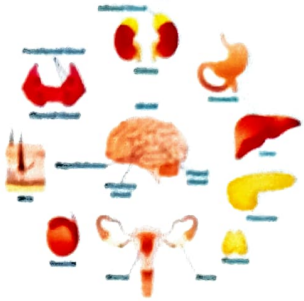
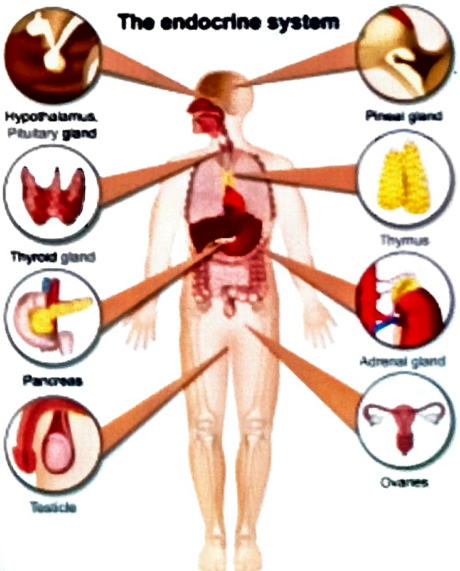
# ENDOCRINE SYSTEM

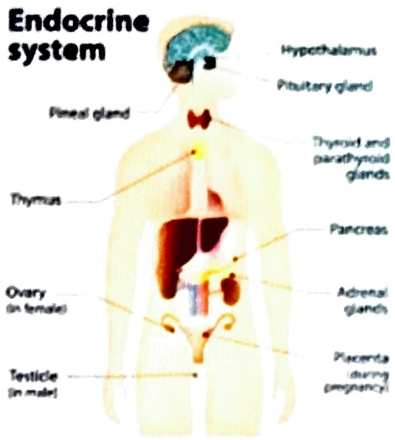
## Points to be covered in this topic



1. INTRODUCTION
2. HORMONES
3. CLASSIFICATION OF HORMONES
4. MECHANISM OF ACTION OF HORMONE
5. STRUCTURE, FUNCTIONS AND DISORDERS OF VARIOUS GLANDS
   - (a) PITUITARY GLAND
   - (b) PARATHYROID GLAND
   - (c) THYROID GLAND
   - (d) ADRENAL GLAND
   - (e) PANCREAS
   - (f) PINEAL GLAND
   - (g) THYMUS GLAND



## ❑ INTRODUCTION




- The endocrine system is the **collection of glands** that secrete **hormones** directly into the circulatory system to be carried to a distant **target organ.**
- The endocrine system consist of **ductless glands** which secrete **hormones.**
- Hormones regulate the **metabolic processes** of the body.
- The secretion of hormones by other endocrine glands is mostly controlled by **pituitary gland**. Hence, it is called **master gland of the body**
- Endocrinology is the branch of science that deals with the study of structure and function of the endocrine glands, their disorders and their treatment.

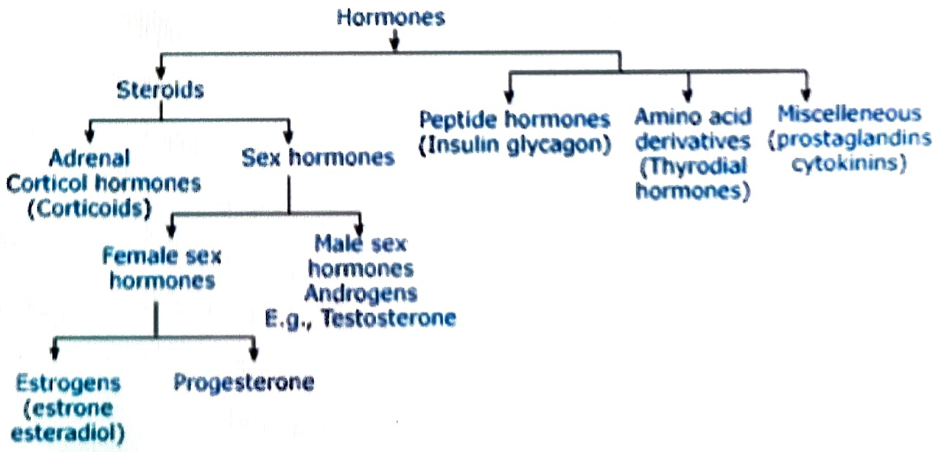
## ❑ HORMONES

- They are **mediator molecules** that are released in one part of the body but regulate the **activity** of cells in other parts of the body.
- They regulate **important** body processes and functions including **growth, reproduction** and **metabolism.**

## ❖ CLASSIFICATION OF HORMONES

Based on chemical nature, hormones are classified into three types:

1. **Steroid hormones**
2. **Protein hormones**
3. **Derivatives of the amino acid called tyrosine**

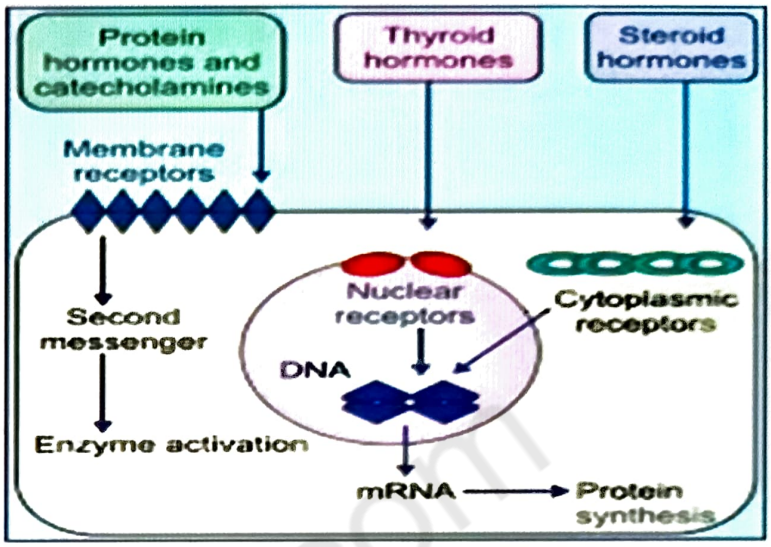


## 1. Steroid hormones

- Steroid hormones are the hormones synthesized from **cholesterol** or its **derivatives**.
- Steroid hormones are secreted by **adrenal cortex, gonads and placenta.**

