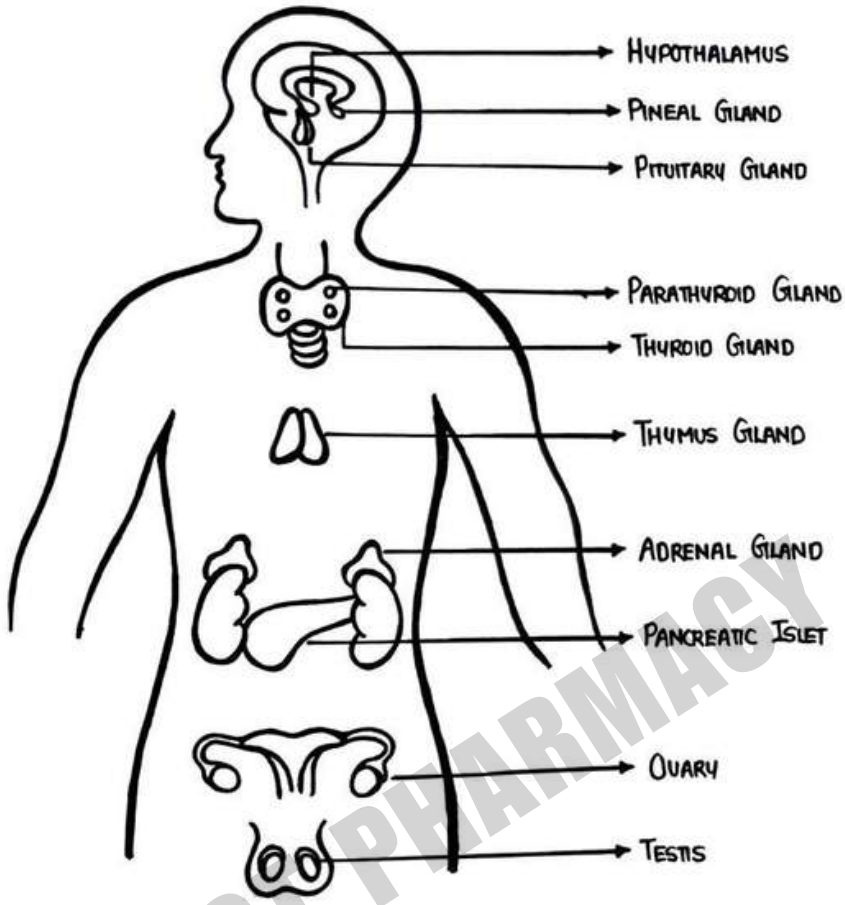
ENDOCRINE SYSTEM

- The Human Endocrine System is consist of group of ductless glands (Endocrine Glands) that regulates the body processes by secreting chemical substances (chemical messengers) known as **Hormones**.
- Endocrine Glands are Ductless.
- They secretes hormones directly into the Bloodstream.
- The Nervous System & Endocrine System together controls & coordinates all the functions of our body.
- The branch of science deals with the study of Endocrine system is known as **Endocrinology**.

ENDOCRINE GLANDS

- Endocrine Glands are ductless glands that secretes hormones into the extracellular spaces that further diffused into blood capillaries & carried throughout the body by circulatory system.
- The Endocrine system consist of number of endocrine glands as follows :

① Pituitary Gland
② Pineal Gland
③ Thyroid Gland
④ Parathyroid Gland
⑤ Thymus Gland
⑥ Adrenal Gland
⑦ Pancreatic Islets
⑧ Ovaries (Females)
⑨ Testes (Males)



ENDOCRINE SYSTEM

HORMONES

- Hormones are nothing but type of chemical messengers primarily produced by Endocrine Glands.
- Hormones regulates & controls a wide range of Physiological Functions.
- They are responsible for various cellular activities specially Growth & Metabolism.

Types Of Hormones

Hormones can be classified into two types :

① Steroidal Hormones

② Non - steroidal Hormones

Steroidal Hormones

- They are generally synthesised / derived from Cholesterol based lipids.
- They are mainly water insoluble / lipid soluble.
- These hormones can easily cross the Plasma Membrane.
- Example : Testosterone, Progesterone, Glucocorticoids etc.

Non- Steroidal Hormones

- They are also known as Protein Hormones.
- They are synthesised from Amino Acids (Amines, Polypeptides, Proteins etc).
- They are generally Water Soluble.
- Protein Hormones cannot cross the Plasma Membrane.
- Example : Insulin, Adrenaline, Glucagon etc.

