Hello Everyone

Hope You Are Having
A Wonderful Physiological Day

☺☺☺


ARE YOU
READY ?
LET'S GET STARTED!

Physiology of Adrenal Cortex

Sem 4

Adrenal Cortex

Site:

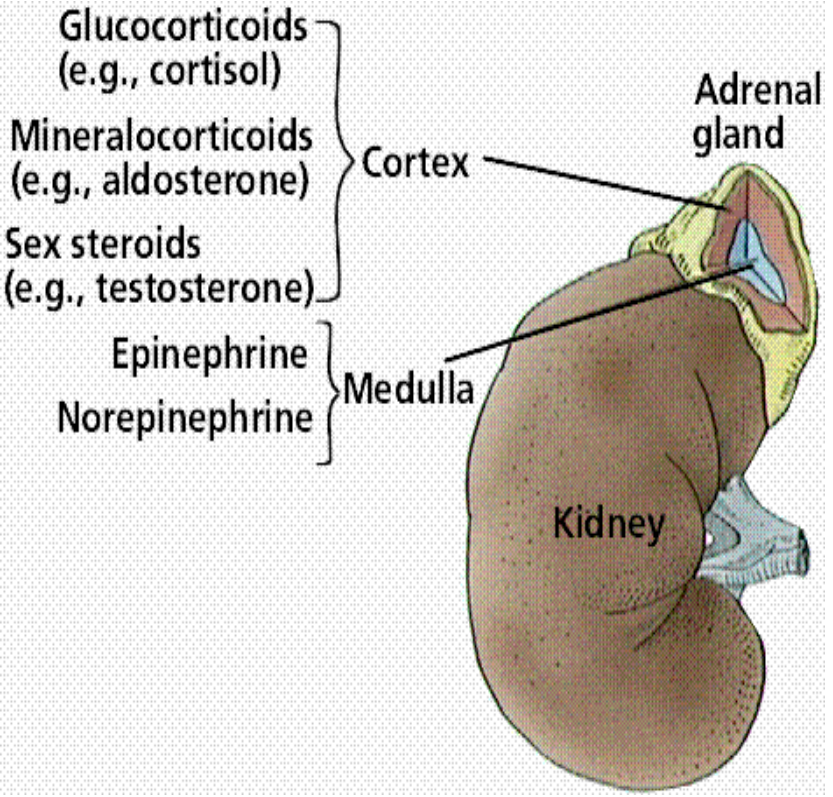
- ✓ 2 adrenal glands (each gland about 5 gm).
- ✓ Lie at the superior poles of the kidneys.

Structure:

- ✓ Each gland is composed of 2 distinct parts;

a-Adrenal medulla (20% of the gland) secretes epinephrine and norepinephrine.

b-Adrenal cortex (80% of the gland) secretes group of hormones, called corticosteroids



Adrenal Cortex

Adrenal cortex consists of 3 distinct layers;

a)Zona Glomerulosa

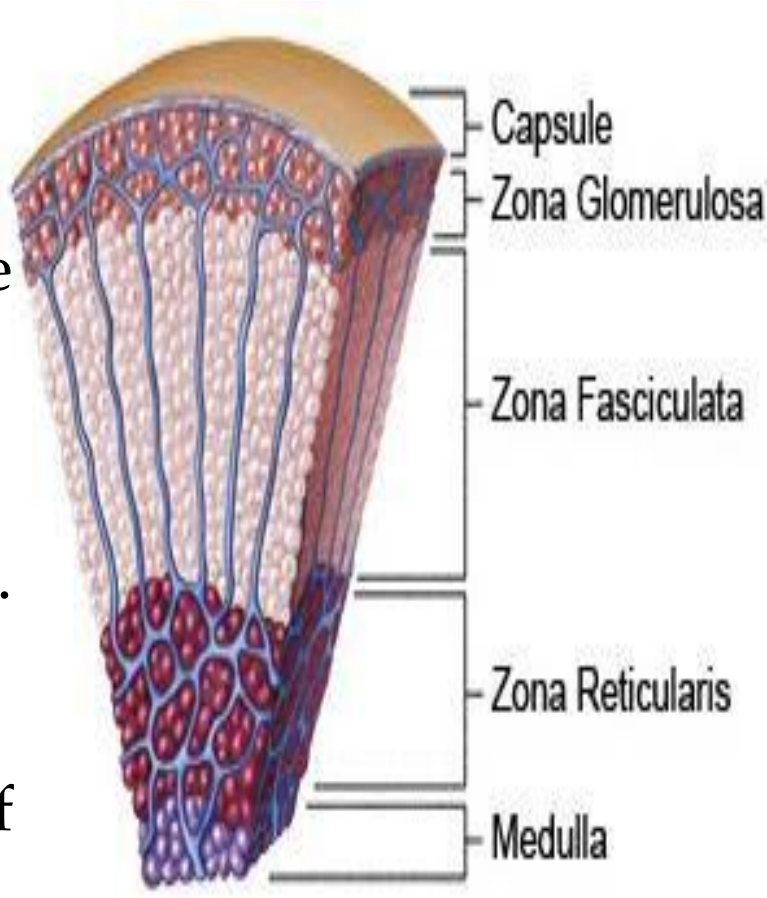
- ✓ Outer layer →15% of cortex.
- ✓ Secretes amounts of the mineralocorticoid e.g. aldosterone

b)Zona Fasciculata

- ✓ Middle layer→ 75% of cortex.
- ✓ Secretes the glucocorticoids e.g. cortisol and corticosterone.

