

EXAM
DRILLChemical Coordination
and Integration

ANSWERS

1. (c) : Parathyroid hormone regulates calcium and phosphate balance between blood and other tissues. It mobilises the release of calcium into the blood from the bones. It also increases calcium absorption from the intestines.

OR

(a) : Steroid hormones, *e.g.*, cortisol and estrogen both are lipid soluble hormones which can easily pass through the membrane into the cytoplasm and bind with intracellular receptors.

2. (c) : Parathyroid hormone regulates calcium levels in the blood, while melatonin hormone secreted by pineal gland also called sleep hormone and plays an important role in regulation of diurnal rhythm, influences metabolism, etc. ADH stimulates water resorption whereas oxytocin promotes contraction of the uterine muscle at the time of birth. Thyroxine regulates basal metabolic rate of the body and promote growth of body tissues.

3. (b) : Glucocorticoids, particularly cortisol is anti-inflammatory as it retards phagocytic activities of WBCs and thus suppresses inflammation reaction. It also reduces the number of mast cells which secrete histamine.

4. (d) : Pituitary gland is known as "the master endocrine gland" as it controls the functions of many other endocrine glands.

5. (b) : Graves disease is a thyroid enlargement in which the thyroid secretes excessive amount of thyroid hormone. It is characterised by exophthalmia (*i.e.*, protrusion, of eyeballs due to fluid accumulation), loss of weight, restlessness, etc.

6. Functions of thyroid hormones (T_3 and T_4) are :
(i) They regulate the metabolic rate of the body and thus maintain basal metabolic rate (BMR).

(ii) They maintain body temperature, as they increase heat production.

(iii) They stimulate protein synthesis and therefore promote growth of the body tissues.

(iv) They help in metamorphosis of tadpole into adult frog.

7. Gonadotropic hormones are the hormones secreted by the anterior lobe of pituitary, *e.g.*, follicle stimulating hormone (FSH) and luteinising hormone (LH).

FSH stimulates growth of ovarian follicles and the secretion of estrogen in females and spermatogenesis in males. LH

stimulates corpus luteum of ovary to secrete progesterone in females.

8. Oxytocin promotes contraction of the uterine muscle during labour and the amount secreted increases just before and during labour, thus it is called birth hormone.

9. Adrenaline

10. Prolactin release inhibiting hormone is an amino acid derivative hormone produced in the hypothalamus.

11. (b)

12. (a) : Polypeptide hormones being water soluble require extracellular receptors that generate second messengers, while lipid soluble hormones can pass through cell membranes and directly enter the cell.

13. (b)

14. (d) : Thymosin hormone influences cell-mediated immunity and plays important role in T-cell differentiation.

15. (i) (a) : Cushing's syndrome is caused by excess of cortisol which may be due to a tumour of the adrenal cortex.

(ii) (b)

(iii) (b) : Cushing's syndrome is caused due to hypersecretion of adrenal gland.

(iv) (d)

(v) (a) : Addison's disease is caused by the deficiency of mineralocorticoids and glucocorticoids. It is also caused by the destruction of adrenal cortex. Its symptoms include low blood sugar, low plasma Na^+ , high K^+ plasma, vomiting, diarrhoea and bronze-like pigmentation of skin.

16. (i) (b)

(ii) (b) : Hormones recognise target organs by the presence of specific receptor molecules on the plasma membrane of target organs. If these receptor molecules are removed then a hormone will be unable to give any response.

(iii) (a)

(iv) (c)

(v) (b) : FSH is a proteinaceous hormone. It does not enter its target cells, thus, it never reaches to cytoplasm. Instead, it binds to the receptor present on the cell membrane and activates a membrane bound enzyme that causes conversion of ATP to cAMP. This then alters the activities of enzymes in the cytoplasm.

17. Aldosterone is a steroid hormone released from the zona glomerulosa region of the adrenal cortex 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 maintenance of electrolytes, body fluid volume, osmotic pressure and blood pressure.

