UNIT8: ENDOCRINE SYSTEM

UNIT STRUCTURE

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8.1 LEARNING OBJECTIVES

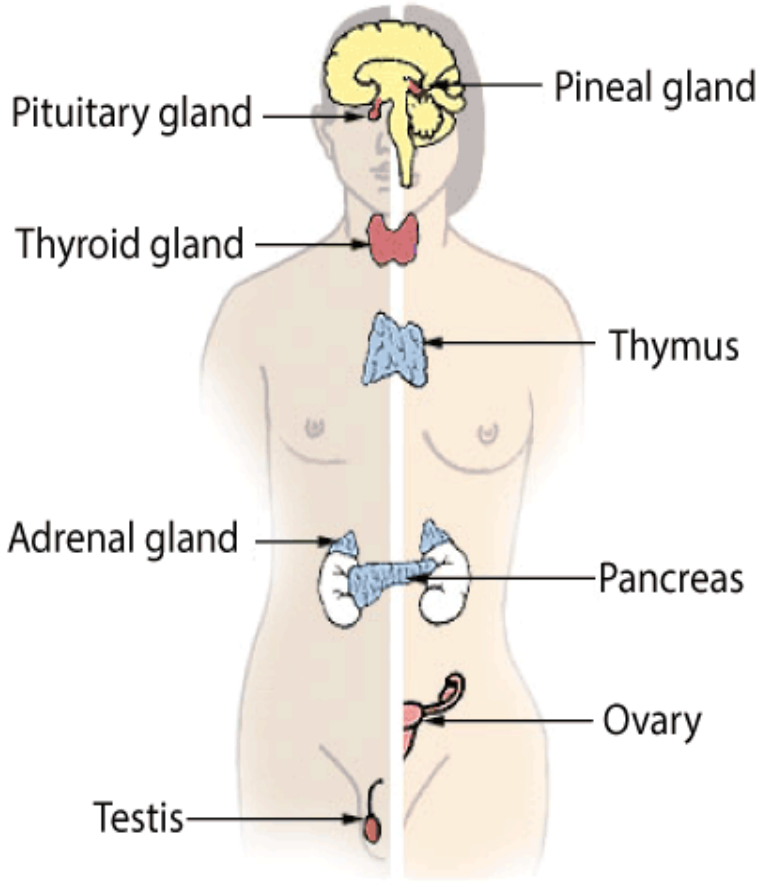
After going through this Unit, you will be able to

- Identify the major endocrine glands in the body
- Acquire the knowledge of the hormones produced by each gland
- Gain the knowledge of the role of each hormone in regulating bodily functions
- Understand the mechanisms that control hormone levels, and recognize the potential endocrine disorders associated with different glands along with the role of hypothalamus and its function.

8.2 INTRODUCTION

The endocrine system is a network of glands that regulate body functions by releasing hormones directly into the bloodstream. These hormones act as chemical messengers that control growth, development, metabolism, reproduction, mood, and stress responses. Major endocrine glands include the pituitary, thyroid, adrenal, pancreas, parathyroid, and reproductive glands. Unlike the nervous system, the endocrine system works slowly but has long-lasting effects. It helps maintain balance within the body, known as

homeostasis, by coordinating activities of organs and tissues. Proper functioning of the endocrine system is essential for normal health, development, and adaptation to environmental changes.



8.3 MAJOR ENDOCRINE GLANDS

1. PITUITARY GLAND

The Pituitary Gland lies at the base of the skull, in the pituitary fossa of the sphenoid. It consists of two lobes, anterior and posterior.

THE ANTERIOR LOBE:

The Anterior Lobe of the Pituitary produces a number of hormones which are instrumental in controlling the production of the secretion of all the endocrine organs.

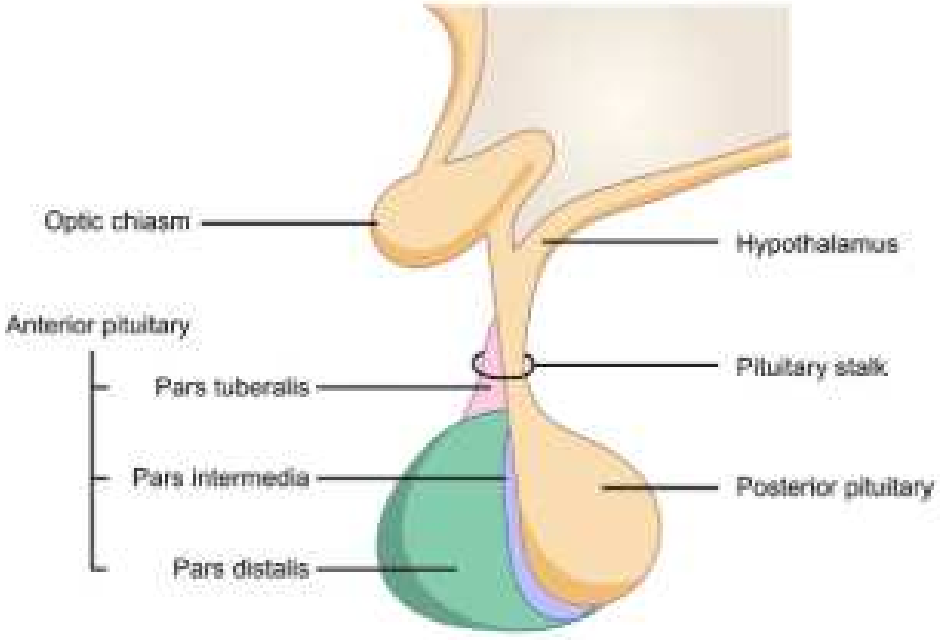
- The Growth hormone (somatotropic hormone) controls the growth of the body.