## 2. Protein hormones

- Protein hormones are **large** or **small peptides**.
- Protein hormones are secreted by **pituitary gland, parathyroid glands, pancreas** and **placenta**




## 3. Derivatives of the amino acid called Tyrosine

- Two types of hormones, namely **Thyroid hormones** and **adrenal medullary hormones** are derived from the **amino acid tyrosine**

### Steroids

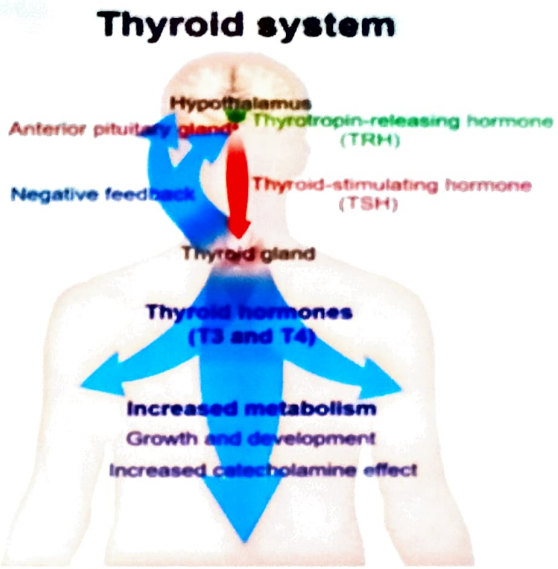
- ✓ Aldosterone
- ✓ 11-deoxycorticosterone
- ✓ Cortisol
- ✓ Corticosterone
- ✓ Testosterone
- ✓ Dihydrotestosterone
- ✓ Dehydroepiandrosterone
- ✓ Androstenedione
- ✓ Estrogen
- ✓ Progesterone

### Proteins

- ✓ Growth hormone (GH)
- ✓ Thyroid-stimulating hormone (TSH)
- ✓ Adrenocorticotropic hormone (ACTH)
- ✓ Follicle-stimulating hormone (FSH)
- ✓ Luteinizing hormone (LH)
- ✓ Prolactin
- ✓ Antidiuretic hormone (ADH)
- ✓ Oxytocin
- ✓ Parathormone
- ✓ Calcitonin
- ✓ Insulin
- ✓ Glucagon
- ✓ Somatostatin
- ✓ Pancreatic polypeptide
- ✓ Human chorionic gonadotropin (HCG)
- ✓ Human chorionic somatomammotropin

## Derivatives of Tyrosine

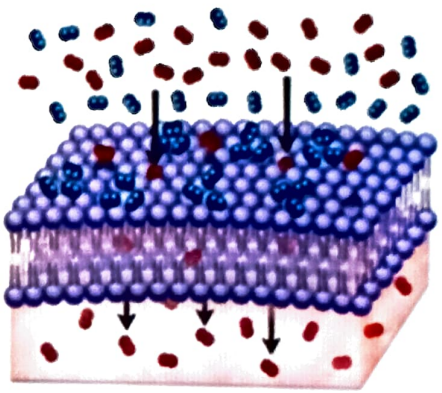
- ✓ Thyroxine (T4 )
- ✓ Triiodothyronine (T3 )
- ✓ Adrenaline (Epinephrine)
- ✓ Noradrenaline (Norepinephrine)
- ✓ Dopamine




## ❑ MECHANISM OF ACTION OF HORMONE

- Hormone does **not** act on the **target cell** directly.
- It combines with receptor to form **hormone-receptor complex.**
- This **complex** executes the hormonal action by any one of the following mechanisms
  1. **By altering permeability of cell membrane**
  2. **By activating intracellular enzyme**
  3. **By acting on Genes**

## 1. BY ALTERING PERMEABILITY OF CELL MEMBRANE



- Neurotransmitters in synapse or neuromuscular junction act by **changing** the **permeability** of **postsynaptic membrane.**
- For example, in a neuromuscular junction, when an **impulse** (action potential) reaches the axon terminal of the motor nerve, **acetylcholine** is released from the vesicles.
- Acetylcholine increases the **permeability** of the postsynaptic membrane for sodium, by opening the **ligand-gated sodium channels.**
- So, **sodium ions** enter the neuromuscular junction from ECF through the channels and cause the development of **Endplate potential.**

## 2. BY ACTIVATING INTRACELLULAR ENZYME

- **Protein hormones** and the **catecholamines** act by activating the intracellular enzymes.
- **First Messenger** The hormone which acts on a **target cell**, is called first messenger or chemical mediator. It combines with the receptor and forms **hormone-receptor complex.**
- **Second Messenger** Hormone-receptor complex activates the **enzymes** of the cell and causes the formation of another substance called the second messenger or **intracellular hormonal mediator.**
- Second messenger produces the **effects** of the hormone inside the cells.
- Protein hormones and the catecholamines act through second messenger. Most common second messenger is **cyclic AMP**

## 3. BY ACTING ON GENES

- **Thyroid** and **steroid hormones** execute their function by acting on genes in the target cells.

