

# Adrenal Gland

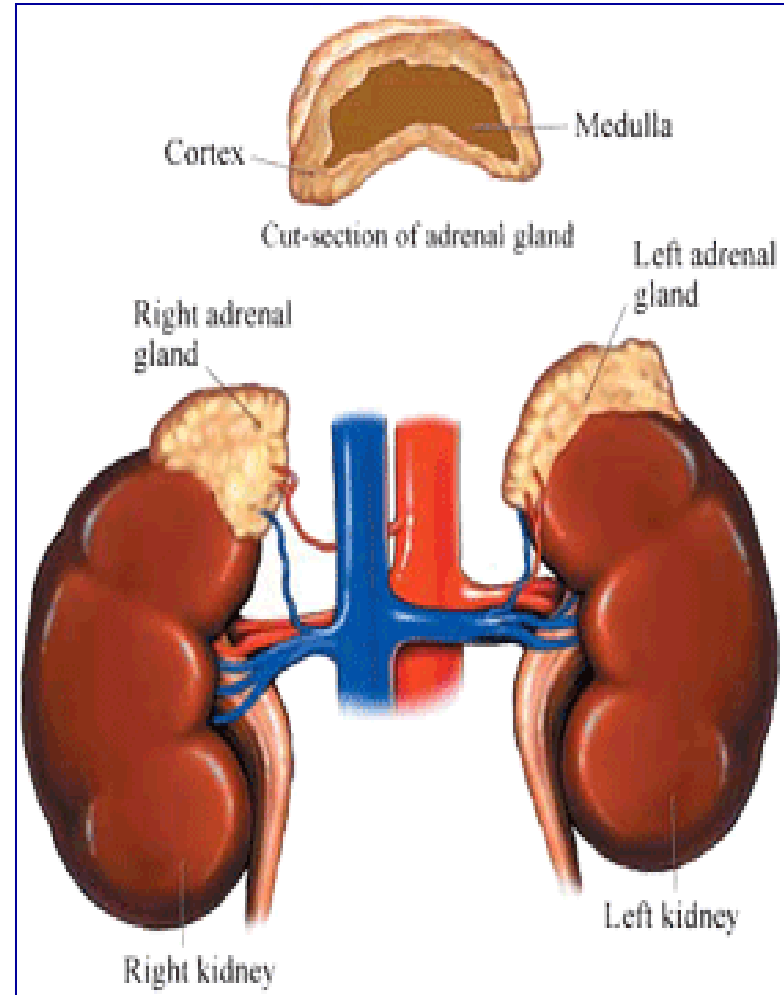
*Prof. Dr. AZZA SAJID*

*2<sup>nd</sup> STAGE*

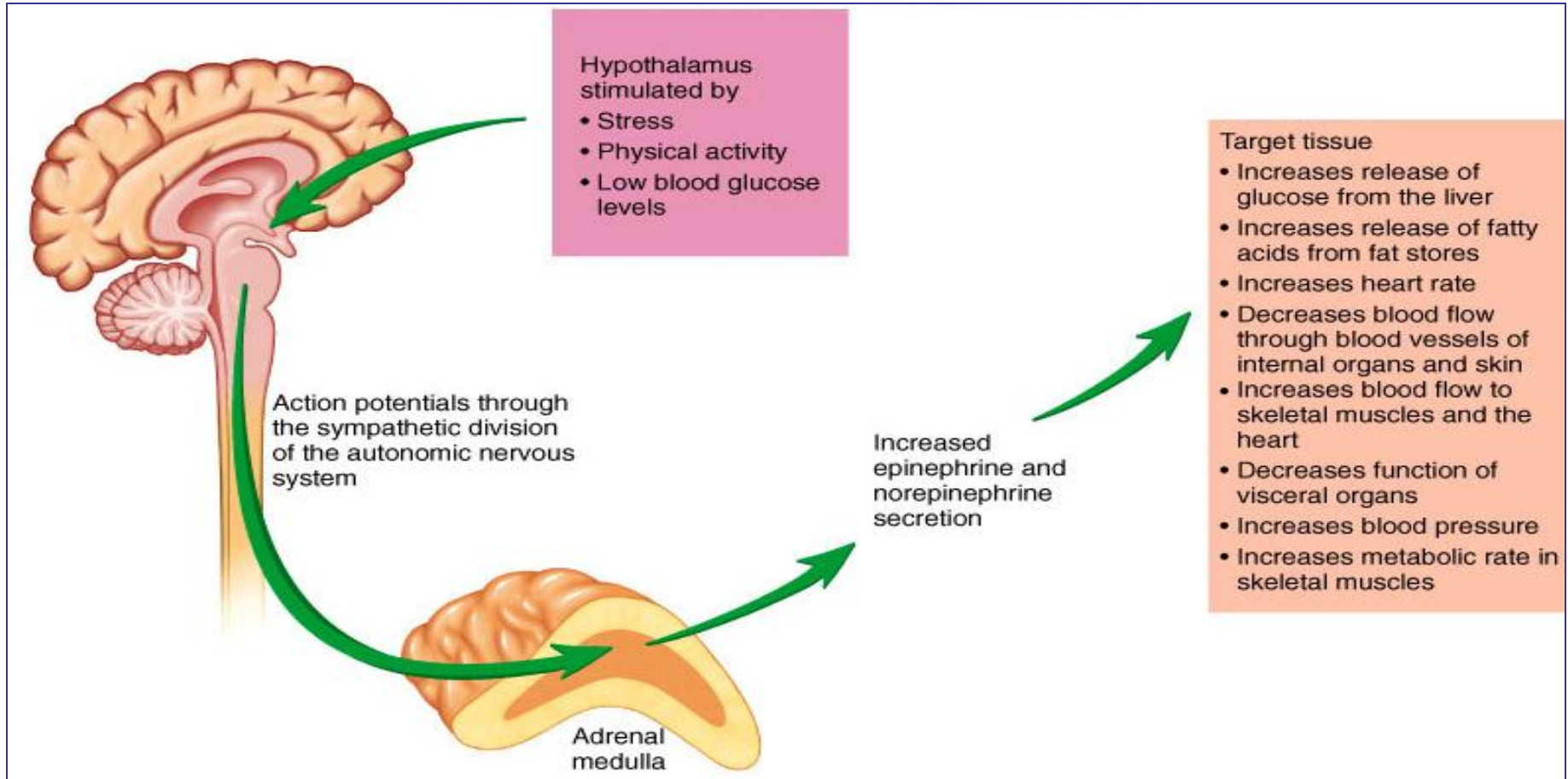
*Physiology#II*

# Adrenal Gland

- There are two adrenal glands
- These glands have a similarity in anatomical structure, function, secreted hormones.
- The two glands are located above the two kidneys, i.e. one gland above each kidney; exactly at the position of 12<sup>th</sup> thoracic vertebra.
- Adrenal glands are also termed **suprarenal glands** (due to the position). The term (**adrenal**) comes from the fact that these glands secrete the hormone (**adrenaline**) in cases of stress.
- Adrenal gland consists of two distinct layers; **Cortex** and **Medulla**.
- These two layers differ in their anatomical structure and in their functions.



- **1- Adrenal medulla**
- Adrenal medulla arises from **neural crest cells** and functions as part of CNS.
- It is composed of closely packed cells, devoted to synthesis of **catecholamine**, which include adrenaline (**epinephrine**) and noradrenaline (**norepinephrine**).
- Both hormones are secreted in stressful situations.
  