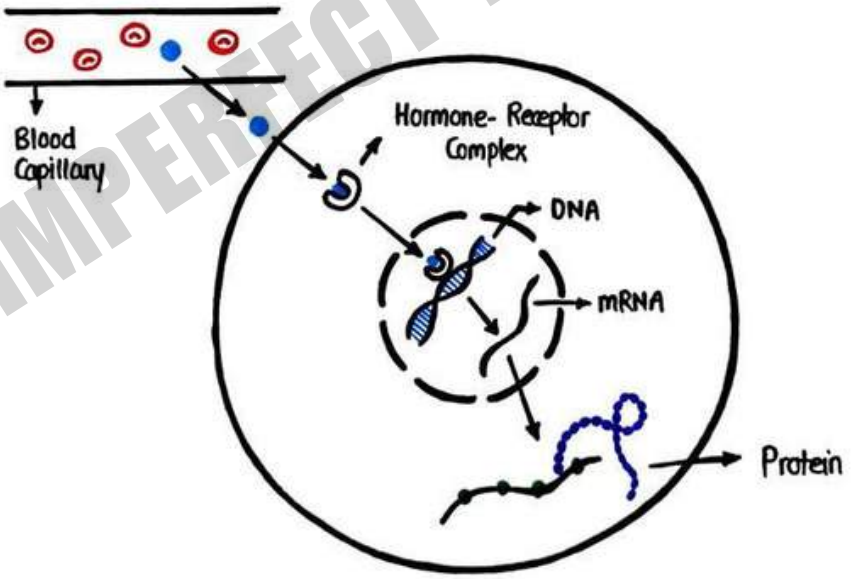
Mechanism Of Hormone Action

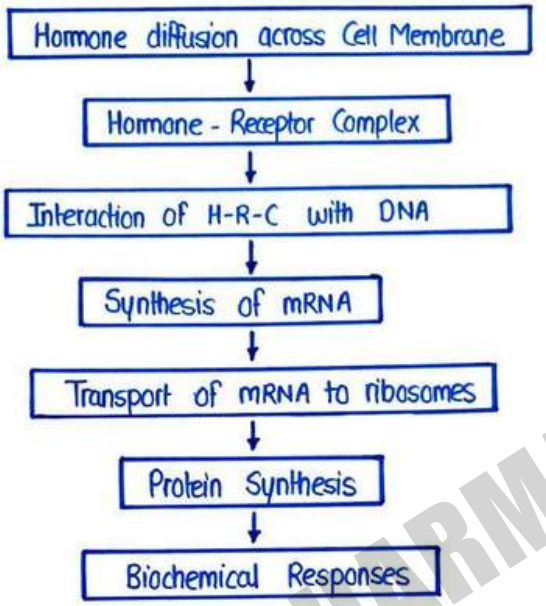
- Hormones shows their action on target cell by binding on specific receptors present either on surface or inside of that cell.
- Hormones binds on their receptor to form Hormone - Receptor Complex.
- Hormones mainly shows their action by following mechanism.

① Direct Gene Activation Mechanism
② Second Messenger Activation Mechanism

① Direct Gene Activation

- This mechanism is mainly performed by Steroidal Hormones or Lipid Soluble Hormones.
- The receptors of these hormones present in intracellular region either in cytoplasm or neucleoplasm.





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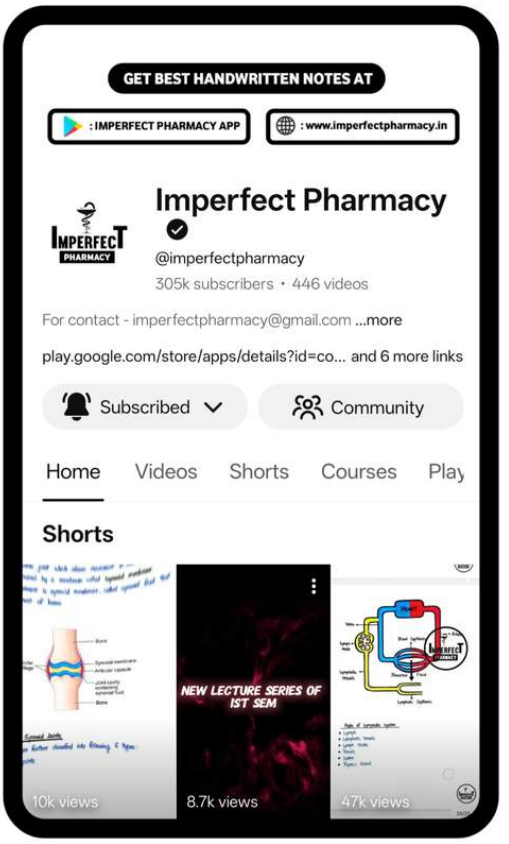

