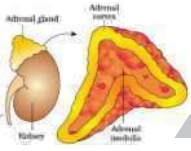


Chapter - 22 Chemical Coordination and Integration

Points To Remember

Endocrine glands : These are ductless glands which secrete hormones directly into the blood stream.

Hormones : Non-nutrient chemicals synthesised in trace amount by Endocrine glands, that act as intracellular messengers and are specific in their action which are transported by blood from site of production to site of action.

Hypothalamus :

- It is basal part of diencephalon.
- Has neurosecretory cells called nuclei which produce hormones to regulate the synthesis and secretion of pituitary gland hormones.
- Two types of hormones released are :

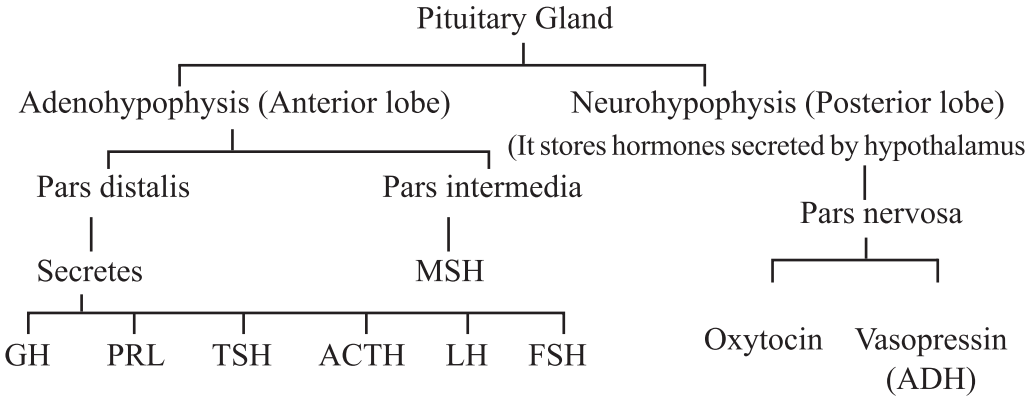
  Releasing hormones : Stimulate secretion of pituitary hormones, *e.g.,* *Gonadotrophin* releasing hormone stimulates pituitary gland to synthesise gonadotrophins.

  Inhibiting hormones : Inhibit secretions of pituitary hormones, *e.g.,* Somatostatin inhibits secretion of growth hormone.

Pituitary Gland :

- Located in bony cavity called as sella tursica.
- Attached to hypothalamus by a stalk.
- Divided anatomically into : Adenohypophysis (Anterior lobe) and Neurohypophysis (Posterior lobe).
- Hormones released from hypothalamic neurons reach anterior pituitary through portal system and through neurons in Posterior pitutary.
- Posterior pituitary is under neural control of hypothalamus.

1. Pituitary Gland



Adenohypophysis : (Anterior lobe of Pituitary)

- **Growth hormone (GH) :** Oversecretion leads to gigantism and low secretion causes dwarfism and Proper secretion leads to proper growth of body.
- **Prolactin (PRL) :** Growth of mammary gland and formation of milk in them.
- **Thyroid stimulating hormone (TSH) :** Stimulates synthesis and secretion of thyroid hormones from thyroid gland.
- **Adrenocorticotrophic hormone (ACTH) :** Stimulates synthesis and secretion of steroid hormones called glucocorticoids from adrenal cortex.
- **Luteinizing hormone (LH) :** Synthesis and secretion of hormones called androgens in males, and helps in ovulation and maintenance of corpus luteum in females.
- **Follicle stimulating hormone (FSH) :** Regulate spermatogenesis in males, and growth and development of ovarian follicles in females.

Neurohypo physis (Posterior lobe of Pituitary)

- **Oxytocin** helps in contraction of uterus during child birth and milk ejection from mammary gland in females.
- **Vasopressin :** Acts on kidney and stimulates reabsorption of water and electrolytes by distal tubules to reduce water loss through urine. It is also called as Anti Diuretic Hormone (ADH).

Diabetes insipidus : Impairment of synthesis of ADH

(i) Diminished ability of kidney to conserve water.

(ii) Water loss and dehydration.

(iii) Can be overcome by taking more water.

Excessive Secretion of Growth Hormone

- **Acromegaly :** It is a condition when the pituitary gland makes too much growth hormone. It is due to a tumour in pituitary gland. Person suffering from acromegaly (acro means tip and megaly means enlargement) may gradually develop a long face with protruding lower jaw, enlarged nose and wider spacing between teeth and enlarged hands and feet.

