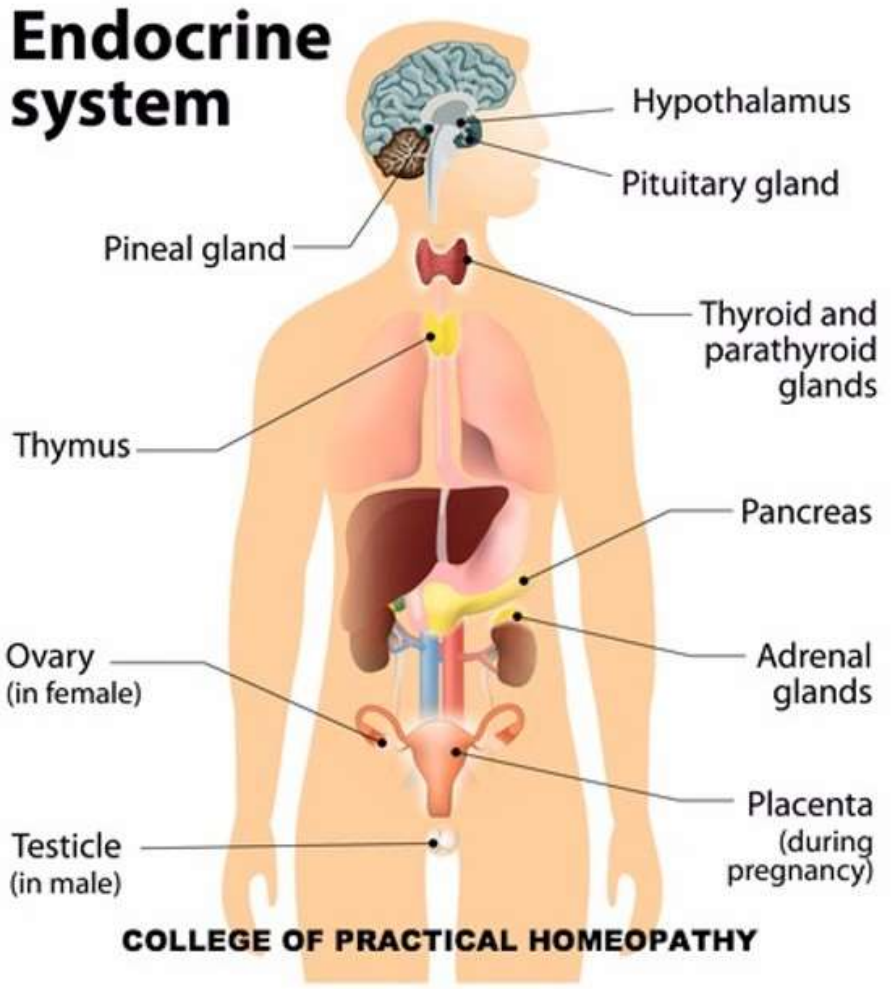
B. A program in Physical Education (Semester 2)
College: Raniganj Girls College (K.N.U)
Department: Physical Education

Endocrine system

Introduction: -

The endocrine glands do not have ducts to carry their product to a surface. They are called ductless glands. The word endocrine is derived from the Greek terms "endo," meaning within, and "krine," meaning to separate or secrete. The secretory products of endocrine glands are called hormones and are secreted directly into the blood and then carried throughout the body where they influence only those cells that have receptor sites for that hormone.

The endocrine system is a chemical messenger system comprising feedback loops of the hormones released by internal glands of an organism directly into the circulatory system, regulating distant target organs. In humans, the major endocrine glands are the thyroid gland and the adrenal glands.



The endocrine system helps control the following processes and systems:

- Growth and development
- Homeostasis (the internal balance of body systems)
- Metabolism (body energy levels)
- Reproduction
- Response to stimuli (stress and/or injury)

Endocrine glands and their functions

The Endocrine Network

The endocrine system completes these tasks through its network of glands, which are small but highly important organs that produce, store, and secrete hormones. The glands of the endocrine system are:

- Hypothalamus
- Pineal Gland
- Pituitary Gland
- Thyroid
- Parathyroid
- Thymus
- Adrenal
- Pancreas
- Ovaries
- Testes

Hypothalamus: - The hypothalamus is located below the thalamus (a part of the brain that relays sensory information) and above the pituitary gland and brain stem. It is about the size of an almond.

