

# 19

## Chemical Coordination and Integration



*The effect of hormones released from the endocrine system can be seen in everyday life. For example, testosterone levels are higher in winners and lower in losers of regional chess tournaments. Testosterone levels are affected not only in humans engaged in physical combat but also in those engaged in simulated combat.*

### Topic Notes

- Endocrine Glands and Hormones

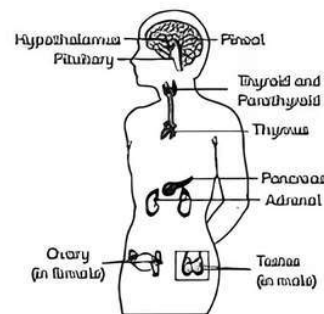
# ENDOCRINE GLANDS AND HORMONES

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## TOPIC 1

### HUMAN ENDOCRINE SYSTEM

The endocrine system is made up of endocrine glands and hormone-producing dispersed tissues/cells are distributed throughout our bodies. Pituitary, pineal, thyroid, adrenal, pancreas, parathyroid, thymus and gonads (testes in males and ovaries in females) are the organised endocrine structures in our body. Besides these glands, some other organs in our body also produce hormones, e.g., gastrointestinal tract, liver, kidney and heart.



Location of endocrine glands

## TOPIC 2

### ENDOCRINE GLANDS

Endocrine glands are also known as ductless glands since their secretions are released into the bloodstream and transported to their specific target organ to perform a particular function. Its secretions are known as hormones and are defined as a chemical produced by endocrine glands that are released into the bloodstream directly, and then transported to distantly located targeted organs.

Scientific definition of hormones: Hormones are non-nutrient chemicals which act as intercellular messengers and are produced in trace amounts. All the endocrine glands coordinate with each other to regulate overall body functions.



#### Important

→ The first hormone was discovered by the English physiologist William M. Bayliss and Ernest H. Starling in 1903. The term was introduced by Starling in 1905.

→ The study of endocrine glands and hormones secreted by them is called endocrinology.

#### Hypothalamus

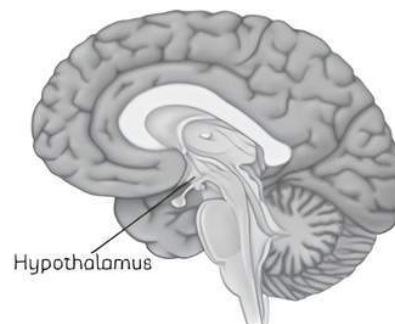
It is the basal part of diencephalon and forebrain. It regulates main functions in our body. It is made up of many groups of neurosecretory cells called nuclei that produce hormones. These hormones regulate synthesis and secretion of the pituitary gland. It produces two types of hormones:

(1) **Releasing hormones (RH):** Stimulates secretion of pituitary hormones.

(2) **Inhibiting hormones (IH):** Inhibits secretion of pituitary hormones.

Examples: Gonadotropin-releasing hormone (GnRH) stimulates the release of gonadotropins from pituitary and Somatostatin inhibits growth hormone released from pituitary.

These hormones enter the pituitary gland via the portal circulatory system and govern the anterior pituitary's activities. The posterior pituitary is directly under the control of hypothalamus.



#### Pituitary Gland

It is situated in a bony cavity of the sphenoid bone of the skull called sella turcica and is attached to the hypothalamus by the stalk. It is divided anatomically into two parts. These two parts have different origins:

## Adenohypophysis

It consists of two parts, *i.e.* pars distalis and pars intermedia.

- (1) **Pars distalis** is commonly called anterior pituitary. Produces hormones such as growth hormone (GH), prolactin (PR), thyroid-stimulating hormone (TSH), adrenocorticotrophic hormone (ACTH), Luteinizing hormone (LH) and follicle-stimulating hormone (FSH).
- (2) **Pars intermedia** only secretes one hormone *i.e.* melanocyte stimulating hormone (MSH).



### Related Theory

→ In humans, pars intermedia and pars distalis are almost merged.

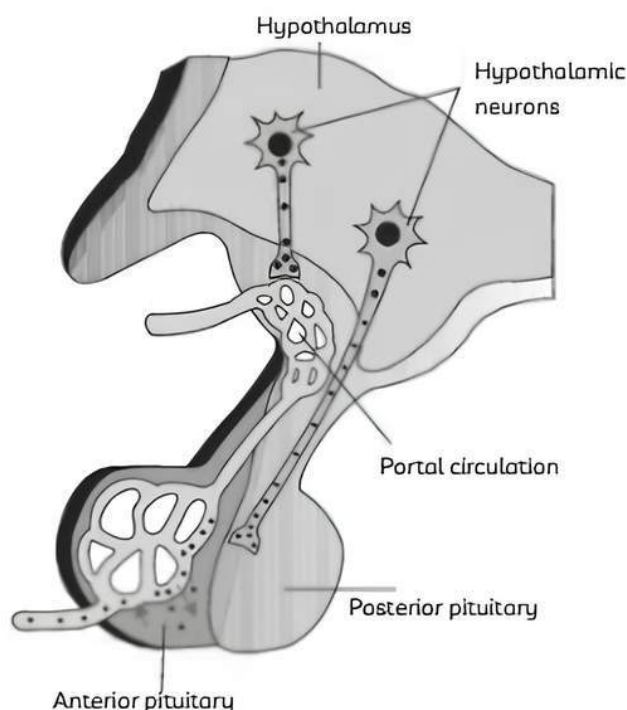
## Neurohypophysis (Pars Nervosa)

It is commonly called posterior pituitary, its function is to store and release oxytocin and vasopressin that are originally synthesised by hypothalamus and are transported axonally to neurohypophyses. These two hormones are stored in very small vesicles in the axons and terminals. These vesicles are known as Herring bodies.

Over-secretion of GH (growth hormone) causes abnormal growth of the body, resulting in gigantism, whereas low secretion causes stunted growth, resulting in pituitary dwarfism. Excess growth hormone secretion in adults, particularly in middle age, can cause severe deformity known as Acromegaly, which can lead to major consequences and early mortality if left untreated. In the early stage, the condition is difficult to identify and it typically remains unnoticed for years until changes in outward features become apparent.

- (1) Prolactin is a hormone that controls the development and production of milk in the mammary glands.
- (2) TSH promotes the thyroid gland to produce and release thyroid hormones.
- (3) ACTH causes the adrenal cortex to produce and secrete glucocorticoids, which are steroid hormones. Gonadotrons, such as LH and FSH, increase gonadal activity. LH increases the production and secretion of androgens from the testis in males. FSH and androgens influence spermatogenesis in males. LH causes completely developed follicles (graafian follicles) to ovulate and preserves the corpus luteum, which is made up of the remains of the graafian follicles, in females after ovulation. Females' ovarian follicles grow and develop normally when FSH is present.
- (4) MSH modulates skin pigmentation by acting on melanocytes (melanin-producing cells).

- (5) Oxytocin is a hormone that causes the contraction of smooth muscles of body. It causes a strong contraction of the uterus and milk ejection from the mammary gland in females after childbirth.
- (6) Vasopressin operates primarily on the kidney, stimulating water and electrolyte reabsorption by the distal tubules and thereby reducing water loss through urine (diuresis). As a result, it is also known as anti-diuretic hormone (ADH). Low secretion of ADH in human, reduced the ability of the kidney to conserve water in the body leading to water loss and dehydration. This disease is called diabetes insipidus.



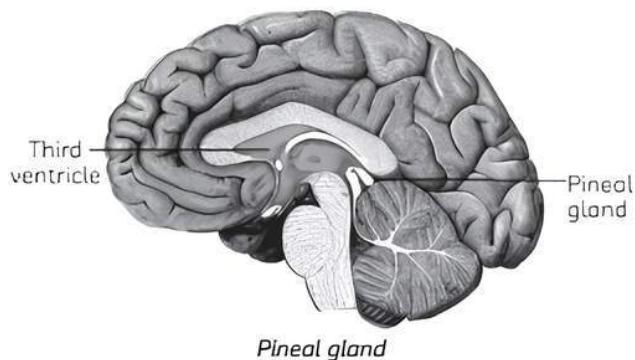
Diagrammatic representation of pituitary and its relationship with hypothalamus

## Pineal Gland

It is located on the dorsal side of the forebrain. Our bodies circadian rhythm is very important when we disturb our sleep-wake cycle or travel across country with different time zones it impacts our pineal gland and hormone secreted by this gland *i.e.*, melatonin secretion which is responsible for regulating our 24-hour body cycle or rhythm.