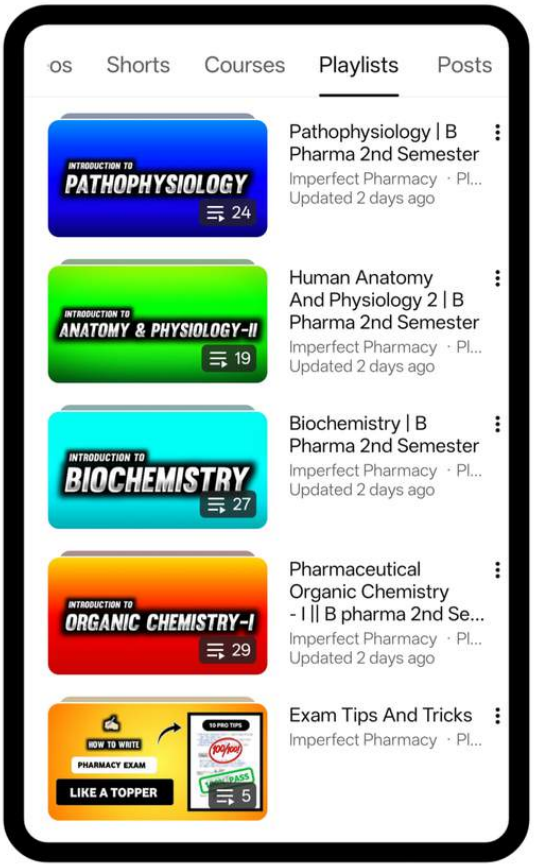

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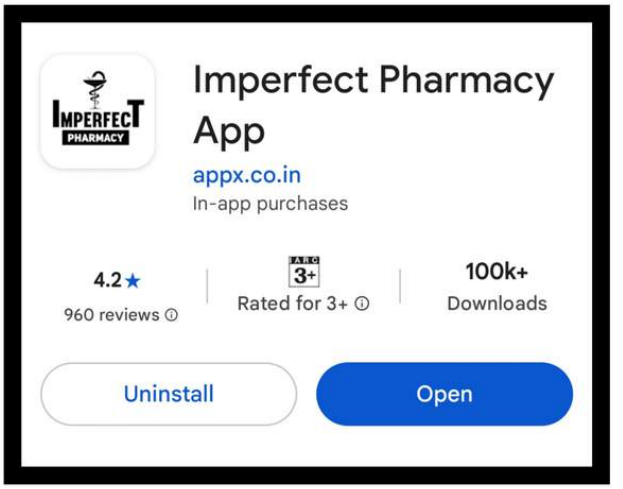
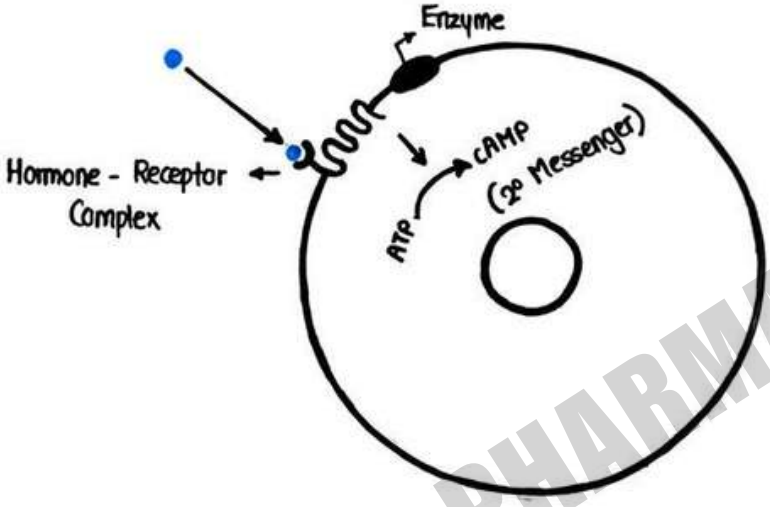


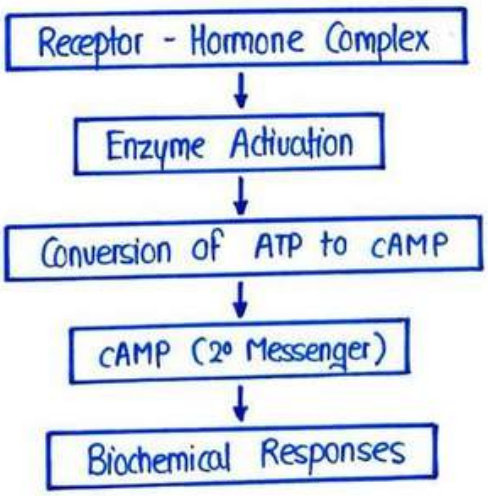
Second Messenger Activation Mechanism

- This mechanism is mainly performed by Non-steroidal Hormone / Protein Hormone or Lipid insoluble hormones.
- The receptors of these hormones present on the surface of the cell.



