



ENDOCRINE

ANATOMY

#9



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Adrenal Gland

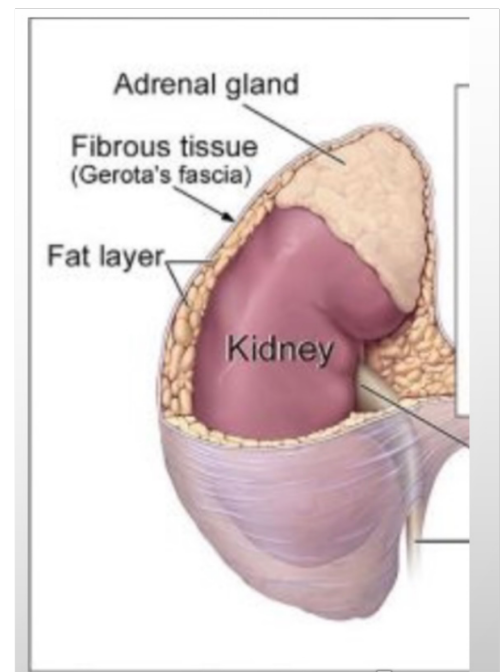
Today we are going to talk about the adrenal gland (the last gland in anatomy lectures) this gland is located over the 2 kidneys we have , it is enclosed by the **renal fascia**, it is separated from the kidney by a fat layer which surrounds the kidney "perirenal fat".

This gland is composed of 2 layers ,an outer called the cortex, and inner which is called the medulla.

The adrenal gland lacks a hilum while it is present in the kidney(the hilum is a depressed area located at the middle of the kidney which is responsible of entry and exist of arteries and veins to supply the kidney without the adrenal gland).

So as you can see blood vessels penetrate the gland from different locations ,further these blood vessels will drain to the major ones (whose supply the kidneys) eventually and they are actually close to them because the 2 glands lies closely enough to the midline.(see the pic for more clarification)

Suprarenal=Adrenal



- Yellowish retroperitoneal organs that lie on the upper poles of the kidneys
- Surrounded by **renal fascia**.
- Separated from the kidneys by the perirenal fat.
- Has a yellow cortex and a dark brown medulla.
- Lacks a hilum; suprarenal arteries arising from larger abdominal arteries penetrate the capsule independently.
- Lie close to critical vessels and organs.

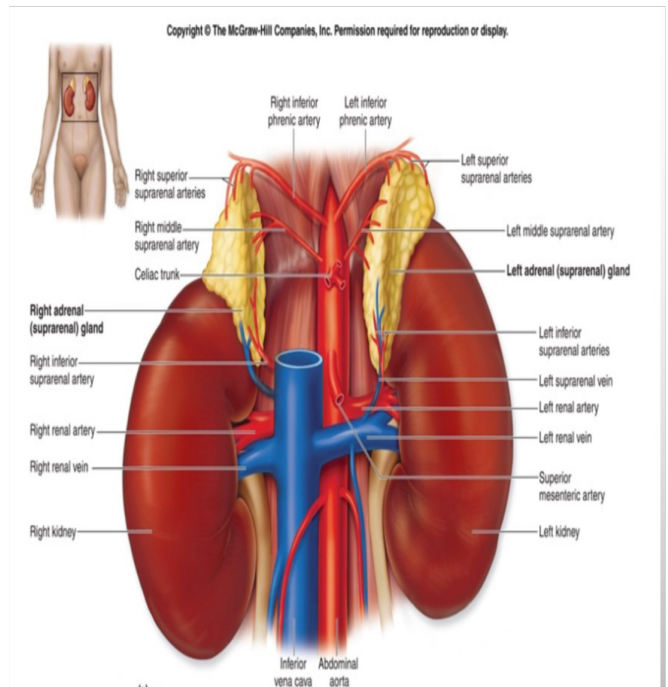
LOCATION AND DESCRIPTION

The adrenal glands are in the retroperitoneum space which is located in the posterior abdominal wall and very close to the crura of the diaphragm (each one of the 2 glands), the anterior part of the left gland tends to descend more anteriorly and it is located much closer to the hilum of the kidney than right one.

Now, let us see what structures lay actually in the front of the glands.

(we said **in front** because the gland lay on posterior abdominal wall and all structures will be anterior to it.)

