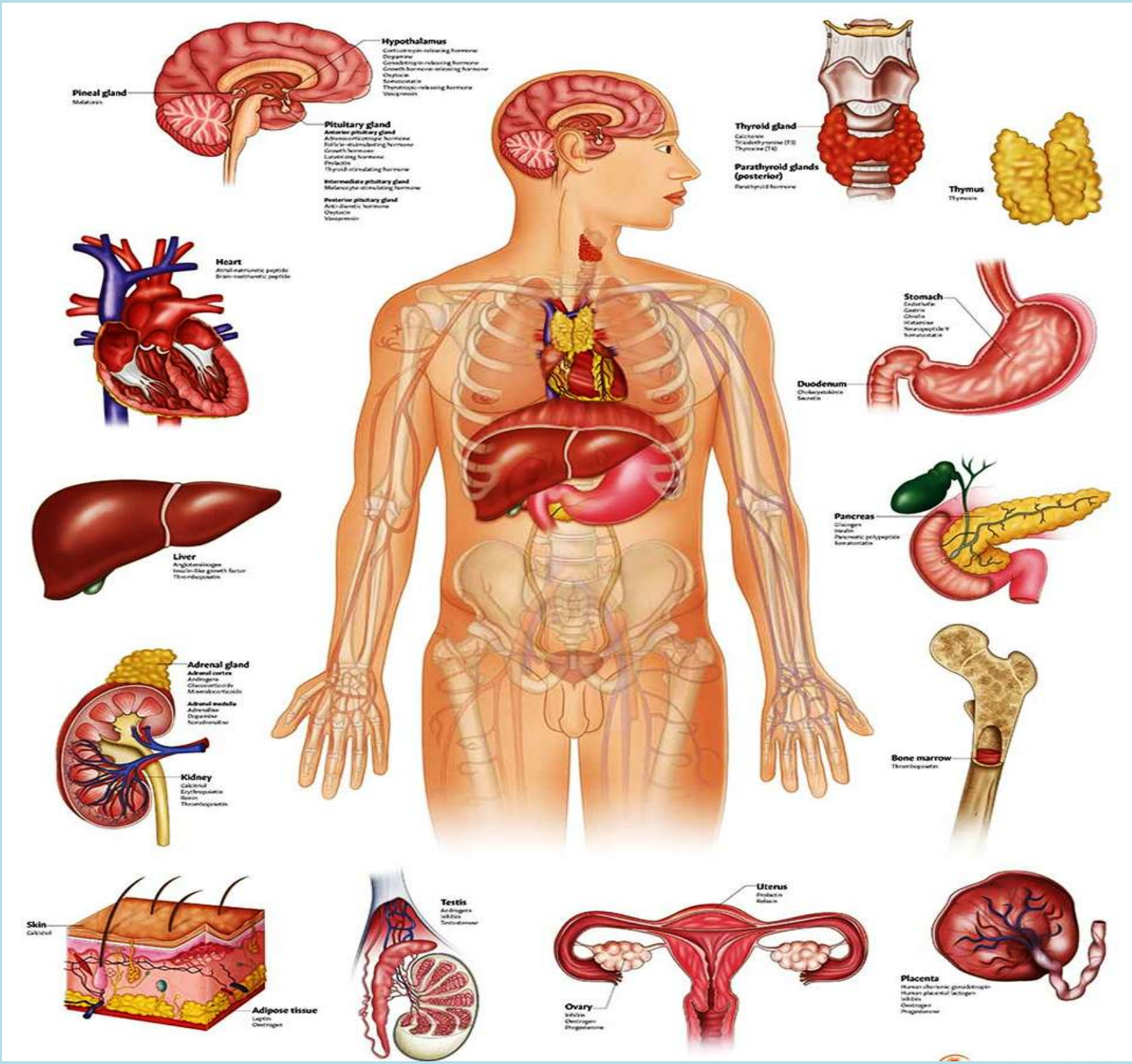
THE ENDOCRINE SYSTEM



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Contents

THE ENDOCRINE SYSTEM

Introduction

- The endocrine system is a network of glands and organs throughout the body that produce and release hormones.
- The primary function of the endocrine system is to coordinate and regulate bodily processes such as metabolism, growth and development, reproduction, mood, and responses to stress.
- The endocrine system is composed of **glands** and their chemical messengers called **hormones**.

Hormones

- Hormones are chemical messengers produced by glands and tissues in the body.
- They are secreted into the bloodstream and travel to target cells or organs where they exert specific effects on physiological processes.
    - Hormones act as chemical messages, produced in one part of the body but having an effect somewhere entirely different.
- Many processes in the body are coordinated by hormones.
- Hormones play a crucial role in regulating various bodily functions, including metabolism, growth and development, reproduction, mood, and responses to stress.
- Most hormones only affect certain tissues or organs (their target organ) and the hormone is picked up from the blood by receptors in the cell membranes.
    - Although hormones reach all parts of the body, only target cells with receptors respond.
- They can have diverse effects depending on their type and target cells.
    - Some hormones stimulate certain activities, while others inhibit them.
- Hormones work in concert with the nervous system to maintain homeostasis.
- They can act rapidly but often slower and long lasting than the nervous system.
    - Hormonal signaling is essential for modulating long-term processes and maintaining overall bodily balance.
- Examples of hormones include insulin, adrenaline, and estrogen and testosterone.

Endocrine Glands

- Endocrine glands are ductless glands of the endocrine system that secrete hormones directly into the blood.
- Exocrine glands are not part of the endocrine system.
  - Many glands in our body are exocrine glands.
  - They have a special tube or duct that carries the secretion from the gland to the place where it is needed.
  - Sweat glands, salivary glands and mammary glands are all examples of exocrine glands.

Aspect	Endocrine Glands	Exocrine Glands
Location	Ductless glands located throughout the body	Glands with ducts that lead to a body surface or cavity
Secretions	Hormones	Enzymes, mucus, sweat, saliva, digestive juices, etc.
Mode of Secretion	Secretion directly into the bloodstream	Secretion via ducts to the body surface or a cavity
Target	Target cells or organs located at a distance from gland	Target areas in close proximity to the gland
Function	Regulation of various physiological processes	Facilitation of digestion, lubrication, protection, etc.
Examples	Pituitary gland, thyroid gland, adrenal glands, pancreas	Salivary glands, sweat glands, sebaceous glands, etc.

Table 1. Key differences between endocrine and exocrine glands

The Major Endocrine Glands

- The endocrine system includes the hypothalamus, pituitary gland, thyroid gland, parathyroid glands, pineal gland, thymus, adrenal glands, gonads, and pancreas.

Hypothalamus

- It connects the nervous system to the endocrine system.
- It translates electrical signals into hormones.
  - Hormones flow to the pituitary gland by infundibulum (pituitary stalk).
- Some of the hormones produced by the hypothalamus are listed below:

Thyrotropin-releasing hormone (TRH)

- Stimulates the release of thyroid-stimulating hormone (TSH) from the anterior pituitary gland.

Corticotropin-releasing hormone (CRH)

- Stimulates the release of adrenocorticotropic hormone (ACTH) from the anterior pituitary gland.

Gonadotropin-releasing hormone (GnRH)

- Stimulates the release of follicle-stimulating hormone (FSH) and luteinizing hormone (LH) from the anterior pituitary gland.

Growth hormone-releasing hormone (GHRH)

- Stimulates the release of growth hormone (GH) from the anterior pituitary gland.

Somatostatin

- Inhibits the release of growth hormone (GH) from the anterior pituitary gland.

Dopamine (Prolactin-inhibiting hormone)

- Inhibits the release of prolactin (PRL) from the anterior pituitary gland.