2° Messenger : 2° Messenger are substances that transmit signals from cell surface to target site within cell

Example : cAMP, cGMP, IP_3, DAG, Ca^{++}



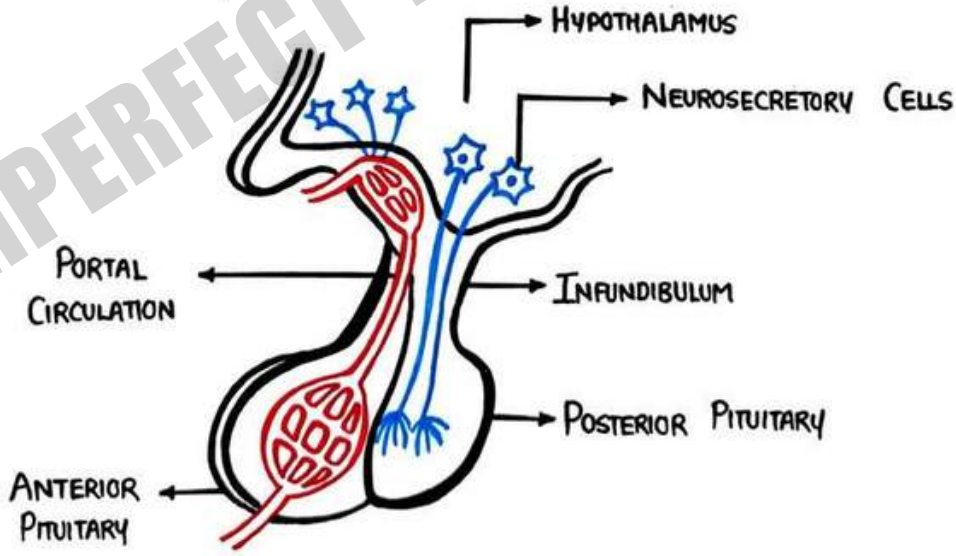
Pituitary Gland

- Pituitary Gland is a very small gland & also known as **Hypophysis**.
- It is located in '**Sella Turcica**' a depression in sphenoid bone.
- It is almost a pea size gland & its weight is about 500 mg.
- It joints with Hypothalamus through **Infundibulum**.
- The Pituitary Gland is also known as '**Master Gland**' of our body as it controls the activity & functions of various other Endocrine Glands.

Parts Of Pituitary Gland

Pituitary Gland can be subdivided into two parts :

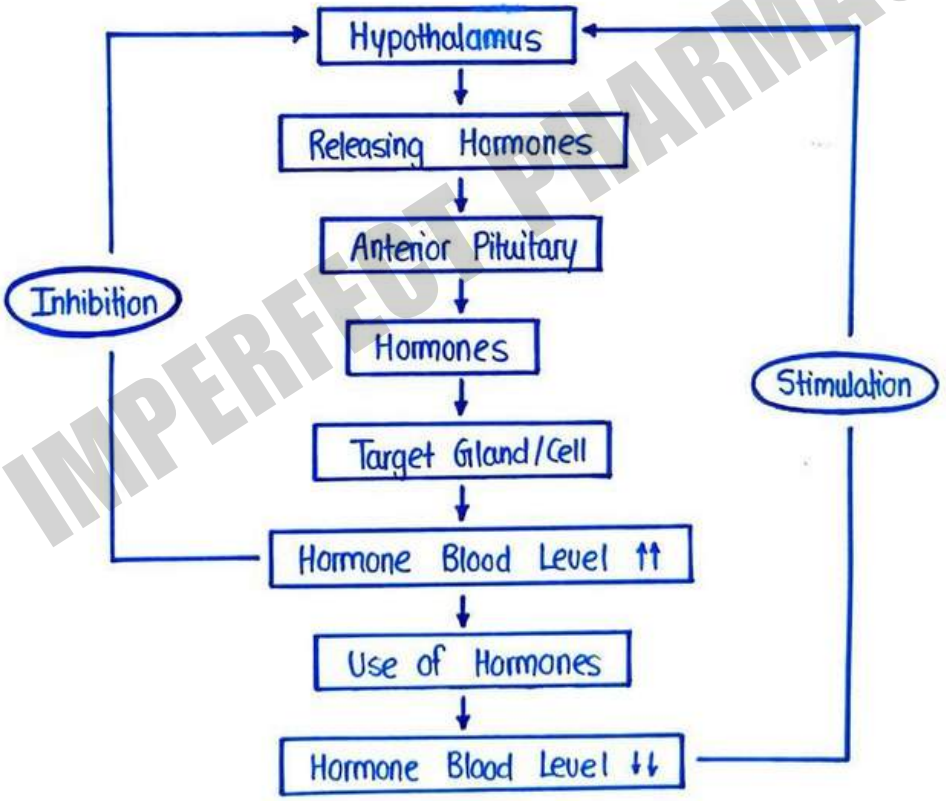
① Anterior Pituitary
② Posterior Pituitary



HYPOTHALAMUS

- Although Hypothalamus is not purely considered as part of Endocrine Glands yet along with Pituitary Gland it plays major role in Endocrine System.
- It is known as Master of 'Master Gland'.
- It releases various 'Releasing' and 'Inhibiting' Hormones to the Anterior Pituitary through 'Portal Circulation'
- It also produces & stores hormones (ADH & Oxytocin) in the posterior pituitary through 'Neurosecretory / Neuroendocrine cells'.

It controls the release or inhibit of hormones from Pituitary Gland as follows:



ANTERIOR PITUITARY

- Anterior Pituitary is also known as Adenohypophysis.
- It can be further divided into two parts :

① Pars Distalis
② Pars Intermedia.