❖ Sequence of Events during Activation of Genes:

i. **Hormone** enters the interior of cell and **binds** with **receptor** in cytoplasm (steroid hormone) or in nucleus (thyroid hormone) and forms **hormone receptor complex**

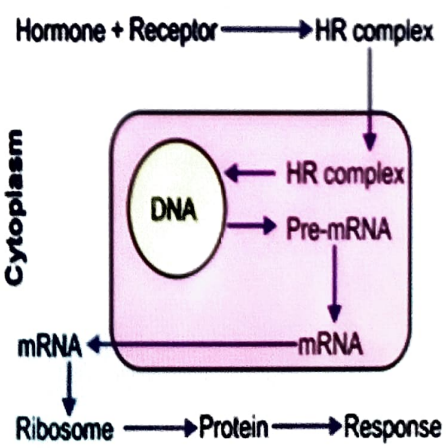
ii. Hormone-receptor complex moves **towards** the **DNA** and **binds** with DNA

iii. This increases **transcription** of mRNA

iv. The **mRNA** moves **out** of nucleus and reaches **ribosomes** and **activates** them

v. Activated ribosomes produce large quantities of **proteins**

vi. These proteins produce **physiological responses** in the target cells



# ❑ PITUITARY GLAND - ITS STRUCTURE AND FUNCTIONS

## ❖ INTRODUCTION

- It is also known as **hypophysis** is a small endocrine gland
- It is situated in a **depression** called '**Sella Turcica**', present in the **sphenoid bone** at the base of skull.
- It is **connected** with the hypothalamus by a **stalk** like structure called the **infundibulum.**


## ❖ Divisions of Pituitary Gland- Two divisions:

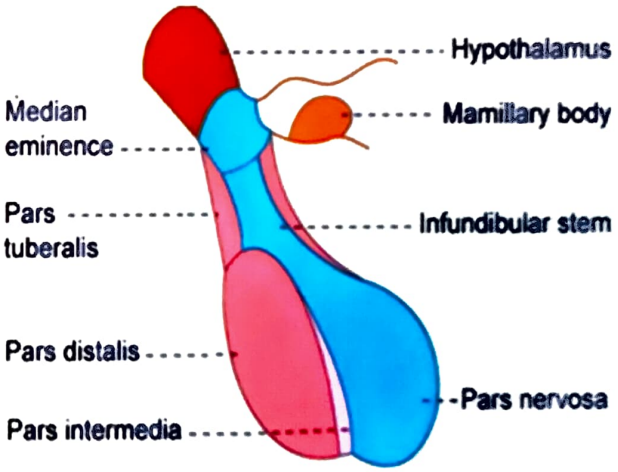
1. **Anterior pituitary** or **Adenohypophysis**
2. **Posterior pituitary** or **Neurohypophysis**

## 1. Anterior pituitary or Adenohypophysis

- Anterior pituitary is also known as the **Master gland** because it regulates many other endocrine glands through its hormones

### ➢ Parts-It consists of three parts

1. Pars distalis
2. Pars tuberalis
3. Pars intermedia




### ➢ Histology - It consists of two parts

1. Chromophobe cells
2. Chromophil cells

#### 1. Chromophobe Cells

- These cells form **50%** of total cells in anterior pituitary.
- Chromophobe cells are **not** secretory in nature, but are the **precursors** of chromophil cells.

#### 2. Chromophil Cells

- Chromophil cells contain **large** number of granules
- They have **different** types of cells

## Classification on the basis of secretory nature:

Chromophil cells are classified into five types:

i. Somatotrophs, which secrete growth hormone

ii. Corticotropes, which secrete adrenocorticotropic hormone

iii. Thyrotropes, which secrete thyroid-stimulating hormone (TSH)

iv. Gonadotrophs, which secrete follicle-stimulating hormone (FSH) and luteinizing hormone (LH)

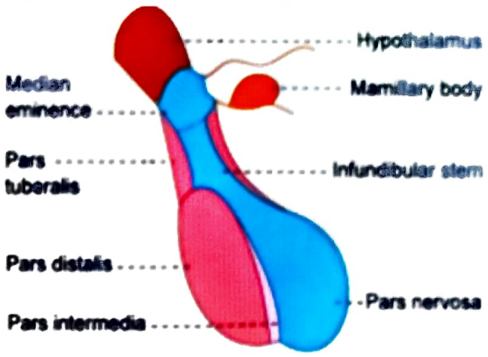
v. Lactotrophs, which secrete prolactin.

## Hormones secreted by anterior pituitary and their functions

| S. NO | HORMONES | FUNCTIONS |
|---|---|---|
| 1 | Growth hormone (GH) or somatotropic hormone (STH) | Important for normal growth and development of the body |
| 2 | Thyroid-stimulating hormone (TSH) or thyrotropic hormone | Regulates the synthesis of thyroid hormone in thyroid gland |
| 3 | Adrenocorticotropic hormone (ACTH) | Stimulates the adrenal cortex to synthesis its hormones |
| 4 | Follicle-stimulating hormone (FSH) | Stimulates:<br>i. ovary in females to produce estrogen<br>ii. Testis in males to produce spermatozoa |
| 5 | Luteinizing hormone (LH) in females or interstitial cell-stimulating hormone (ICSH) in male | Stimulates:<br>i. ovary in females to produce progesterone<br>ii. Testis in males to produce testosterone |
| 6 | Luteotropic hormone | Stimulates milk production in females |

## 2. Posterior pituitary or Neurohypophysis

- Posterior pituitary does **not** synthesis hormones but it **stores** and releases two hormones which are synthesized by the hypothalamus.
- The axon terminals in the posterior pituitary are associated with specialized neuroglia called **pituicytes**



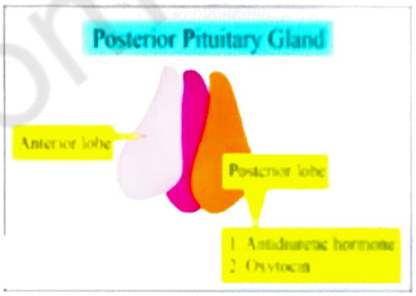

➢ **Parts**- Three parts:

i. **Pars nervosa or infundibular process**

ii. **Neural stalk or infundibular stem**

iii. **Median eminence.**

**Pars tuberalis** of anterior pituitary and the **neural stalk** of posterior pituitary together form the **hypophyseal stalk.**




➢ **Hormones of posterior pituitary hormones are:**

i. **Antidiuretic hormone (ADH) or vasopressin**

ii. **Oxytocin**

### i. Antidiuretic hormone (ADH) or vasopressin

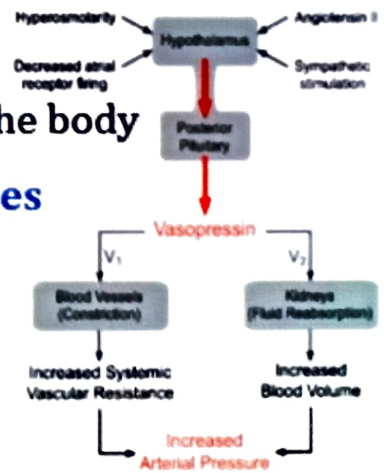
Antidiuretic hormone has **two** actions:

**a) Retention of water**

- Major function of **ADH** is retention of water by acting on kidneys
- It increases the **facultative reabsorption** of water from distal convoluted tubule and collecting duct in the kidneys

**b) Vasopressor action**

- In large amount, **ADH** shows vasoconstrictor action. it causes **constriction** of the **arteries** in all parts of the body
- Due to vasoconstriction, the **blood pressure increases**




### ii. Oxytocin

It has **two** actions

a) **Contraction** off uterus during labour (delivery) and to bring about parturition

b) **Ejection** of milk from the breast

## ❑ DISORDERS OF PITUITARY GLAND

### ✓ Hyperactivity of anterior pituitary

**1. Gigantism**

- It is characterized by **excess growth** of the body.
- The subjects look like the **giants** with average height of about 7 to 8 feet.
- It Causes due to **hypersecretion of GH** in childhood or in pre-adult life before the fusion of epiphysis of bone with shaft.

**2. Acromegaly**

- It is the disorder characterized by the **enlargement, thickening** and **broadening** of **bones**, particularly in the extremities of the body

**3. Acromegalic Gigantism**

- It is a rare disorder with symptoms of both **gigantism** and **acromegaly**.

### ✓ Hypoactivity of anterior pituitary

**1. Dwarfism**

- It is a pituitary disorder in children, characterized he **stunted growth.**

**2. Acromicria**

- It is a rare disease in adults characterized by the **atrophy** of the extremities of the body

### ✓ Hyperactivity of Posterior Pituitary

**1. Syndrome of Inappropriate Hypersecretion of Antidiuretic Hormone (SIADH)**

- SIADH is the disease characterized by loss of **sodium** through urine due to **hypersecretion of ADH.**

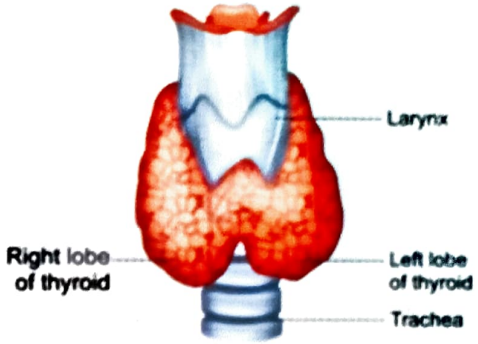
### ✓ Hypoactivity of Posterior Pituitary

**1. Diabetes Insipidus**

- It s is a posterior pituitary disorder characterized by **excess excretion** of water through urine.

# ❑ THYROID GLAND- ITS STRUCTURE AND FUNCTIONS

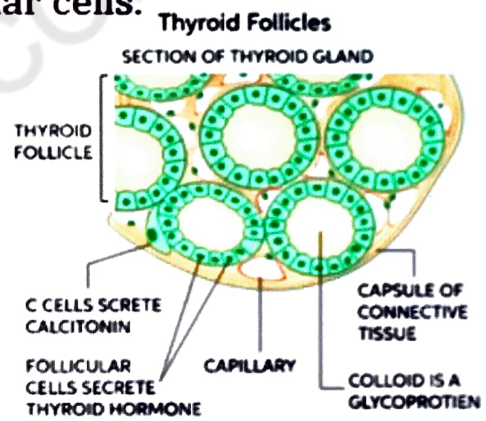
## ❖ INTRODUCTION




- Thyroid is an endocrine gland situated at the **root** of the neck on either side of the trachea.
- It has **two** lobes, which are connected in the middle by an **isthmus**
- Thyroid is larger in females than in males.

## ❖ Histology of Thyroid Gland

- Thyroid gland is made up of several number of closed **follicles** which is lined by **cuboidal** epithelial cells also known as **follicular cells .**
- Follicular cavity is filled with a colloidal substance known as **thyroglobulin,** which is secreted by the follicular cells.




## ❖ Hormones of Thyroid Gland

Thyroid gland secretes three hormones:

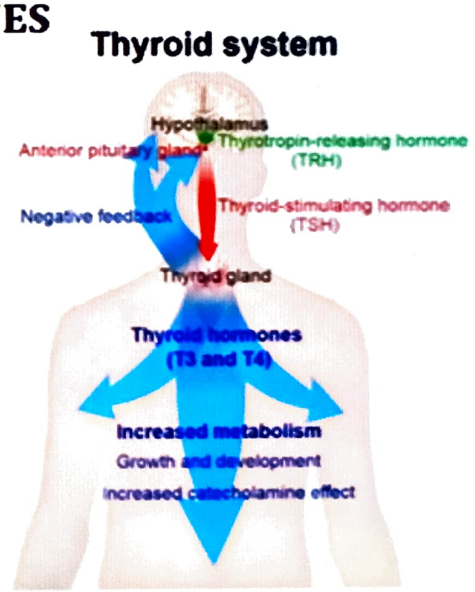
1. **Tetraiodothyronine or T4 (thyroxine)**
2. **Tri-iodothyronine or T3**
3. **Calcitonin.**

## ❖ Synthesis of Thyroid Hormones

**STAGES OF SYNTHESIS OF THYROID HORMONES**

It occurs in five stages:

1. **Thyroglobulin synthesis**
2. **Iodide trapping**
3. **Oxidation of iodide**
4. **Transport of Iodine into follicular cavity**
5. **Iodination of tyrosine**
6. **Coupling reactions**




### 1. Thyroglobulin Synthesis

- **Endoplasmic reticulum** and **Golgi apparatus** in the follicular cells of thyroid gland **synthesize** and **secrete** thyroglobulin continuously.
- Then it is **stored**

