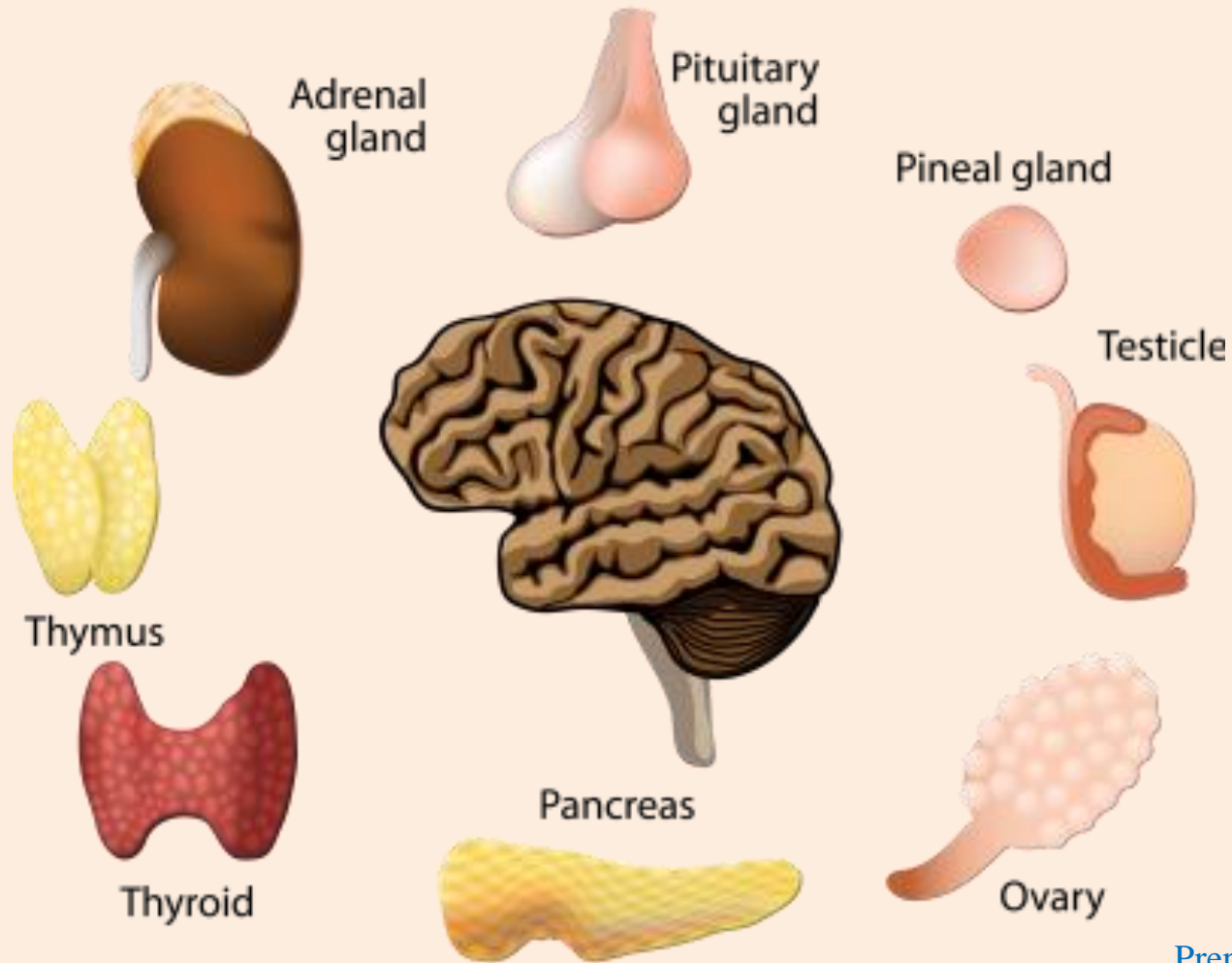


# Hormones



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## **Hormone:**

Hormones are various chemicals released within a human body that regulate and control the activities of multiple organs. The introduction of hormones to the blood takes place via endocrine glands.

## **Function of Hormones:**

Hormones act as a messenger which is released into the blood. Blood transmits them to various organs and tissues of the human body. After reaching a target site, hormones bind to the receptors. Once this process is complete, hormones then transmit the message which causes an organ or tissue to perform a specific action.

Hormones are made of a diverse range of chemicals, but they are classified in three classes –

- ❖ Eicosanoids
- ❖ Amino acid/protein derivatives (amines, proteins, and peptides)
- ❖ Steroids

# GENERAL PRINCIPLES OF HORMONE ACTION

**Trophic hormone:** A hormone that has its primary function the regulation of hormone secretion by another endocrine gland.

**Synergism:** When different hormones work together and have a greater effect than individual hormone action.

**Permissiveness:** A small amount of one hormone allows a second hormone to have its full effect on a target cell; i.e. first hormone 'permits' the full action of the second hormone.

**Antagonism :** One hormone produces the opposite effect of the other.

# MECHANISM OF HORMONE ACTION

The hormones fall into two general classes based on their solubility in water.

**1. Hydrophilic Hormone:** The water soluble hormone. They are transported simply dissolved in blood, Examples: the catecholamine's (epinephrine and nor epinephrine) and peptide/protein hormones.

**2. Lipophilic Hormone:** They are poorly soluble in water. So they cannot be dissolved in watery blood. They bind to plasma protein and present in the blood in protein bound form. They are lipid soluble. Examples: The lipid soluble hormones include thyroid hormone, steroid hormones and Vitamin D3.