- Hypothalamus controls the release & inhibition of hormones released from anterior pituitary by sending hormones through 'Hypophaseal Portal Vein'.
- Anterior Pituitary secretes various hormones that controls & coordinates the functions of other endocrine glands.
- The Hormones releases by Anterior Pituitary are as follows :

(i) Growth Hormone (GH)
(ii) Thyroid Stimulating Hormone (TSH)
(iii) Adrenocorticotrophic Hormone (ACTH)
(iv) Prolactin
(v) Gonadotrophins

GROWTH HORMONE

- It releases from Anterior Pituitary in most abundant amount.
- It is responsible for growth & development of body by increasing cell division, Protein Synthesis, Blood-Glucose Level & Lipid breakdown.
- It targets various tissues & organs i.e. Liver, Connective Tissue, Bones, Muscles etc.
- Hypothalamus stimulate the release of growth hormone by secreting 'Growth Hormone Releasing Hormone' & suppresses / inhibited it by secreting 'Growth Hormone Release Inhibiting Hormone' (GHRIH).
- Secretion of GH is greatre at night during sleep.
- Hypersecretion of GH leads to Gigantism.
- Hyposecretion of GH leads to Dwarfism.

Thyroid Stimulating Hormone (TSH)

- It is also known as Thyrotrophin.
- It stimulates growth & activity of Thyroid Gland
- The blood levels of TSH is stimulated by 'Thyrotrophin Releasing Hormone' secreted by Hypothalamus.
- Its inhibition is regulated by Negative Feedback Mechanism.
- Its release is lower in early evening & highest during night.

Adrenocorticotrophin Hormone (ACTH)

- It acts on Adrenal Cortex
- Its secretion is stimulated by 'Corticotrophin Releasing Hormone' from Hypothalamus.
- It promotes the release of steroid hormones (especially cortisol) from Adrenal Cortex.
- Its inhibition is regulated by Negative Feedback Mechanism.

Prolactin

- This hormone is responsible for Lactation (Milk Production) & has a direct effect on breast after Childbirth.
- The release of Prolactin is stimulated by 'Prolactin Releasing Hormone' & further lowered by 'Prolactin Inhibiting Hormone'.
- Its secretion is Increased during sleep & emotional stress.

GONADOTROPHINS

- After Puberty two Gonadotrophins (Sex Hormones) are secreted by Anterior Pituitary in response to 'Gonadotrophin Releasing Hormone' via Hypothalamus.
- These Hormones are :

① FSH (Follicle Stimulating Hormone)
② LH (Luteinizing Hormone)

In Males :
- In Males FSH stimulates Spermatogenesis.
- LH also known as Interstitial Cell Stimulating Hormone (ICSH) stimulates interstitial cell of testes to secrete Testosterone.

In Females :
- In Females FSH stimulates Oogenesis.
- LH & FSH are involved in secretion of hormones Oestrogen & Progesterone during menstrual cycle.

Posterior Pituitary

- It is also known as **Neurohypophysis**.
- The hormones of Posterior Pituitary is basically synthesized by Hypothalamus while they are stored & secreted through Posterior Pituitary.
- There are basically two hormones secreted by Posterior Pituitary as follows :

① Oxytocin
② Antidiuretic Hormone

Oxytocin

- Oxytocin is often called 'Love Hormone' as it plays role in social bonding, trust, empathy etc.
- Oxytocin mainly acts on two target tissues during & after the childbirth Uterine Smooth Muscles & Breast Muscles.
- During Labour (Delivery / Childbirth) it contract the Uterine Smooth Muscles & helps with birthing process.
- It also facilitates milk ejection during breastfeeding by contracting cell around milk producing glands in breast.
- The release of oxytocin is triggered by suckling of nipples by baby.

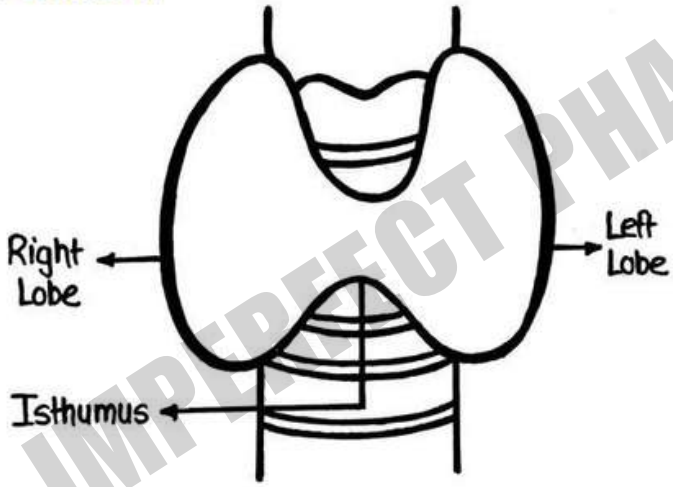
Antidiuretic Hormone (ADH)