- The **right** is pyramid shaped:
- Caps the upper pole of the right kidney
- It lies behind the right lobe of the liver and extends medially behind the inferior vena cava.
- It rests posteriorly on the diaphragm.
- The **left** is crescentic (هلال) in shape:
- Extends along the medial border of the left kidney from the upper pole to the hilus.
- It lies behind the pancreas, the lesser sac and the stomach.
- Rests posteriorly on the diaphragm.



Blood supply

- A superior, middle, and inferior suprarenal arteries branches from inferior phrenic, aorta (abdominal aorta), and renal artery, respectively.
- A single **vein** emerges and drains into the IVC on the right and into the renal vein on the left.

You might find other scenarios in each of the artery's sources (superior suprarenal artery could be branch of the abdominal aorta and so on, but most humans have what written up).

Notice that the venous drainage is different in the 2 right and left glands, the right one the suprarenal vein drains to the inferior vena cava eventually , the left suprarenal vein drains firstly to the renal vein then the inferior vena cava.

Lymph drainage

- Drains into the lateral aortic nodes.

Nerve supply

- Preganglionic sympathetic fibers derived from the splanchnic nerves (bilateral visceral autonomic nerves) supply the glands (T5–T8 spinal cord segments)
- Most of the nerves end in the medulla of the gland. (to stimulate their secretion later on).

STRUCTURE

We said that we have the inner medulla and the outer cortex which is subdivided further into 3 parts "zones", each zone secretes one type of hormone.

A cortex and a medulla

The cortex secretes:

- **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:

- **Catecholamines** epinephrine and norepinephrine

ORGANOGENESIS—CORTEX

- Develops from two components: a mesodermal portion---cortex, and an ectodermal portion---- medulla.
- During the 5th week (4-6 week), mesothelial cells(derived from the mesoderm)between the root of the mesentery and the developing gonad (within the urogenital ridge---we call the cells that exit and make the

adrenal: the adrenal-gonadal primordial germ cells) begin to proliferate and penetrate the underlying mesenchyme.

- Here they differentiate into large acidophilic organs, which form the **fetal cortex**, or **primitive cortex** (the first part of the 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.

Now we have the fetal cortex-contains the medulla inside it- inside, and the definitive cortex outside, then:

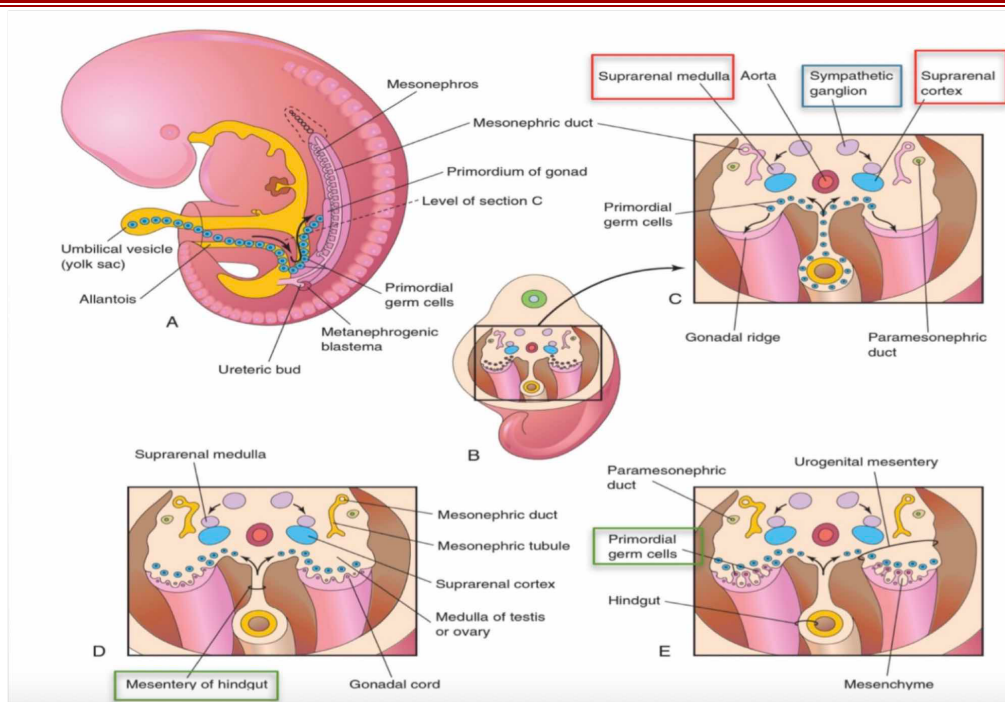
- **After birth**, the fetal cortex regresses(will be smaller in size) rapidly (largely completed in the first few weeks of life) except for its outermost layer, which differentiates(shrink) into a tiny zone called the **reticular zone**(it is the closest to the medulla inside).
- The adult structure of the cortex is not achieved **until puberty**.