- The Thyrotropic hormone controls the activity of the thyroid gland in the production of thyroxin.
- The Adrenocorticotropic hormone (ACTH) controls the activity of the Adrenal glands in the production of Cortisol from the cortex of the gland.
- The Gonadotrophic hormones are:
- The Follicle –stimulating hormone, (FSH) which stimulates the development of Graafian follicles in the Ovary and the formation of Spermatozoa in the Testis.
- The Leuteinising hormone, (LH) controls the secretion of the oestrogen and progesterone in the ovary and the testosterone in the testis.
- The Luteotrophin or prolactin, controls the secretion of milk, and maintains the existence of the corpus luteum during pregnancy.

THE POSTERIOR LOBE

The posterior lobe of the pituitary secretes two hormones: Antidiuretic hormone (ADH), which regulates the amount of water passed by kidneys, and the Oxytocic hormone stimulating the contraction of the uterus during the birth of a baby and the release of milk during breast feeding.

ANATOMY OF PITUITARY GLAND



FUNCTION OF ANTERIOR AND POSTERIOR PITUITARY GLAND

The anterior pituitary gland produces hormones that regulate many bodily functions, including growth, metabolism, and reproduction:

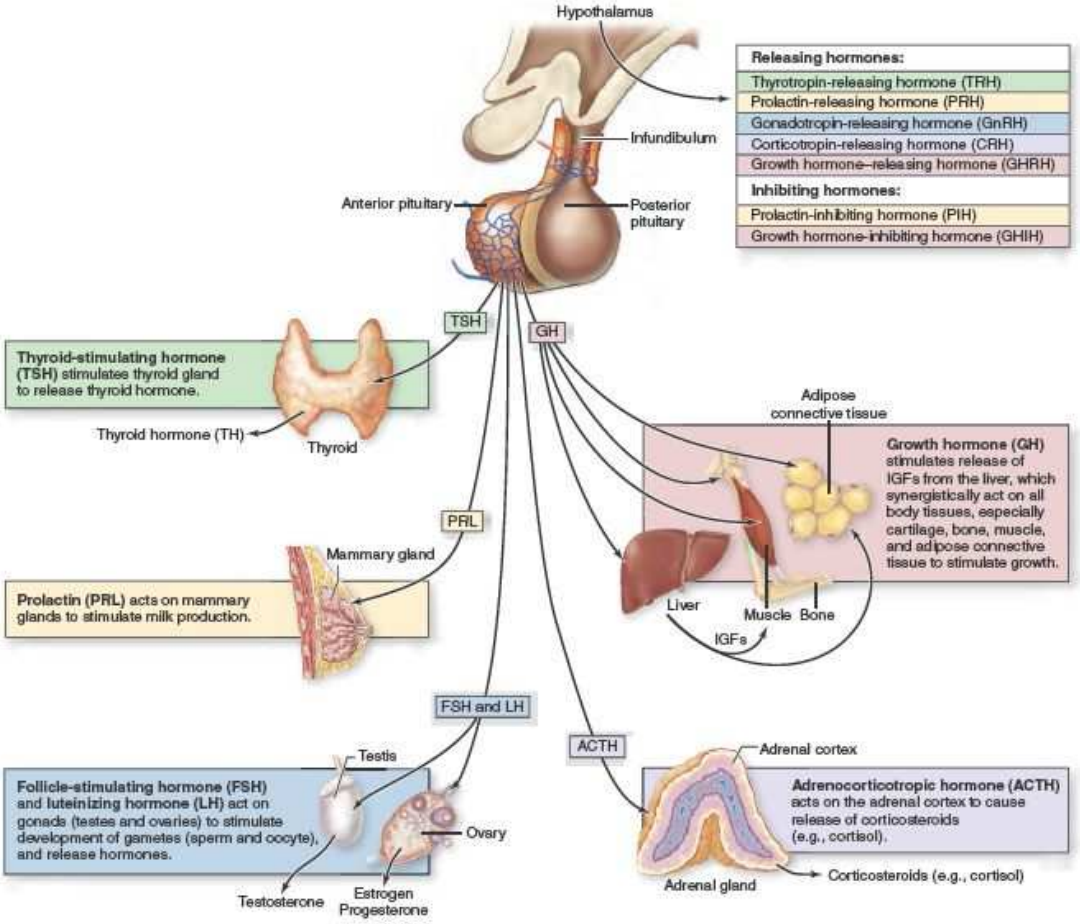
Growth hormone (GH)
Stimulates growth in children and helps maintain tissues and organs in adults. GH increases the uptake of amino acids, enhances cellular proliferation, and reduces apoptosis.

Prolactin (PRL)
Promotes milk production in women. During pregnancy, PRL contributes to the development of mammary glands.

Thyroid-stimulating hormone (TSH)
Triggers the thyroid to produce and release hormones that maintain the body's metabolic rate.

Adrenocorticotropic hormone (ACTH)
Stimulates the adrenal gland to release stress hormones, such as cortisol. Cortisol helps regulate blood pressure, increase glucose metabolism, and reduce inflammation.

Follicle-stimulating hormone (FSH) and luteinizing hormone (LH)
Regulate the production of sex hormones. In females, FSH helps follicles grow and develop in preparation for ovulation. In males, FSH helps control sperm production.



POSTERIOR PITUITARY GLAND

The posterior pituitary releases hormones such as Oxytocin and anti-diuretic hormone.