It secretes melatonin which regulates circadian rhythm, *i.e.* 24-hour diurnal rhythm of the human body, maintains sleep-wake cycle and body temperature.

In addition, melatonin also influences metabolism, pigmentation, mensuration cycle as well as our defence capabilities.



**Example 1.1:** Fill in the blanks:

| Hormones                     | Target gland |
|------------------------------|--------------|
| (A) Hypothalamic hormones    | .....        |
| (B) Thyrotropin (TSH)        | .....        |
| (C) Corticotropin (ACTH)     | .....        |
| (D) Gonadotrophins (LH, FSH) | .....        |
| (E) Melanotrophin (MSH)      | .....        |

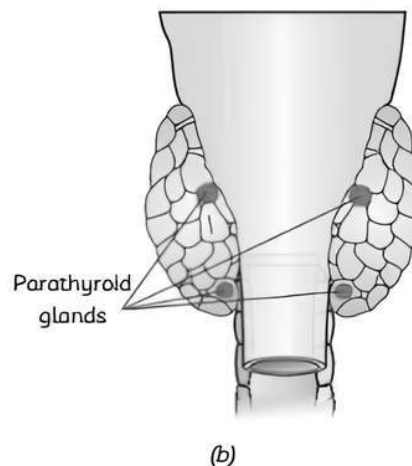
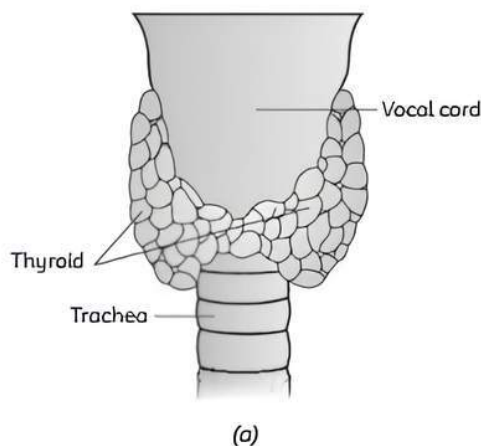
- Ans.** (A) Pituitary  
 (B) Thyroid  
 (C) Adrenal cortex  
 (D) Gonads — Testes in males and ovaries in females  
 (E) Skin

## Thyroid Gland

Thyroid gland is endodermal in origin. It is the largest endocrine gland located on either side of the trachea and is composed of two lobes that are interconnected with a thin flap of connective tissue known as isthmus.

Thyroid gland is made up of follicles and stromal tissues. Follicle is made up of follicular cells enclosing the cavity. Thyroid follicles are composed of cuboidal epithelium and are filled with a homogenous material called colloid. These follicular cells synthesise two hormones:

- (1) Tetraiodothyronine or thyroxine [ $T_4$ ]
- (2) Triiodothyronine [ $T_3$ ]



Diagrammatic view of the position of thyroid and parathyroid

(a) Ventral side, (b) Dorsal side

Iodine is necessary for the synthesis of thyroid hormones. Its deficiency can cause:

- (1) **Hypothyroidism:** Enlargement of thyroid gland, causes disease name goitre. During pregnancy, it causes defects in growing baby, stunted growth (cretinism), mental retardation, low IQ, abnormal skin and deaf mutism. In adult women, hypothyroidism causes irregular menstrual cycles.
- (2) **Hyperthyroidism:** Caused due to cancer in thyroid gland, due to development of nodules of the thyroid glands and secretion of the thyroid hormones is increased to an abnormally high levels, leading to a condition which can also adversely affect the body's physiology.

Function of thyroid gland is to regulate basal metabolic rate, help in the formation of red blood cells, also regulate the metabolism of carbohydrates, proteins and fats and maintain water and electrolyte balance.

In the stroma of thyroid gland, small clusters of specialised parafollicular cells or 'C' cells. C-cells secrete thyrocalcitonin (TCT), a protein hormone that regulates blood calcium levels. Thyrocalcitonin is also known as calcitonin.

**Example 1.2:** Case Based:

Sheela was hanging out with her friends. She noticed in one of her friend's neck has swollen abnormally. On enquiring, she was also told that her body weight is decreasing. Sheela suggested that She visit a doctor to know the cause. Her friend got a little worried and asked her several questions.



- (A) Name the affected gland of the body.
- (a) Pancreas (b) Thyroid  
(c) Ovaries (d) Adrenal
- (B) Name the disease associated.
- (a) Grave's disease (b) Goitre  
(c) Diabetes mellitus (d) Addison's disease
- (C) Name the cells that secrete this hormone, also name the hormone.
- (D) Write the functions of this hormone.
- (E) Assertion (A): Iodine is necessary for a normal rate of hormone synthesis.
- Reason (R): Its deficiency causes diseases.
- (a) Both A and R are true and R is the correct explanation of A.  
(b) Both A and R are true and R is not the correct explanation of A.  
(c) A is true but R is false.  
(d) A is false but R is true.

**Ans. (A) (b) Thyroid**

**Explanation:** Thyroid is located on either side of trachea and is composed of two lobes that are interconnected with a thin flap of connective tissue called isthmus.

(B) (a) Grave's disease

**Explanation:** Hyperthyroidism: Caused due to cancer in thyroid gland, hormones are secreted in high amounts causing the disease exophthalmic goitre. Causes enlargement of thyroid gland, protrusion of eyeballs, increased basal metabolic rate, and weight loss, also called Graves' disease.

(C) Gland is made up of follicles and stromal tissues. Follicle is made up of follicular cells enclosing the cavity. These follicular cells synthesise two hormones: Tetraiodothyronine or thyroxine [ $T_4$ ] and Triiodothyronine [ $T_3$ ].

(D) Regulates basal metabolic rate, helps in the formation of red blood cells, also regulates the metabolism of carbohydrates, proteins and fats and maintains water and electrolyte balance. It also secretes thyrocalcitonin (TCT), a protein hormone that regulates blood calcium levels.

(E) (a) Both A and R are true and R is the correct explanation of A.

**Explanation:** Iodine is necessary for a normal rate of hormone synthesis. Its deficiency causes:

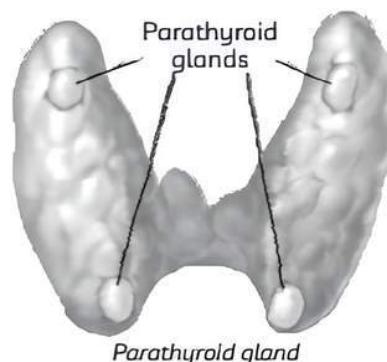
- (1) Hypothyroidism  
(2) Hyperthyroidism

## Parathyroid Gland

Present on the back side of thyroid glands, one pair each in the two lobes of the thyroid gland.

Parathyroid gland secretes a peptide hormone called Parathyroid Hormone (PTH). Its secretion is regulated by levels of  $Ca^{2+}$  ions in circulating blood.

PTH increases  $Ca^{2+}$  levels in the blood, thus called hypercalcemic hormone. It acts on bones and stimulates bone demineralisation. Stimulates reabsorption of calcium by renal tubules and from digested foods. Along with TCT, it plays an important role in maintaining calcium balance in the body.



## Thymus

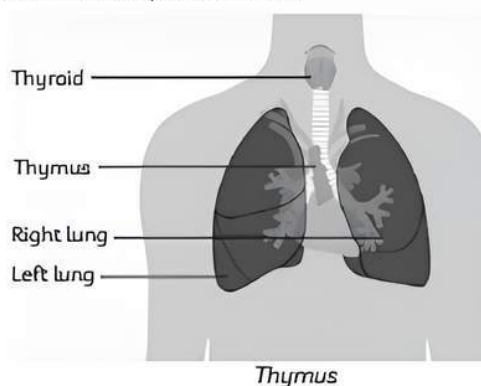
Located between the lungs behind the sternum on the ventral side of the aorta. It has a lobular structure.

### Function

It has an important role in the immune system. It secretes Thymosin (a peptide hormone). This hormone is responsible for differentiation of T-lymphocytes and thus, provides cell-mediated immunity. It also promotes production of antibodies, thus providing humoral immunity.

### Important

➔ Thymus degenerates in old people which results in decreased production of its hormone, which causes a reduced immune response in them.



## Adrenal Gland

**Location:** Paired gland located on the top of the kidney. (one on the anterior part of each kidney).

**Composition:** Each adrenal gland has two parts: External adrenal cortex and internal adrenal medulla.

## Adrenal Medulla

Centrally located tissue which secretes two types of hormones commonly called catecholamines. These are:

- (1) Adrenaline: Also known as epinephrine.
- (2) Noradrenaline: Also known as norepinephrine.

