Pituitary Gland

Definition of Pituitary Gland

The pituitary gland is an endocrine gland that works to maintain cellular homeostasis in the body by the release of different hormones.

- The pituitary gland is also called the master gland as it regulates the working and secretion of other endocrine glands.
- Even though the pituitary gland is the most important endocrine gland, it remains regulated by the secretions of the hypothalamus. The pituitary gland is attached to the hypothalamus of the brain by a single stalk called the infundibulum.
- The term 'pituitary' is derived from the Latin term 'pituita', meaning phlegm or slime.
- The gland is present posterior and superior to the sphenoidal sinus in the depression called the sella turcicia.
- Structurally, the pituitary gland is divided into two distinct parts; anterior pituitary and posterior pituitary. The anterior pituitary is the glandular part called adenohypophysis, whereas the posterior pituitary is composed of neural tissue called neurohypophysis.
- In between the two lobes of the pituitary gland is a small avascular region called the pars intermedia, which is functional in some animals but underdeveloped in humans.
- The two lobes of the gland have different embryological origins; the anterior pituitary originates from the Rathke's pouch present in the pharyngeal epithelium, whereas the posterior pituitary originates from the neural tissue outgrowth in the hypothalamus.
- The anterior pituitary account for most of the pituitary gland and releases about six different peptide hormones. The posterior pituitary occupies a smaller volume and releases two peptide hormones.
- The hormones of the anterior pituitary are secreted within the lobe as it is composed of glandular tissue. The hormones of the posterior pituitary, in turn, are obtained from the hypothalamus, and the lobes act as a hormone-storage area.
- The pituitary gland remains in a close relationship with the hypothalamus, and the organs interact with each other via the hypophyseal portal system. The portal system is essential to release and transport even minute quantities of hormones from the hypothalamus to the pituitary gland.