18. Differences between hormones and vitamins are as follows:

| S.No. | Hormones | Vitamins |
|-------|--|---|
| (i) | Hormones may be steroids, proteins, peptides or amino acids derivatives. | Vitamins are simple organic compounds such as amines. |
| (ii) | They are secreted by the animal in its own body. | They are mostly taken with food and rarely synthesised in body. |
| (iii) | They are effective in low concentration and their excess or deficiency may cause hormonal disorders. | They are needed in small quantity and their deficiency causes malfunctioning called avitaminosis. |

19. Cretinism caused by extreme hypothyroidism during fetal life, infancy or childhood. It is characterised by failure of body growth, mental retardation, slow heart beat, lower blood pressure, decrease in temperature, stunted growth, pot-belly, pigeon chest, protruding tongue, etc. It results from congenital lack of a thyroid gland or from failure of the thyroid gland to produce thyroid hormones. Iodine deficiency in diet during pregnancy is the major cause of cretinism.

20. Two disorders that occur due to abnormal secretion of parathyroid hormones are hypocalcaemic tetany and osteoporosis. Tetany is caused by hypoparathyroidism; deficiency of parathormone. Tetany is sustained contraction of the muscles of larynx, face, hands and feet.

Osteoporosis is due to excess of parathormone. It draws more calcium from bones, causes demineralisation, resulting in softening and bending of bones. This condition leads to osteoporosis.

21. The adrenal cortex is subdivided into three distinct zones :
(i) Zona glomerulosa : This is the outer zone and it secrete hormones called mineralocorticoids, mainly aldosterone.

(ii) Zona fasciculata : This is the middle zone which is widest of three zones. The cells of this zone secrete glucocorticoids, which affect glucose metabolism.

(iii) Zona reticularis : This is the inner zone and cells secrete gonadocorticoids.

22. Hypersecretion of adrenal gland leads to following disorders :

(i) Cushing's syndrome : It is caused by excess of cortisol which may be due to a tumor of the adrenal cortex. It is

characterised by high blood sugar, appearance of sugar in the urine, rise in plasma Na^+ , fall in plasma K^+ , rise in blood volume, high blood pressure and obesity.

(ii) Conn's syndrome or aldosteronism : Excessive production of aldosterone from an adrenal cortical tumor cause this disease. Its symptoms include a high plasma Na^+ , low plasma K^+ , rise in blood volume and high blood pressure.

(iii) Gynaecomastia : It is development of enlarged mammary glands in the males. It is due to excessive secretion of female sex hormones (estrogens) in males.

OR

During stress or emergency situations, adrenal gland releases adrenaline (epinephrine) hormone in blood which helps in quick actions to deal with the emergency situations. It induces 'fight or flight actions' by the body, thereby helping to deal with the situation. Hence, it is known as gland of emergency.

23. Cortisol, a glucocorticoid hormone secreted by zona fasciculata of adrenal cortex controls inflammatory responses. This hormone retards phagocytic activities of WBCs and thus suppresses 'inflammatory reaction'. It also reduces number of mast cells, secretion of histamine. Cortisol also stimulates RBC production and it is involved in maintaining cardiovascular functions as well as kidney functions.

24. Luteinising hormone (LH) in males activates Leydig's cells (interstitial cells) of testes to secrete androgens hence it may be called interstitial cell stimulating hormone (ICSH). Androgens control the spermatogenesis along with FSH. In females, LH stimulates steroid release from the ovaries. It stimulates corpus luteum of ovary to secrete progesterone. LH also helps control the menstrual cycle.

25. Following are some differences between hypoparathyroidism and hyperparathyroidism.

| S.No. | Hypoparathyroidism | Hyperparathyroidism |
|-------|---|---|
| (i) | It is deficiency of parathormone (PTH). | It is excess of PTH. |
| (ii) | It is due to accidental damage to the parathyroids or their blood supply during thyroidectomy. | It is usually due to formation of a tumor in the parathyroids. |
| (iii) | There is deficiency of calcium which leads to muscle twitches, spasms and convulsions. This condition is called parathyroid tetany or hypocalcaemic tetany. | The bones become soft, deformed and the destroyed bone tissues are replaced by cavities that are filled with fibrous tissues. Such bones are easily fractured. This condition is called osteoporosis. |

26. The hormones produced by ovaries include estrogens, progesterone, relaxin and inhibin.

(i) Estrogen produces 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, development of mammary gland and uterine epithelium.