It is secreted in response to any stress, during emergencies, thus also known as emergency hormones or hormones of fight and flight. These hormones function by increasing alertness, pupillary dilation, piloerection and sweating. It results in an increased heartbeat and rate of respiration, raises blood pressure, slow peristalsis, etc. They also stimulate catabolism of glycogen that causes increased blood glucose level. It also stimulates catabolism of protein and lipids.

## Adrenal Cortex

Divided into three layers:

- (1) Zona reticularis (inner layer)
- (2) Zona fasciculata (middle layer)
- (3) Zona glomerulosa (outer layer)

It secretes hormones known as corticoids. There are:

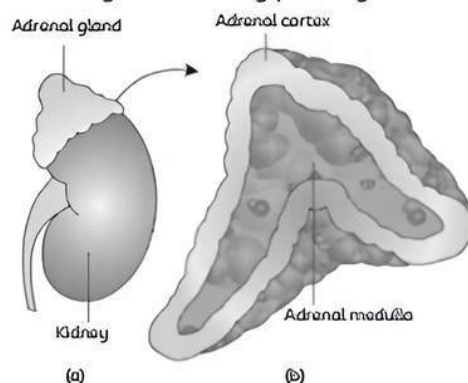
- (i) **Glucocorticoids:** These are involved in carbohydrate metabolism, for example cortisol are main glucocorticoid.

They stimulate gluconeogenesis, lipolysis and proteolysis and inhibit cellular uptake and utilisation of amino acids. Cortisol produce anti-inflammatory reactions, suppress the immune response, and stimulate RBCs production. It also helps in maintaining cardio - cardiovascular system and regulates kidney functions.

- (ii) **Mineralocorticoids:** Regulates the balance of water and electrolytes for example aldosterone - main mineralocorticoid in the body.

It acts on renal tubules and stimulates reabsorption of  $\text{Na}^+$  and water and excretion of  $\text{K}^+$  and phosphate ions. It also helps in maintaining electrolytes, body fluid volume, osmotic pressure and blood pressure.

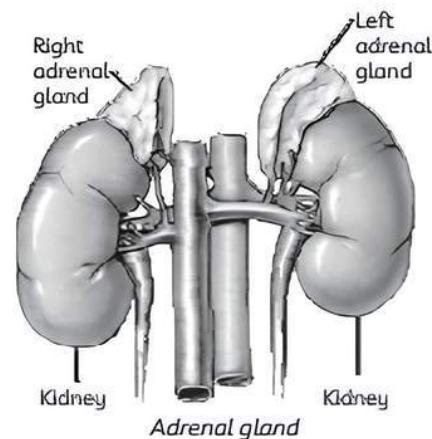
Adrenal cortex also secretes some androgenic steroids in small amounts which plays a crucial role in the growth of axial hairs, pubic hairs and facial hair growth during puberty.



Diagrammatic representation of:  
(a) Adrenal gland above kidney (b) Section showing two parts of adrenal gland

## Important

→ Underproduction of hormones by the adrenal cortex alters carbohydrate metabolism causing acute weakness and fatigue leading causing Addison's disease.



## Pancreas

Blood glucose level is important for our body. Its imbalance results in various diseases; lower levels cause hypoglycemia and increase in blood sugar levels results in hyperglycemia. Prolonged hyperglycemia results in diabetes mellitus which is a very common disease that we see in our families. Do we ever wonder why this happens and how it is regulated? We will get all the answers here in this section.

Pancreas is a composite gland that acts as both an exocrine and endocrine gland.

Consists of 'Islets of Langerhans' made up of two main types of cells that are:

### $\alpha$ -cells secrete a peptide hormone

Glucagon, that maintains normal blood glucose levels, it mainly acts on liver cells, *i.e.* hepatocytes, and stimulates glycogenolysis and gluconeogenesis causing hyperglycemia, *i.e.* increased blood sugar. It reduces cellular glucose uptake and utilisation. Thus, it is a hyperglycemic hormone.

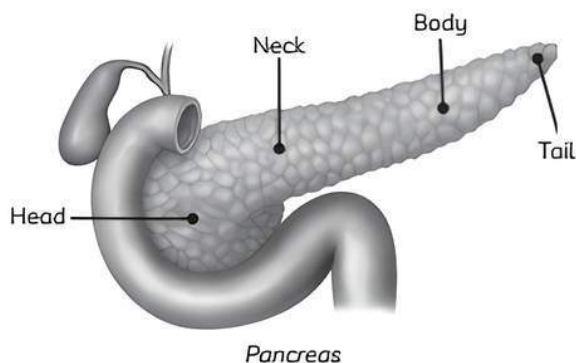
### $\beta$ -cells secrete a peptide hormone

Insulin that regulates glucose homeostasis, it mainly acts on hepatocytes and adipocytes, *i.e.* cells of fat tissue improve cellular glucose uptake and utilisation that causes rapid movement of glucose from blood to hepatocytes and adipocytes resulting into hypoglycemia, *i.e.* decreased blood glucose levels. It stimulates glycogenesis in targeted cells. Thus, it is called hypoglycemic hormone.

These two hormones regulate glucose homeostasis in blood.

## Important

→ Prolonged hyperglycemia results in diabetes mellitus which is associated with loss of glucose through urine and formation of harmful compounds known as ketone bodies but the patients dealing with diabetics can easily treated by insulin therapy.



**Example 1.3:** Give example(s) of:

- (A) Hyperglycemic hormone and hypoglycemic hormone
- (B) Hypercalcemic hormone
- (C) Gonadotrophic hormones
- (D) Progestational hormone
- (E) Androgens and estrogens

- Ans. (A)** Glucagon, Insulin  
 (B) Parathormone (PTH)  
 (C) Follicle-stimulating hormone (FSH) and Luteinizing hormone (LH)  
 (D) Progesterone  
 (E) Testosterone and Estradiol

**Example 1.4. Case Based:**

Akansha lived in a joint family, her grandmother from a few days was complaining of increased thirst, frequent urination, weight loss, fatigue. She suspected her of some disease and asked her to see a doctor, when she took her to the doctor, he referred her to a sugar test. Tests revealed high blood glucose levels. Her grandmother was curious to know about the disease she was suffering from and asked Akansha to answer her questions.

- (A) Disease is associated with which gland of the body:
  - (a) Pancreas                      (b) Thyroid
  - (c) Ovaries                        (d) Adrenal
- (B) Name the hormone associated with above disease.
  - (a) Thyrocalcitonin    (b) Glucagon
  - (c) Thymosins            (d) Calcitonin
- (C) Name the cells that secrete this hormone.
- (D) This gland is an exception in the endocrine system. Explain by giving a reason.
- (E) Assertion (A): Glucagon hormone is known as hyperglycemic hormone.  
 Reason (R): Increases blood glucose.
  - (a) Both A and R are true and R is the correct explanation of A.
  - (b) Both A and R are true and R is not the correct explanation of A.

- (c) A is true but R is false.
- (d) A is false but R is true.

**Ans. (A)** (a) Pancreas

**Explanation:** Disease is associated with the composite gland located below stomach i.e. Pancreas.

(B) (b) Glucagon

**Explanation:** Glucagon, its impaired function causes diabetes mellitus.

(C)  $\alpha$ -cells secrete a peptide hormone—Glucagon is secreted by  $\alpha$ -cells. It is a peptide hormone that maintains normal blood glucose levels. It mainly acts on liver cells, i.e. hepatocytes and stimulates glycogenolysis and gluconeogenesis which in turn causes hyperglycemia, i.e. increased blood sugar.

(D) Pancreas is a composite gland which acts as both an exocrine and endocrine gland. Exocrine function as part of the digestive system secretes pancreatic juices for digestion of food and endocrine function secretes hormones insulin and glucagon.

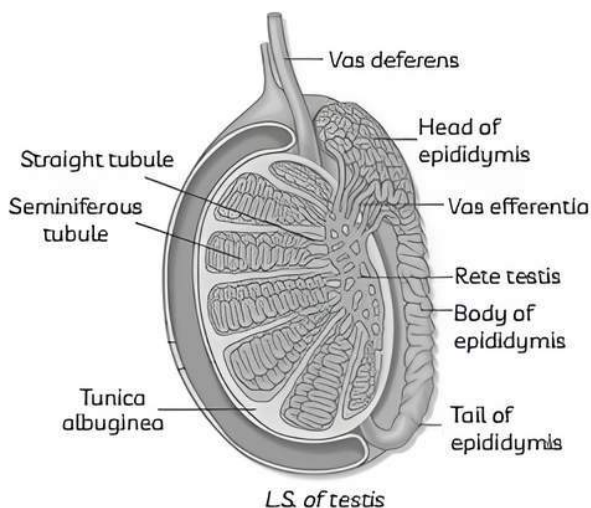
(E) (a) Both A and R are true and R is the correct explanation of A.