Structure of Pituitary Gland

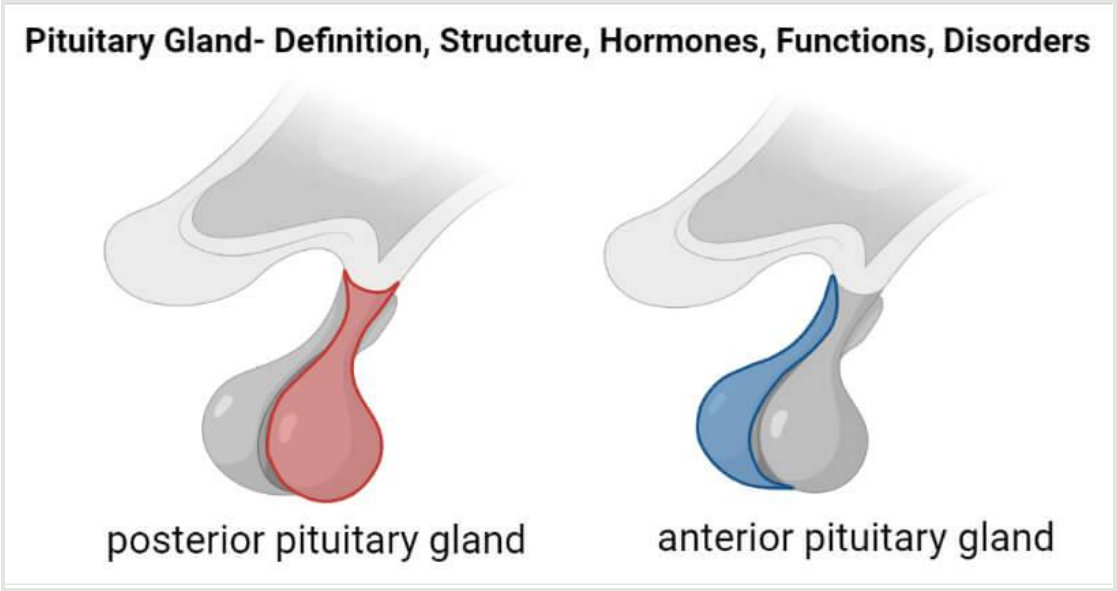

Fig:- Pituitary Gland. Created with BioRender.com

- The pituitary gland is a small pea-shaped gland that occurs at the base of the skull, typically housed within the bony structure beneath the hypothalamus.
- The gland is also called the hypophysis to indicate that the gland is present below the brain.
- It is attached to the hypothalamus by a small stalk composed of neural axons and veins. The gland weighs about 500-900 depending on the age and physiological condition of the individual.
- Typically, the pituitary gland consists of three distinct lobes; anterior lobe, posterior lobe, and intermediate lobe.
- The intermediate lobe, in the case of humans, doesn't exist as a distinct anatomical structure but remains as a part of the anterior pituitary.
- The two lobes of the gland differ from each other in their functions, anatomical structures, and embryological origin.
- The anterior pituitary is composed of glandular epithelium with cells having secretory functions.
- The posterior pituitary is composed of neurons that do not secrete their own hormone but act as a region of hormone storage.
- The anterior pituitary contains five different types of cells, each of which secretes a different hormone. Most of the space in the anterior pituitary is covered by somatotrophs.
- Even though the posterior pituitary doesn't have secretory units, the hormones are brought into this region for activation.
- Once in the posterior pituitary, the precursor protein of the hormone is cleaved to form the hormone.

Hormones of Pituitary Gland

The anterior pituitary secretes six different hormones, and the posterior pituitary secretes two hormones.

