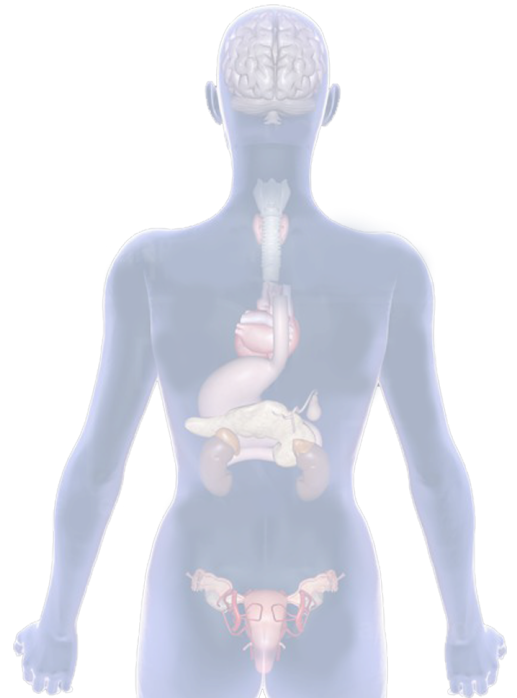

#10 Adrenal gland hormones(mineralocorticoids)

Objectives:

- The cellular arrangements and functional components of the adrenal gland.
- The hormones secreted by the medulla and cortex of the adrenal gland.
- The synthesis of the adrenocortical steroids.
- The physiological actions of aldosterone.
- The regulation of aldosterone secretion.
- The major stimuli for aldosterone secretion.



- Important
- Male's notes
- Female's notes
- Extra

Resources: 435 male's & female's slides + guyton

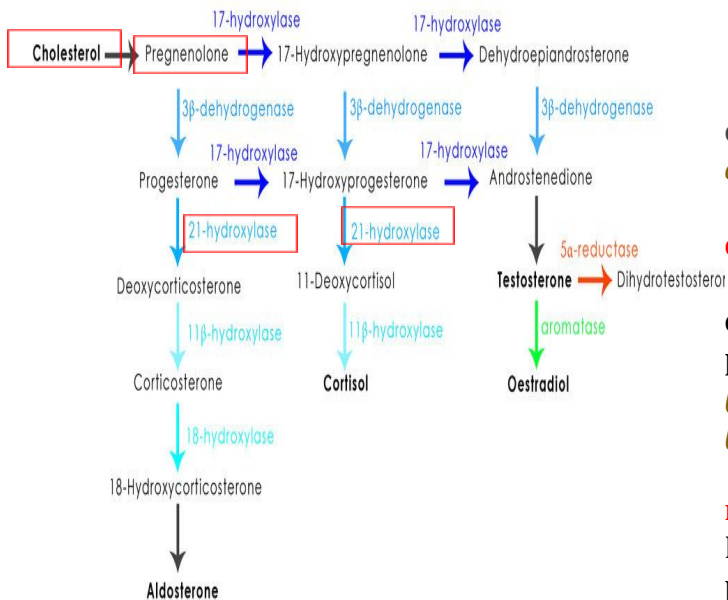
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Revised by

خولة العماري & هشام الغفيلي

Steroid hormone

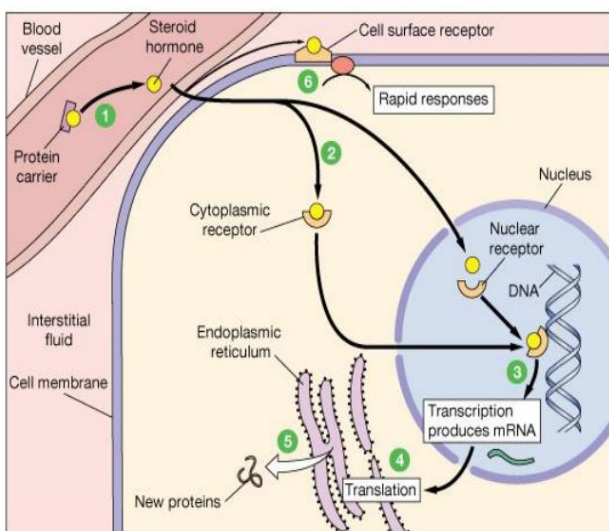
Synthesis



- Steroids are derivatives of cholesterol (*Cholesterol is from the lipid droplets in cortical cells*)
 - Steroid hormones are synthesized and secreted **on demand** (not stored in its producing gland).^٨ تذكر سؤال المبد
 - The first and rate-limiting step in the synthesis of all steroid hormones is conversion of cholesterol to pregnenolone by **the enzyme cholesterol side chain cleavage enzyme (SCC)**.
 - Newly synthesized steroid hormones are **rapidly** secreted from the cell
- Following secretion, all steroids bind to some extent to plasma proteins: **CBG (corticosteroid binding globulin) and albumin.**