2. Pineal Gland :

- Located on dorsal side of forebrain.
- Secretes Melatonin for regulation of 24-hours rhythm, sleep-wake cycle, menstrual cycle, pigmentation etc.

3. Thyroid Gland :

- Has two lobes on either side of trachea interconnected by isthmus (connective tissue).
- Composed of follicles and stromal tissues.
- Follicular cells synthesise thyroxine (T_4) and tri-iodothyronine (T_3).
- Iodine is necessary for normal functioning of thyroid.
- **Goitre (Hypothyroidism) :** Enlargement of thyroid gland; Hypothyroidism may lead to mental retardation and stunted growth (cretinism) Deaf-mutism in the baby if it occurs during pregnancy.
- **Hyperthyroidism :** Occurs due to cancer or due to development of nodules in thyroid glands, affects body physiology as abnormally high levels of thyroid hormones is synthesised. Basic metabolic rate increases.
- **Exophthalmic goitre :** It is a form of hyperthyroidism, characterised by enlargement of thyroid gland, protrusion of eye balls and increased BMR
- Thyroid hormone controls carbohydrates, proteins & fats metabolism.
- Also secretes a protein hormone called Thyrocalcitonin (TCT) which regulates blood calcium level.

4. Parathyroid Gland :

- Present on back side of thyroid gland. Each lobe of thyroid gland has its one pair.
- Secrete peptide hormone called parathyroid hormone (PTH) which increases calcium levels in blood so called **hypercalcemic** hormone.
- PTH stimulates bone resorption, and reabsorption of calcium from blood and reabsorption of calcium by renal tubules, thus increasing blood Ca^{++} level.

5. Thymus Gland

- Located on dorsal side of heart and aorta.
- Secrete peptide hormones called Thymosins which play role in differentiation of T-lymphocytes (help in cell mediated immunity.)
- Thymosins also produce antibodies and provide humoral immunity.
- Immunity of old people usually becomes weak as thymus gets degenerated with age.

6. Adrenal Gland

- Located at anterior part of each kidney.
- Has centrally located adrenal medulla and at periphery in adrenal cortex.
- **Adrenal medulla.**

1. **Adrenal medulla secretes** adrenaline (epinephrine) and nor adrenaline (norepinephrine), commonly called as catecholamines or emergency hormones or hormones of fight or flight.
2. These hormones increase heart beat, rate of respiration, breakdown of glycogen thus increase blood glucose level, breakdown of lipids and protein, alertness, raising of hairs, sweating etc.

- Adrenal Cortex-(3 layers) : Zona reticularis (inner layer)
  Zona fasciculata (middle layer)
  Zona glomerulosa (outer layer)
- **Adrenal cortex secretes :**

1. Androgenic steroids : (Secreted by Zona reticularis)

- Secreted in small amounts.
- Play role in growth of axial pubic and facial hair during puberty.

2. Glucocorticoids : (Secreted by fasciculata)

- Involved in carbohydrate metabolism.
- Stimulates gluconeogenesis, lipolysis and proteolysis.
- *e.g.,* Cortisol which is also involved in cardio-vascular and kidney functions.
- It also suppresses immune response and stimulates RBC production.

3. Mineralocorticoids : (Secreted Zona glomerulosa)

- Regulate balance of water and electrolytes in body.
- *e.g.,* Aldosterone which also helps in reabsorption of Na^+ and water. Excretion of K^+ and phosphates ions from renal tubules.

- When adrenal cortex is damaged, it does not produce enough cortisols (which regulate body's reaction to stressful situations) and aldosterone.
- It result in **Addison's disease**. Symptons of addison's disease are weak muscles, extreme fatigue, increased skin pigmentation, weight loss, sores in mouth and depression.

Two major adrenal insufficiency

- Primary adrenal insufficiency where our immune system mistakes adrenal for an antigen and tries to damage it.
- Secondary adrenal insufficiency-when pituitary gland can't produce ACTH

7. Pancreas : It is called composite/dual gland. As it acts as Exocrine and endocrine gland i.e. has both exocrine and endocrine function.