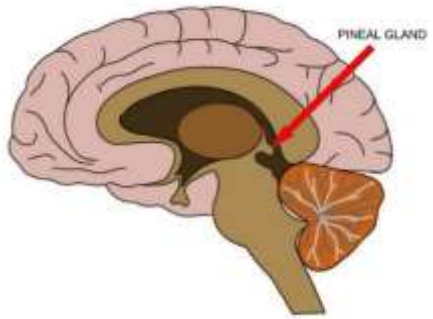
Hormones of the Hypothalamus

The hypothalamus is highly involved in pituitary gland function. When it receives a signal from the nervous system, the hypothalamus secretes substances known as neurohormones that start and stop the secretion of pituitary hormones.

Primary hormones secreted by the hypothalamus include:

- **Anti-diuretic hormone (ADH):** This hormone increases water absorption into the blood by the kidneys.
- **Corticotropin-releasing hormone (CRH):** CRH sends a message to the anterior pituitary gland to stimulate the adrenal glands to release corticosteroids, which help regulate metabolism and immune response.
- **Gonadotropin-releasing hormone (GnRH):** GnRH stimulates the anterior pituitary to release follicle stimulating hormone (FSH) and luteinizing hormone (LH), which work together to ensure normal functioning of the ovaries and testes.
- **Growth hormone-releasing hormone (GHRH) or growth hormone-inhibiting hormone (GHIH) (also known as somatostain):** GHRH prompts the anterior pituitary to release growth hormone (GH); GHIH has the opposite effect. In children, GH is essential to maintaining a healthy body composition. In adults, it aids healthy bone and muscle mass and affects fat distribution.
- **Oxytocin:** Oxytocin is involved in a variety of processes, such as orgasm, the ability to trust, body temperature, sleep cycles, and the release of breast milk.
- **Prolactin-releasing hormone (PRH) or prolactin-inhibiting hormone (PIH) (also known as dopamine):** PRH prompts the anterior pituitary to stimulate breast milk production through the production of prolactin. Conversely, PIH inhibits prolactin, and thereby, milk production. Thyrotropin releasing hormone (TRH): TRH triggers the release of thyroid stimulating hormone (TSH), which stimulates release of thyroid hormones, which regulate metabolism, energy, and growth and development.

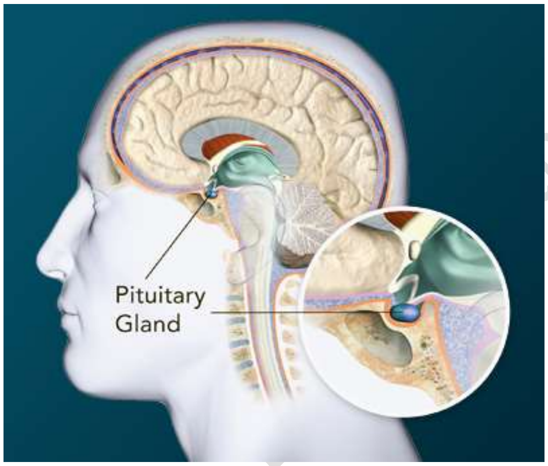
Pineal Gland: - Located near the center of the brain, the pineal gland is a very small organ shaped like a pine cone (which is where it gets its name). It's reddish-gray and about 1/3-inch long. Pineal cells and neuroglia cells (which support the pineal cells) mainly comprise the gland.



- **Melatonin: The Pineal Gland Hormone: -** The pineal gland secretes a single hormone—melatonin (not to be confused with the pigment melanin). This simple hormone is special because its secretion is dictated by light. Researchers have determined that melatonin has two primary functions in humans—to help control your circadian (or biological) rhythm and regulate certain reproductive hormones.

Pituitary Gland

The pituitary gland is only about 1/3 of an inch in diameter (that's about as large as a pea) and located at the base of the brain.



Since their functions are so intertwined, it's no surprise that the hypothalamus and pituitary are located near each other. They're actually connected by the pituitary stalk, or more technically, the infundibulum.

The pituitary glands are made of the **anterior lobe and posterior lobe.** The anterior lobe produces and releases hormones. The posterior lobe does not produce hormones per se—this is done by **nerve cells in the hypothalamus**—but it does release them into the circulation.

