

بِسْمِ اللَّهِ الرَّحْمَنِ الرَّحِيمِ
(وَفَوْقَ كُلِّ ذِي عِلْمٍ عَلِيمٌ)



Endocrine Anatomy, Histology & Embryology | MID 2

Adrenal Gland



Written by : Bushra Masalha
Rzan Al-adhami

Reviewed by : Nadeen Rawajfeh

Adrenal Gland (Suprarenal gland)

A hybrid gland: which mean two glands in one organ (2in1) , two differ function and origin : cortex/ Medulla.

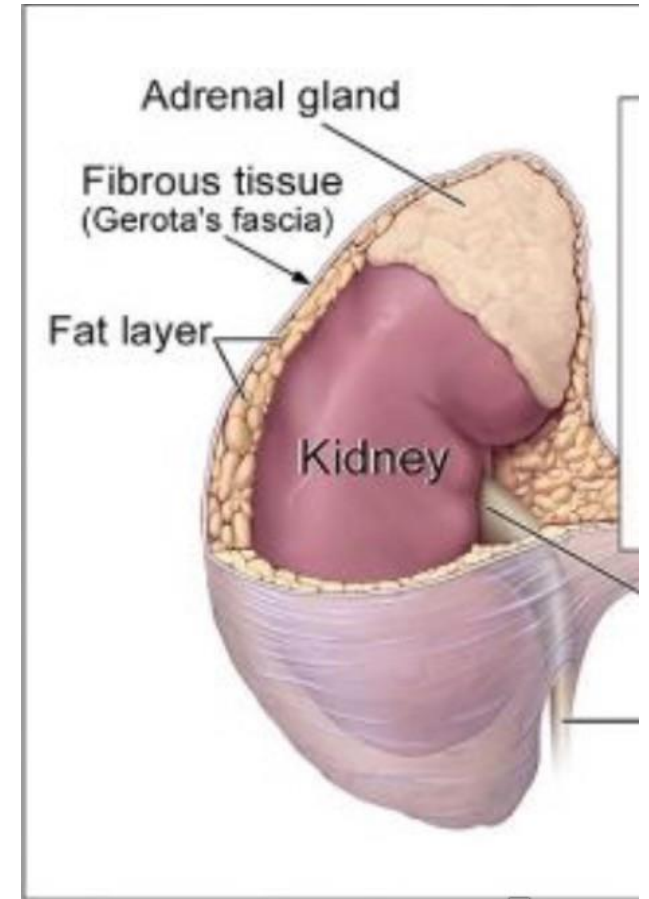
Adrenal Gland

- Yellowish retroperitoneal organs that lie on the upper poles of the kidneys

Retroperitoneal means: out side peritoneum, they rest on the diaphragm (posterior abdominal wall).

The kidney contain three layers: Capsule, Fat (around the kidney), Fascia.

- Suprarenal glands Surrounded by renal fascia.
So during kidney surgery may expose the adrenal_glands.
- Separated from the kidneys by the perirenal fat.
- Has a yellow cortex and a dark brown medulla .
They differ in color, differ in function also differ in the origin.
- lacks a hilum; **as consequence the vessels will enter from different location** suprarenal arteries arising from larger abdominal arteries penetrate the capsule independently.
Hilum : is a depression as port of entry and exit (like in the liver and spleen).



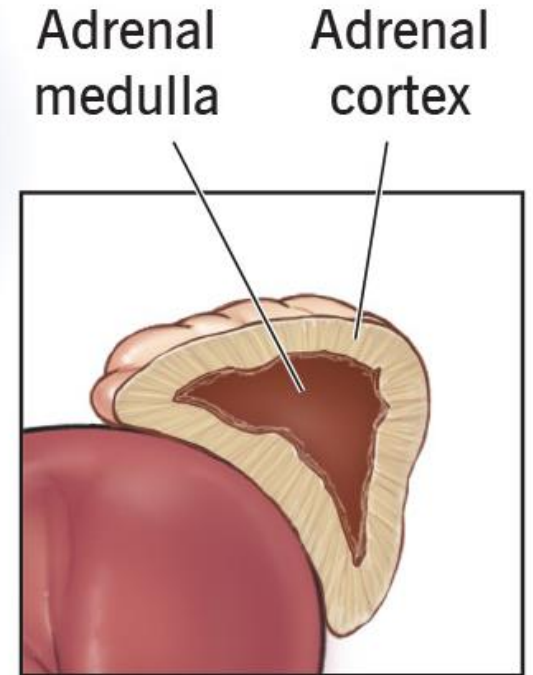
The cortex secretes:

- **Three different category of secretion from three differ cells from three differ layers(Zones).**
- **Mineral corticoids:** control of fluid and electrolyte balance.
- **Glucocorticoids:** control of the metabolism of carbohydrates, fats, and proteins.
- **Sex hormones** (small amounts): probably play a role in the prepubertal development of the sex organs.

The medulla secretes (**Inner most**)

Completely differ from the cortex

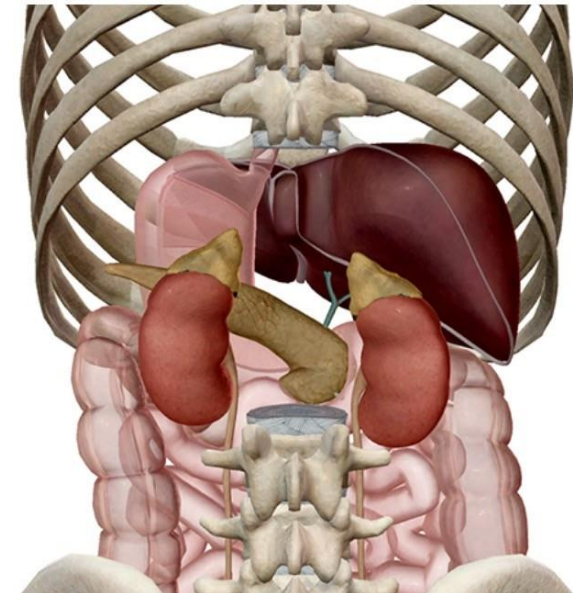
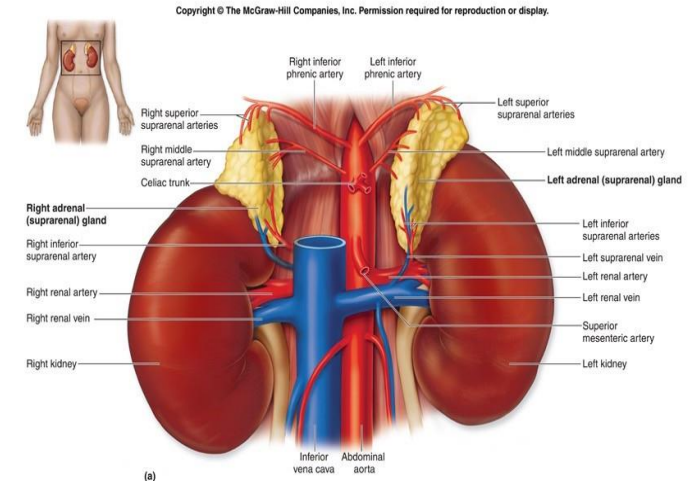
- **Catecholamines** epinephrine and norepinephrine.