Oxytocin

- It stimulates uterine contractions during childbirth and facilitates milk ejection during breastfeeding.
- It also plays a role in social bonding, trust, and stress regulation.

Vasopressin (Antidiuretic Hormone, ADH)

- It regulates water balance by controlling water reabsorption in the kidneys.
- Vasopressin helps maintain blood pressure and prevent dehydration.
    - It also constricts blood vessels, increasing blood pressure when needed.
- ADH and oxytocin are synthesized in the hypothalamus but stored and released from the posterior pituitary gland.

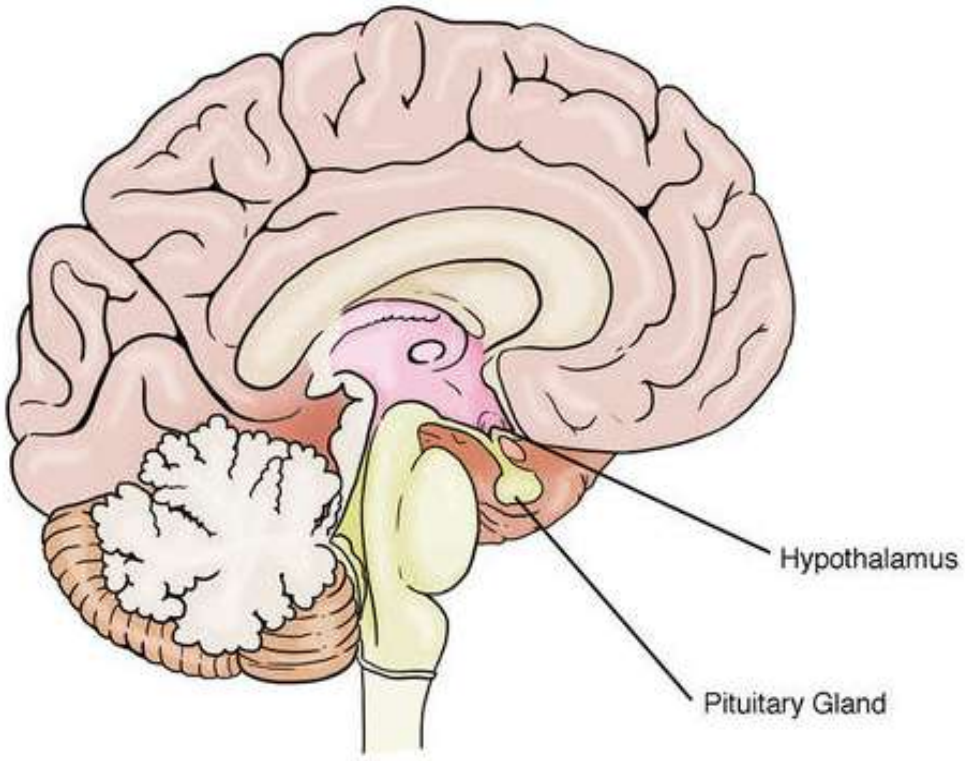


Figure 1. Hypothalamus and Pituitary gland

The Pituitary Gland

- It is located at the base of the brain, below the hypothalamus.
- It is about the size of a pea.
- It is considered the master gland because it controls the secretion of many other hormones.
- It involves in the coordination between the nervous system and endocrine system.
- It is divided into anterior lobe and posterior lobe.
    - The anterior lobe is three times larger.

Anterior Pituitary Gland (Adenohypophysis)

- It makes peptide hormones.
- Its secretion is regulated by hypothalamus.
    - Most hypothalamic hormones are releasing hormones
    - Hypothalamus also makes inhibiting hormones.
- Its hormones play a major role in the control of metabolic functions.
- It secretes six major peptide hormones.

Growth Hormone (GH)

- It promotes growth.
    - It enhances protein synthesis in various tissues.
    - It stimulates cell multiplication, particularly in tissues undergoing growth and repair.
    - It plays a role in cell differentiation, particularly during development and tissue repair.
- It is high in quantity during childhood and adolescence.
- Insufficient production or secretion of growth hormone causes **pituitary dwarfism** in children.
- When children produce too much growth hormone (GH), **gigantism** can occur.
- Excess growth hormone (GH) in adults results in a condition known as **acromegaly**.

Adrenocorticotropin (Corticotropin)

- It controls adrenocortical hormones (corticosteroids).
    - Corticosteroids are produced by adrenal cortex.
    - They regulate metabolism.

Thyroid-stimulating hormone (Thyrotropin)

- It controls secretion rate of thyroxine and triiodothyronine.
  - These hormones control the rate of chemical reactions.

Prolactin

- It is associated with lactation (milk production)
- It stimulates mammary glands.
- Elevated levels of prolactin can suppress ovulation.
- It helps regulate testosterone levels and sperm production in males.

Follicle stimulating hormone (FSH)

- It stimulates the growth and development of ovarian follicles.
  - Each follicle contains and immature egg.
  - Within the follicle, the egg matures and ripens.
- It also stimulates the ovaries to produce hormones, particularly estrogen.
  - Estrogen prepares endometrium for implantation.

Luteinizing hormone (LH)

- It triggers ovulation (the release of the egg from the ovary).
- It stimulates the development of corpus luteum after ovulation.
  - Corpus luteum secrets progesterone and prepares the uterus for pregnancy.

Posterior Pituitary Gland (Neurohypophysis)

- It stores and releases hormones produced by hypothalamus.
  - It does not synthesize its hormone.

Antidiuretic hormone (ADH) or vasopressin

- It regulates rate of water excretion
- It acts on the kidneys.
  - It increases water reabsorption.
  - It reduces urine output.
- It constricts blood vessels.
  - It raises blood pressure when necessary.

- The undersecretion of ADH is the cause of diabetes insipidus.
  - disrupted water balance in the body
  - excessive urination and thirst

Oxytocin

- It is best known for its role in stimulating uterine contractions during childbirth.
- It plays a role in breastfeeding by stimulating the ejection of milk from the mammary glands.
- It may play a role in sexual arousal and orgasm, particularly in females.
- It plays a role in social bonding and maternal behaviour.

Thyroid Gland

- It is a small, butterfly-shaped endocrine gland located below the larynx.
- It consists of two connected lobes, one on each side of the trachea.
  - The two lobes are connected by a narrow band of tissue called the **isthmus**.
- It produces three main hormones: thyroxine (T4), triiodothyronine (T3), and calcitonin.
  - T4 and T3 regulate metabolism.
  - Calcitonin decreases blood calcium and phosphate levels.

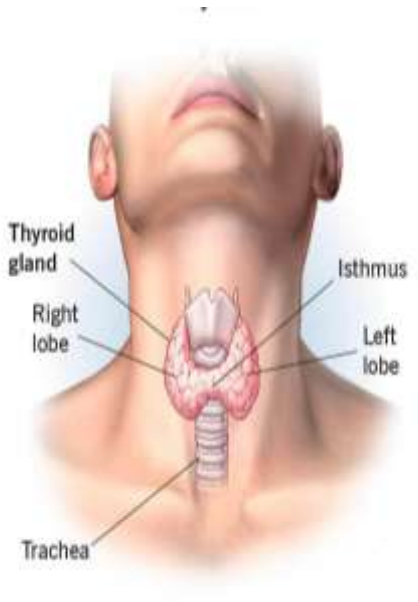


Figure 2. Thyroid gland

Thyroxine (T4)

- Thyroxine is a thyroid hormone composed of four iodine atoms.
- Its production is regulated by thyroid-stimulating hormone (TSH) released by the pituitary gland.
- Thyroxine is a prohormone and is converted into the more biologically active triiodothyronine (T3) in peripheral tissues.
- It plays a role in regulating metabolism and energy production in the body.