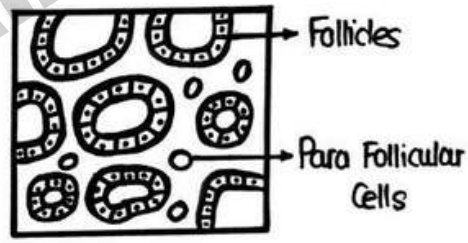
- It is also known as Vasopressin.
- The main function of ADH is to reduce urine output by increasing water reabsorbtion through Nephrons.
- It also causes vasoconstriction in blood vessels leads to increase blood pressure that's why alternatively called **Vasopressin**

THYROID GLAND

- It is the largest endocrine gland in our body.
- It present around trachea at level of 5th, 6th & 7th cervical & 1st thoracic vertebrae.
- It resembles the shape of butterfly.
- It consist of two lobes connected with Isthumus.
- It composed of hollow structures known as 'Follicles'.
- It secretes two hormones :

① Thyroid Hormone
② Calcitonin





CALCITONIN

- It is secreted by Parafollicular cells.
- It acts on bone & kidneys to reduce blood calcium level when increased.
- It basically decreases Blood Calcium level.
- Release of calcitonin is stimulated by increase in Blood Calcium level.

Thyroid Hormones

- There are mainly two types of Thyroid Hormones.

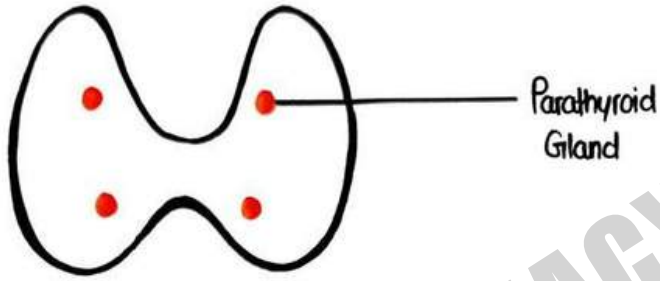
① Triiodothyronine (T_3)

② Thyroxine (T_4)

- Iodine is most essential for formation of thyroid hormones.
- The release of T_3 & T_4 is stimulated by Thyroid Stimulating Hormone (TSH).
- They are known as 'Master Hormones'
- It increases the BMR & Heat Production
- It regulates metabolism of Carbohydrates, Proteins & Fats.
- T_3 & T_4 are essential for normal growth & development especially Skeleton & Nervous System.
- T_3 is more potent while T_4 is more abundant.
- It also regulates Menstrual Cycle & Water - Electrolyte Balance.
- They also play a role in maintaining Healthy skin, hair & nail.
- Thyroid Hormones can also affect mood & their imbalance leads to Mood swings, anxiety & depression.

PARATHYROID GLAND

- There are 4 small Parathyroid Glands, located within Thyroid Gland.
- Parathyroid Gland secretes Parathyroid Hormone



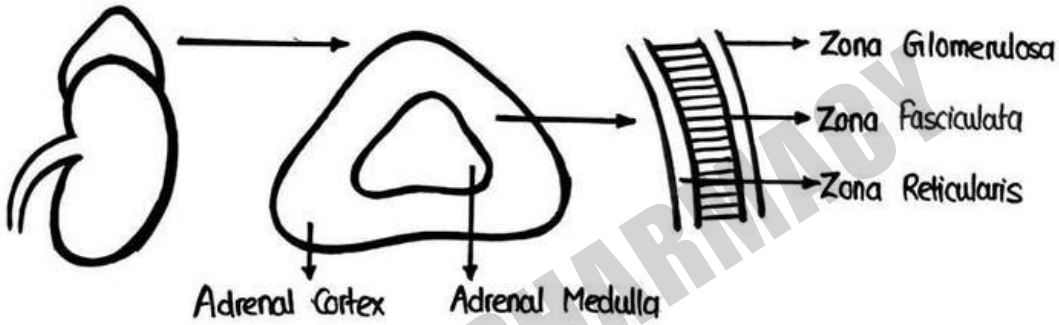
PARATHORMONE

- The Parathyroid hormone (Parathormone, PTH) regulates or increased Blood Calcium Level, when it is low.
- It maintains proper calcium balance in body. by stimulating release of calcium from bones enhancing calcium absorbtion from intestine & reducing calcium excretion from kidneys
- Parathormone & Calcitonin from Thyroid Gland act in complementary manner to maintain Blood Calcium Level within normal range.

ADRENAL GLAND

- There are two Adrenal Glands in our body at top of both kidneys.
- They are around 4 cm long, 3 cm thick & 4 gram in weight.
- They can be further subdivided into two parts :

① Adrenal Cortex
② Adrenal Medulla



ADRENAL CORTEX

- It is the outer part of Adrenal Gland.
- It develops from Renal Tissues.
- Adrenal Cortex produces three groups of steroid hormones collectively known as Corticoids / Corticosteroids.
- It is further subdivided into 3 subparts :

① Zona Glomerulosa : Mineralocorticoids
② Zona Fasciculata : Glucocorticoids
③ Zona Reticularis : Gonadocorticoids (Sex Hormones)

MINERALOCORTICOIDS (ALDOSTERONE)

- Aldosterone is the major mineralocorticoid hormone.
- It helps to maintain Water & Electrolyte balance in our body.
- It stimulates Na^+ reabsorbtion & k^+ excretion.
- Release of Aldosterone is stimulated by increase Blood Potassium level & RAAS system.