(ii) Progesterone stimulates further development of the uterine epithelium and mammary glands. It is also required for the formation of the placenta and for the maintenance of pregnancy.

(iii) Relaxin is secreted by the corpus luteum only during the later stages of pregnancy and helps soften ligaments.

(iv) Inhibin hormone inhibits the FSH production from anterior lobe of pituitary gland.

OR

Functions of testosterone are :

(i) It regulates the development, maturation and functions of the male accessory sex organs like epididymis, vas deferens, seminal vesicles, prostate gland, etc.

(ii) It stimulates the development of the male secondary sexual characteristics like beard, moustache and low pitch male voice in man.

(iii) It plays a major role in the process of spermatogenesis (formation of spermatozoa).

(iv) It promotes the growth of many body tissues such as bones and muscles.

27. Diabetes mellitus (hyperglycemia) is the most common endocrine disorder of the pancreas. There are two general types of diabetes mellitus :

(a) Type I diabetes, also called insulin dependent diabetes mellitus (IDDM) : It is caused by lack of insulin secretion due to failure of beta-cells to produce insulin.

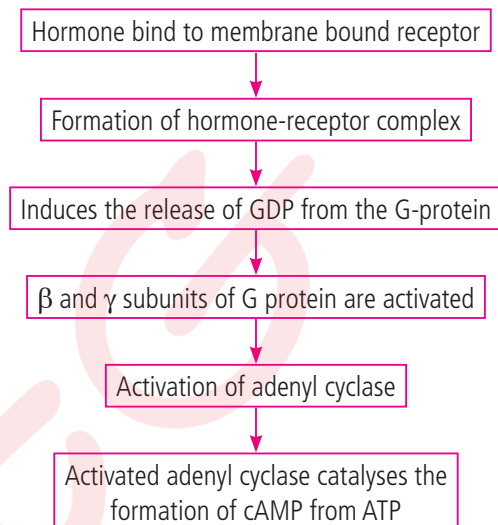
(b) Type II diabetes, also called non-insulin dependent diabetes mellitus (NIDDM) : It is due to failure of insulin to facilitate the movement of glucose into cells. In both disorders the blood glucose concentration is elevated above the normal range. Some of the glucose is excreted in the urine, and water follows the glucose, causing excessive urination and dehydration of body tissues. This causes excessive thirst (polydipsia). The cells are unable to utilise glucose and other carbohydrates for energy production. They utilise their proteins for it. The person becomes very weak. Degradation of fats increases, producing ketone bodies (ketosis).

28. (a) Peptide or protein hormone action mechanism is shown here. They are water soluble and bind to membrane

bound receptor and normally do not enter the target cell, but generate second messengers (e.g., cAMP, IP₃, Ca²⁺, etc.) which in turn regulate cellular metabolism.

(b) Second messengers are molecules inside cells that act to transmit signals from a receptor to a target, e.g., cGMP, Ca⁺⁺, etc.

(c) Flow chart showing generation of second messenger is as follows :



29. (a) Hypoglycemia is caused by an excess of insulin or deficiency of glucagon. It occurs when the blood glucose level falls below normal.

(b) Insulin is known as the hypoglycemic and glucagon is known as the hyperglycemic hormone.

(c) Two functions of hypoglycemic (insulin) hormone are :

(i) Insulin stimulates glycogenesis, i.e., converts glucose into glycogen in liver and muscles. (ii) It reduces catabolism of proteins and thus, is an anabolic hormone.

30. (a) Excessive production of aldosterone from an adrenal cortical tumour causes aldosteronism or Conn's syndrome.

(b) Functions : (i) It regulates sodium content of the body.

(ii) It helps in maintenance of electrolytes, osmotic pressure and blood pressure.