Hormones of the Pituitary Gland

The hormones of the pituitary gland send signals to other endocrine glands to stimulate or inhibit their own hormone production. For example, the anterior pituitary lobe will release adrenocorticotropic hormone (ACTH) to stimulate cortisol production in the adrenal glands when you're stressed.

The anterior lobe releases hormones upon receiving releasing or inhibiting hormones from the hypothalamus. These hypothalamic hormones tell the anterior lobe whether to release more of a specific hormone or stop production of the hormone.

Anterior Lobe Hormones:

- **Adrenocorticotropic hormone (ACTH):** ACTH stimulates the adrenal glands to produce hormones.
- **Follicle-stimulating hormone (FSH):** FSH works with LH to ensure normal functioning of the ovaries and testes.
- **Growth hormone (GH):** GH is essential in early years to maintaining a healthy body composition and for growth in children. In adults, it aids healthy bone and muscle mass and affects fat distribution.
- **Luteinizing hormone (LH):** LH works with FSH to ensure normal functioning of the ovaries and testes.
- **Prolactin:** Prolactin stimulates breast milk production.
- **Thyroid-stimulating hormone (TSH):** TSH stimulates the thyroid gland to produce hormones.

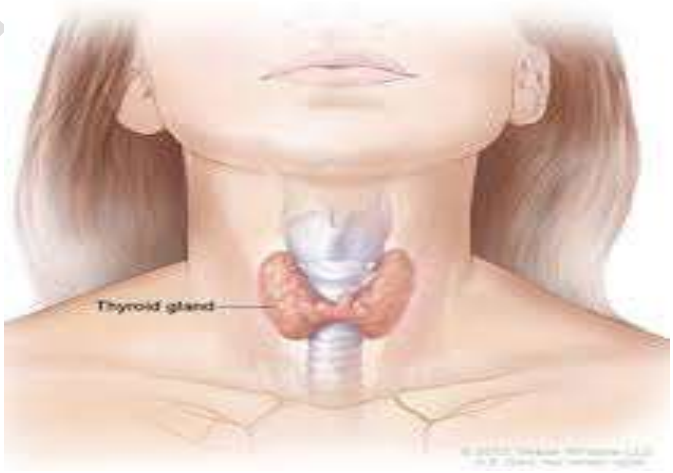
The posterior lobe contains the ends of nerve cells coming from the hypothalamus. The hypothalamus sends hormones directly to the posterior lobe via these nerves, and then the pituitary gland releases them.

Posterior Lobe Hormones:

- **Anti-diuretic hormone (ADH):** This hormone prompts the kidneys to increase water absorption in the blood.
- **Oxytocin:** Oxytocin is involved in a variety of processes, such as contracting the uterus during childbirth and stimulating breast milk production.

Thyroid Gland

Derived from the Greek word meaning **shield,** the thyroid is a butterfly-shaped gland located in front of the windpipe (called the trachea) and just below the larynx or Adam's apple in the neck. It is comprised of two halves, known as lobes, which are attached by a band of thyroid tissue called the isthmus.

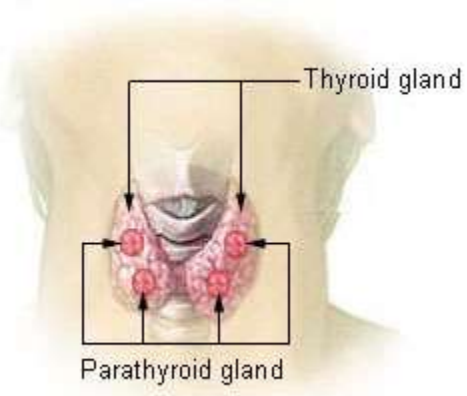


Hormones of the Thyroid Gland

The two main hormones the thyroid produces and releases are **T3 (tri-iodothyronine) and T4 (thyroxine).** A thyroid that is functioning normally produces approximately 80% T4 and about 20% T3, though T3 is the stronger of the pair.

Parathyroid Gland: -

The four parathyroid are typically found on the back side of the thyroid. They're about the size and shape of a grain of rice.