Location and Description

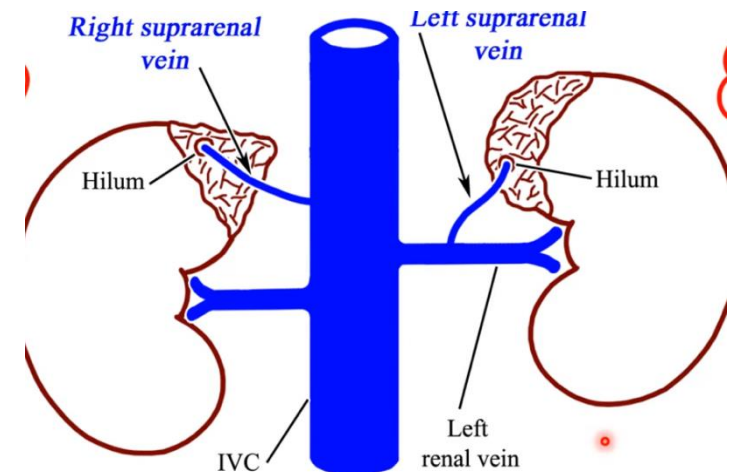
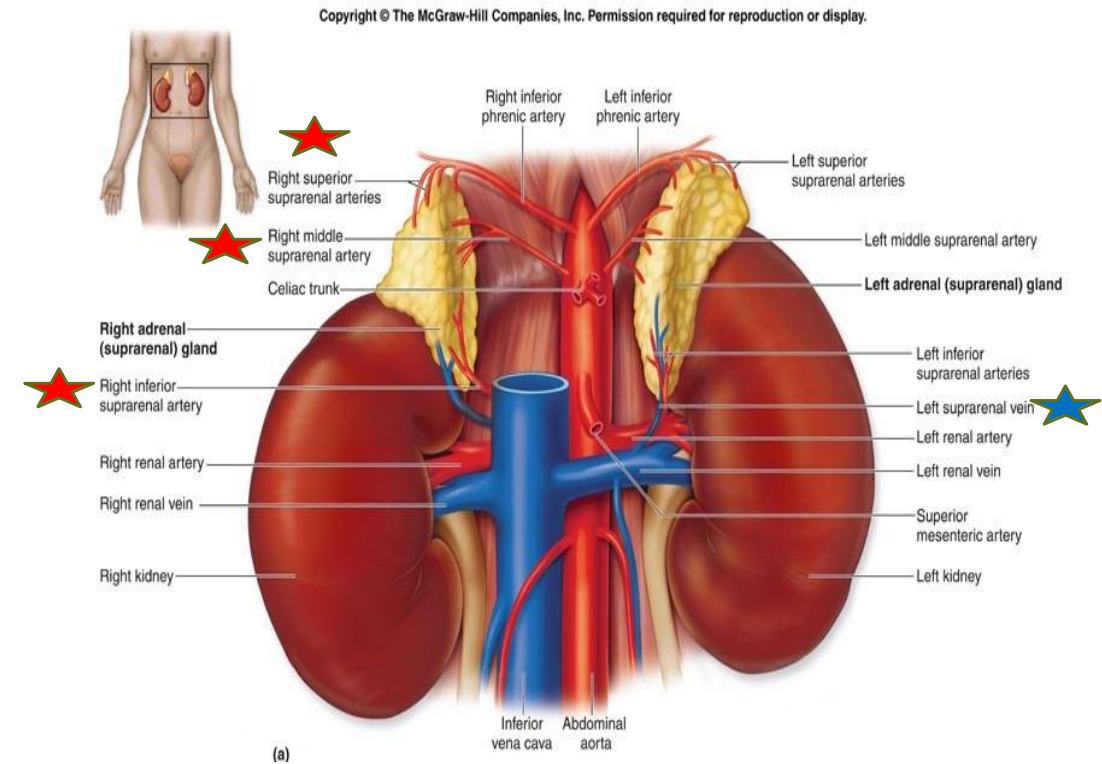
- The **right** is pyramidal in shape.
- Caps the upper pole of the right kidney.
- **Anterior relations:** It lies behind the right lobe of the liver extends medially behind the IVC.
- Rests posteriorly on the diaphragm.
- The **left** is crescentic in shape:
- Extends along the medial border of the left kidney from the upper pole to the hilum.
- **Anterior relations:** It lies behind the pancreas, the lesser sac, and the stomach
- Rests posteriorly on the diaphragm.

Posterior view



Blood supply

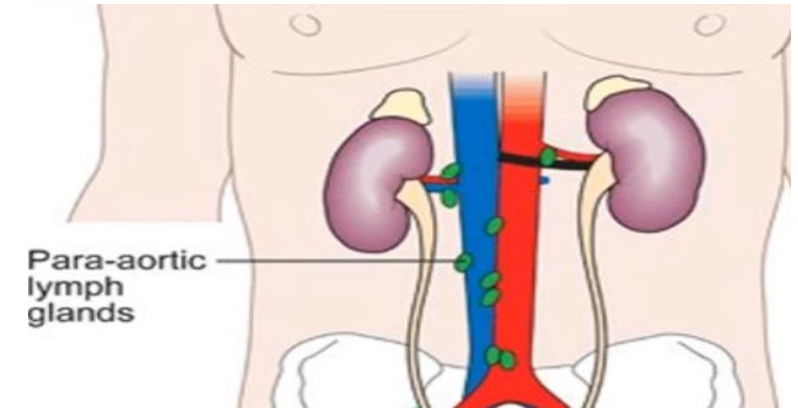
- A superior suprarenal artery (inferior phrenic artery)
- **it relate to diaphragm**
- A middle suprarenal artery (**Abdominal** aorta).
- An inferior suprarenal artery (renal artery).
- **These three Suprarenal arteries enter the gland ,pass beneath the capsule and get branch form subcapsular arterial plexus(inferior ,middle,superior) which ensures a rich blood supply to the cortex and medulla .**
- A single **vein** emerges from the hilum (base) of each gland and drains into the IVC on the right and into the renal vein on the left.



