The Endocrine System

☑ Sheet ☐ Slide ☐ Handout

ANATOMY

Number:	5
Subject:	Adrenal gland
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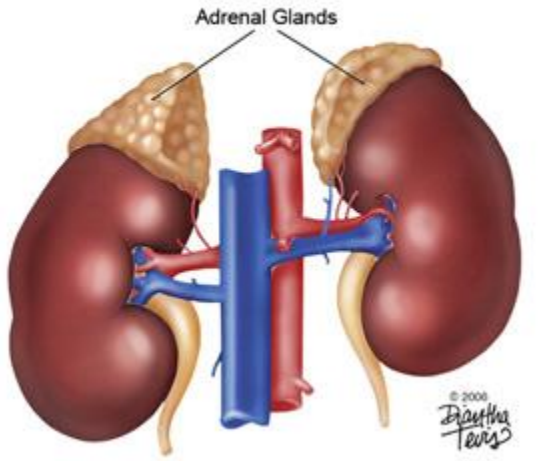
Price:	

Adrenal Gland

***This sheet was written according to the record of sec2, but in different arrangement.**

1.1- General overview:

Figure 1: Kidneys and Adrenal Glands



* There are two adrenal glands in our body; one in the right side and another in the left side.

* Anatomists usually refer to them as suprarenal glands, because of their location above to the kidneys.

* Each gland is further divided into two regions:

- outer adrenal cortex.

- inner adrenal medulla .

Each of these regions has its distinct embryological origin and specific secretions.

1.2- Embryology of the adrenal gland

*** First I will mention the whole story of development and then it will be summarized. So, don't worry if you don't understand the following.**

During the development of the fetus, certain structures and layers start to differentiate to give rise to many organs.

Two of these concerning our topic are:

1- Neural crest cells

2- Mesoderm

Cells migrate from both the neural crest and the notochord toward the dorsal aorta till they meet one another. Neural cells give rise to adrenal medulla inside and the mesoderm cells give rise to the adrenal cortex outside.

At early fetal life, the cortex is divided into two layers:

- outer definite cortex (thin)

- inner fetal cortex (thick)

Later on at puberty age the fetal cortex will be replaced by adult (definite) cortex and will differentiate into three zones (discussed later in this sheet).

1- zona glomerulosa.

2-zona fasciculata.

3- zona reticularis.

- Fetal adrenal hormones are important for maturation and development of the lungs and other developing organs.

A- Adrenal Cortex

- Formed at week 4 to 6
- Arise from mesoderm.
- Differentiate into three zones
- At puberty, it's transformed from having two layers (fetal and definite) into one definite layer

B- Adrenal medulla:

- Arises from neural crest cells
- Considered as a modified sympathetic ganglion that was arrested during cell migration. (This is because the sympathetic ganglion is also derived from the neural crest cells).

1.2.a-clinical correlate:

Extra-adrenal chromaffin tissue:

As cells migrate from neural crest to adrenal medulla, they might be arrested anywhere through its pathway. Since the tissue of adrenal medulla is called chromaffin tissue, any arrest through its migration will create extra-adrenal chromaffin tissue and secrete extra adrenaline and noradrenaline.

- Adrenaline acts on the heart to increase the heart rate, elevating the systolic BP (i.e. causing hypertension).
- Sometimes, a patient may present with hypertension and when you examine the medulla, it tests normal. At this point, you have to think of another problem, any try a urine sample. If the urine sample tests positive for VMA, the end product of catecholamines metabolism, there must be something that's similar to the adrenal medulla and doing the same action, which is the extra-adrenal chrmoaffin tissue.

1.2.b-clinical correlate:

Renal agenesis:

A medical term that refers to failure of formation of one or both of the kidneys.

Because the development of the kidneys is not related to development of the adrenal gland, any failure of formation of the kidney won't affect the formation of the suprarenal gland above it, but yet it will be formed in a different location >>this will be termed as **Ectopic adrenocortical tissue.**

Where each part of the adrenal gland may reside ectopically?

- The adrenal cortex :

It's derived from mesothelium so it would be found anywhere in the vagina, urinary bladder, ovaries.

-**The adrenal medulla:**

Derived from neural crest cells, so it would be found

1- along the paraortic sympathetic chain

2- inferior mesenteric artery (the last branch before the division of the abdominal aorta)

* Embryology is done ^^

1.3- Anatomy of the adrenal gland:

- The suprarenal glands are associated with the superior pole of each kidney.
- They are surrounded by perinephric fat and enclosed in renal fascia.
- A thin septum from the fascia separate each gland from its nearby kidney.
- It's a retroperitoneal structure (lying on posterior abdominal wall)
- If you want to reach it surgically, you have to go through the posterior abdominal wall.
- Located at the level of T12.