ORGANOGENESIS--MEDULLA

•While the fetal cortex is being formed, cells originating in the sympathetic system (sympathochromaffin cells—neural crest) invade its medial aspect of the forming cortex , where they are arranged in cords and clusters.

- These cells give rise to the medulla of the suprarenal gland.
- They stain yellow-brown with chrome salts and hence are called chromaffin
- The medulla comes to occupy a central position.
- During embryonic life, chromaffin cells are scattered widely throughout the embryo, but in the adult the only persisting group is in the medulla of the adrenal glands.
- Preganglionic sympathetic nerve fibers grow into the medulla and influence the activity of the medullary cells.

*we said before that the nerve supply of the gland comes from the splanchnic nerves, it comes from preganglionic which they did not do any synapse with any sympathetic ganglion.

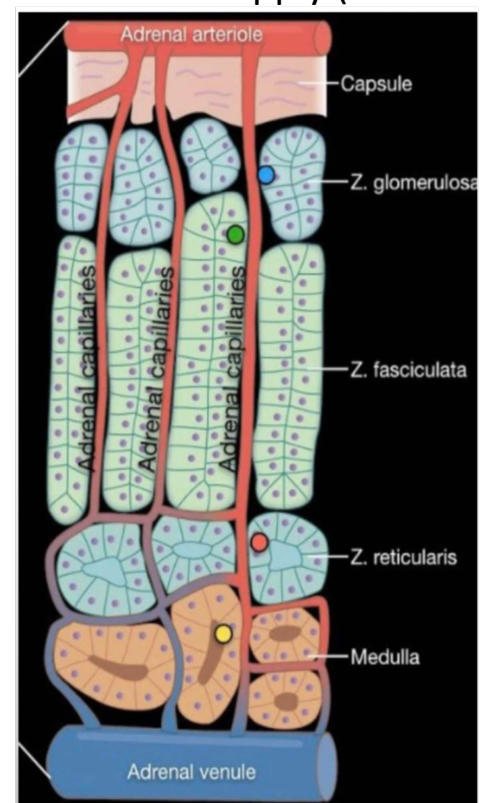


HISTOLOGY

If we have a section of the gland we will see an outer lighter cortex and inner darker medulla, usually they are arranged into cords that surround the blood vessels which supply them and where the cells will deliver their hormones, these arteries form an arterial plexus which will supply cortex and medulla separately, but eventually the capillaries drainage of the cortex will irrigate the medulla, which means that it has a dual blood supply (see pic).

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



Now, we will talk about each part separately:

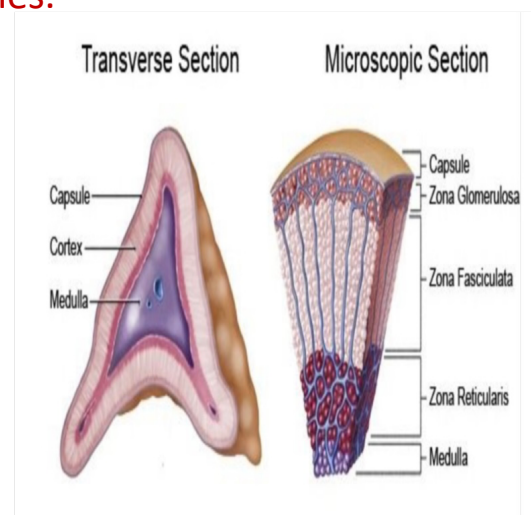
ADRENAL CORTEX

- 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.