Nerve Supply & Lymphatic Drainage

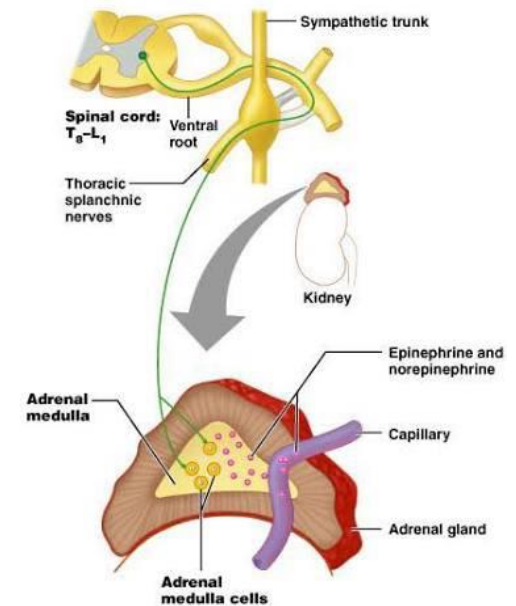
Lymph drainage :

- Do as Immune function contain (T,B lymphocytes ,antigen presenting cells).
- The lymph drains into the lateral aortic nodes.



Nerve supply :

- Preganglionic sympathetic fibers derived from the splanchnic nerves supply the glands. Most of the nerves end in the medulla of the gland.

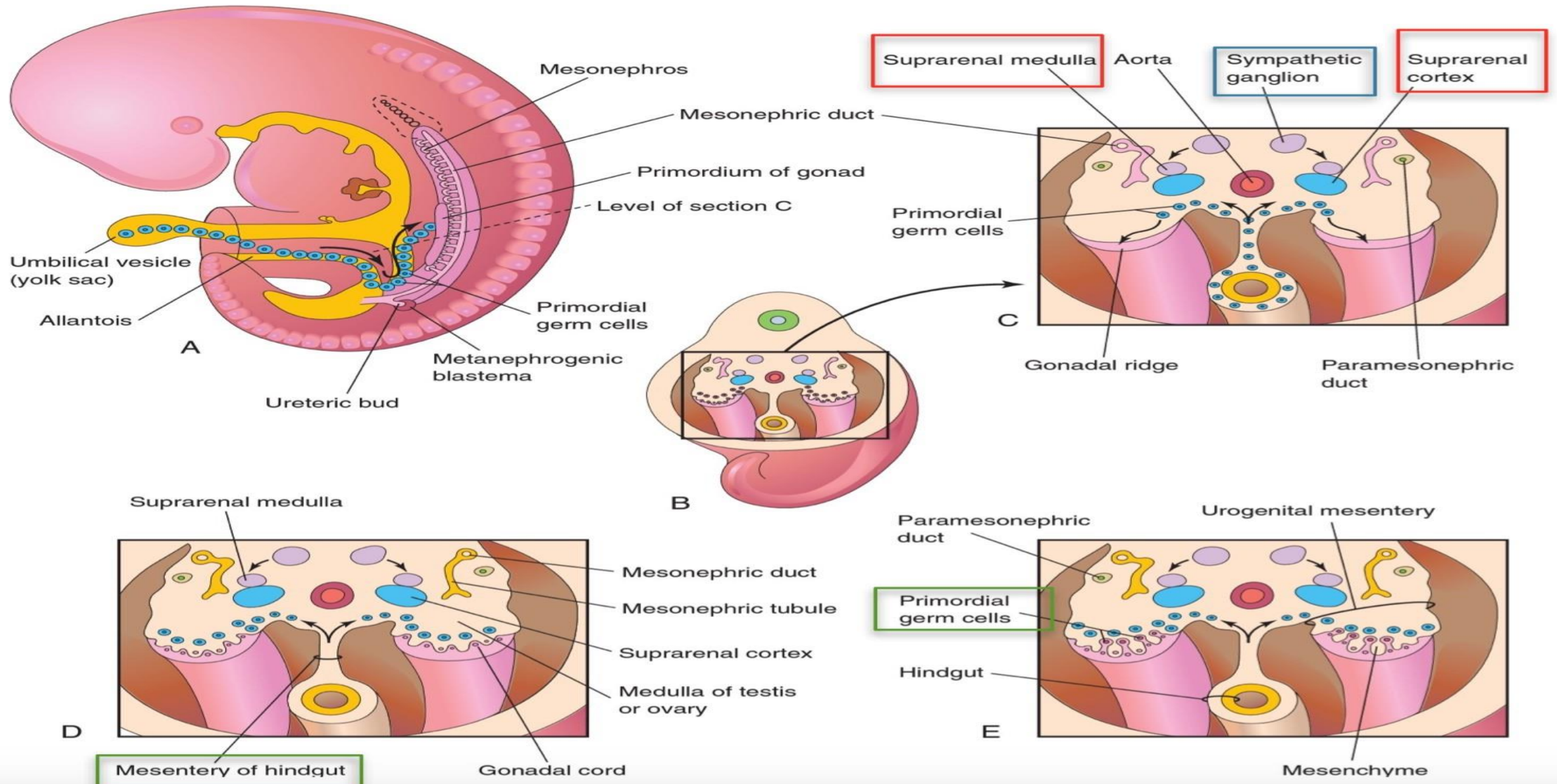


Not included!!

Organogenesis--cortex

- Develops from two components: a mesodermal portion---cortex, and an **Neuro**ectodermal portion----medulla.
- During the 5th week, mesodermal cells between the root of the mesentery and the developing gonad
begin to proliferate and penetrate the underlying mesenchyme (adrenal-gonadal primordial germ cells).
- Here, they differentiate into large acidophilic organs, which form the **fetal cortex, or primitive cortex**.
- Shortly afterward a second wave of cells (smaller) from the mesothelium penetrates the mesenchyme and surrounds the original acidophilic cell mass--- **definitive cortex** of the gland.
- **After birth** the fetal cortex regresses rapidly (**largely completed in the first few weeks of life**) except for its outermost layer, which differentiates into the reticular zone.
- The adult structure of the cortex is not achieved until puberty.

Organogenesis



Organogenesis

- There will be **three migration of cells** (two for the cortex, one for medulla)

❑ **First wave of cells :**

- During the embryonic development, in the area between the **root of mesentery** of the **hind gut** and the **gonadal ridge** , **mesodermal cells arise and migrate to the future Suprarenal location** which forming the primitive cortex one layer (reticularis) – around 5th week.

❑ **Second wave of cells :**

- **Neural crest cells** will also migrate at the same time with mesodermal cells and merge together not completely (one in forming the core (medulla) , the other is coating (cortex)).

❑ **Third wave of cells :**

- Another mesodermal migrate forming two layer (glomerulosa, fasciculata) of definitive cortex hugging the primitive and medulla
- primitive near to medulla.



Organogenesis--Medulla

The medulla has a neuroectodermal (ectodermal/neural crest cells) origin because of the nerves (as it's derived from the central nervous system).

- While the fetal cortex is being formed, cells originating in the sympathetic system (sympathochromaffin cells — **come from** ->neural crest) invade its medial aspect, where they are arranged in cords and clusters—7th week.

It used to be postganglionic but it shed its axons and dendrites and retained its preganglionic synapsing ability!!!! [\(To understand more click me!\)](#).