Anti-diuretic hormone (ADH, or Vasopressin)

ADH helps regulate the water balance in your body by controlling the amount of water, your kidneys reabsorb while they're filtering wastes out of your blood.

Oxytocin

Oxytocin helps labor to progress by contracting the uterus, causes breast milk to flow and influences the bonding between parent and baby. Oxytocin can also influence the bonding between parent and baby and plays a part in ejaculation. Oxytocin contracts the Vas deferens to push sperm and semen forward for ejection.

2. THYROID GLAND

A butterfly-shaped gland that sits in front, on each side of the windpipe (trachea) and below the voice box that is located in the neck.The Thyroid gland consists of two lobes, placed one on each side of the trachea, and connected by a strip of thyroid tissue, called the isthmus of the thyroid, which lies across, in front of the trachea.

STRUCTURE:

The thyroid gland is composed of numbers of vesicles lined with cubical epithelium, abundantly supplied with blood, and held together by connective tissue. These cells secrete a sticky fluid, the colioid of the thyroid, which contains an iodine compound: the active principle of this compound is a hormone thyroxine.

FUNCTION OF THYROID GLAND

- The thyroid produces hormones thyroxine and tri-iodothyronine, these hormones contain iodine.
- These hormones regulate metabolism, growth, and development. These hormones also help regulate weight, energy levels, internal temperature, skin, hair, and nail growth.
- If there is an iodine deficiency, the thyroid cannot make sufficient hormone.This stimulates the anterior pituitary to secrete thyroid-stimulating hormone (TSH), which causes the thyroid gland to increase in size in a vain attempt to produce more hormones. But it cannot produce more hormones because it does not have the necessary raw material, iodine.
- Calcitonin is secreted by the para-follicular cells of the thyroid gland. This hormone opposes the action of the parathyroid glands by reducing the calcium level in the blood. If blood calcium becomes too high, calcitonin is secreted until calcium ion levels decrease to normal.

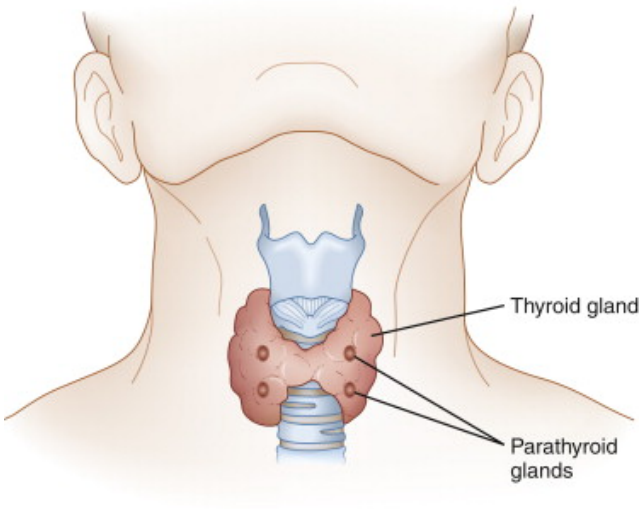
A thyroid disorder is a medical condition that occurs when the thyroid gland produces too much or too little of the hormones.

Hyperthyroidism

An overactive thyroid that produces too much thyroid hormone. Symptoms include weight loss, sweating, nervousness, and an irregular heartbeat. Hyperthyroidism can lead to Graves' disease, which can cause eye and skin problems.

Hypothyroidism

An underactive thyroid that produces too little thyroid hormone. Symptoms include weight gain, tiredness, and feeling depressed.



3. PARATHYROID GLANDS

Four small, oval-shaped glands that sit behind the thyroid gland. The parathyroid glands produce parathyroid hormone, which regulates calcium levels in the blood.

Hypoparathyroidism, or insufficient secretion of parathyroid hormone, leads to increased nerve excitability. The low blood calcium levels trigger spontaneous and continuous nerve impulses, which then stimulate muscle contraction.

FUNCTIONS

The parathyroid hormone helps the body maintain adequate calcium stores in the bloodstream to protect bone health. It also stimulates the release of

calcium by bones into the bloodstream, the absorption of calcium from food by the intestines, and the conservation of calcium by the kidneys.

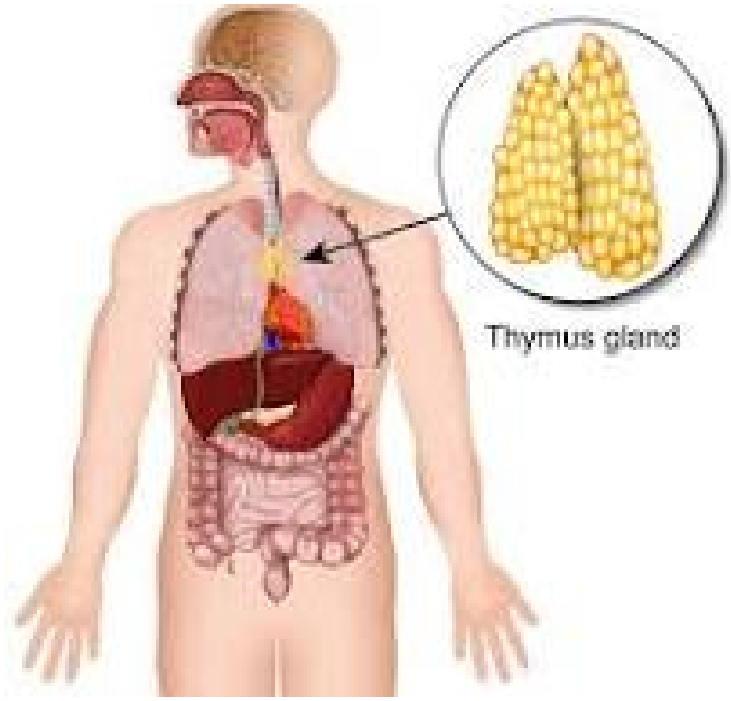
DISORDERS

Hyperparathyroidism occurs when the body produces too much parathyroid hormone, which can lead to bone thinning or osteoporosis. Hypoparathyroidism occurs when the body produces too little parathyroid hormone, which can lead to muscle cramps and spasms.