- It increases basal metabolic rate (BMR).
    - ✓ BMR is the amount of energy expended by the body at rest to maintain basic physiological functions.
- It increases oxygen consumption, heat production, and energy expenditure by cells.
- It also enhances the breakdown of carbohydrates, fats, and proteins.
- It influences the function of virtually every organ system.

- Abnormally low or high levels of thyroxine can have significant effects on metabolism, energy levels, and overall health.
- Hyposecretion of thyroxine (Hypothyroidism) can be caused by:
    - Autoimmune thyroiditis (Hashimoto's thyroiditis)
    - Iodine deficiency
    - Thyroid surgery
- One common manifestation of hypothyroidism is the development of a **goiter**.
    - A goiter is an enlargement of the thyroid gland, often visible as a swelling in the front of the neck.
    - The goiter is a compensatory response to the thyroid gland's inability to produce adequate amounts of thyroid hormones.
- The lack of thyroid hormone production or action during fetal development or infancy causes **cretinism**.
    - Severe intellectual disability, delayed growth and development, poor muscle tone, and lethargy
    - Physical deformities (short stature, coarse facial features, abnormally large tongue)
    - Goiter (enlarged thyroid gland)
    - Constipation
    - Hoarse cry
    - Dry and cool skin
- Iodine deficiency disorders are very common in Ethiopia.
    - Women and children are more likely to be diagnosed with hypothyroidism than men.
    - The problem is worse in rural areas, particularly in the mountainous regions.

- The solution for most of the problems of iodine deficiency and goiter is to include more iodine in our diet.

- Hypersecretion of thyroxine (Hyperthyroidism) can be caused by:
  - Graves' disease
    - ✓ Autoimmune disorder stimulating excessive thyroid hormone production.
  - Thyroiditis
  - Excessive iodine intake
  - Pituitary or thyroid tumors
  - Thyroid hormone resistance

Triiodothyronine (T3)

- It contains three iodine atoms and it is more biologically active than thyroxine (T4).
- It is the more potent thyroid hormone and has a faster onset of action.
- It increases basal metabolic rate (BMR) more rapidly than T4, leading to increased energy expenditure and heat production.
- Its secretion is regulated by thyroid-stimulating hormone (TSH).
- Abnormal levels of T3 can indicate thyroid disorders such as hyperthyroidism (excess hormone production) or hypothyroidism (insufficient hormone production).

Calcitonin

- It plays a crucial role in regulating calcium levels in the blood.
  - When blood calcium levels are elevated, calcitonin is released by the thyroid gland.
- Calcitonin acts to lower blood calcium levels.
  - It helps promote the deposition of calcium into bones.
  - It reduces calcium concentration in the bloodstream.
- It can influence phosphate levels through its actions on bone and kidney function.

Parathyroid Glands

- They are four small, oval-shaped glands located on the back surface of the thyroid gland.
- They release parathyroid hormone (PTH).
  - PTH plays a crucial role in calcium homeostasis.

- ✓ It is secreted in response to low blood calcium levels.
- ✓ It acts to increase calcium levels in the bloodstream.

- PTH increases blood calcium levels through several mechanisms:
  - ➢ Bones release calcium (Stimulation of bone resorption)
  - ➢ Intestines absorb more calcium
  - ➢ Kidneys keep calcium in blood
- Excessive production of PTH (hyperparathyroidism) causes **Osteitis fibrosa cystica (OFC)**.
  - ➢ It is characterized by the loss of bone mass and weakening of the bones.
- Insufficient production of PTH leads to **tetany**.
  - ➢ It is characterized by involuntary muscle contractions or spasms.

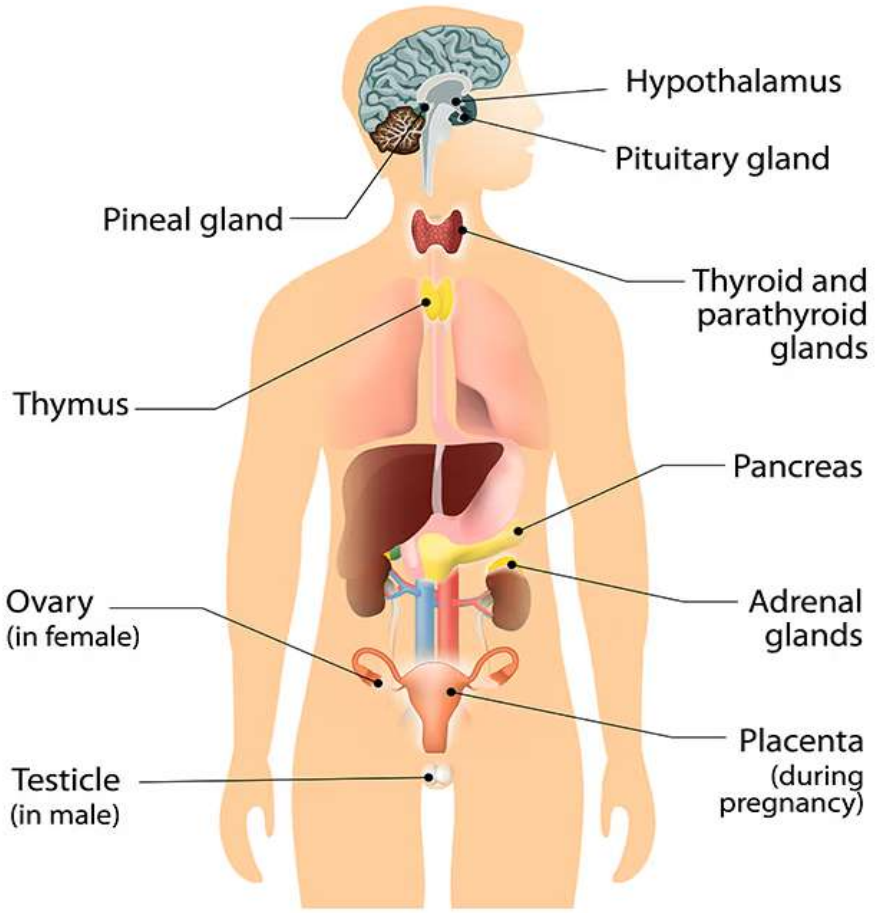


Figure 3. The Human Endocrine System

Adrenal Glands

- They are small, triangular-shaped glands located on top of each kidney (Suprarenal glands).
- They are composed of two parts: Cortex and Medulla.

Adrenal Cortex

- It is the outer portion.
- It has 3 regions: zona glomerulosa, zona fasciculata and zona reticulosa.
  - The zona glomerulosa is the outermost layer of the adrenal cortex.
- It produces several steroid hormones.

Aldosterone

- It is primarily synthesized and secreted by the zona glomerulosa.
- It acts on the kidneys to enhance the reabsorption of sodium ions (Na^+) from the urine.
  - Aldosterone indirectly promotes water retention.
- It stimulates the secretion of potassium ions (K^+) into the urine.

Glucocorticoids (Cortisol)

- It is primarily synthesized and secreted by the zona fasciculata.
- It stimulates the breakdown of glycogen.
- It promotes the synthesis of glucose from non-carbohydrate sources.
- Cortisol also plays a vital role in immune function, stress response, and maintaining overall homeostasis in the body.

Androgens

- Zona reticularis is the source of androgen production in both males and females.
- Adrenal androgens include dehydroepiandrosterone (DHEA) and DHEA sulfate (DHEA-S).
- They play a role in the development of secondary sexual characteristics during puberty.
- They contribute to sexual desire and libido in both males and females.
- Androgens help maintain bone density and strength.