- Contains about 1-2 million islets of Langerhans which has glucagon secreting α-cells and insulin secreting β-cell.
- **Glucagon :** Peptide hormone, stimulates glycogenolysis by acting on liver cells. Also, stimulates gluconeogenesis. Hence called hyperglycemic hormone.
- **Insulin :** Peptide hormone, acts on hepatocytes and adipocytes to enhance cellular glucose uptake, stimulates conversion of glucose to glycogen (glycogenesis), so decrease blood glucose level. Hence called hypoglycemic hormone.
- Deficiency of insulin causes diabetes mellitus in which loss of glucose occurs through urine. Excessive hunger and thirst (polydipsia) are other symptoms of Diabetes.
- Insulin and glucagon are antagonistic hormones i.e. play opposite role.

  Glycogenolysis : Breaking of glycogen into glucose.

  Gluconeogenesis : Formation of glucose from substances other than glycogen.

  Glycogenesis : Conversion of glucose into glycogen.

8. Testis :

- A pair of testis composed of seminiferous tubules and interstitial cells is present in the scrotal sac of males.
- Leydig cells (interstitial cells) produce androgens (mainly testosterone) which regulate development and maturation of male accessory sex organs, formation of secondary sex characters and play stimulatory role in spermatogenesis. Male sexual behaviour (libido) is influenced by androgens.

9. **Ovary :** A pair of ovaries which produce one ovum in each menstrual cycle are present in abdomen in females.

- Ovary composed of ovarian follicles and stromal tissue.
- Estrogen synthesised by growing ovarian follicles helps in stimulation of growth of female secondary sex organs, female behaviour, mammary gland development and female secondary sex characters.
- Ruptured follicle form corpus luteum which secretes progesterone. Progesterone supports pregnancy and stimulates alveoli formation and milk secretion in mammary glands.

Hormones secreted by tissues which are not endocrine glands :

(a) Heart : Atrial wall secrets Atrial Natriuretic factor (ANF) which decreases blood pressure by dilation of the blood vessels.

(b) Kidney : Juxtaglomerular cells secretes erythropoietin which stimulates erythropoiesis (RBC formation).

(c) Gastro-intestinal tract : It secretes four peptide hormones.

- **Gastrin :** Acts on gastric glands and stimulates secretion of hydrochloric acid and pepsinogen.
- **Secretin :** Acts on pancreas and stimulates secretion of water and bicarbonate ion.
- **Cholecystokinin (CCK) :** Act on pancreas and gall bladder to stimulate secretion of pancreatic juice and bile juice respectively.

Gastric inhibitory peptide (GIP) : Inhibits gastric secretion and motility.

Mechanism of hormone action : By hormone receptors of two kinds, *i.e.*,

(a) Located on membrane of target cell

- These are membrane bound receptors.
- Form hormone receptor complex.

↓

Leads to biochemical changes in tissue.

↓

Release of second messengers like (cyclic AMP, IP_3, Ca^{2+} etc.) which regulate cellular metabolism.

(b) Located inside the target cell

- These are intra cellular receptors.
- Hormones (steroid hormones iodothyronines etc.) interact with them and cause physiological and developmental effects of regulating gene expression.

Questions

(SRT) Select Response Type Question (1 mark each)

1. Which to system coordinate and regulate physiological function of our body?
   (a) muscular system and endocrine system
   (b) neural system and muscular system
   (c) neural system, and endocrine system
   (d) endocrine system and reproductive system
2. What is the role of melanocyte stimulating hormone?
   (a) act on hepatic cells
   (b) act on melanocytes and regulate pigmentation of skin
   (c) act on ovarian follicles
   (d) act on osteocytes
3. Name the hormone which act antagonistically in order to regulate calcium level in blood?
   (a) Glucocorticoid and adrenocortical
   (b) Thyrocalcitonin and parathyroid hormone
   (c) Mineralocorticoid and Thyrocalcitonin
   (d) Parathyroid hormone and glucocorticoid

CONSTRUCTED RESPONSE TYPE (CRT)

Very Short Answer Questions (1 mark each)

4. Give the names of any one glucocorticoid and one mineralocorticoid.
5. How does Atrial natriuretic factor decrease blood pressure ?

6. Which structure is formed from ruptured follicle in females ? What is its role ?

7. Immunity of old persons becomes very week. Give reason.

Short Answer Questions-I (2 marks each)

8. What happens if a person suffers from prolonged hyperglycemia ?

9. What are the two modes through which the hypothalamus causes the release of hormones by pituitary gland ?

10. Androgen regulates the development, maturation and other important functions in human male. List them.

11. Mr. Akshay notices that his shoe size has progressively increased. He also observes that shape of his face is gradually changing with protruding lower jaw. What can be the cause for all changes. Name the disorder.