# Broad Classification (Structure)

```
graph TD; A[Broad Classification (Structure)] --> B[Hydrophilic]; A --> C[Lipophilic]; B --> D[Proteins, peptide hormones & catecholamine's]; D --> E[Primarily act through second messenger system]; E --> F[Circulate mainly dissolved in the plasma]; C --> G[Steroid and thyroid hormones]; G --> H[Activate genes on binding with receptors in the nucleus]; H --> I[Largely bound to plasma proteins];
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Hydrophilic



Proteins, peptide hormones & catecholamine's



Primarily act through second messenger system



Circulate mainly dissolved in the plasma

Lipophilic



Steroid and thyroid hormones

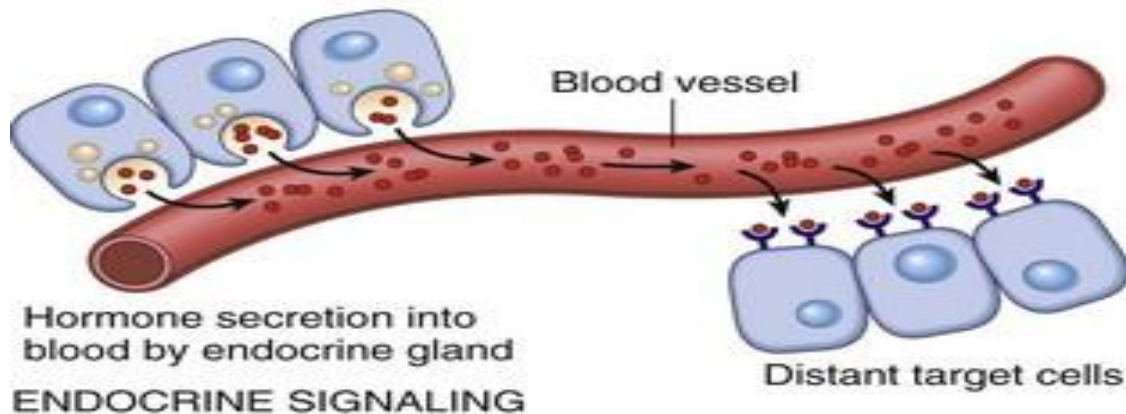
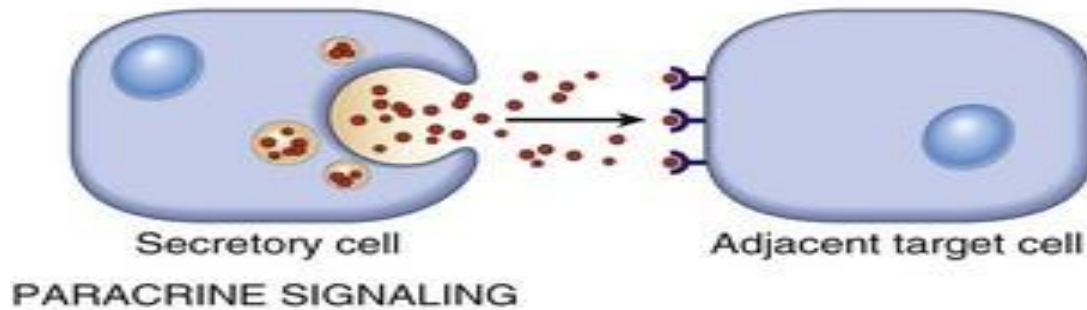
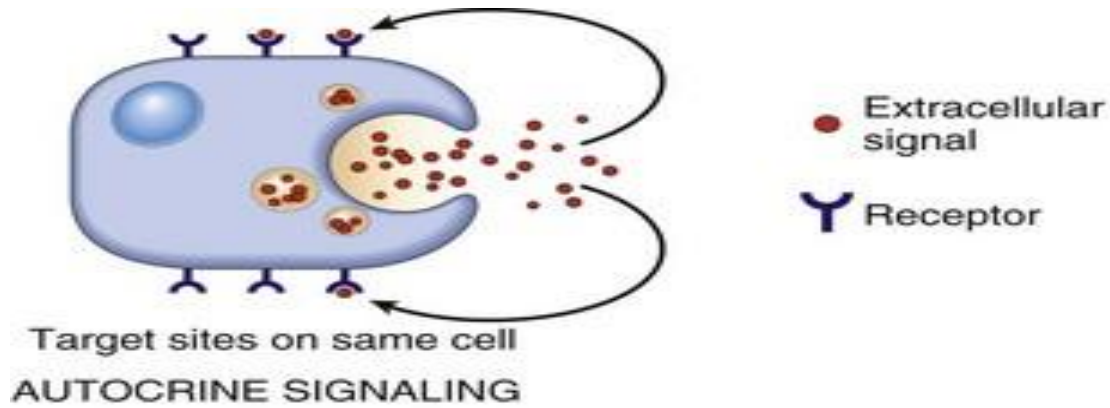


Activate genes on binding with receptors in the nucleus



Largely bound to plasma proteins

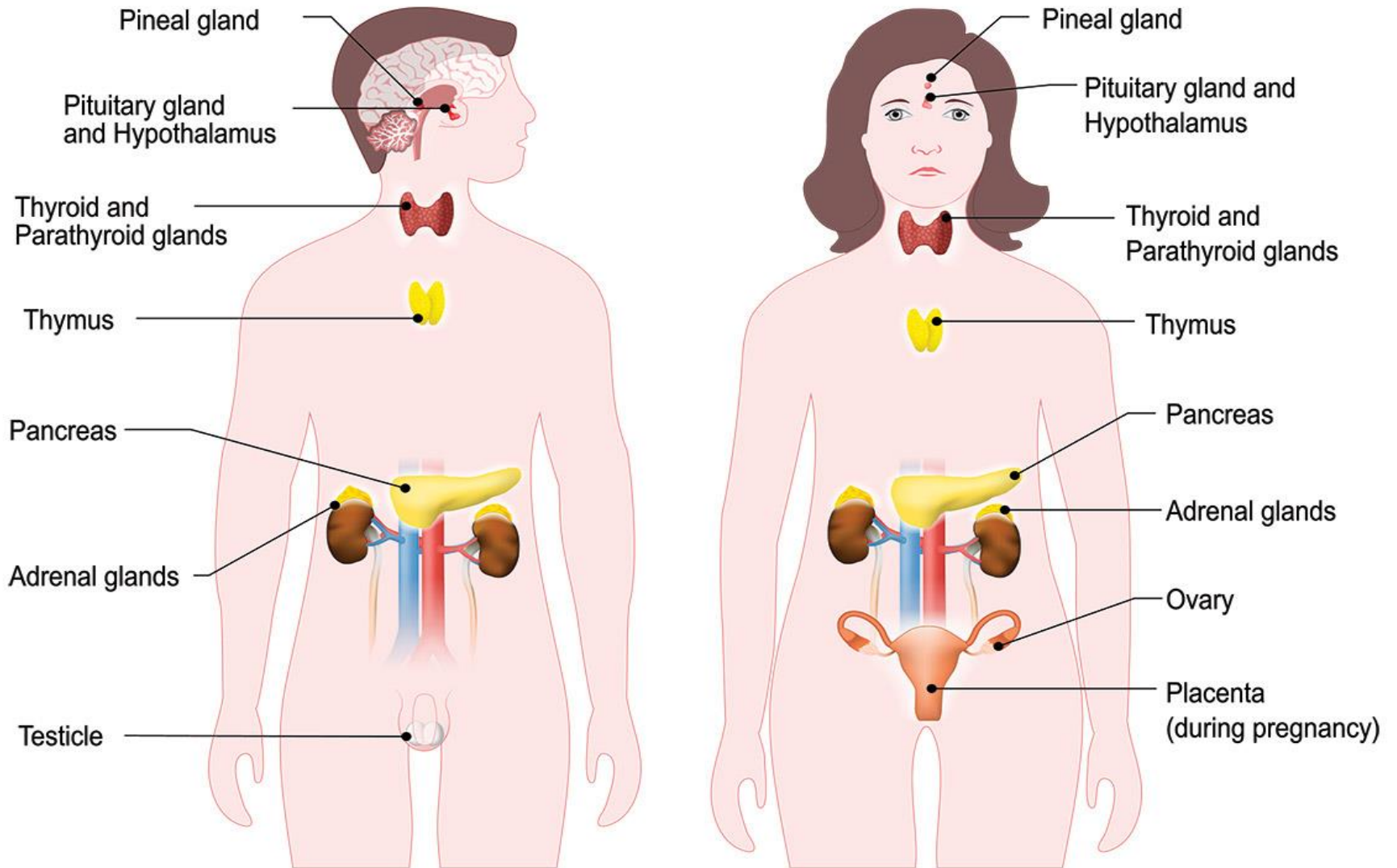
# Types of Signaling Molecules



## **Endocrine System Introduction**

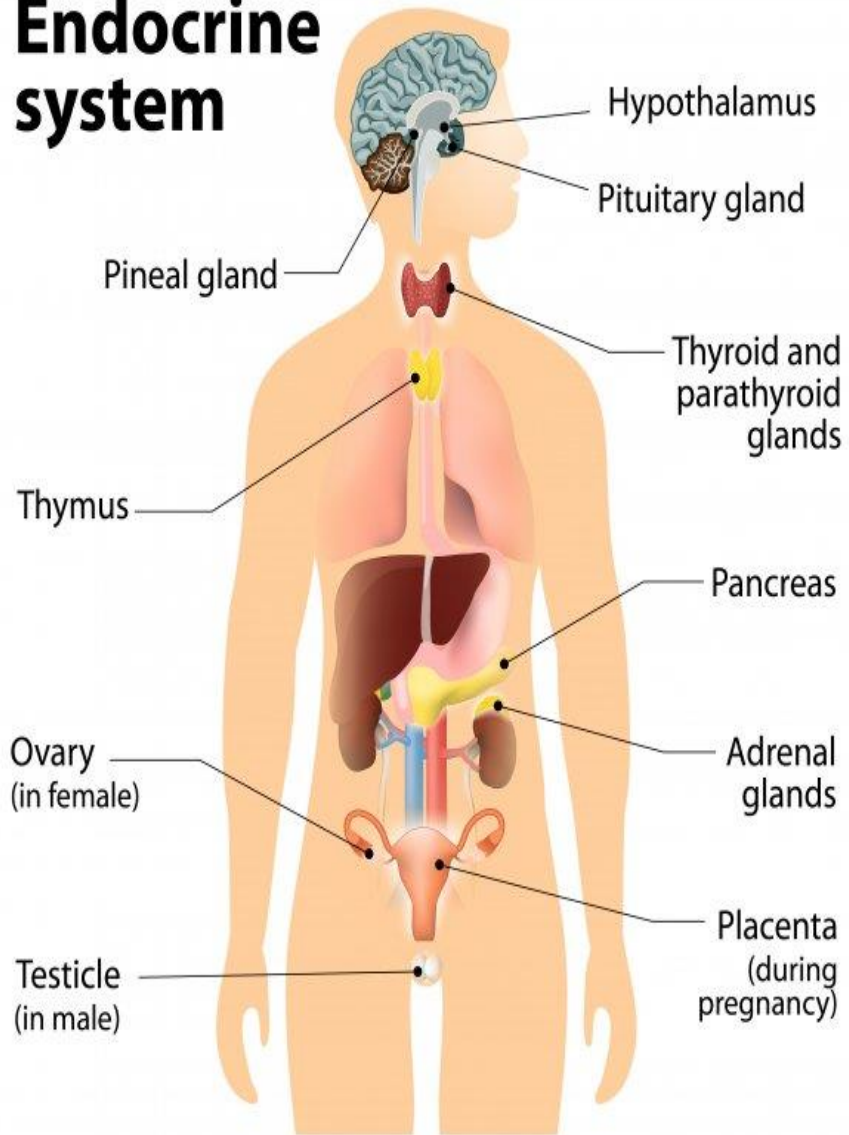
- ✓ The endocrine system is made up of glands that produce and secrete hormones, chemical substances produced in the body that regulate the activity of cells or organs.
