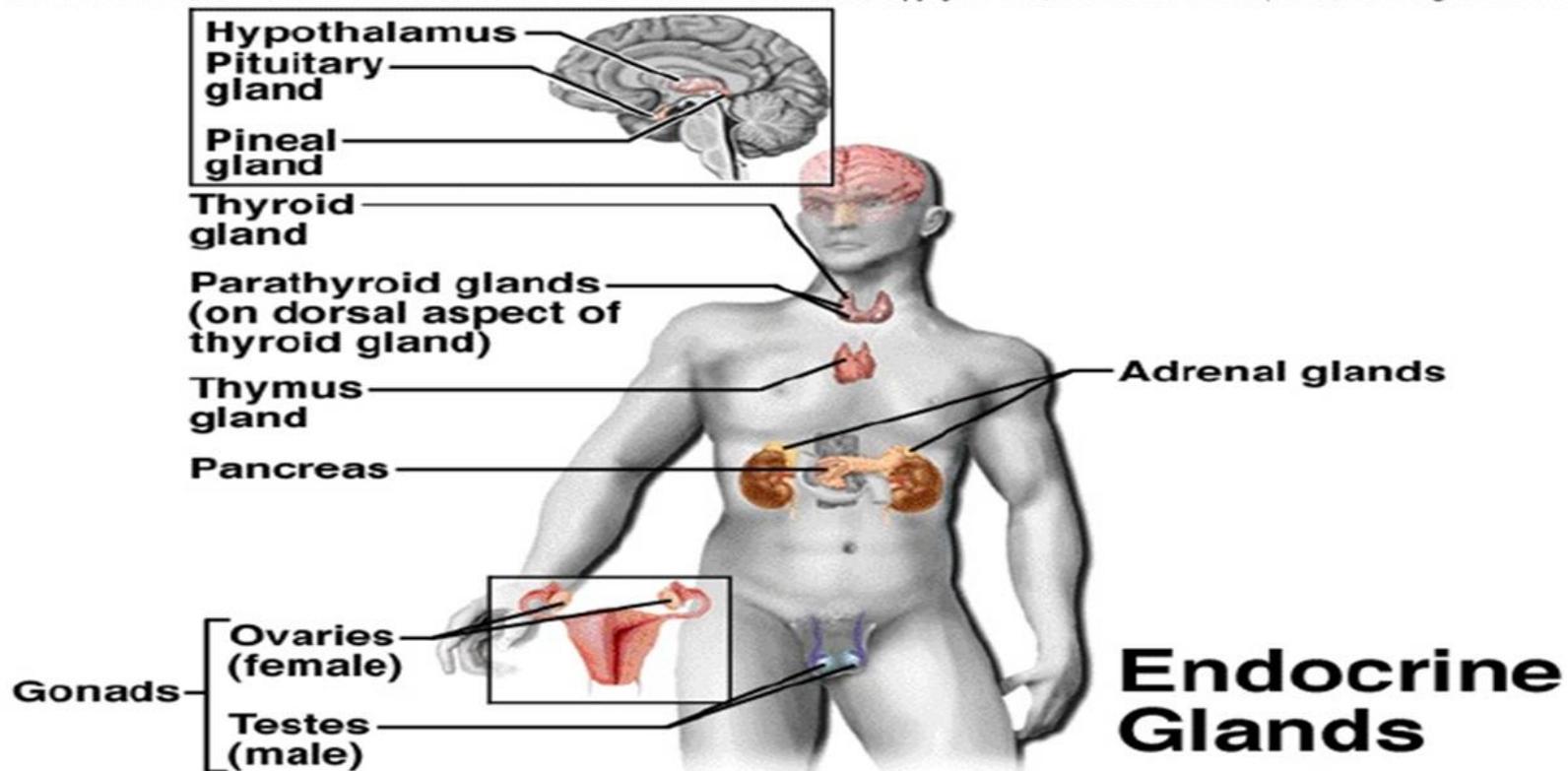


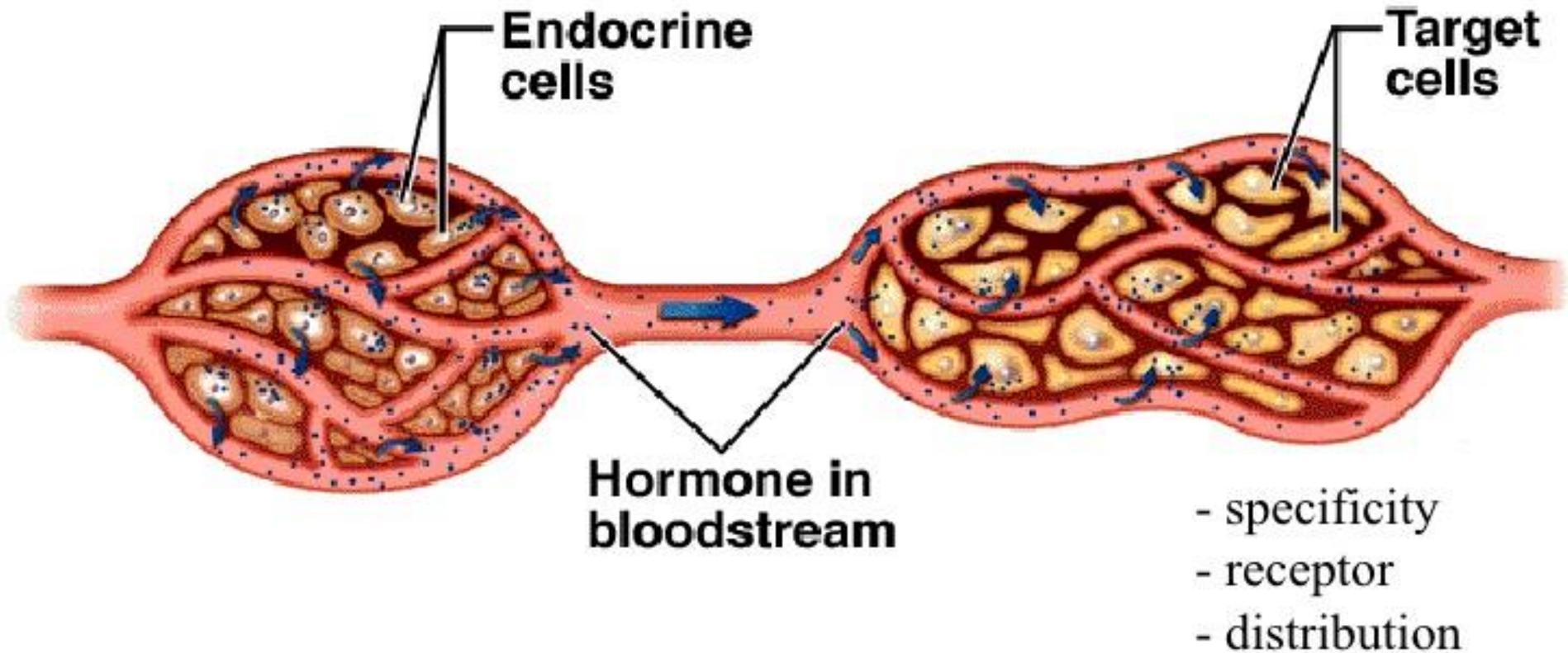
# Physiology of Endocrine System(1)

Second Stage/ University of Anbar-College of Dentistry  
 By : Dr. Rana Hazim  
 Ph.D. Human Physiology.  
 Dep. Basic Science



## Hormone

is a chemical messenger secreted by one endocrine gland or cell into the bloodstream and targeted toward cells in another organ.



# Endocrine System

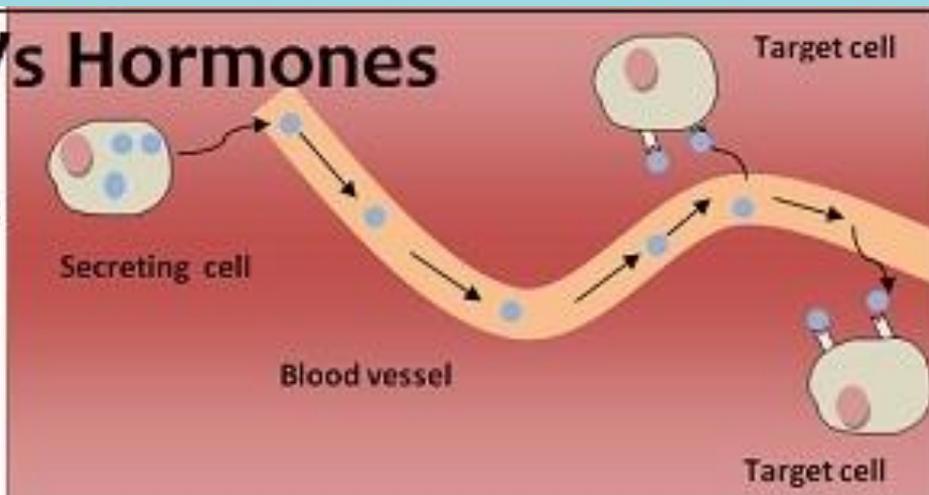
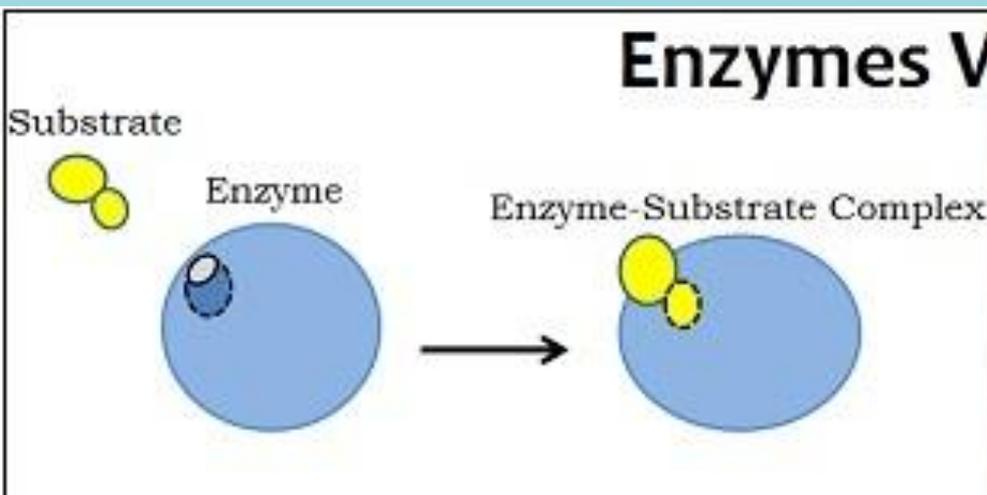
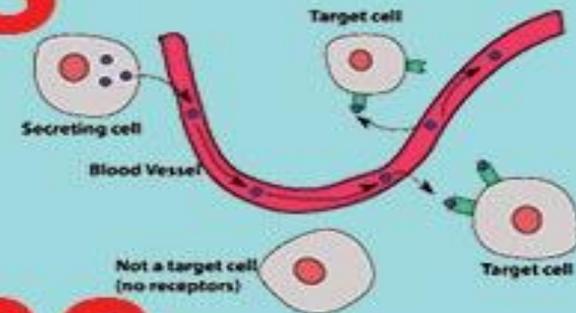
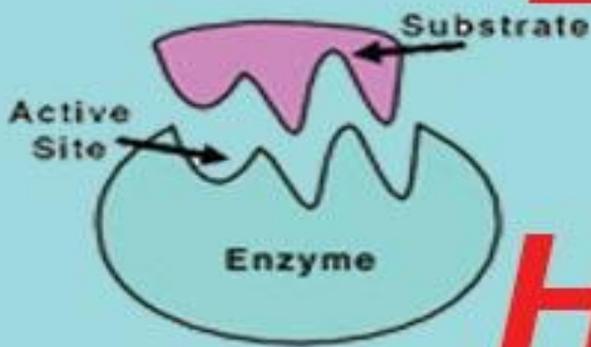
## **Hormone**

**is a small chemical can  
enter the bloodstream  
and cause an action at  
a distant location in the  
body**

# The difference between Endocrine and exocrine

<b>Endocrine glands</b>	<b>Exocrine glands</b>
ductless	Have ducts
Secrete their products (hormones) into the blood	Secrete their products to the outer surface or the lumen of GIT
Can reach distant tissue	Can not

# Differences between *Enzymes* and *Hormones*



# ENZYMES

# HORMONES

Enzymes	Hormones
All enzymes are proteins	Not all the hormones are proteins
Enzymes are secreted and act on the <b>same place</b>	Secretion and activation of Hs. take place in <b>different locations</b> .
Enzymes control <b>all biochemical reactions</b> of the cell.	<b>Some</b> of the biochemical reactions of the systems are controlled by hormones.
Enzymes take <b>part in met.</b>	Hs. <b>regulate</b> metabolic activities.
Enzymes are <b>substrate</b> specific.	hormones are <b>specific to the target</b> cell, tissue, or system
Enzymes are <b>not</b> changed after a reaction and could be used again.	Hormones are <b>degenerated</b> after the reaction.