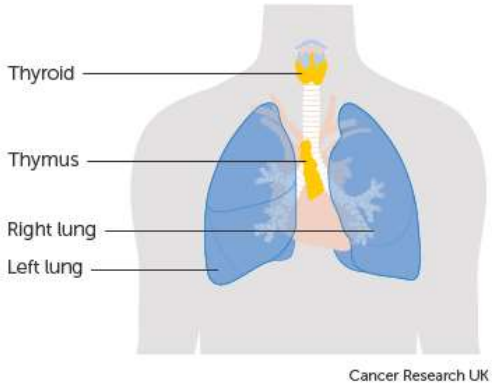
Although the parathyroid are very close to the thyroid gland anatomically, they have no related function. The thyroid gland regulates the body's metabolism, while parathyroid glands regulate calcium levels and have no effect on metabolism.

Parathyroid Hormone

- Parathyroid hormone (PTH) has a very powerful influence on the cells of your bones by causing them to release their calcium into the bloodstream.
- PTH regulates how much calcium is absorbed from your diet, how much calcium is excreted by your kidneys, and how much calcium is stored in your bones.
- We store many pounds of calcium in our bones, and it is readily available to the rest of the body at the request of the parathyroid glands.
- PTH increases the formation of active vitamin D, and it is active vitamin D that increases intestinal calcium and phosphorus absorption.

Thymus Gland: -

The thymus is located in the upper anterior (front) part of your chest directly behind your sternum and between your lungs. The pinkish-gray organ has two thymic lobes.



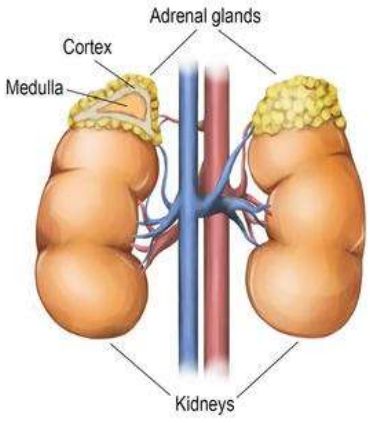
The thymus reaches its maximum weight (about 1 ounce) during puberty.

Thymosin: The Hormone of the Thymus

Thymosin stimulates the development of T cells. Throughout your childhood years, white blood cells called lymphocytes pass through the thymus, where they are transformed into T cells.

Adrenal Gland: -

The adrenal glands are two, triangular-shaped organs that measure about 1.5 inches in height and 3 inches in length. They are located on top of each kidney. Their name directly relates to their location (ad—near or at; renes—kidneys).



Each adrenal gland is comprised of two distinct structures—the outer part of the adrenal glands is called the adrenal cortex. The inner region is known as the adrenal medulla.

Hormones of the Adrenal Glands

The adrenal cortex and the adrenal medulla have very different functions. One of the main distinctions between them is that the hormones released by the adrenal cortex are necessary for life; those secreted by the adrenal medulla are not.

Adrenal Cortex Hormones

The adrenal cortex produces two main groups of corticosteroid hormones—**glucocorticoids and mineralocorticoid's**. The release of glucocorticoids is triggered by the hypothalamus and pituitary gland. Mineralocorticoid's are mediated by signals triggered by the kidney.

When the hypothalamus produces **corticotrophin-releasing hormone** (CRH), it stimulates the pituitary gland to release adrenal corticotrophic hormone (ACTH). These hormones, in turn, alert the adrenal glands to produce corticosteroid hormones.

Glucocorticoids released by the adrenal cortex include:

Hydrocortisone: Commonly known as cortisol, it regulates how the body converts fats, proteins, and carbohydrates to energy. It also helps regulate blood pressure and cardiovascular function.

Corticosterone: This hormone works with hydrocortisone to regulate immune response and suppress inflammatory reactions.

The principle mineralcorticoid is aldosterone, which maintains the right balance of salt and water while helping control blood pressure.

There is a **third class of hormone** released by the adrenal cortex, known as **sex steroids or sex hormones**. The adrenal cortex releases small amounts of male and female sex hormones. However, their impact is usually overshadowed by the greater amounts of hormones (such as **estrogen and testosterone**) released by the **ovaries or testes.**

Adrenal Medulla Hormones

Unlike the adrenal cortex, the adrenal medulla does not perform any vital functions. That is, you don't need it to live. But that hardly means the adrenal medulla is useless. The hormones of the adrenal medulla are released after the sympathetic nervous system is stimulated, which occurs when you're stressed. As such, the adrenal medulla helps you deal with physical and emotional stress.

