

07

Chemical Coordination and Integration

01. INTRODUCTION

- The neural system and the endocrine system jointly co-ordinate and regulate the physiological functions in the body.
- The neural co-ordination is fast, very exact and short lived, whereas chemical co-ordination is usually slow, widespread and long lasting.
- All cells of our body are not innervated by nerve fibres but the cellular function need to be continuously regulated, so a special kind of coordination and integration has to be provided. This function is carried out by hormones.

NCERT Question :

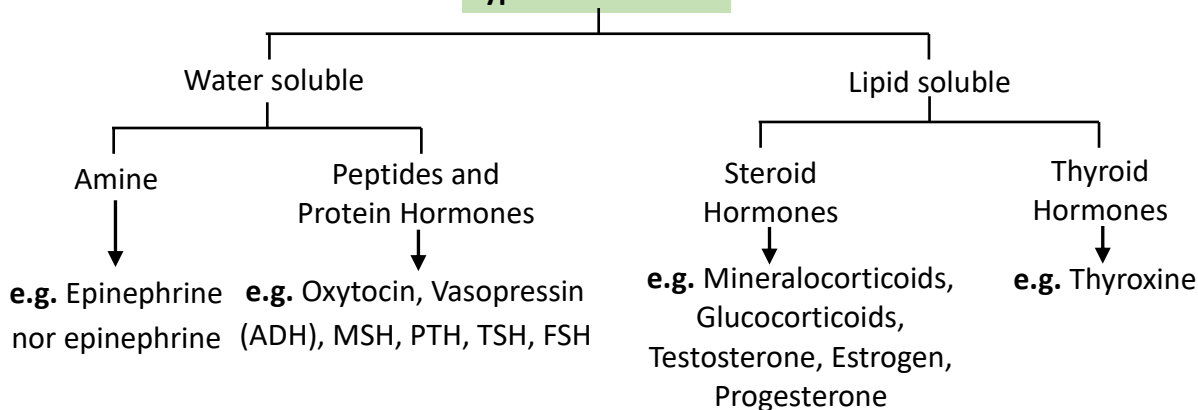
Define Hormone.

02. ENDOCRINE GLANDS AND HORMONES

- Endocrine glands lack ducts and are hence, called **ductless glands**. Their secretions are called **hormones**.
- **Classical definition of hormone** – A chemical produced by endocrine glands which is released into the blood and transported to a distantly located **target organ**.
- **Current scientific definition of hormones** – **Non-nutrient chemicals** which act as **intercellular messengers** and are produced in **trace amounts**.
- The new definition covers a number of new molecules in addition to the hormones secreted by the organised endocrine glands.
- **Invertebrates** possess very simple endocrine systems with few hormones whereas a large number of chemicals act as hormones and provide coordination in the **vertebrates**.

CHEMICAL NATURE OF HORMONES :

Types of Hormones



Human Endocrine System :

- The endocrine glands and hormone producing diffused tissues/cells located in different parts of our body constitute the endocrine system. A brief account of the structure and functions of all major endocrine glands and hypothalamus of the human body is given in the following sections.

Organised endocrine gland : where hormone producing cells are present in cluster/tissue form called organised endocrine gland.

Examples : Pituitary, Pancreas, Parathyroid, Pineal, Thyroid, Thymus, Adrenal and Gonads (Testis in males and Ovary in females)

Non-organised endocrine gland : where hormone producing cells are present in scattered form called non-organised or diffused endocrine tissue.

Example : Heart, Liver, Kidney, Gastrointestinal tract

NCERT Question :

Define the following :-

- (a) Exocrine gland (b) Endocrine gland

Ans.

- (a) These glands secrete substances through ducts. For example Sweat gland, Salivary gland, Sebaceous gland.
- (b) These glands secrete hormones and lack ducts. For example Thyroid gland, Pituitary gland.

03. MECHANISM OF HORMONE ACTION

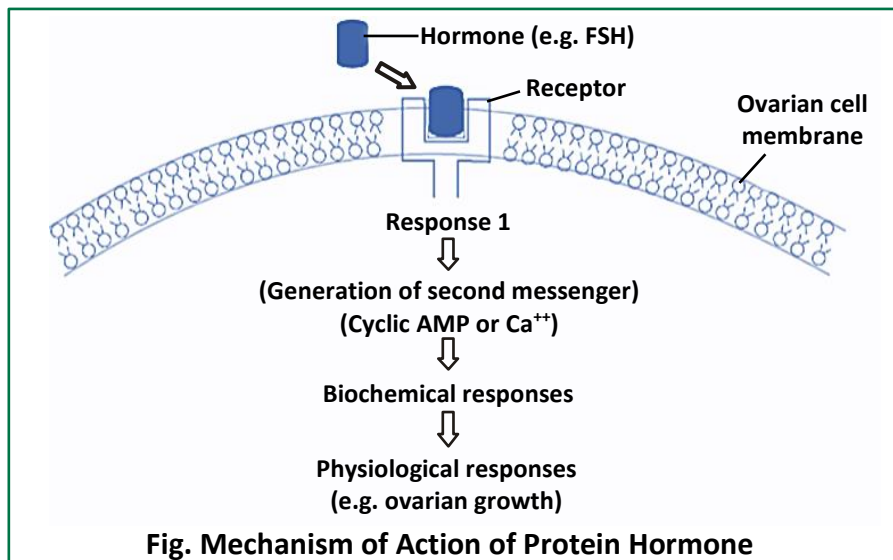
- Hormones are of two types :
(i) Water soluble hormones, (ii) Lipid soluble hormones
- Hormones produce their effects on target tissues by binding to specific proteins called **hormone receptors** located in the target tissues only.
- Hormone receptors present **on the cell membrane** of the target cells are called **membrane-bound receptors** and the receptors present **inside the target cell** are called **intracellular receptors**, Mostly nuclear receptors (present in the nucleus). Binding of a hormone to its receptor leads to the formation of a **hormone-receptor complex**.
- Each receptor is specific to one hormone only and hence **receptors are specific**.
- Hormone-Receptor complex formation leads to certain biochemical changes in the target tissue. Target tissue metabolism and hence physiological function are regulated by hormones.

NCERT Question :

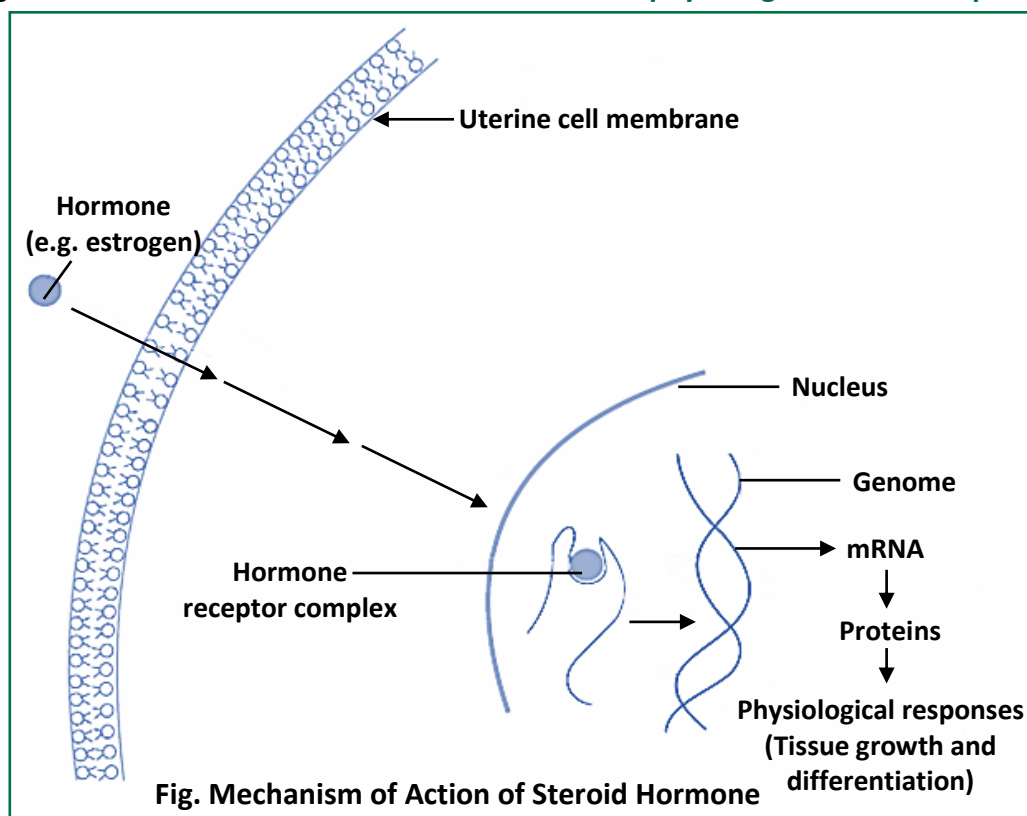
Briefly mention the mechanism of action of FSH.

(A) WATER SOLUBLE HORMONES :

Hormones which interact with membrane-bound receptors normally do not enter the target cell, but generate secondary messengers (e.g. cyclic GMP / cyclic AMP, IP_3 , Ca^{++} etc.) which in turn regulate cellular metabolism.

**(B) LIPID SOLUBLE HORMONE :**

Hormone which interact with intracellular receptors (Steroid, iodothyronines) mostly **regulate gene expression** or chromosome function by the interaction of hormone receptor complex with the genome. **Cumulative biochemical action results in physiological and developmental effects.**



On the basis of their chemical nature, hormones can be divided into groups :

- (i) **Peptide, polypeptide, protein hormones** (e.g., insulin, glucagon, pituitary hormones, hypothalamic hormones, etc.)
- (ii) **Steroids** (e.g., cortisol, testosterone, estradiol and progesterone)
- (iii) **Iodothyronines** (thyroid hormones)
- (iv) **Amino-acid derivatives** (e.g., epinephrine).