# Classification of Hormones :-

Based on **chemical nature** the hormones are classified **into three types**

## **Chemical Identity of Hormones**

- 1) **Steroid hormones**
- 2) **Biogenic amines**
- 3) **Peptide hormones**

# 1- Steroid Hormones

Estrogens  
Progesterone  
Androgens  
glucocorticoids  
aldosterone

- derived from cholesterol

# 2- Biogenic amines

Epinephrine

Norepinephrine

Dopamine

Serotonin

Melatonin

thyroid hormones

- Synthesized from amino acids

# 3- Peptide Hormones

Hypothalamic hormones

Pituitary hormones

Pancreatic hormones

GI hormones

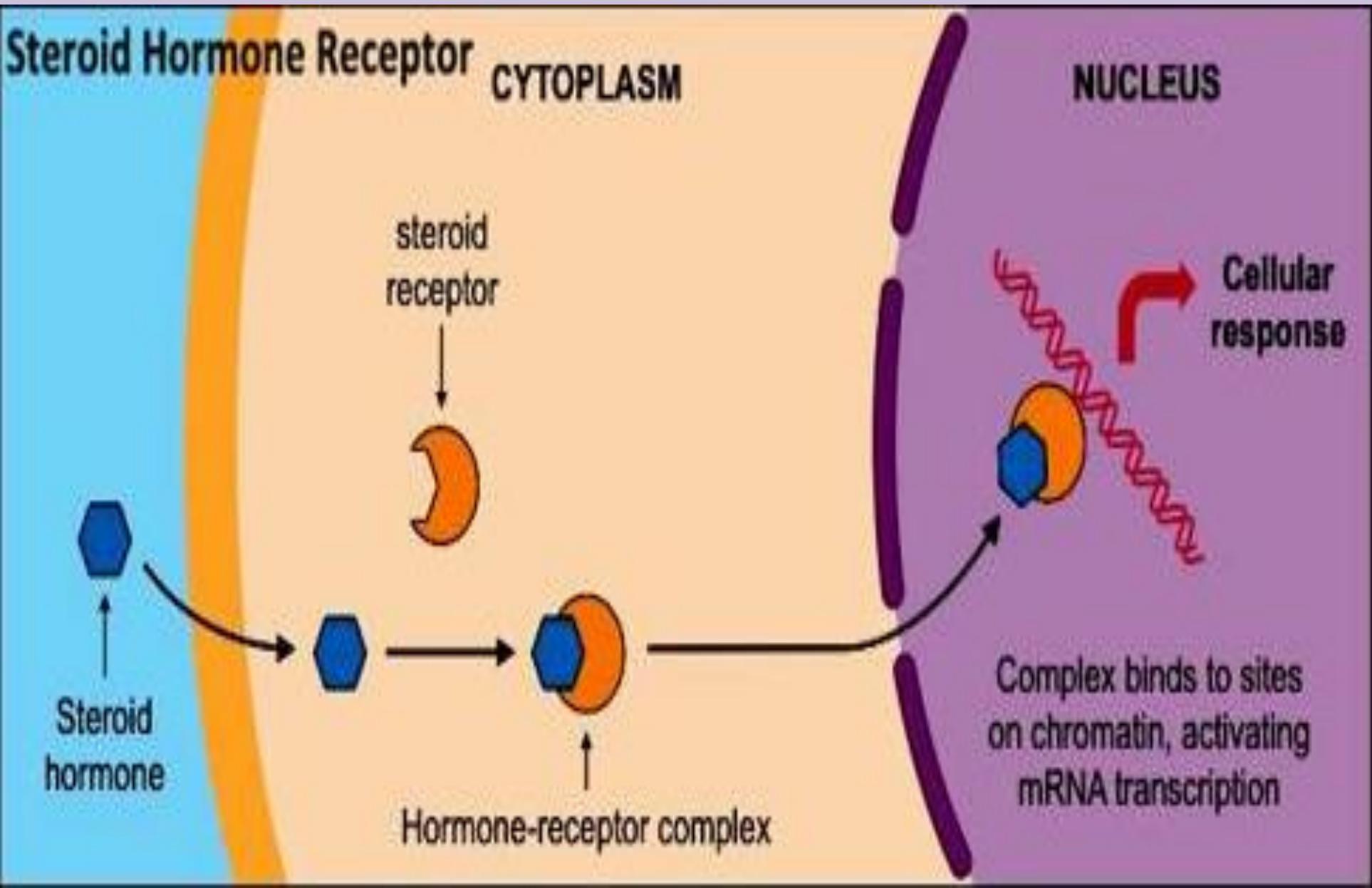
- are peptides

# Endocrine System

## Hormonal Action

Hormone does **not act directly** on the cellular structures. (First it combines with receptors present on the target cells and forms a hormone-receptor complex). **This hormone-receptor complex induces various changes or reactions in the target cells.**

# Hormone-receptor complex



# Endocrine System

## Hormone Receptors

- ✓ **Are the large proteins**
- ✓ **Present in the target cells.**
- ✓ **Each receptor is specific for one single hormone.**

**Situation of hormone receptor????**

# Endocrine System

## Situation of the Hormone Receptors

c

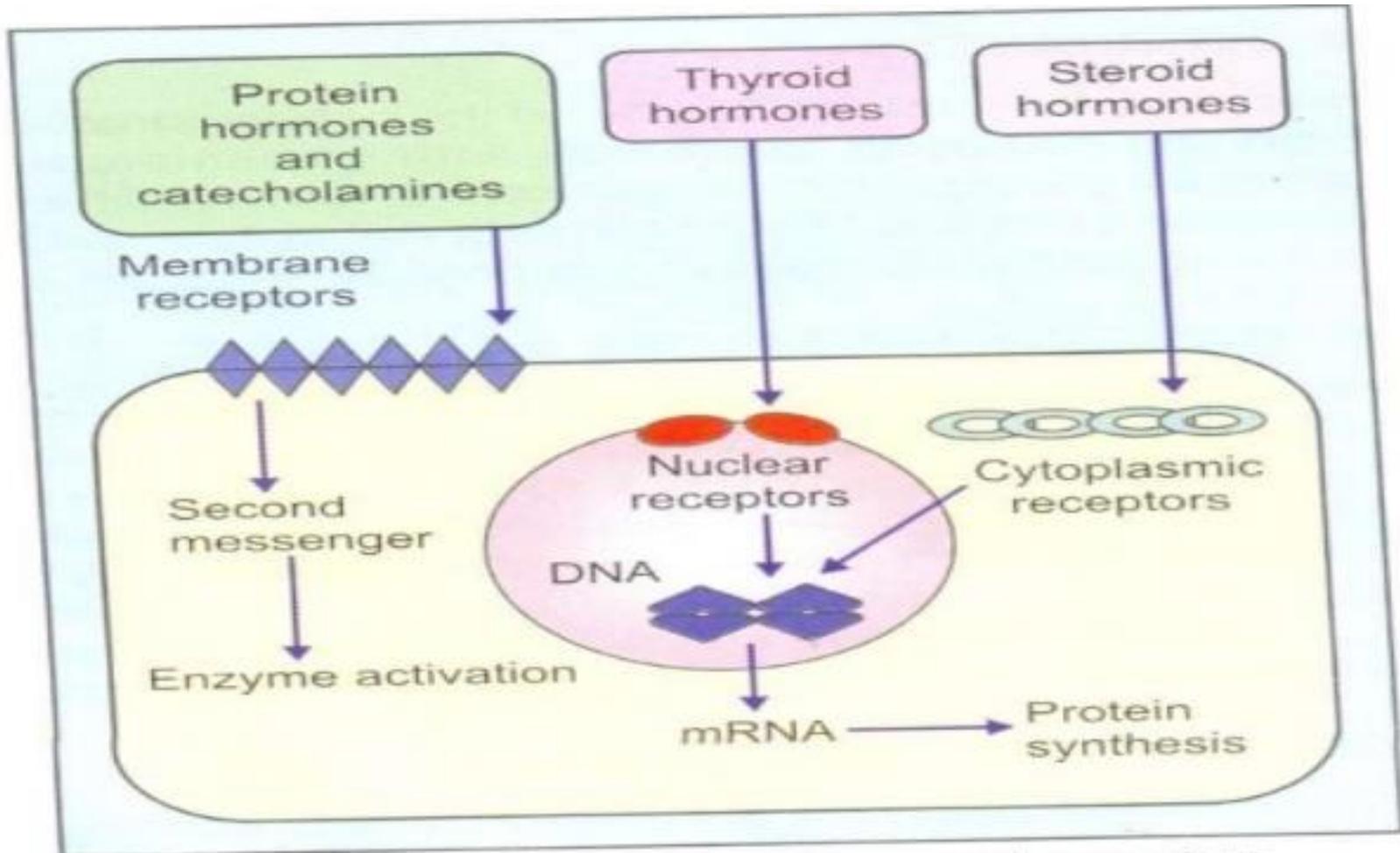
1- **Cell membrane** (Receptors of protein hormones and adrenal medullary hormones)

2- **Cytoplasm** (Receptors of steroid hormones are situated in cytoplasm of target cells)

3- **Nucleus** (Receptors of thyroid hormones are in the nucleus of the cell.)

# Endocrine System

## Situation of hormonal receptors



# Endocrine System

## Mechanism of Hormonal Action

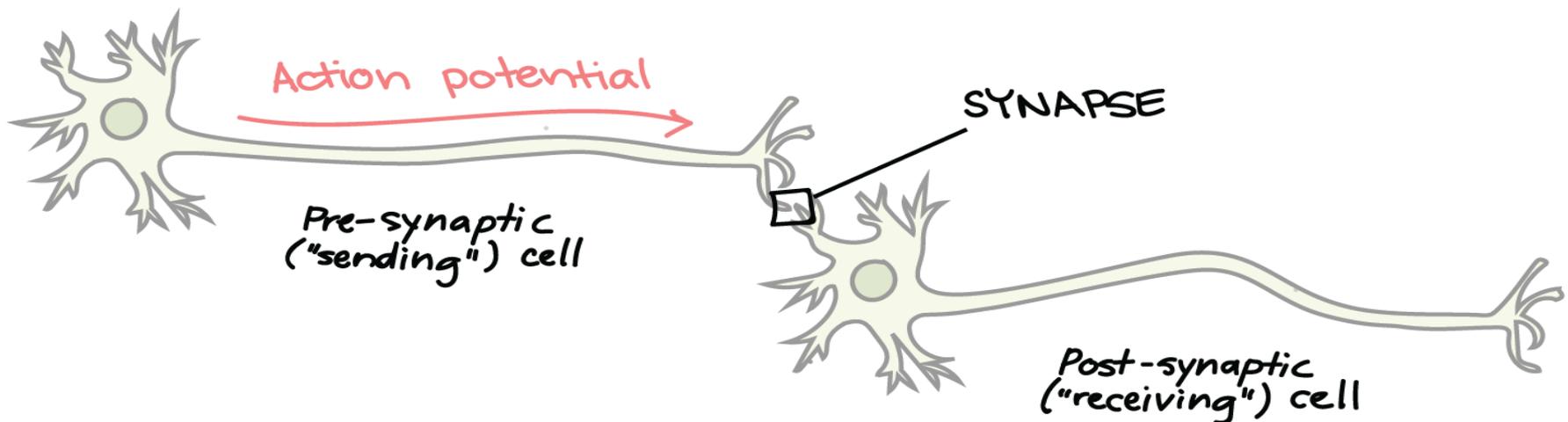
**On the target cell, the hormone–receptor complex acts by any one of the following mechanisms:**

- 1. By altering the permeability of the cell membrane**
- 2. By activating the intracellular enzyme**
- 3. By activating the genes**

# Endocrine System

By Altering the Permeability of Cell Membrane

**The neurotransmitter substances in a synapse or neuromuscular junction act by changing the permeability of postsynaptic membrane.**



# By Altering the Permeability of Cell 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 permeability of postsynaptic membrane by opening the ligand gated sodium channels**