## 2. Iodide Trapping

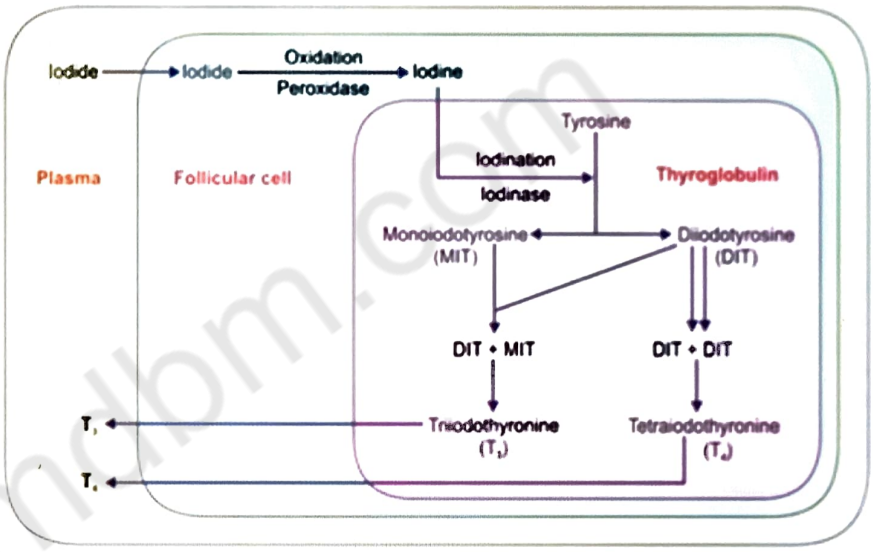
- Iodide is actively transported from blood into follicular cell, against electrochemical gradient. This process is called iodide trapping.
- Iodide is transported into the follicular cell along with sodium by sodium-iodide symport pump, which is also called iodide pump.

## 3. Oxidation of Iodide

- Iodide must be oxidized to elementary iodine, because only iodine is capable of combining with tyrosine to form thyroid hormones.
- It occurs inside the follicular cells in the presence of thyroid peroxidase.

## 4. Transport of Iodine into Follicular Cavity

- From the follicular cells, iodine is transported into the follicular cavity by an iodide-chloride pump called pendrin.




## 5. Iodination of Tyrosine

- Combination of iodine with tyrosine is known as iodination.
- First, iodine is transported from follicular cells into the follicular cavity, where it binds with thyroglobulin. This process is called organification of thyroglobulin.
- Iodide combines with the amino acid tyrosine and forms

**a) Mono iodo Tyrosine (MIT)** **b) Di iodo Tyrosine (DIT)**

## 6. Coupling Reactions

- Iodotyrosine residues get coupled with one another.
- The coupling occurs in different configurations, to give rise to different thyroid

**Tyrosine + I = Monoiodotyrosine (MIT)**
**MIT + I = Di-iodotyrosine (DIT)**
**DIT + MIT = Tri-iodothyronine (T3 )**
**MIT + DIT = Reverse T3**
**DIT + DIT = Tetraiodothyronine or Thyroxine (T4 )**

## ❖ Functions of Thyroid Gland

### 1. Increase in basal metabolic rate

- ✓ Thyroid hormone **increases** basal metabolic rate.

### 2. Effect on growth

- ✓ **T3 and T4** promote the **physical growth** in children, **development** of **skeleton growth** of individual and also promote mental growth.
- ✓ It promotes **growth** and **development** of brain during fetal life.
- ✓ **Hypersecretion** of thyroid hormone causes mental retardation in children.

### 3. Effect on carbohydrate, fat and protein metabolism

- ✓ The thyroid hormones stimulate **protein synthesis** increases lipolysis, increase **cholesterol** excretion in bile and **increase** the use of glucose for ATP production.

### 4. Effect on cardio vascular system

- ✓ Thyroid hormones increases **heart rate, cardiac contractility and cardiac output**
- ✓ They also promote **vasodilation**, which leads to enhanced blood flow to many organs.

### 5.Effect on central nervous system

- ✓ Both decreased and increased concentrations of **thyroid hormones** lead alterations in mental state.

### 6. Action on skeletal muscle

- ✓ **Hypersecretion** of thyroxine causes weakness of the muscles due to catabolism of proteins. This condition is called **Thyrotoxic myopathy.**
- ✓ **Hyperthyroidism** also causes fine muscular tremor.

### 7. Action on gastrointestinal tract

- ✓ Thyroxine increases the **appetite** and **food intake.**
- ✓ It also increases the **secretions** and **movements** of GI tract.

## ❖ Disorders of Thyroid gland

### 1. HYPERTHYROIDISM

- Increased secretion of thyroid hormones is called hyperthyroidism.

### 2. HYPOTHYROIDISM

- Decreased secretion of thyroid hormones is called hypothyroidism.
- Hypothyroidism leads to myxedema in adults and cretinism in children

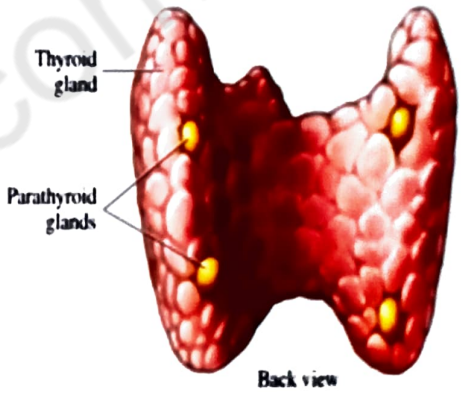
### 3. GOITER

- Goiter means enlargement of the thyroid gland.
- It occurs both in hypothyroidism and hyperthyroidism.