BEGINNER'S BOX-1

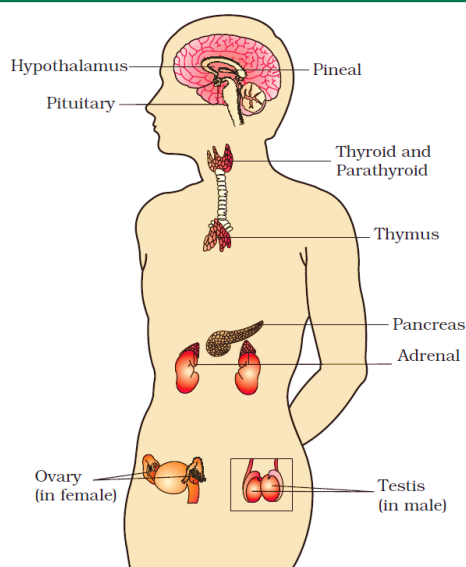
MECHANISM OF HORMONE ACTION

- Following are the examples of organised gland except :
 (1) Pituitary (2) Pineal (3) Thyroid (4) Kidney **BCI288**
- Which of the following characteristics is not mentioned in current scientific definition of hormone?
 (1) Non-antigenic substance (2) Non-nutrient chemical
 (3) Act as intercellular messenger (4) Produced in trace amount **BCI289**
- Following are the hormones which binds with membrane bounded receptor except one :
 (1) Insulin (2) Thyrocalcitonin (3) Oxytocin (4) Progesterone **BCI290**
- Which of the following hormone does not bind with cytoplasmic or nuclear receptor?
 (1) Cortisol (2) Aldosterone (3) Insulin (4) Oestrogen **BCI291**
- Body co-ordination is exhibited by :
 (1) Blood vascular system (2) Nervous system
 (3) Endocrine system (4) Nervous and endocrine system **BCI292**
- Hormones may be :
 (1) Amino acid derivatives (2) Peptides
 (3) Steroids (4) All of the above **BCI293**
- Endocrine glands produce or action of endocrine glands is mediated through :
 (1) Hormones (2) Enzymes (3) Minerals (4) Vitamins **BCI294**

NCERT Question :

Diagrammatically indicate the location of the various endocrine glands in our body.

Ans.



04. HYPOTHALAMUS

- The hypothalamus is the basal part of **diencephalon** (forebrain) and it regulates a wide spectrum of body functions.
- It contains several groups of **neurosecretory cells** called **nuclei** which produce hormones known as neurohormones. These hormones regulate the synthesis and secretion of pituitary hormones.

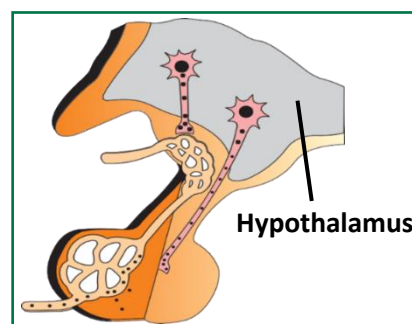
NCERT Question :

List the hormones secreted by hypothalamus.

- However, the hormones produced by hypothalamus are of two types, the **releasing hormones** (which stimulate the secretion of pituitary hormones) and the **inhibiting hormones** (which inhibit the secretions of pituitary hormones).

For example :

- A hypothalamic hormone called **Gonadotrophin releasing hormone (GnRH)** stimulates the pituitary to synthesize and release of gonadotrophins.
- On the other hand, **somatostatin** from the hypothalamus, inhibits the release of growth hormone from the pituitary.
- These hormones originating in the hypothalamic neurons, pass through axons and are released from their nerve endings.
- These hormones reach the pituitary gland through a portal circulatory system and regulate the functions of the anterior pituitary.
- The posterior pituitary is under the **direct neural regulation** of the hypothalamus.

**NCERT Question :**

Fill in the blank.

Hormones Target gland.

Hypothalamic _____

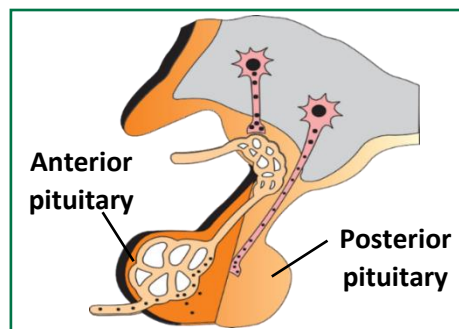
Hormone

Ans. Pituitary gland

05. PITUITARY GLAND

- On the basis of development, pituitary gland is completely ectodermal.
- It is located in the sella tursica (bony cavity) of sphenoid bone.
- This gland is **attached to the hypothalamus** through a stalk which is called as **infundibulum**.
- It is **divided anatomically** into an adenohypophysis (anterior pituitary) and a neurohypophysis (posterior pituitary).

- **Adenohypophysis** consists of two portions, pars distalis and pars intermedia.
- The **pars distalis** region of pituitary, commonly called anterior pituitary, produces Growth hormone (GH), Prolactin (PRL), Thyroid stimulating hormone (TSH), Adrenocorticotrophic hormone (ACTH), Luteinizing hormone (LH) and Follicle stimulating hormone (FSH).
- **Pars intermedia** secretes only one hormone called melanocyte stimulating hormone (MSH). However, in humans, the pars intermedia is almost merged with pars distalis.
- **Neurohypophysis** (pars nervosa) also known as posterior pituitary, stores and releases two hormones called oxytocin and vasopressin, **which are actually synthesised by the hypothalamus** and are transported axonally to neurohypophysis.



Posterior Lobe or Neurohypophysis :

- Posterior lobe of pituitary gland is $\frac{1}{4}$ th part of total gland. It is just like nervous tissue, because in it, the terminal ends of the axons of neurosecretory cells of hypothalamus are swollen.

NCERT Question :

List the hormones secreted by Pituitary gland.

(A) HORMONES SECRETED BY NEUROHYPOPHYSIS :

(i) Oxytocin or Pitocin or Birth Hormone :

- Oxytocin acts on the **smooth muscles** (non-striated) of our body and stimulates their contraction.
- This hormone is secreted by pituitary gland of mother at the time of parturition.
- It is the main **parturition hormone**. It stimulates a **vigorous contraction of uterus** at the time of child birth. It stimulates the fast / rapid contractions of smooth muscles of the uterine wall during the last phase of gestation period (pregnancy). Due to these uterine contractions, **labour pains** start just before the child birth.
- It stimulates **milk ejection** from the mammary glands so it is also called **milk let down hormone**.
- Oxytocin hormone contracts the myoepithelial cells present at all the sides of alveoli of mammary glands.
- In female, this hormone is related with emotion. Even thought, cry or sound of baby can bring about release of this hormone in lactating mother.

(ii) ADH or Vasopressin or Pitressin :

- It acts mainly at the kidney and stimulates reabsorption of water and electrolytes by the distal tubules (in DCT and collecting duct of nephrons) and thereby reduces loss of H_2O through urine (**Diuresis**). Hence, it is also called as '**Anti-diuretic hormone (ADH)**'.
- Hyposecretion of ADH causes '**Diabetes insipidus**' (tasteless urine or water drinker's disease), which is characterised by polyuria, diluted urine, dehydration, excessive thirst (polydipsia), low BP (hypotension), etc.
- Intake of coffee, tea and excess alcohol etc. decreases the secretion of ADH.

(B) HORMONES SECRETED BY ADENOHYPOPHYSIS :**(i) Growth Hormone or Somatotrophic Hormone [G.H. or S.T.H] :****Effect on growth—**

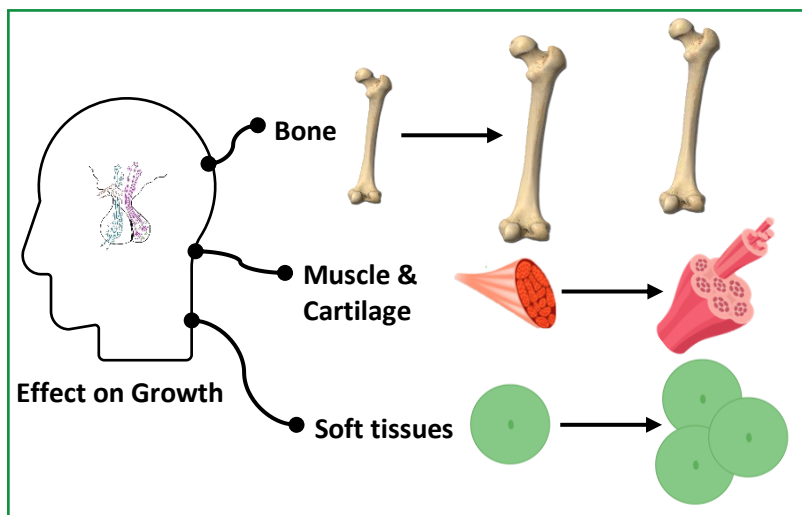
- (a) Promotes elongation of bones
- (b) GH promotes mitosis & increases number of cells in many visceral organs e.g. liver
- (c) GH stimulates growth of muscle and cartilage

Effect on metabolism

Fat : Increases lipolysis. Under the influence of growth hormone fat is used for energy in preference to carbohydrates and proteins.

Carbohydrate : GH decreases uptake of glucose in the cells, so it is also called **diabetogenic hormone**.

Protein : GH increases amino acid uptake by the cells of the liver & muscles & helps in protein synthesis.

**Diseases due to hyposecretion or hypersecretion of Somatotrophic hormone .:****(a) Hyposecretion of STH :**

- Due to deficiency of STH in **childhood** or **adolescence**, **pituitary dwarfism** is observed.
- Clowns of circus are such dwarfs, they are called **midgets**.
- Intelligence and alertness is normal but sexual maturation is delayed.

(b) Hypersecretion of STH :

- (i) Due to hypersecretion of GH in **childhood**, the bones of legs & hands become very long and height of that person increases very much. Body becomes imbalanced. This disease is called **Gigantism**.
- (ii) Excess secretion of growth hormone in **adults** specially in middle age can result in severe disfigurement like excess enlargement of bones of face, vertebral column and fore limbs, called **Acromegaly**, which may lead to serious complications, and premature death if unchecked.

This disease is hard to diagnose in the early stages and often goes undetected for many years, until changes in external features become noticeable.



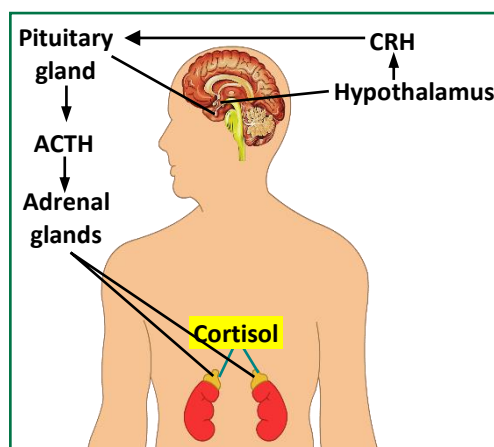
Over secretion of GH = Gigantism = Abnormal growth of body
Low secretion of GH = Pituitary dwarfism = Stunted growth of body

(ii) Prolactin / Lactotrophic Hormone (PRL/LTH) :

- Regulates the **growth of mammary glands** and **formation of milk**.
- Responsible for lactation after delivery.
- **Hormone of maternity**.

(iii) Adrenocorticotrophic Hormone (ACTH) :

- Stimulates the synthesis and secretion of steroid hormones from adrenal cortex. (Mainly Glucocorticoids)

**(iv) Thyrotrophic [T.T.H OR T.S.H.] or Thyroid Stimulating Hormone :**

- T.S.H. stimulates thyroid gland to secrete thyroxine. TSH helps in almost all steps of the thyroid hormone synthesis & it causes growth of thyroid gland.
- Secretion of **TSH** is stimulated by Thyrotrophin releasing factor of hypothalamus.