- These cells give rise to the medulla.
They stain yellow-brown with chrome salts and hence are called chromaffin (**modified postganglionic neurons**).
- The medulla comes to occupy a central position and is arranged in cords and clusters.
- Preganglionic sympathetic nerve fibers grow into the medulla and influence the activity of the medullary cells. **Excitation of chromaffin cells is by preganglionic neurons.**

- Sympathetic postganglionic neurons migrate to help form the adrenal gland, integrating into the mesodermal tissue that becomes the cortex. Because they can no longer function as typical neurons in this new location, they lose their axons and dendrites – structurally, they're no longer classified as neurons. However, functionally they retain the ability to release epinephrine and norepinephrine – but now **as hormones** secreted into the bloodstream, rather than as neurotransmitters released across a synapse.
- They still receive synaptic input from preganglionic fibers. During acute stress, these preganglionic neurons release acetylcholine, which triggers the immediate release of catecholamines (epinephrine and norepinephrine) into the blood.
- Because of this direct autonomic wiring, the medulla is considered under **ANS control**, not ACTH. ACTH instead acts on the cortex, stimulating it to release its own hormones. ACTH itself is secreted by corticotrophs in the anterior pituitary.

Organogenesis

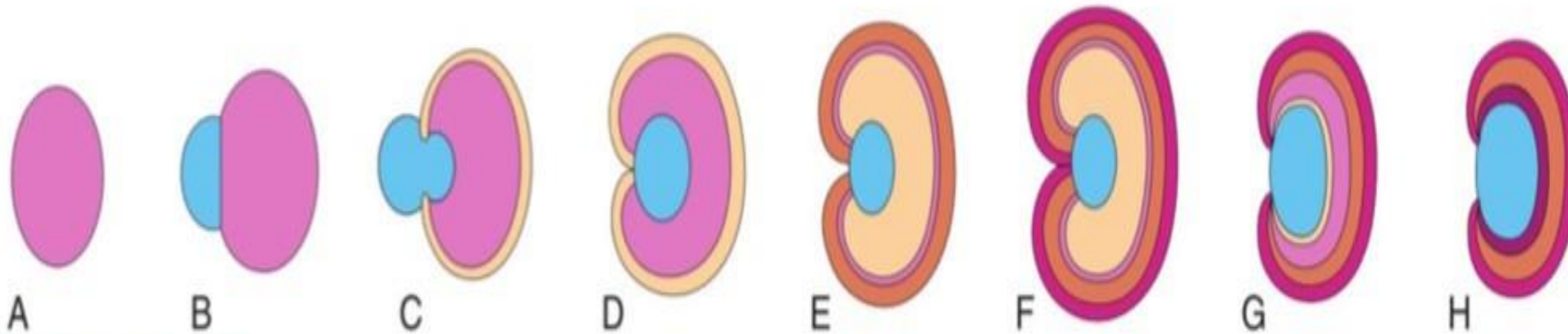
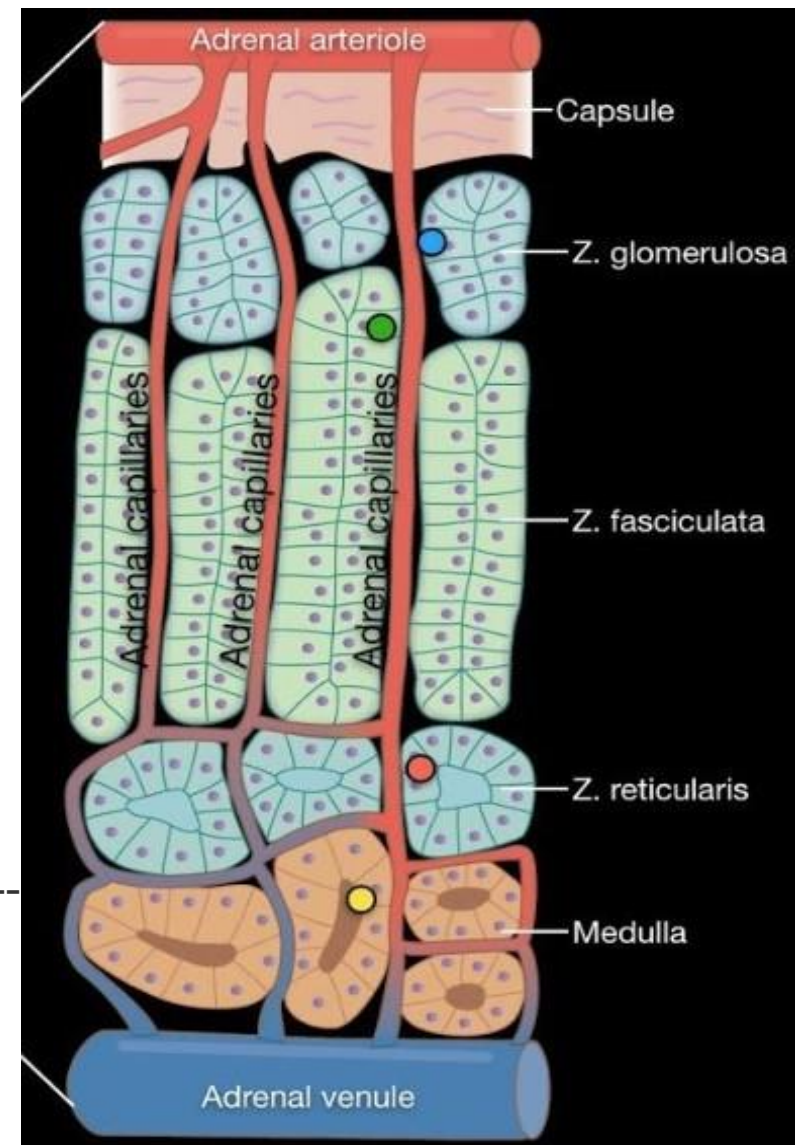


FIGURE 12-27 Schematic drawings illustrating development of the suprarenal glands. **A**, At 6 weeks, showing the mesodermal primordium of the fetal cortex. **B**, At 7 weeks, showing the addition of neural crest cells. **C**, At 8 weeks, showing the fetal cortex and early permanent cortex beginning to encapsulate the medulla. **D** and **E**, Later stages of encapsulation of the medulla by the cortex. **F**, Gland of a neonate showing the fetal cortex and two zones of the permanent cortex. **G**, At 1 year, the fetal cortex has almost disappeared. **H**, At 4 years, showing the adult pattern of cortical zones. Note that the fetal cortex has disappeared and that the gland is much smaller than it was at birth (**F**).