# ❑ PARATHYROID GLAND- ITS STRUCTURE AND FUNCTIONS

## ❖ Introduction

- Human beings have four parathyroid glands
- They are situated on the posterior surface of upper and lower poles of thyroid gland
- Parathyroid glands are very small in size, with dark brown color




## ❖ Structure of parathyroid gland

- The parathyroid glands are composed of masses of epithelial cells
- The cells are of two types

  **1) Chief cells 2) Oxyphil cells**

- The **chief cells** secrete the Parathyroid hormone (PTH)

## ❖ Functions of parathyroid hormone

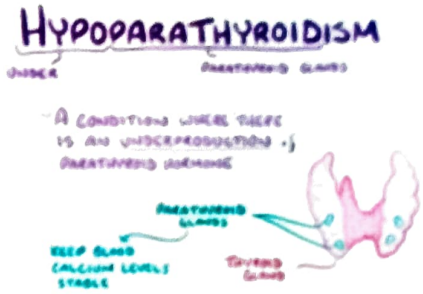
- PTH increases calcium level of plasma and extracellular fluid
- This effect is produced by the following mechanisms :

  ✓ Mobilization of calcium of bone into the extracellular

  ✓ Increased reabsorption of calcium in the renal tubule

  ✓ Increased absorption of calcium in the gastrointestinal tract

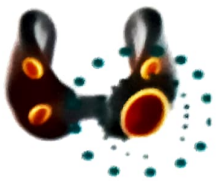
## ❖ Disorders of Parathyroid gland




### 1. HYPOPARATHYROIDISM – HYPOCALCEMIA

- Hyposecretion of PTH is called hypoparathyroidism. It leads to **hypocalcemia** (decrease in blood calcium level).

### 2. HYPERPARATHYROIDISM – HYPERCALCEMIA



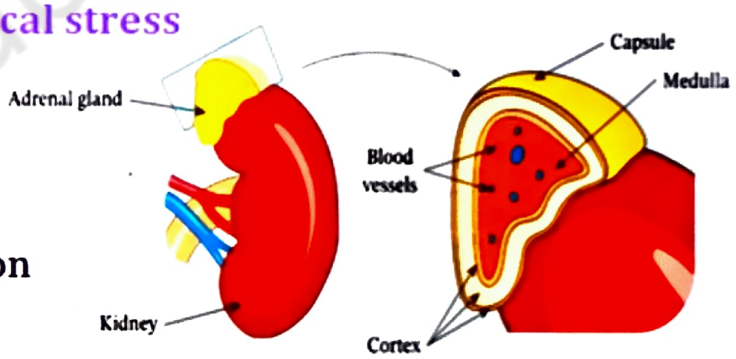
- Hypersecretion of PTH is called hyperparathyroidism. It results in **hypercalcemia**.

# ❑ ADRENAL GLAND- ITS STRUCTURE AND FUNCTIONS

## ❖ INTRODUCTION

- Adrenal glands are called the **'Life- Saving Glands'** or **'Essential Endocrine Glands'**. It is because the absence of adrenocortical hormones causes death within 3 to 15 days
- Absence of adrenomedullary hormones, drastically **decreases** the **resistance** to **mental** and **physical stress**

## ❖ Parts of Adrenal Gland

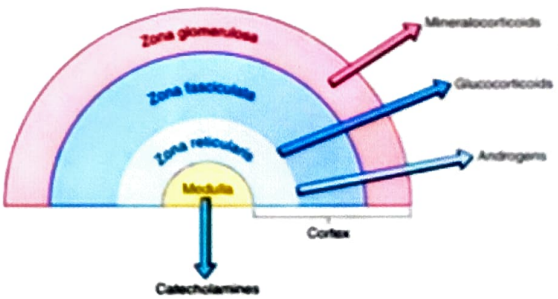



- ✓ **Adrenal cortex:** Outer portion
- ✓ **Adrenal medulla:** Central portion

### ✓ Adrenal cortex

➢ **Layers of Adrenal cortex: three** distinct layers

i. **Zona glomerulosa-** an outer layer
ii. **Zona fasciculata-** a middle layer
iii. **Zona reticularis-** an inner layer




➢ **Hormones of Adrenal cortex**

Different layers of cortex secretes **three** groups of hormones

i. Zona glomerulosa secretes **Mineralo corticoids**
ii. Zona fasciculata secretes **Glucocorticoids**
iii. Zona reticularis secretes **Sex steroids**

### i. Mineralo corticoids

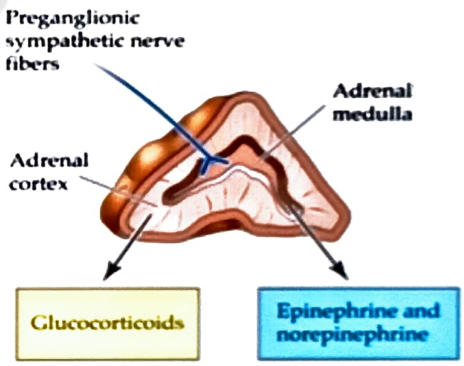
- They are-
  a) Aldosterone b) Deoxycorticosterone

- They influence water and mineral metabolism
- They help to maintain electrolyte and water balance of the body as follows:
  a) By increasing the reabsorption of sodium in the renal tubules
  b) By promoting excretion of potassium

### ii. Glucocorticoids

- They are-
  a) Cortisol b) Cortisone c) Corticosterone

- They influence carbohydrate metabolism. Functions-
  a) To increase the synthesis of glycogen
  b) To increase the breakdown of protein into amino acids
  c) Mobilization and redistribution of fat
  d) Decreasing the production of eosinophils and lymphocytes
  e) Anti inflammatory and anti allergic effect




### iii. Sex steroids

- They are-
  a) Androgens ( in males) b) Oestrogens (in females)

- These two hormones influence growth and sex development

### ✓ Adrenal medulla

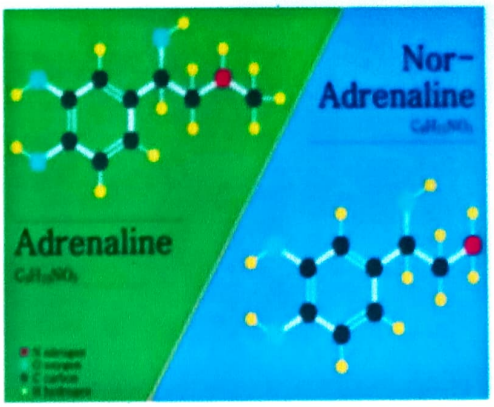
➢ **Hormones of Adrenal Medulla**

i. Adrenaline

ii. Noradrenaline

## Functions of Adrenaline & Nor Adrenaline

- **Vasoconstriction** and **rise** in blood pressure
- Contraction of **splenic capsule** and **release** of **RBC**
- **Dilation** of pupil
- **Contraction** of nictitating membrane in animals
- **Relaxation** of the intestine
- **Erection** of the hair due to contraction of erector **pili muscle**




## Disorders of Adrenal Gland

- Hypersecretion of adrenocortical hormones leads to the following conditions

### 1. Cushing syndrome

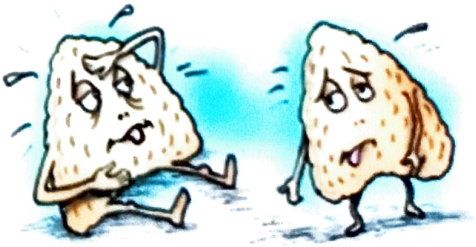
- Cushing syndrome is a disorder characterized by **obesity**.