- Together weigh about 8 gm (differs from one individual to another and according to physiologic status and age).
- The diaphragm and kidneys are related to the liver at the right side and the spleen at the left side. Being larger than the spleen, the liver pushes the diaphragm upwards and the kidney downwards, which explains why the right kidney is present at a lower level than the left.

	Right adrenal gland	Left adrenal gland
Size	Smaller	larger
Shape	Pyramidal in shape	Semilunar (crescent) shape
Anterior relation	1- part of the right lobe of the liver 2- IVC (inferior vena cava)	1-part of the stomach 2-tail of the pancreas 3- sometimes the spleen
Posterior relation	Right crus of diaphragm superior pole of kidney	Left crus of diaphragm Aorta superior pole of kidney

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The Blood Supply and Venous Drainage.

- Important concept:
  Endocrine glands are rich in blood supply, because their function depends on delivering their hormones into the blood. That's why each gland is surrounded by a capsule, that sends septa through which lymphatics and capillaries pass into the internal parenchyma.
- The difference in shape is partly attributable to the difference in their venous drainage. The left drains into the left renal vein, while the right drains directly into the inferior vena cava.

- **Arterial Blood Supply**

Derived from branches from:

1- Abdominal aorta:

a- Superior suprarenal artery: a branch from the inferior phrenic artery.

b- middle suprarenal artery: direct branches from the abdominal aorta

2- Renal arteries:

c- inferior suprarenal arteries: branches from renal arteries (Right and left renal arteries).

	Right adrenal	Left adrenal gland
	Doesn't reach the hilum of the right kidney	Reaches the hilum of left kidney
	The hilum is directed upward	The hilum is directed downward

* The following is very important.

As the arteries enter the glands, they divide into many small branches called arterioles, these enter in various points.

They pass through the cortex in two different manners:

1- Cortical arterioles:

These arterioles branch and form capillaries and sinusoids that irrigate within the cortex and then pass to join medullary capillaries

- These are used for delayed responses

2- Medullary arterioles:

Penetrate directly to the adrenal medulla to form fenestrated capillaries there.

* Their action is mostly needed for fast responses as in fight and flight for secretion of adrenaline

- Venous drainage of the adrenal gland
We here notice two things:
1- We care a lot about the venous drainage of the gland because we only have one vein!
2- In contrast to the arterial supply we don't have symmetry in the right and left side so each will be discussed separately.

A- The right suprarenal vein: (DANGEROUS)

- it's very short
- almost immediately enter the posterior wall of the IVC
- pass superiorly

(must be careful with in surgery)

B- The left suprarenal vein :

- longer
- pass inferiorly
- enter the renal vein (the renal vein then enter the IVC)

within the gland, the capillaries and sinusoids form medullary veins (very small) which join and form suprarenal vein

*anatomy is done

1.4- Histology and function of the adrenal gland :

General functions of the adrenal gland:

* The adrenal glands functions to respond to stress
*Each part of it is responsible for responding to certain types of stress
For example:
If the body is responding to an acute stress, as seen in cases of fight and flight, then the adrenal medulla will be responding by secreting adrenaline.

Why adrenaline??
in acute stress> to say you're facing a speeding car>> you want to run>> this needs energy derived from glucose in the blood>>adrenaline increase blood pressure>> thus more blood flow to the muscles >> more glucose >> fast action

On the other hand, the adrenal cortex responds to daily stress, delayed responses by secreting glucocorticosteroids.

(This is in general; more will be discussed in physiology lectures)

Histology :

you can live without your adrenal medulla but you will definitely die without your adrenal coretx

1.4.a- Adrenal Cortex :

- Cells of the adrenal cortex show the typical features of steroid secreting cells
    1. Acidophilic cytoplasm rich in fat droplets
    2. Central nuclei
    3. profuse smooth ER (synthesis of cholesterol and steroids)
    4. spherical mitochondria