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** → outermost
2. **Zona fasciculata** → middle
3. **Zona reticularis** → inner

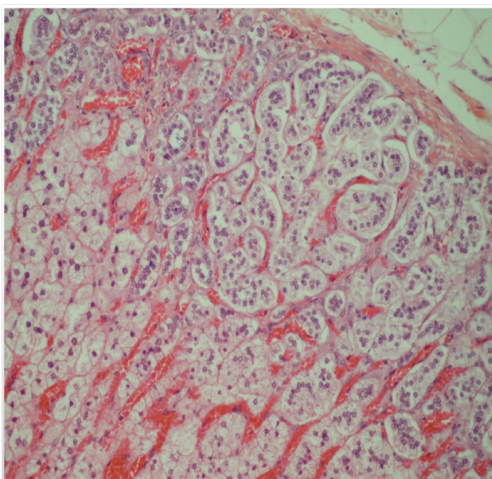


CORTEX- ZONA GLOMERULOS

- 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, very well blood supplied.
- The steroids made by these cells are called **mineralocorticoids**
- The principal product is **aldosterone** (uptake of Na^+ , K^+ , and water by cells of renal tubules).

***Aldosterone** which effects actually many structures in the body like salivary glands, retention (reabsorption) of sodium by the kidney (which

leads to prevention of water loss according to osmolarity rules) then raise blood pressure.

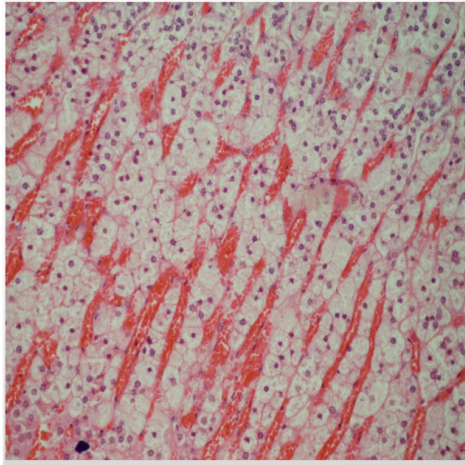


CORTEX- ZONA FASCICULATA

Biggest zone of cortex, arranged into columns unlike the glomerulosa (more rounded) many capillaries in between like others endocrine glands, lipid droplets between these cells are obvious , this layer is responsible of secretion of **Glucocorticoids** which involves in carbs metabolism and gluconeogenesis ,fat mobilization (Glucocorticoids regulate how much fat is stored in specific fat depots) , protein degradation , decreasing immune functions . secretion of **Glucocorticoids** is controlled by secretion of ACTH from anterior pituitary(doctor said it comes from adrenal gland by mistake) an increase in the secretion of Glucocorticoids will be decreased by negative feedback from anterior pituitary

65%-80% of the cortex

- Long cords of large polyhedral cells, one or two cells thick,
- Fenestrated sinusoidal capillaries
- The cells are filled with lipid droplets.
- Secrete **glucocorticoids**, especially cortisol (carbs metabolism--- gluconeogenesis in many cells (liver))
- Suppresses many immune functions.
- Induce fat mobilization and muscle proteolysis(degradation of proteins in order to use them).
- Secretion is controlled by ACTH (negative feedback)
- Small amounts of weak androgens are also produced here.

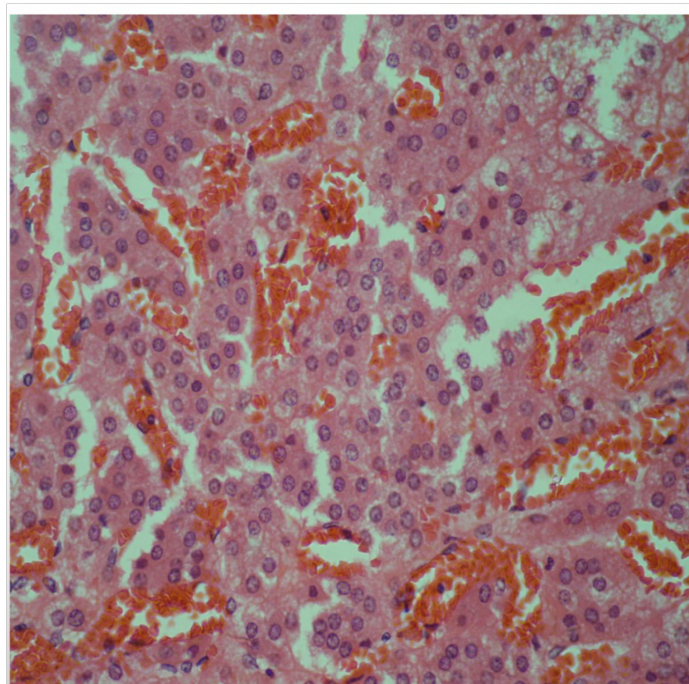


CORTEX- ZONA RETICULARIS

the zona fasciculata cells can produce small amount of androgen (sex male hormone mainly).