(c) It is a mineralocorticoid secreted from zona glomerulosa of adrenal cortex.

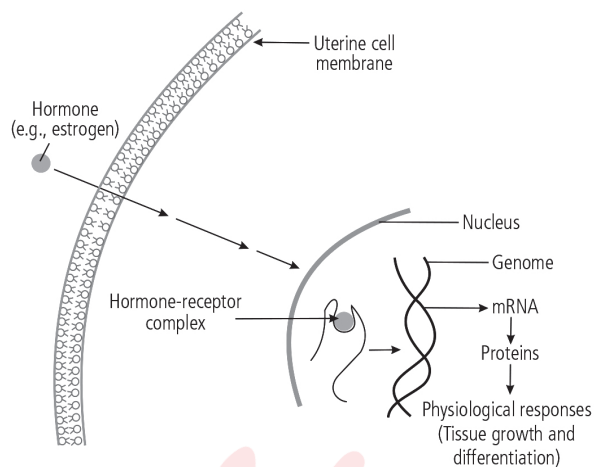
31. Hormone of adrenal gland are as follows:

| | | |
|---------------------|------------------------------|---|
| (a) Adrenal medulla | (i) Adrenaline (epinephrine) | It is also called emergency hormone as it is secreted at time of emergency or stress. It is responsible for fight or flight response. |
|---------------------|------------------------------|---|

| | | |
|--------------------|---------------------------------------|---|
| | (ii) Nor-adrenaline (nor epinephrine) | It regulates blood pressure under normal conditions. It increases heart activity, pupil dilation, etc. |
| (b) Adrenal cortex | (i) Mineralo-corticoid; Aldosterone | It regulates mineral metabolism. Its main function is to regulate the sodium content of the body. |
| | (ii) Glucocorticoid; Cortisol | It stimulates gluconeogenesis, lipolysis and proteolysis and inhibit cellular uptake and utilisation of amino acid. It is anti-inflammatory and also an immunosuppressive. It is called stress hormone. |
| | (iii) Gonadocorticoids | Androgens in males and estrogens in females stimulate the development of secondary sexual characters. |

OR

Steroid hormones are lipid soluble and easily pass through the cell membrane of a target cell into the cytoplasm. In the cytoplasm they bind to specific intracellular receptors to form a hormone receptor complex that enters the nucleus. In the nucleus, hormones which interact with intracellular receptors *i.e.*, steroid hormones, iodothyronines, etc. mostly regulate gene expression or chromosome function by the interaction of hormone receptor complex with the genome. Biochemical actions result in physiological and development effect (tissue growth and differentiation, etc.). Hormone receptor complex binds to a specific regulatory site on the chromosome and activates certain genes. The activated genes transcribes mRNA which direct the synthesis of protein and usually enzymes in the cytoplasm. These enzymes promote the metabolic reactions in the cell. The diagrammatic representation of the mechanism of steroid hormone is given below :



32. The parathyroid glands consist of four separate glands located on the posterior surface of the lobes of the thyroid gland. The cells of parathyroid glands are of two types : chief cells and oxyphil cells. The chief cells of the parathyroids secrete parathormone or parathyroid hormone (PTH). It is also called Collip's hormone.

Functions of this hormone are as follows :

- (i) It regulates the calcium and phosphate balance between the blood and other tissues.
- (ii) It inhibits collagen synthesis by osteoblasts.
- (iii) It mobilises the release of calcium into the blood from the bones.

Disorders of Parathyroid gland are :

(a) Hypoparathyroidism (Deficiency of PTH) :

- (i) It causes the lowering of blood calcium level.
- (ii) Some skeletal muscles, usually of hand and feet, fail to relax after a contraction and remain in sustained contraction. This is called tetany.

(b) Hyperparathyroidism (excess of PTH) :

- (i) Osteoporosis : Excess of PTH draws more calcium from the bones. It causes demineralisation, resulting in softening and bending of the bones. Some of the bone substance is replaced by cavities that are filled with fibrous tissues, and this condition leads to osteoporosis.