4. THYMUS GLAND

The thymus gland is a very unique organ that is at its largest in children and shrinks away as the body grows older. It is about 2.5 to 5 cm wide, 4 to 6 cm long and 1 cm thick at birth.At its largest instance, (viz. during puberty) the thymus weighs just under 30 grams. After puberty, the thymus slowly starts to shrink and by the age of 75, it is nothing more than fatty tissue.

It is a primary lymphoid organ that has both immune and endocrine functions. T lymphocytes mature in the thymus before being released into the general circulation.



Thymus Location

The thymus gland is located in the anterior part of the chest, right behind the breastbone (or the sternum) and between the lungs. It has a pinkish-grey complexion and is lobed, with primary two lobes and smaller lobes radiating from within. The two lobes may be separated or united and generally vary in size.

Thymus Function

One of the most important functions of the thymus is to stimulate the production of very specialized cells called T-cells (also called T-lymphocytes). These cells are responsible for directly fending off foreign pathogens such as viruses and bacteria. They also regulate the immune system, helping to prevent autoimmunity, wherein, the body's immune system elicits immune responses on its own healthy cells.

Thymus also secretes thymosin to stimulate the development of T-cells.

5. THE ISLETS OF LANGERHANS OF THE PANCREAS

The pancreas is an organ with dual functions regulates blood glucose levels through the endocrine system by secreting different hormones. The Pancreas is situated in the abdomen, posterior to the stomach, which is a long, flat organ and sits in the loop of the duodenum. Its weighs approximately 100g and measures around 14-23 cm in length. The endocrine pancreas consists of clusters of cells, known as the pancreatic islets (Islets of Langerhans), scattered throughout the gland. Pancreatic hormones are secreted directly into the bloodstream and circulate throughout the body.

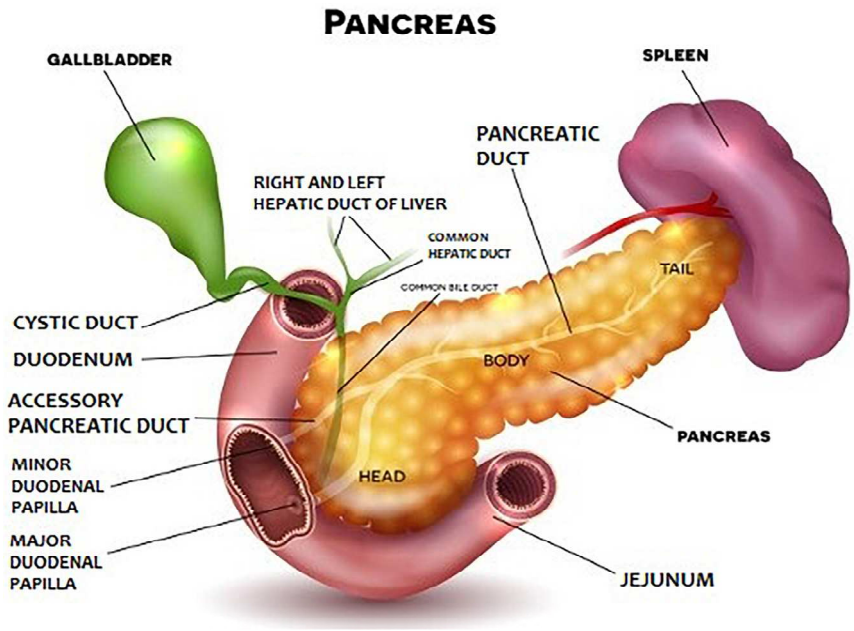
There are three main types of cells in the pancreatic islets:

- Alpha (α) cells secrete glucagon
- Beta (β) cells secrete insulin
- Delta (δ) cells secrete somatostatin

- F cells secrete pancreatic polypeptide

Insulin and Glucagon are the primary hormones involved in glucose homeostasis (Maintain blood glucose levels). After the consumption of meal, a beta cells detect an increase in blood-glucose concentration and secrete insulin directly into the blood to control glucose levels in the body.

Glucagon increases blood glucose levels by promoting glycogen breakdown and glycogenesis in the liver. Somatostatin inhibits the secretion of insulin, glucagon, and pancreatic polypeptide.