**Explanation:** Glucagon maintains normal blood glucose levels, it mainly acts on liver cells, i.e. hepatocytes and stimulates glycogenolysis and gluconeogenesis causing hyperglycemia, i.e. increased blood sugar. It reduces cellular glucose uptake and utilisation. Thus, it is a hyperglycemic hormone.

## Testis

A pair of testis is found in the scrotal sac in males and has dual function of being the primary sex organ and an endocrine gland. It is composed of seminiferous tubules and stromal or interstitial tissue. It is located outside the body cavity because spermatogenesis requires 2-2.5 degrees Celsius lower temperature than core body temperature.

Leydig or interstitial cells that are present in between seminiferous tubules produce hormones called androgens (male hormone). Chief androgen is testosterone. It regulates development, maturation and functions of male accessory sex organs like epididymis, vas deferens, seminal vesicles, prostate gland, urethra, etc. It also stimulates muscular growth, growth of facial and axillary hair, aggressiveness, low pitch of voice, etc. It plays an important role in spermatogenesis and affects male sexual behaviour.



## Ovary

A pair of ovaries are located in the abdomen in females and act as primary sex organ and produce one ovum every month. It produces hormones estrogen and progesterone.

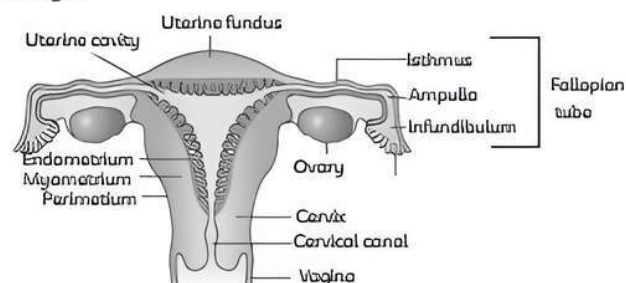
Ovary has two regions—an outer cortex and inner medulla. It is made up of stromal tissues in which follicles are present in different stages of development. Estrogen is synthesised and secreted by maturing ovarian follicles. After ovulation, the remains of Graafian follicles form corpus luteum that secretes mainly progesterone. These hormones cause stimulation of growth and activities of female secondary sex organs, development of growing

ovarian follicles, secondary sexual characteristics in females and mammary gland development. Estrogen is responsible for regulating females' sexual behaviour.



### Important

→ Progesterone is also known as pregnancy hormone because it supports pregnancy. It also acts on the mammary gland and stimulates the alveoli for milk secretion and storage.



Diagrammatic sectional view of the female reproductive system

**Example 1.5.** Which hormonal deficiency is responsible for the following?

- (A) Diabetes mellitus
- (B) Goitre
- (C) Cretinism

**Ans. (A)** Insulin

- (B) Thyroxine and Triiodothyronine
- (C) Thyroxine and Triiodothyronine.

## TOPIC 2

### MECHANISM OF HORMONE ACTION

Hormones are non-nutrient chemicals which act as intercellular messengers and are produced in trace amounts. Hormones are transported via the bloodstream and act on target cells or organs. Hormones produce their effects on target tissues by binding to a specific protein called hormone receptors. Hormone receptors are of two types. Membrane-bound receptors which are located on the cell membrane of the target cell. Others present inside the target cell and are called intracellular receptors, mostly present in the nucleus of the cell is termed as nuclear receptors.

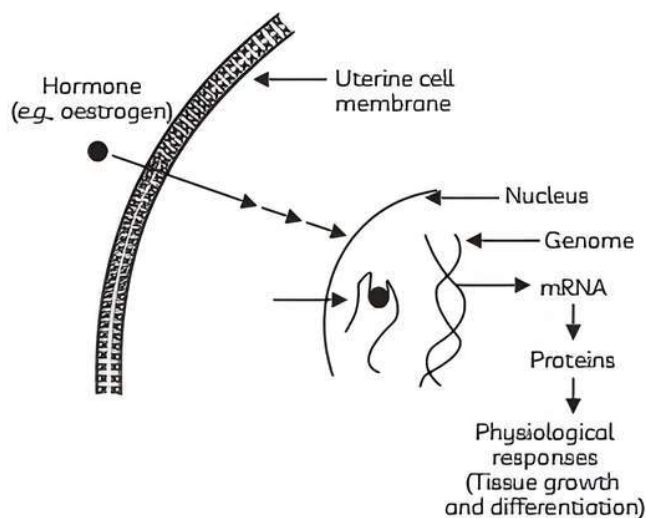
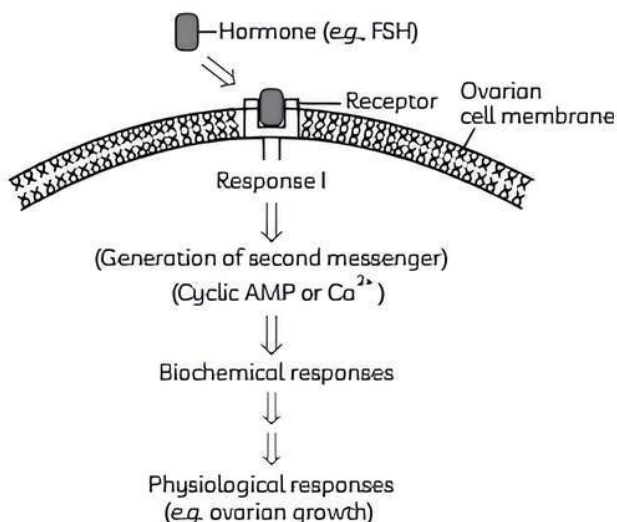
Hormone-receptor complex is formed when a hormone binds to its respective receptor. Each receptor is specific for one type of hormone. Formation of hormone-receptor complex causes biochemical changes in target tissue, thus changing its physiological functions, this is how hormones functions and regulate body mechanisms.

On the basis of their chemical structure they can be divided into groups:

- (1) **Peptide, polypeptide, protein hormones:** Insulin, glucagon, hypothalamic and pituitary hormones.
- (2) **Steroids:** Cortisols, estrogen, progesterone and testosterone.
- (3) **Iodothyronines:** Thyroid hormones.
- (4) **Amino acid derivatives:** Epinephrines

Hormones which interact with membrane-bound receptors normally do not enter the target cell but generate second messengers. For example: AMP,  $IP_3$ ,  $Ca^{2+}$ , etc., which in turn regulate cellular metabolism.

Hormones which interact with intracellular receptors. For example: steroids, hormones, iodothyronines, etc., mostly regulate gene expression or chromosome function by the interaction of hormone receptor complexes with the genome. Cumulative biochemical actions results in physiological and developmental effects.



## OBJECTIVE Type Questions

[ 1 mark ]

### Multiple Choice Questions

1. Which of the following hormones is not secreted by the anterior pituitary?

- (a) Growth hormone
- (b) FSH
- (c) Oxytocin
- (d) Adrenocorticotrophic hormone [Diksha]

Ans. (c) Oxytocin

**Explanation:** Neurohypophysis (pars nervosa) commonly called posterior pituitary, its function is to store and release oxytocin and vasopressin that are originally synthesised by the hypothalamus.

2. Corpus luteum secretes a hormone called:

- (a) Prolactin
- (b) Progesterone
- (c) Aldosterone
- (d) Testosterone

[NCERT Exemplar]

Ans. (b) Progesterone

**Explanation:** After ovulation, in the absence of fertilisation ovum is ruptured to form corpus luteum that secretes mainly progesterone.

### ! Caution

→ Students tend to forget that progesterone is also known as pregnancy hormone.

3. A hormone responsible for a normal sleep-wake cycle is:

- (a) Epinephrine
- (b) Gastrin
- (c) Melatonin
- (d) Insulin

[NCERT Exemplar]

Ans. (c) Melatonin

**Explanation:** A hormone responsible for a normal sleep-wake cycle is melatonin. Pineal gland secretes melatonin and regulates the circadian rhythm, i.e. 24 - hour diurnal rhythm of the human body, maintains sleep-wake cycle and body temperature.

4. Hormones in pancreas are produced by:

- (a) Islets of Langerhans
- (b) Follicular cells
- (c) Stromal cell
- (d) Medulla

Ans. (a) Islets of Langerhans

**Explanation:** Pancreas is a composite gland which acts as both an exocrine and endocrine gland.

It consists of 'Islets of Langerhans' made up of two main types of cells that produce hormones insulin and glucagon.