c)Zona Reticularis

- ✓ Deep layer of the cortex→ 10% of cortex
- ✓ Secretes the adrenal androgens e.g. dehydro-epiandrosterone (DHEA)



Mineralocorticoids

Source:

✓ Zona glomerulosa

Types: 2 types;

a) Aldosterone: is the major mineralocorticoid

✓ Exerts about 90% of the mineralocorticoid activity of the adrenocortical hormones.

b) Deoxycorticosterone→ 3% of activity of aldosterone.

N.B.

✓ Cortisol's mineralocorticoid activity is only about 1/400 that of aldosterone

✓ But its plasma concentration is nearly 1000 times that of aldosterone.

Physiological Effects of Aldosterone

1) Renal Effects: stimulates

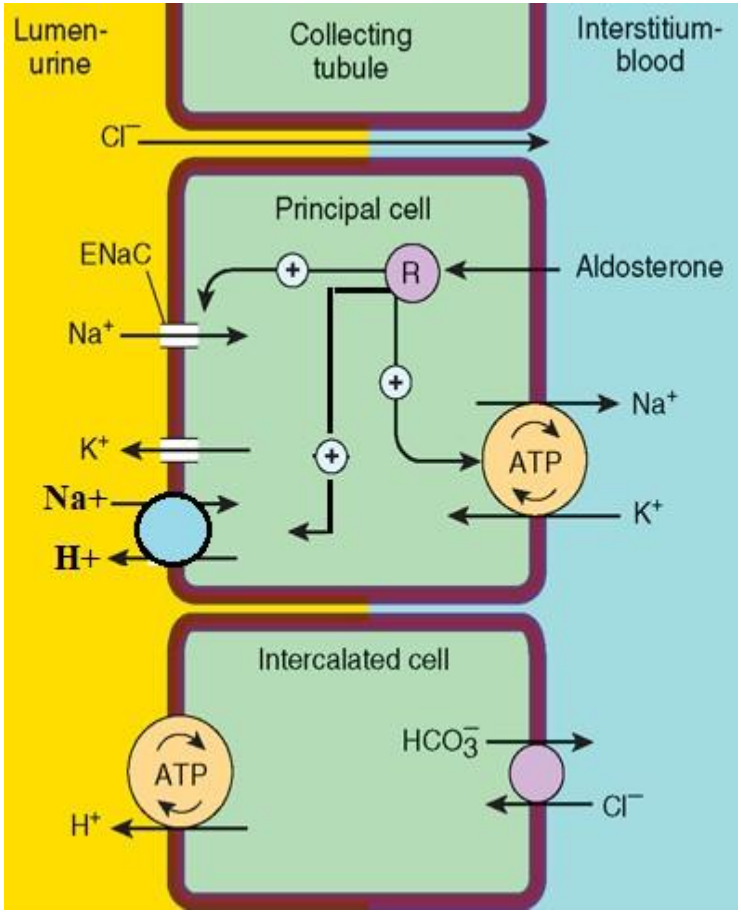
a) **Na reabsorption** from DCTs and CDs via ENaC (1%-2% of filtered Na)

b) **K secretion** via K channels 2ry to its effect on Na reabsorption

c) **H secretion** in exchange with a small amount of Na.

N.B.

✓ In **acidosis,** Na reabsorption occurs mainly in exchange with H secretion.



Physiological Effects of Aldosterone

2) Effect of other tissues:

a) ↑es reabsorption of Na from sweat, saliva, gastric juice and milk.

b) ↑es Na reabsorption and K secretion in the colon→ prevents loss of Na in the stools.

Control of Aldosterone Secretion

- Aldosterone secretion is promoted by the following stimuli;

1) ↑ed activity of renin-angiotensin system:

✓ ↓ ECF volume or intravascular volume → ↑ renin secretion→ ↑ angiotensin II formation →↑ aldosterone secretion from zona glomerulosa

2) Hyperkalemia:

✓ ↑ of plasma K concentration (about1%) stimulate aldosterone secretion

3) Hyponatremia:

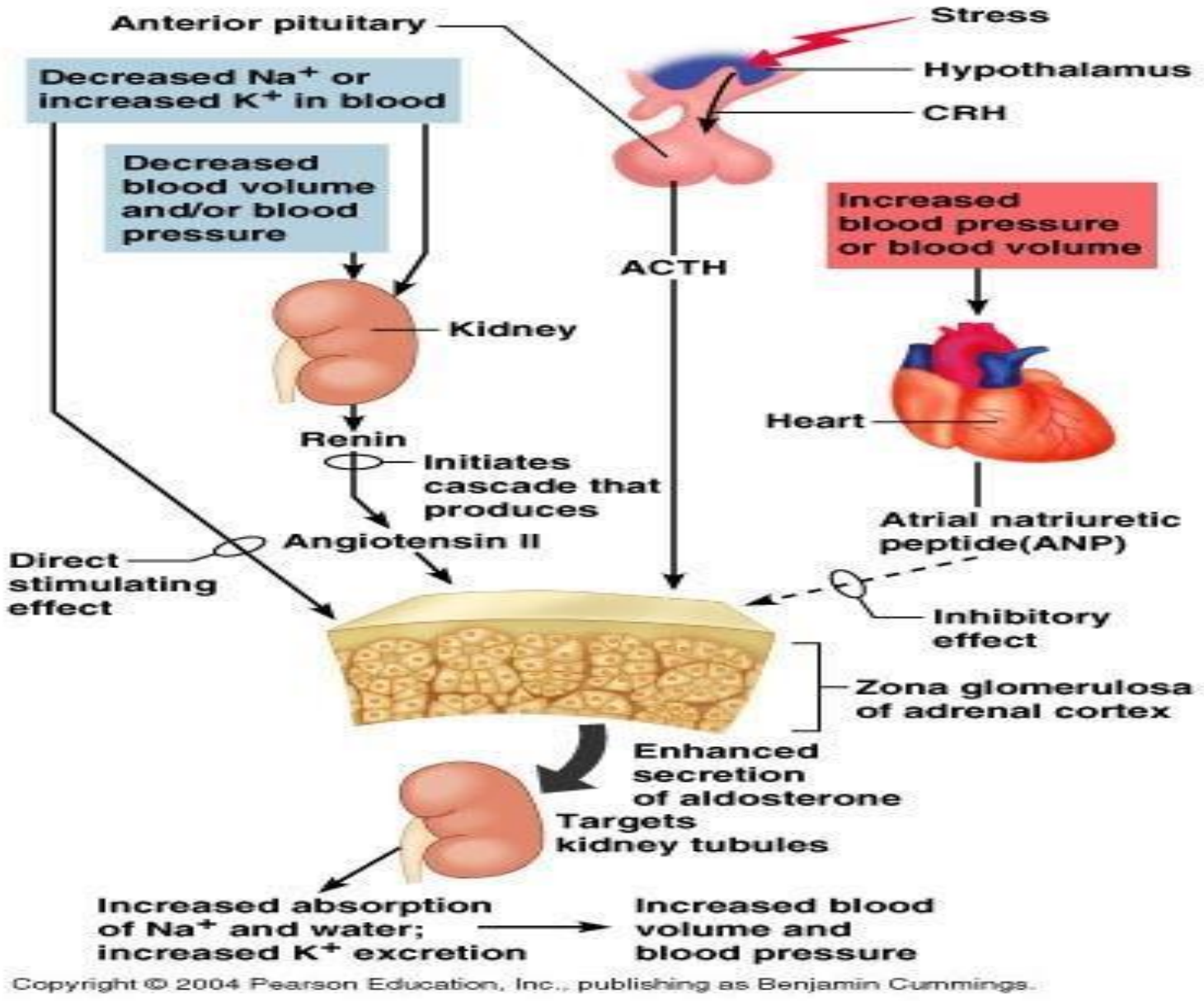
✓ ↓ of plasma Na concentration (about 10%) stimulate aldosterone secretion

4) ACTH:

✓ ACTH is not a major factor in the control of secretion of aldosterone.

✓ ACTH maintains the growth and biosynthetic capacity of zona glomerulosa → enhances aldosterone secretion

Control of Aldosterone Secretion



Hyperaldosteronism

	Conn's syndrome or 1ry aldosteronism	2ry aldosteronism
Def.,	Condition characterized by excess aldosterone secretion due to adrenal cause	Condition characterized by excess aldosterone secretion due to extra adrenal cause
Causes	Adrenal hyperplasia or tumors	a)Extravascular loss of Na and water, which is associated with edema as in liver cirrhosis and congestive heart failure. b)Excessive renin secretion by tumors
Manifestation	**a)Hypokalemia (↓ K):** leads to: i)Ms weakness and periodic paralysis ii)Renal damage and polyuria iii)ECG changes: Prominent U wave **b)Hypernatremia (↑Na)** This leads to: i)Metabolic alkalosis due to loss of H in urine. Tetany may occur. ii)Mild hypertension **c)No edema.**	a)Peripheral edema. b)Hypertension. c) ↑ed angiotensin and plasma renin activity. d)Hypokalemic alkalosis. e) ↑ed plasma (and urinary) aldosterone.

Glucocorticoids

Source

✓ Zona fasiculata

Types:

a) **Cortisone** → 95% of glucocorticoids activity.

b) **Corticosterone** → small amount of glucocorticoids activity

Physiologic Effects of Glucocorticoids

1) Effects on metabolism:

A) CHO metabolism:

1. Stimulate gluconeogenesis.

2.↓ Glucose utilization by most cells.

- ✓ These effects cause ↑ in blood glucose level
- ✓ So, chronic use of cortisone may cause **steroid DM**

B) Protein metabolism

- ✓ **In ms and bone** → stimulates protein breakdown.
- ✓ **In liver**→ stimulates hepatic protein synthesis.