(v) Follicle Stimulating Hormone [FSH] :

- It is secreted in male and female both.
- In males, it stimulates **spermatogenesis** and normal functioning of seminiferous tubules.
- In females, it stimulates **oogenesis** and development of Graafian follicles in ovary.
- Estrogen hormone that is secreted by Graafian follicles is also affected by FSH.

(vi) Luteinizing Hormone [LH Or ICSH] or Interstitial Cell Stimulating Hormone :

- It stimulates **ovulation** in female. As a result of this corpus luteum is formed.
- Hormone **progesterone** which is secreted by corpus luteum is also stimulated by L.H.
- In men **LH** is called **ICSH**. It affects the Leydig's cells or Interstitial cells of testes and stimulates the secretion of male hormone '**Testosterone**'.
- **FSH** and **LH** both are called **gonadotrophic hormone GTH**.
- FSH and LH act in combined form so these are called **synergistic** hormones.
- Gonadotrophic hormones (FSH & LH) secretion starts during puberty. Their secretion is regulated by hypothalamus.

Melanocyte Stimulating Hormone (MSH) / Intermedin)

HORMONE	TARGET ORGAN	FUNCTIONS
Melanocyte Stimulating hormone (MSH) or (Intermedin)	Skin (In man MSH is secreted by anterior lobe because middle lobe is ill developed)	Regulate pigmentation of skin (Darkening). It is responsible for colour change in Amphibian and Reptiles (Metachrosis). MSH is functional in Poikilothermals. Function in humans is still unknown.

NCERT Question :

Fill in the blanks:

Hormones	Target gland
(a) Thyrotrophin (TSH)	_____
(b) Corticotrophin (ACTH)	_____
(c) Gonadotrophins (LH, FSH)	_____
(d) Melanotrophin (MSH)	_____

Ans. (a) Thyroid gland (b) Adrenal cortex
(c) Testis, Ovaries (d) Pigment cells of the dermis of the skin

**BEGINNER'S BOX-2****PITUITARY & HYPOTHALAMUS**

- Which of the following adenohypophysis hormone have diabetogenic effect?
(1) PRL (2) TSH (3) LH (4) GH **BCI295**
- Abnormal growth of bones due to hypersecretion of growth hormone in adult is known as:
(1) Acromegaly (2) Dwarfism (3) Gigantism (4) Both (1) and (2) **BCI296**
- Which of the following hormone induces ovulation ?
(1) FSH (2) LH (3) Vasopressin (4) Oxytocin **BCI297**

4. Hypophyseal hormone that stimulates reabsorption of water and electrolyte by the distal tubules of kidneys is:
 (1) Oxytocin (2) Aldosterone (3) Cortisol (4) Vasopressin **BCI298**
5. The hyposecretion of posterior pituitary hormone cause :
 (1) Cretinism (2) Diabetes insipidus
 (3) Goitre (4) Diabetes mellitus **BCI299**
6. Neurohypophysis releases :
 (1) Vasopressin (2) Oxytocin
 (3) Oxytocin & prolactin (4) Vasopressin & oxytocin **BCI300**
7. 'Sella tursica' is a :
 (1) Depression in skull enclosing pituitary
 (2) Cavity of skull enclosing ears
 (3) Covering of testis
 (4) Kind of endocrine gland **BCI301**
8. Growth hormone is produced in which gland:
 (1) Adrenal (2) Thyroid (3) Pituitary (4) Thymus **BCI302**
9. MSH produced by the pars intermedia of pituitary causes in lower vertebrates :
 (1) Darkening of skin (2) Light coloration of skin
 (3) Both (4) None of these **BCI303**

06. THYROID GLAND

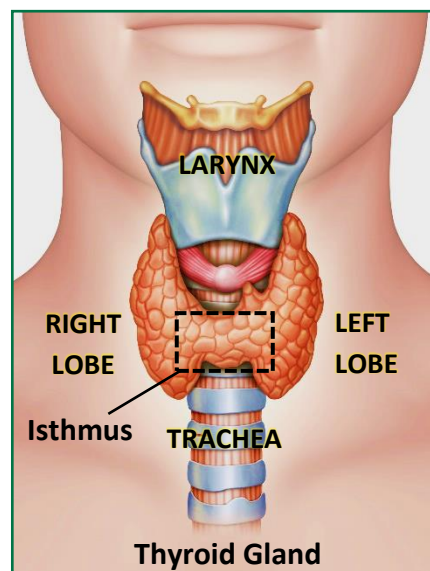
- The thyroid gland is composed of two lobes which are located on either side of the trachea.
- Both the lobes are interconnected with a thin flap of connective tissue called **isthmus** (non-glandular part).

Origin : Endodermal

Position : Located in the neck between the trachea and larynx.

Structure : 'H' shape, Largest Endocrine gland.

- The thyroid gland is composed of **follicles** and **stromal tissues**.

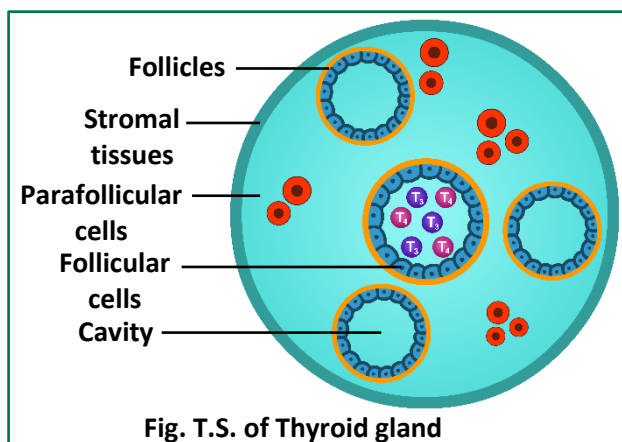


NCERT Question :

List of hormones secreted by the thyroid gland.

- Each thyroid follicle is composed of follicular cells, enclosing a cavity. These follicular cells synthesise two hormones, **tetraiodothyronine** or **thyroxine** (T_4) and **triiodothyronine** (T_3).

- Thyroid is the **only endocrine gland** in the body which stores its hormone (for 2-3 months) in its inactive state. Synthesis of Thyroxine is stimulated by TSH.
- Thyroglobulin is the stored form of Thyroid hormones in the follicles of thyroid gland sufficient for body supply of thyroxine for the next 3 months.
- Iodine is essential for the normal rate of hormone synthesis in the thyroid.
- Thyroid gland requires approximately '**120 μg ' iodine per day** for the production of thyroxine.
- Minimum intake** of iodine is **200 $\mu\text{g/day}$** .
- If iodine intake is **< 50 $\mu\text{g/day}$** , then **thyroid disorders** may develop.

**NCERT Question :**

Write short notes on the functions of the Thyroid hormones.

(A) FUNCTION OF THYROID HORMONE :

- Regulates basal metabolic rate (**BMR**) of the body. (**Calorigenic Hormone**)
- Supports the process of **red blood cell formation**. (**Erythropoiesis**)
- Thyroid hormones control the metabolism of carbohydrates, proteins and fats.
- Maintenance of **water and electrolyte balance** is also influenced by thyroid hormones.
- It is responsible for physical, mental and sexual growth.
- Required for the development of the nerve fibres and their myelination.
- It stimulates the **metamorphosis of tadpole larva** in amphibians. Due to its deficiency, larva does not metamorphose into adult.

(B) THYROID DISORDERS :**Hyposecretion of Thyroid or Hypothyroidism :****NCERT Question :**

Which hormonal deficiency is responsible for the following :-

(a) Goitre (b) Cretinism

Ans. (a) Thyroxine (b) Thyroxine

- SIMPLE GOITRE** – Deficiency of Iodine in our diet results in hypothyroidism and **enlargement of the thyroid gland (Simple goitre)**.

- **CRETINISM** – Hypothyroidism **during pregnancy** causes defective development and maturation of the growing baby leading to **stunted growth (cretinism), mental retardation, low intelligence quotient, abnormal skin, deaf-mutism**, etc.

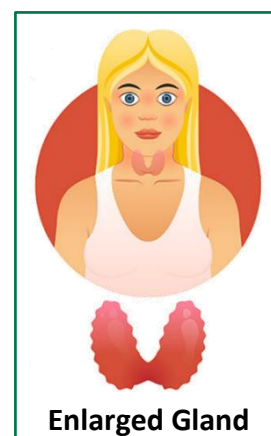


- **MYXOEDEMA** – In **adult women**, hypothyroidism may cause **menstrual cycle to become irregular**. Falling of hair, loose and swollen skin, deposition of adipose fat (puffy appearance) are other symptoms related to it.



Hypersecretion of Thyroid or Hyperthyroidism :

- Due to cancer of the thyroid glands or due to development of nodules the rate of synthesis and secretion of thyroid hormones is increased to abnormal high levels leading to a condition called **hyperthyroidism**.
- **GRAVE'S DISEASE OR EXOPHTHALMIC GOITRE OR BASEDOW'S DISEASE**– Enlargement of thyroid gland, protrusion of eye balls, increased BMR and weight loss is seen.



(C) PARAFOLLICULAR CELLS :

- These cells are found in the **stroma of thyroid** gland & basal part of follicles. These cells are of **endocrine nature**.
- These cells secrete **thyrocalcitonin (TCT) or Calcitonin hormone** which lacks Iodine. It enhances the deposition of Ca^{++} in bones, thus **making bones solid and strong**. This hormone is **antagonistic to Collip's hormone or PTH**. It is a **hypocalcemic hormone & proteinaceous in nature**.
- Thus thyrocalcitonin (TCT) regulates the blood calcium level.

07. PARATHYROID GLAND

Origin : Endodermal

Position : Present on the backside of thyroid gland.

Four in number (One pair each lobe of the thyroid gland).

NCERT Question :

List the hormones secreted by Parathyroid gland.