GLUCOCORTICOIDS

- Cortisol, Corticosterone & Cortison are major Glucocorticoids.
- They are essential for life, regulation of Metabolism & responses to stress. Release of cortisol triggered by stress.
- It is also known as Life Saving Hormone
- It performs various functions as follows:

- Gluconeogenesis
- Lipolysis
- Sodium & Water Reabsorbtion
- It also have Anti-inflammatory action.
- Supoesses Immune Response
- Delay Wound Healing
- Supress response of tissue to injury.

GONADOCORTICOIDS (SEX HORMONES)

- Sex hormones secreted by Adrenal Cortex are mainly Androgens (Male Sex Hormones) & to a lesser extent Estrogen.
- The amount of sex hormones produced by Adrenal Cortex are generally insignificant compared with those secreted by Testes & Ovaries

ADRENAL MEDULLA

- It is the innermost part of Adrenal Gland.
- It is surrounded by Cortex.
- It develops from Nervous Tissue.
- It mainly releases two hormones collectively known as Catacholamines.

① Adrenaline (Epinephrine)
② Nor- Adrenaline (Nor- Epinephrine)

ADRENALINE & NOR - ADRENALINE

- Adrenaline & Nor- adrenaline are released into Bloodstream from Adrenal Medulla during activation of Sympathatic Nervous System.
- They are structurally very similar & shows similar responses as follows :

- Increasing Heart Rate
- Increasing Blood Pressure
- Pupil Dilation
- Bronchodilation
- Increased Blood Sugar Level
- Decreases Digestive Activity

PANCREATIC ISLETS

- The Pancreatic Islets also known as Islets of Langerhans are found
- in clusters irregularly distributed throughout the pancreas.
- It is the only part of pancreas behaves as Endocrine Glands.
- There are mainly 3 types of cells in Pancreatic Islets.

① α Cells : Secretes Glucagon
② β Cells : Secretes Insulin
③ δ Cells : Secretes Somatostatin

INSULIN

- It is secreted by β cells of Pancreas.
- It decreases Blood-Glucose Level by promoting Glycogenesis, Lipogenesis & preventing Glycogenolysis & Gluconeogenesis
- Secretion of insulin is stimulated by increased Blood Glucose Level & decreased by Glucagon, Adrenaline, cortisol & somatostatin.

GLUCAGON

- It is secreted by α-cells of Pancreas.
- It increase Blood-Glucose Level by promoting Glycogenolysis & Gluconeogenesis.
- Secretion of Glucagon is stimulated by low Blood Glucose Level & decreased by Somatostatin & Insulin.

SOMATOSTATIN

- Somatostatin is also known as Growth Hormone Release Inhibiting Hormone (GHRIH).
- It is produced by δ cells & also via Hypothalamus.
- This Hormone inhibits the secretion of both Insulin & Glucagon.

PINEAL GLAND

- Pineal Gland is considered as smallest Endocrine Gland in Human body.
- It is located within brain, attached with roof of 3rd ventricle connected by a short stalk.
- It is about 10 mm long & reddish brown in colour.
- The hormone secreted by Pineal Gland is Melatonin.

MELATONIN

- Melatonin, secreted by Pineal Gland, regulates Sleep-wake cycle.
- It also maintains & controls body's internal clock.
- It is also believed to be associated with inhibition of growth & development of sex organs before puberty.
- Its level rises in evening & decrease in early morning.

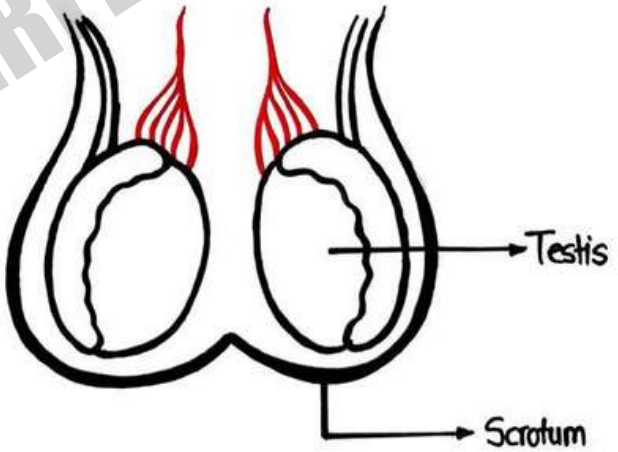
GONADS

- Gonads are Males & Females reproductive glands responsible for producing Gametes (Sperm in Males, Eggs / Ovum in Females) & sex hormones.
- There are different types of Gonads in Males & Females :

① Testes
② Ovaries

TESTES

- Testes are Male reproductive Glands responsible for producing sperm & testosterone.
- They are present in a pair in the scrotum outside the body to maintain a cooler temperature for optimal sperm production.