C) Fat metabolism

- ✓ ↑ mobilization of fatty acids (FFA) from adipose tissue →↑es the concentration of FFA in the plasma.
- ✓ ↑oxidation of fatty acids→↑ ketone body formation

Physiologic Effects of Glucocorticoids

2) Renal effects:

✓ Have weak **mineralocorticoid effect** i.e. ↑es Na reabsorption and ↑es excretion of K in urine.

In case of dehydration	In case of hydration
Cortisol has an **antidiuretic effect** secondary to ↑ Na^+ reabsorption.	Cortisol has a **diuretic effect** caused by: • ↑ RBF & GFR. • Inhibition of ADH action on CDs.

3) Resistance to stress:

✓ ↑ the resistance of the body to stress through;

a) Rapid mobilization of amino acids and fats from their stores→ make them available both for energy and for synthesis of other compounds, needed by different tissues of the body.

b) Stabilizes lysosomal membrane→ cell protection.

c) ↑es the vascular reactivity→ maintain the normal ABP and volume.

Physiologic Effects of Glucocorticoids

6) Antiallergic effect:

✓ Inhibit the release of histamine from mast cells and basophils.

7) Effects on blood cells and lymphoid tissue:

i)↓ the No of lymphocytes, monocytes, basophils and eosinophils

ii)↑ the No of RBCs, platelets and neutrophils by ↑ing their formation and ↓ing their migration.

8) Gastric effects:

i) ↑ gastric acid secretion.

ii)Inhibit gastric mucosal cell proliferation.

Physiologic Effects of Glucocorticoids

9) Permissive effect:

- ✓ Permit the action of glucagon on gluconeogenesis
- ✓ Permit the action of catecholamines on lipolysis, bronchodilatation and V.C.

10) Effect on ACTH secretion:

- ✓ Inhibit ACTH secretion through a -ve long-loop feedback on the hypothalamus and anterior pituitary.

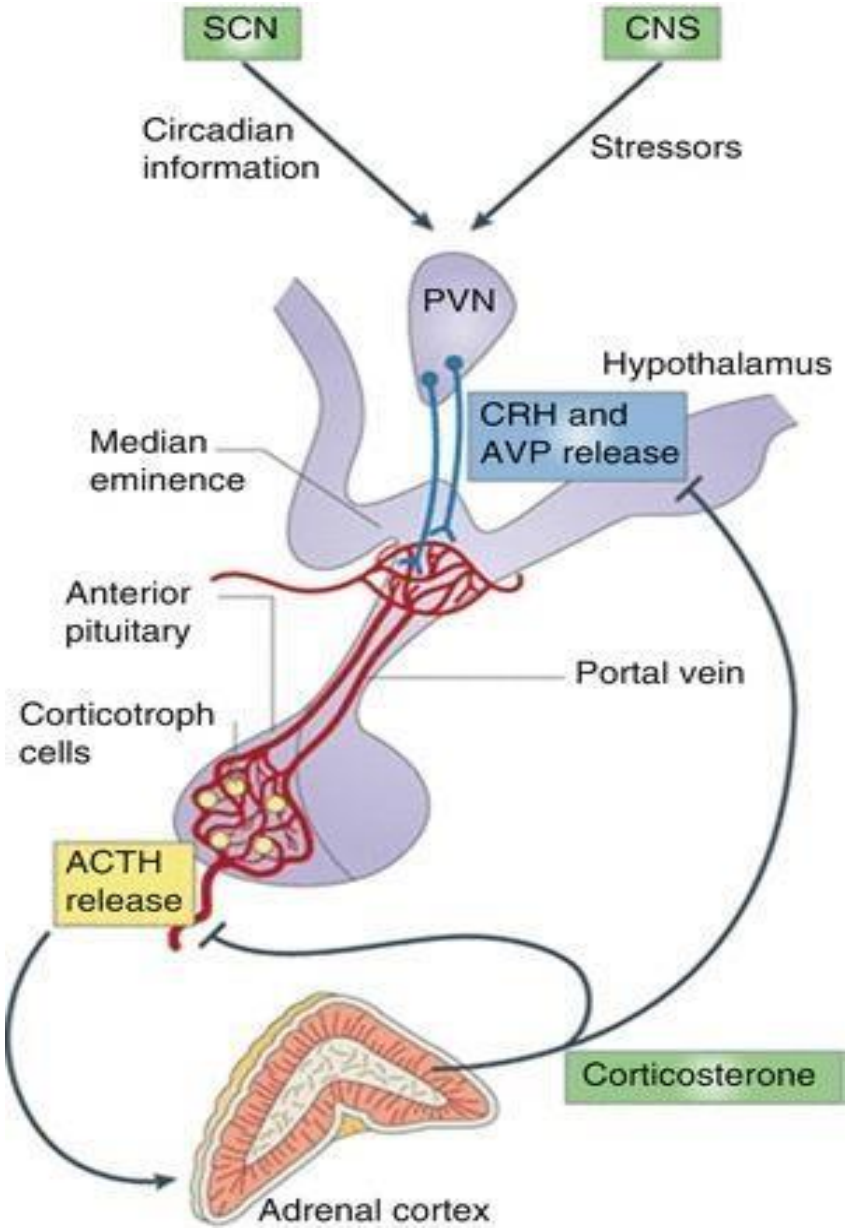
Physiologic Effects of Glucocorticoids

11-Anti-inflammatory effect:

a. **Stabilizes lysosomal membrane** ➔ ↓ release of proteolytic enzymes which cause inflammation.
b. **↓ release of proteolytic enzymes** ➔ ↓ capillary permeability ➔ prevent plasma loss into tissues.
c. **↓ migration of WBCs** into inflamed areas.
d. **↓ phagocytosis** of damages cells.
e. **↓ T-cells and antibodies**.
f. **Inhibit fibroblast activity** ➔ inhibit collagen deposition.
g. **↓ release of IL-1 from WBCs** ➔ lowers fever.