- ✓ These hormones regulate the body's growth, metabolism (the physical and chemical processes of the body), and sexual development and function.
- ✓ The hormones are released into the bloodstream and may affect one or several organs throughout the body.
- ✓ The major glands of the endocrine system are the hypothalamus, pituitary, thyroid, parathyroids, adrenals, pineal body, and the reproductive organs (ovaries and testes).
- ✓ The pancreas is also a part of this system; it has a role in hormone production as well as in digestion.

# ENDOCRINE SYSTEM





# Endocrine system



## Help regulate:

- ✓ Extracellular fluid
- ✓ Metabolism
- ✓ Biological clock
- ✓ Contraction of cardiac & smooth muscle
- ✓ Glandular secretion
- ✓ Some immune functions
- ✓ Growth & development
- ✓ Reproduction

## **What Does the Endocrine System Do?**

❑ Once a hormone is secreted, it travels from the endocrine gland that produced it through the bloodstream to the cells designed to receive its message. These cells are called target cells.

❑ Along the way to the target cells, special proteins bind to some of the hormones. These proteins act as carriers that control the amount of hormone that is available for the cells to use.

❑ The target cells have receptors that latch onto only specific hormones, and each hormone has its own receptor, so that each hormone will communicate only with specific target cells that have receptors for that hormone.

❑ When the hormone reaches its target cell, it locks onto the cell's specific receptors and these hormone-receptor combinations transmit chemical instructions to the inner workings of the cell.

□ When hormone levels reach a certain normal amount, the endocrine system helps the body to keep that level of hormone in the blood.

Another example of this process is : **Parathyroid hormone.**

Parathyroid hormone increases the level of calcium in the blood. When the blood calcium level rises, the parathyroid glands sense the change and reduce their secretion of parathyroid hormone. This turnoff process is called a negative feedback system.

## General Mechanisms of Hormone Action

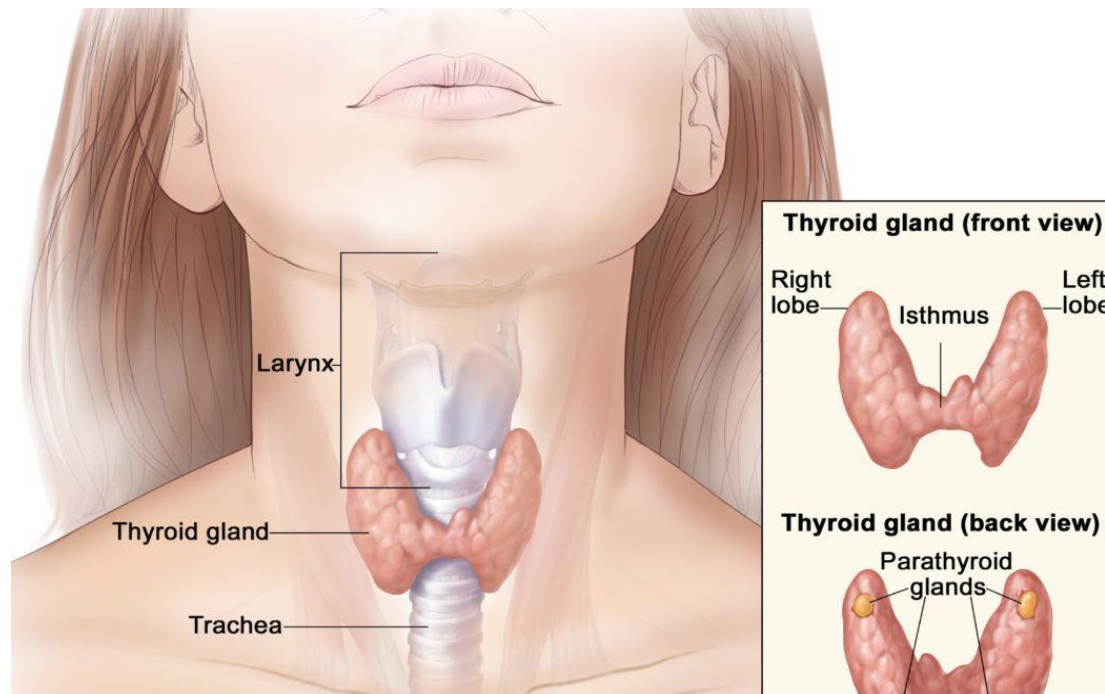
- Hormone binds to cell surface or receptor inside target cell
- Cell may then
  - ✓ synthesize new molecules
  - ✓ change permeability of membrane
  - ✓ alter rates of reactions