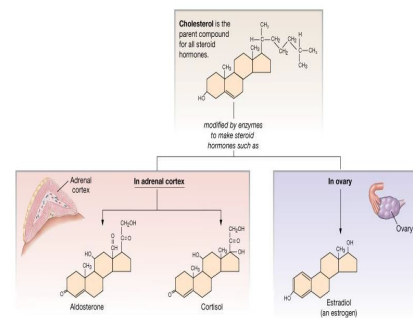
- **Steroidogenesis:** processes by which cholesterol is converted to biologically active steroid hormones. باختصار يعني هي العملية التي تخلي جميع الستيرويدات تصير اکتيف ستيرويد هورمون.
- **Genetic Defects in Adrenal Steroidogenesis:** leads to **Congenital adrenal hyperplasias:** Congenital adrenal hyperplasia (CAH) are any of several autosomal recessive diseases resulting from mutations of genes for enzymes mediating the biochemical steps of production of cortisol from cholesterol by the adrenal glands (steroidogenesis).
Eg:¹ 21-hydroxylase (P450c21) deficiency: → cortisol, corticosterone, and aldosterone deficiency
 → ↑ ACTH → Adrenal hypertrophy and high amounts of androgen → Virilization² of female (masculinization)
 تصنع الكورتيزول انعطب وبالتالي قل جازاد اي سي تي انتش، لازالت الغدة تفرز كمية قليلة، تتضخم لأجل تعوض الكمية من الناحية الثانية، الأندروجين ما صار له شيء لأن الإنزيم مو داخل في تصنيع الهرمونات اللي تحته فيصير له اوفر بروتكشن ويسبب الترجل عند المرأة.

Steroid Hormones Action



- 1 Most hydrophobic steroids are bound to plasma protein carriers. Only unbound hormones can diffuse into the target cell.
- 2 Steroid hormone receptors are in the cytoplasm or nucleus.
- 3 The receptor-hormone complex binds to DNA and activates or represses one or more genes.
- 4 Activated genes create new mRNA that moves back to the cytoplasm.
- 5 Translation produces new proteins for cell processes.
- 6 Some steroid hormones also bind to membrane receptors that use second messenger systems to create rapid cellular responses.

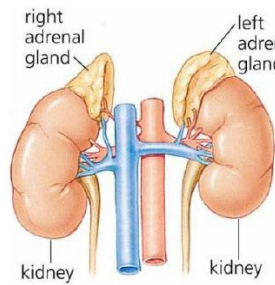
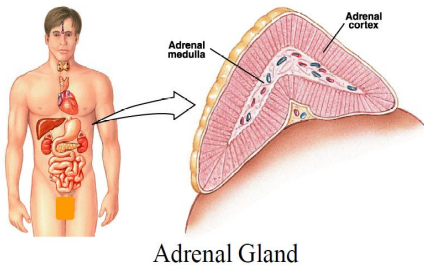
Structure



Cholesterol under the control of different enzymes in adrenal cortex is converted into cortisol and aldosterone, where in the ovary is converted into estradiol (estrogen).

¹ تقولك انه فيه انزيم اسمه 21 هيدروكسلايز مهم لتصنيع الكورتيزول والاندسترون بدون ما تصنع اما الاندروجين فما يحتاج هذا الانزيم ايدا ((، فاذا كان هالانزيم مومجد وششش بيصير اكد مب متصنع الكورتيزول والاندسترون لكن الاندروجين بما انه ما يحتاجه فيتصنع وكل الكلسترول بيتحول لاندروجين لانه الوحيد من الستيرويدات اللي الانزيمات المساعدة على تصنيعه سليمة

Overview of Adrenal gland



- There are two adrenal (suprarenal) glands that lie at the superior pole of the two kidneys.
- Small, pyramid-shaped.
- Weight 6-10 g
- Divided into two morphologically and distinct regions:
 - **Adrenal cortex:** true glandular tissue.
 - **Adrenal medulla:** modified sympathetic ganglia.