# Endocrine System

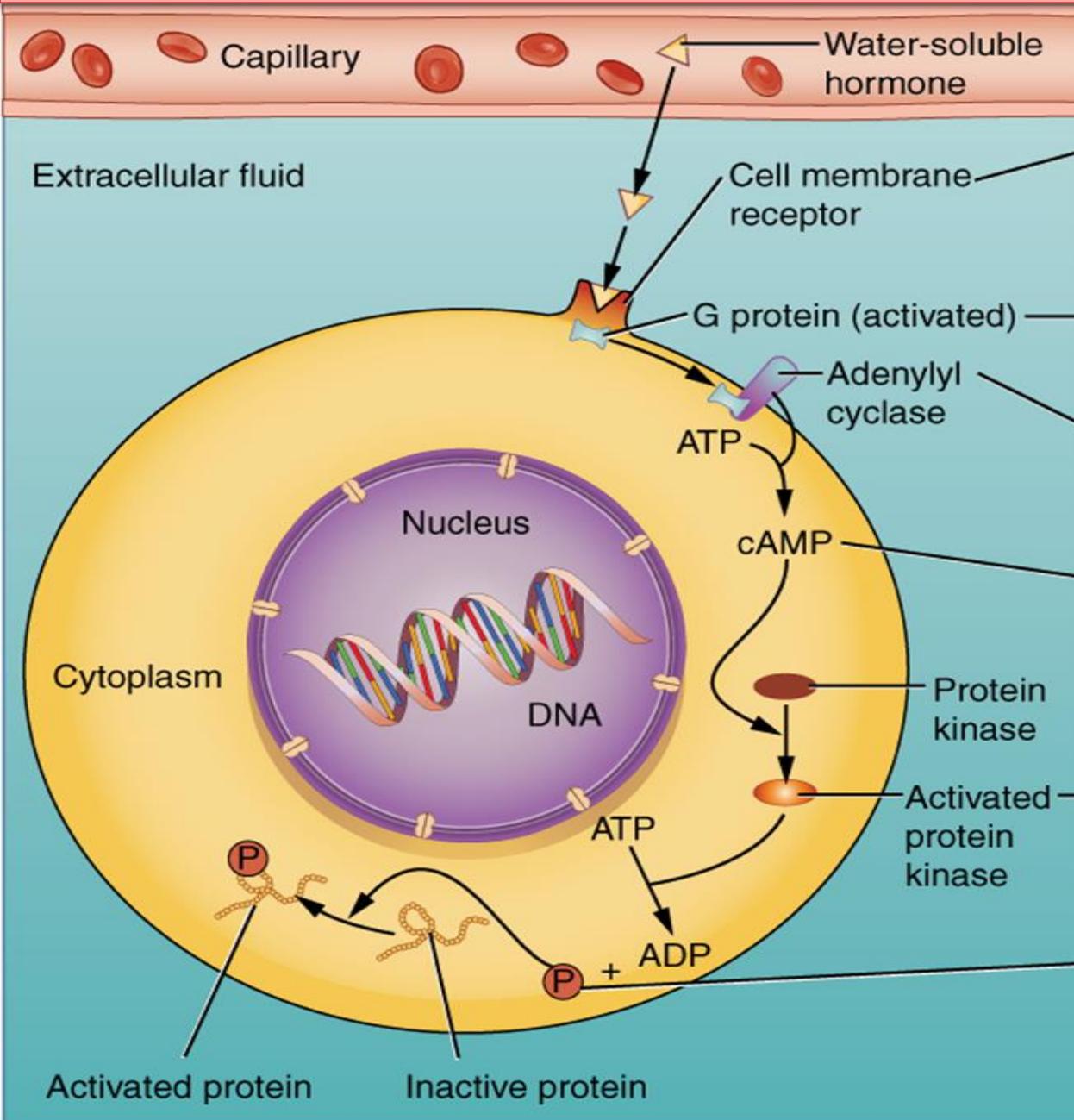
## By Activating the Intracellular Enzyme

The protein hormones and the catecholamine act by activating the intracellular enzymes.

The hormone, which acts on a target cell, is called first messenger or chemical intermediary.

This hormone, in combination with the receptor forms hormone-receptor complex. This in turn activates the enzymes of the cell and causes the formation of another substance called the second messenger

# By Activating the Intracellular Enzyme



- ① Water-soluble hormones are membrane insoluble. They bind to membrane receptors.
- ② The binding activates a G protein.
- ③ The activated G protein activates adenylyl cyclase.
- ④ Adenylyl cyclase catalyzes the conversion of ATP to cAMP, the secondary messenger in this pathway.
- ⑤ cAMP activates protein kinases.
- ⑥ Protein kinases phosphorylate proteins in the cytoplasm. This activates these proteins, allowing them to alter cell activity.

# Endocrine System

## By Acting on Genes

**Sequence of events during activation of genes:**

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

**ii. This complex binds to DNA and increases transcription of mRNA**

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

**iv. The activated ribosomes produce large quantities of proteins which produce the physiological responses in the target cells**



# HUMAN ENDOCRINE SYSTEM

Pituitary Gland

Pineal Gland

Thyroid Gland

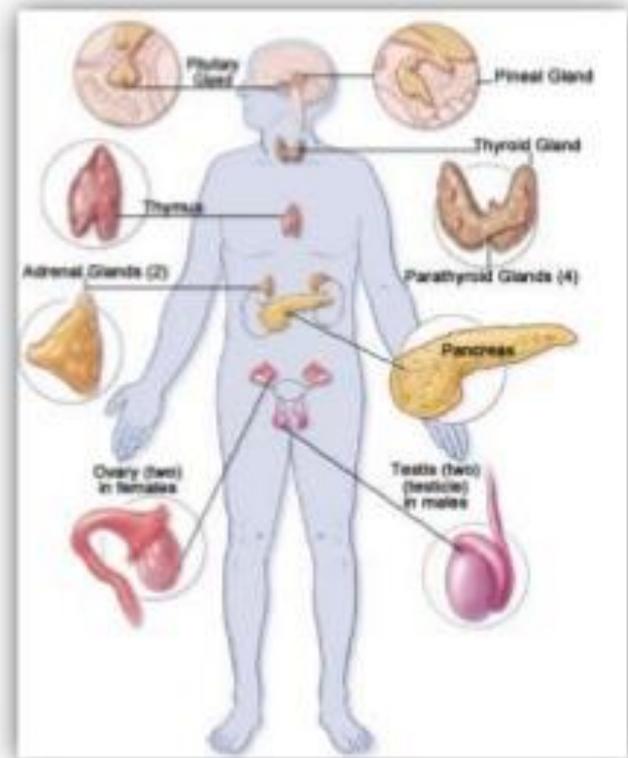
Parathyroid Gland

Thymus Gland

Adrenal Gland

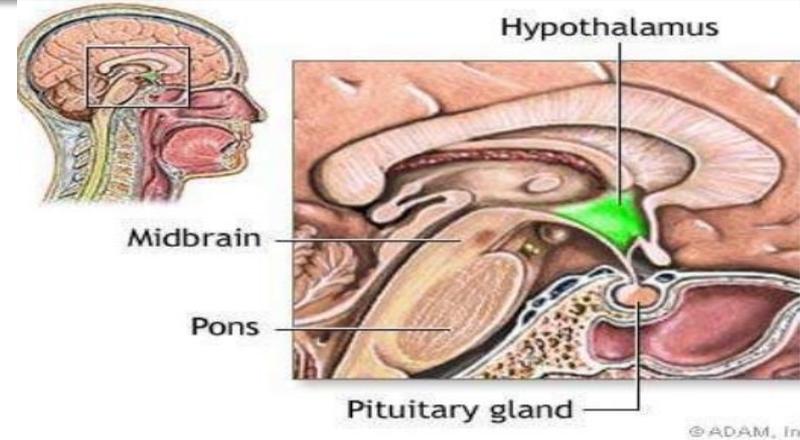
Pancreas

Gonads (Testis & Ovary)



# Hypothalamus

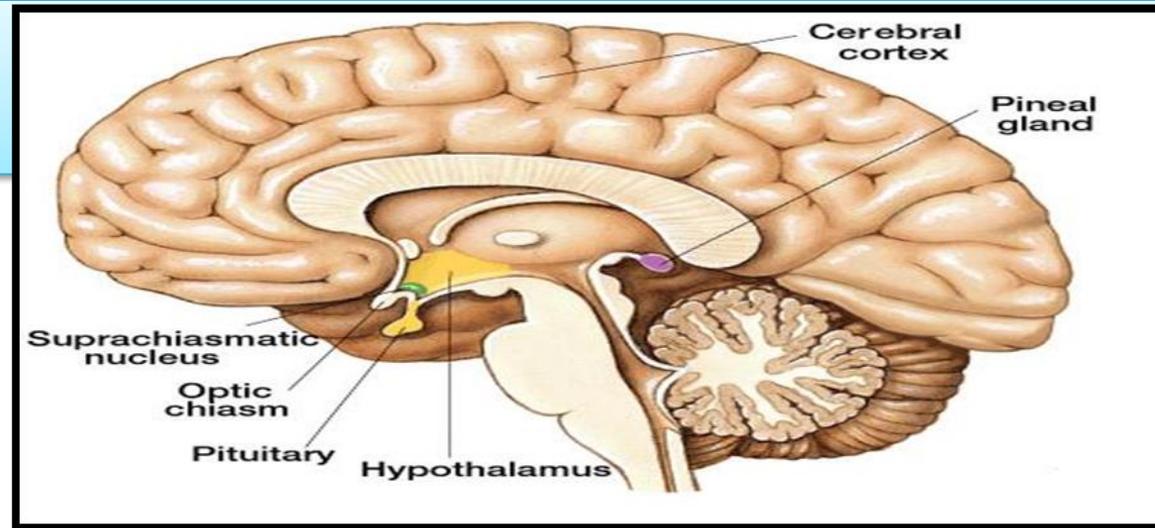
The hypothalamus is a small , important part of the brain.



## Functions:

- controls the release of 8 major hormones by the pituitary gland.
- controls body temperature .
- control of food and water intake, hunger and thirst .
- control of sexual behavior and reproduction .
- mediation of emotional responses.
- control of daily cycles in physiological state and behavior also known as circadian rhythm

# Hypothalamus



**The hypothalamus is located below the thalamus and right above the brain stem.**

**It plays an important role in the nervous system as well as in the endocrine system.**

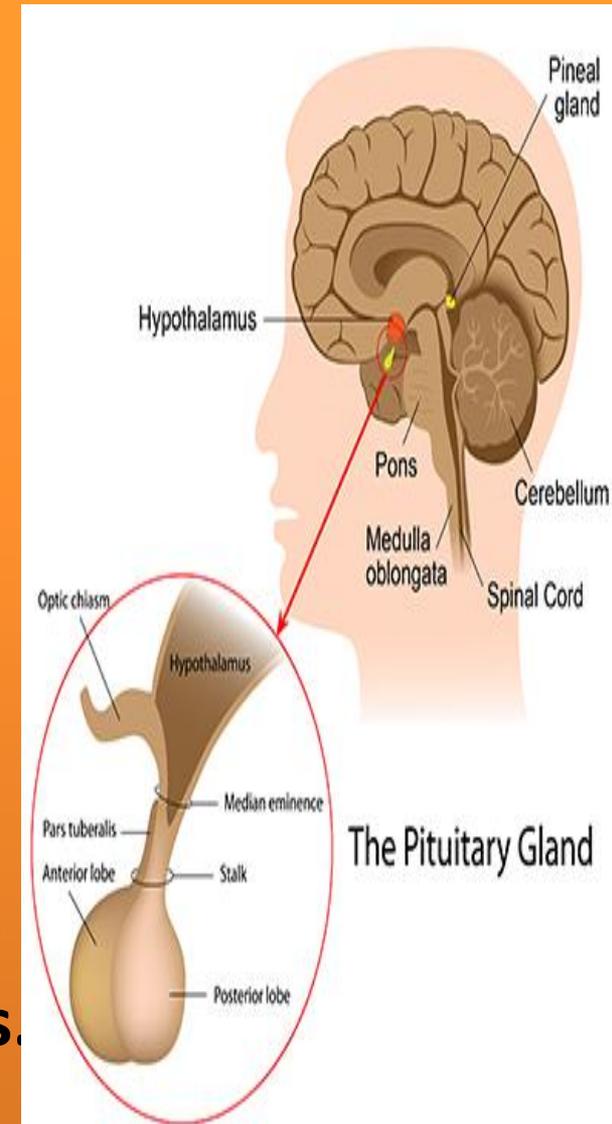
**It is linked to another small and vital gland called the pituitary gland**

# Pituitary Gland

- **The pituitary gland =hypophysis.**
- **It is a small gland that lies at the base of the brain.**
- **It is connected with the hypothalamus by the pituitary stalk or hypophyseal stalk.**