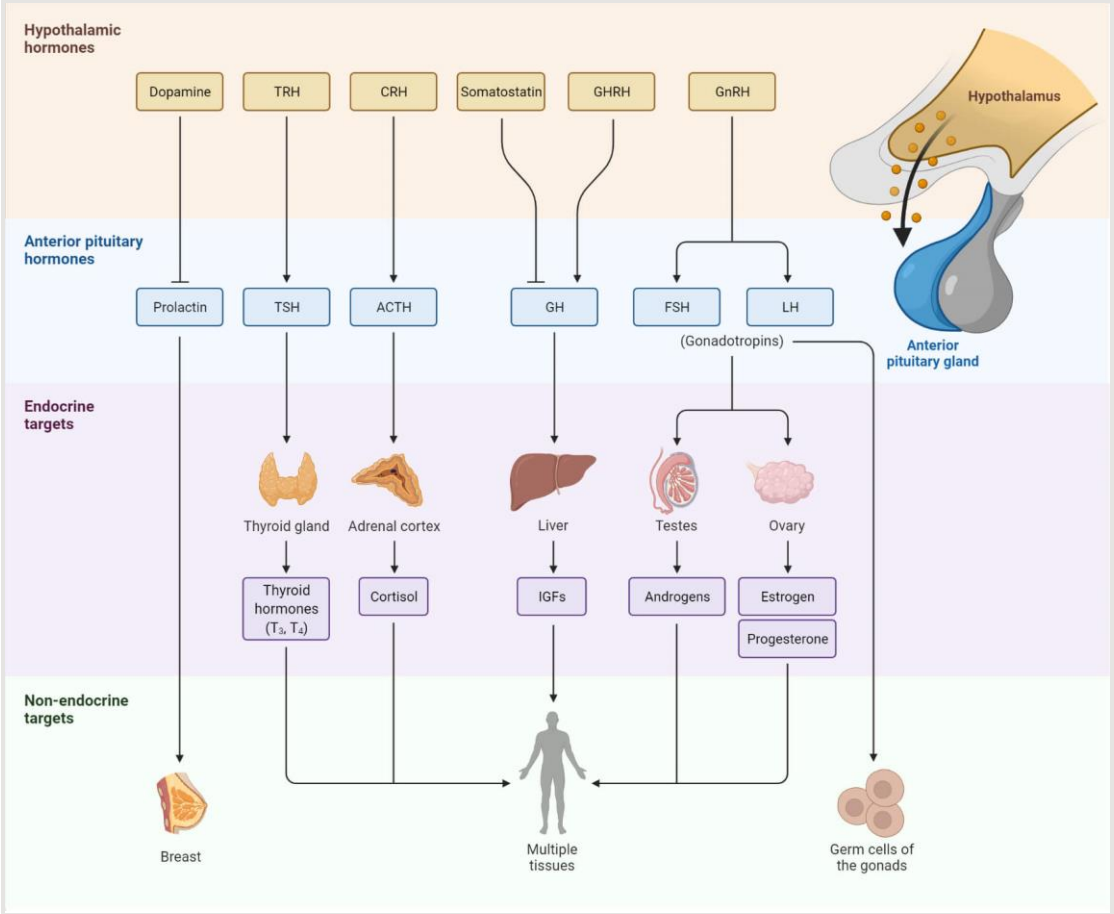

Fig:- Hormones of the hypothalamus and pituitary gland

1. Growth Hormone

- Growth hormone is produced by the somatotropic cells of the anterior lobe. The growth hormone is thus, also called somatotropin.
- The hormone is an anabolic or tissue-building hormone that has metabolic and growth-inducing functions.
- Growth hormones exert a wide range of direct and indirect effects on metabolism and other cellular functions.
- Growth hormone is responsible for the mobilization of fat in the body by increasing the levels of fatty acids. Growth hormone from the pituitary also affects the glycogen breakdown and the release of glucose into the blood.
- The hormone is also involved in growth-enhancing effects by the formation of a group of growth-promoting proteins called insulin-like growth factors.
- These proteins influence cell division and differentiation in organs like the liver, skeletal muscle, bones and connective tissues.
- The secretion of growth hormone by the anterior pituitary is regulated by two hypothalamic hormones; growth hormone-releasing hormone and growth hormone-inhibiting hormone.

2. Thyroid Stimulating hormone

- Thyroid-stimulating hormone is a hormone that stimulates the development of the thyroid gland and the secretion of thyroid hormones. The hormone is a tropic hormone and is also called thyrotropin.
- Like in the case of growth hormone, the activity and secretion of the thyroid-stimulating hormone are influenced by the thyrotropin-releasing hormone from the hypothalamus.
- Besides, the growth hormone-inhibiting hormone of the hypothalamus also affects the activity of this hormone.
- The release of the regulatory hormone, in turn, is controlled by the levels of thyroid hormones in the blood.

3. Adrenocorticotropic Hormone

- Adrenocorticotropic hormone or ACTH is secreted by the anterior pituitary that regulates the release of adrenocortical hormones by the adrenal gland.
- The hormone is secreted by the corticotropic cells in the form of a prohormone or precursor molecule.
- The most important function of the hormone is the activation of the adrenal cortex for the release of glucocorticoids.
- The release of ACTH is regulated by the hypothalamic corticotrophin-releasing hormone. The hormone is released in a daily rhythm where the levels are highest in the morning and decrease during the night.

4. Gonadotropin

- The gonadotropin hormone secreted by the anterior pituitary includes two important hormones; luteinizing hormone and follicle-stimulating hormone.
- Both of these hormones are essential for the stimulation of gonads in males and females.
- Follicle-stimulating hormone (FSH) is responsible for the production of gametes, whereas the luteinizing hormone (LH) controls the production of gonadal hormones.
- The function of FSH and LH in females is extended to the regulation of the ovarian cycle and the release of ovarian hormones.
- In males, LH also stimulates the testes to produce the male sex hormone, testosterone.
- Gonadotropins are released in very small quantities before puberty; however, the concentration of these hormones in the blood increases at puberty.
- At puberty, the gonadotropic cells of the anterior pituitary mature to increase the level of gonadotropin in the blood.
- The release of these hormones is regulated by the gonadotropin-releasing hormone released by the hypothalamus. Besides, the increased level of gonadal hormones suppresses the release of these hormones.

5. Prolactin

- Prolactin is secreted by the prolactin cells of the anterior pituitary and is responsible for the stimulation of mammary glands to release milk.
- The hormone is also produced in males, but its role in males is not yet understood.
- The release of prolactin, unlike other pituitary hormones, is regulated by prolactin-inhibiting hormone, also known as dopamine.