Adrenal Medulla

- It is the inner portion.
- It is under direct regulation of ANS.
- It produces and secretes epinephrine (adrenaline) and norepinephrine (noradrenaline)
  - ➢ They are closely related hormones
  - ➢ Similar in chemical structure and physiological effects
  - ➢ Released in response to stress, danger or excitement
    - ✓ "fight or flight" response
- The main changes produced by adrenalin are:
  - ➢ Pupils dilate
  - ➢ Increased heart rate
  - ➢ Increased breathing rate
  - ➢ Body hair stands on end
  - ➢ Increased mental awareness and speed of reaction times
  - ➢ Stored carbohydrate in the liver is converted into glucose
  - ➢ Blood is diverted away from the gut and into the big limb muscles
- Chronic exposure to stress and elevated adrenaline levels can increase the risk of hypertension, heart disease, and stroke.

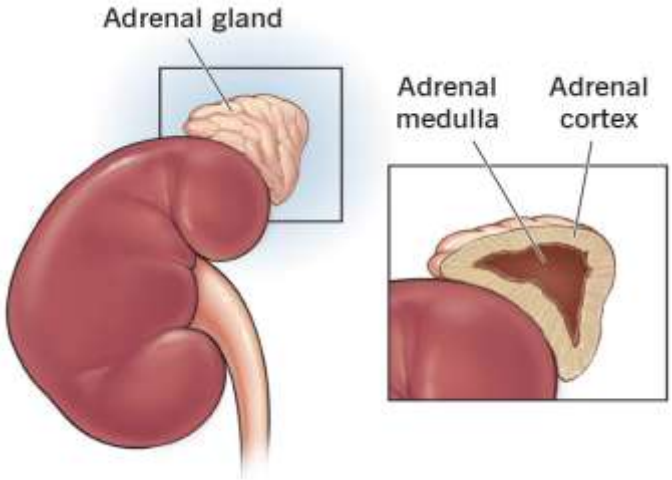


Figure 4. Adrenal gland

Pancreas

- A small pink organ located behind the stomach, close to the small intestine.
- It has both exocrine and endocrine function.
  - It consists of 99% exocrine tissue.
- The Islets of Langerhans (Pancreatic islets) are responsible for producing and secreting hormones.
  - Islet is a portion of tissue structurally distinct from its surroundings.
- The islets contain different types of endocrine cells, each producing specific hormones.
  - Alpha cells: Produce glucagon
  - Beta cells: Produce insulin
  - Delta cells: Produce somatostatin (GHIH)
- Thus, the pancreatic islets are microorgans within the pancreas responsible for producing and releasing hormones that regulate blood sugar levels (Insulin and Glucagon).

Insulin

- It is a peptide hormone produced by beta cells of the pancreatic islets.
- After consuming meals, blood glucose levels tend to increase.
- The pancreas usually produces more insulin after eating a meal.
  - Insulin reduces blood glucose level.
  - Insulin stimulates the liver to convert excess glucose into glycogen.
- It facilitates the uptake, utilization and storage of glucose.
  - It converts excess glucose into glycogen.
  - It facilitates glucose oxidation by promoting uptake of glucose
  - It converts glucose to fat (lipogenesis) in adipose tissue and the liver.
  - It regulates the rate at which amino acids are catabolized into water and CO_2.
- Hypersecretion of insulin causes hyperinsulinism (hypoglycemia and weight gain).
- Hyposecretion of insulin causes **diabetes mellitus**.
- Diabetes mellitus is a group of metabolic disorders characterized by high blood sugar levels (hyperglycemia) over a prolonged period.

- The symptoms of Diabetes mellitus are:
  - Frequent urination, excessive thirst, increased hunger
  - Weight loss, fatigue and weakness
  - Blurry vision
  - Slow wound healing and frequent infections
- There are several types of diabetes, each with distinct causes, characteristics, and management approaches.

Type I diabetes (T1D)

- It is also known as insulin-dependent diabetes or juvenile diabetes.
  - It typically develops during childhood or adolescence.
- It is an autoimmune disorder
  - The immune system mistakenly attacks and destroys insulin-producing beta cells.
  - The exact trigger for this autoimmune response is not fully understood.
- Little or no insulin production
- Type 1 diabetes symptoms can appear suddenly and may include:
  - urinating a lot
  - feeling more thirsty than usual
  - feeling very hungry
  - losing weight without trying
  - feeling irritable
  - feeling tired and weak
  - having blurry vision
- Diagnosis is typically made based on symptoms, blood tests, and detection of autoantibodies against beta cells.
- Poorly controlled T1D can lead to long-term complications, including cardiovascular disease, kidney disease, nerve damage (neuropathy), eye damage (retinopathy), foot problems, and increased risk of hypoglycemia (low blood sugar) and diabetic ketoacidosis (DKA).
- Treatment focuses on replacing the lost insulin through insulin therapy which is usually administered via injections.

- Insulin injections treat diabetes successfully but they do not cure it.
- Insulin injections keep the blood sugar level within safe limits.

- For many years insulin from pigs and cows was used to treat affected people.
  - There are allergic reactions and immune responses associated with animal insulin.
- In recent years, genetically modified bacteria are used to produce pure human insulin.

Type II diabetes (T2D)

- It is also known as non-insulin-dependent diabetes or adult-onset diabetes.
- It is the most common form of diabetes.
- Insulin resistance is a key feature of T2D.
  - Cells become less responsive to the action of insulin.
  - There will be impaired glucose uptake by cells.
- It is associated with obesity, physical inactivity, unhealthy diet and over-eating.
- Advancing age is a risk factor for T2D, with the incidence of the condition increasing with age.
- Control of type 2 diabetes involves healthy eating, regular physical activity, weight management, blood sugar monitoring, medication (if necessary), and regular medical care.
  - Insulin therapy in type 2 diabetes addresses insulin resistance by providing higher insulin levels, which can partially overcome the resistance.
  - Exercise can increase the number and sensitivity of insulin receptors on cell surfaces, particularly in muscle cells.
- In Ethiopia, there are relatively low rates of reported diabetes but it often causes many problems.
  - Many people suffering from diabetes are not diagnosed.
  - They may suffer symptoms and die without ever having treatment.

Glucagon

- It is a hormone produced by the alpha cells of the pancreas.
- It plays a crucial role in regulating blood sugar levels.
  - Glucagon acts in opposition to insulin.
- Blood glucose concentration of about 90 mg/dL is considered normal for a fasting state in adults.
- When the blood glucose concentration falls below the ideal range, glucagon is secreted.

- The primary stimulus for glucagon is low blood glucose level.

- Its main function is to increase blood glucose levels.
  - It stimulates the breakdown of glycogen stored in the liver into glucose (glycogenolysis)
  - It promotes the synthesis of glucose from amino acids in the liver (gluconeogenesis).
  - It stimulates the release of fatty acids from adipose tissue.
    - ✓ Fatty acids are used as an alternative energy source during low blood sugar.
- Excessive levels of glucagon can lead to persistent elevation of blood sugar levels (hyperglycemia).
- Insufficient glucagon production or release increases the risk of severe hypoglycemic episodes.

The Gonads (Ovary and Testis)

- They are organs responsible for producing gametes (sex cells) and sex hormones.
- In females, the ovaries are located in the pelvis, one on each side of the uterus and in males, the testes are located within the scrotum.
- At puberty, the gonads undergo significant changes.
  - In males, the testes enlarge significantly, initiating spermatogenesis and testosterone secretion.
  - In females, the ovaries undergo changes including the maturation of ovarian follicles, secretion of estrogen and progesterone and initiation of the menstrual cycle.
- Puberty is controlled by hormones from the pituitary gland and from the gonads themselves.