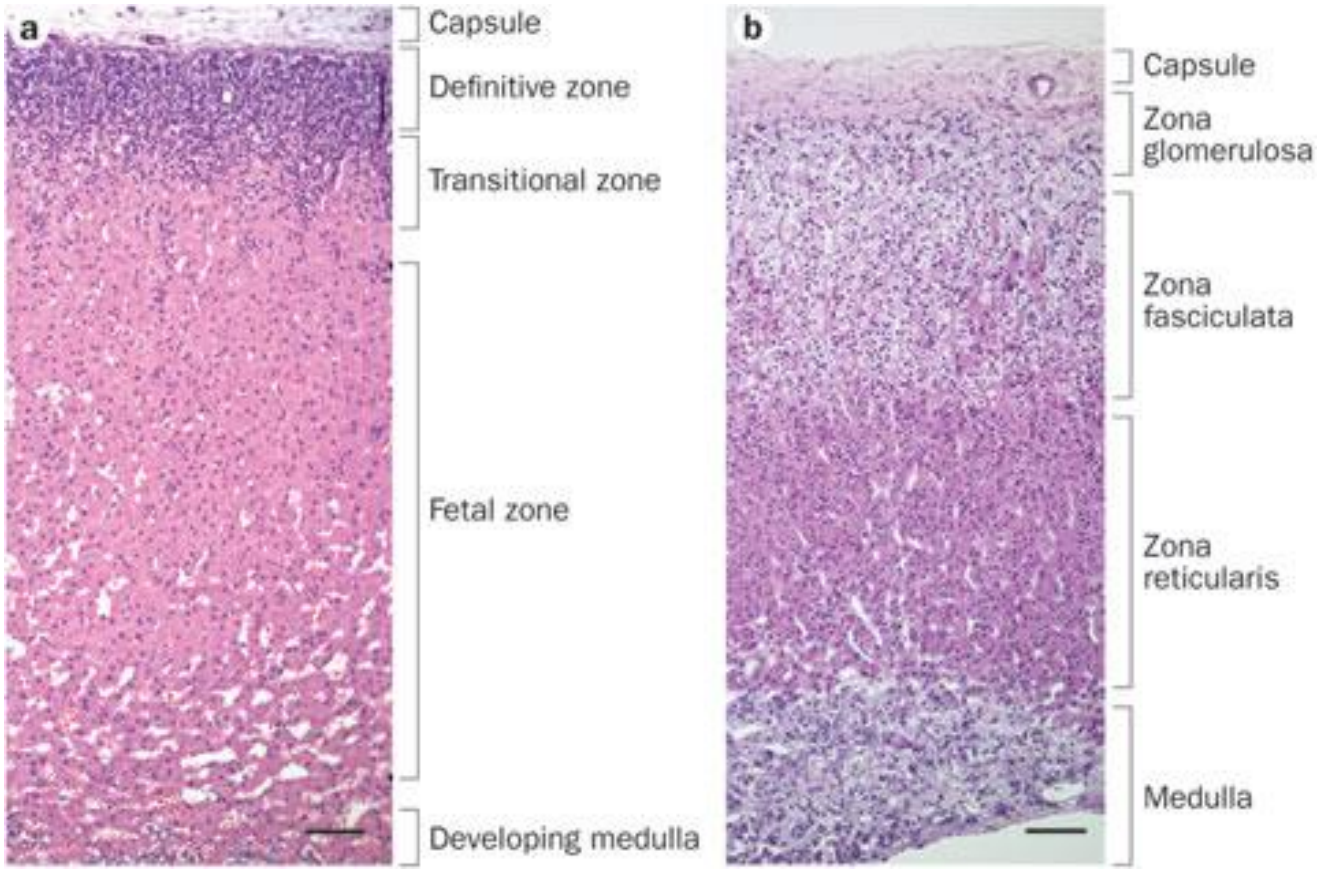
- Steroid hormones are small lipophilic molecules. They don't need to be packaged in granules, instead they diffuse freely through the plasma membrane.

The adrenal cortex is divided into three concentric zones according to:

1-their histological arrangement and morphology

2- type of hormone secreted

These zones are:



a- Fetal adrenal gland
b- Adult adrenal gland

1- Zona glomerulosa:

- immediately below the capsule
- 15% of the entire cortex
- closely packed rounded cells
- forming a circular pattern and they are surrounded by capillaries
- the hormone secreted is **Aldosterone**
- hormone function: sodium reabsorbtion in distal tubules

2-Zona fasciculata :

- under glomerulosa
- 65% to 80% of the cortex
- columnar cells
- the capillaries are found in a cytosol **between cells**
- filled with fat droplets and appear vacuolated
- secretes cortisol and small amounts of weak androgens
- functions of cortisol:

1. stimulate gluconeogenesis
2. glycogen synthesis in liver
3. Immunosuppressant.