6. Oxytocin

- Oxytocin is one of two hormones secreted by the hypothalamus and released by the posterior pituitary.
- The primary function of oxytocin is to stimulate uterine contractions during childbirth. The number of oxytocin receptors on the uterine wall increases at the end of pregnancy which causes the smooth muscles of the uterine wall to be sensitive.
- Besides, oxytocin is also called the milk ejection hormone in women producing milk in response to prolactin.
- Suckling of nipples causes a reflex-induced release of oxytocin that targets the specialized myoepithelial cells of the mammary glands.
- Oxytocin is produced in the hypothalamus as a neurotransmitter that is involved in sexual and affectionate behavior like cuddling, nurturing and couple bonding.
- During labor or childbirth, both natural and synthetic oxytocin drugs are administered in order to hasten the process.

7. Antidiuretic Hormone (ADH)

- Antidiuretic hormone is the second hormone of the posterior pituitary, which regulates urine formation.
- The hormone is responsible for maintaining water balance and prevents dehydration and water overload in the body.
- The hormone is secreted by the hypothalamus under the influence of osmoreceptors that monitors the level of solute in the blood.
- When the levels of solute increase in the blood, the osmoreceptors transmit excitatory signals to the hypothalamus to release ADH.
- ADH targets the convoluted tubules and collecting the ducts of the nephrons in the kidney, causing them to reabsorb water and release more solute into the urine.

Functions of Pituitary Gland

The following are some of the important functions of pituitary glands:

1. The pituitary gland is called the master gland as it controls and regulates the activity of almost all other endocrine glands in the body.
2. Hormones of the pituitary gland are essential for the normal functioning of different organs and systems in the body.
3. The growth hormone of the anterior pituitary regulates cell division and differentiation of different organs, especially bones and skeletal muscles.
4. The gonadotrophic hormones are essential for the proper development of the reproductive system in both males and females.
5. The hormones of the posterior pituitary are essential during childbirth as well as post-childbirth.
6. The pituitary gland acts as a connective link between other endocrine glands and the nervous system (hypothalamus) in the body.

Diseases and Disorders of Pituitary Gland

The disorders and diseases associated with the pituitary gland are usually due to the hypersecretion or hyposecretion of the hormones.

The following are some of the disorders associated with the pituitary gland and its secretions;

1. Gigantism

- Gigantism is observed in children due to the excess of the growth hormone, causing the epiphyseal cartilages of long bonds to keep growing.
- Gigantism is the most prominent in the bones of the limbs and extremities, where an individual can grow up to 2.1 to 2.4 m in height.
- The increased secretion of growth hormone from the anterior pituitary is due to the excess release of growth hormone-releasing hormone by the hypothalamus.
- It might even cause enlargement of the internal organs and the formation of excess connective tissue mass in the body.
- Even though gigantism results in abnormally large limbs, the body proportions remain normal.

2. Acromegaly

- Acromegaly is similar to gigantism except that the increased secretion of growth hormone takes place after bone ossification.
- The condition is characterized by abnormally thick bones along with the thickening of soft tissues.
- Acromegaly is most prominent on the facial bones in the form of excessive growth of the lower jaw and enlarged tongue.
- Unlike gigantism, the body of the individual doesn't remain proportional.

3. Ischemic necrosis

- Ischemic necrosis is a condition caused due to the hypofunction of the anterior pituitary and the deficiency of hormones.
- Usually, intense hypotensive shock results in ischemic necrosis, which can be characterized by effects like deficient stimulation of the target glands and deficiency of the respective hormones.
- The overall effect of the condition depends on the degree of pituitary necrosis and the extent of hormone deficiency in different glands.

4. Pituitary Dwarfism

- Pituitary dwarfism is caused by the deficiency of the growth hormone and other anterior pituitary hormones during childhood.
- The body of the individual is smaller than usual, but the body remains normally proportioned. The cognitive and behavioral development of the individual remains unaffected.
- If the deficiency is followed by the deficiency of gonadotrophin hormone, puberty will be delayed, which affects the reproductive health of the individual.
- The condition arises due to the deficiency of the growth-stimulating hormone from the hypothalamus.