Ans. Parathormone

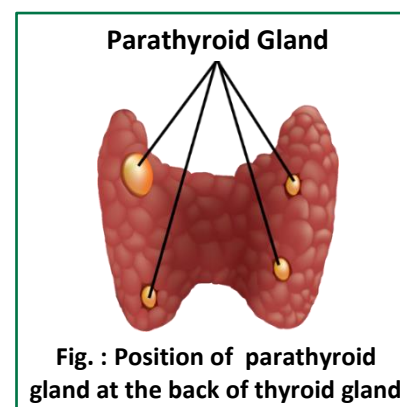
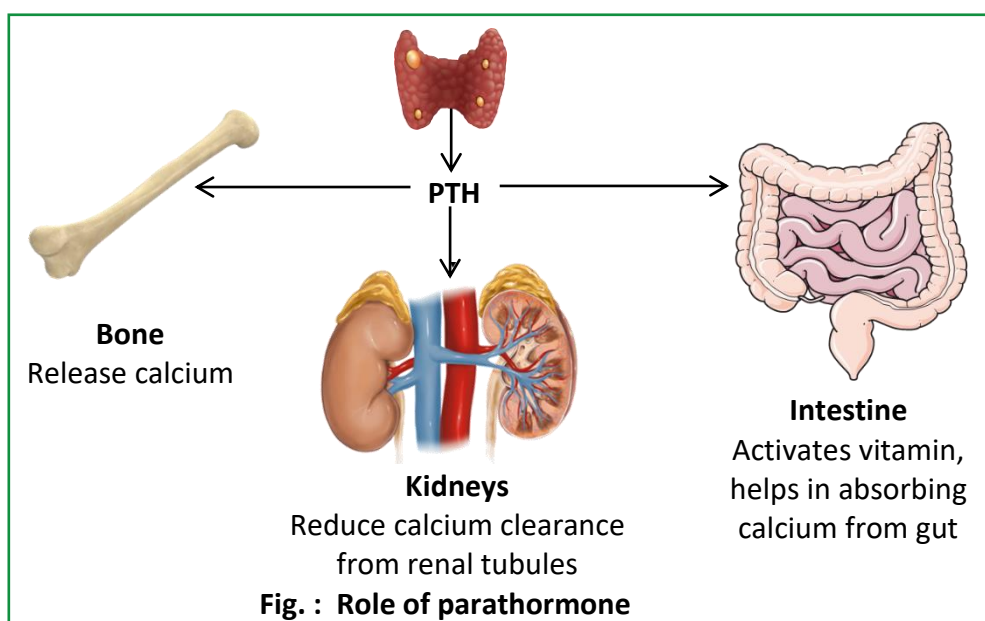


Fig. : Position of parathyroid gland at the back of thyroid gland

- Parathyroid hormone (**PTH**) or Collip's hormone or **parathormone** is secreted by parathyroid gland.
- It is **polypeptide in nature**.
- The secretion of PTH is regulated by the circulating levels of Calcium ions.
 - (i) Increases activity of osteoclast cells and stimulates the process of bone resorption (bone demineralisation / dissolution) of bones.
 - (ii) Also stimulates reabsorption of Ca^{++} by renal tubules.
 - (iii) Increases Ca^{++} absorption from the digested food.
 - (iv) Increases urinary excretion of PO_4^{3-} .

(A) FUNCTIONS OF PARATHYROID GLAND :



- Increase in blood calcium level causes Hypercalcemia
- Decrease in blood phosphate level causes Hypophosphatemia
- Parathyroid hormone (PTH) increases the Ca^{2+} levels in the blood.
- **Parathormone is essential for survival** because it significantly contributes to 'homeostasis' by **regulating the amount of calcium and phosphate ions in the ECF**.
- Calcium is key element in many physiological functions like proper permeability of cell membranes, muscular activities, nerve impulse conduction, heart-beat, blood coagulation, bone formation, fertilisation of ova, etc.
- Along with TCT, it plays a significant role in Calcium balance in the body.

NCERT Question :

Give example of Hypercalcemic hormone.

Ans. Parathyroid hormone

(B) IRREGULARITIES OF PARATHYROID GLAND :

(i) Hypoparathyroidism :

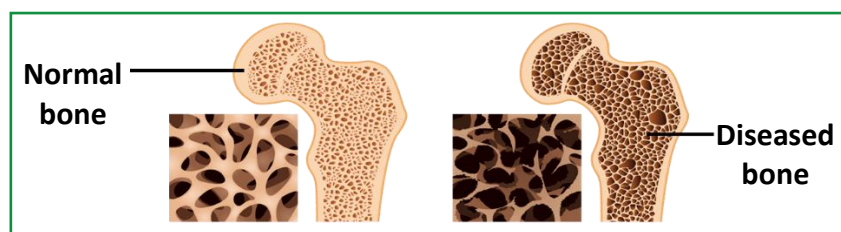
Tetany (Hypocalcaemia)

- Amount of Ca^{2+} in ECF decreases.
- Muscles and nerves get unnecessarily irritated without usual stimulus and start convulsion and cramping.

(ii) Hyperparathyroidism :

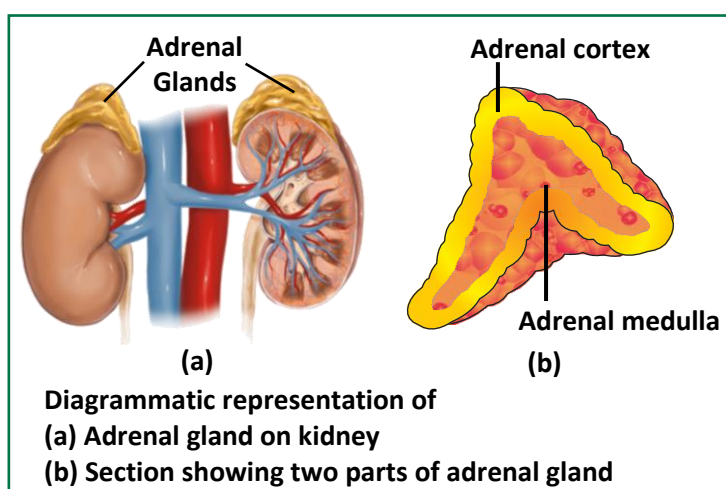
Osteoporosis

- Due to hypersecretion of PTH, osteoclast cells feed excess amount of bone unnecessarily.
- As a result of this, bones become brittle and weak. This condition is called as Osteoporosis.



08. ADRENAL GLAND

- Also called suprarenal glands or glands of emergency.
- Our body has one pair of adrenal glands, one at the anterior part of each kidney.
- The gland is composed of two types of tissues –
 - (i) The centrally located tissue is called the **adrenal medulla**
 - (ii) Outside this lies the **adrenal cortex**



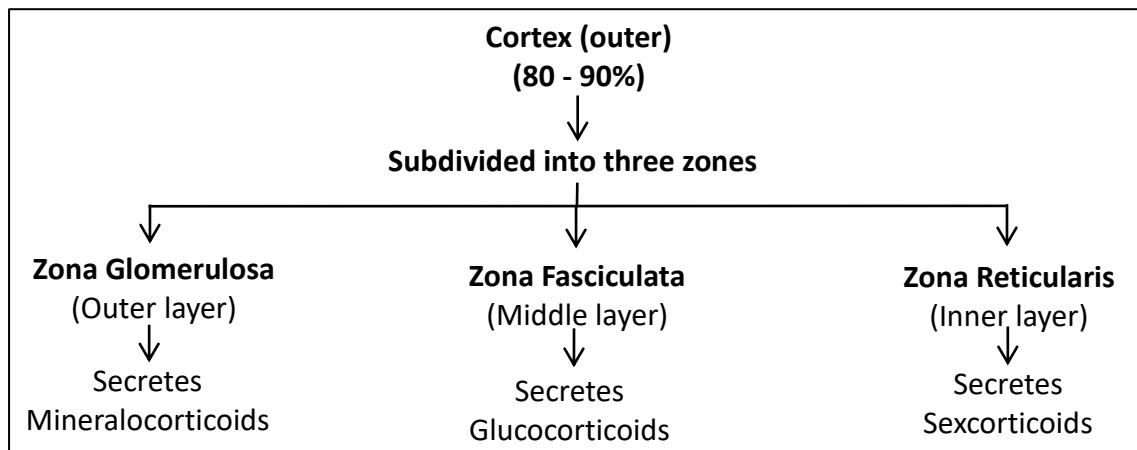
- Adrenal Gland divided into 2 parts :
 - (i) Outer Cortex (80 - 90%) – Mesodermal in origin
 - (ii) Inner Medulla (10 - 20%) – Ectodermal in origin

NCERT Question :

List the hormones secreted by Adrenal gland.

Ans. Adrenal Cortex → Mineralocorticoids, Glucocorticoids, Sex corticoids

Adrenal Medulla → Adrenaline, Noradrenaline

(A) ADRENAL CORTEX :

- The adrenal cortex secretes many hormones, commonly called as corticoids.
- They are grouped in three major categories, namely mineralocorticoid, glucocorticoid & sex corticoids.

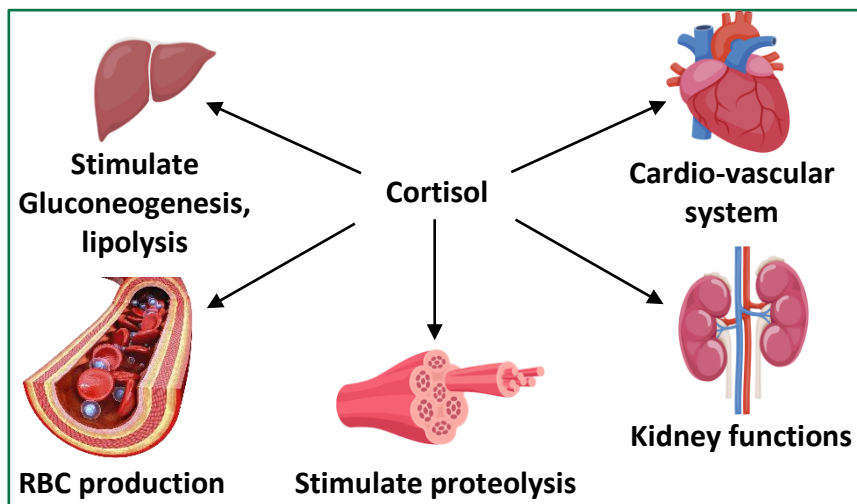
Zona Glomerulosa (Mineralocorticoids) :

- Corticoids, which **regulate the balance of water** and **electrolytes** in our body are called mineralocorticoids. **Aldosterone** is the **main mineralocorticoid** in our body.
- Aldosterone acts mainly at the **renal tubules** and stimulates the reabsorption of Na^+ and water and excretion of K^+ and phosphate ions. Thus, aldosterone helps in the –
 - (i) Maintenance of electrolytes
 - (ii) Maintenance of body fluid volume
 - (iii) Maintenance of osmotic pressure
 - (iv) Maintenance of blood pressure.
- Aldosterone hormone is also known as salt retaining hormone. It increases sodium concentration in ECF.

Zona Fasciculata (Glucocorticoids) :

- Hormone – Glucocorticoids / Cortisol / Hydrocorticosterone / Diabetogenic hormone / Life-saving hormone.
- The corticoids, which are involved in **carbohydrate metabolism** are called **glucocorticoids**. In our body, **cortisol** is the main glucocorticoid.
- Glucocorticoids stimulate gluconeogenesis, lipolysis and proteolysis; and inhibit cellular uptake and utilisation of amino acids.

- Cortisol is also involved in maintaining the cardio-vascular system as well as the kidney functions.
- Glucocorticoids, particularly cortisol, produces anti-inflammatory reactions and suppresses the immune response (Now a days, Cortisol is used in transplantation of organs).
- Cortisol stimulates the RBC production.