Control of Cortisol Secretion

- ✓ **Glucocorticoid secretion** is controlled by **hypothalamohypophyseal-adrenal axis**
- ✓ **Parvicellular neurosecretory** neurons located in the **medial basal hypothalamus** secrete CRH into the 1ry capillary plexus of the **hypothalamohypophyseal portal circulation** in the median eminence of the hypothalamus→ to the anterior pituitary gland, where it induces ACTH secretion.



Control of Cortisol Secretion

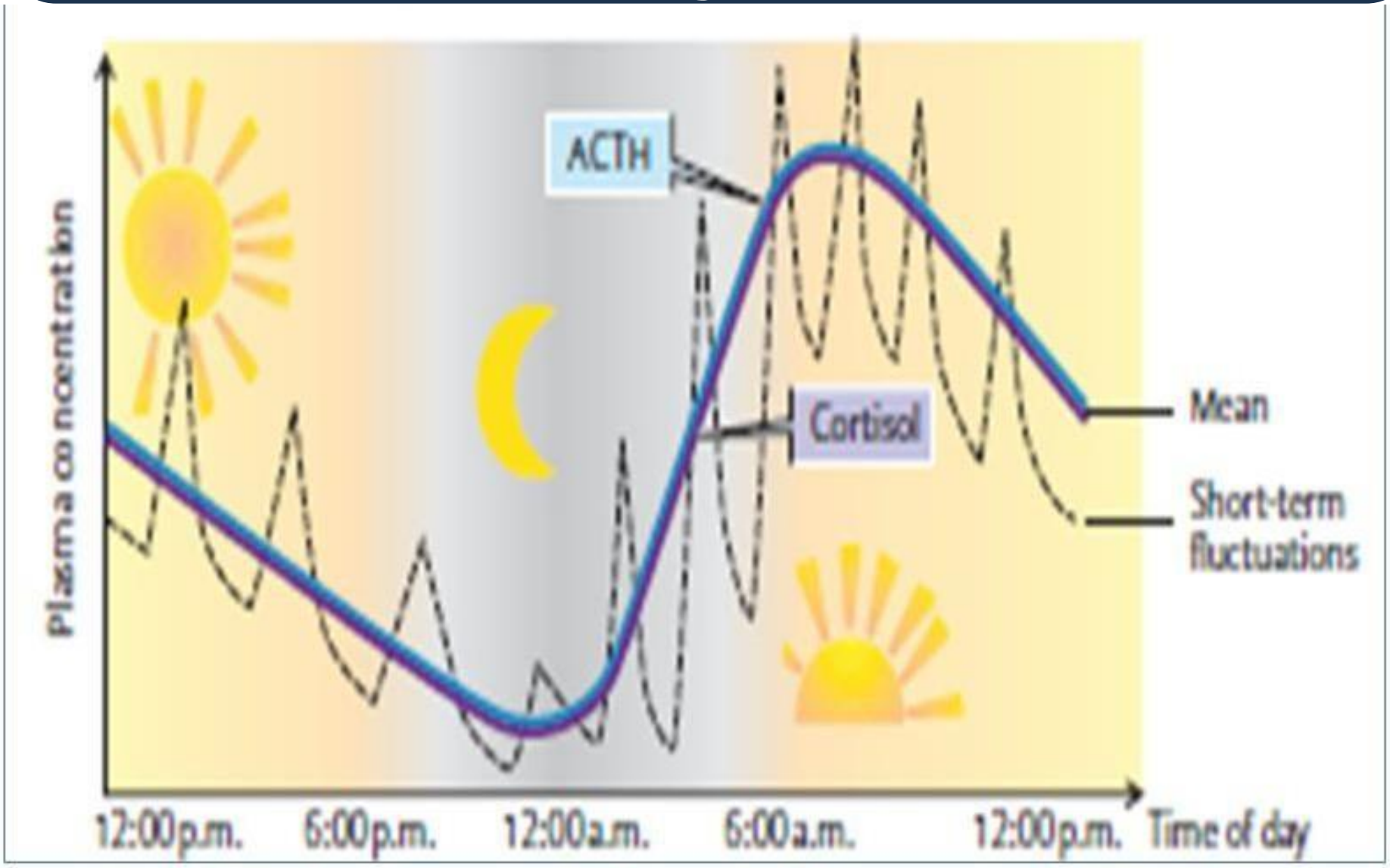
- ✓ **ACTH** is secreted from anterior pituitary gland in **pulsatile pattern** (**circadian rhythm)**

1. Pulses are **more frequent** in the early morning (4-8 AM).
2. Pulses are **least frequent** in the evening (8-10 PM) .