5. Frohlich's syndrome

- The condition is caused due to hypopituitarism characterized by the decreased release of all pituitary hormones.
- Bu the condition is most commonly observed with a deficiency of growth hormone, follicle-stimulating hormone, and luteinizing hormone.

- Some of the common features include reduced growth, delayed sexual development, and obesity in females. Some individuals might even develop learning disabilities.
- The primary cause of the condition is often associated with the formation of tumors in the anterior pituitary or the hypothalamus, but in many cases, the cause is known.

6. Diabetes insipidus

- Diabetes insipidus is a rare condition caused due to the hyposecretion of antidiuretic hormone by the posterior pituitary.
- The most common cause of the condition is the failure of the renal tubules to respond to the hormone.
- The deficiency of the hormone results in the lack of reabsorption of water in the renal tubules, resulting in dilute urine.
- The condition can lead to severe dehydration if an appropriate amount of water is not taken to maintain the water balance.

7. Pituitary adenoma

- One of the most common diseases associated it the pituitary gland is a pituitary adenoma. In this condition, tumors are observed in the sellar region of the gland.
- The tumors are classified as microadenomas (size less than 10 mm) and macroadenomas (size more than 10 mm).
- The larger tumors can compress other organs of the area, which might create other severe conditions.
- These are mostly asymptomatic or exhibit mild headaches.

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Thyroid Gland

Thyroid Gland Definition

The thyroid gland is an endocrine gland that occurs in the neck and is essential for iodine metabolism and secretion of thyroid hormones.

- The gland is small and highly vascular, like most endocrine glands. It occurs in the neck between the 5th, 6th, and 7th cervical vertebrae.
- The development of the gland and secretion of thyroid hormones is regulated by the anterior pituitary, which in turn is regulated by the hypothalamus.
- The thyroid gland is the largest pure endocrine gland in the body. Since the gland is large and highly vascular, thyroid surgeries are usually difficult.
- Embryologically, thyroid glands develop by the pharynx at the third or fourth week of pregnancy. The gland then slowly moves down and migrates to the base of the neck.
- The thyroid gland secretes two important hormones that are composed of iodine atoms; triiodothyronine and thyroxine. Besides, the thyroid gland also secretes a peptide hormone called calcitonin.
- Thyroxine and triiodothyronine are involved in the regulation of fat metabolism as well as growth and development in children.
- The hormone calcitonin plays an essential role in calcium metabolism and homeostasis.

- The gland rests on the thyroid cartilage and has two lobes on either side of the cartilage. The two lobes of the gland are joined together by a narrow piece of muscle called the isthmus.