Histology

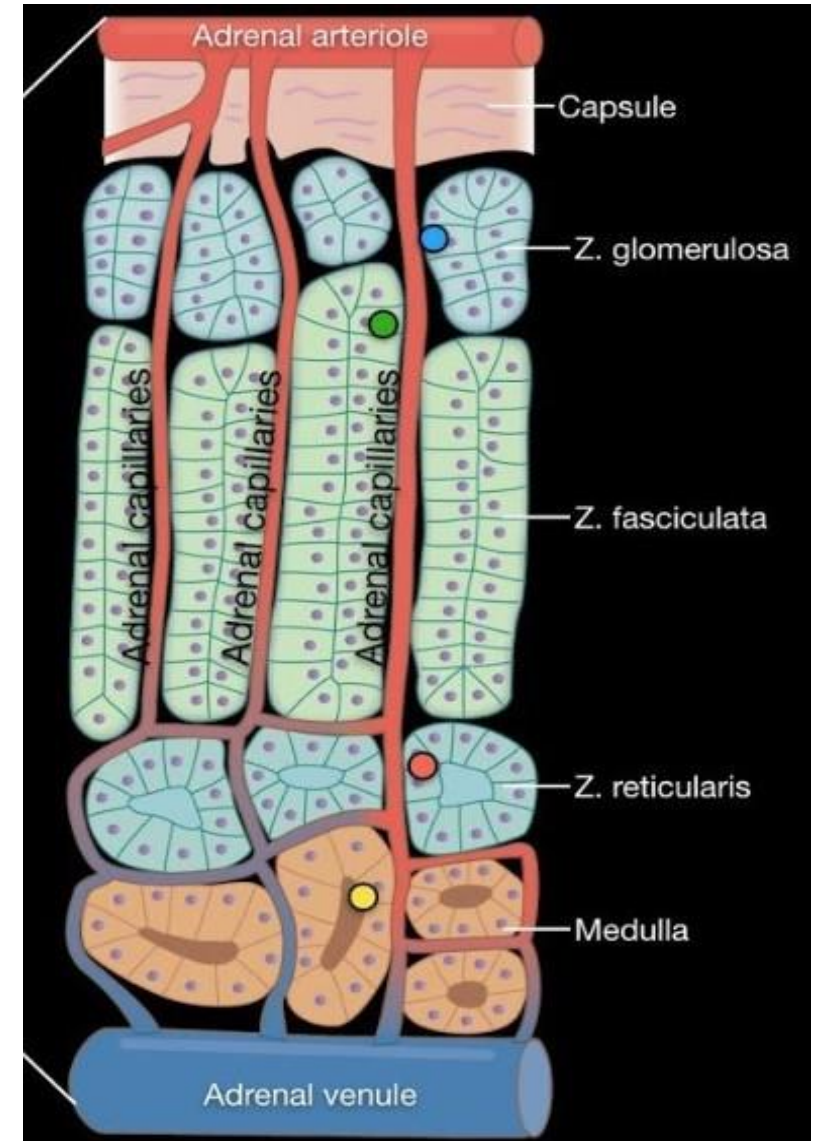
- The adrenal gland exhibits a distinct histological color difference: **the cortex appears lighter, while the medulla appears darker**, consistent with their differing cellular composition and vascularity.
- Arterial supply to the adrenal gland is derived from three sources – the **superior, middle, and inferior suprarenal arteries**. These vessels penetrate the gland capsule at multiple points and anastomose to form a **subcapsular arterial plexus**. From this plexus, small arteriolar branches (of smaller caliber than the parent arteries) descend to supply both the cortex and medulla independently, with each layer receiving its own dedicated arteriolar branches.
- Cells of cortex and medulla are grouped in cords along wide capillaries.
- Suprarenal arteries ----- subcapsular arterial plexus.
- From this plexus arterioles for the adrenal cortex and Medulla emerge separately----- networks of fenestrated capillaries and sinusoids.
- Cortical capillaries irrigate endocrine cells then drain into the medulla.
- The medulla ----- dual blood supply:
- Venous drainage from the glands occurs via the suprarenal veins



Histology

❖ Venous drainage:

- For the cortex it goes to the medulla.
- The medulla receives dual blood supply (its own arterial and via venous drainage of cortex).
- In histology you will see it as wide veins within the medulla.
- Now how many veins do I have? One, coming from the base or the inferior aspect of the gland (**One adrenal vein per gland**):
 - 1) Right adrenal vein → inferior vena cava (IVC).
 - 2) Left adrenal vein → left renal vein (often after joining the left inferior phrenic vein).



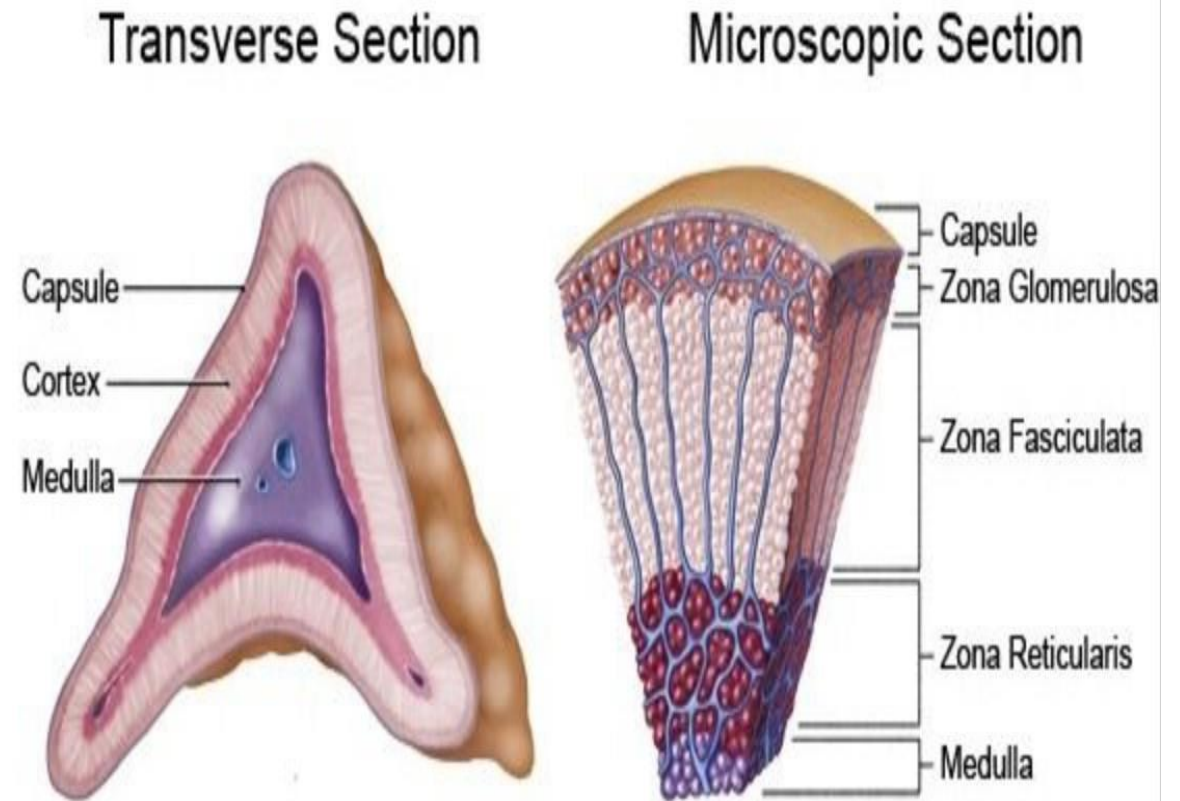
Adrenal Cortex

- Steroid-secreting cells: **acidophilic** cytoplasm rich in lipid droplets, with central nuclei.
- Profuse **SER** of interconnected tubules, which contain the enzymes for cholesterol synthesis and conversion of the steroid prohormone pregnenolone into specific active steroid hormones.
- The **mitochondria** are often spherical, with **tubular** rather than shelflike cristae
- The function of steroid-producing cells involves close collaboration between SER and mitochondria.
- The cortex releases corticosteroids (steroid(lipid) based hormones).
- Now as we learned when lipids are involved, the cytoplasm will appear like foamy, clear, empty and washed out by solvent use during tissue preparation, nuclei are centrally located.
- When we say fat/lipid based type of secretion we see SER and lots of ATP so we need mitochondria.
- (Protein based we see RER and the cytoplasm is dense)