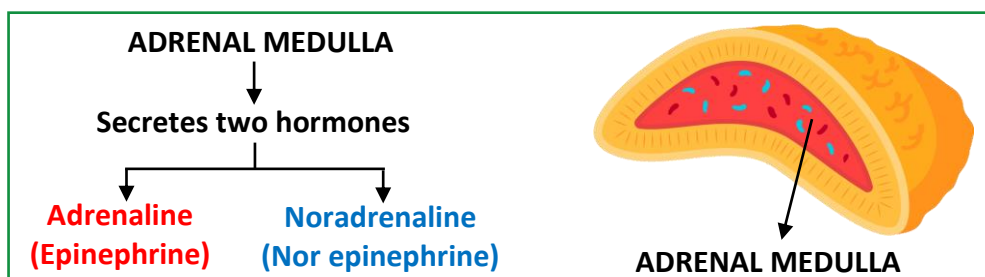


Zona Reticularis (Sex Corticoids) (Sex Hormones) (Gonadocorticoids) :

- **Androgens** in males and **estrogens** in females.
- Small amounts of **androgenic steroids** are also secreted by the adrenal cortex which play a role in the growth of axial hair, pubic hair and facial hair during puberty.
- Both hormones are secreted in both male and female, but hormones secreted by gonads inactivate opposite hormones secreted by Adrenal gland.

(B) ADRENAL MEDULLA :

- Adrenaline & nor-adrenaline are commonly called as Catecholamines.
- These are rapidly secreted in response to stress of any kind and during emergency situations so, called **emergency hormones or hormones of flight and fight**.



Functions of Catecholamines :

- It **increases alertness** and **pupillary dilation**. It also constricts the **errector pilli muscle** of hair, due to this hair are raised (**PILOERECTION**) and **increases sweating** by stimulating sweat glands.
- **Increases the heartbeat**, the **strength of heart contraction** and thus circulation of blood becomes faster.

- The hormone stimulates the trachea and bronchi muscles to relax, as a result of it, **rate of respiration** is **increased**. So, adrenaline hormone is used to cure **asthma**.
- The hormone enhances the flow of blood by vasodilation of blood vessels of brain, heart, liver and skeletal muscles.
- It constricts the blood vessels of skin (Vasoconstriction).
- Adrenal gland is also known as **4 - S gland**

4-S	S –	Sugar metabolism
	S –	Salt retaining actions
	S –	Sex hormones
	S –	Stress reactions

ADRENAL GLAND = 'TRIPLE-F – GLAND'

F = FEAR

F = FLIGHT

F = FIGHT

- It also stimulates the **breakdown of glycogen** resulting in an **increased concentration of glucose in blood**.
- In addition, it also **stimulates the breakdown of lipids and proteins**.
- The hormone **stimulates contraction in spleen**, as a result of it, spleen pours its stored blood into blood stream.
- It checks the secretion of saliva and **reduces the peristaltic movements** in alimentary canal.
- Due to the effect of this hormone, **clotting period of blood is reduced**.

Control of Adrenal Secretion :

- ACTH of anterior pituitary controls the secretion of adrenal cortex (mainly glucocorticoids).
- Secretion of mineralocorticoids is controlled by Renin (Kidney).
- Adrenal medullary hormones are controlled by nervous system.

Disorder related to Adrenal Gland (cortex) (HYPOSECRETION) :

Addison's Disease (Symptoms)

- Underproduction of hormones by adrenal cortex alters carbohydrate metabolism.
- Hyperpigmentation/bronzing of skin.
- Acute weakness.
- Hypoglycaemia.
- Increased susceptibility to stress.

Disorder related to Adrenal Gland (cortex) (HYPERSECRETION) :

- Leads to Cushing's syndrome.
- Over secretion of Cortisol leads to the excess break down of body fat (lipolysis).
- This fat is deposited in unusual body areas like face and upper abdominal region which is characterised by - moon face, fish mouth, buffalo hump.



BEGINNER'S BOX-3

THYROID, PARATHYROID AND ADRENAL GLAND

1. Non iodinised hormone secreted by thyroid gland is :
 (1) T_3 (2) T_4 (3) Calcitonin (4) Oxytocin **BCI304**
2. Largest endocrine gland is:
 (1) Adrenal gland (2) Thyroid gland (3) Thymus (4) Kidney **BCI305**
3. The basal metabolic rate (BMR) in body cells is regulated by:
 (1) Parathyroid (2) Thyroid (3) Pituitary (4) Thymus **BCI306**
4. Hypothyroidism in adults causes:
 (1) Addison's disease (2) Myxoedema (3) Sterility (4) Cretinism **BCI307**
5. Which gland stores hormone in intercellular space before its secretion into blood?
 (1) Pancreas (2) Thyroid (3) Testis (4) Ovary **BCI308**
6. The secretion of PTH in man is regulated by :
 (1) Circulating level of sodium. (2) Circulating level of potassium.
 (3) Circulating level of calcium. (4) Circulating level of magnesium. **BCI309**
7. Removal of Parathyroid in human beings result in :
 (1) Tetany (2) Simmond's disease
 (3) Myxoedema (4) Addison's disease **BCI310**
8. Parathormone controls :
 (1) Fatty acid metabolism
 (2) Sodium and potassium metabolism
 (3) Calcium and phosphate metabolism
 (4) Protein metabolism **BCI311**
9. Deficiency of adrenal cortex hormone may cause :
 (1) Simmond's disease (2) Acromegaly
 (3) Cushing's syndrome (4) Addison's disease **BCI312**
10. Epinephrine is :
 (1) Secreted from pancreas and decreases heart beat.
 (2) Secreted from adrenal medulla and increases heart beat.
 (3) Secreted from adrenal medulla and decreases heart beat.
 (4) Secreted from pancreas and increases heart beat. **BCI313**
11. Hormones produced by adrenal cortex and gonads (sex hormone) are chemically :
 (1) Proteinous (2) Steroids
 (3) Glycoprotein (4) Phenolic compound **BCI314**
12. The function of norepinephrine is :
 (1) Almost similar to epinephrine (2) Similar to ADH
 (3) Opposite to epinephrine (4) Opposite to ADH **BCI315**

09. THYMUS GLAND

Origin :- Endodermal

Position :- The thymus gland is a **lobular structure** (bilobed) located between lungs behind sternum on the ventral side of aorta.

Hormone :- Thymosin

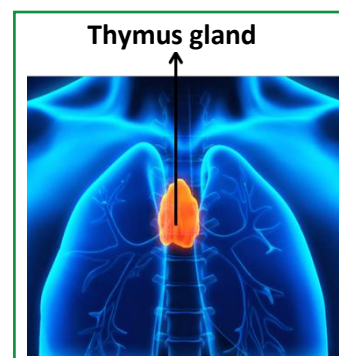
Nature of thymosin :- Proteinaceous.

NCERT Question :

Write short notes on the functions of the Thymosin hormone.

Function of Thymus Gland :

- The thymus plays a **major role in the development of the immune system**.
- This gland secretes the peptide hormones called **thymosins**.
- Thymosins play a major role in the **differentiation of T-lymphocytes**, which provide **cell-mediated immunity**.
- Thymus provide cell mediated immunity so thymus is also called "**Throne of immunity**" and "**Training school of T- lymphocytes**".
- In addition, thymosin also **promote production of antibodies** to provide **humoral immunity**.
- Thymus is **degenerated in old individuals** resulting in a decreased production of thymosins. As a result, the immune **responses of old persons become weak**.

**10. PINEAL GLAND**

Origin :- Ectodermal

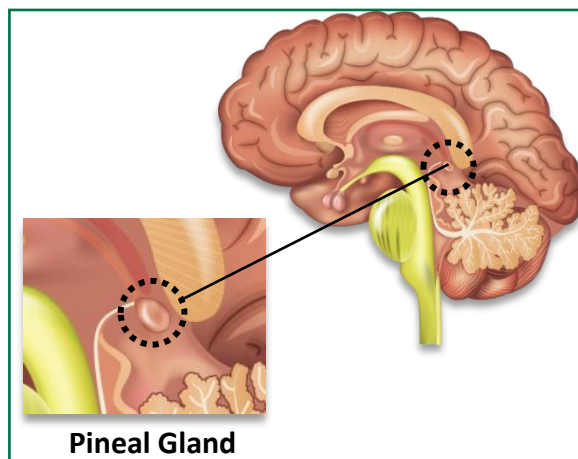
Position :- It is located at the dorsal side of forebrain (Dorsal side of Diencephalon). **Also known as Epiphysis cerebri.**

Nature of hormone :- Amino acid derivative

Hormone secreted :- Melatonin

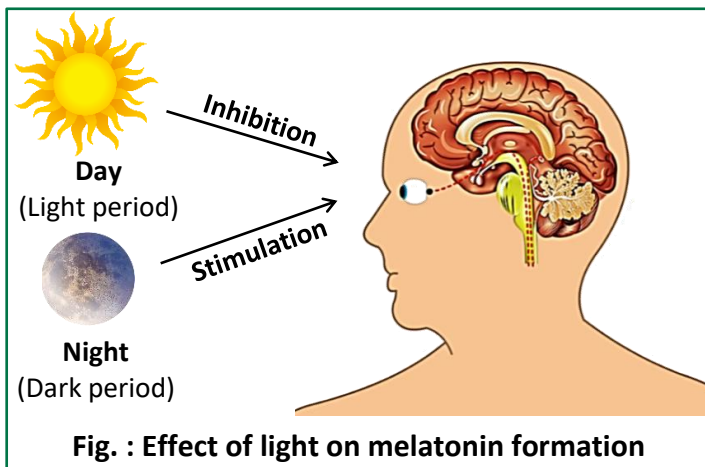
Light reduces melatonin formation.

It has its maximum concentration at mid night & minimum during noon.