Ovaries

- They are two walnut-sized organs located low in the abdomen in either side of the uterus.
- They are closely associated with the uterus and the Fallopian tubes, but are not actually attached to them.
  - The suspensory ligaments attach each ovary to the pelvic sidewall.
- They produce eggs and hormones : Estrogen and Progesterone.
- They are stimulated by FSH to become active and start producing estrogen.

Estrogen

- A group of hormones primarily produced by the ovaries in females.
  - Estradiol (most potent), estrone and estriol
- It is produced by the follicle cells of ovary.
- It stimulates the maturation of ovarian follicles and triggers ovulation.
- It promotes growth of endometrial lining of uterus.
- It plays a key role in the development of female secondary sexual characteristics.

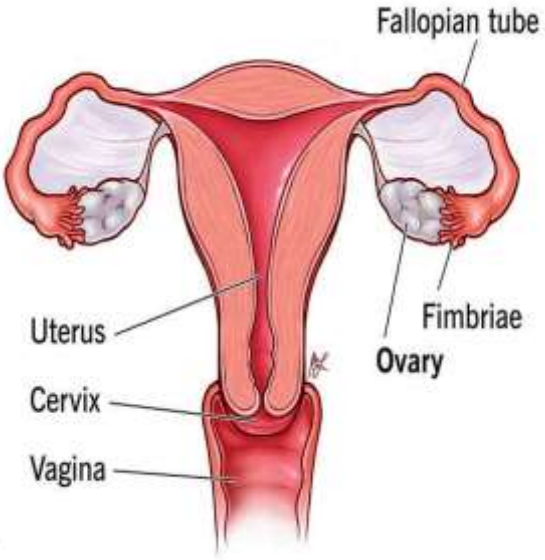


Figure 5. Ovaries

- The secondary sexual characteristics in females include:
  - Adolescent growth spurt, Breast development, Growth of pubic hair
  - The external genitalia become larger and the colour of the skin darkens
  - More subcutaneous fat in the hips, thighs, and buttocks
  - The ovaries begin the production of mature ova and menstruation begins
  - The uterus grows and begins to produce a thickened lining each month
  - The brain changes too as she make the transition from girl to woman.

Progesterone

- It is produced by corpus luteum following ovulation.
  - LH stimulates corpus luteum to produce and secrete progesterone.
- It promotes storage of glycogen and further growth of endometrium

The Menstrual Cycle

- The menstrual cycle is a sequence of events which takes place approximately every four weeks.
- It occurs throughout the fertile life of a woman (the age of puberty to around 50 years of age).
  - The ovaries contain a limited number of ova.
- The action of hormones from the pituitary gland and the ovary makes it possible for women to produce fertile eggs and become pregnant.

- There are four main hormones which have an effect on the female reproductive system.
  - FSH and LH are produced by the pituitary gland.
  - Estrogen and progesterone are produced by the ovaries.
- The stages that summarize the menstrual cycle are:
  - FSH stimulates development of ovarian follicles and initiates estrogen production.
  - Ovaries build up uterine lining (endometrium) in response to estrogen.
  - Surge in LH triggers rupture of mature follicle, releasing egg into fallopian tube.
  - When ovulation happens FSH and LH begin to drop dramatically.
  - Corpus luteum forms from ruptured follicle.
    - ✓ Corpus luteum is filled with a yellowish fat.
    - ✓ It secretes progesterone to maintain uterine lining.
  - Uterus prepares for potential implantation of fertilized egg.
  - If egg is not fertilized, corpus luteum degenerates, leading to drop in estrogen and progesterone levels.
  - Thickened uterine lining is shed through vagina as menstrual bleeding.
  - If egg is fertilized, it implants into thickened uterine lining, and pregnancy begins.
- Women do not have periods throughout their lives.
  - A natural biological process that marks the end of a woman's reproductive years is called **Menopause**.
  - During menopause, the ovaries gradually reduce their production of estrogen and progesterone.

Testes

- It is homologous to the female ovary.
- They produce both sperm and androgens, primarily testosterone.
  - Leydig cells produce and secrete testosterone.
  - Sperm production occurs within the seminiferous tubules
- Testosterone release is controlled by LH, whereas sperm production is controlled by FSH.
- The testes play a crucial role in the development of secondary sexual characteristics in males through the production of testosterone.

- The secondary sexual characteristics in males include:
  - Adolescent growth spurt
  - Pubic hair, body hair and facial hair begin to grow.
  - The larynx enlarges so the voice deepens.
  - The shoulders and chest broaden
  - The testes grow larger, become active and start producing sperm.
  - The penis enlarges and the skin of the penis and the scrotum may darken.
  - The brain changes too as he makes the transition from boy to man.

Pineal Gland

- It is a small, pinecone-shaped endocrine gland.
- It is located between the two cerebral hemispheres of the brain.
- It is often referred to as the "third eye".
  - It is associated with spiritual and metaphysical concepts.
- The primary function of the pineal gland is the production of melatonin.
  - Melatonin regulates the sleep-wake cycle (circadian rhythm).
  - Melatonin synthesis is influenced by environmental factors such as light and darkness.
    - ✓ Production increases during the night and decreases during the day.
  - Melatonin secretion helps regulate sleep patterns, promote relaxation, and modulate other physiological processes such as body temperature and hormone secretion.
- Melatonin promotes sleep in diurnal animals but it promotes activity in nocturnal animals.
  - Nocturnal animals are active during the night and rest during the day.
- Melatonin levels decline gradually over the life-span and may be related to lowered sleep efficacy.

Thymus Gland

- It is a primary lymphoid organ located in the upper chest, behind the sternum and between the lungs.
- It is most prominent in infants and children and gradually decreases in size and function with age.
    - As individuals age, the thymus gland undergoes a process called involution, characterized by a gradual decline in size and function.
- It is a vital organ of the immune system.
- It is responsible for the development and maturation of T lymphocytes (T cells)
    - Immature T cells migrate from the bone marrow to the thymus gland.
- It produces several hormones, including thymosin, thymopoietin, and thymulin.
    - They play a role in the development of the immune system and help coordinate immune responses.

Nervous and Hormonal Systems in Coordination

- The combination of nervous and hormonal control enables the body to work as a coordinated whole and plays a vital role in the homeostasis.
    - Both the nervous system and the hormone system are important for coordination and control.
- They both have features in common, but in many ways they are very different.

Aspect	Nervous System	Hormonal Control
Message Transmission	Electrical messages along neurons	Chemical messages in the blood
Transmission Speed	Fast (milliseconds)	Slower (minutes)
Message Type	Electrical and chemical	Only chemical
Effect Speed	Rapid	Often slower to take effect
Duration of Effect	Short-lived	Often long-lasting
Localization of Effect	Very localized (affecting individual cells or tissues)	Widespread (affecting any organ or tissue with receptors)

Table 2. Key differences between nervous and hormonal control

Selected Questions from EGSECE Biology Exam (1995 – 2014)

1. Which of the following hormones controls body metabolism? (1995)
   A. Antidiuretic hormone
   B. Corticoid
   C. Adrenalin
   D. Thyroxin
2. Which of the following diseases is caused by the deficiency of thyroxin that results in reduction of mental and physical development of infants? (1996)
   A. Goiter
   B. Gigantism
   C. Cretinism
   D. Obesity
3. A synthetic hormone, syntocin, has the same effect on the body as oxytocin. For what purpose would syntocin be used? (1997)
   A. Control of blood glucose levels
   B. Inhibition of the menstrual cycle
   C. Regulation of the heart rate
   D. Stimulation of uterine contraction
4. Which one of the following produces progesterone? (1997)
   A. Corpus luteum
   B. Oviduct
   C. Adrenal gland
   D. Pituitary gland
5. Which of the following hormones causes ovulation? (1997)
   A. Oxytocin
   B. FSH
   C. Progesterone
   D. Estrogen
6. The release of stored sugar in emergencies is stimulated by (1998)
   A. Trypsin
   B. Thyroxin
   C. Adrenalin
   D. Insulin
7. Regulation of sexual reproductive cycles of human males is related most directly to the presence of the hormone called (1998)
   A. estrogen
   B. insulin
   C. testosterone
   D. progesterone
8. The hormone whose deficiency results in slow growth and mental development in children is (2003)
   A. thyroxine.
   B. adrenaline.
   C. parathyroid.
   D. insulin.