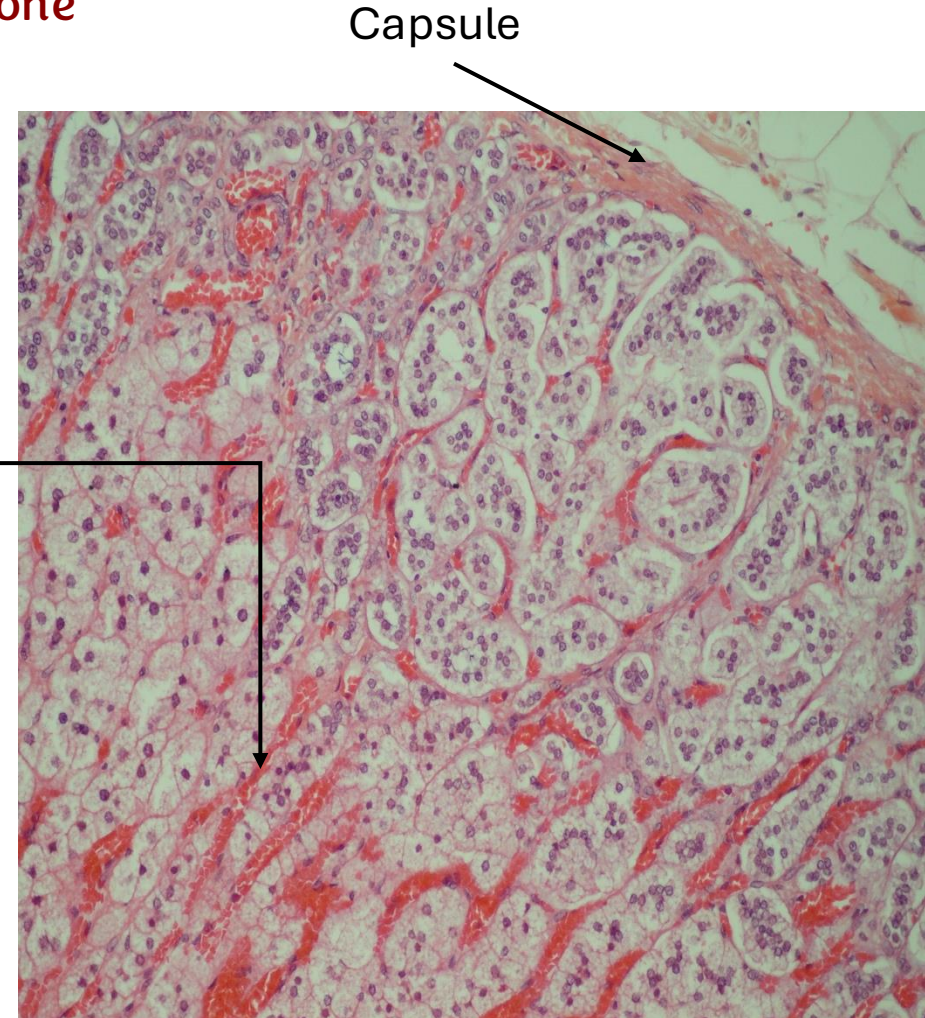
Adrenal cortex

- Steroid hormones are not stored in granules
---- small lipid-soluble molecules, steroids diffuse freely from cells.
- The adrenal cortex has **three concentric zones** :
 1. **Zona glomerulosa (OUTER, kinda small, come from definitive cortex).**
 2. **Zona fasciculata (BIGGEST, comes from definitive cortex).**
 3. **Zona reticularis (innermost, comes from leftover primitive cortex).**