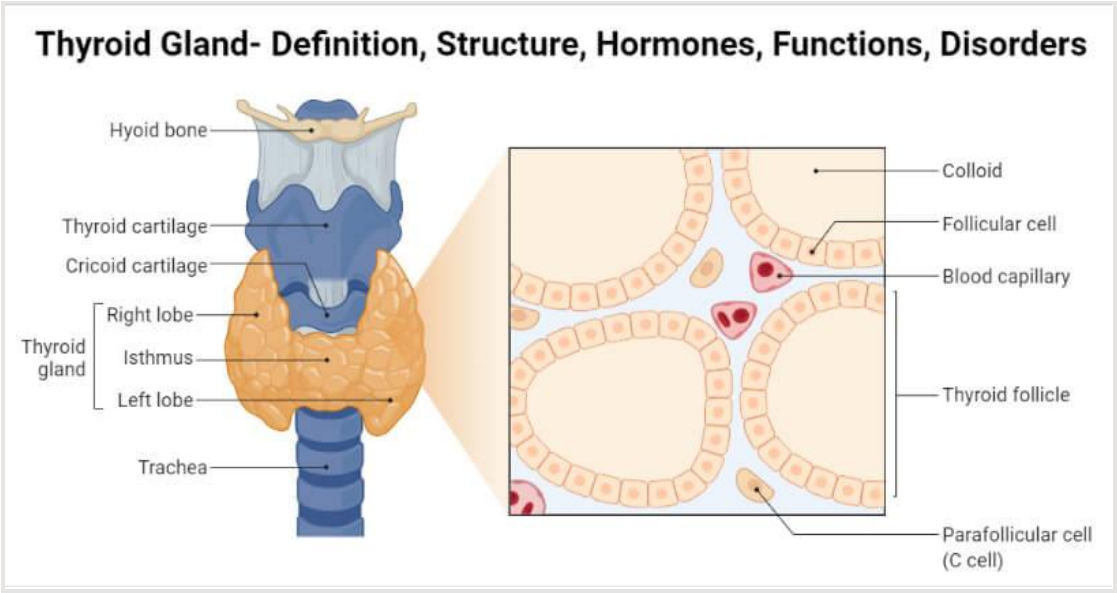

Fig:- Thyroid Gland Anatomy and Histology. Created with BioRender.com

Structure of Thyroid Gland

- The thyroid gland is a butterfly-shaped gland that is present on the anterior side of the neck, in front of the trachea.
- The gland weighs about 25 grams and has two lobes on either side of the trachea. Each of the lobes is cone-shaped, 5 cm long, and 3 cm wide.
- In between the two lobes is a median mass of tissue called the isthmus, which connects the two lobes.
- The internal structure of the gland consists of hollow spherical follicles that remain scattered through the structure.
- The walls of these follicles are composed of cuboidal epithelial cells, also known as follicular cells.
- These cells secrete the thyroid hormones in the form of a glycoprotein called thyroglobulin. The hormone is released in the form of an amber-colored, sticky liquid called colloid.
- In addition to the follicular cells, the thyroid gland also contains parafollicular cells, which produce calcitonin.
- The parafollicular cells are present within the follicular epithelium and do not form a separate mass with the connective tissue.
- The thyroid gland is highly vascular and is supplied with arterial blood supply through the superior and inferior thyroid arteries.

Hormones of Thyroid Gland

The thyroid gland secretes three different hormones; triiodothyronine, thyroxine, and calcitonin.

1. Thyroid Hormone (thyroxine and triiodothyronine)

- Thyroid hormone consists of two iodine-containing hormones, thyroxine and triiodothyronine.
- Thyroxine is also known as T4 as it contains four atoms of iodine, whereas triiodothyronine is also called T3 as it contains three atoms of iodine.
- The follicular cells of the thyroid gland produce thyroxine as the major hormone, which is then converted to T3.
- Both thyroxine and triiodothyronine are composed of two tyrosine amino acid units linked together with iodine atoms. The number of iodine atoms differs between the two hormones.
- The primary function or role of thyroid hormone is to increase the basal metabolic rate and heat production via glucose oxidation.
- Besides, it is also necessary for tissue growth and development, especially in the case of skeletal and nerve tissues.
- The level of thyroid hormone in the blood is regulated by the pituitary gland by the release of thyroid-stimulating hormone. The regulation and control of the release of thyroid hormone work by a negative feedback mechanism.

2. Calcitonin

- Calcitonin is secreted by the parafollicular cells or C cells of the thyroid gland as a response to an increased level of calcium in the blood.
- However, the hormone is not given as much importance as the increased level of calcium in the blood doesn't have a physiological effect on the body.
- Calcitonin is given to patients suffering from osteoporosis as it has a bone-sparing effect.
- Calcitonin acts on bones where it inhibits osteoclastic activity, decreasing the release of calcium into the blood. It also stimulates the uptake of calcium from the blood into the bone matrix.

Functions of Thyroid Gland

The following are some of the functions of the thyroid gland:

1. The most important function of the thyroid gland is to produce thyroid hormones that are essential for metabolic activities and growth.
2. The thyroid hormone regulates the basal metabolic rate in the body by influencing glucose, fat, and protein metabolism.
3. The hormones are composed of iodine atoms; thus, these also play an essential role in iodine metabolism in the body.
4. Calcitonin produced by the C cells of the thyroid gland regulates the levels of calcium ions in the blood.
5. The thyroid hormone plays a crucial role in the growth and development of the target organs in the body like the brain and kidneys.