- Each target cell responds to hormone differently
  - ✓ liver cells---insulin stimulates glycogen synthesis
  - ✓ adipose---insulin stimulates triglyceride synthesis

## **Hypothalamus and Pituitary Gland**

- ❑ Both are master endocrine glands since their hormones control other endocrine glands
- ❑ Hypothalamus is a section of brain above where pituitary gland is suspended from stalk (surrounds 3rd ventricle)
- ❑ Hypothalamus receives input from cortex, thalamus, limbic system & internal organs
- ❑ Hypothalamus controls pituitary gland with different releasing & inhibiting hormones (gonadotropin-releasing hormone, growth hormone-releasing hormone, growth hormone-inhibiting hormone)
- ❑ Major integrating link between nervous and endocrine systems

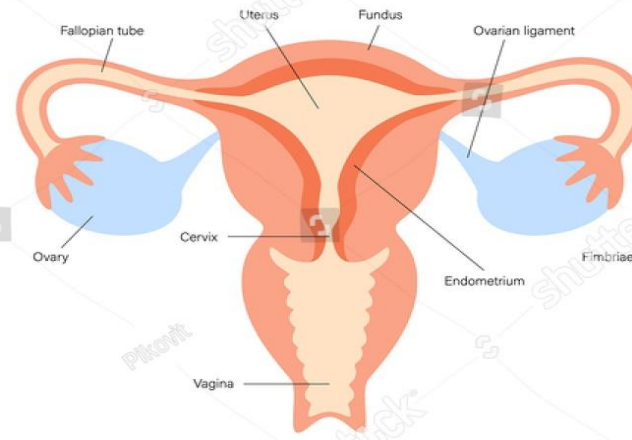
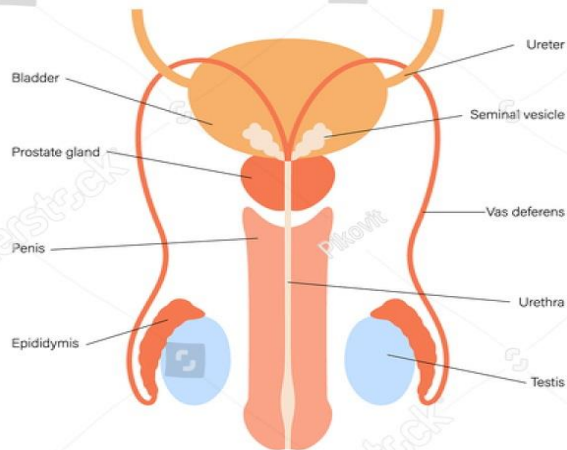
# Thyroid Stimulating Hormone (TSH)

- ❑ Hypothalamus regulates thyrotroph cells
- ❑ Thyrotroph cells produce TSH
- ❑ TSH stimulates the synthesis & secretion of T3 and T4
- ❑ Metabolic rate stimulated



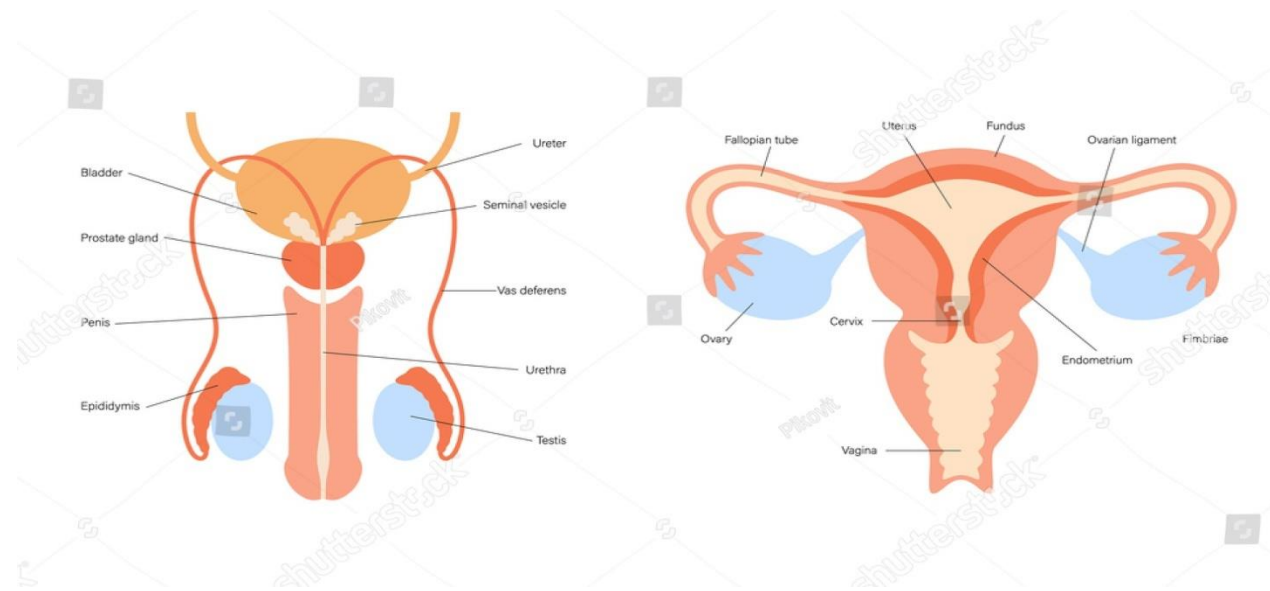
# Follicle Stimulating Hormone (FSH)

- ❑ GnRH from hypothalamus controls gonadotrophs
- ❑ Gonadotrophs release FSH