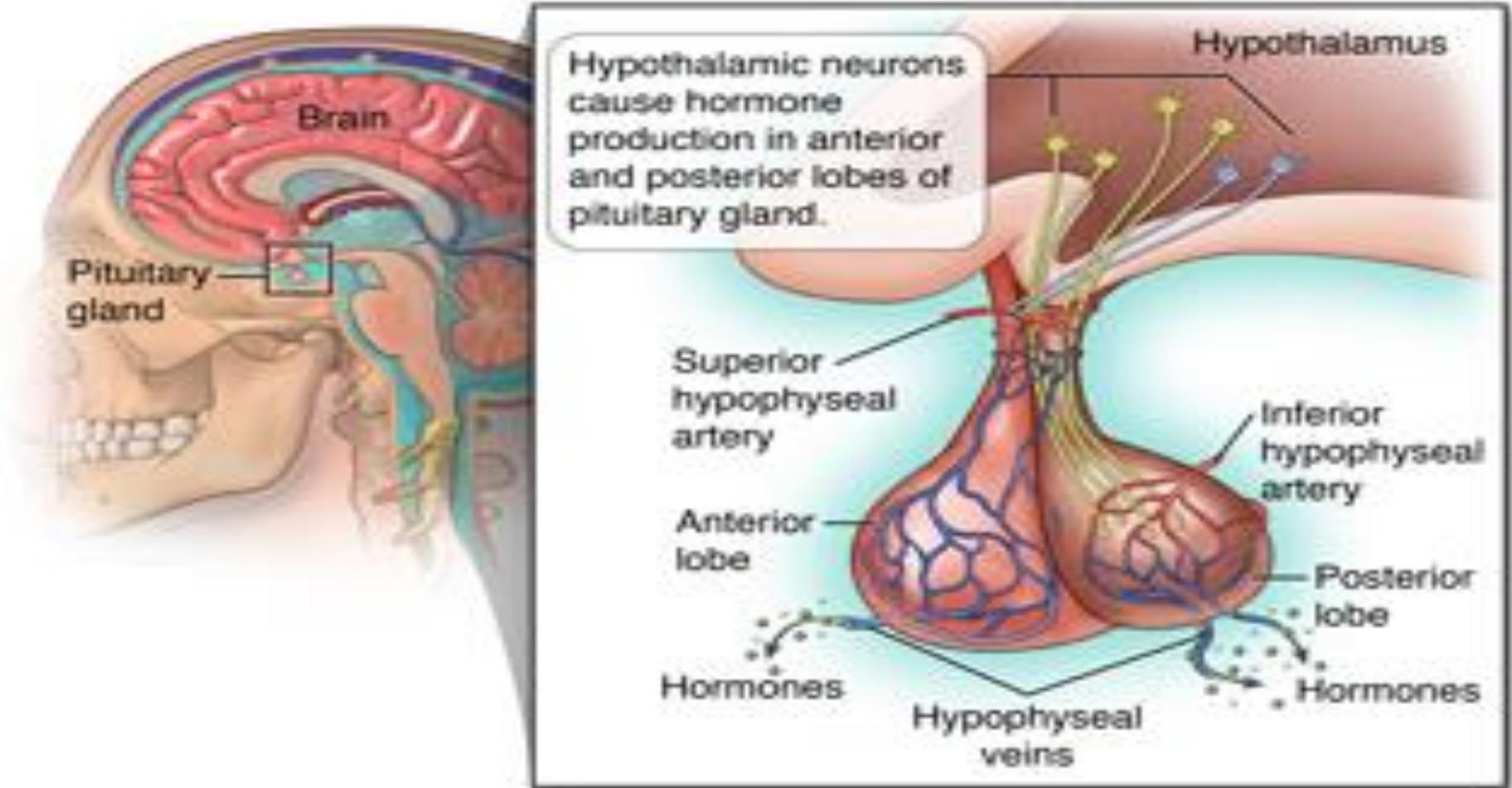
**2 parts :**

- 1. Anterior pituitary or adenohypophysis.**
- 2. Posterior pituitary or neurohypophysis.**



# Pituitary Gland

Pituitary gland



## 2. PITUITARY GLAND: PARTS

### **Neurohypophysis**

Small posterior lobe

Stores hormones

Oxytocin

Anti Diuretic hormone  
(ADH)

### **Adenohypophysis**

Large anterior lobe

Releases hormones

Growth hormone (GH)

Thyroid Stimulating hormone  
(TSH)

Adenocorticotrophic hormone  
(ACTH)

Lutenizing hormone (LH)

Follicle stimulating hormone  
(FSH)

Melanocyte stimulating  
hormone (MSH)

Prolactin (PRL)



**1-Essentials of Physiology for Dental Students. K Sembulingam and Prema Sembulingam ,2016, four Edition , Jaypee Brothers Medical Publishers.**

**2- Human Physiology. Stuart Ira Fox., TWELFTH EDITION,2017. Published by McGraw-Hill**

**Thank You!**



# Pituitary Gland

## Disorders of Pituitary Gland

### **Anterior pituitary**

### **Hyperactivity**

- 1. Gigantism**
- 2. Acromegaly**
- 3. Acromegalic Gigantism**
- 4. Cushing's disease**

# Hyperactivity

**Acromegaly**



**Gigantism**



# Hypoactivity

**Anterior pituitary**

**1. Dwarfism**



**2. Acromicria**



**3. Simmond's disease**

# Pituitary Gland

## **Gigantism (Hyperactivity)**



**1- Gigantism is the pituitary disorder characterized by excess growth of the body.**

**2- Cause Gigantism is due to hypersecretion of GH in childhood or in the pre-adult life before the fusion of epiphysis of bone with the shaft.**

**3- It appears due to pituitary tumors.**

# Pituitary Gland

## Acromegaly

(Hyperactivity)

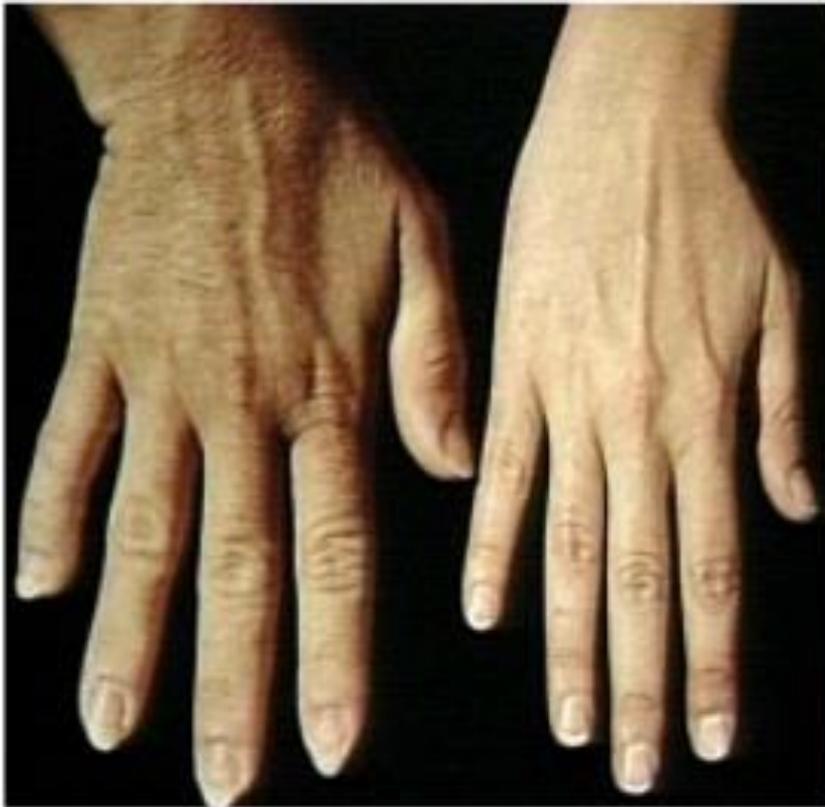


**1- disorder characterized by the enlargement, thickening and broadening of bones, particularly in the extremities of the body.**

**2-Cause Acromegaly is due to hypersecretion of GH in adults after the fusion of epiphysis with shaft of the bone.**

**3-Hypersecretion of GH is due to adenomatous tumor of anterior pituitary involving the acidophil cells.**

# Acromegaly (Hyperactivity)



# Pituitary Gland

## Acromegaly Gigantism (**Hyperactivity**)

**Hypersecretion of GH in children, before the fusion of epiphysis with shaft of the bones causes gigantism.**

**And, if hypersecretion of the GH is continued even after the fusion of epiphysis, the symptoms of acromegaly also appear**

# Cushing syndrome

An array of symptoms as a result of abnormally high levels of cortisol or other glucocorticoids in the blood

## •Cushing's Syndrome

- Excess cortisol due to any cause

## •Cushing's Disease

- Excess cortisol due to pituitary micro-adenoma

# Cushing's Disease / HYPERACTIVITY OF ANTERIOR PITUITARY

**1-Cushing syndrome appear when your body is exposed to high levels of the hormone cortisol for a long time.**

**2-The condition can also appear when your body makes too much cortisol on its own.**

**3-may be caused by the use of oral corticosteroid medication.**

**4-Cushing syndrome, sometimes called hypercortisolism**

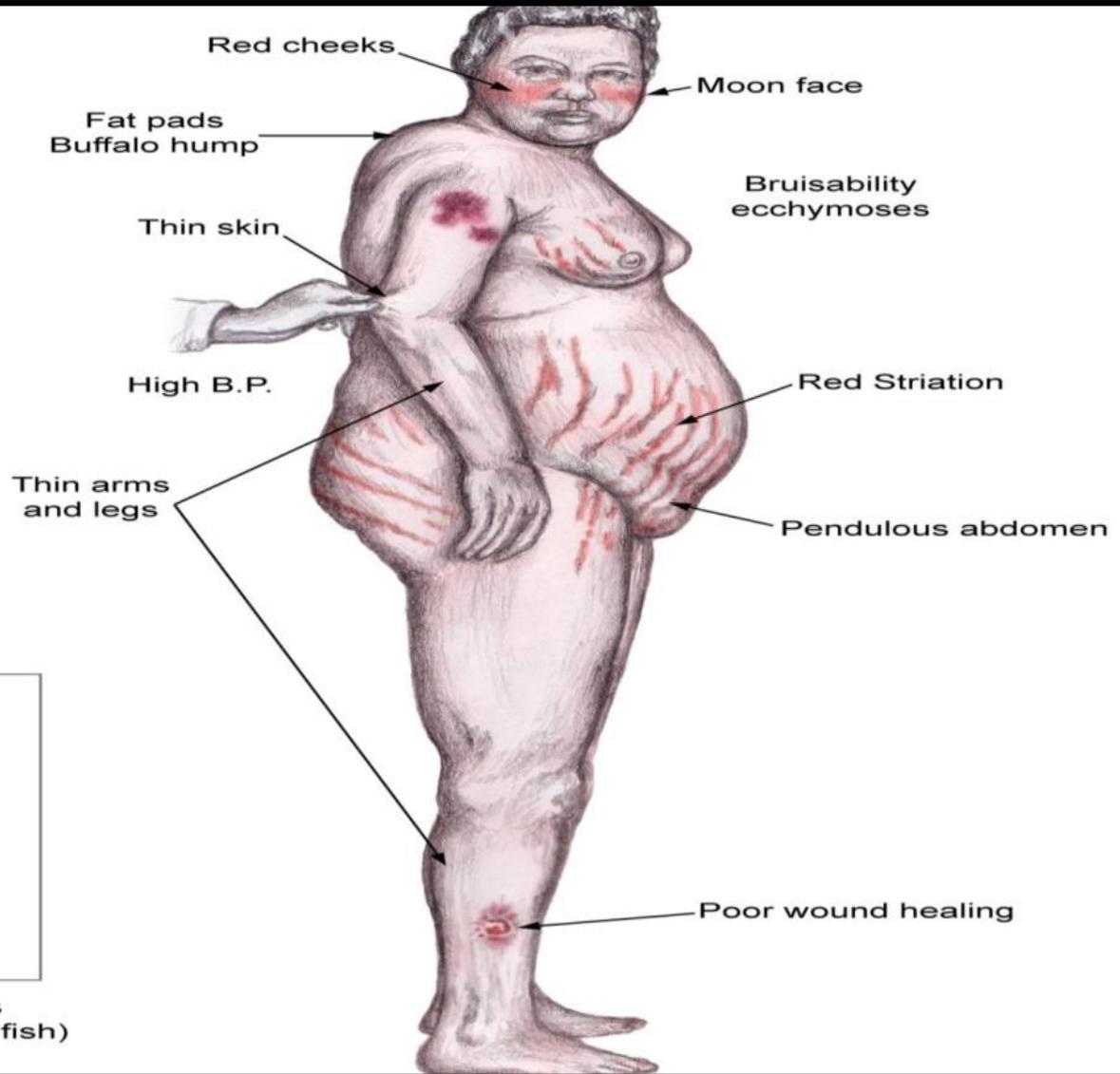
## **The hallmark signs:**

- **a fatty hump between your shoulders,**
- **a rounded face(moon face).**
- **pink or purple stretch marks(striae) on the skin,abdomen,breast,thighs and arms.**
- **Thinning , fragile skin, bone loss and, on occasion, type 2 diabetes**

# CUSHING Syndrome

## Background

Cushing syndrome is caused by prolonged exposure to elevated levels of either endogenous glucocorticoids or exogenous glucocorticoids