Function of Pineal Gland :

- Melatonin plays a very important role in the **regulation of a 24-hour (diurnal/circadian) rhythm of our body.**
- For example, it **helps in** maintaining the normal rhythms of **sleep-wake cycle, body temperature.**
- Melatonin also **influences metabolism, pigmentation, menstrual cycle** and our **defense capability.**
- It **regulates** our **sexual maturity.**

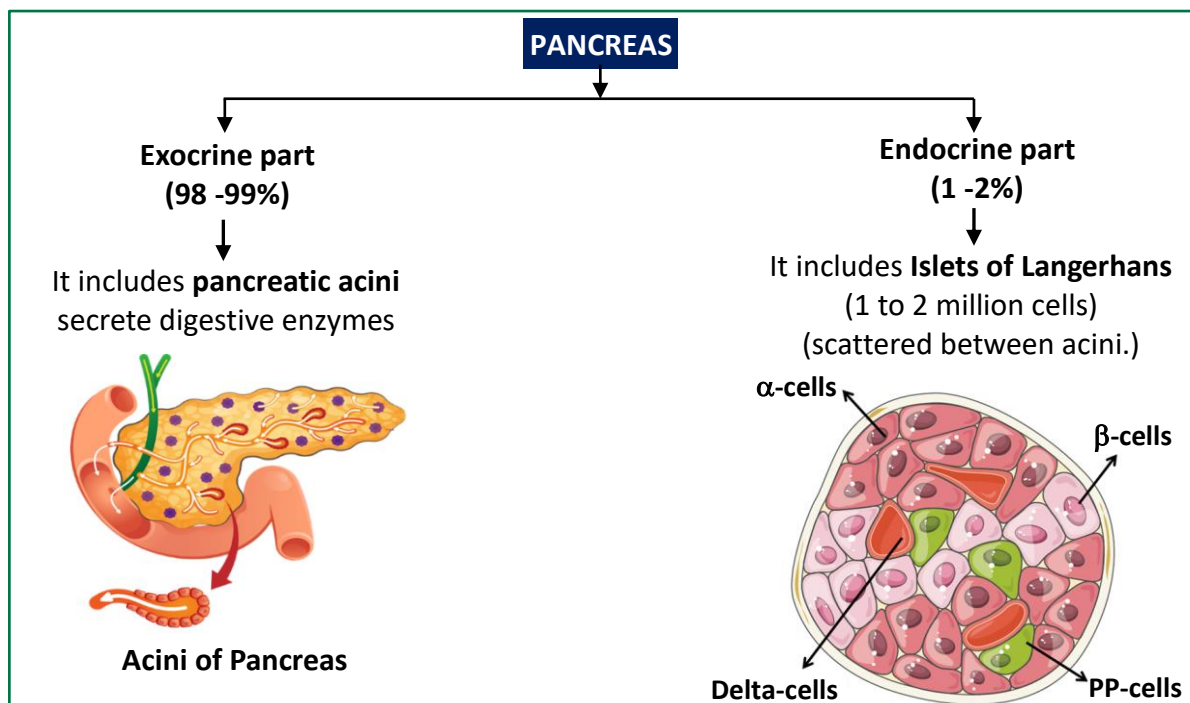
**11. PANCREAS**

Origin : Endodermal

Position : Elongated organ situated between the limbs of the 'C' shaped duodenum.

Nature : Heterocrine / Mixed / Composite gland / Compound (both exocrine and endocrine).

- The exocrine portion secretes an alkaline pancreatic juice containing enzymes and the endocrine portion secretes hormones, insulin and glucagon.

**NCERT Question :**

List the hormones secreted by Pancreas.

Ans. Glucagon, Insulin, Somatostatin

- The two main types of cells in the Islet of Langerhans are called α -cells and β -cells.

NCERT Question :

Write short notes on the functions of the Insulin and Glucagon hormones.

(i) α -cells :

- Secrete **glucagon**.
- It is a **peptide hormone**.
- Plays an important role in **maintaining the normal blood glucose levels**.
- Acts mainly on the **liver cells** (hepatocytes).
- Stimulates **glycogenolysis** resulting in an increased blood sugar (hyperglycemia).
- In addition, this hormone stimulates the process of **gluconeogenesis** which also contributes to **hyperglycemia**.
- Glucagon **reduces the cellular glucose uptake** and utilisation. Thus, glucagon is a **hyperglycemic hormone**.

(ii) β -cells :

- Secrete **insulin**.
- Insulin is a **peptide hormone**, which plays a major role in the **regulation of glucose homeostasis**.
- Insulin acts mainly on **hepatocytes** and **adipocytes** (cells of adipose tissue), and enhances cellular glucose uptake and utilisation. As a result, there is a rapid movement of glucose from blood to hepatocytes and adipocytes resulting in decreased blood glucose levels (**hypoglycemia**).
- Insulin also stimulates **conversion of glucose to glycogen (glycogenesis)** in the target cells.
- **The glucose homeostasis in blood is thus maintained jointly by the two – insulin and glucagon.**

Hyposecretion of Insulin :**NCERT Question :**

Which hormonal deficiency is responsible for Diabetes mellitus.

Ans. Insulin

Diabetes mellitus –

- **Prolonged hyperglycemia** (Increased level of glucose in blood > 180 mg/dl) leads to a complex disorder called **diabetes mellitus** which is associated with loss of glucose through urine and formation of harmful compounds known as ketone bodies.
- Diabetic patients are successfully treated with **insulin therapy**.

- Three hallmark symptoms of diabetes mellitus –
 - (i) **Polyuria** (Excessive urination)
 - (ii) **Polydipsia** (Excessive thirst)
 - (iii) **Polyphagia** (Excessive hunger)
- Other symptoms include – Dehydration, Loss of weight and tiredness.
- Due to active and incomplete decomposition of fats in fatty tissues, ketone bodies are formed which leads to **ketoacidosis**.
- The combined effect of Ketoacidosis, Dehydration and Hyperglycemia may cause **Diabetic Coma** to the patient, patient becomes unconscious and even may die.

Somatostatin :

- Secreted by **δ -cells**
- It **regulates** (inhibits) the **secretion of insulin and glucagon**.

Pancreatic Polypeptide (PP) :

- Secreted by **F-cells / PP-cells**
- Its functions are unknown yet today, perhaps it controls the absorption of food in intestine.

12. GONADS AND OTHER ORGANS**(A) GONADS (IN MALE -TESTIS) :**

- A pair of testis is **present in the scrotal sac (outside abdomen)** of male individuals.
- Testis performs dual functions as a **primary sex organ** as well as **an endocrine gland**.
- Testis is composed of **seminiferous tubules** and **stromal** or **interstitial tissue**.

NCERT Question :

List the hormones secreted by the Testis.

Ans. Testosterone

- The **Leydig cells** or **interstitial cells**, which are present in the intertubular spaces produce a group of hormones called androgens mainly **testosterone**.

NCERT Question :

Write short note on the functions of the Androgens hormones.

- Androgens **regulate the development, maturation and functions of the male accessory sex organs** like epididymis, vas deferens, seminal vesicles, prostate gland, urethra etc.
- These hormones **stimulate muscular growth, growth of facial and axillary hair, aggressiveness, low pitch of voice** etc.

- Androgens play a **major stimulatory role in the process of spermatogenesis** (formation of spermatozoa).
- Androgens **act on the central neural system and influence the male sexual behaviour (libido)**.
- These hormones produce **anabolic (synthetic) effects** on protein and carbohydrate metabolism.

(B) GONADS (IN FEMALE - OVARY) :

- Females have a pair of ovaries **located in the abdomen**.
- Ovary is the **primary female sex organ** which produces one ovum during each menstrual cycle.

NCERT Question :

List the hormones secreted by the Ovary.

Ans. Estrogen and Progesterone.

- In addition, ovary also produces two groups of **steroid hormones** called **estrogen** and **progesterone**.
- Ovary is composed of **ovarian follicles** and **stromal tissues**.
- The estrogen is synthesised and secreted mainly by the growing ovarian follicles. After ovulation, the ruptured follicle is converted to a structure called **corpus luteum**, which secretes mainly progesterone.

NCERT Question :

Write short note on the functions of the Estrogen hormones.

- Estrogens produce wide ranging actions such as stimulation of growth and activities of 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.
- Estrogens also regulate female sexual behavior.
- **Progesterone supports pregnancy.**
- It is secreted by corpus luteum.
- It produces routine temporary changes in the endometrial lining of uterus.
- Progesterone also acts on the mammary glands and stimulates the formation of alveoli (sac-like structures which store milk) and milk secretion.

NCERT Question :

Give example(s) of :-

(a) Gonadotrophic hormones. (b) Progestational hormone.

Ans. (a) FSH, LH (b) Progesterone and Estrogens

(C) HEART :

- 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 reduces the blood pressure.

NCERT Question :

Give example(s) of :-

Blood pressure lowering hormone

Ans. ANF (Atrial Natriuretic Factor)

(D) KIDNEY :

- The **juxtaglomerular cells** of kidney produce a **peptide hormone** called **Erythropoietin** which stimulates **erythropoiesis** (formation of RBC).

(E) GASTRO INTESTINAL TRACT HORMONE :

- Endocrine cells present in different parts of the gastro-intestinal tract secrete four major peptide hormones –
 - (i) **Gastrin**
 - (ii) **Secretin**
 - (iii) **Cholecystokinin (CCK)**
 - (iv) **Gastric inhibitory peptide (GIP)**
- **Gastrin** acts on the gastric glands and stimulates the secretion of hydrochloric acid and pepsinogen.
- **Secretin** acts on the exocrine pancreas and stimulates secretion of water and bicarbonate ions. It is the first hormone discovered by Starling and Bayliss.
- **Cholecystokinin (CCK)** acts on both pancreas and gall bladder and stimulates the secretion of pancreatic enzymes and bile juice, respectively.
- **Gastric inhibitory peptide (GIP)** inhibits gastric secretion and motility.
- It is also known as Entero gastrone.
- Several **other non-endocrine tissues** secrete hormones called **growth factors**. These factors are essential for the **normal growth of tissues** and their **repairing/regeneration**.

NCERT Question :

List the hormones secreted by the following:

- (a) Atrium (b) Kidney (c) G-I Tract

Ans.

- (a) Atrial Natriuretic Factor (ANF)
 (b) Erythropoietin
 (c) Stomach → Gastrin
 Intestine → Secretin, Gastrin, Cholecystokinin.

**BEGINNER'S BOX-4****THYMUS, PINEAL, PANCREAS AND OTHER GLANDS**

- Role of thymus in *Homo sapiens* is chiefly concerned with :

(1) Reproduction	(2) Immunology	
(3) Calcium balance	(4) Blood coagulation	BCI316
- Origin of Thymus Gland is :

(1) Ectoderm	(2) Endoderm	
(3) Mesoderm	(4) None of above	BCI317
- Pineal body originates from :

(1) Dorsal part of diencephalon	(2) Ventral part of diencephalon	
(3) Ventral part of cerebellum	(4) Dorsal part of cerebellum	BCI318
- Melatonin is a hormone produced by :

(1) Adrenal gland	(2) Pituitary gland	
(3) Pineal gland	(4) Thymus gland	BCI319
- Which hormone influences metabolism, pigmentation, menstrual cycle and our defense capability?

(1) Melatonin	(2) Thymosin	
(3) Thyroxine	(4) Epinephrine	BCI320
- Which gland is both exocrine as well as endocrine?