- ✓ **ACTH** stimulates the synthesis and secretion of glucocorticoids in adrenal cortex
- ✓ The cortisol has a **-ve feedback effect** on ACTH at the level of the pituitary gland and the hypothalamus.
- ✓ **This axis** can be stimulated by a wide range of **stress conditions** as;

1. Severe trauma, hemorrhage, surgery and shock
2. Hypoglycemia, burns, infections and chemical intoxication.
3. Exercise, psychological stress and cold exposure.

Circadian Rhythm of ACTH



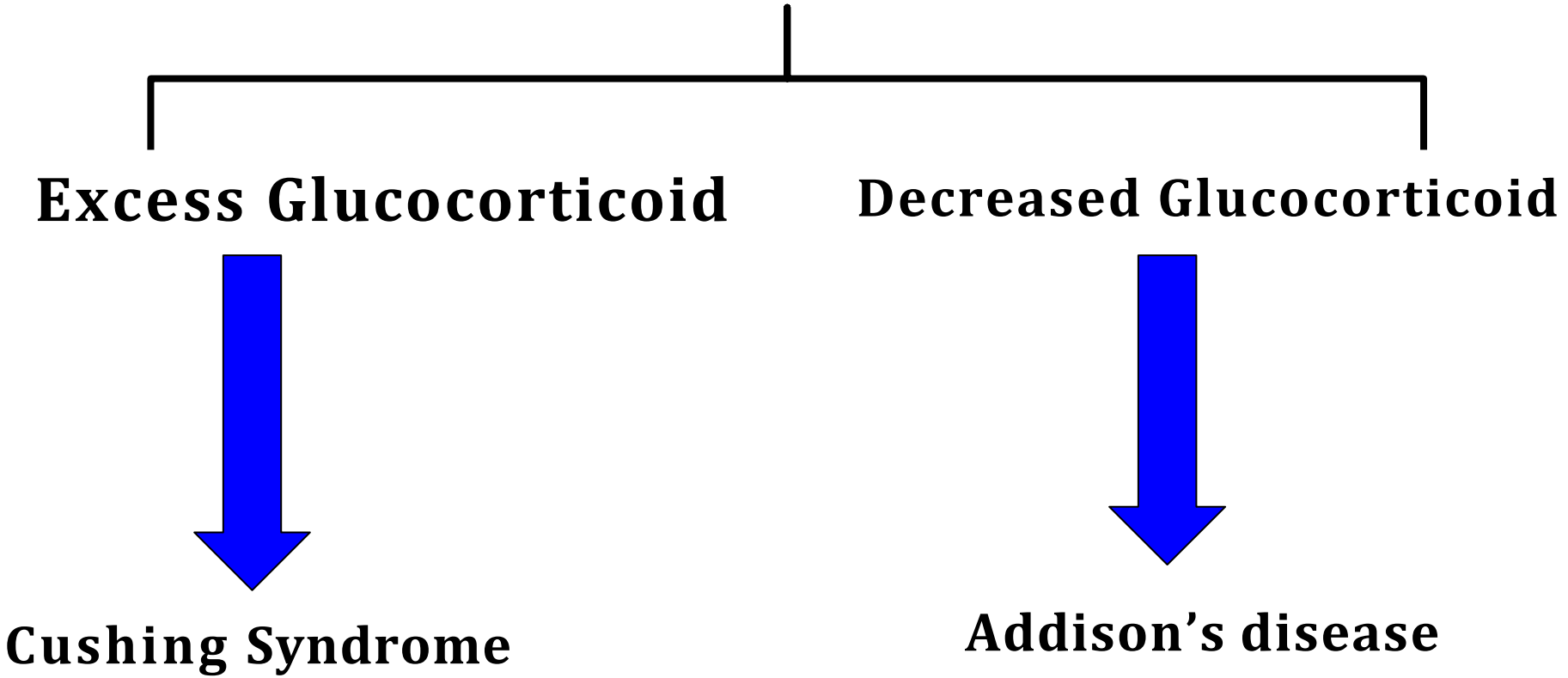
Circadian Rhythm of ACTH

- ✓ **ACTH** is secreted in **irregular pulses** throughout the 24 hr, the **plasma cortisol rises** and **falls** in response to these pulses.

In humans;