- ❑ FSH functions
  - ✓ initiates the formation of follicles within the ovary
  - ✓ stimulates follicle cells to secrete estrogen
  - ✓ stimulates sperm production in testes



## Luteinizing Hormone (LH)

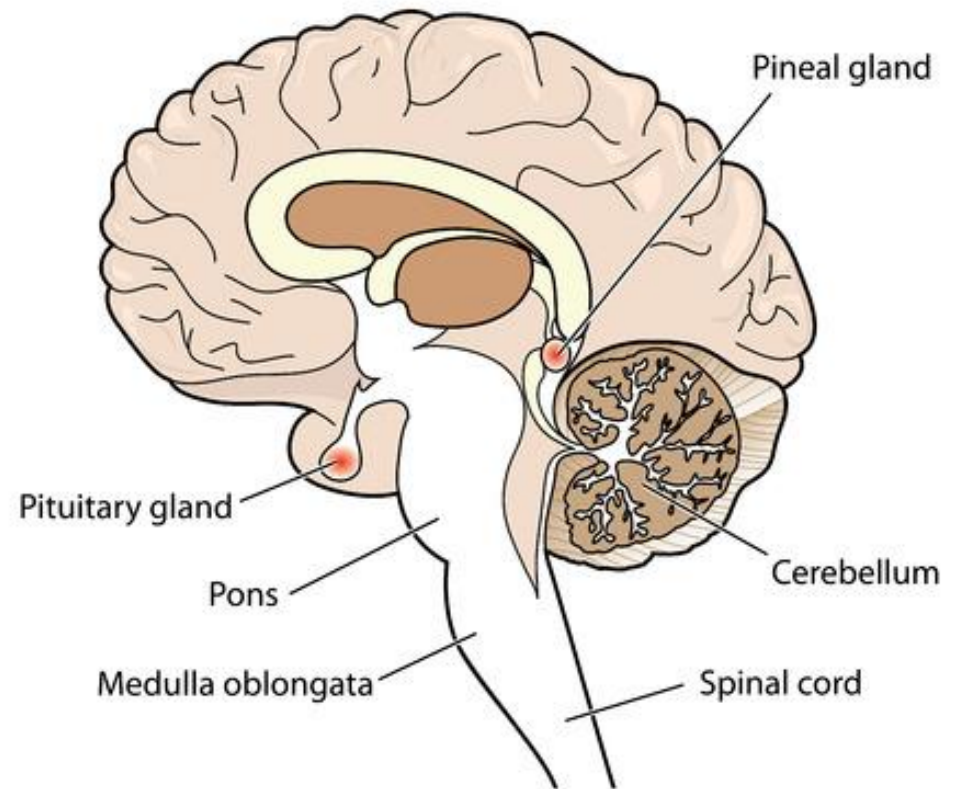
- ❑ GnRH from hypothalamus stimulate gonadotrophs
- ❑ Gonadotrophs produce LH
- ❑ In females, LH stimulates
  - ✓ secretion of estrogen
  - ✓ ovulation of oocyte from ovary
  - ✓ secretion of progesterone
- ❑ In males, stimulates interstitial cells to secrete testosterone





## PINEAL GLAND

The pineal gland, or the pineal body is in the middle of the brain. It secretes **melatonin**, a hormone that regulates when you sleep at night and wake up in the morning.



❑ Pineal gland is a small, cone shaped gland found in the roof of the third ventricle of the brain.

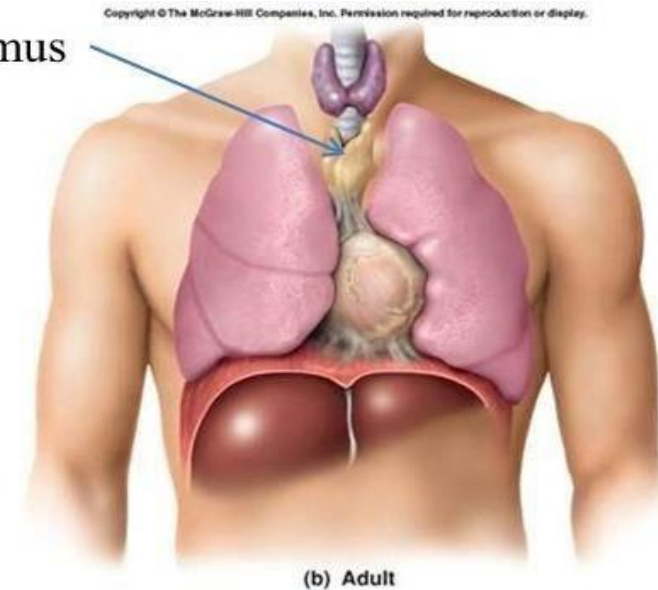
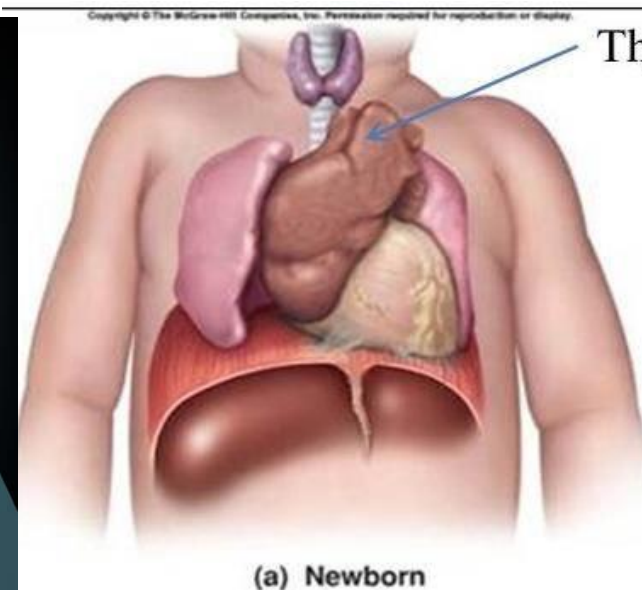
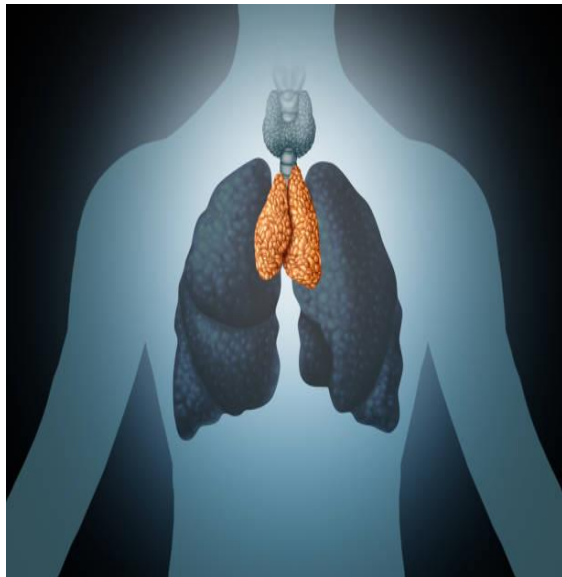
❑ Melatonin hormone appears to be secreted in substantial amounts.

❑ It is believed to coordinate the hormones of fertility and to inhibit the reproductive system (especially the ovaries of females).