9. Which of the following hormones stimulates liver to remove excess glucose from the blood? (2003)

A. Follicle stimulating hormone
B. Thyroid stimulating hormone
C. Glucagon
D. Insulin

10. Which of the following hormones is secreted by pituitary gland? (2003)

A. Thyroxin
B. Progesterone
C. Parathyroid hormone
D. Luteinising hormone

11. What is the function of thyroxine in human body? (2006)

A. It causes the development of secondary sexual characteristics.
B. It causes the development of embryo inside the uterus.
C. It controls the blood glucose concentration.
D. It controls the metabolic rate of the body.

12. Diabetes mellitus can be treated by (2007)

A. keeping personal hygiene.
B. injecting insulin before meal.
C. avoiding contact with infected person.
D. avoiding sex with infected person.

13. When there is no pregnancy after ovulation, (2009)

A. follicle is formed in the ovary.
B. oestrogen level increases
C. progesterone level decreases.
D. the egg is released from the ovary.

14. What is the difference between endocrine and exocrine glands? Endocrine glands (2009)

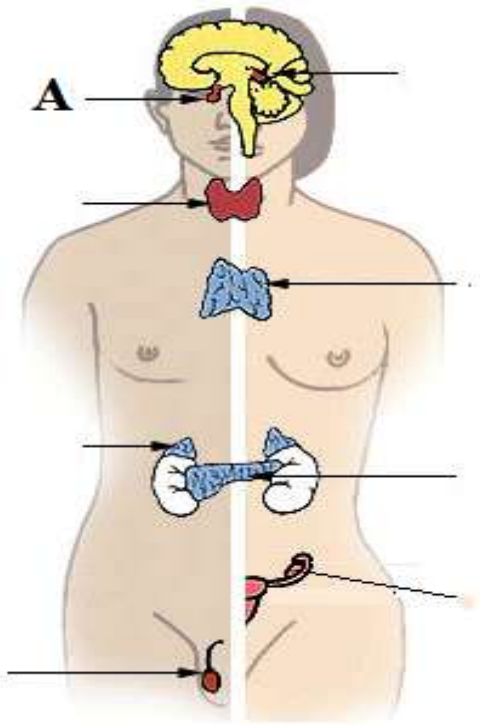
A. are more in number in our body than exocrine glands.
B. have ducts whereas exocrine glands do not have ducts.
C. do not have ducts whereas exocrine glands do have ducts.
D. release their secretions through ducts to site of destination.

15. Which one of the following methods is used to treat diabetes? (2009)

A. Eating red meat
B. Taking more glucose
C. Taking antibiotics
D. Insulin injection

16. What happens during ovulation in a woman? (2009)
    A. The follicle forms the yellow body called corpus luteum.
    B. A new egg matures in the ovary.
    C. The mature egg is released from the ovary.
    D. The levels of pituitary hormones begin to increase.
17. What do you call structure which produce secretions that have an effect on other parts of the body? (2010)
    A. Vessels
    B. Glands
    C. Gonads
    D. Vesicles
18. Which of the following is the function of thyroxin? (2010)
    A. Development of sexual characteristics
    B. Conversion of glucose to glycogen
    C. Conversion of glycogen to glucose
    D. Control of the metabolic rate
19. What do you call glands that produce secretions which are directly released to the blood stream? (2010)
    A. Mammary
    B. Exocrine
    C. Endocrine
    D. Salivary
20. Which of the following glands produces insulin? (2010)
    A. Pancreas
    B. Adrenal
    C. Pituitary
    D. Thyroid

21. Letter “A” represents (2010)



A. Salivary gland.
B. Pituitary gland.
C. Adrenal gland.
D. Thyroid gland.

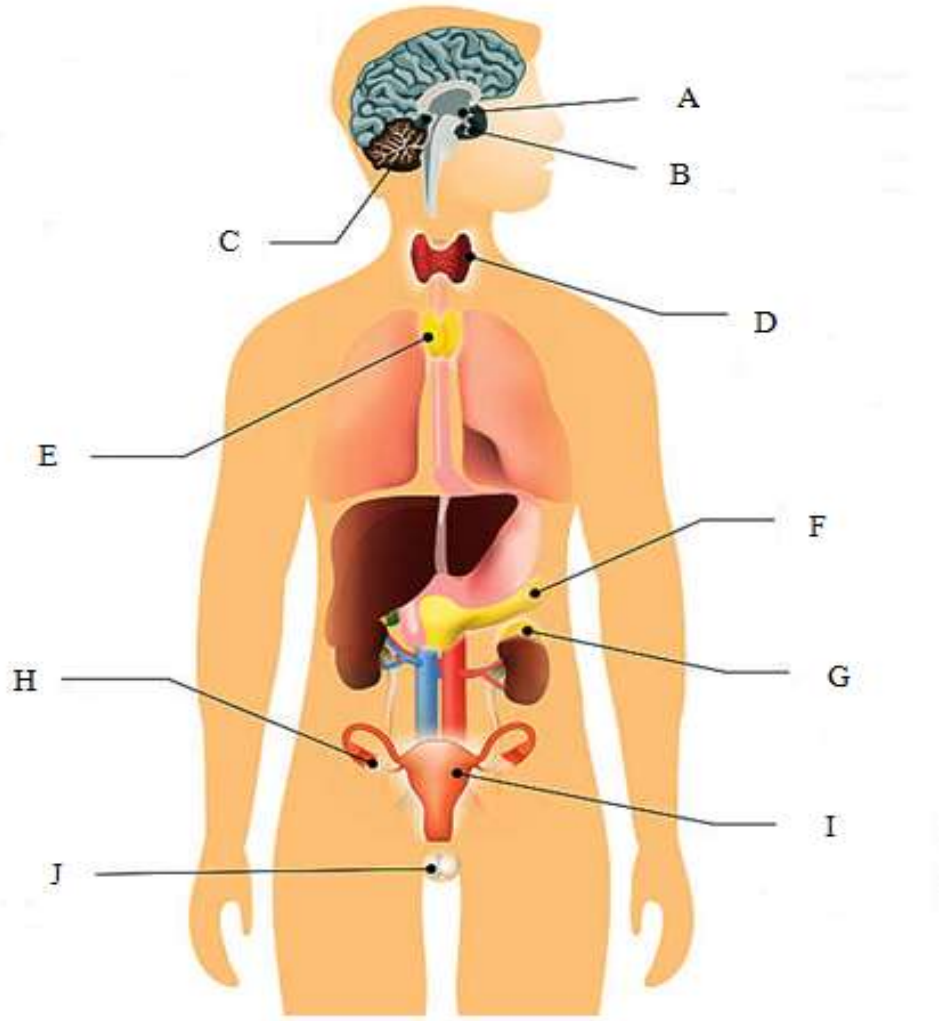
22. What is the difference between endocrine and exocrine glands?(2011)

A. Exocrine glands have ducts, but endocrine glands have no ducts.
B. Endocrine glands have ducts, but exocrine glands have no ducts.
C. Exocrine glands are found in animals, but endocrine glands are absent.
D. Endocrine glands produce enzymes, but exocrine glands produce hormones.