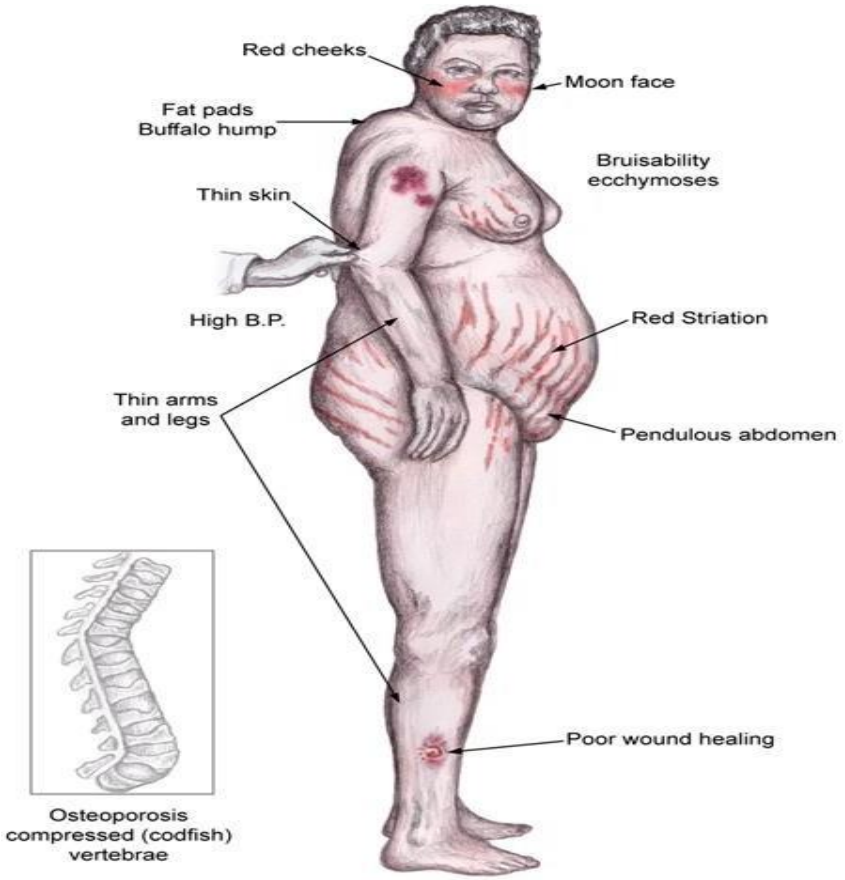
- ✓ Pulses are **more frequent early in the morning**, and about **75%** of the daily production of cortisol occurs **between 4 and 10 AM.**
- ✓ Pulses are **least frequent** in the **evening**.
- ✓ This **diurnal (circadian) rhythm** is related to **sleep hours** and is reversed if the sleeping hours are reversed.
- ✓ The **biological clock** responsible for the diurnal ACTH rhythm is located in the **suprachiasmic nuclei** of the hypothalamus.

Disorders of Glucocorticoid

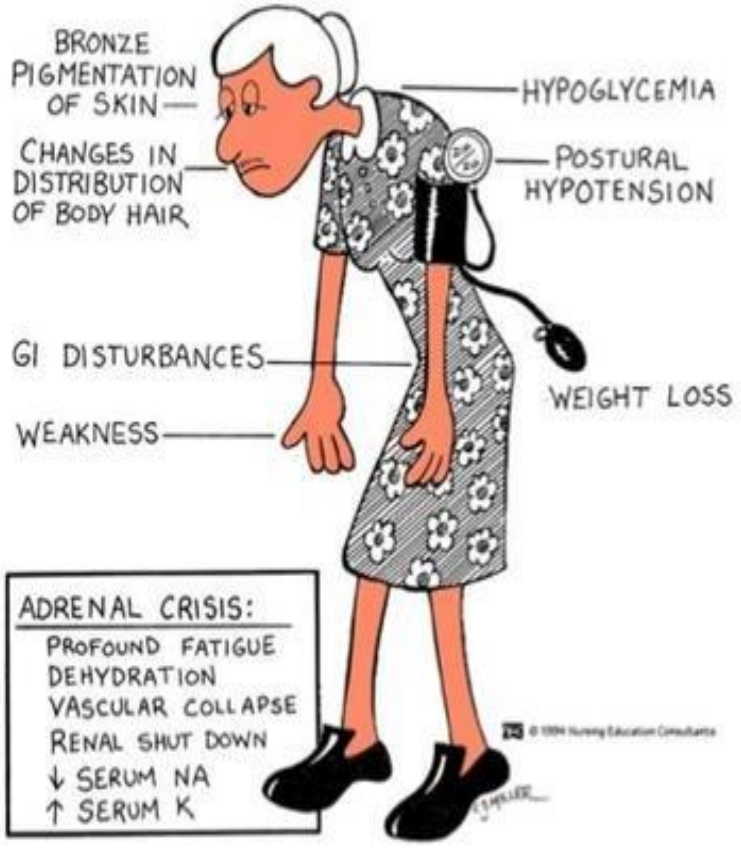


Disorders of Glucocorticoid

	Cushing's Syndrome	Addison's disease
Def.	Condition caused by excessive secretion of glucocorticoids.	condition caused by failure of secretion of adrenal cortical hormone
Manifestations	1. Hypertension and edema 2. Muscles wasting and weakness. 3. Osteoporosis → bones become fragile and easily fractured. 4. Purplish striae in skin. 5. Face→ becomes rounded (moon face) 6. Back of the neck → buffalo hump. 7. Trunk and abdomen → trunkal obesity. 8. Hyperglycemia 9. Peptic ulcers	1.Hypotension due to loss of Na and H2O in urine. 2.Hypoglycemia (↓ blood glucose) 3. Hyperkalemia 4.Metabolic acidosis 5.Muscles weakness 6.Dark pigmentation of skin and mucous membranes 5.↓ed BMR 6.Moderate anemia 7.Nausea, vomiting and diarrhea.