Overview of Adrenal cortex

Adrenal cortex:

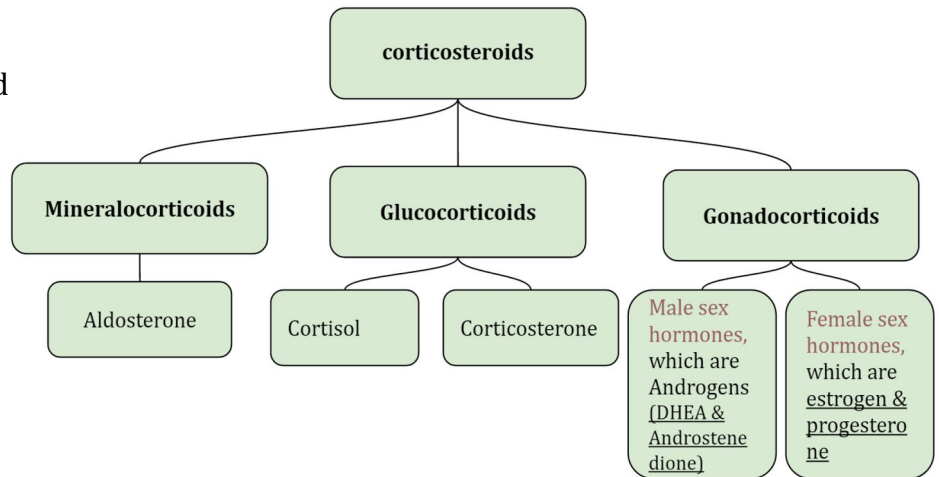
- It synthesizes and releases steroid hormones (corticosteroids).
- Different corticosteroids are produced in each of the three layers.

Hint for secretion S S S:

Salt: control Na,K By aldosterone

Sugar: from the name Glu... it play a role in gluconeogenesis (cortisol)

Sex hormone: responsible for sex hormone (androgen)



Region	Major hormone's group	Hormones
Zona glomerulosa Salt	Mineralocorticoids	Aldosterone
Zona fasciculata Sugar	Glucocorticoids	<ul style="list-style-type: none"> • Cortisol (mainly) • Corticosterone • Androgens(DHEA & Androstenedione) (small amount) • Estrogens (small amount)
Zona reticularis Sex	Gonadocorticoids	<ul style="list-style-type: none"> • Androgens(DHEA & Androstenedione)(mainly) • Estrogen (small amount) • Glucocorticoids(small amount)

Tissue area	Hormones released	Examples
Zona glomerulosa (adrenal cortex)	Mineralocorticoids (regulate mineral balance)	Aldosterone
Zona fasciculata (adrenal cortex)	Glucocorticoids (regulate glucose metabolism)	Cortisol, Corticosterone, Cortisone
Zona reticularis (adrenal cortex)	Androgens (stimulate masculinization)	Dehydroepiandrosterone
Adrenal medulla	Stress hormones (stimulate sympathetic ANS)	Epinephrine, Norepinephrine

NOTES about Hormones of adrenal cortex:

1- Cortisol is at 1000 fold higher concentrations than aldosterone

2- Corticosterone >>>>aldosterone

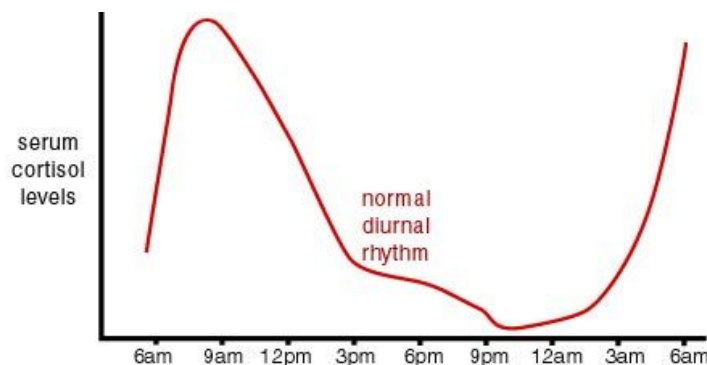
3- Cortisol binds well to the mineralocorticoid receptor.