### Caution

→ Students should know that digestive enzymes and bicarbonate are two secretory products essential for effective digestion found in pancreatic juice. The exocrine acinar cells produce and secrete the enzymes, whereas the epithelial cells lining tiny pancreatic ducts secrete bicarbonate.

5. Which of the following is a steroid hormone?

- (a) Testosterone
- (b) Cortisol
- (c) TSH
- (d) Epinephrine

Ans. (a) Testosterone

**Explanation:** Steroid hormones are derived from cholesterol and are lipid-soluble molecules. For example, estrogen, progesterone, testosterone, etc.



### Related Theory

- The male sex hormone testosterone is produced in the testicles. Testosterone levels are crucial for appropriate male sexual development and function. During puberty (adolescence), testosterone aids the development of masculine characteristics such as body and facial hair, a deeper voice, and physical strength in males.



### Caution

- Students usually don't know that testosterone is produced in females too. It is also secreted in females in a small amount.

### 6. Catecholamines are also known as

- (a) Pregnancy hormone
- (b) Thyroid hormone
- (c) Emergency hormones
- (d) Parathyroid hormone

**Ans. (c) Emergency hormones**

**Explanation:** Adrenal medulla secretes two types of hormones commonly called catecholamines i.e., adrenaline and noradrenaline secreted in response to any stress, during emergencies. That is why these are also known as emergency hormones or hormones of fight, fright and flight. These hormones function by increasing alertness, pupillary dilation, piloerection and sweating.

### 7. In the mechanism of action of a protein hormone, one of the secondary messengers is:

- (a) Cyclic AMP
- (b) Insulin
- (c)  $T_3$
- (d) Gastrin

[NCERT Exemplar]

**Ans. (a) Cyclic AMP**

**Explanation:** Hormones that bind to membrane-bound receptors do not generally penetrate the target cell, but instead produce secondary messengers (e.g. cyclic AMP, cGMP, DAG,  $IP_3$ ,  $Ca^{2+}$ , and so on) that control cellular metabolism.

### 8. .... hormone is released by the posterior pituitary.

- (a) Vasopressin
- (b) GH
- (c) FSH
- (d) TSH

**Ans. (a) Vasopressin**

**Explanation:** Vasopressin is a hormone produced by the pituitary gland that causes the kidneys to retain water and raises blood pressure.



### Related Theory

- Vasopressin (also known as an antidiuretic hormone) helps to regulate the circadian rhythm or the 24-hour cycle of sleep and waking. Vasopressin

also aids in the regulation of the body's internal temperature, blood volume, and urine output from the kidneys.

### 9. Human body immunity is associated with \_\_\_\_\_ gland.

- (a) Thymus
- (b) Thyroid
- (c) Adrenal
- (d) Pineal

**Ans. (a) Thymus**

**Explanation:** Thymus gland is located between the lungs behind the sternum on the ventral side of the aorta. It has a lobular structure and has an important role in the immune system, secretes thymosins, a peptide hormone which is responsible for differentiation of T-lymphocytes.

### 10. Which of the following is not the part of the adrenal cortex?

- (a) Zona reticularis
- (b) Zona fasciculata
- (c) Zona glomerulosa
- (d) Follicles

**Ans. (d) Follicles**

**Explanation:** Adrenal cortex is divided into three layers:

- (1) Zona reticularis (inner layer)
- (2) Zona fasciculata (middle layer)
- (3) Zona glomerulosa (outer layer)

### 11. The gland is crucial for our immune system development and gets degenerated in old individuals causing decreased production of the hormone, thus resulting in lower immunity.

Name the gland affected.

- (a) Adrenal
- (b) Thyroid
- (c) Thymus
- (d) Pituitary

**Ans. (c) Thymus**

**Explanation:** Thymus is located between the lungs behind the sternum on the ventral side of the aorta. It secretes thymosins. It has a lobular structure.



### Related Theory

- It has an important role in the immune system and secretes Thymosins – a peptide hormone. Helps in T-lymphocytes differentiation that provides cell-mediated immunity and promotes production of antibodies, thus providing humoral immunity. It degenerates in old people which results in decreased production of its hormone, which causes a reduced immune response in them.

### 12. In the brain, there is a little pea-shaped gland. Its purpose isn't entirely clear. Some hormones, including melatonin, are produced and regulated by it. According to

researchers melatonin is most recognised for its ability to regulate sleep cycles. Circadian rhythms are another name for sleep patterns. Name this gland.

- (a) Pineal gland      (b) Thyroid gland
- (c) Adrenal gland    (d) Pituitary gland

**Ans.** (a) Pineal gland

**Explanation:** Pineal gland secretes melatonin, regulates circadian rhythm i.e., 24-hour diurnal rhythm of the human body and maintains sleep-wake cycle and body temperature.

- 13. Statement A:** A fall in blood calcium level stimulates parathyroid to secrete parathormone.

**Statement B:** Parathormone decreases blood calcium to normal by drawing calcium from bones into plasma.

- (a) Both A and B are correct.
- (b) Both A and B are incorrect.
- (c) Only A is correct.
- (d) Only B is correct.

**Ans.** (c) Only A is correct.

**Explanation:** Calcium levels in the blood are mostly regulated by parathyroid hormone by raising them when they are too low. It accomplishes this *via* affecting the kidneys, bones, and intestine: Bones: Parathyroid hormone increases the release of calcium into the bloodstream from significant calcium deposits in the bones.

- 14. Statement A:** Adrenals are called glands of emergency.

**Statement B:** Hormones of adrenal medulla whip up metabolism for preparing the animal to face physical and emotional stress.

- (a) Both A and B are correct.
- (b) Both A and B are incorrect.
- (c) Only A is correct.
- (d) Only B is correct.

**Ans.** (a) Both A and B are correct.

**Explanation:** The adrenal glands are referred to as emergency glands. Each kidney's upper surface is home to these glands. Because they emit the hormone adrenaline, these glands are known as emergency glands. A hormone called adrenaline is released when there is an emergency. Adrenaline raises blood pressure, heart rate, and other physiological indicators in an effort to combat the emergency scenario.

- 15. Statement A:** Vasopressin is also called as an antidiuretic hormone

**Statement B:** Vasopressin increases the loss of water in the urine by

increasing water reabsorption in the nephrons.

- (a) Both A and B are correct.
- (b) Both A and B are incorrect.
- (c) Only A is correct.
- (d) Only B is correct.

**Ans.** (c) Only A is correct.

**Explanation:** ADH, or antidiuretic hormone, is also known as vasopressin. It is a naturally occurring hormone that aids in regulating a number of bodily functions as well as some potentially fatal disorders, such as irregular bleeding and septic shocks. Its primary functions include regulating and balancing the blood's water content and raising glomerular blood flow via raising blood pressure. ADH concentrations that are higher tighten the blood vessels, raising blood pressure. The posterior part of the pituitary gland stimulates the ADH.

- 16. Fatima is about to face an interview. But during the first five minutes before the interview, she experiences sweating, increased rate of heartbeat, respiration etc. Which of the following hormones are responsible for her restlessness?**

- (a) Estrogen and progesterone
- (b) Oxytocin and vasopressin
- (c) Adrenaline and noradrenalin
- (d) Insulin and glucagon

[Diksha]

**Ans.** (c) Adrenaline and noradrenalin

**Explanation:** Adrenaline and noradrenaline are two hormones secreted by the adrenal glands' medulla. In times of emergency, adrenaline is released and widens blood vessels, increasing blood flow. Moreover, it raises blood glucose levels and elevates heart rate, increasing oxygen consumption. As a result, it is sometimes referred to as an emergency hormone. Norepinephrine (also known as noradrenaline) increases heart rate, inhibits the digestive system, dilates the pupils of the eyes, and does other things.

### Assertion-Reason (A-R)

Given below are two statements labelled as Assertion (A) and Reason (R). Select the most appropriate answer from the options given below:

- (a) Both A and R are true and R is the correct explanation of A.
- (b) Both A and R are true and R is not the correct explanation of A.
- (c) A is true but R is false.
- (d) A is false but R is true.

**17. Assertion (A):** Melatonin regulates circadian rhythm.

**Reason (R):** Its secreted by pineal gland and regulates sleep-wake cycle.

**Ans.** (a) Both A and R are true and R is the correct explanation of A.

**Explanation:** Dorsal side of the forebrain secretes melatonin. It regulates circadian rhythm i.e., 24-hour diurnal rhythm of the human body, maintains sleep-wake cycle and body temperature.