❑ so that sexual maturation is prevented from occurring before adult body size has been reached.

# THYMUS GLAND

- ❑ Located in the upper thorax region.
- ❑ Large in infants and children, it decreases in size throughout adult hood. By old age, it is composed mostly of fibrous connective tissue and fat.
- ❑ Thymus produces a hormone called thymosin.
- ❑ During childhood, it acts as an incubator for the maturation of a special group of white blood cells (T lymphocytes or T cells).
- ❑ T cells are play a great role in immune response.

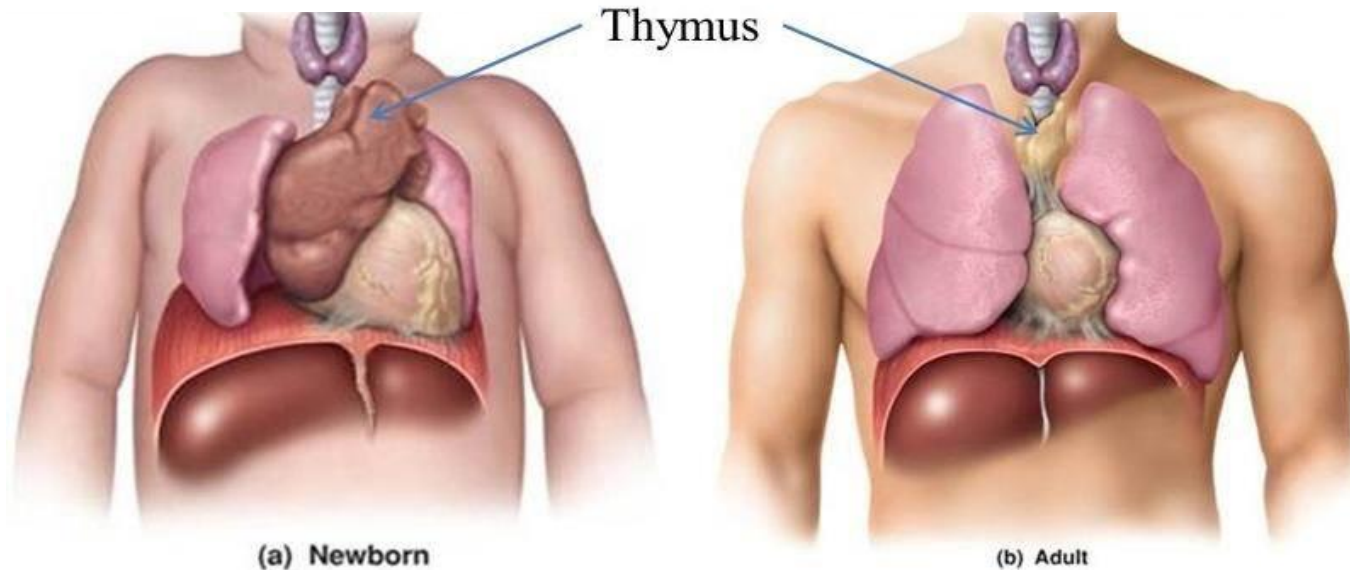


## Location:

Located close to thyroid cartilage. Has two lateral lobes connected by thyroid isthmus medially.

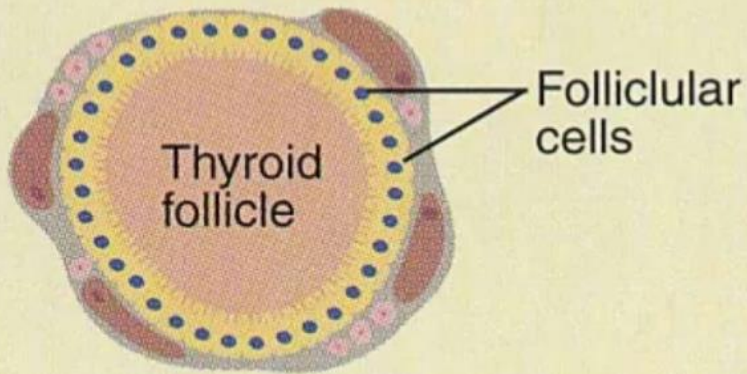
## Development:

First endocrine gland to appear during development. Develops from endodermal thickening in floor of early pharynx and epithelium of 3rd and 4th gill slit pouches as early as 24 days after fertilization. Starts out caudal to tongue, but ultimately comes to be wrapped around laryngeal cartilages.

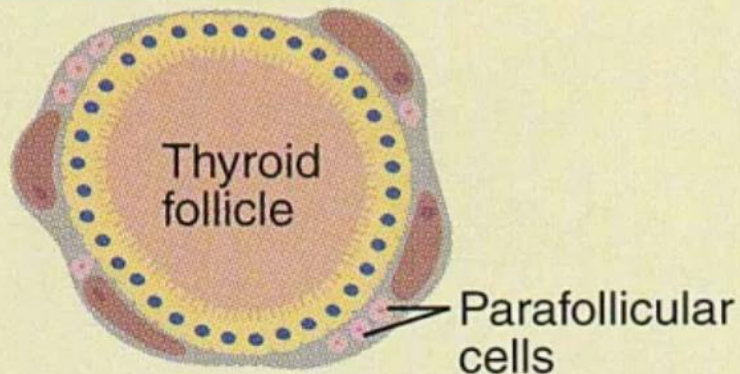


# Actions of Thyroid Hormones

$T_3$  (triiodothyronine) and  $T_4$  (thyroxine) or **thyroid hormones** from **follicular cells**