You may be familiar with the fight-or-flight response—a process initiated by the sympathetic nervous system when your body encounters a threatening (stressful) situation. The hormones of the adrenal medulla contribute to this response.

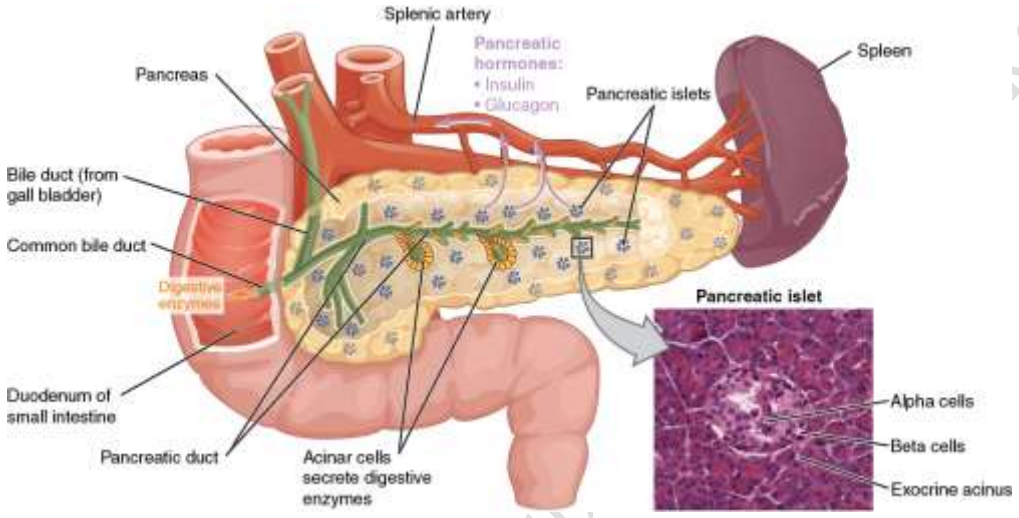
Hormones secreted by the adrenal medulla are:

Epinephrine: Most people know epinephrine by its other name—**adrenaline**. This hormone rapidly responds to stress by increasing your heart rate and rushing blood to the muscles and brain. It also spikes your blood sugar level by helping convert glycogen to glucose in the liver. (Glycogen is the liver's storage form of glucose.)

Norepinephrine: Also known as noradrenaline, this hormone works with epinephrine in responding to stress. However, it can cause vasoconstriction (the narrowing of blood vessels). This results in high blood pressure.

Pancreas Gland: -

The pancreas is a 6-inch-long flattened gland that lies deep within the abdomen, between the stomach and the spine. It is connected to the duodenum, which is part of the small intestine.



Only about 5% of the pancreas is comprised of endocrine cells. These cells are clustered in groups within the pancreas and look like little islands of cells when examined under a microscope. These groups of pancreatic endocrine cells are known as pancreatic islets or more specifically, **islets of Langerhans** (named after the scientist who discovered them).

Hormones of the Pancreas

The production of pancreatic hormones, including insulin, somatostatin, gastrin, and glucagon, play an important role in maintaining sugar and salt balance in our bodies.

Primary hormones secreted by the pancreas include:

Gastrin: This hormone aids digestion by stimulating certain cells in the stomach to produce acid.

Glucagon: Glucagon helps insulin maintain normal blood glucose by working in the opposite way of insulin. It stimulates your cells to release glucose, and this raises your blood glucose levels.