3- Zona reticularis :

- 10% of the cortex
- small cells arranged in irregular cords
- the darkest area
- secrete androgens (sex hormones)

Clinical correlate

1- performing adrenalectomy :removal of the adrenal glands.
- Recently has been carried out by endoscopy rather than surgery.

- Patients are treated after the surgery with cortisone and aldosterone medications to maintain normal functions but not with androgens.
- This indicates that the function of these androgens isn't clear yet and doesn't affect the patient clinically.

Clinical Correlate

Male patients with adenoma in the reticularis layer show excess androgens and features of precocious puberty, whereas female androgens are protected, yet they might show some features but not as severe as males

1.4.b- Adrenal Medulla :

- large , poorly-stained cells
- arranged in clumps and surrounded by reticular fiber network
- sinusoidal capillaries between adjacent clumps
- few parasympathetic ganglion cells
- Its parenchyma is referred to as (Chromaffin cells)
- Contains granules that are dense in color for storage of (adrenaline and noradrenaline) *different from cortex
- granules for adrenaline are less dense than those of nor-adrenaline.
- Cells are stimulated by parasympathetic nerve endings for fast action

- In H&E stain it is very difficult to differentiate between cells that secrete epinephrine and cells that secrete norepinephrine , but it's very easy to distinguish them by electron microscope ,we use special stain to differentiate between 2 types of cells that secret epinephrine and norepinephrine Endocrine system adrenal gland & pancreas adjacent cells of adrenal medulla some secret norepeniphrine or noradrenalin the other secret adrenalin or epinephrine in electron microscope some permit electrons to pass through and appear light (electron lucent) , other don't(appear dark they reflect electrons back) …..electron dense noradrenalin secreting cells have Electron dense granules while adrenalin secreting cells are light in color (electron lucent) .

**These are the topics given by the doctor, the next pages contain clinical cases discussed by Dr.Darweesh and a **

" You Only lose when you stop trying ;) "

- These things will be discussed in pathology, so you can skip them.
- The following clinical applications are not corrected by the correction team.

-clinical applications:

A- **Cushing syndrome** ..hyper secretion of cortisol …

Clinical features:

1.you can see stretching marks on the skin (striae) . Some ladies during gestation can find marks on their abdomen because of abdomen enlargement. it form psychological◊ cortisol cause personality change

◊2.First of all disorder in those patients it can be◊ different touch ◊ skin is stretched

◊3.Moon face of the patient distinguished easily

. 4.Extremities are thin compared to their body gynecomastia(female breast like)

◊5.Breast enlargement in males patient will always suffer from

◊6.Disturbances in gastrointestinal tract hyperacidity ,because of continuous stimulation of the parietal cells of the stomach by coritsol

7.They might develop Osteoporosis consequently any minimal trauma which in normal condition won't affect normal people it will break a bone in that patient

. 8. easily bruised by any minimal trauma

9.Female complain from amenorrhea and when they have their period it will be spotting bleed rather than normal . hair grow in places not usual to grow

◊10.Abnormal distribution of hair in .

11- hypernitermia (increase in Na+ levels in the blood) and wherever sodium goes water follows and this explains the edema in these patients Endocrine system adrenal gland &

B- Adison disease…hyposecretion of cortisol

. Clinical feature:

1. Bronze pigmentation in his skin

2. Change in the Distribution of hair

3. Postural hypotension : Once he stand up after resting , if you measure the blood pressure before and after they got postural hypotension , when you are sleeping and get up suddenly you will feel drowsy so it's better to set down for a while then stand up , so the patient can't get up immediately because blood pressure will fall suddenly he is going to fall down .

4. GI disturbance

5. Weight loss because of low levels of coritsol since hypersecretion of cortisol cause weight gain then hyposecretion will cause the opposite.

6. They have weak musculature , they can't do an effort which other patient can get fatigue easily .◊people find very easy

7. Hyponatremia and hyperkalemia : because the physiological function of cortisol is to preserve sodium in the blood , when cortisol go down -< Potassium will go up to compensate for sodium loss (hyperkalemia)

pheochromocytoma PCC (clinical application)

it is a neuroendocrine tumor of the adrenal medulla that secret

enormous amounts of epinephrine .

-patients look thin you can never ever find an obese patient

-they suffer from hypertension ..hypersecretion of adrenalin and nor adrenalin