(1) Pituitary	(2) Mammary gland	
(3) Thyroid	(4) Pancreas	BCI321
- Glucagon is secreted by :

(1) Leydig cells	(2) Islets of Langerhans	
(3) Corpus luteum	(4) Glisson's capsule	BCI322
- Insulin by chemical nature is :

(1) Carbohydrate	(2) Protein	(3) Steroid	(4) Lipid	BCI323
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- 9.** Following are the principle action of insulin except :
 (1) Increase transport of Glucose in to the cells
 (2) Stimulate glycogenesis
 (3) Promote Glycogenolysis
 (4) Increase lipogenesis **BCI324**
- 10.** Which hormone has anti insulin effect :
 (1) Cortisol (2) Oxytocin (3) Aldosterone (4) Glucagon **BCI325**
- 11.** Which of the following disease is not caused by hyper/hyposecretion of hormone ?
 (1) IDDM (2) NIDDM (3) Acromegaly (4) Myxoedema **BCI326**
- 12.** Diabetes insipidus is due to :
 (1) Hypersecretion of insulin (2) Hyposecretion of vasopressin
 (3) Hypersecretion of vasopressin (4) Hyposecretion of insulin **BCI327**
- 13.** Estrogen is secreted by :
 (1) Liver (2) Spleen (3) Ovaries (4) Pituitary **BCI328**
- 14.** Androgens are secreted by :
 (1) Pituitary (2) Testes (3) Ovaries (4) Thyroid **BCI329**
- 15.** The "erythropoietin" hormone regulates :
 (1) Blood pressure
 (2) Water level of blood
 (3) Glucose level of blood
 (4) Rate of formation of red blood cells **BCI330**
- 16.** Which of the following hormone is not secreted by gastro-intestinal tract ?
 (1) Gastrin (2) Secretin
 (3) Cholecystokinin (4) Erythropoietin **BCI331**

NCERT Question :

Match the following :-

Column-I

- (a) T₄
 (b) PTH
 (c) GnRH
 (d) LH

Column-II

- (i) Hypothalamus
 (ii) Thyroid
 (iii) Pituitary
 (iv) Parathyroid

Ans. a-ii, b-iv, c-i, d-iii



BEGINNER'S BOX

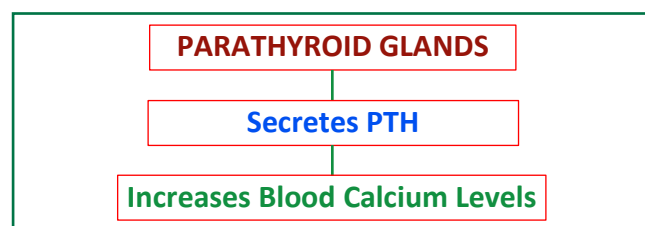
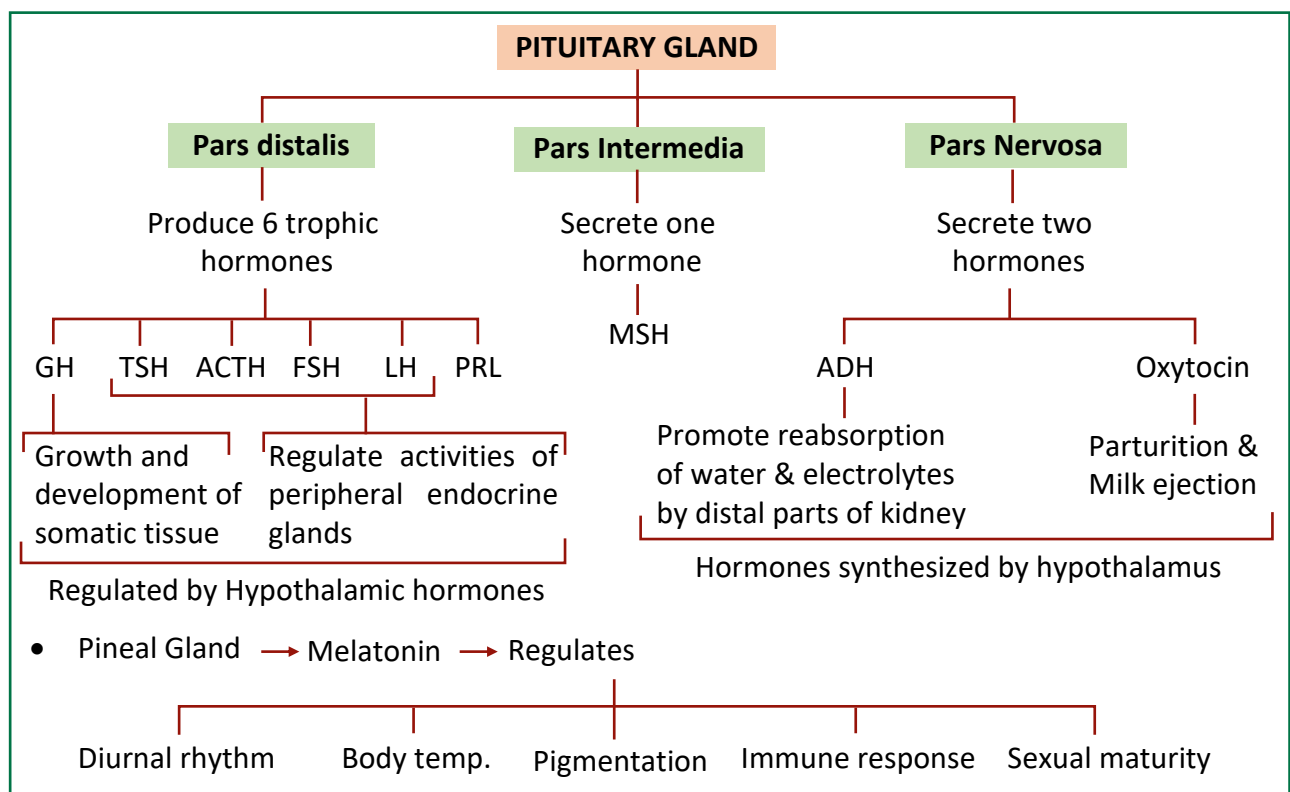
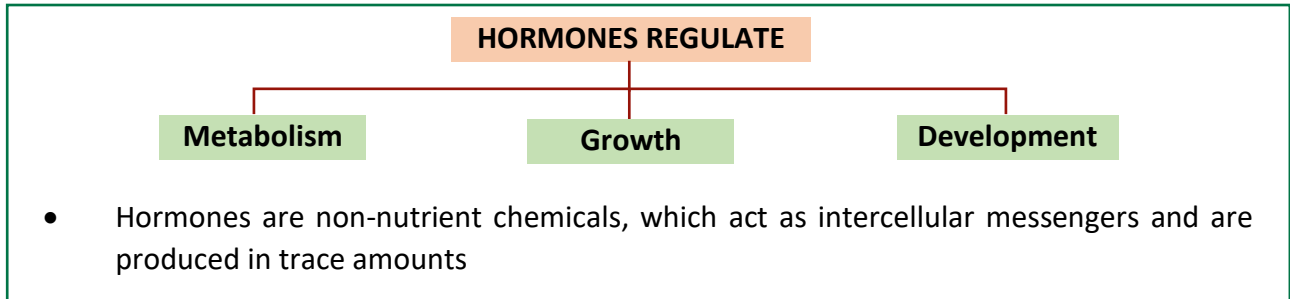
ANSWERS KEY

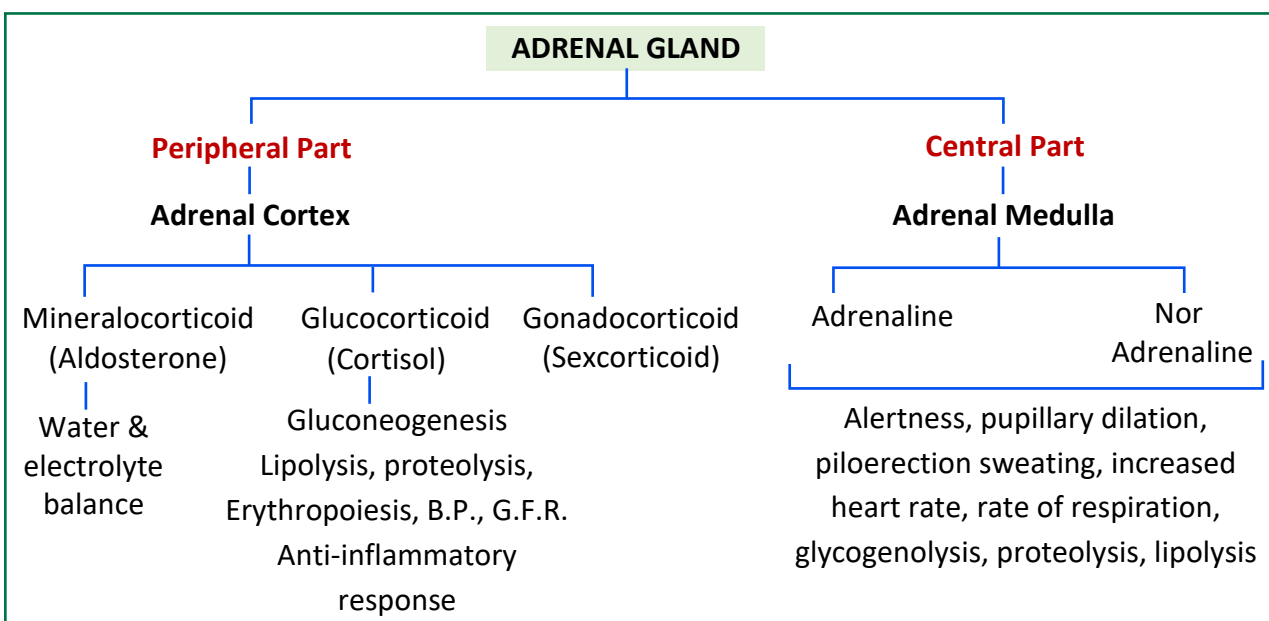
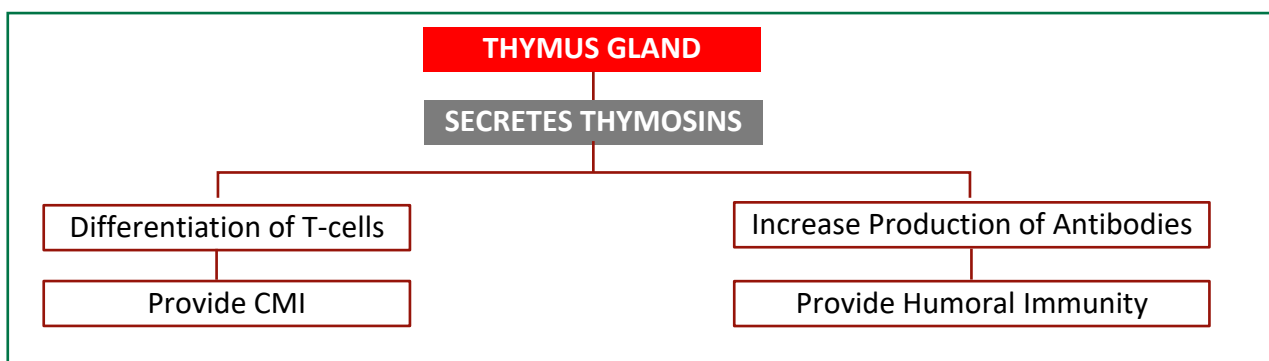
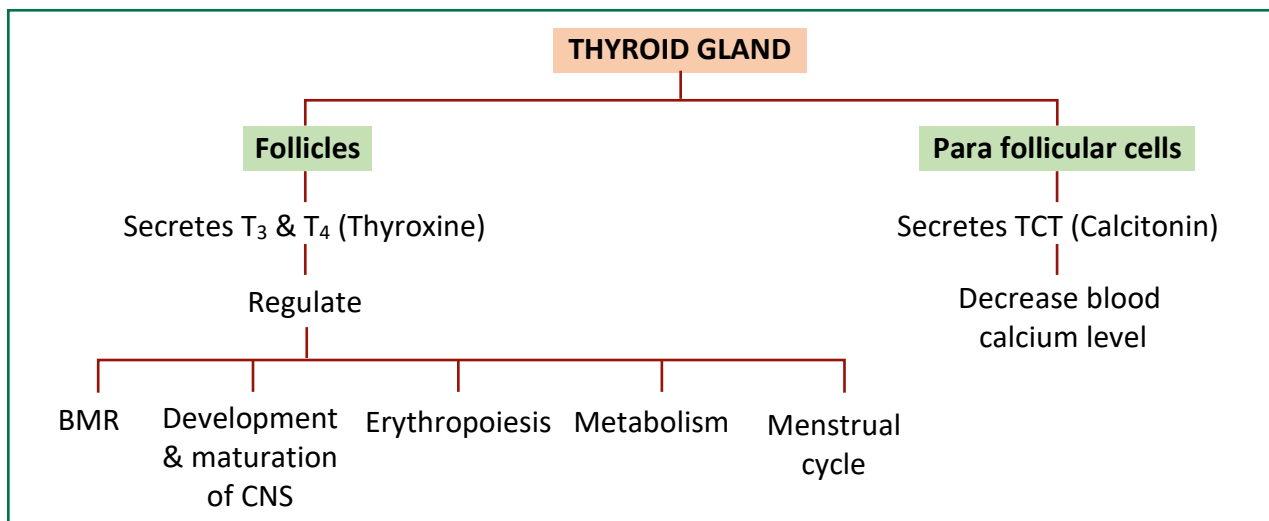
BEGINNER'S BOX-1	Que.	1	2	3	4	5	6	7		
	Ans.	4	1	4	3	4	4	1		