Diseases and Disorders of Thyroid Gland

The disorders and diseases associated with the thyroid gland are usually due to the hypersecretion or hyposecretion of the hormones. The following are some of the disorders associated with the thyroid gland and its secretions;

1. Grave's disease

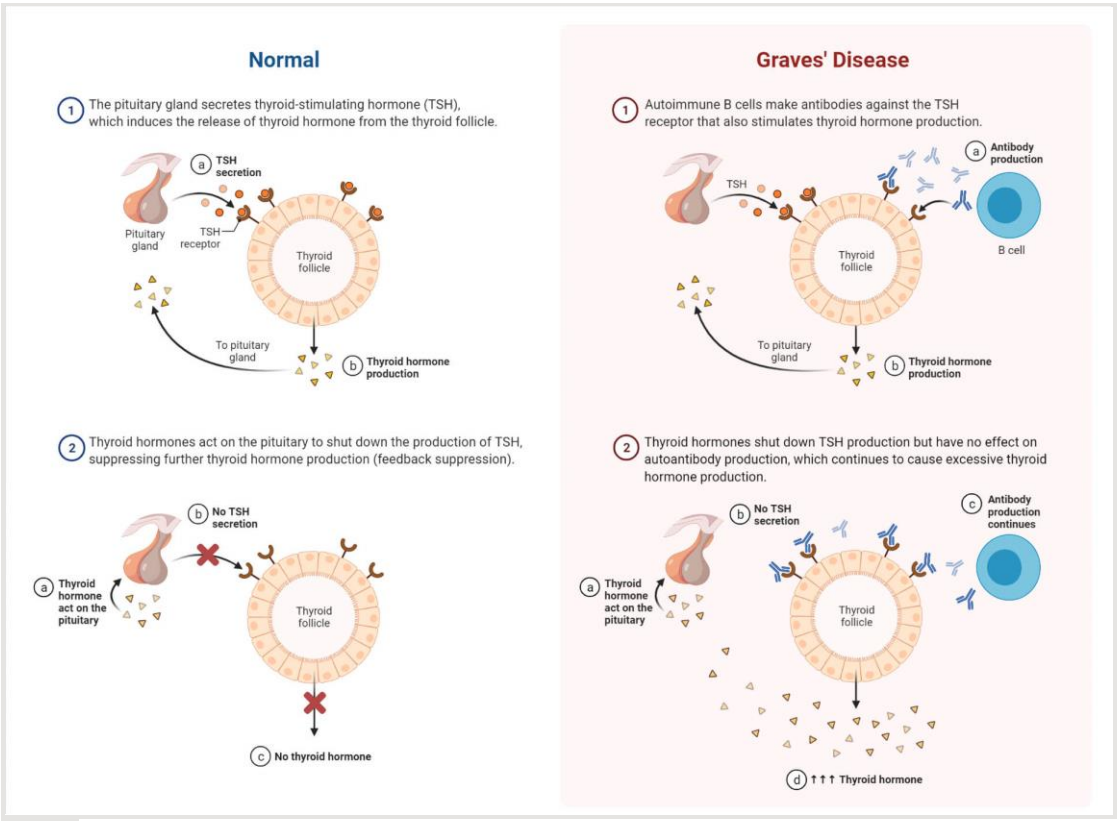

Fig:- Grave's disease

- Grave's disease or Grave's thyroiditis is a condition caused due to the hypersecretion of the thyroid hormone.
- The condition is more common in women than in men and can occur at any age but is common among individuals between 30-50 years.
- Grave's disease is an autoimmune condition in which the abnormal antibodies of the body are directed against the thyroid follicular cells.
- These unusual antibodies mimic the thyroid-stimulating hormone of the pituitary gland and stimulate the thyroid gland to produce the hormone.
- Some of the common symptoms associated with this condition are nervousness, elevated metabolism, sweating, weight loss, etc.