# Cushing's Disease

# Dwarfism/ Hypoactivity of anterior pituitary

Reduction in the GH secretion in infancy

## **The reasons**

**1- Deficiency of GHRH from hypothalamus**

**2- Deficiency of somatomedin-C**

**3- Atrophy or degeneration of acidophilic cells in the anterior pituitary**

**4-Tumor of chromophobes: It is a nonfunctioning tumor, which compresses and destroys the normal GH secreting cells.**

**Panhypopituitarism: In this condition, there is reduction in the secretion of all the hormones of anterior pituitary gland**

## Simmond's Disease Hypoactivity of anterior pituitary

- **It is a rare pituitary disease. It is also called pituitary cachexia.**

### **Causes:**

**mostly in panhypopituitarism, i.e. hyposecretion of all the anterior pituitary hormones due to the atrophy or degeneration of anterior pituitary**

# **Pituitary Gland**

## **Posterior pituitary**

### **Hyperactivity**

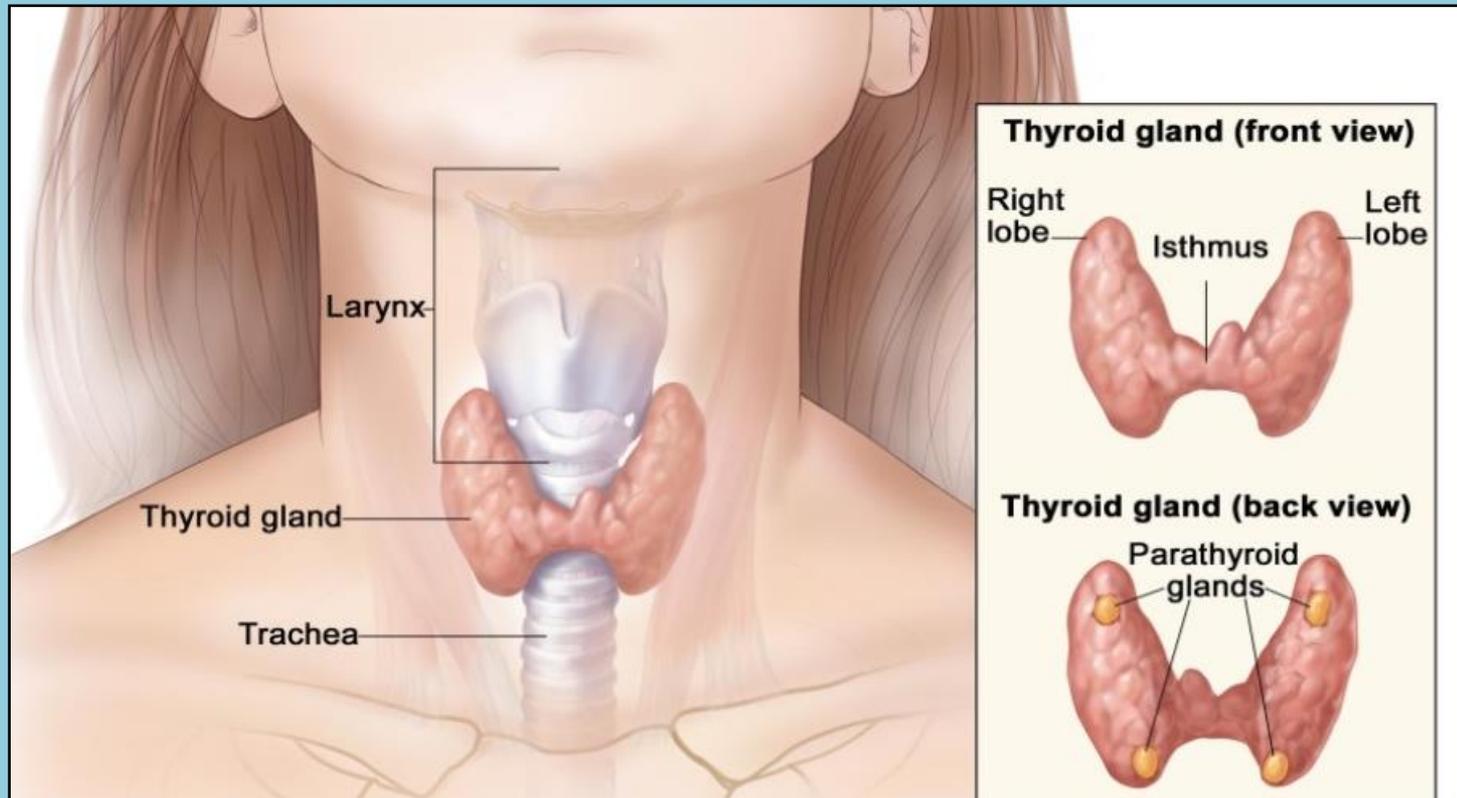
**Syndrome of inappropriate hypersecretion of ADH**

### **Hypoactivity**

**Diabetes insipidus**

# Thyroid Gland

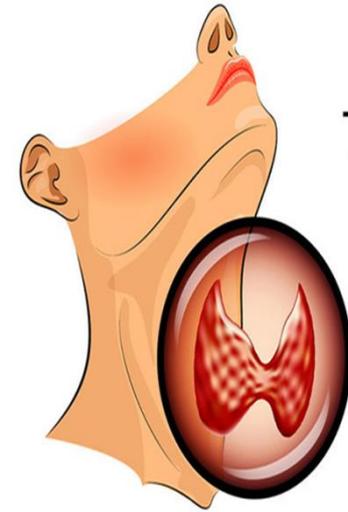
**Thyroid is an endocrine gland situated at the root of the neck on either side of the trachea.**



# Thyroid Gland

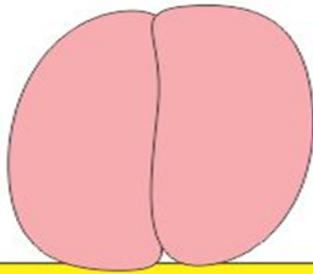
## Hormones of Thyroid Gland

Thyroid gland secretes  
three hormones:



THE  
THYROID  
GLAND

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



## Thyroid gland functions

Thyroid gland



Functions

### ■ **Thyroid Hormone:**

- Role/Function: Help regulate growth and the rate of chemical reactions (metabolism)

### ■ **Calcitonin:** a hormone secreted by the thyroid gland that lowers blood calcium

- Role/Function: Lowers the concentration of calcium in the blood when it rises above normal value—this is done by inhibiting the osteoclasts in bone tissue

# Disorders of Thyroid Gland

## Hyperthyroidism

### Graves' disease

1- Graves' disease is an autoimmune disease. Normally, thyroid stimulating hormone (TSH) combines with surface receptors of thyroid cells and causes the synthesis of thyroid hormones.

2- In Graves' disease the B lymphocytes produce autoimmune antibodies called **thyroid stimulating autoantibodies**. These antibodies act like TSH by binding with membrane receptors of TSH and activating cAMP system of the thyroid follicular cells. This results in hypersecretion of thyroid hormones.

# Thyroid Gland

## Thyroid adenoma:

Sometimes, a localized tumor develops in the thyroid tissue. It is known as thyroid adenoma and it secretes large quantities of thyroid hormones.

## Goiter:

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

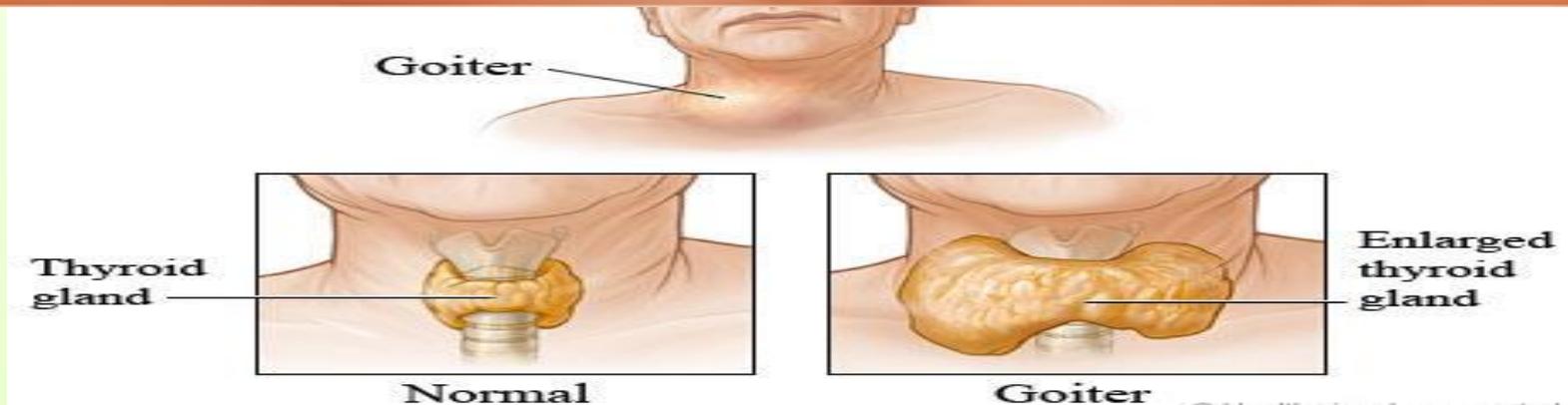
# The Causes of Goiter

**A goiter is an enlarged thyroid gland.**

**The thyroid gland is a butterfly-shaped gland in the neck, slightly below the Adam's apple.**

**Hormone changes or other symptoms can cause the gland to swell and become enlarged.**





**A goiter is often **painless**, but it can cause **hoarseness**, a **cough**, a feeling of **tightness** in the throat, **difficulty swallowing**, or even **difficulty breathing**.**

# Thyroid Gland

## **Goiter in Hyperthyroidism — Toxic Goiter**

**Toxic goiter is the enlargement of thyroid gland with increased secretion of thyroid hormones caused by thyroid tumor.**

**Goiter in Hypothyroidism — Nontoxic Goiter** is the enlargement of thyroid gland **without increase in hormone secretion**. It is also called hypothyroid goiter.

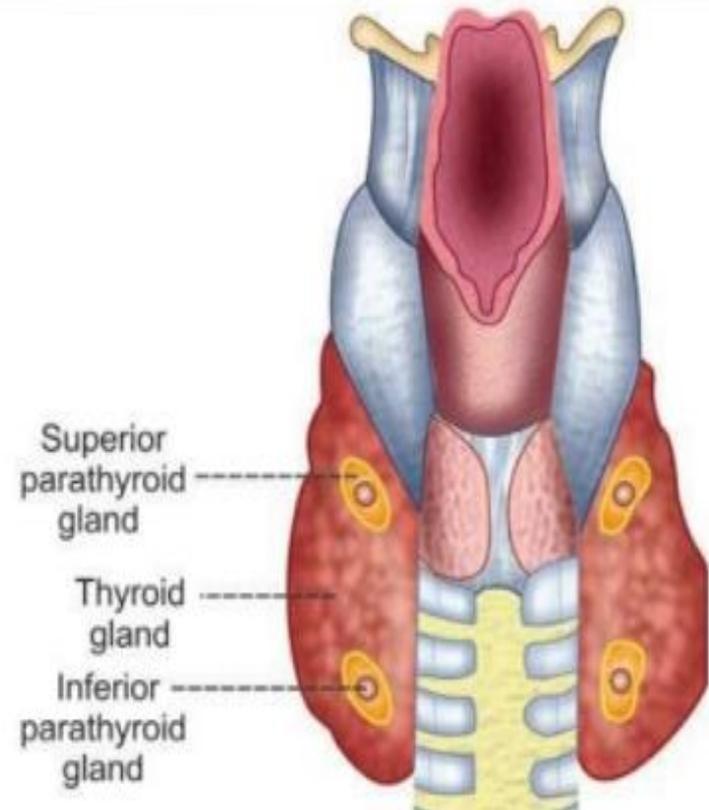
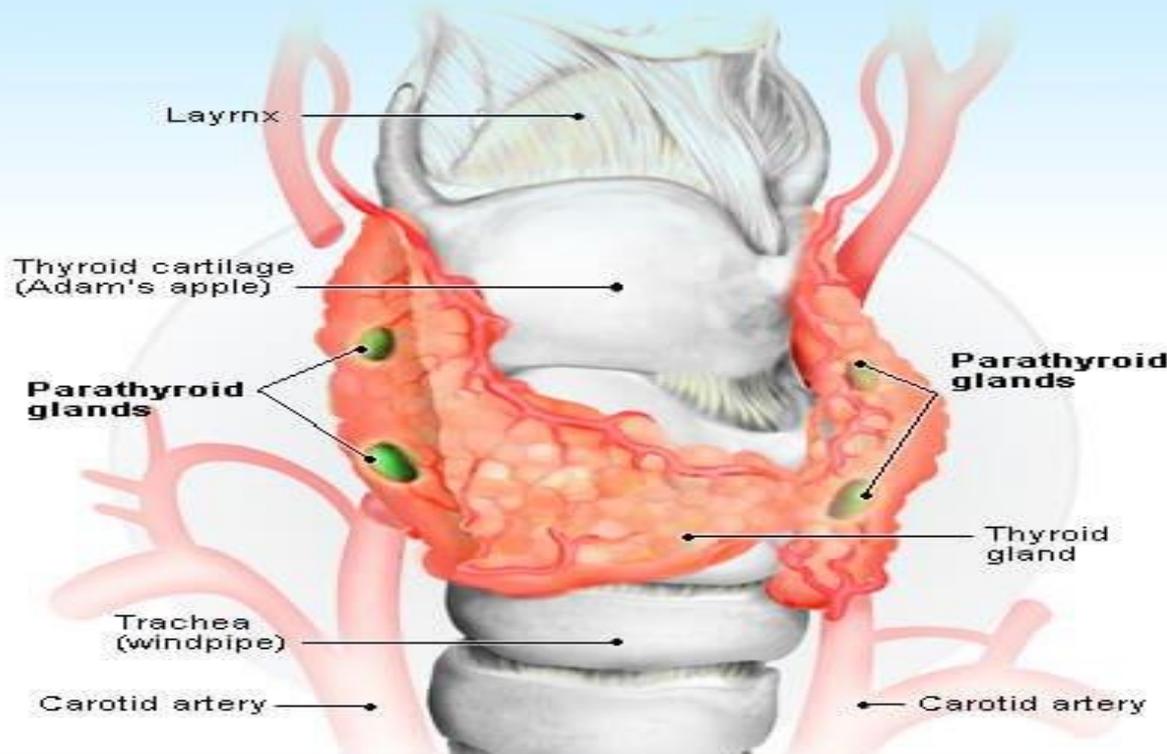
**Based on the cause, the nontoxic hypothyroid goiter is classified into two types:**

- 1- Endemic colloid goiter .**
- 2- Idiopathic nontoxic goiter**

# Parathyroid Glands

There are four parathyroid glands located immediately behind thyroid gland at the upper and lower poles.