Clinical Conditions:

Hyperglycemia

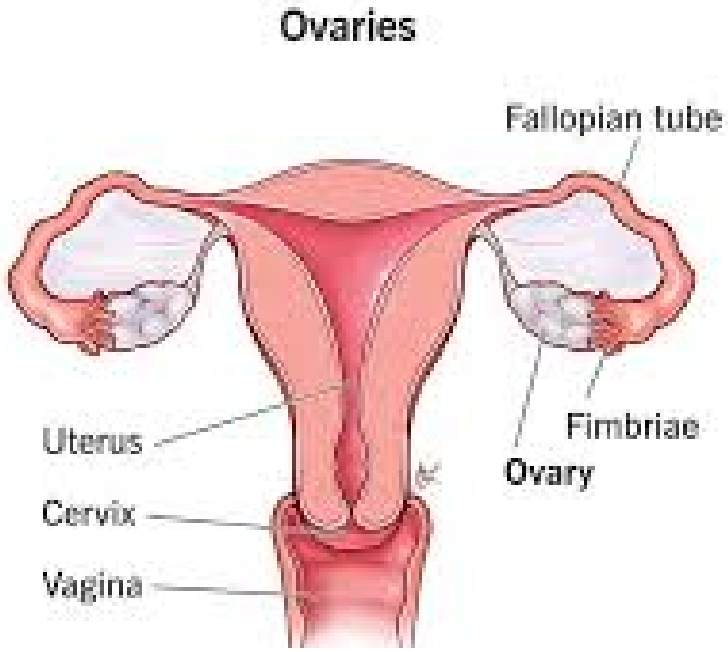
Deficiency results in hyperglycemia, a high blood sugar, loss of weight, fatigue, and polyuria, with its accompanying thirst, hunger, dry skin, dry mouth and tongue.It also causes ketosis and an increased rate of breathing.

Hypoglycemia

Hypoglycemia is a low blood sugar, may be produced by an overdose of Insulin, or by patient not eating or vomiting food taken after his injection of insulin when the excess in his blood may lead to hypoglycemic coma.

6. OVARIES

The ovary is a primary gonad of the female reproductive system. It produces the female reproductive cells called the ovum (non-motile). The ovum is fertilized by a motile sperm to form a zygote. Also, the ovaries act as an endocrine gland by releasing certain hormones in females.



OVARIES STRUCTURE

Ovaries are flat oval structures that measure approximately 4 cm in length, 1 cm in thickness and 2 cm in breadth. Females have two ovaries. They are present on the left and right sides of the uterus in a portion termed the ovarian fossa. The side close to the fallopian tube is connected via a suspensory ligament called the infundibulopelvic ligament. The other side connects to the uterus through ovarian ligaments. Each ovary is connected to the broad ligament of the uterus at the hilum (depression) through the mesovarium and ovarian ligament.
Each ovary is divided into two parts:
1. The medulla

2. The cortex

Medulla

The medulla, also known as the zona vasculosa, is the **deeper core region** of the ovary. It has a stroma made up of loose connective tissues. Near the hilum, it comprises blood arteries, lymphatics, nerve fibers, and bundles of smooth muscle fibers.

Cortex

The cortex is the **wider outer section** with dense cellular layers. It is broken at the hilum, where the medulla joins the mesovarium. The germinal epithelium lines the cortex beneath a fibrous layer known as tunica albuginea.

The cortex is made up of the following structures:

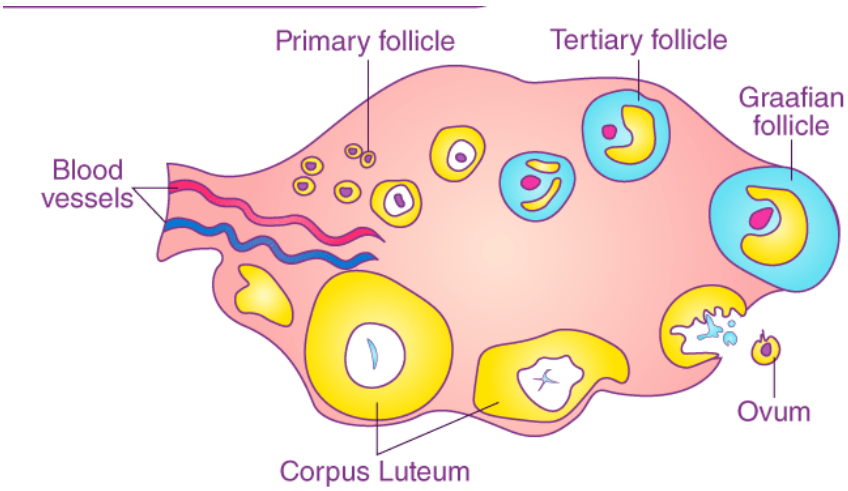
- Glandular structures that indicate various phases of ovarian follicles
- Cells of connective tissue
- Interstitial cells are clusters of epithelial cells with tiny lipid granules that are generated mostly from theca interna of ovarian follicles.

Ovarian Follicles

The outer cortex comprises germinal epithelium that is formed from the germinal ridges. The germinal epithelium gives birth to a number of **primordial eggs**. The primordial eggs migrate to the cortex's inner substance. The ova or egg cell is surrounded by a layer of spindle cells termed granulosa cells from the ovarian stroma. The primordial egg cells and granulosa cells together form the primordial follicles. These primordial follicles develop into **tertiary vesicular follicles** with a characteristic fluid-filled cavity called the antrum. The final fully mature follicle that ruptures to release the ovum is termed the **Graafian follicle**.

The ovary has around 6 million primordial follicles by the seventh or eighth month of intrauterine development. However, at birth, only 1 million primordial follicles are visible in both ovaries, and the remainder of the follicles degenerate. During adolescence, the number drops to around 300,000 to 400,000. Also, during each menstrual cycle, one of the follicles grows and

discharges its ovum. Throughout each menstrual cycle, only one egg is released from each of the ovaries. Many follicles degenerate with each cycle.
After the release of the mature ovum, the remains of the ovarian follicles are termed **corpus luteum**. This corpus luteum regresses to form a remnant termed corpus Albicans.