**18. Assertion (A):** Thymus plays an important role in developing immune system.

**Reason (R):** Helps differentiation of T-lymphocytes.

**Ans.** (a) Both A and R are true and R is the correct explanation of A.

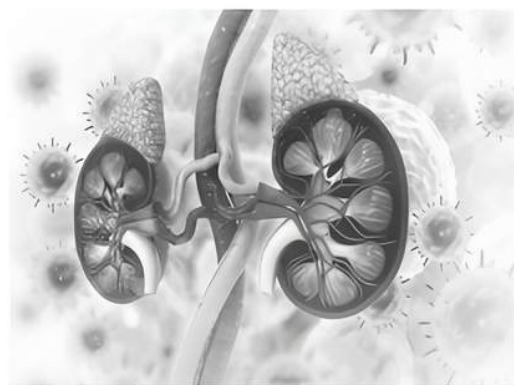
**Explanation:** Thymus gland secretes thymosins, a peptide hormone which helps T-lymphocytes to differentiate and provide cell-mediated immunity, promoting production of antibodies, thus providing humoral immunity.



#### Caution

Thymus and thyroid gland are two different glands, secreting different hormones and different functions.

**19. When you think of the adrenal glands (also known as suprarenal glands), stress might come to mind. And rightly so—the two adrenal glands are arguably best known for secreting the hormone adrenaline, which rapidly prepares your body to spring into action in a stressful situation. But the adrenal glands contribute to your health even at times when your body isn't under extreme stress.**



**Assertion (A):** Adrenaline and noradrenaline are called emergency hormones.

**Reason (R):** These hormones increases alertness, pupillary dilation and piloerection.

**Ans.** (a) Both A and R are true and R is the correct explanation of A.

**Explanation:** Adrenal medulla secretes two types of hormones commonly called catecholamines i.e., adrenaline and noradrenaline secreted in response to any stress, during emergencies, thus also known as emergency hormones or hormones of fight, fright and flight. These hormones function by increasing alertness, pupillary dilation, piloerection and sweating.

**20. Assertion (A):** Pancreas is known as composite gland.

**Reason (R):** It has both endocrine and exocrine functions.

**Ans.** (a) Both A and R are true and R is the correct explanation of A.

**Explanation:** Pancreas gland's exocrine function is to help in digestion and endocrine function is to secrete insulin and glucagon.

## CASE BASED Questions (CBQs)

[ 4 & 5 marks ]

Read the following passages and answer the questions that follow:

**21. A 20-year-old female patient was admitted in October with a 3-month history of persistent vomiting between 5 and 15 times a day and weight loss. She was dehydrated and unable to tolerate oral intake due to nausea and vomiting. Her bowel motions were normal; she had no problems with micturition or symptoms of infection, however had noticed significant weight loss in the preceding few months.**

*She was diagnosed with Addison's disease. This disease is known to have associations*

*with other conditions; therefore, knowledge of this can lead to prompt diagnosis and earlier management once this diagnosis is made.*



**(A) Name the gland associated with the disease. Hormones are secreted by which**

part of this gland? Name the hormones associated with above events.

- (B) They are also known as ..... hormone. Give a reason.
- (C) What is the physiological function of these hormones?

**Ans.** (A) Adrenal gland is made of inner adrenal medulla and outer adrenal cortex. Adrenal medulla secretes hormones known as catecholamines, i.e. adrenaline and noradrenaline. Adrenal medulla is centrally located tissue of the adrenal gland. It secretes two types of hormones commonly called catecholamines:

- (1) Adrenaline: Also known as epinephrine.
- (2) Noradrenaline: Also known as norepinephrine.

(B) They are also known as emergency hormones secreted in an emergency situation in our body. It is secreted in response to any stress, during emergencies, thus also known as emergency hormones or hormones of fight, fright and flight (3F hormone).

(C) These hormones function by increasing alertness, pupillary dilation, piloerection and sweating. It results in an increased heartbeat and rate of respiration. They also stimulate catabolism of glycogen that causes increased blood glucose level. It also stimulates catabolism of protein and lipids.

- 22.** Type 2 diabetes mellitus is likely the third modifiable risk factor for pancreatic cancer after cigarette smoking and obesity. Epidemiological investigations have found that long-term type 2 diabetes mellitus is associated with a 1.5-fold to 2.0-fold increase in the risk of pancreatic cancer. A causal relationship between diabetes and pancreatic cancer is also supported by findings from pre diagnostic evaluations of glucose and insulin levels in prospective studies. Insulin resistance and associated hyperglycemia, hyperinsulinemia, and inflammation have been suggested to be the underlying mechanisms contributing to development of diabetes-associated pancreatic cancer. Signalling pathways that regulate the metabolic process also play important roles in cell proliferation and tumour growth.



(A) Name the gland associated with the first type of disease mentioned in the case and write its composition.

(B) Name the hormone secreted by the  $\beta$ -cells of this gland.

(C) Name the disease associated with glucagon.

**Ans.** (A) Pancreas is a composite gland; acts as both an exocrine and endocrine gland. It consists of 'Islets of Langerhans' made up of two main types of cells that are,  $\alpha$ -cells and  $\beta$ -cells that secrete glucagon and insulin, respectively.

(B)  $\beta$ -cells secrete a peptide hormone, i.e. insulin that regulates glucose homeostasis, it mainly acts on hepatocytes and adipocytes, i.e. cells of fat tissue, improving cellular glucose uptake and utilisation that causes rapid movement of glucose from blood to hepatocytes and adipocytes resulting into hypoglycemia, i.e. decreased blood glucose levels. It stimulates glycogenesis in targeted cells.

(C) It mainly acts on liver cells, i.e. hepatocytes and stimulates glycogenolysis and gluconeogenesis causing hyperglycemia, i.e. increased blood sugar. It reduces cellular glucose uptake and utilisation. Thus, it is a hyperglycemic hormone.

- 23.** Xenoestrogens are found in a variety of everyday items. Its sources are plastic, pesticides, insecticides, beauty products, etc. Many of us don't think twice about the make-up we wear or the container we use to pack a lunch.

Unfortunately, this may be altering the way our body works naturally because they all contain endocrine disruptors called Xenoestrogens. Xenoestrogens are a subcategory of endocrine disruptor that specifically has estrogen-like effects. Estrogen is a natural hormone synthesised by the growing ovarian follicles in females. It helps in the growth of female secondary sex organs and female secondary sex characters. It is also important for bone growth and reproduction in men and women. When xenoestrogen enters the body they increase the total amount of estrogen in the body resulting in a phenomenon called estrogen dominance. As they are not biodegradable they are stored in our fat cells. This leads to breast cancer, prostate cancer, obesity, infertility, miscarriages and diabetes.

[Delhi Gov. QB 2022]

(A) Xenoestrogen mimics the action of ..... and its excess causes .....

(a) Progesterone, bone and prostate cancer

- (b) Estrogen, breast and prostate cancer
  - (c) Cortisol, brain and blood cancer
  - (d) Thyrocalcitonin, bone and lung cancer
- (B) Estrogen is secreted mainly by:
- (a) GI tract
  - (b) Pancreas
  - (c) Growing ovarian follicles
  - (d) Thymus
- (C) Select the function/functions performed by estrogen in females:
- (a) Growth of female secondary sex organs
  - (b) Bone growth
  - (c) Female secondary sex-characters
  - (d) All of the above
- (D) What measures, as an individual you would take to reduce your exposure to these harmful xenoestrogens?
- (a) Eat local and organic food.
  - (b) Use beauty products made from natural ingredients.
  - (c) Do not use plastic lunch boxes and water bottles.
  - (d) All of the above
- (E) Assertion (A): Estrogen belongs to the class of steroid hormones.
- Reason (R): Cholesterol is the precursor used in synthesising estrogen hormone.
- (a) Both A and R are true and R is the correct explanation of A.
  - (b) Both A and R are true and R is not the correct explanation of A.
  - (c) A is true but R is false.
  - (d) A is false but R is true.

**Ans.** (A) (b) Estrogen, breast and prostate cancer

**Explanation:** Xenoestrogens are clinically significant because they can mimic the effects of endogenous estrogen and thus have been implicated in precocious puberty and other disorders of the reproductive system.

(B) (c) Growing ovarian follicles

**Explanation:** The female sex hormone is oestrogen. Under the influence of FSH, it is mostly released by the granulosa cells of the ovarian follicles (in the ovary). Additionally, the placenta and the corpus luteum (after the egg has been expelled from the follicle) release these hormones.



### Related Theory

It is in charge of keeping women's secondary sexual traits intact. It aids in the development of sperm in males. When pregnant, it also thickens the uterine lining during the menstrual cycle in females.