## Parathyroid Glands



# Parathyroid Glands

## Parathormone(PTH)

- 1- is essential for the maintenance of blood calcium level within a very narrow critical level.**
- 2- Parathormone (PTH) is secreted by the chief cells of the parathyroid glands. It is protein in nature having 84 amino acids**

# Parathyroid Glands

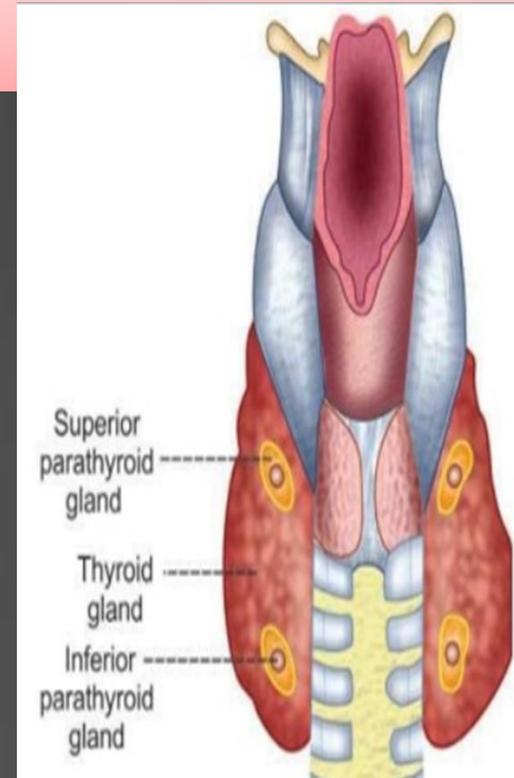
- ▶ Made up of chief cells and oxyphil cells.

## 1. Chief cells:

- ▶ Secrete parathormone.

## 2. Oxyphil cells

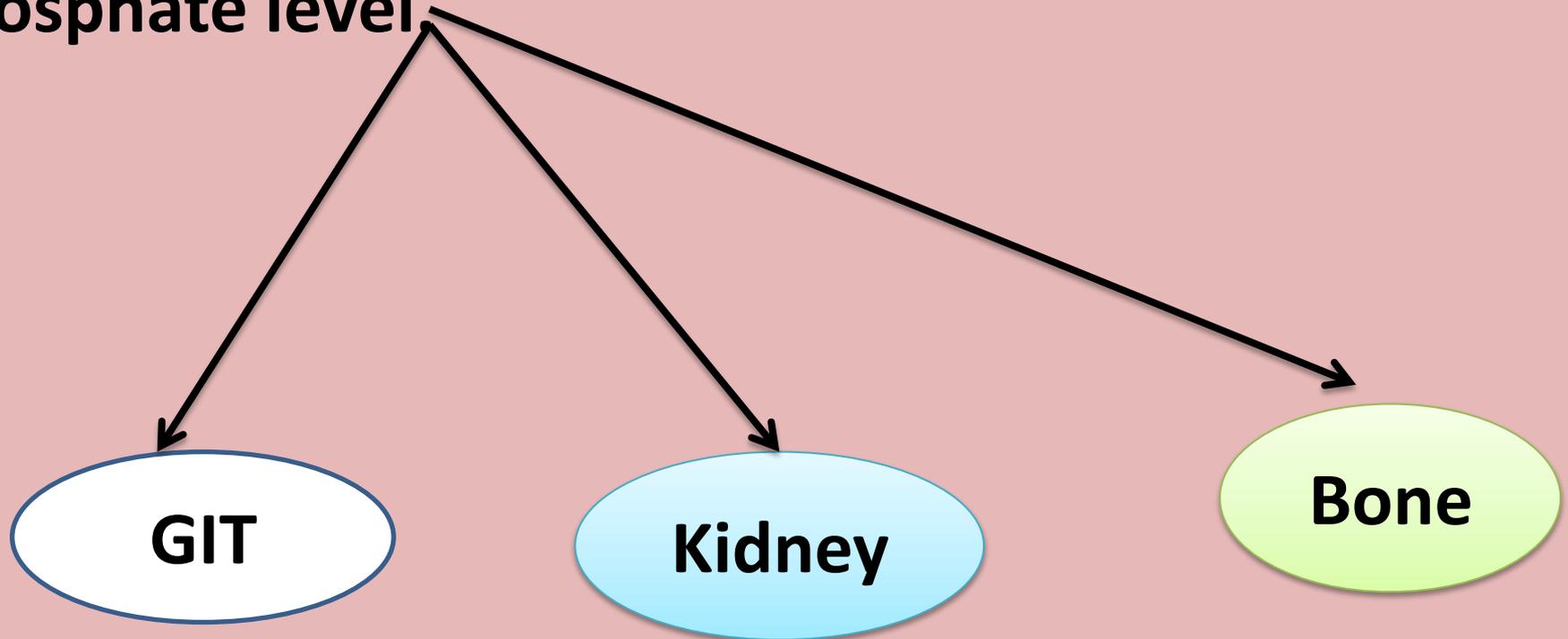
- ▶ Degenerated chief cells and their function is unknown.
- ▶ May secrete parathormone during pathological condition called **parathyroid adenoma**.



# Parathyroid Glands

## Actions of Parathormone PTH

maintains the blood calcium level and blood phosphate level



# Parathyroid Glands

## Bone

**PTH increases resorption of calcium from the bones by acting on osteoblasts, osteocytes and osteoclasts of the bone.**

**PTH increases the permeability of the membranes of osteoblasts and osteocytes for calcium ions. So calcium ions move from these bone cells into the blood.**

**PTH stimulates osteoclasts and causes release of proteolytic enzymes and some acids such as citric acid and lactic acid.**

**All these substances digest or dissolve the organic matrix of the bone, releasing the calcium ions into the plasma**

# Parathyroid Glands

## Kidneys

**PTH increases the reabsorption of calcium from distal convoluted tubule and proximal part of collecting duct into the plasma.**

**It also increases the formation of 1,25-dihydroxycholecalciferol (activated form of vitamin D) from 25-hydroxycholecalciferol in kidneys which is necessary for absorption of calcium from GI tract.**

# Parathyroid Glands

## Activation of vitamin D:

There are various forms of vitamin D but, the most important one is vitamin D3. It is also known as cholecalciferol.

**Vitamin D3 is synthesized in the skin from 7-dehydrocholesterol by the action of ultra-violet rays from the sunlight**

The activation of vitamin D3, appear in two steps :-

**First step, cholecalciferol (vitamin D3) is converted into 25-hydroxycholecalciferol in the liver. This process is limited and is inhibited by 25-hydroxycholecalciferol itself by feedback mechanism**

**second step, 25-hydroxycholecalciferol is converted into 1,25-dihydroxycholecalciferol (calcitriol) in kidney. And, it is the active form of vitamin D3. This step needs the presence of PTH.**

# Disorders of Parathyroid Glands

## **Hypocalcemic Tetany**

**Tetany is an abnormal condition characterized by painful muscular spasm (involuntary contraction of muscle or group of muscles) particularly in feet and hand.**

**It is because of hyperexcitability of nerves and skeletal muscles due to calcium deficiency.**

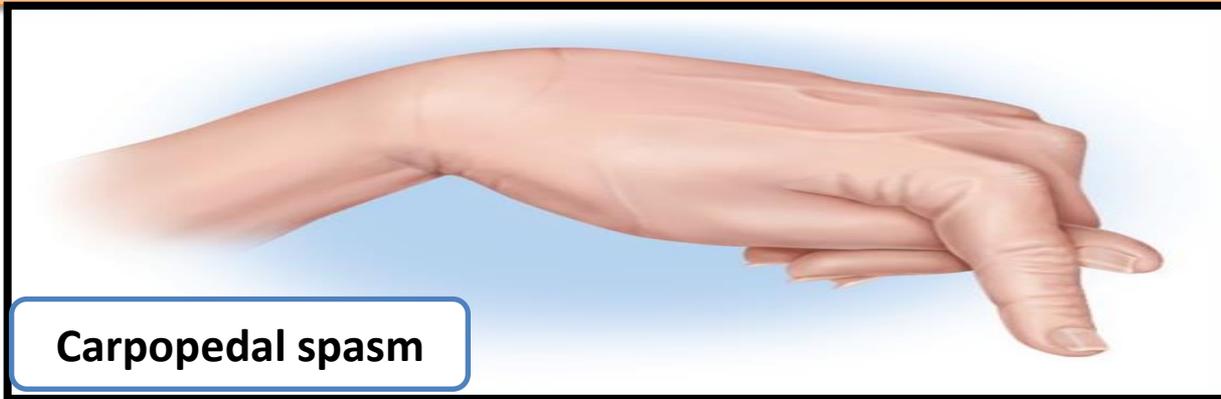
# The signs of hypocalcemic tetany

## 1- Hyper-reflexia and convulsions

The increased neural excitability results in hyperreflexia (overactive reflex actions) and convulsive muscular contractions

## 2- Carpopedal spasm

Carpopedal spasm is the spasm (violent and painful muscular contraction) in hand and feet that appear due to hypocalcemia



During the spasm, the hand shows a peculiar attitude with flexion at wrist joint and metacarpophalangeal joints, adduction of the thumb, and extension of interphalangeal joints

# Calcitonin

calcitonin is secreted by the parafollicular cells or clear cells (C cells) situated amongst the follicles in thyroid gland. It is a polypeptide chain with 32 amino acids. Its molecular weight is about 3,400. Plasma level of calcitonin is 1 to 2 ng/L.