Short Answer Questions-II (3 marks each)

12. Define hormone and classify them on basis of their chemical nature.

13. How do oxytocin, progesterone and estrogen differ from each other ?

14. What are the disorders caused and the effects produced due to malfunctioning/ improper secretion from thyroid gland ?

15. Name the disease/disorder caused by :

    (a) Excessive secretion of Thyroid hormone in adults.

    (b) Insufficient amount of insulin secreted by pancreas.

    (c) Damage of adrenal cortex.

Long Answer Questions (5 mark each)

16. 'The master gland regulates a number of physiological functions in our body.' Give reasons and explain.

Answers

(SRT) Select Response Type Question (1 mark each)

1. (c) Nerual system and endocrine system.
2. (b) Acts on melanocytes and regulates pigmentation of skin.
3. (b) Thyrocalcitonin (TCT) and parathyroid hormone (PTH).

Very Short Answers (1 mark each)

4. Glucocorticoid—Cortisol; Mineralocorticoid—aldosterone.
5. By dilation of the blood vessels.
6. Corpus luteum which secrets progesterone.
7. Thymus gland degenerates with age.

Short Answer Questions-I (2 marks each)

8. Gets affected by diabetes mellitus which causes loss of glucose through urine and formation of harmful ketone bodies.
9. Anterior pituitary receives signals (hormones) from hypothamus via portal system and posterior pituitary receives signals directly from nerve endings of hypotatamus to which runs tell posterior pituitary.
10. Refer Points to Remember.
11. Increased secretion of growth hormone Acromegaly

Short Answers Questions-II (3 marks each)

12. Refer Points to Remember of this support material
13. Oxytocin causes milk ejection and contraction of uterus at time of child birth.

    Progesterone–causes milk secretion and maintains pregnancy.

    Estrogen : Refer Points to Remember.
14. Refer Points to Remember.
15. (a) Exophthalmic goitre (b) Diabetes

(c) Addison's disease

Long Answers Questions-II (3 mark each)

16. Explain the role of pituitary gland + Refer Points to Remember.

Case Study based question :

17. Read the following and answer any four questions from 17 (i) to 17 (v) given below :

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, 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 synthesized 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 enter 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.

(i) 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

(ii) Estrogen is secreted mainly by :

(a) GI tract

(b) Pancreas

(c) Growing ovarian follicles

(d) Thymus

(iii) 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 these

(iv) What measures, as an individual you would take to reduce your exposure to these harmful exenoestrogens?

(a) Eat local and organic food

(b) Use beauty products made from natural ingredients

(c) Do not use plastic lunch box and water bottles

(d) All of these

(v) **Assertion :** Estrogen belongs to the class of steroid hormones.

Reason : Cholesterol is the precursor used in synthesizing estrogen hormone.

(a) Both assertion & reason are true, and the reason is the correct explanation of the assertion.

(b) Both assertion and reason are true, but the reason is not the correct explanation of the assertion.

(c) Assertion is true but reason is false

(d) Both the assertion and reason are false

(SRT) Assertion and Reason type Questions-II : (1 mark each)

In each of the following questions, two statements are given, one is Assertion and other is Reason. Mark the correct answer as :

(a) Both assertion & reason are true, and the reason is the correct explanation of the assertion.

(b) Both assertion and reason are true, but the reason is not the correct explanation of the assertion.

(c) Assertion is true but reason is false

(d) Both the assertion and reason are false

18. **Assertion :** Hormone thyrocalcitonion has antagonistic effect to that of parathyroid hormone (PTH).

Reason : Thyrocalcitonin decreases the blood calcium level while parathyroid hormone increases blood calcium level.

19. **Assertion :** Immunity of old person becomes weak.

Reason : Thymus degenerates in old individuals.

Answers :

17. (i) (b) Estrogen, breast and prostate cancer

(ii) (c) Growing ovarian follicles

(iii) (d) All of these

(iv) (d) All of these

(v) (a) Both assertion & reason are true, and the reason is the correct explanation of the assertion

18. (a) Both assertion & reason are true, and the reason is the correct explanation of the assertion.

19. (a) Both assertion & reason are true, and the reason is the correct explanation of the assertion.