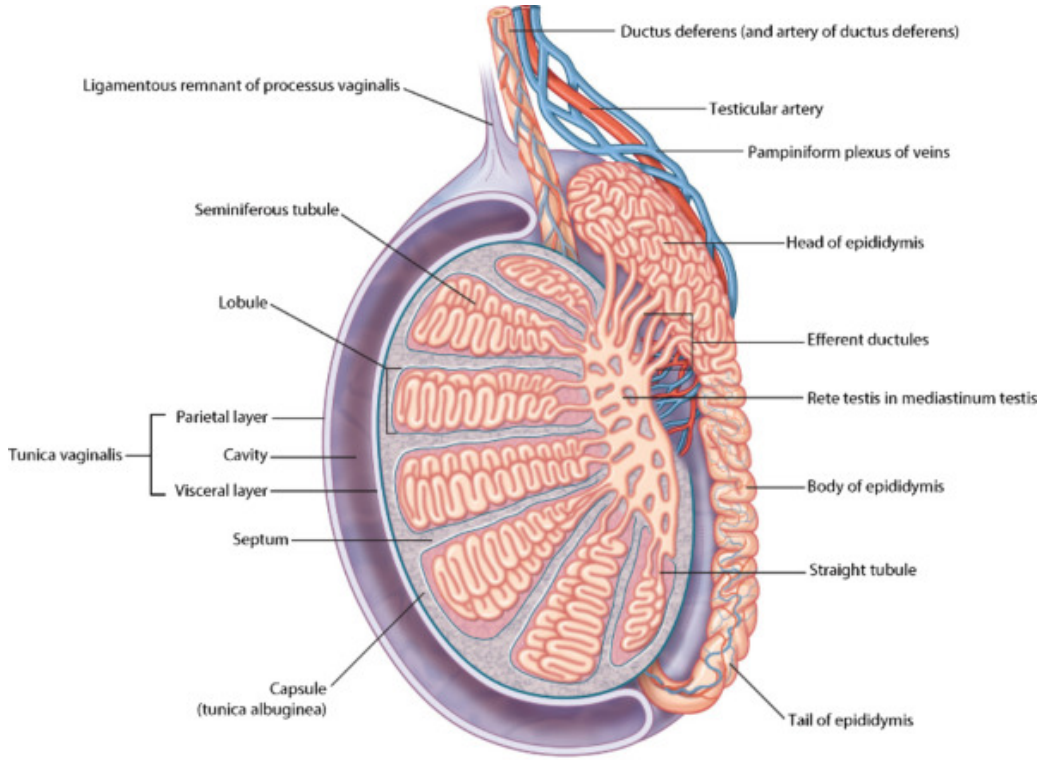
FUNCTIONS OF OVARY

Some of the functions of the ovary are as follows:

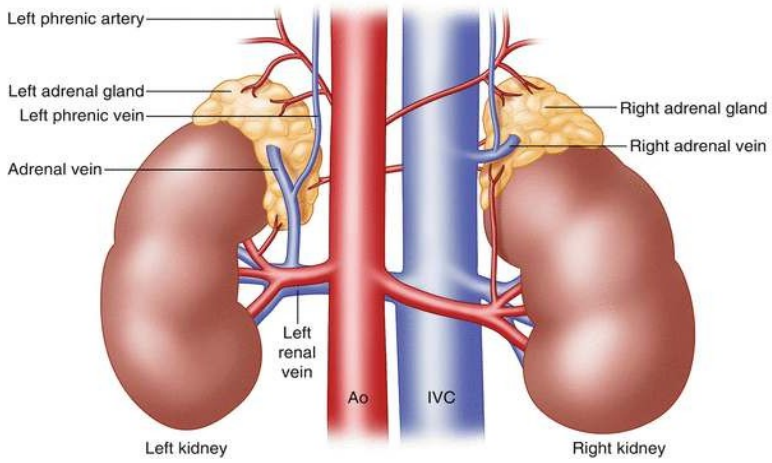
- Secretion of female sex hormones like progesterone and estrogen. It also secretes other hormones like relaxin, inhibin and small quantities of androgens.
- Oogenesis (female gametogenesis) happens in the ovary. It is a process through which the ovum is formed.
- It governs the menstruation process by which the unfertilized ovum is shed.
- Produce hormones that help with the growth and development of female reproductive organs and secondary sexual characteristics. They are also responsible for the menstrual cycle.

7. TESTES

The male gonads, the testes are oval glands that lie in the scrotum behind the penis. Each testis is attached to the body by the spermatic cord, which contains nerves, blood vessels and the vas deference (Which carries sperm to the urethra).The two main functions of the testes are to produce sperm and to produce the male sex hormone. The main hormone produced and secreted by the testes is testosterone. Testosterone regulates production of sperm and causes development of male reproductive structures and at puberty the enlargement of testes and penis. It also causes the development of secondary male sex characteristics like facial and chest hair, low pitched voice, narrow hips and broad shoulder etc.



8. ADRENAL GLAND



The adrenal glands are situated on the upper pole of each kidney enclosed within the renal fascia. They are about 4 cm long and 3 cm thick. The adrenal gland composed of two parts which have different structures and functions. The outer part is the cortex and the inner part is the medulla.

Adrenal cortex:

It consists of three distinct zones: Zona glomerulosa, Zona fasciculata and Zona reticularis.

Zona glomerulosa:

The Zona glomerulosa is the outermost zone that is composed of thin layer of columnar cells. It produces the hormone Mineralocorticoids (aldosterone) which involved in maintaining water and electrolyte balance.