(C) (d) All of the above

**Explanation:** In addition to breast enlargement and nipple erection, secondary sexual characteristics that emerge during puberty include pubic and underarm hair growth, wider hips, a lower waist-to-hip ratio than adult males, smaller hands and feet than men, a rounder face, and greater development of thigh muscles behind the femur rather than in front of it.



### Caution

Estrogen is a steroid hormone that helps mammals develop their feminine traits. Its proper name is 'estradiol'. While the testes secrete testosterone, the male sex hormone and the thyroid gland secretes thyroxine, which regulates the fundamental metabolic rate.

(D) (d) All of the above

**Explanation:** Common sources of xenoestrogens are food, plastic, skin care products, building supplies, pesticides, and contraceptives. Here are a few ways to reduce your exposure the xenoestrogens:

- (1) Avoid pesticides by choosing organic, locally grown, and in season foods.
- (2) Peel non-organic fruits and vegetables.
- (3) Buy hormone free meats and dairy products.
- (4) Avoid plastics in everyday kitchen products
- (5) Plastic wrap to cover food and by removing plastic covered food as soon as you get home from the store

(E) (a) Both A and R are true and R is the correct explanation of A.

## VERY SHORT ANSWER Type Questions (VSA)

[ 1 mark ]

**24.** Immunity of old persons becomes very weak. Give a reason. [Delhi Gov. QB 2022]

**Ans.** Thymus begins to degenerate in older individuals, resulting in decreased production

of thymosin. As a result, the immune system becomes weak in old people.

**25.** Describe hyperglycemic hormone using an example.

**Ans.** Glucagon is called hyperglycemic hormone. It is secreted by  $\alpha$ -cells of pancreas and this hormone is a peptide hormone. Glucagon maintains normal blood glucose levels, it mainly acts on liver cells *i.e.*, hepatocytes and stimulates glycogenolysis and gluconeogenesis causing hyperglycemia *i.e.*, increased blood sugar. It reduces cellular glucose uptake and utilisation. Thus it is a hyperglycemic hormone.

**26. How will you define hormone receptor – complex?**

**Ans.** Hormone-receptor complex is formed when a hormone binds to its respective receptor. Each receptor is specific for each hormone. Formation of hormone-receptor complex causes biochemical changes in target tissue, thus changing its physiological functions, that is how hormones functions and regulates body mechanisms.

**27. Which hormones need iodine for their synthesis?**

**Ans.** Thyroid hormones need iodine for their synthesis. Follicular cells of thyroid gland synthesise two hormones called: Tetraiodothyronine or thyroxine [ $T_4$ ] and Triiodothyronine [ $T_3$ ].

**28. What is erythropoiesis? Which hormone stimulates it? [NCERT Exemplar]**

**Ans.** Erythropoiesis is the process of formation of RBCs in bone marrow. Erythropoiesis is regulated by a hormone - erythropoietin. It is a peptide hormone secreted by juxtaglomerular cells of kidneys that stimulates RBCs formation.

**29. What is the role of the second messenger in hormone action? [NCERT Exemplar]**

**Ans.** Hormones that do not cross the cell membrane of target cells, they show their action through binding with receptors which are present on cell membrane and, resulting in the generation of second messengers (e.g., cAMP) on the plasma membrane's inner side.

**30. What is the function of Leydig cells? [Diksha]**

**Ans.** Leydig or interstitial cells that are present in between seminiferous tubules produce hormones called androgens – testosterone. It regulates development, maturation and functions of male accessory sex organs like epididymis vas deferens, seminal vesicles, prostate gland, urethra, etc.

## SHORT ANSWER Type-I Questions (SA-I)

[ 2 marks ]

**31. On an educational trip to Uttaranchal, Ketki and her friends observed that many local people were having swollen necks. Please help Ketki and her friends to find out the solutions to the following questions.**

(A) Which probable disease these people are suffering from?

(B) How is it caused?

(C) What effect does this condition have on pregnancy? [NCERT Exemplar]

**Ans.** (A) Enlargement of thyroid gland, causes a disease named goitre.

(B) Hypothyroidism is caused due to deficiency of iodine in diet causing low secretion of thyroid hormone.

(C) During pregnancy, it causes defects in growing fetuses, stunted growth (cretinism), mental retardation, low IQ, abnormal skin and deaf mutism. In adult women, it causes irregular menstrual cycles.

**32. Inflammatory responses can be controlled by a certain steroid. Name the steroid,**

**its source and also its other important functions. [NCERT Exemplar]**

**Ans.** Anti-inflammatory responses are induced by glucocorticoids mainly cortisol, and the immunological response is suppressed *i.e.*, cortisol retards phagocytic activities of WBCs. RBCs production is stimulated by cortisol but WBCs production is decreased. Glucocorticoids promote gluconeogenesis, lipolysis, and proteolysis while inhibiting amino acid absorption and utilisation. Cortisol is also necessary for the proper functioning of the cardiovascular system and the kidneys. This is why cortisol is used for treatment of allergies.

**33. Describe the role of hormones secreted by ovaries.**

**Ans.** Ovaries produce hormones like estrogen and progesterone.

Ovary is made up of follicles and stromal tissues. Estrogen is synthesised and secreted by maturing ovarian follicles. After ovulation, remaining part of Graafian follicle forms corpus

luteum that secretes mainly progesterone. Estrogen stimulates the development of female secondary sex characteristics during puberty and maintains them through the reproductive years of adult life. It also stimulates development of growing ovarian follicles and mammary gland. Estrogen is responsible for regulating females' sexual behaviour.

Progesterone is also known as pregnancy hormone because it supports a pregnancy.

**34. How are hormones grouped into different categories?**

**Ans.** On the basis of their chemical nature, they can be divided into various groups. These are:

- (1) Peptide, polypeptide, protein hormones: Insulin, glucagon, hypothalamic and pituitary hormones.
- (2) Steroids: Cortisols, estrogen, progesterone, testosterone.
- (3) Iodothyronines: Thyroid hormones.
- (4) Amino acid derivatives: Epinephrines.

## SHORT ANSWER Type-II Questions (SA-II)

[ 3 marks ]

**35. What are the Islets of Langerhans? Describe the role of hormones secreted by them.**

**Ans.** Islets of Langerhans are a group of different types of cells present in pancreas. Pancreas is a composite gland which acts as both an exocrine and endocrine gland.

'Islets of Langerhans' made up of two main types of cells that are:

- (1)  $\alpha$ -cells secrete a peptide hormone, glucagon that maintains normal blood glucose levels, it mainly acts on liver cells *i.e.*, hepatocytes and stimulates glycogenolysis and gluconeogenesis causing hyperglycemia *i.e.*, increased blood sugar. It reduces cellular glucose uptake and utilisation. Thus, it is a hyperglycemic hormone.
- (2)  $\beta$ -cells secrete a peptide hormone, insulin that regulates glucose homeostasis, it mainly acts on hepatocytes and adipocytes, *i.e.* cells of fat tissue improving cellular glucose uptake and utilisation that causes rapid movement of glucose from blood to hepatocytes and adipocytes resulting into hypoglycemia *i.e.*, decreased blood glucose levels. It stimulates glycogenesis in targeted cells.

**36. George comes on a vacation to India from US. The long journey disturbed his biological system and he suffered from jet lag. What is the cause of his discomfort?**

[NCERT Exemplar]

**Ans.** George travels to India on vacation from the United States. His biological system is disrupted by the lengthy flight, and he suffers from jet lag. It is caused by a disruption in the diurnal cycle. Melatonin is essential for our body's 24-hour (diurnal) rhythm to function properly. It aids in the maintenance of appropriate sleep-wake cycles and body temperatures.

**37. 'Parathyroid glands' hormone has a specific role to play. Enumerate a few.**

**Ans.** Parathyroid glands are present on the back side of thyroid glands, one pair each in the two lobes of the thyroid gland. It secretes peptide hormone: Parathyroid Hormone (PTH) or parathormone or also called collip's hormone, it is regulated by levels of ions in blood circulation. PTH increases  $\text{Ca}^{2+}$  levels in the blood, thus hypercalcemic hormones. It acts on bones and stimulates bone demineralisation. Stimulates reabsorption of calcium by renal tubules and from digested foods in intestine. It plays an important role in maintaining calcium balance in the body.

**38. Androgen regulated the development, maturation and other important functions in human male. List them.**

[Delhi Gov. QB 2022]

**Ans.** The hormones known as androgens are in charge of the development of secondary sexual characteristics. Testicular Leydig cells create androgens like testosterone. Male sex hormone testosterone controls the growth of secondary sex traits including facial hair, a gruff voice, the development of reproductive organs, etc. Androgens also control how certain male accessory organs, such as the epididymis and prostate glands, develop, mature, and perform. It promotes the development of mature sperm and spermatogenesis. Additionally, it affects how men act sexually.