## **On Blood Calcium level**

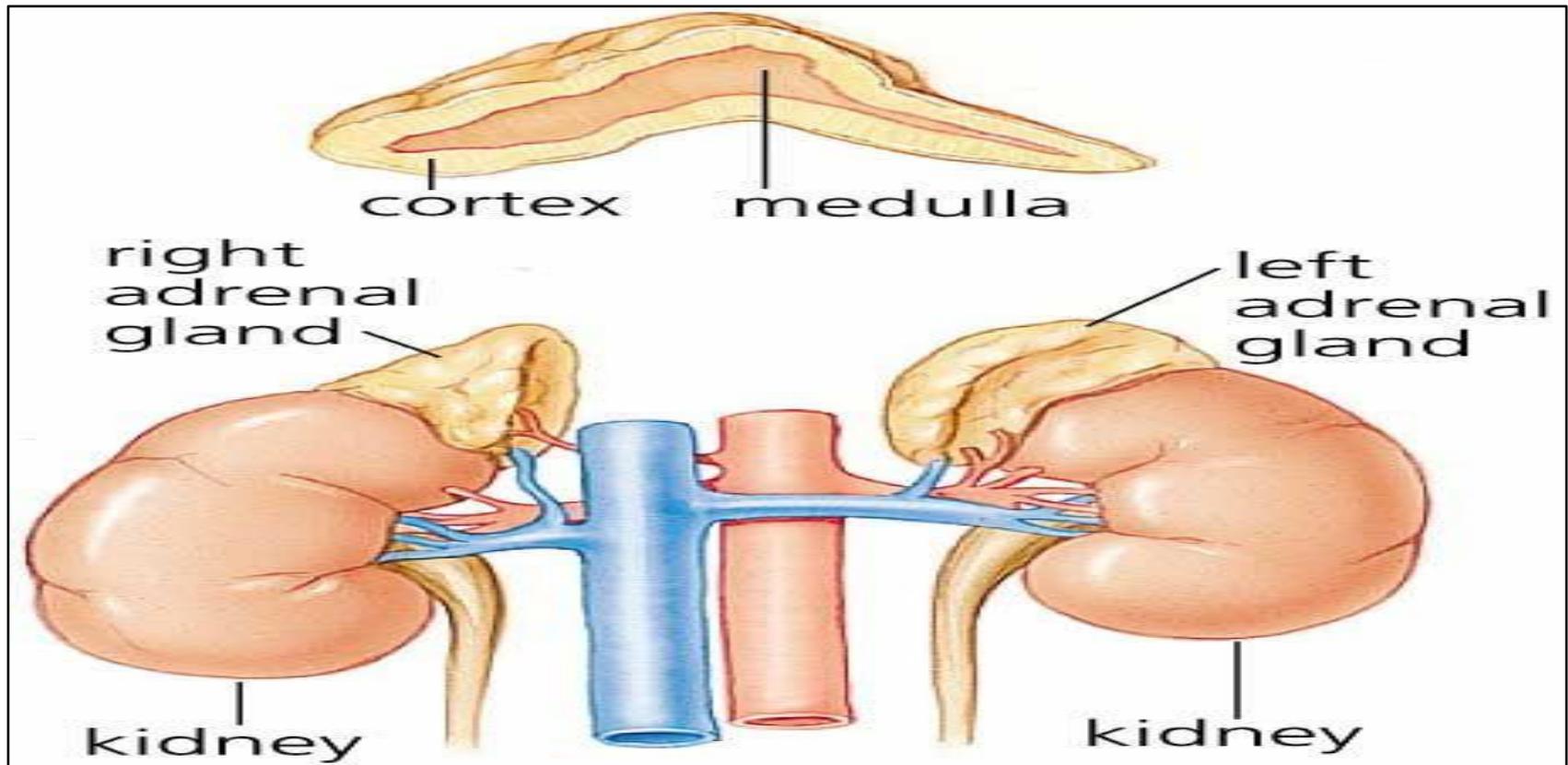
**Calcitonin plays an important role in controlling the blood calcium level. decreases the blood calcium level and there by counteracts parathormone. Calcitonin reduces the blood calcium level by acting on bones, kidneys and intestine**

## **On Blood Phosphate level**

**With respect to calcium, calcitonin is an antagonist to PTH. But it has similar actions of PTH with respect to phosphate. It decreases the blood level of phosphate by acting on bones and kidneys**

# Adrenal gland

There are two adrenal glands. Each gland is situated on the upper pole of each kidney.



# Adrenal gland

Because of the situation, adrenal glands are otherwise called **suprarenal** glands.

Each gland is made of two parts, the **adrenal cortex** and **adrenal medulla**.

**Adrenal cortex** is the outer portion forming **80%** of the gland.

**Adrenal medulla** is the central portion of gland forming **20%**.

# Hormones of Adrenal Cortex

The hormones secreted by adrenal cortex are collectively known as **adrenocortical** hormones or **corticosteroids**.

Based on their functions the corticosteroids are classified into three groups:

1. **Mineralocorticoids**
2. **Glucocorticoids**
3. **Sex hormones**

# Mineralocorticoids

Mineralocorticoids are the corticosteroids that act on the minerals (electrolytes) particularly **sodium** and **potassium**. The mineralocorticoids are secreted :

- 1. Aldosterone**
- 2. 11-Deoxycorticosterone**

# **Glucocorticoids**

- 1. Cortisol**
- 2. Corticosterone**
- 3. Cortisone**

# Adrenal Sex Hormones

- 1. Dehydroepiandrosterone**
- 2. Androstenedione**
- 3. Testosterone.**

THANK

you

# Endocrine System



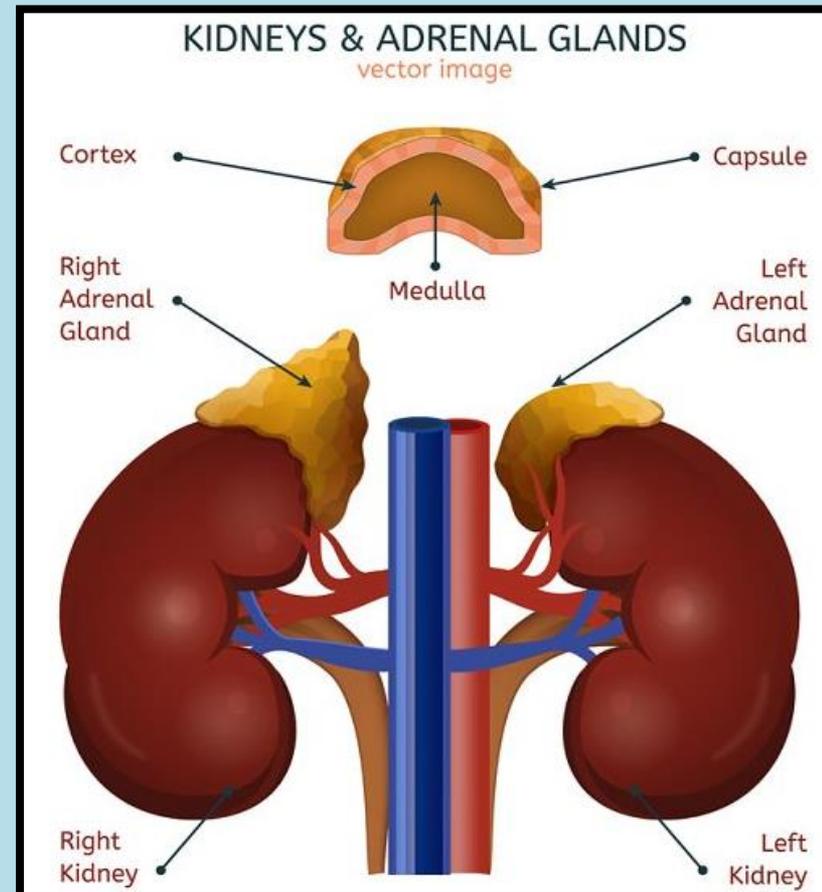
**Dr. Rana Hazim**  
**Ph.D. of Physiological**

# Hormones of Adrenal Cortex

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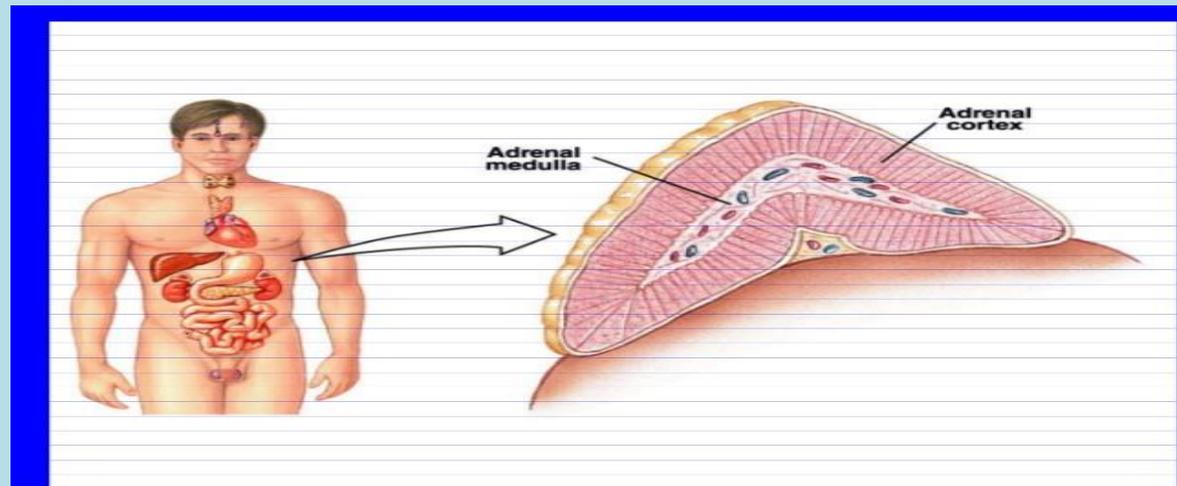
1. **Mineralocorticoids**
2. **Glucocorticoids**
3. **Sex hormones**



# Hormones of Adrenal Medulla

**Adrenal medullary hormones are the amines derived from catechol and so these hormones are called catecholamines. Three catecholamines are secreted by medulla:**

- 1. Adrenaline or epinephrine**
- 2. Noradrenaline or norepinephrine**
- 3. Dopamine.**



# Hyperactivity

## Cushing's syndrome

is due to the hypersecretion of glucocorticoids, especially cortisol.

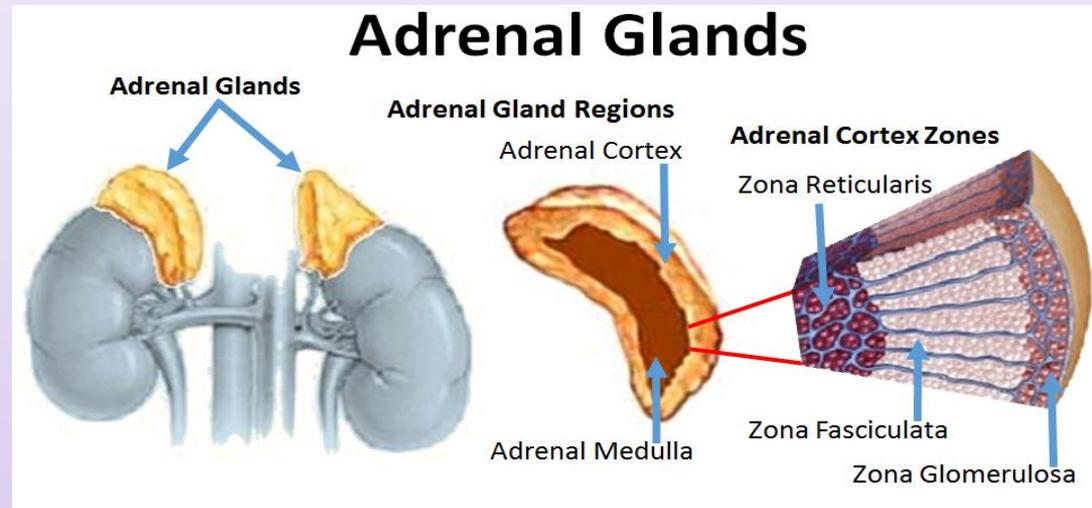
It may be due to either **pituitary origin** or **adrenal origin**:-

1- If it is due to pituitary origin it is known as **Cushing's disease**.

2- If it is due to adrenal origin it is called **Cushing's syndrome**.

# Hyperactivity

**Hyperaldosteronism :- Increased secretion of aldosterone, hyperaldosteronism is classified into two types:**



**Primary hyperaldosteronism which appear due to tumor in zona glomerulosa of adrenal cortex. It is otherwise known as Conn's syndrome**

**Secondary hyperaldosteronism which appear due to extra-adrenal causes such as congestive cardiac failure, nephrosis, toxemia of pregnancy and cirrhosis of liver**