- **Physiological effects of catecholamine**
- Catecholamine cause general physiological changes that prepare the body for physical activities. In case of (***fight or flight***), catecholamine cause :
  - Elevation of blood pressure .
  - Increasing blood sugar.
  - Increasing heart rate.
  - Increased metabolic rate.
  - Affects peripheral nervous system.
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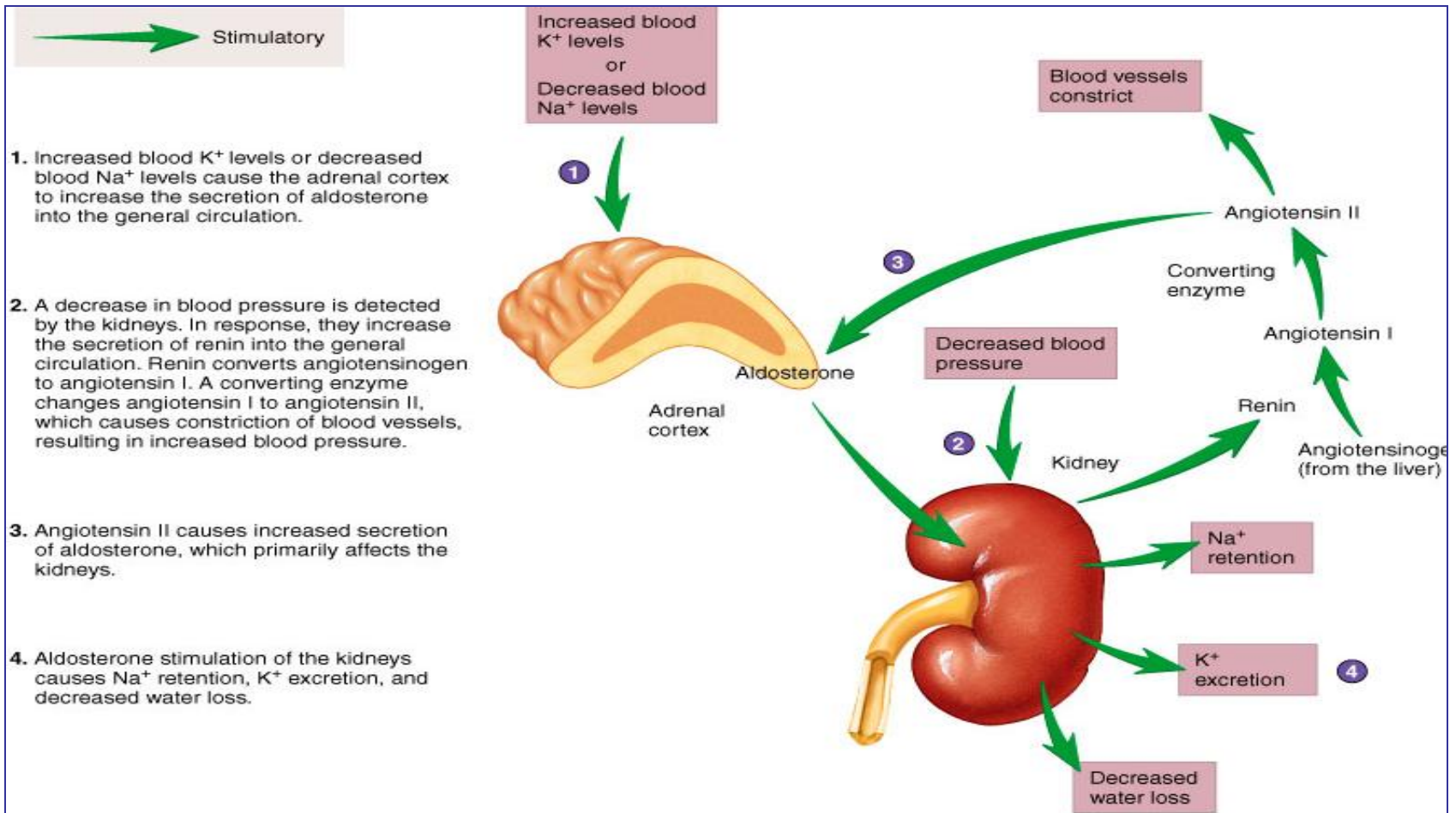
## Actions of adrenal medulla hormones.

- **Adrenal cortex**
- It is derived from mesoderm
- Adrenal cortex is devoted to the synthesis of **CORTICOSTEROID HORMONES** due to the presence of large amounts of fats specially **cholesterol** which is the precursor of these hormones.
- Adrenal cortex exhibits three functional zones:
- **Zona glomerulosa**
- **Zona fasciculata**
- **Zona reticularis**

### **1. Zona glomerulosa**

- The outer most layer of the cortex.
- It is the main site for production of ( **Mineralcorticoids** )
- The main mineralcorticoid in human is **aldosterone** while there are some endogenous hormones which have a mineralcorticoid function (**progesterone & deoxycorticosterone**).
- Aldosterone hormone is a derivative of cholesterol.
- Its normal level is about (**4-9 Mg /100 ml blood**). About **2-18 Mg** of aldosterone is wasted with urine daily.
- Aldosterone acts on kidneys to provide active reabsorption of sodium and passive absorption of water. (increases the blood pressure)
- It causes secretion of both potassium ions and protons from the collecting ducts and distal tubules.
- Aldosterone synthesis is regulated by:
- **Angiotensin II.**
- **Adrenocorticotrophic hormone (ACTH).**
- **Blood level of Na<sup>+</sup> and K<sup>+</sup>.**