Zona fasciculata:

Zona fasciculata is the middle and thickest zone of the cortex. It is composed of columns of secretory cells surrounded by multiple capillaries. It produces Glucocorticoids (Primarily cortisol, corticosterone and cortisone in minor amounts) responses to stress.

Zona reticularis:

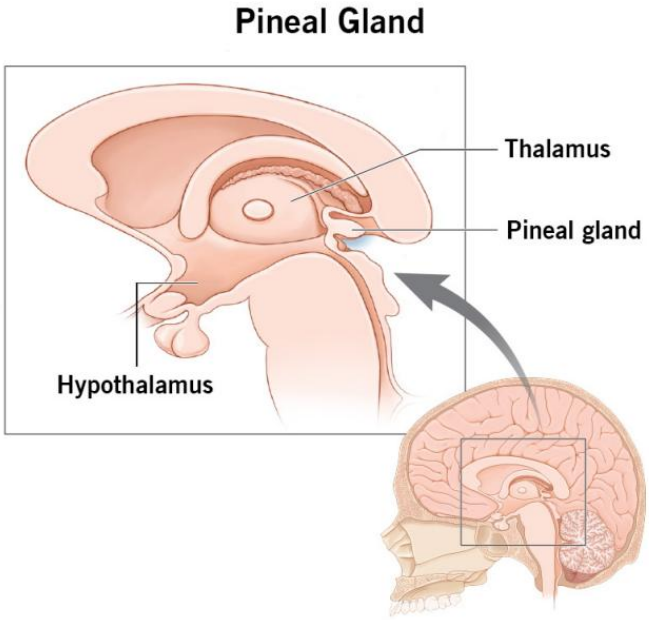
The Zona reticularis is the innermost layer composed of polyhedral cells. It mainly produces androgen (Male sex hormone).

Adrenal medulla:

Adrenal medulla is surrounded by adrenal cortex. The hormones secreted by adrenal medulla are- Adrenaline (Epinephrine) and Noradrenaline (Norepinephrine). They are commonly referred to as the fight-or-flight hormone. Adrenaline and noradrenaline have multiple and diverse physiological effects prepare the body for immediate, automatic reaction of the body to a stressful, dangerous or threatening situation. By increasing heart rate, it increases blood pressure. They also increase blood flow to the heart, liver, skeletal muscles and adipose tissue, dilate airway to the lungs and increase blood levels of glucose and fatty acids.

9. PINEAL GLAND

Pineal gland, also called the pineal body or epiphysis cerebri, is a tiny gland in your brain.Located between the two halves of the brain, beneath the back part of the corpus callosum, this gland produces melatonin, which influences the body's internal clock.



FUNCTION

The main function of your pineal gland is to receive information about the daily light-dark (day-night) cycle from the retinas in your eyes and then produce and release (secrete) melatonin accordingly — elevated levels at night (during dark hours) and low levels during the day (during light hours).

8.4 EFFECT OF YOGIC PRACTICES ON ENDOCRINE SYSTEM

Although yoga probably will not significantly alter functions of the endocrine system like growth and metabolism, it may have a beneficial effect on our stress response. Moreover, yoga poses pressurize and depressurize specific glands and these subtle compression and decompression can regulate secretions.
Some Yogic Practices which can be beneficial for Endocrine Glands are:
Sirsasana, standing forward bend increases blood flow to brain which improves the functioning of brain and hypothalamus along with improving the functioning of pituitary and pineal gland.Halasana, Sarvangasana and shoulder stand improve the functioning of thyroid and parathyroid gland. Setu-Bandhasana and Bhujangasana will stimulate testes and ovaries.

Yoga Nidra is also great way to control stress and emotion. It is not about just sleeping but stays awake and controls your thoughts and your senses, replace negative thoughts with positive ones and relax, and energize your mind and body. It will also improve the functioning of brain.

Pranayama initiates a relaxation response in the endocrine system and reduces muscle tension, lowers the heart rate and slows brain wave patterns.Pranayama has dual benefits in controlling body along with mind. The blood supply and the oxygen supply to the brain and hypothalamus increases, thereby, improving their functioning. Pranayama improves the relationship between hypothalamus–pituitary and the other glands and thus, the entire endocrine system is balanced.

Slow and deliberate breathing in Sukhasana corrects the hormonal signals to adrenal gland and reducesthe stress.Bhujangasana releases stress through invigorating adrenal glands and kidneys.
The practice of Shashankasana stimulates the thyroid and parathyroid. It leads to the well-functioning of adrenal glands. Also enhances the health of both male and female reproductive organs.Janusirsasanastimulate the thymus, thyroid,

kidneys, and pancreas. Practice of Paschimottanasana stimulates the ovaries, and uterus. It also relieves the symptoms of menopause and menstrual discomfort. Shirshasanastimulates the pituitary and pineal glands.

8.5 LET US SUM UP

Endocrine glands release hormones into the bloodstream, which travel to cells throughout the body. These hormones help control many functions, including mood, growth, metabolism, and reproduction.