# Hyperactivity

## Adrenogenital syndrome

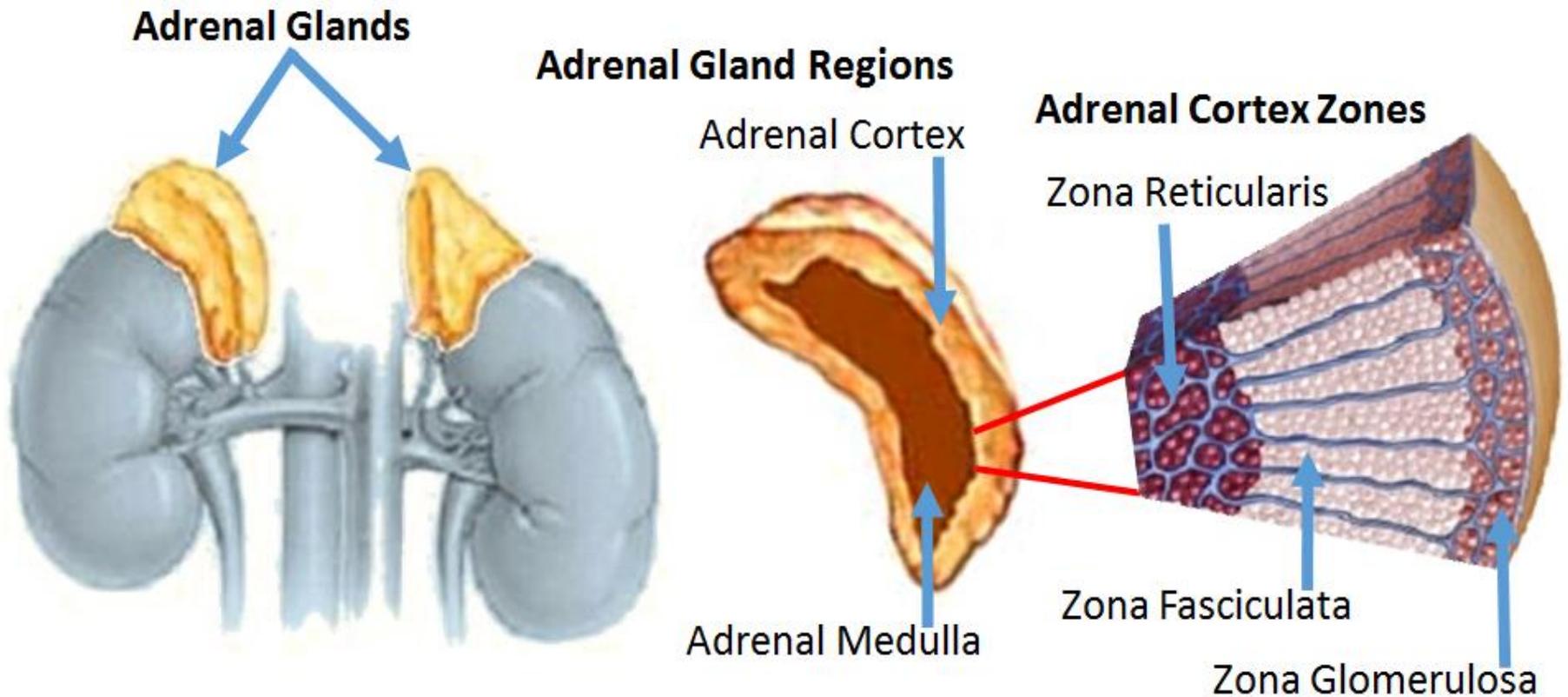
**Under normal conditions, adrenal cortex secretes small quantities of androgens which do not have any significant effect on sex organs or sexual function.**

**However, secretion of abnormal quantities of adrenal androgens develops adrenogenital syndrome.**

**Causes / It is due to the tumor of zona reticularis in adrenal cortex.**

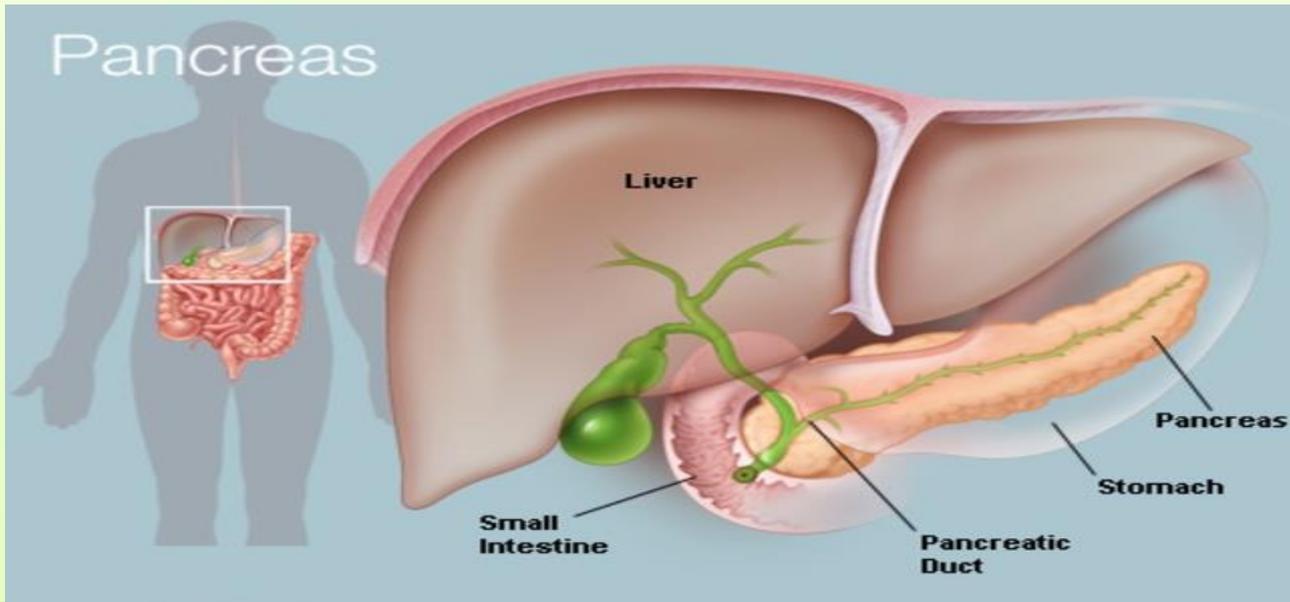
# Adrenal Cortex Zones

## Adrenal Glands



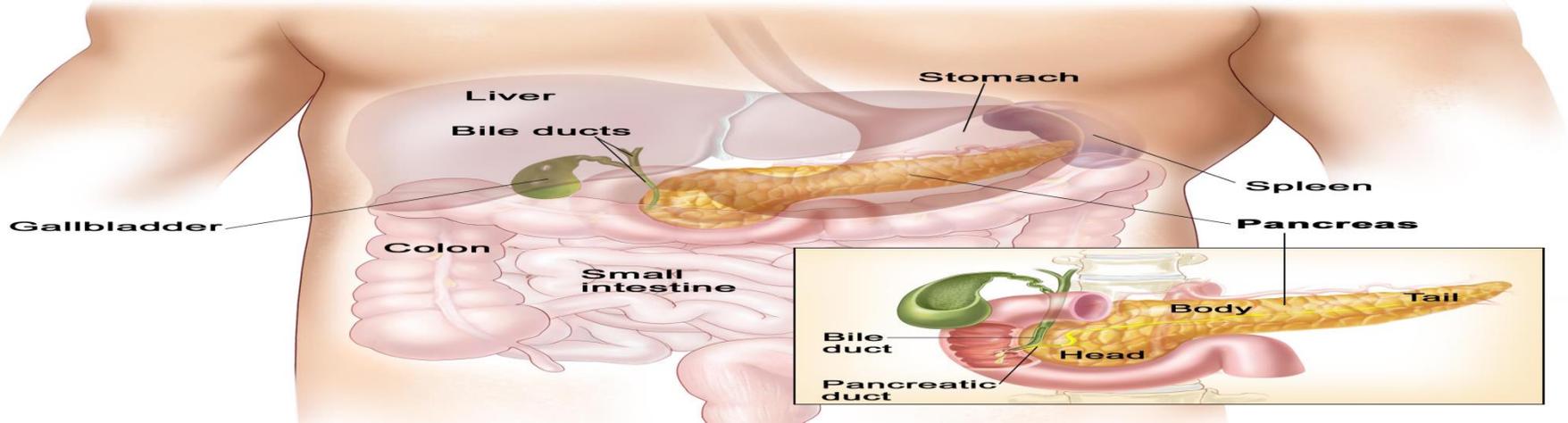
# Pancreas

**It contains both exocrine (GI enzymes) and endocrine cells. Pancreatic islets (islets of Langerhans) are populations of cells:**



**Alpha cells produce glucagon which is a hyperglycemic hormone.**

**beta cells produce insulin which is a hypoglycemic hormone.**



**Other cells produce somatostatin and pancreatic peptide (PP).**

**Regulation of glucagon is by humoral response to decreased circulating glucose**

**while regulation of insulin is by humoral response to increased circulating glucose.**

# **Glucagon effects**

- 1. Breakdown of glycogen to glucose (gluconeogenesis).**
- 2. Synthesis of glucose from lactic acid, fatty acids and amino acids (gluconeogenesis).**
- 3. Release of glucose from liver**

# **Insulin effects**

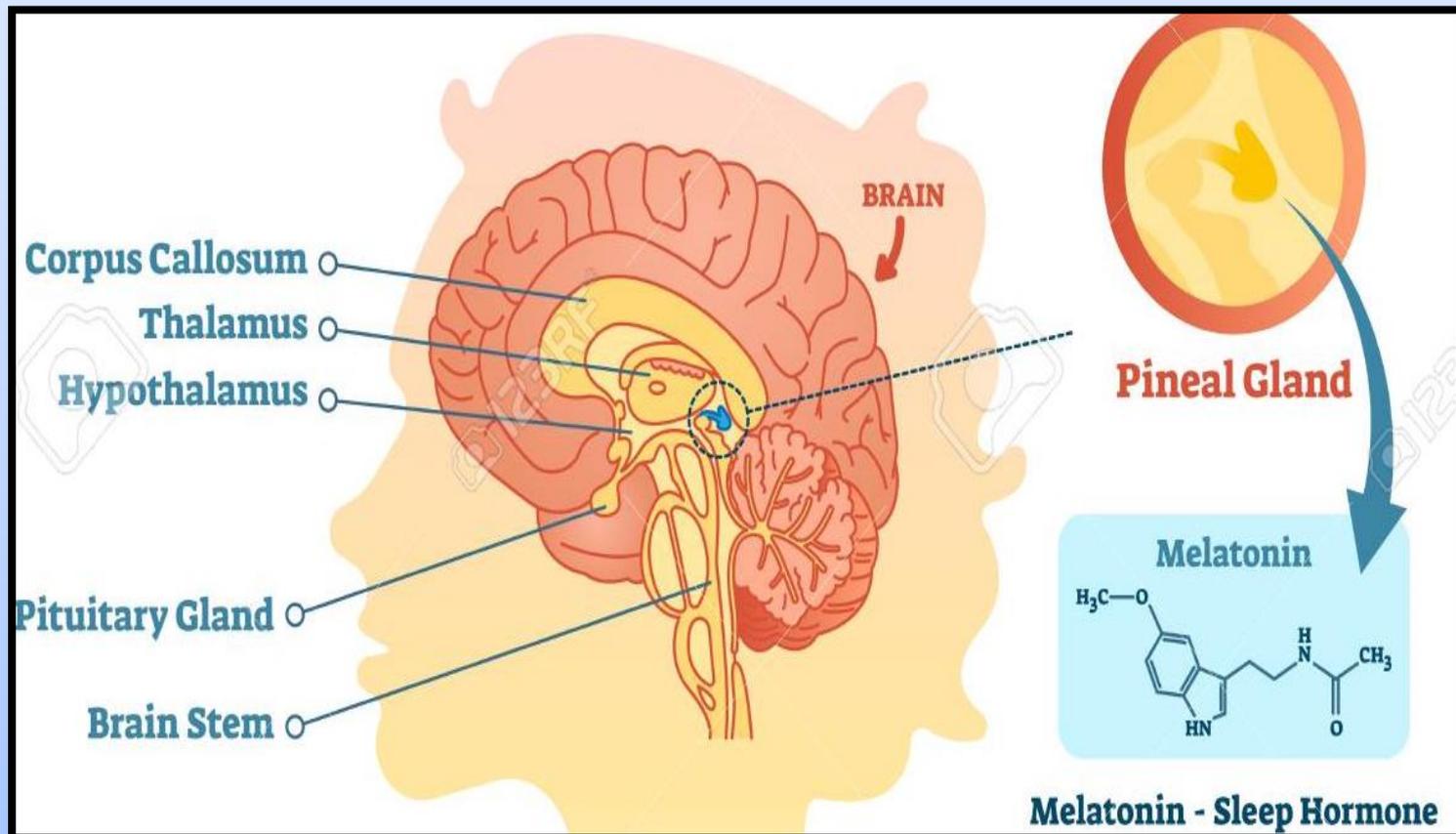
- 1. Lower blood glucose**
- 2. Alter protein and fat metabolism.**
- 3. Inhibits breakdown of glycogen.**

# Hyperinsulinism

**excessive insulin secretion results :  
in hypoglycemia,  
anxiety,  
nervousness,  
tremors,  
weakness,**

# Pineal gland

is located in diencephalic area of brain above the hypothalamus.



Melatonin - Sleep Hormone

# **Pineal gland**

**In human, pineal gland has two types of cells:**

**1- Parenchymal cells, which are large epithelial cells**

**2- Neuroglia cells. In adults, the pineal gland is calcified. But, the epithelial cells remain and secrete the hormonal substance**

**Pineal gland has two functions:**

**1- It controls the sexual activities.**

**2- The parenchymal cells of pineal gland secrete a hormone called melatonin.**

**Actions:**

**acts mainly on gonads. Its action differs from species to species. In some animals, it stimulates the gonads while in other animals it inhibits the gonads. In humans, it inhibits the onset of sexual maturity by inhibiting the gonads.**

# Reference:-

**1-Essentials of Physiology for Dental Students. K Sembulingam and Prema Sembulingam ,2016, four Edition , Jaypee Brothers Medical Publishers.**

**2- Human Physiology. Stuart Ira Fox., TWELFTH EDITION,2017. Published by McGraw-Hill**

**Thank You!**