PROSTAGLANDINS

- They act as lipid s local hormones and are lipid substances .
- They have various physiological effects as follows :
  - Inflammatory Response
  - Potentiating Pain
  - Fever
  - Blood Pressure Regulation
  - Blood Clotting
  - Uterus Contraction

GIASTROINTESTINAL HORMONES

- Several local hormones including Gastrin , secretin , cholecystokinin (CCK) influences secretion of digestive juices .

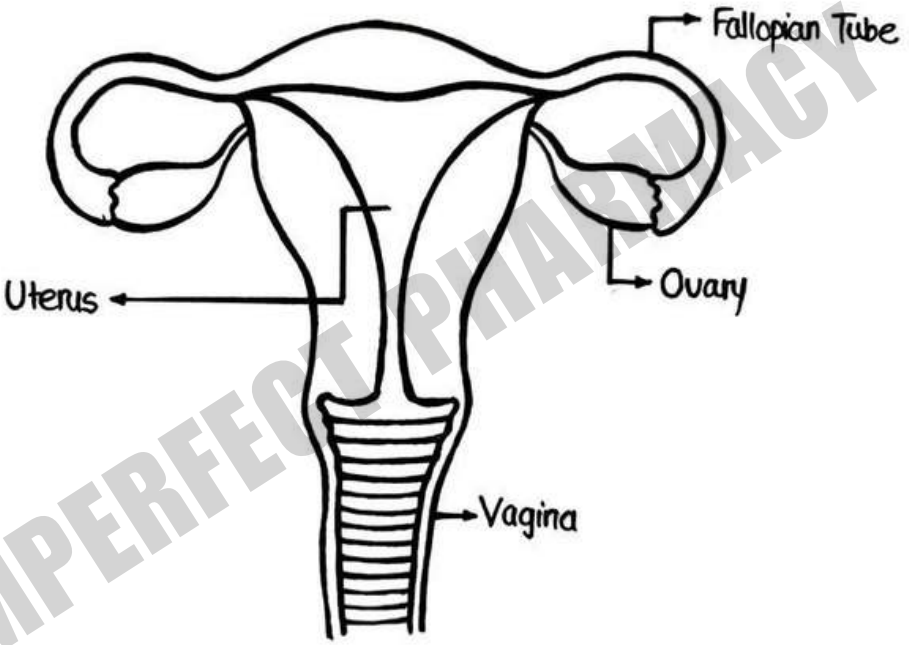
TESTOSTERONE

- Testosterone is the major male sex hormone secreted by Testes.
- Testosterone stimulates the production of sperm cells in testes through a process called Spermatogenesis.
- It plays a crucial role in development and maturation of Male Reproductive Organs, including testes & prostate gland.
- Testosterone plays a significant role in regulating sexual desires.
- It also helps to maintain bone density & strength.
- Testosterone is an anabolic hormone, promotes muscle growth & strength.
- Testosterone is also responsible for development & maintainance of secondary sexual characteristics in Males such as:

- Facial & Body hair growth
- Pubic Hairs
- Excessive Sweat Production
- Pimples
- Aggressive Behaviour
- Deepening of Voice
- Penis Erection etc.

OVARIES

- Ovaries are female reproductive glands responsible for producing eggs (ova) and releasing hormones like Estrogen & Progesterone.
- They are present in a pair in Females.
- They are crucial for fertility & regulating Menstrual Cycle.
- They present inside the female body.



PROGESTERONE

- It is also known as Pregnancy Maintaining Hormone.
- It prepares the uterus for pregnancy by thickening its lining.
- It is produced by corpus luteum in the ovaries.
- It also helps to regulate mood & promotes bone health.

ESTROGEN

- Estrogen (Oestrogen) is the major female sex hormone responsible for various primary & secondary sexual characteristics in females.
- It helps to regulate Menstrual Cycle.
- It is essential for growth & maintainance of reproductive tissues such as vagina, uterus.
- Estrogen levels rise significantly during pregnancy to support fetal develop.
- It is responsible for various secondary sexual characteristics in females as follows :

- High Pich Voice
- Pimple
- Pelvic Girdle broadening
- Breast Development
- Mammary Glands Development
- Pubic Hairs
- Thickening of Uterus Lining

LOCAL HORMONES

- A number of body tissues not normally described as Endocrine Glands secretes substances that act locally
- Some of them are described as follows :

HISTAMINE

- Histamine is synthesized by mast cells in tissues & basophills in blood.
- It released as part of inflammatory process.
- It increases capillary permeability & dilation.
- It also causes broncho constriction
- It stimulates the secretion of gastric juice.

SEROTONIN

- It is present in platelets, brain & intestinal wall.
- It helps in mood regulation
- It causes smooth muscle contraction.
- It also plays role in Homeostasis

ERYTHROPOIETIN

- This hormone is synthesized by kidneys.
- It increases the process of Erythropoiesis.

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