OR

(a) Hyperthyroidism (Hypersecretion of thyroid hormone)

- (i) Exophthalmic goitre or Graves' disease : It is a thyroid enlargement in which the thyroid secrete excessive amount of thyroid hormone. The symptoms of Graves' disease include protruding eyes (exophthalmia), weight loss, increased appetite, restlessness, heat sensitivity, fatigue, muscle cramps, frequent bowel movement, rapid heartbeat, nervousness and blurred vision.

(b) Hypothyroidism (Hyposecretion of thyroid hormone)

(i) **Myxoedema** : It is caused by deficiency of thyroid hormone in adults and is characterised by puffy appearance due to accumulation of fat in subcutaneous tissue because of low metabolic rate. The patient lacks alertness, intelligence and initiative. They also suffer from slow heartbeat, low body temperature and retarded sexual development.

(ii) **Cretinism** : It is caused by hypothyroid deficiency in infants. It is characterised by failure of body growth, mental retardation, slow heartbeat, lower blood pressure, decrease in temperature, stunted growth, pot-belly, pigeon chest and protruding tongue. This can be treated by an early administration of thyroid hormones.

(iii) **Goitre** : It is caused by deficiency of iodine in diet because iodine is needed for the synthesis of thyroid hormone. It causes thyroid enlargement.

(iv) **Hashimoto's disease** : It is an autoimmune disease in which the thyroid gland is destroyed by autoimmunity.

33. The posterior pituitary is composed mainly of glial-pituicytes. They do not secrete any hormone but release two hormones (i) oxytocin and (ii) vasopressin or antidiuretic hormone (ADH), which are synthesised by hypothalamus.

(i) **Oxytocin** : Oxytocin stimulates contraction of the pregnant uterus specially towards the end of gestation. It also plays an important role in lactation. In lactation, oxytocin causes milk to be expressed from the alveoli into the ducts of the breast so that the baby can obtain it by suckling. Because of its role, oxytocin is also called birth hormone and milk ejecting hormone.

(ii) **Vasopressin or antidiuretic hormone (ADH)** : It increases the reabsorption of water in the distal convoluted tubule and collecting ducts of the nephrons of the kidney. As a result, the reabsorption of water from the glomerular filtrate is increased. In the absence of ADH, the collecting tubules and ducts become almost impermeable to water, which prevents significant reabsorption of water and therefore allows extreme

loss of water into the urine, also causing extreme dilution of the urine. This condition is known as diabetes insipidus.

OR

Pancreas is a composite gland which acts as both exocrine and endocrine gland. Pancreatic duct runs through the glands, carrying enzymes and other secretions from pancreatic acinas cells to small intestine.

Mainly following three kinds of cells have been identified in the islets :

(i) **Alpha cells** : Constitute about 15 per cent of all the cells of the islets. They secrete glucagon.

(ii) **Beta cells** : Constitute about 65 per cent of all the cells of the islets. They produce insulin.

(iii) **Delta cells** : Constitute about 5 percent of all the cells of the islets. They produce somatostatin.

In addition, one other type of cell called PP cells or pancreatic polypeptide cells are present in small number in the islets and secrete a hormone of uncertain function called pancreatic polypeptide. These cells also constitute about 15 per cent of all the cells.

Functions of the hormones of pancreas are :

(i) **Glucagon** plays an important role in maintaining the normal blood glucose levels, it stimulates the hepatocytes to convert stored glycogen into glucose (glucogenolysis). It is also called an 'anti-insulin' hormone.

Low blood glucose : Glycogen $\xrightarrow{\text{Glucagon}}$ Glucose

(ii) **Insulin** plays a major role in the regulation of glucose homeostasis. It acts mainly on the hepatocytes and adipocytes and enhances cellular glucose uptake and utilisation.

(iii) **Insulin** promotes protein synthesis in tissues from amino acids.

(iv) **Insulin** reduces catabolism of proteins.

(v) **Insulin** stimulates glycogenesis.

High blood glucose : Glucose $\xrightarrow{\text{Insulin}}$ Glycogen