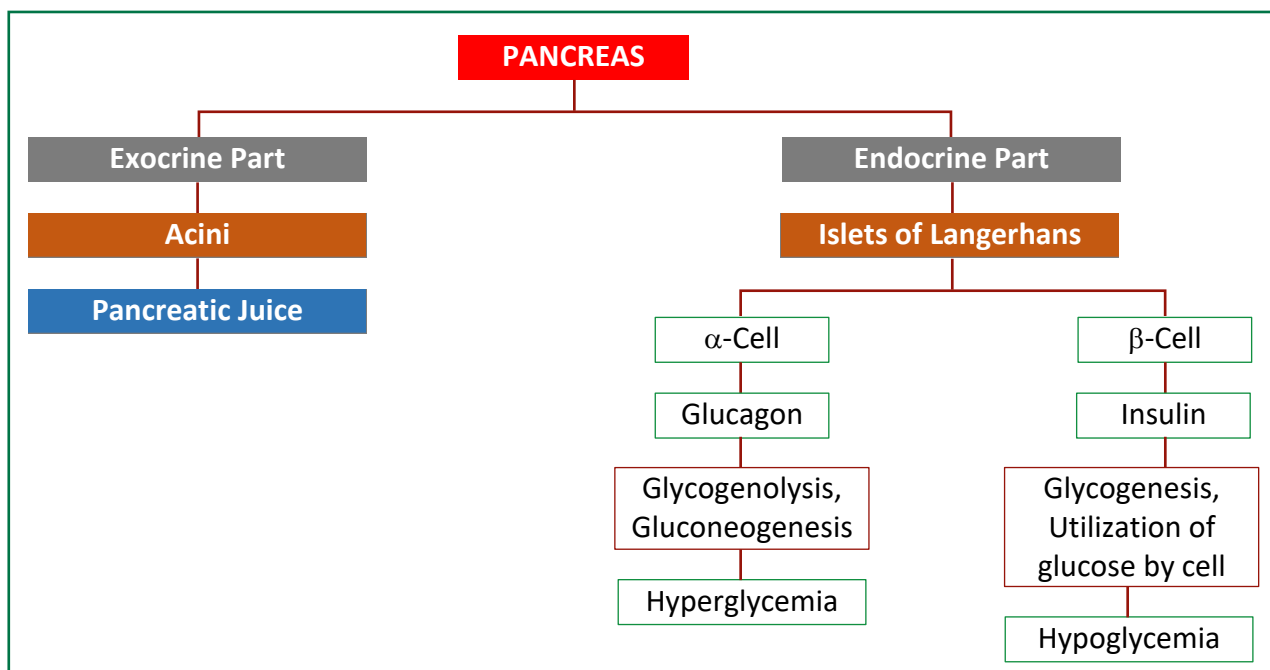
BEGINNER'S BOX-2	Que.	1	2	3	4	5	6	7	8	9	
	Ans.	4	1	2	4	2	4	1	3	1	

BEGINNER'S BOX-3	Que.	1	2	3	4	5	6	7	8	9	10
	Ans.	3	2	2	2	2	3	1	3	4	2
	Que.	11	12								
	Ans.	2	1								

BEGINNER'S BOX-4	Que.	1	2	3	4	5	6	7	8	9	10
	Ans.	2	2	1	3	1	4	2	2	3	4
	Que.	11	12	13	14	15	16				
	Ans.	2	2	3	2	4	4				







- The testis secretes androgens, which stimulate the development, maturation and functions of the male accessory sex organs, appearance of the male secondary sex characters, spermatogenesis, male sexual behaviour, anabolic pathways and erythropoiesis.
- The ovary secretes estrogen and progesterone.
- Estrogen stimulates growth and development of female accessory sex organs and secondary sex characters.
- Progesterone plays a major role in the maintenance of pregnancy as well as in mammary gland development and lactation.
- The atrial wall of the heart produces atrial natriuretic factor which decreases the blood pressure.
- Kidney produces erythropoietin which stimulates erythropoiesis.
- The gastrointestinal tract secretes gastrin, secretin, cholecystokinin and gastric inhibitory peptide.

Disorders :

- | | | |
|----------------------|---|---|
| • Dwarfism | – | Deficiency of GH. |
| • Gigantism | – | Over secretion of GH in growth age. |
| • Acromegaly | – | Over secretion of STH. |
| • Diabetes insipidus | – | Deficiency of ADH. |
| • Cretinism | – | Deficiency of thyroid hormones in embryo / pregnancy. |
| • Myxoedema | – | Deficiency of thyroid hormones in adults. |
| • Simple goitre | – | Deficiency of iodine in diet. |

- | | | |
|-----------------------|---|-------------------------------------|
| • Exophthalmic goitre | – | Over secretion of thyroid hormones. |
| • Tetany | – | Deficiency of PTH |
| • Osteoporosis | – | Over secretion of PTH. |
| • Diabetes mellitus | – | Deficiency of insulin. |
| • Addison's disease | – | Deficiency of corticoids |
| • Cushing's disease | – | Hypersecretion corticoids |

NCERT SUMMARY

There are special chemicals which act as hormones and provide chemical coordination, integration and regulation in the human body. These hormones regulate metabolism, growth and development of our organs, the endocrine glands or certain cells. The endocrine system is composed of hypothalamus, pituitary and pineal, thyroid, adrenal, pancreas, parathyroid, thymus and gonads (testis and ovary). In addition to these, some other organs, e.g., gastrointestinal tract, kidney, heart etc., also produce hormones. The pituitary gland is divided into three major parts, which are called as pars distalis, pars intermedia and pars nervosa. Pars distalis produces six trophic hormones. Pars intermedia secretes only one hormone, while pars nervosa (neurohypophysis) secretes two hormones. The pituitary hormones regulate the growth and development of somatic tissues and activities of peripheral endocrine glands. Pineal gland secretes melatonin, which plays a very important role in the regulation of 24-hour (diurnal) rhythms of our body (e.g., rhythms of sleep and state of being awake, body temperature, etc.). The thyroid gland hormones play an important role in the regulation of the basal metabolic rate, development and maturation of the central neural system, erythropoiesis, metabolism of carbohydrates, proteins and fats, menstrual cycle.

Another thyroid hormone, i.e., thyrocalcitonin regulates calcium levels in our blood by decreasing it. The parathyroid glands secrete parathyroid hormone (PTH) which increases the blood Ca^{2+} levels and plays a major role in calcium homeostasis. The thymus gland secretes thymosins which play a major role in the differentiation of T-lymphocytes, which provide cell-mediated immunity. In addition, thymosins also increase the production of antibodies to provide humoral immunity. The adrenal gland is composed of the centrally located adrenal medulla and the outer adrenal cortex. The adrenal medulla secretes epinephrine and norepinephrine. These hormones increase alertness,

pupillary dilation, piloerection, sweating, heart beat, strength of heart contraction, rate of respiration, glycogenolysis, lipolysis, proteolysis. The adrenal cortex secretes glucocorticoids and mineralocorticoids. Glucocorticoids stimulate gluconeogenesis, lipolysis, proteolysis, erythropoiesis, cardio-vascular system, blood pressure, and glomerular filtration rate and inhibit inflammatory reactions by suppressing the immune response. Mineralocorticoids regulate water and electrolyte contents of the body. The endocrine pancreas secretes glucagon and insulin. Glucagon stimulates glycogenolysis and gluconeogenesis resulting in hyperglycemia. Insulin stimulates cellular glucose uptake and utilisation and glycogenesis resulting in hypoglycemia. Insulin deficiency and/or insulin resistance result in a disease called diabetes mellitus.

The testis secretes androgens, which stimulate the development, maturation and functions of the male accessory sex organs, appearance of the male secondary sex characters, spermatogenesis, male sexual behaviour, anabolic pathways and erythropoiesis. The ovary secretes estrogen and progesterone. Estrogen stimulates growth and development of female accessory sex organs and secondary sex characters. Progesterone plays a major role in the maintenance of pregnancy as well as in mammary gland development and lactation. The atrial wall of the heart produces atrial natriuretic factor which decreases the blood pressure. Kidney produces erythropoietin which stimulates erythropoiesis. The gastrointestinal tract secretes gastrin, secretin, cholecystokinin and gastric inhibitory peptide. These hormones regulate the secretion of digestive juices and help in digestion.