23. Diabetes mellitus can be treated by (2011)

A. injecting insulin before meal.
B. avoiding contact with infected person.
C. avoiding sex with infected person.
D. keeping personal hygiene.

24. This item is based on the following diagram which shows the endocrine glands of the human body. (2011)



Which of the following letters represents the gland responsible for the production of adrenalin?

A. H
B. F
C. G
D. E

25. Which of the following glands controls all endocrine glands? (2011)

A. Thyroid gland
B. Pituitary gland
C. Adrenal gland
D. Mammary gland

26. A patient exhibited symptoms of weight loss, sweating, and irritability and the doctor suspected an endocrine malfunction that can be related to the (2014)

A. pancreas
B. adrenal gland
C. thyroid gland
D. gonads

27. Secretions of endocrine glands require receptors on cell membrane to be picked by their targets while exocrine secretions do not. This is because (2014)
    A. exocrine glands secrete hormone directly to the blood stream
    B. endocrine glands are ductless
    C. exocrine glands are controlled by the nervous system
    D. endocrine glands produce protein-based hormones

CHECKPOINT

1. What are the chemical messengers produced by glands in the endocrine system called?
    A. Antibodies
    B. Hormones
    C. Enzymes
    D. Neurotransmitters
2. How does the endocrine system coordinate bodily processes?
    A. Through electrical signals
    B. Through the release of hormones
    C. Through the production of antibodies
    D. Through physical contact with target organs
3. Which statement about hormones is true?
    A. Hormones are only produced in the brain
    B. All hormones affect all tissues in the body
    C. Hormones have immediate effects on all organs
    D. Only target cells with receptors respond to hormones
4. How do hormones compare to the nervous system in terms of speed and duration of action?
    A. Hormones act more slowly and have longer-lasting effects
    B. Hormones act more rapidly and have shorter-lasting effects
    C. Hormones act more rapidly and have longer-lasting effects
    D. Hormones act more slowly and have shorter-lasting effects
5. Which of the following is true about exocrine glands?
    A. They are ductless glands.
    B. They are part of the endocrine system.
    C. They secrete hormones directly into the bloodstream.
    D. They have ducts that carry secretions to specific locations.
6. What is the role of the hypothalamus in the body?
    A. To regulate metabolism and growth
    B. To coordinate responses to stress and danger
    C. To produce hormones directly into the bloodstream
    D. To connect the nervous system to the endocrine system

7. Which of the following is an example of an exocrine gland?

    A. Sweat gland
    B. Adrenal gland
    C. Thyroid gland
    D. Pituitary gland

8. What is the function of exocrine glands?

    A. To coordinate responses to stress and danger
    B. To secrete hormones directly into the bloodstream
    C. To regulate bodily processes such as metabolism and growth
    D. To produce and release sweat, saliva, or enzymes through ducts

9. How do hormones from the hypothalamus reach the pituitary gland?

    A. Through ducts
    B. Through nerve fibers
    C. Through the bloodstream
    D. Through the infundibulum

10. Which hormone stimulates the release of thyroid-stimulating hormone (TSH) from the anterior pituitary gland?

    A. Corticotropin-releasing hormone (CRH)
    B. Gonadotropin-releasing hormone (GnRH)
    C. Thyrotropin-releasing hormone (TRH)
    D. Growth hormone-releasing hormone (GHRH)

11. What is the function of oxytocin?

    A. It regulates water balance in the kidneys
    B. It inhibits the release of growth hormone
    C. It simulates the binding of oxygen to hemoglobin
    D. It stimulates uterine contractions during childbirth

12. How does vasopressin regulate water balance in the body?

    A. By dilating blood vessels
    B. By increasing blood pressure
    C. By decreasing blood pressure
    D. By controlling water reabsorption in the kidneys

13. Where are oxytocin and vasopressin synthesized?

A. In the thyroid gland
B. In the hypothalamus
C. In the anterior pituitary gland
D. In the posterior pituitary gland

14. What is another name for vasopressin?

A. Growth hormone-releasing hormone (GHRH)
B. Adrenocorticotropic hormone (ACTH)
C. Thyrotropin-releasing hormone (TRH)
D. Antidiuretic hormone (ADH)

15. Which hormone stimulates the release of follicle-stimulating hormone (FSH) and luteinizing hormone (LH) from the anterior pituitary gland?

A. Thyrotropin-releasing hormone (TRH)
B. Corticotropin-releasing hormone (CRH)
C. Gonadotropin-releasing hormone (GnRH)
D. Growth hormone-releasing hormone (GHRH)

16. What is the role of growth hormone-releasing hormone (GHRH)?

A. To stimulate uterine contractions
B. To inhibit the release of growth hormone
C. To regulate water balance in the kidneys
D. To stimulate the release of growth hormone

17. What is the function of corticotropin-releasing hormone (CRH)?

A. To inhibit the release of growth hormone (GH)
B. To stimulate uterine contractions during childbirth
C. To stimulate the release of thyroid-stimulating hormone (TSH)
D. To stimulate the release of adrenocorticotropic hormone (ACTH)

18. What is the role of hypothalamus in endocrine system?

A. By connecting the exocrine glands to the endocrine system
B. By controlling the release of hormones from the pituitary gland
C. By storing and releasing hormones from the anterior pituitary gland
D. By synthesizing and releasing enzymes directly into endocrine glands

19. What is the primary target of the releasing and inhibiting hormones of the hypothalamus?

A. Adrenal gland
C. Anterior pituitary
B. Thyroid gland
D. Posterior pituitary

20. Which of the following gland is regarded as a master gland?

A. Adrenal gland
C. Hypothalamus
B. Pituitary gland
D. Thyroid gland

21. Which of the following is **NOT** released by anterior pituitary gland?

A. Prolactin
C. ADH
B. FSH
D. TSH

22. Which hormone is deficient in a patient diagnosed with diabetes insipidus, a rare condition characterized by disrupted water balance in the body leading to excessive urination and thirst?

A. Insulin
C. Vasopressin
B. Adrenaline
D. Aldosterone

23. What kind of endocrine disorder is present in a 35-year-old previously healthy woman that has symptoms such as enlargement of the nose, lips, and jaw?

A. Goiter
C. Gigantism
B. Cretinism
D. Acromegaly

24. A 10-year-old boy presents to the pediatric endocrinology clinic with concerns regarding short stature compared to peers. The child's parents note that despite being born at term with a normal birth weight, their child's growth rate has been significantly reduced over the past few years. Based on the presentation described, what would be the likely diagnosis?

A. Pituitary dwarfism
C. Turner Syndrome
B. Hyperthyroidism
D. Diabetes mellitus

25. Which gland controls basal metabolic rate (BMR)?

A. Testes
C. Pancreas
B. Thyroid
D. Parathyroid

26. Which region is likely to have a higher prevalence of goiter due to iodine deficiency?

A. Coastal area
C. Grassland area
B. Desert region
D. Mountainous region

27. A 9-month-old infant is brought to the pediatric clinic by concerned parents who noticed delayed development and poor growth. The parents report that the infant has been lethargic, constipated, and has a hoarse cry since birth. What condition is the 9-month-old infant most likely diagnosed with based on the clinical presentation?

    A. Cretinism
    B. Hyperthyroidism
    C. Down syndrome
    D. Diabetes mellitus

28. Which endocrine gland is at risk of being affected during tracheal surgery due to its close proximity?

    A. Adrenal gland
    B. Thyroid gland
    C. Thymus gland
    D. Pituitary gland

29. Which of the following would be expected in a patient with Graves' disease?

    A. Excess sugar in the blood
    B. Decreased O_2 consumption
    C. Increased Urination at Night
    D. Increased triiodothyronine levels

30. Which hormone helps with temperature homeostasis by causing increased body heat production in cold weather?

    A. Glucagon
    B. Thyroxine
    C. Adrenaline
    D. Testosterone

31. What condition is most likely diagnosed in a 45-year-old woman presenting to the emergency department with muscle cramps and spasms, a history of hypoparathyroidism, and laboratory findings showing hypocalcemia and hyperphosphatemia?