### 2. Hyperaldosteronism

- Increased secretion of aldosterone is called **hyperaldosteronism.**

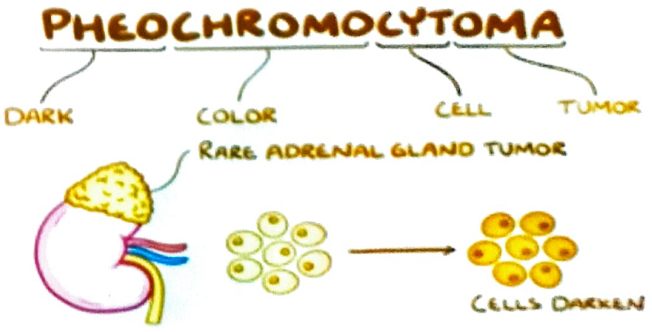
### 3. Adrenogenital syndrome

- Secretion of **abnormal** quantities of adrenal androgens develops **adrenogenital syndrome.**
- **Testosterone** is responsible for the androgenic activity in adrenogenital syndrome.



### 4. Pheochromocytoma

- It is a condition characterized by hypersecretion of **catecholamines**



# ❑ PANCREAS - ITS STRUCTURE AND FUNCTIONS

## ❖ Introduction

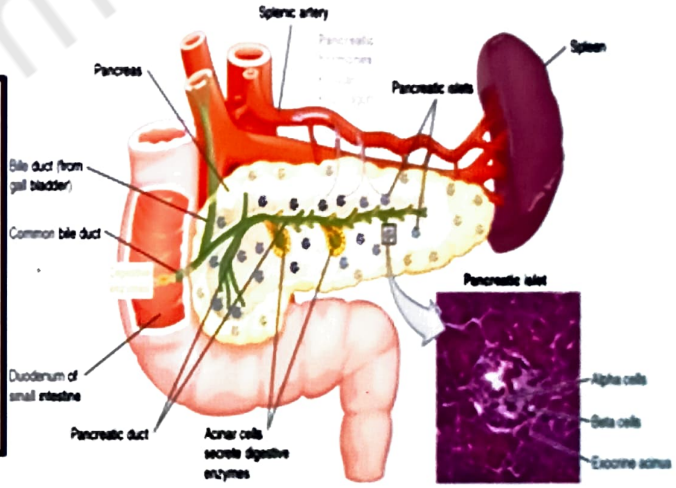
- It is a **composite gland** that acts as both **exocrine and endocrine glands.** Such glands are called **heterocrine glands.**
- The pancreas lies on the posterior abdominal wall in front of abdominal aorta and lumbar vertebrae.
- It extends between the C-shaped curvature of duodenum and the spleen. The pancreas contains a head, body and tail.

## ❖ Structure of Pancreas

- The bulk of pancreas contains **exocrine cells** called **acini** , it secretes the **pancreatic juice** which is **digestive** in function
- In **between** the acini, there are some **endocrine cells** called **Islets of langerhans**

✓ **Islets of Langerhans**

- These are present **more** in the **tail portion** of pancreas the islets contains **two** types of cells:
- **Alpha cells** which secretes **glucagon**
  **Beta cells** secretes **insulin**




### i. Glucagon

**Functions:**

a) Increase in **blood sugar level** by mobilizing glycogen from the liver
b) Mobilization of **stored** fat
c) **Release** of **insulin** from pancreas

### ii. Insulin

**Functions:**

a) The important action of insulin is to **decrease** the level of **glucose** in **blood** This effects are:
b) Increasing glycogen **synthesis** but preventing glycogen **breakdown** in the liver

c) By **preventing** fresh synthesis of glucose

d) **Stimulating** the uptake and utilization of **glucose** in the skeletal muscle

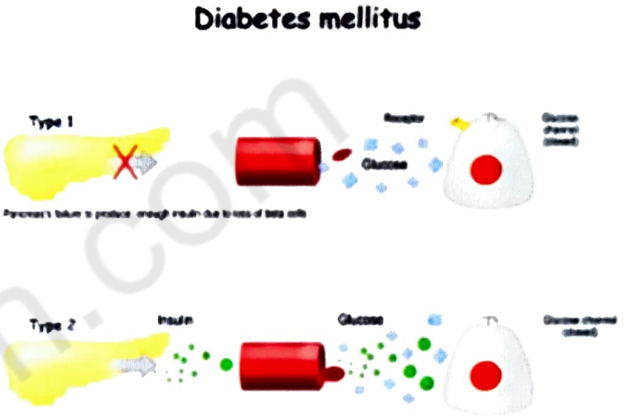
e) **Promoting** the **conversion** of glucose into **fat** in the adipose tissue

## ❖ Disorders of Pancreas

### 1. HYPOACTIVITY – DIABETES MELLITUS

Diabetes mellitus is a metabolic disorder characterized by **high blood glucose level**, associated with other manifestations.'