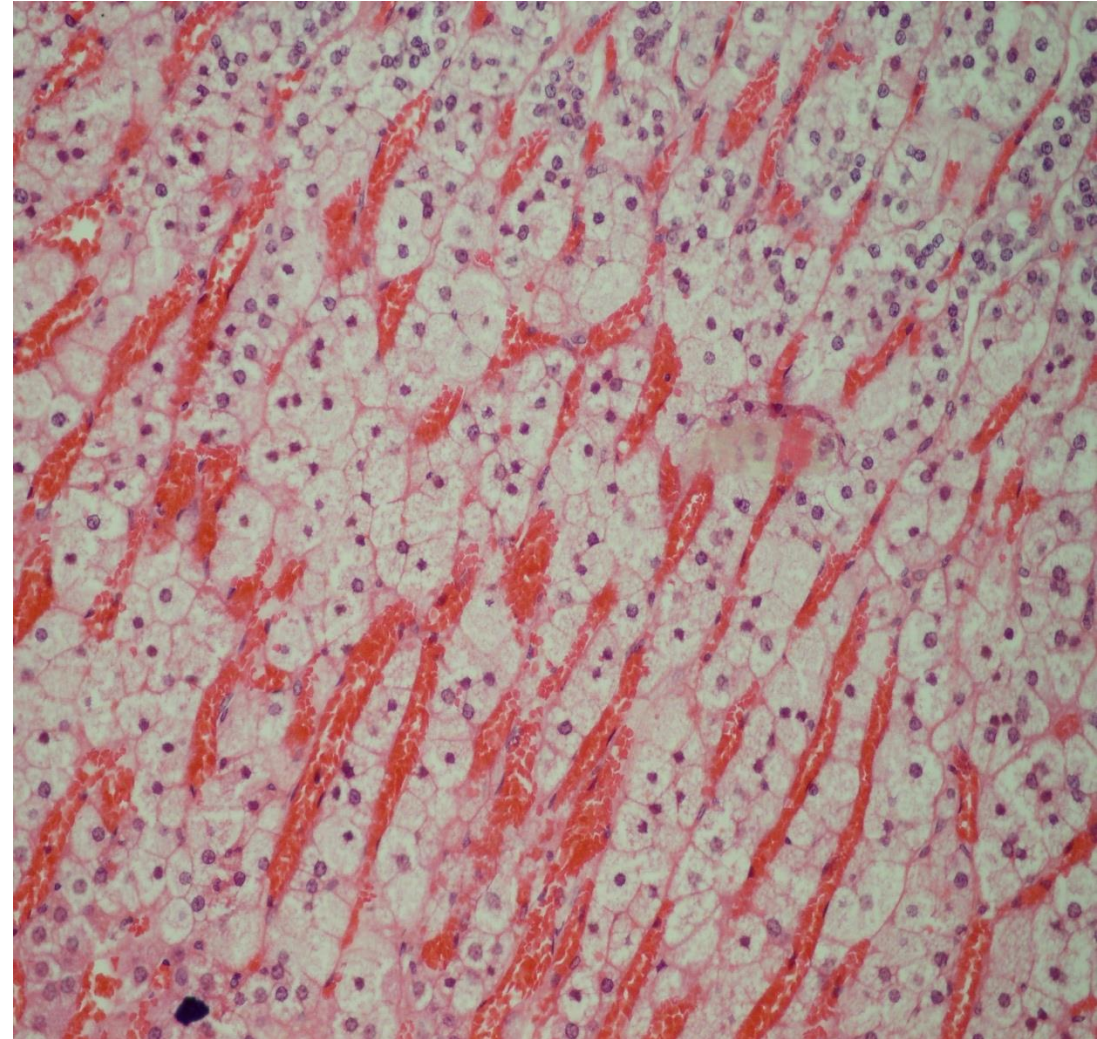
Cortex- zona glomerulosa Outermost zone

- Immediately inside the capsule and comprising about 15% of the cortex
- Consists of closely packed, rounded or arched cords of columnar or pyramidal cells.
- Many capillaries (or sinusoids). —————
- The steroids are called mineralocorticoids
- The principal product is aldosterone (uptake of Na^+ , K^+ , and water by cells of renal tubules).
- Aldosterone secretion is stimulated primarily by **angiotensin II** (increase in plasma K^+ concentration, weakly by ACTH. **Less significantly influenced by ACTH (BUT ACTH receptors can be found in the lower 2 layers!!)**)



Cortex- zona fasciculata

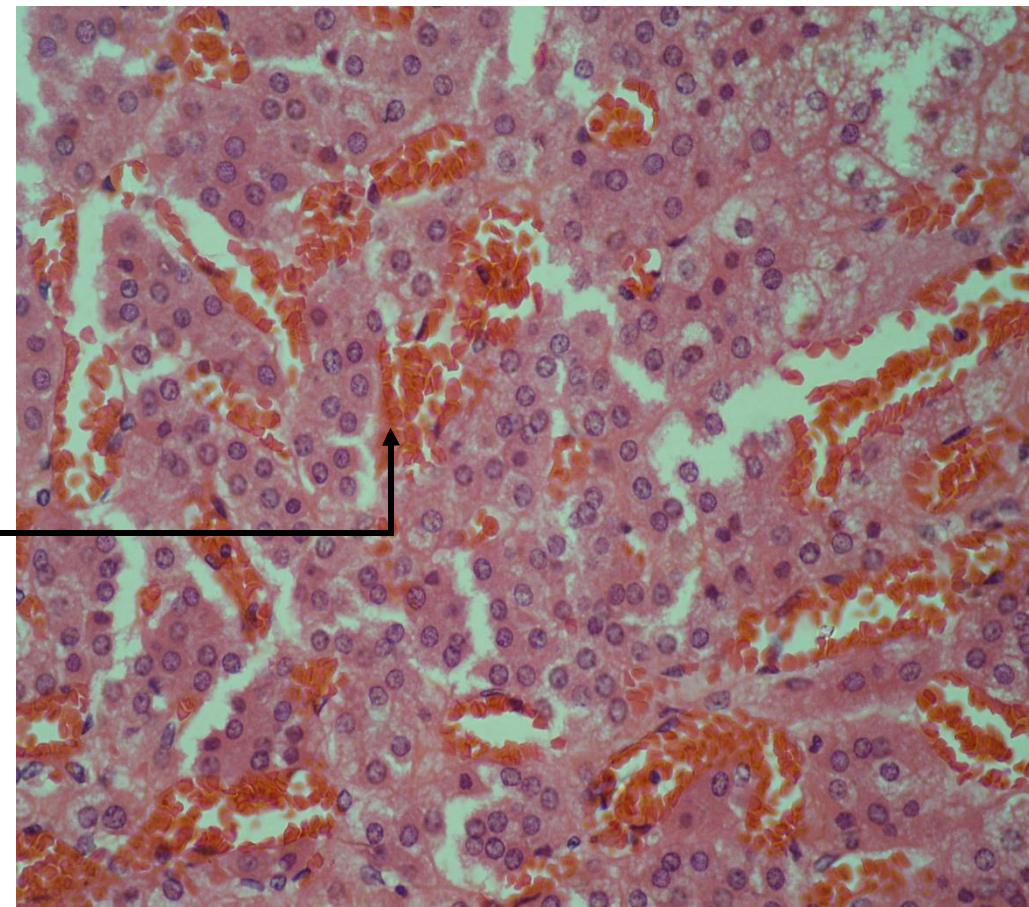
- 65%-80% of the cortex (**LARGEST Zone of the cortex**).
- Long cords of large polyhedral cells, one or two cells thick,
- Fenestrated sinusoidal capillaries
- Cells are filled with lipid droplets.
- Secrete glucocorticoids, especially cortisol **STRESS HORMONE** (carbs metabolism—gluconeogenesis in many cells (liver)) **cause to elevate sugar levels in blood**
- Suppresses many immune functions. **Explains why if ur stressed for too long u get sick more.**
- Induce fat mobilization and muscle proteolysis.
- Secretion is controlled by ACTH (negative feedback)
- Small amounts of weak androgens are also produced here.



Linear, sometimes u see one row of cells or two
The width of capillaries seem to increase as we come closer to the center.