## Aldosterone regulation



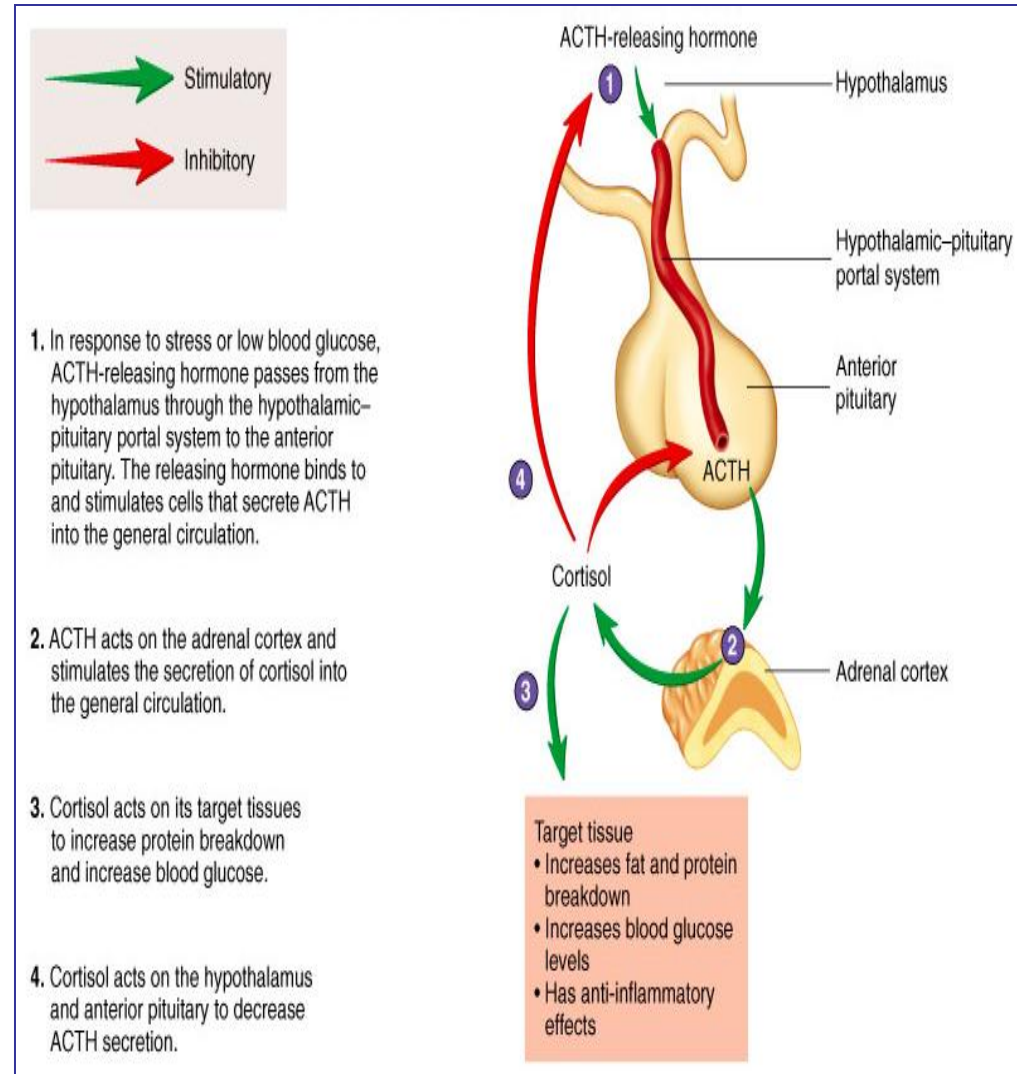
- **2- Zona fasciculata**
- The central region of the adrenal cortex.
  - It is the main site for production of **(Glucocorticoids)** )
- The primary glucocorticoid in human is (**cortisol**).
- Cortisol (**a stress hormone**) secretion is stimulated by hypoglycemia or stressful conditions, anxiety, and when the sympathetic nervous system is activated.
- Cortisol has a diurnal pattern of secretion based on daily pattern of **ACTH**.
- Its primary function is to increase blood sugar and stores of sugar in the liver as glycogen.
- Zona fasciculata can produce (**7-7.5 mg/day**) of cortisol hormone.
- Biosynthesis of cortisol is done by conversion of **cholesterol** to **pregnenolone**.