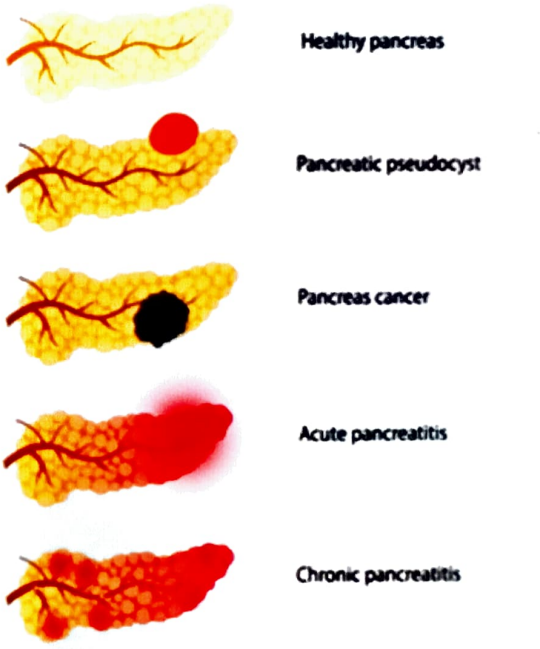
#### Type I Diabetes Mellitus




- It is due to deficiency of insulin because of destruction of β-cells in islets of Langerhans.
- This type of diabetes mellitus may occur at any age of life.
- But, it usually occurs before 40 years of age

#### Type II Diabetes Mellitus

- It is due to insulin resistance (failure of insulin receptors to give response to insulin). So, the body is unable to use insulin.
- About 90% of diabetic patients have type II diabetes mellitus. It usually occurs after 40 years.




### 2. HYPERACTIVITY – HYPERINSULINISM

- Hyperinsulinism is the **hypersecretion of insulin**
- Hyperinsulinism occurs due to the tumor of **β-cells** in the islets of Langerhans

# ❑ PINEAL GLAND - ITS STRUCTURE AND FUNCTIONS

## ❖ Introduction

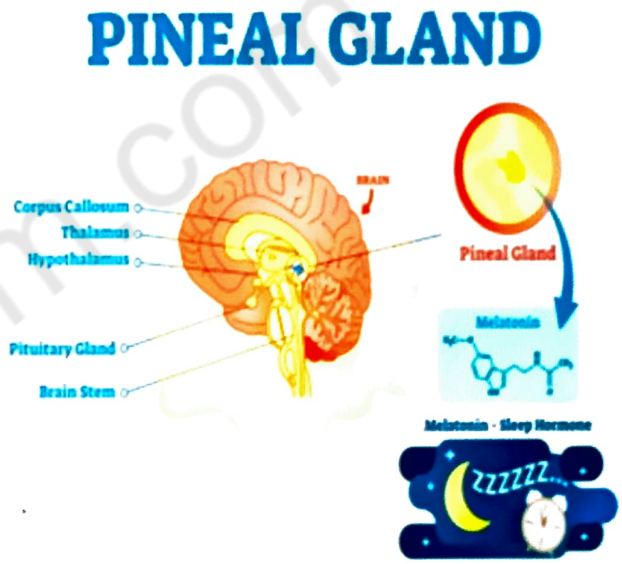
- Pineal gland or epiphysis is located in the diencephalic area of brain above the hypothalamus.
- It is a small cone shaped structure with a length of about 10 mm.

## ❖ Structure

- Pineal gland has two types of cells:

1. **Large epithelial cells called parenchymal cells**
2. **Neuroglial cells.**

## ❖ Functions




Pineal gland has two functions:

1. It controls the sexual activities in animals by regulating the seasonal fertility.
2. The pineal gland plays little role in regulating the sexual functions in human being
3. It secretes the hormonal substance called melatonin.

## ❖ Disorders of Pineal gland

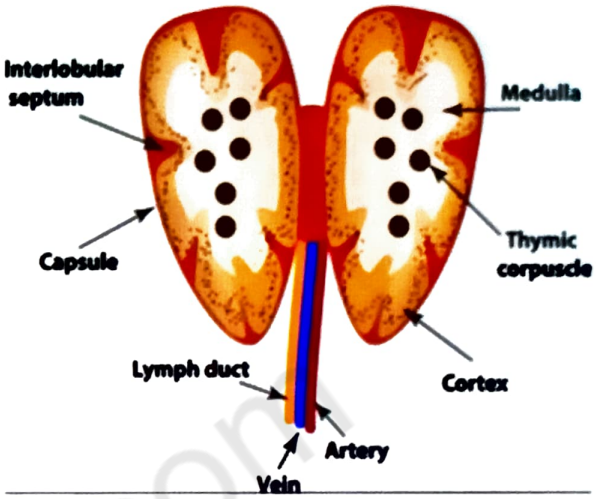
**1. Alzheimer's disease (AD)**- Common neurodegenerative disease

- It is accompanied by alterations to various lifestyle patterns, such as sleep disturbance.
- The pineal gland is the primary endocrine organ that secretes hormones, such as melatonin, and controls the circadian rhythms.
- The decrease in pineal gland volume and pineal calcification leads to the reduction of melatonin production.

# ❑ THYMUS - ITS STRUCTURE AND FUNCTIONS

## ❖ Introduction

- Thymus is situated in front of trachea, below the thyroid gland.
- Thymus is small in newborn infants and gradually enlarges till puberty and then decreases in size



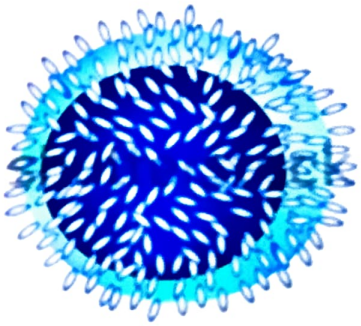

## ❖ Functions

- Thymus has lymphoid function and endocrine function.
- It plays an important role in development of immunity in the body.

Thymus has two functions:

1. Processing the T lymphocytes
2. Endocrine function

**T - Lymphocytes**



### 1. Processing the T Lymphocytes

- Thymus plays an essential role in the development of immunity by processing the T lymphocytes.

### 2. Endocrine Function of Thymus

- Thymus secretes two hormones:

1. Thymosin is a peptide. It accelerates lymphopoiesis and proliferation of T lymphocytes.

2. Thymin is also called thymopoietin. It suppresses the neuromuscular activity by inhibiting acetylcholine release. Hyperactivity of thymus causes myasthenia gravis.


## ❖ Disorders of Thymus

### 1. Myasthenia gravis

- It occurs when the thymus is abnormally large and produces antibodies that block or destroy the muscles' receptor sites.