The endocrine glands and their functions are:

- **Pancreas**: Produces insulin and glucagon, which help regulate blood sugar levels
- **Adrenal glands**: Located on top of the kidneys, these glands produce hormones that regulate many functions, including the fight-or-flight response
- **Parathyroid glands**: Located behind the thyroid, these glands produce parathyroid hormone, which helps regulate calcium levels in the blood
- **Pituitary gland**: Located at the base of the brain, this gland regulates the amount of hormones produced by other glands, and produces its own hormones, including growth hormone
- **Thyroid**: This gland controls metabolism, or how the body uses energy
- **Pineal gland**: Located in the brain, this gland produces melatonin, which helps regulate the body's circadian rhythm
- **Ovaries**: These female reproductive organs produce estrogen and progesterone, which contribute to female characteristics
- **Testes**: These male reproductive organs produce testosterone and sperm
- The beneficial effects of yoga on various hormone levels have been studied and proved.
- Yoga improves overall circulation of different organs and endocrine glands of the body and thus helps in better hormonal imbalances.
- Weight is controlled, metabolic profile improves and various other lifestyle diseases like hypertension, diabetes, stress disorders, depression and anxiety disorders are also improved and cured.
- Immunity increases and autoimmune disorders show improvement.

- Certain yoga practices and meditations are also believed to be causing genetic changes.
- Overall, it is proven in various studies that Yoga is a scientific way of living which helps in balancing the endocrine system of the body.

CHECK YOUR PROGRESS

Que. 1 Where is the thymus gland located?

Que. 2 Name the hormone produced by the thymus.

Que. 3 What is the function of the thymus?

Que. 4 What are T-Cells?

Que. 5 Write a short note on the Thymus.

Que. 6 What are the functions of ovarian hormones?

Que. 7 What is the pituitary gland?

Que. 8 Name the hormones that is released by anterior pituitary gland.

Que. 9 What are the primary hormones produced by thyroid gland? And what key role do they play in the body's metabolism?

Que. 10 What is ovulation?

Que. 11 What are the primary hormones secreted by the adrenal cortex and what are their main function in the body?

Que. 12 Name the Asanas which are beneficial for thyroid gland.

8.6 FURTHER READING

Mahajan, A. S. (2014). Role of yoga in hormonal homeostasis. International Journal of Clinical and Experimental Physiology, 1(3)

1- Bevan AJ. Endocrine changes during transcendental meditation. Clin Exp Pharmacol Physiol 1980; 7:75-6.

2- Role of yoga in hormonal homeostasis, International Journal of Clinical and Experimental Physiology| Jul-Sep 2014

3- Arora S, Bhattacharjee J. Modulation of immune responses in stress by Yoga. Int J Yoga 2008; 1:45-55

4-Pearce, Evlyn C.-Anatomy and physiology for Nurses (Jaypee Brothers)

5-Tortora - Anatomy and Physiology.

✓ 8.7 ANSWER TO CHECK YOUR PROGRESS

Answer 1: Thymus is located in the upper part of the chest, between the lungs.

Answer 2: Thymosin hormone is produced by thymus.

Answer 3: Thymus produces progenitor cells that develop into T-cells. These T-cells help the body fight against infections. They also aid in the growth of other organs in the immune system.

Answer 4 : T-cells are a type of white blood cell that originates in the bone marrow and mature in the thymus. They play an important role in defending the body against viruses, protozoa and bacteria.

Answer 5: Thymus is an irregular-shaped gland located in the upper part of the chest, between the lungs. It is large during childhood and shrinks as the body grows. It is a part of the lymphatic system along with the spleen, tonsils and adenoids. It also forms a part of the endocrine system. It is made up of epithelial cells, lymphocytes and fat tissues. This gland is active only until puberty.

Answer6: The two major ovarian hormones are progesterone and estrogen. Progesterone is primarily associated with preparing the uterus for pregnancy and the breasts for nursing. The primary function of estrogen is to increase tissue development in sexual organs. During puberty, the secretion of estrogen rises dramatically, causing changes in the sexual organs.

Answer7: The pituitary gland is a small, pea-sized gland located at the base of the brain. It's also known as the "master gland" because it regulates many bodily functions.

Answer8: The anterior pituitary gland produces six basic hormones: 1) Growth Hormone (GH) 2) Adrenocorticotropic hormone (ACTH), 3) Prolactin hormone (PL), 4) Luteinizing hormone (LH), 5) Follicle Stimulating Hormone (FSH), 6) Thyroid Stimulating Hormone (TSH)

Answer9: The thyroid gland produces the hormones thyroxine (T4) and triiodothyronine (T3), which are crucial for regulating metabolism, impacting functions like body temperature, heart rate, and energy levels throughout the body.

Answer10: Ovulation is the process by which the Graafian follicle ruptures, resulting in the release of an egg (ovum) into the abdominal cavity. The luteinizing hormone has an impact on it. In a typical 28-day cycle, ovulation happens on the 14th day of the menstrual cycle.

Answer11: Adrenal Cortex: The outer layer of the adrenal gland, responsible for producing hormones like cortisol (stress hormone), aldosterone (regulates blood pressure), and androgens (sex hormones).

Answer 12: Sarvangasana, Bhujangasana, Matsyasana, Ushtrasana, chakrasana etc.

8.8 MODEL QUESTION

A. Objectives questions

1. Name the Endocrine gland?
2. Which gland is called the master of gland?
3. Name the hormones which produces by the Anterior Pituitary gland?
4. Name the hormone which releases by the posterior pituitary gland?
5. Name the hormone which is produces by the Thymus gland?

B. Very short notes (Words Limit 150-200)

1. Write the function of Thyroid gland?
2. What is the function of adrenal gland?
3. Write the structure of ovary and its function?

C. Long Essay(Words Limit 300-500)

1. Explain in detail about the Pituitary gland and its yogic management?
2. Elaborate the structure, function and its disorders of thyroid gland and suggest the possible yogic practices?
3. Explain about the structure and its function of pineal gland and its yogic management?
4. Explain in detail about the structure and hormones secreted by the ovary and testis?

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