## Physiological effects of cortisol

- Cortisol has anti – insulin effect.
- It contributes to “hyperglycemia” by stimulation of hepatic gluconeogenesis and inhibition of peripheral utilization of glucose.
- It increases gastric acid secretion.
- It cooperates with adrenaline to create memories of short – term events.
- It has an anti – inflammatory action as inhibits secretion of histamine from basophils and mast cells and it can cause immune suppression
- It elevates blood pressure by increasing the expression of adrenergic receptors in various tissues.
- Cortisol may weaken the bones by inhibiting **osteoblasts** and stimulating bone degrading cells (**osteoclast**).
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- **Regulation of cortisol secretion**
- **CRH** is released by the hypothalamus as response to stress and decreased blood glucose.
- **CRH** affects the anterior pituitary to release **ACTH**.
- **ACTH** stimulates the secretion of **cortisol** by the adrenal cortex.
- Cortisol acts on the target tissues to cause its effects.
- Cortisol has **negative feedback** effect to inhibit CRH releasing from the hypothalamus and decrease ACTH secretion from anterior pituitary.



## Pathological conditions of cortisol

- **1-Hypercortisolism (*Cushing syndrome*)**
- **The condition results from increased amount of cortisol hormone in the blood.**
- **It may be caused by:**
  - **Tumors in cortisol secreting cells.**
  - **Tumors in ACTH secreting cells.**
  - **Iatrogenic (Taking glucocorticoids drugs).**
  - **Symptoms of Cushing syndrome include :**
- **Rapid weight gain.**
- **Increased growth of body and facial hair**
- **Very high blood sugar which may lead to diabetes mellitus.**
- **High blood pressure**
- **Loss of minerals which leads to osteoporosis**
- **2-Hypocortisolism (*Addison disease*)**
  - **Addison disease is due to an inadequate secretion of cortisol.**
  - **The causes of Addison disease are:**
- **Iatrogenic is the most common cause, occurs because of abrupt cessation of chronically administrated cortisol.**
- **Primary adrenal insufficiency causing increase level of ACTH.**
- **Secondary adrenal insufficiency or chronic use of steroid, the ACTH is low.**
- **Symptoms of Addison include:**
- **Low blood sugar.**
- **Low blood pressure.**
- **High potassium levels in the blood.**
- **Full body weakness and loss of energy.**

### 3-Zona reticularis

It is the interior layer of the adrenal cortex.

It is responsible for production of ( **Androgens** ) and ( **Estrogen** )

The main adrenal androgen is **Testosterone**, while the main adrenal estrogen is **Estradiol**

#### **1- Testosteron**

Testosterone is secreted in both males and females , but in males in a larger amount so , its effects appear clearly on males and therefore , it is the “muscularity hormone”

In males, it is secreted mainly from **Leyding cells** in the testes, and a small amount from **adrenal reticularis**.

In females, it is secreted from **Thecal cells** in the ovaries, placenta and a small amount from adrenal reticularis.

Its activity is mediated by **LH** and **FSH**.

#### **Physiological effects of testosterone**

Regulation the production of sperms (**spermatogenesis**)

Development and maintenance of male reproductive organs and secondary sex characteristics.

Stimulating protein synthesis (**anabolic effect**)

#### **2-Estradiol**

Estradiol is the predominant sex hormone in females.

It is produced primarily by **granulosa cells** in ovaries, in addition to small amount from adrenal reticularis.

During pregnancy, its amount increases due to secretion from placenta also.

It is present in males but in lower amounts than females.

Its activity is mediated by **LH** and **FSH**.

## Physiological effects of estradiol

- Growth of female reproductive organs.
- Maintaining of oocytes in ovaries.
- During pregnancy, it promotes uterine blood flow and stimulates breast growth.
- Regulation of menstrual cycle.
- It affects liver to synthesize lipoproteins, binding proteins and proteins of blood clotting.

**THANKS**