Keep in your mind guys Cortisol has very low mineral activity (Na,K regulation) compared to Aldosterone , but because it has very high concentration it has its effect on mineral activity.

Aldosterone

Overview:

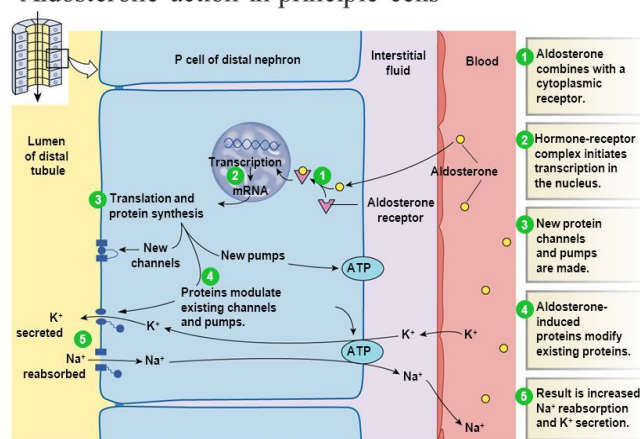
- The main mineralocorticoid produced by the adrenal gland.
- A steroid hormone.
- **Essential for life.**
- Synthesized in zona glomerulosa
- Aldosterone exerts 90% of all the mineralocorticoid activity.
- Target cells are called “principal (P) cell”.
- 60% of aldosterone bound to plasma protein...40% is free form.
- Half life: 20 min
- Much of secreted aldosterone is metabolized by the liver and converted to tetrahydroglucuroind derivative.
- Aldosterone levels fluctuate diurnally—highest concentration being at 8 AM, lowest at 11 PM, in parallel to cortisol rhythms.



Actions of aldosterone:

- **Renal action:** Acts mainly on the cells of the collecting ducts and distal tubules by Increases Renal Tubular Reabsorption of Na⁺ in the ECF and Secretion of K⁺ and H⁺ in the urine, **By:**
Increase transcription (synthesis) of Na⁺/K⁺ pump & Increase the expression of apical Na⁺ channels and Na⁺/K⁺ /Cl⁻ cotransporter.
- **Circulatory Actions:** Increases ECF volume and Arterial Pressure.

Aldosterone action in principle cells



Figure

- It also affects Na⁺ reabsorption by **sweat, salivary** and intestinal cells.

Abnormalities

Primary hyperaldosteronism (Conn's syndrome)	Complete failure to secrete aldosterone
<p>Cause: adenoma or nodular hyperplasia of zona glomerulosa → secretes large amounts of aldosterone.</p> <p>Effects:</p> <ul style="list-style-type: none"> • hypokalemia. • Occasional period of Neuromuscular manifestations (weakness, paresthesia, intermittent paralysis) caused by the hypokalemia, The paralysis is caused by a depressant effect of low extracellular potassium concentration on action potential transmission by the nerve fibers,. • slight increase in ECF volume and blood volume. • very slight increase in plasma sodium concentration. • Almost always hypertension. • decreased plasma renin concentration (from feedback suppression of renin secretion caused by the aldosterone or by the excess ECF volume and arterial pressure طبيعيا الرينين (وش يسوي يزيد ضغط الدم ويحفز افراز الالديسترون فإذا علت هالاشياء خلاص يوقف شغل). • Nocturnal polyuria & polydipsia . • Increased tubular (intercalated cells) hydrogen ion secretion, with resultant mild alkalosis → low free ca → tetany. <p>Treatment: usually surgical removal, Spironolactone (K sparing diuretic)..</p>	<p>If so, Dehydration → Low blood volume → low blood pressure → death (emergency)</p>

NOTE:

Conn's syndrome (primary hyperaldosteronism)	Secondary hyperaldosteronism
↓ plasma renin	<p style="text-align: center;">↑ plasma renin</p> <p>2ry hyperaldosteronism caused by extra adrenal cause such as (cirrhosis, ascites, nephrotic syndrome) → excess renin secretion leading to high aldosterone secretion. SO the main pathology is → excess renin secretion leading to high aldosterone secretion.</p>



Thanks to this amazing team!

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لينه عبدالله الشهري
رَبى السليمي
رزان السبتي
عمر الشهري