Cushing syndrome



Addison's disease

Adrenal Androgens

Source:

Zona reticularis

Types:

There 2 types of adrenal androgens;

a) **Dehydro-epiandrosterone (DHEA)**

b) **Androstenedione**

✓ Adrenal androgens have less than 20% of the androgenic activity of the principal testicular androgen testosterone.

Control of secretion: by

1. ACTH
2. Possibly by a pituitary adrenal androgen-stimulating hormone

✓ Pituitary gonadotrophins have no effect

Physiological Effects of Adrenal Androgens

1)In males,

They have **little effects** as compared with testicular androgens.

2) In females,

They have the following actions:

a) Appearance and maintenance of **pubic and axillary hair** and growth of the clitoris.

b) Protein anabolism which promotes **physical growth** especially in the pubertal phase.

c) ↑ed sebaceous glands secretion in skin → progress to **acne formation**.

Adrenogenital syndrome

Def.,

It is a condition caused by excessive secretion of adrenal androgens.

Cause:

Excessive secretion of adrenal androgens due to:

a. Congenital absence of enzymes in adrenal cortex during **the fetal life.**

b. Androgen-secreting tumors in the adrenal cortex → **in children and adults.**

Manifestations: depend on the sex and age of onset of the disease.

1) In the Fetus:

a. Male:

✓ Enlarged external genital organs →**macrogenitosomtiaprecox.**

b- Female:

✓ Development of male type external genitalia → **female pseudo-hermaphroditism.**

Adrenogenital syndrome

2) In Children:

a. Male:

✓ **Precocious pseudopuberty** i.e. male sex characters but without spermatogenesis.

b- Female:

✓ Virilism development of 2ry sex characters of male in a female

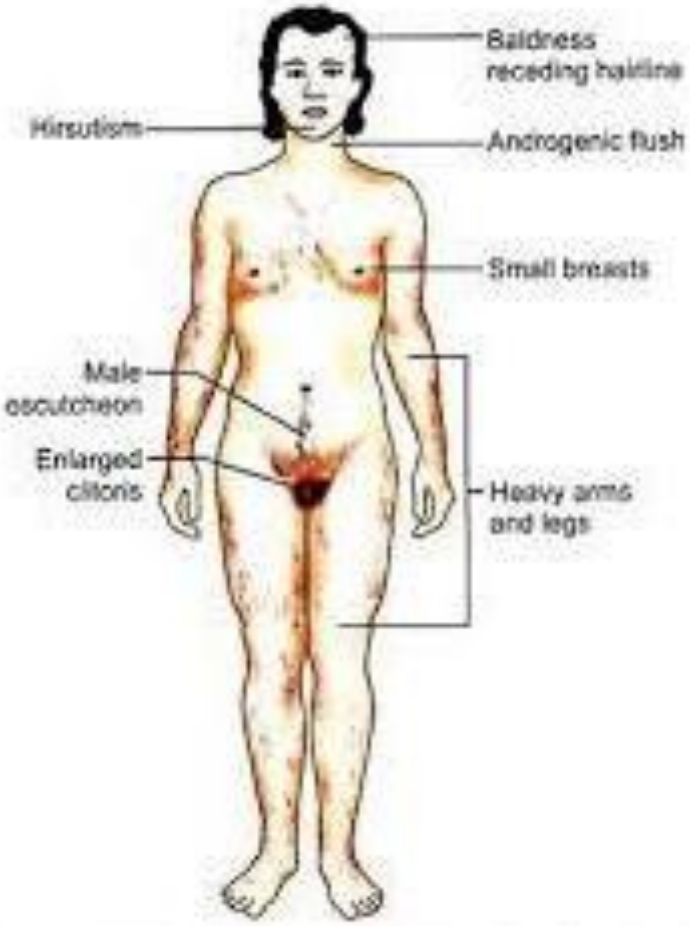
3) In adults:

a- Male:

✓ ↑ed masculinization and some ↑ in the sexual activity.

b. Female:

✓ Virilism



Adrenogenital syndrome

❖ Virilism:

• **Def:** development of **male secondary sex characteristics in female** due to excessive secretion of adrenal androgens.

• **Manifestations:**

1- ***Hirsutism:***
   a. Male distribution of hair in face, axilla, pubis and all over the body.
   b. Recession of scalp hair.
2- ***Deeping of voice***.
3- ↑ ***muscle bulk and power***.
4- ***Enlargement of clitoris***.
5- ***Atrophy of breast and external genital organs*** (***except clitoris***) due to suppression of estrogen action.
6- ***Amenorrhea***.
7- ***Psychological disturbance*** and homosexuality.

Any Questions

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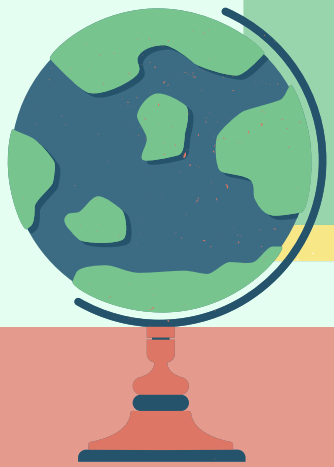


Thank
You