2. Simple goiter

- Simple goiter is a condition caused by the hyposecretion of the thyroid hormone as a result of enlargement of the gland.
- Goiter is characterized by the formation of extra thyroid tissue, which causes the enlargement of the gland.
- It is caused due to persistent iodine deficiency, which causes a relative lack of T3 and T4 in the body.
- In some cases, the increased size of the gland can cause damage to the adjacent tissues like the esophagus and nerves.

3. Cretinism

- Cretinism is caused due to the hyposecretion of thyroid hormone in children.
- Clinical features of the condition are observed in the form of mental retardedness and a disproportionately sized body.

- The effect of the condition depends on the age and physiological activity of the individual, but it is usually more severe in children than in adults.
- Cretinism might be caused due to genetic deficiency of the thyroid gland or maternal factors like the lack of iodine.

4. Thyroid tumor

- Malignant tumors of the thyroid gland are rare, but benign tumors, including single adenomas, are fairly common.
- However, in the case of older adults, the tumor might become malignant.
- Even with benign tumors, some might produce a large amount of hormones, resulting in hyperthyroidism.
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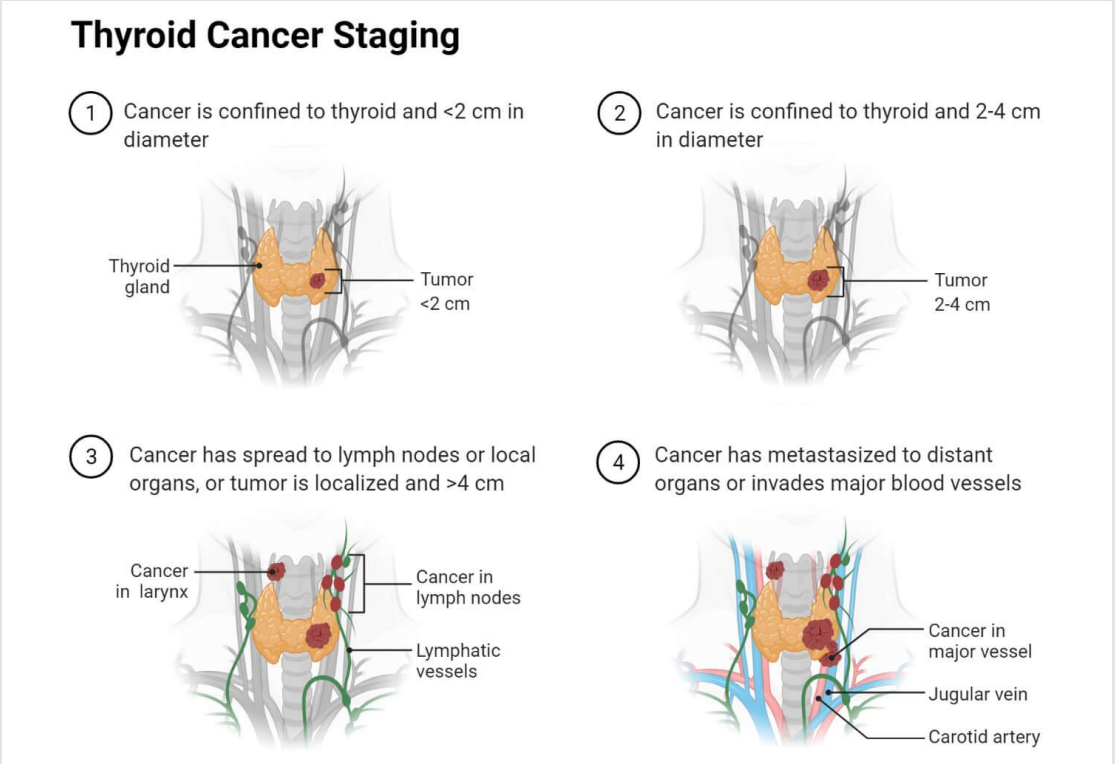

Fig:- Thyroid Cancer Staging