    A. Goiter
    B. Tetany
    C. Muscular atrophy
    D. Hypothyroidism

32. How do hormones from the thyroid and parathyroid regulate the calcium concentration of the blood?

    A. Calcitonin lowers blood calcium; parathyroid hormone raises blood calcium.
    B. Parathyroid hormone lowers blood calcium; calcitonin raises blood calcium.
    C. Thyroxine and triiodothyronine together regulate calcium levels, as needs dictate.
    D. Thyroxine lowers blood calcium level; triiodothyronine raises blood calcium level.

33. A 28-year-old woman has had difficulty concentrating at work for the past month. She complains that the work area is too hot. She seems nervous and often spills her coffee. She has been eating more but has lost 5 kg in the past 2 months. Which of the following laboratory findings is most likely to be present in this woman?

    A. High levels of estrogen and progesterone
    B. Elevated thyroxine and triiodothyronine levels
    C. Low levels of epinephrine and norepinephrine
    D. Excessive accumulation of ketones in the blood

34. Which of the following hormones are responsible for the "fight-or-flight" response?

    A. Insulin and glucagon
    B. Thyroxin and melatonin
    C. Estrogen and progesterone
    D. Epinephrine and norepinephrine

35. All of the following are regions of the adrenal gland **EXCEPT**

    A. Zona insulata
    B. Zona fasciculata
    C. Zona reticularis
    D. Zona glomerulosa

36. What hormone increases heart rate when present in high concentrations in the blood?

    A. Insulin
    B. Calcitonin
    C. Adrenaline
    D. Growth hormone

37. Which symptoms would be present in a case of aldosterone hyposecretion?

    A. low blood calcium levels and low metabolic rate
    B. low blood potassium and high blood sodium levels
    C. low blood sodium and high blood potassium levels
    D. high blood glucose levels and low blood calcium levels

38. Where are androgens produced in females?

    A. Ovary
    B. Kidney
    C. Hypothalamus
    D. Adrenal cortex

39. Which of the following pairs correctly matches an endocrine gland with its location?

    A. Pancreas - Behind the stomach
    B. Adrenal gland - On the pancreas
    C. Pineal gland - In the neck
    D. Thymus gland - In the brain

40. Which cells in the pancreas produce insulin?

A. Beta cells
C. Alpha cells
B. Delta cells
D. Epsilon cells

41. After consuming a lot of chocolate, which hormone would be expected to increase?

A. Insulin
C. Thyroxine
B. Glucagon
D. Adrenaline

42. Which of the below is an example of a gland that can be classified as both an endocrine and an exocrine gland?

A. Thymus
C. Pancreas
B. Pituitary
D. Thyroid

43. What are the clusters of cells in the pancreas that produce hormones called?

A. Acinar Cells
C. Pancreatic ducts
B. Schwann cells
D. Islets of Langerhans

44. What medical condition is commonly associated with elevated fasting blood glucose levels?

A. Hypoglycemia
C. Graves' disease
B. Hyperthyroidism
D. Diabetes Mellitus

45. Which of the following hormones would be expected to increase if you were studying all day for an exam and skipped breakfast and lunch?

A. Insulin
C. Melatonin
B. Glucagon
D. Calcitonin

46. What might be the potential cause if a 10-year-old boy, who is normally at a healthy weight, is showing signs of excessive thirst, frequent urination, increased hunger, and slow-healing wounds?

A. Type 1 diabetes
C. Diabetes insipidus
B. Type 2 diabetes
D. Hyperthyroidism

47. Which of these glands produces secretions that vary between males and females?

A. Gonad
C. Adrenal gland
B. Pancreas
D. Parathyroid gland

48. Which of these is a temporary endocrine structure that forms in the ovary following ovulation?

A. Endometrium
C. Corpus luteum
B. Placental cells
D. Umbilical cord

49. Which hormone is required for ovulation and formation of the corpus luteum?

A. FSH
C. LH
B. TSH
D. PRL

50. In which pair of hormones does the first cause increased secretion of the second?

A. LH; insulin
C. TSH; prolactin
B. ACTH; thyroxine
D. FSH; estrogen

51. During menopause, which hormones experience a gradual decrease in production by the ovaries?

A. Estrogen and testosterone
B. Estrogen and progesterone
C. Progesterone and testosterone
D. FSH and luteinizing hormone

52. Which one is the common secondary sexual characteristic in both girls and boys during puberty?

A. Increase in muscle mass and strength
B. Enlargement of the larynx (voice box)
C. The growth of hair on the chest and face
D. Growth spurts and changes in body shape

53. What endocrine gland is responsible for the body's circadian rhythm?

A. Pineal gland
C. Thymus gland
B. Pituitary gland
D. Parathyroid gland

54. Which of the following statements about melatonin is correct?

A. The secretion of melatonin is stimulated by exposure to light.
B. Melatonin is synthesized from melanocyte stimulating hormone.
C. Its secretion is controlled by environmental light and dark periods.
D. Melatonin is secreted by the pituitary gland but stored in pineal gland.

55. Thymic hypoplasia is a condition characterized by the underdevelopment or incomplete development of the thymus gland. What symptom may arise from thymic hypoplasia?

A. Persistent feelings of tiredness
B. Intolerance to cold temperatures
C. Increased frequency of urination
D. Increased susceptibility to infections

56. The administration of which hormone may be advantageous for shift workers experiencing disruptions to their sleep-wake cycle due to irregular work schedules?

A. Melatonin
B. Adrenaline
C. Thymosin
D. Thyroxine

57. Which three endocrine glands are situated in the brain?

A. Thyroid gland, hypothalamus, thymus gland
B. Pituitary gland, pineal gland, hypothalamus
C. Pituitary gland, thyroid gland, adrenal gland
D. Pineal gland, adrenal gland, parathyroid gland

58. Which of the following factors may contribute to making it more difficult for elderly individuals to fall asleep at the desired bedtime?

A. Reduced melatonin levels
B. Decreased insulin production
C. Decreased sex hormone levels
D. Increase in adrenaline secretion

59. Which of the following functions is associated with the thymus gland?

A. Maturation of T lymphocytes
B. Regulation of RBC production
C. Regulation of sleep-wake cycle
D. Control the reabsorption of calcium

60. Which endocrine gland is responsible for the maturation and development of $CD4^+$ T cells?

A. Pancreas
B. Thymus gland
C. Thyroid gland
D. Lymph nodes

ANSWERS FOR EGSECE QUESTIONS

1. D
2. C
3. D
4. A
5. D
6. C
7. C
8. A
9. D
10. D
11. D
12. B
13. C
14. C
15. D
16. D
17. C
18. B
19. D
20. C
21. B
22. A
23. A
24. C
25. B
26. C
27. B

ANSWERS FOR THE CHECKPOINT

1. B	16. D	31. B	46. A
2. B	17. D	32. A	47. A
3. D	18. B	33. B	48. C
4. A	19. C	34. D	49. C
5. D	20. B	35. A	50. D
6. D	21. C	36. C	51. B
7. A	22. C	37. C	52. D
8. D	23. D	38. D	53. A
9. D	24. A	39. A	54. C
10. C	25. B	40. A	55. D
11. D	26. D	41. A	56. A
12. D	27. A	42. C	57. B
13. B	28. B	43. D	58. A
14. D	29. D	44. D	59. A
15. C	30. B	45. B	60. B