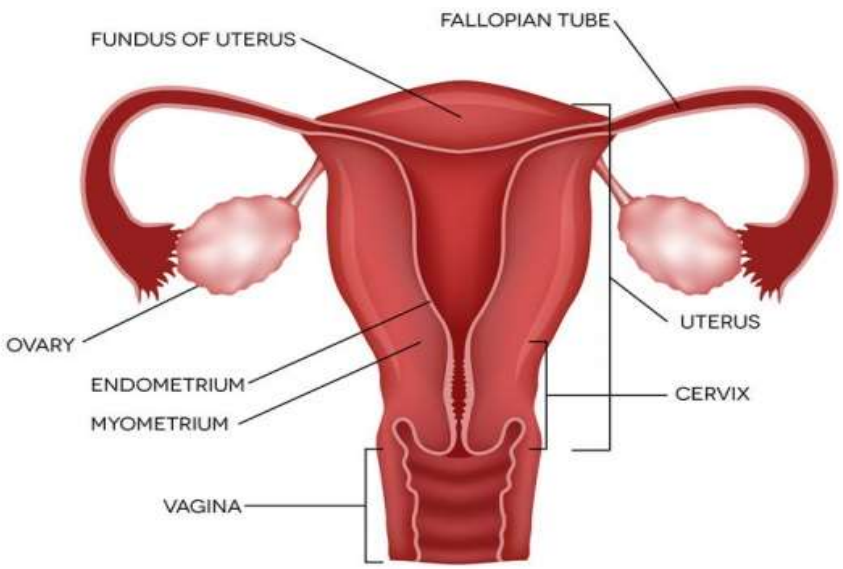
Insulin: This hormone regulates blood glucose by allowing many of your body's cells to absorb and use glucose. In turn, this drops blood glucose levels.

Somatostatin: When levels of other pancreatic hormones, such as insulin and glucagon, get too high, somatostatin is secreted to maintain a balance of glucose and/or salt in the blood.

Vasoactive intestinal peptide (VIP): This hormone helps control water secretion and absorption from the intestines by stimulating the intestinal cells to release water and salts into the intestines.

Ovaries Gland: -

The ovaries are oval shaped and about the size of a large grape. They are located on opposite ends of the pelvic wall, on either side of the uterus. The ovaries are each attached to the fimbria (tissue that connects the ovaries to the fallopian tube).



Hormones of the Ovaries

Ovaries produce and release two groups of sex hormones—**progesterone and estrogen**. There are actually three major estrogens, known as estradiol, estrone, and estriol. These substances work together to promote the healthy development of female sex characteristics during puberty and to ensure fertility.

Estrogen (estradiol, specifically) is instrumental in breast development, fat distribution in the hips, legs, and breasts, and the development of reproductive organs.

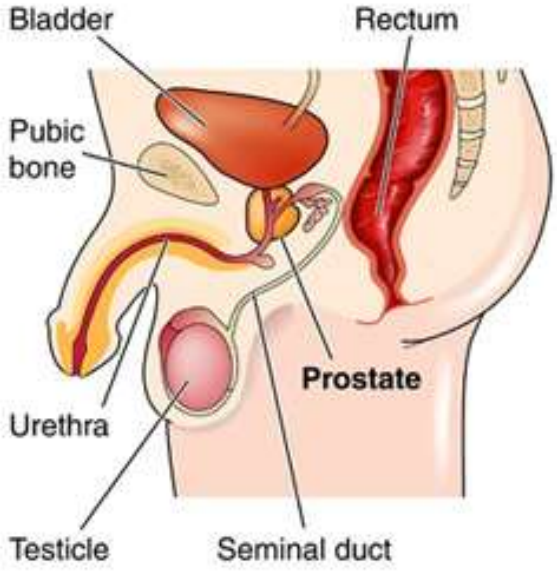
To a lesser extent, the ovaries release the hormone relaxin prior to giving birth. Another minor hormone is inhibin, which is important for signaling to the pituitary to inhibit follicle-stimulating hormone secretion.

Progesterone and Estrogen Production and Function

Progesterone and estrogen are necessary to prepare the uterus for menstruation, and their release is triggered by the hypothalamus.

Testes Gland: -

The testes are twin oval-shaped organs about the size of a large grape. They are located within the scrotum, which is the loose pouch of skin that hangs outside the body behind the penis. While this location makes the testes vulnerable to injury (they have no muscles or bones to shield them), it provides a cooler temperature for the organs. A cooler environment is necessary for healthy sperm production.



Testosterone: The Hormone of the Testes

Testosterone is necessary for proper physical development in boys. It is the primary androgen, which is the term for any substance that stimulates and/or maintains masculine development. During puberty, testosterone is involved in many of the processes that transition a boy to manhood, including:

- Healthy development of male sex organs
- Growth of facial and body hair
- Lowering of the voice
- Increase in height
- Increase in muscle mass
- Growth of the Adam's apple