Cortex- zona reticularis

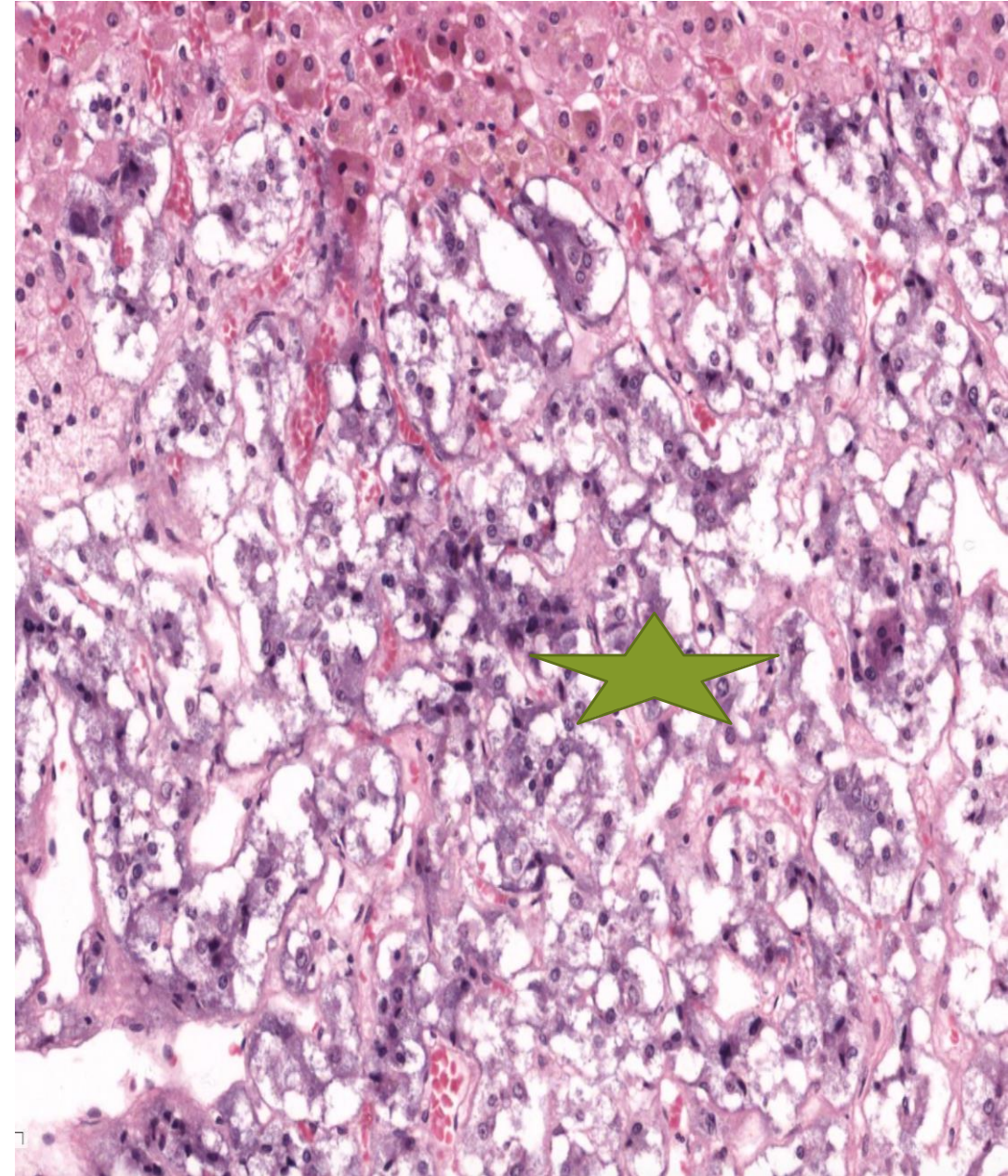
- 10% of the cortex and
- Consists of smaller cells in a network of irregular cords interspersed with
- Wide capillaries
- The cells are more heavily stained than those of the other zones (fewer lipid droplet and more lipofuscin pigment).
- Primarily secrete weak androgens (also produce cortisol).
- Dehydroepiandrosterone (DHEA) that is converted to testosterone in both men and women.
- Secretion is stimulated by **ACTH** with **regulatory feedback**.



- The cells here are eosinophilic, the vacuoles storing hormones are less that's why we see well stained cytoplasm (**lipids in other zones is way higher**).
- **HUGE CAPILLARIES** cause blood near cortex is passing to the medulla then the vein exits and drains everything else.

The adrenal medulla

- Comes from **neural crest** → future is **postganglionic fibers** → **cell shift** → **chromaffin cells** (no axons or dendrites BUT excitable and release hormones)
- Composed of large, pale-staining polyhedral cells — cords or clumps and supported by a reticular fiber network
- A profuse supply of sinusoidal capillaries intervenes between adjacent cords
- A few parasympathetic ganglion.
- Medullary parenchymal cells, known as **CCs** (modified sympathetic postganglionic neurons; lacking axons and dendrites).



The adrenal medulla (AM)

- CCs (**chromaffin cells**) contain many electron-dense granules (catecholamines, either epinephrine or norepinephrine)
- The conversion of norepinephrine to epinephrine (adrenalin) occurs only in chromaffin cells of the AM.
- 80% of the catecholamine secreted from the adrenal is epinephrine.
- Medullary CCs are innervated by **preganglionic** sympathetic neurons.
- **There is a Postganglionic parasympathetic fibers at the AM.**

❑ Why You See Both (Sympathetic & Parasympathetic)?

- ✓ **Arriving Fibers (Preganglionic):** The nerve bundles coming from the splanchnic nerves into the medulla are **preganglionic**. They act as the "trigger switches" for the chromaffin cells.
- ✓ **Internal Network (Postganglionic):** Scattered throughout the adrenal medulla are actual **sympathetic ganglion cells** (true neurons). These cells receive signals and extend **postganglionic axons** locally to innervate the medullary blood vessels and help regulate blood flow.
- ✓ So, while the main functional input to the hormone-secreting cells is preganglionic, true **postganglionic fibers and cell bodies** are structurally present inside the tissue under a microscope (like an eye looking at you).

The adrenal medulla (AM)

Main secretion is epinephrine

We have two cause each one is responsible for either “fight or flight”

- **Epinephrine** increases heart rate, dilates bronchioles **by relaxing smooth muscles** , and dilates arteries of cardiac and skeletal muscle. **Inc heart rate to pump more blood to skeletal muscles and brain , become pale, dilation of pupils.**
- **Norepinephrine** constricts vessels of the digestive system and skin, increasing blood flow to the heart, muscles, and brain.
- **Both** hormones stimulate glycogen breakdown, elevating blood glucose levels.
- During **normal** activity the adrenal medulla continuously secretes

Surgical Significance/ Trauma

- **Surgical Significance of Renal Fascia:**

- The suprarenal glands, together with the kidneys, are enclosed within the renal fascia. **/capsule (basically c.t. that comes from mesoderm).**
- The suprarenal glands lie in a separate compartment, which allows the two organs to be separated easily at operation.

- **Susceptibility to Trauma at Birth:**

- The suprarenal glands are relatively large at birth because of the presence of the fetal cortex. **Large endocrine, good blood supply, and still not very well connected/mature → Any trauma could lead to damage to the gland leading to massive bleeding.**
- Later, when this part of the cortex involutes, the gland becomes reduced in size.
- During the process of involution, the cortex is friable and susceptible to damage and severe hemorrhage.

رسالة من الفريق العلمي:

نسألك أن نُوفِّقَ في مَسَاعِينَا
وأن يُكْتَبَ لنا الخير
وأن نسير في طَرِيقِنَا آمِنِينَ
مُطْمَئِنِّينَ ، وأن نَتَذَوِّقَ بَهْجَةَ
الوصول والوصول .. آمين

For any feedback, scan the code or click on it.



Corrections from previous versions:

Versions	Slide # and Place of Error	Before Correction	After Correction
V0 → V1			
V1 → V2			