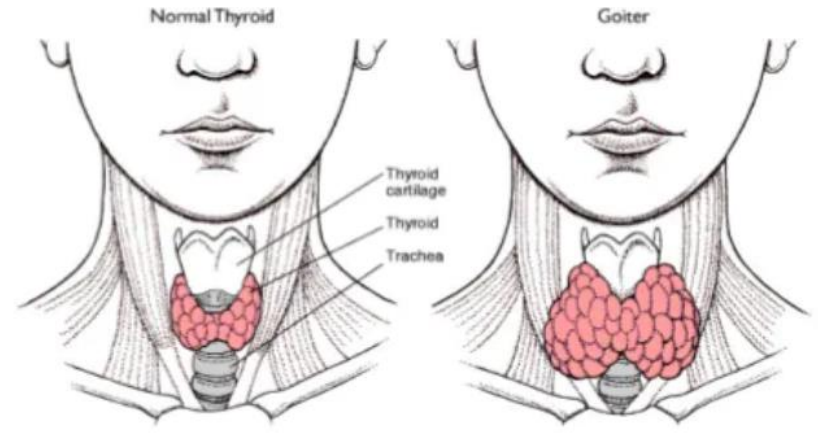
**Calcitonin (CT)** from **parafollicular cells**



- **T3 & T4** = thyroid hormones responsible for our metabolic rate, synthesis of protein, breakdown of fats, use of glucose for ATP production
- **Calcitonin** = responsible for building of bone & stops reabsorption of bone (lower blood levels of Calcium)

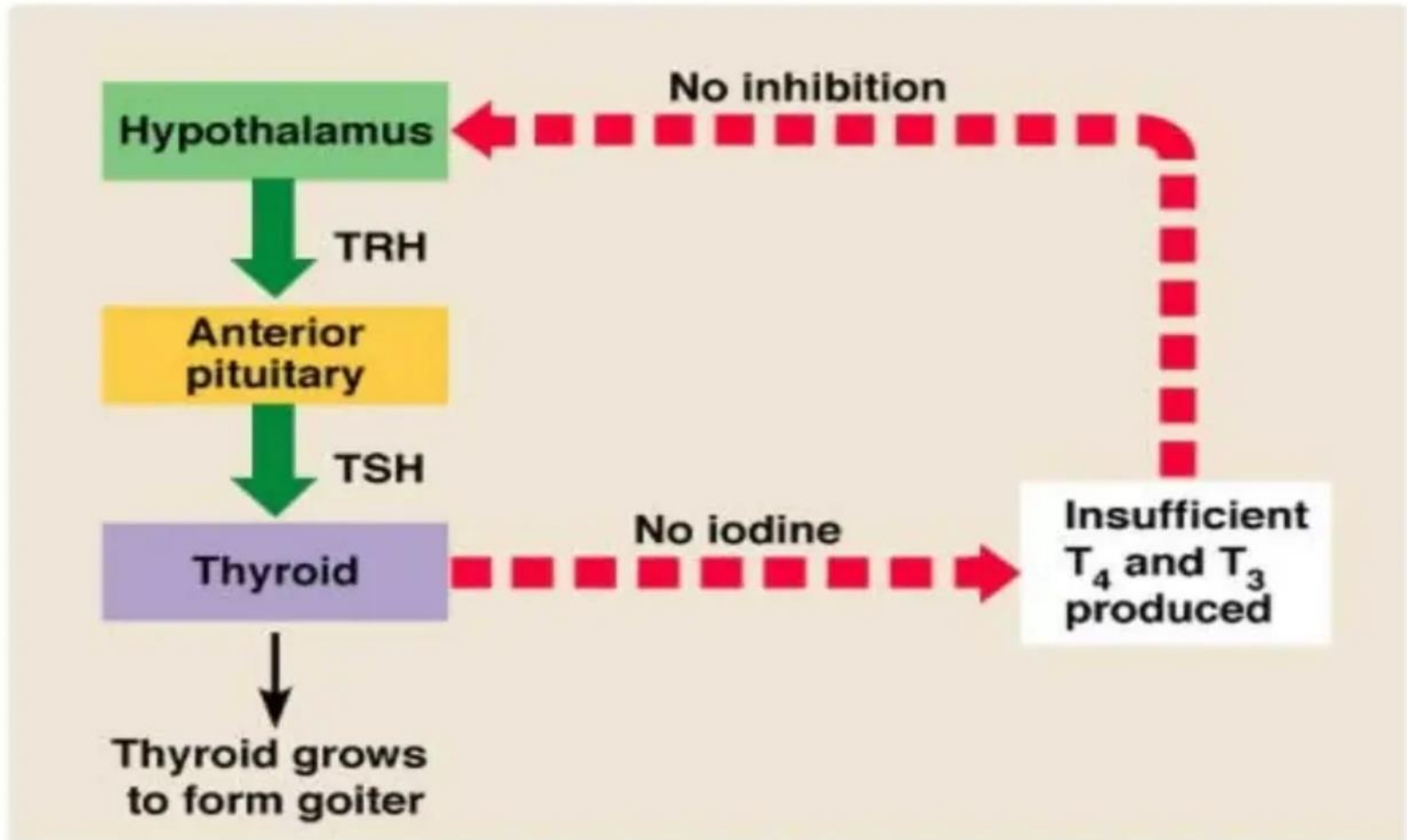
# Goiter

Iodine deficiency causes thyroid to enlarge as it tries to produce thyroxine



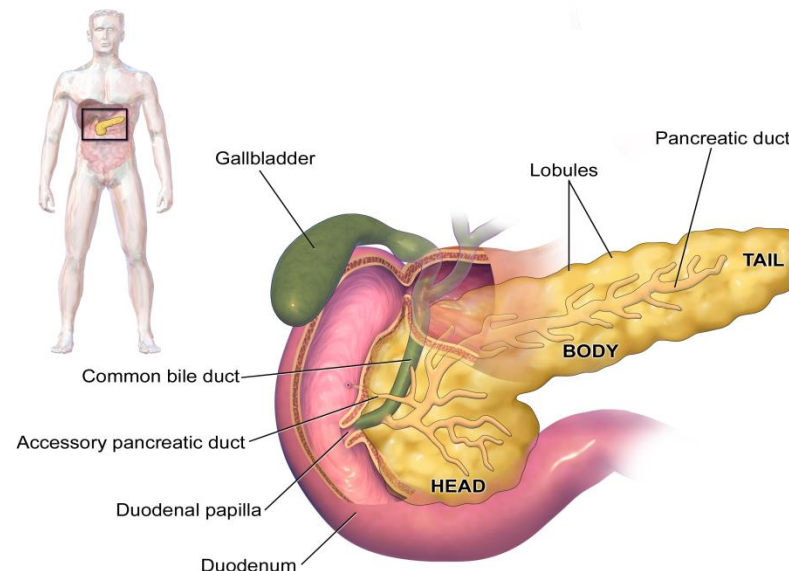
# Mechanism

- Goiters A thyroid goiter is a dramatic



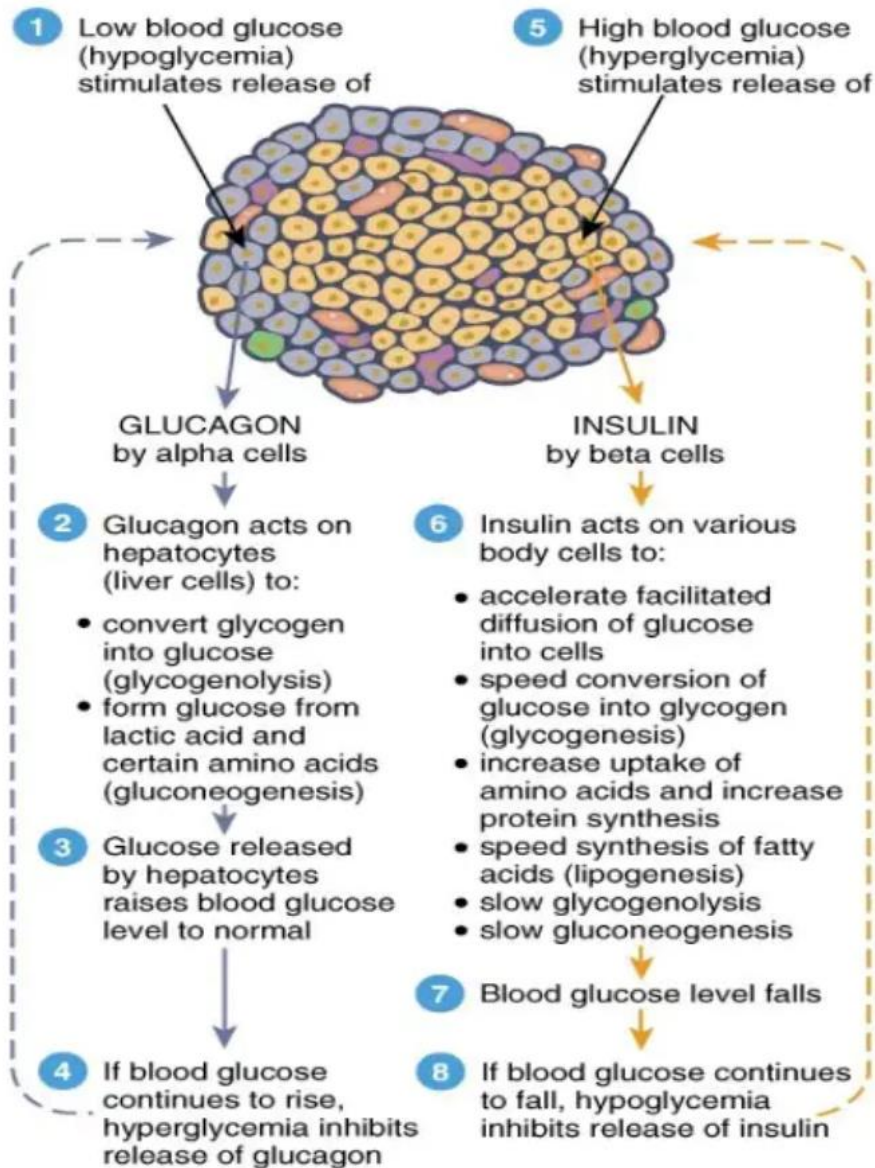
# PANCREAS

- ❑ The pancreas is an elongated organ located toward the back of the abdomen behind the stomach.
- ❑ The pancreas has digestive and hormonal functions. One part of the pancreas, the exocrine pancreas, secretes digestive enzymes.
- ❑ The other part of the pancreas, the endocrine pancreas, secretes hormones called insulin and glucagon. These hormones regulate the level of glucose (sugar) in the blood.





# Regulation of Glucagon & Insulin Secretion



- Low blood glucose stimulates release of glucagon
- High blood glucose stimulates secretion of insulin