**39. What role does pineal gland have in the human body, elaborate with its location?**

**Ans.** Pineal gland produces circadian rhythm which is very important for us. When we disturb our sleep-wake cycle or travel across country with different time zones it affects our pineal gland and hormone secreted by this gland *i.e.*, melatonin secretion is disturbed. Melatonin is

responsible for regulating our 24-hour body cycle or rhythm.

**Location:** Dorsal side of forebrain. It secretes melatonin which regulates circadian rhythm i.e., 24-hour diurnal rhythm of the human body, maintains sleep-wake cycle and body temperature.

**40. Which hormones are secreted by neurohypophysis? Mention their functions also.**

**Ans.** Neurohypophysis (pars nervosa) commonly called posterior pituitary stores and releases oxytocin and vasopressin (ADH) that are originally synthesised by hypothalamus. Oxytocin is a hormone that controls muscle contraction in females (muscle contraction of uterus during childbirth) and also contracts mammary gland causing ejection of milk. Vasopressin, also known as antidiuretic hormone (ADH) is a hormone that helps to regulate osmolarity (the concentration of dissolved particles in the serum, such as salts and glucose) and hence the amount of water in the extracellular fluid (the fluid space that surrounds cells).

**41. Mr Akshay notices that his shoe size has progressively increased. He also observes that shape of his face has gradually changing with protruding lower jaw. What can be the cause for all changes? Name the disorder.** [Delhi Gov. QB 2022]

**Ans.** The cause of these changes is the overproduction of Growth Hormone by the pituitary gland.

This is known as acromegaly. Due to the excessive growth of pituitary gland, the surrounding nerve tissues and optic nerves get compressed. This results in the growth of the bone and the enlargement of organs. People suffering from this disease have much larger bones when compared to other people.

**42. On an educational trip to Uttarakhand, Ketki and her friends observe that many local people were having swollen necks. Please help Ketki and her friends to find out the solutions to the following questions.**

**(A) Which probable disease are these people suffering from?**

**(B) How is it caused?**

**(C) What effect does this condition have on pregnancy?** [Diksha]

**Ans.** (A) Goitre. This is due to the overstimulation of thyroid gland which causes an enlargement in the gland.

(B) It is caused due to the deficiency of iodine in the diet that results in hyperthyroidism and enlargement of the thyroid gland.

(C) Defective development and maturation of the growing baby lead to stunted growth (cretinism).

## LONG ANSWER Type Questions (LA)

[ 4 & 5 marks ]

**43. You have learnt that a characteristic feature of endocrine system is the presence of feedback loops. By this what is meant is that if hormone A stimulates gland 'X' to secrete hormone B, the production of 'A' could be modified when the level of B changes in our blood. An example is the relationship between hormones LH and estrogen ( $E_2$ ). An old woman exhibits the following features. High levels of LH in blood but low levels of  $E_2$  in the blood. Another woman exhibits a high level of LH in blood and also a high level of  $E_2$  in the blood. Where is the defect in both these women? Provide suitable diagrams to support this answer.** [NCERT Exemplar]

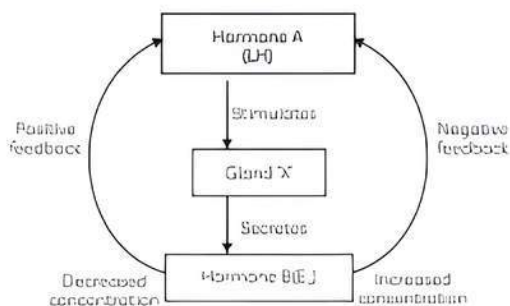
**Ans.** Feedback control occurs when hormone secretion is influenced by factors or other hormones.

When there is a high concentration of the hormone B in our blood, it inhibits the secretion

of a hormone A. Decreased secretion of A will eventually result in a decrease in the production of hormone. This is an example of negative feedback control. If we have a low concentration of hormone B in our blood, it will stimulate the secretion of hormone A. Increased secretion of A will eventually lead to an increase in B's production. This is an example of positive feedback control.

Low levels of  $E_2$  should have a positive feedback control on LH secretion, resulting in an increase in  $E_2$  production. However, an elderly woman has a low level of  $E_2$  and a high level of the hormone LH, indicating that LH is not stimulating gland X to secrete  $E_2$ .

A high level of  $E_2$  should have a negative feedback control on LH secretion, resulting in a decrease in  $E_2$  production. However, another woman has high levels of both  $E_2$  and LH, indicating a flaw in the negative feedback loop.



**44. Hypothalamus is a super master endocrine gland. Elaborate. [NCERT Exemplar]**

**Ans.** Hypothalamus contains neurosecretory cells which secrete hormones. It is the basal part of diencephalon and forebrain and regulates many body functions. It is made up of many groups of neurosecretory cells called nuclei that produce hormones. These hormones regulate synthesis and secretion of the pituitary gland. It produces two types of hormones:

- (1) The releasing hormones [stimulates secretion of pituitary hormones] (RH).
- (2) The inhibiting hormones [inhibits secretion of pituitary hormones] (IH).

Examples: Gonadotropin-releasing hormone (GnRH) stimulates the release of gonadotropins from pituitary and somatostatin inhibits growth hormone release from pituitary.

These hormones enter the pituitary gland via the portal circulatory system and govern the anterior pituitary's activities. The posterior pituitary gland is under direct control of the hypothalamus. It does not synthesise any hormone but it stores and releases hormones already synthesised by hypothalamus.

**45. Explain the significance of the hormones associated with pituitary gland.**

- Ans.** (1) Prolactin is a hormone that controls the development and production of milk in the mammary glands.
- (2) TSH promotes the thyroid gland to produce and release of thyroid hormones ( $T_3$  and  $T_4$ ).
- (3) ACTH causes the adrenal cortex to produce and secrete glucocorticoids, which are steroid hormones.
- (4) Gonadotrophins, such as LH and FSH, increase gonadal activity. LH increases the production and secretion of androgens from the testis in males. FSH and androgens influence spermatogenesis in males. LH causes completely developed follicles (Graafian follicles) to ovulate and preserves the corpus luteum, which is made up of the remains of the Graafian follicles, in females after ovulation. Under the influence of FSH growth of ovarian follicles occurs in females.
- (5) MSH modulates skin pigmentation by acting on melanocytes (melanin-producing cells).

(6) Oxytocin is a hormone that causes the contraction of smooth muscles of body. It causes a strong contraction of the uterus during childbirth and milk ejection from the mammary gland in females after childbirth.

(7) Vasopressin operates primarily on the kidney, stimulating water and electrolyte reabsorption by the distal tubules and thereby reducing water loss through urine (diuresis). As a result, it is also known as antidiuretic hormone (ADH). (Any 5)

**46. Explain the role of ovaries as an endocrine gland.**

**Ans. Location:** A pair of ovaries located in the abdomen in females.

**Function:** It acts as primary sex organ and produces one ovum every month.

It produces the hormones estrogen and progesterone.

It is made up of follicles and stromal tissues. Estrogen is synthesised and secreted by maturing ovarian follicles. After ovulation, in absence of fertilisation ovum is ruptured to form corpus luteum that secretes mainly progesterone. These hormones cause stimulation of growth and activities of female secondary sex organs, development of growing ovarian follicles, secondary sexual characteristics in females and mammary gland development. Estrogen is responsible for regulating females' sexual behaviour. Progesterone is also known as pregnancy hormone because it supports a pregnancy. It also acts on the mammary gland and stimulates the alveoli for milk secretion and storage.

**47. Mention the difference between hypothyroidism and hyperthyroidism. [NCERT Exemplar]**

**Ans.** Hypothyroidism is the low secretion of thyroid hormone while hyperthyroidism is the high secretion of thyroid hormone. Iodine is required for the thyroid to synthesize and produce thyroid hormones at a regular pace.

Hypothyroidism and swelling of the thyroid gland, known as goitre, are caused by a lack of iodine in our diet. Hypothyroidism during pregnancy results in stunted growth (cretinism), mental retardation, low intelligence quotient, deaf-mutism, and other problems. Hypothyroidism in adult women can induce irregular menstrual cycles.

The rate of synthesis and release of thyroid hormones is elevated to abnormally high levels as a result of thyroid cancer or the formation of nodules in the thyroid glands, resulting in hyperthyroidism, which has a negative impact on human physiology.