- 10% of the cortex
- Consists of smaller cells in a network of irregular cords interspersed with
- Wide capillaries between the groups of cells.
- The cells are more heavily stained than those of the other zones (fewer lipid droplet and more lipofuscin pigment).
- Primarily secrete the 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.

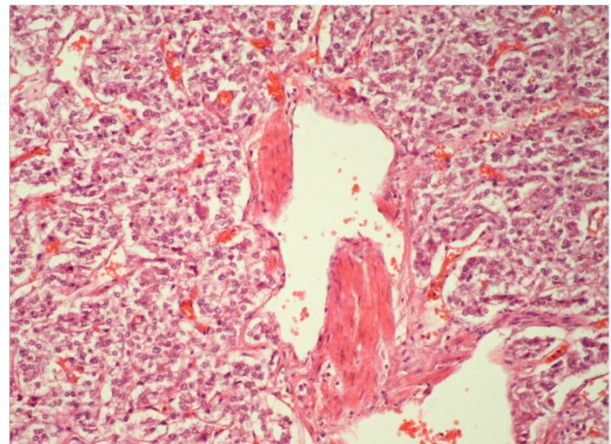
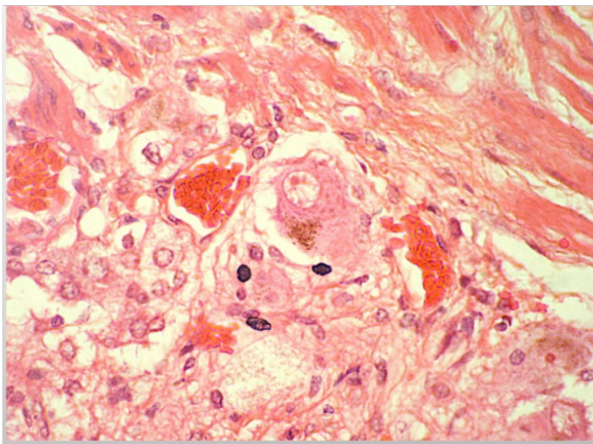
*The cells might be bigger in the pic but actually they are smaller than previous layers(because of the high zoom)cells causing a network cells shape.



THE ADRENAL MEDULLA

- 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).

As we said the origin of medulla is chromaffin cells—neural crest , they considered large in size and pale (باهت) staining its further grouped into cords or clumps and interspersed by many sinusoids In between , and we said it has a dual blood supply : venous that comes from the cortex and its own arterial supply. We have a number of ganglion between the chromaffin cells with large nucleus and large cytoplasm, the cells in medulla are called medullary parenchymal cells , or **CCs** (modified sympathetic postganglionic neurons, lacking axons and dendrites) the sympathetic neurons which comes from t5-t8 (spinal cord) they don't synapse on a paravertebral ganglion or any ganglion outside the adrenal gland , instead they synapse on theses **CCs** (medullary parenchymal cells) because they are considered as modified sympathetic postganglionic neurons. Modified= no neural accessory (axons, dendrites).



The doctor said: that a summary about the medulla and its secretion which are mainly the catecholamines.

- CCs 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.

- About 80% of the catecholamine secreted from the adrenal is epinephrine.
- Medullary CCs are innervated by **preganglionic** sympathetic neurons.
 - **Epinephrine** increases heart rate, dilates bronchioles, and dilates arteries of cardiac and skeletal muscle.
 - **Norepinephrine** constricts vessels of the GIT 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 **small** quantities of these hormones.

As you can see every hormone has different target, for example the epinephrine increases heart rate, while norepinephrine shifts blood from unnecessary organs like GIT and skin toward more critical organs such as heart in emergency situations and increases blood flow to the heart, muscles, brain. Both of them stimulates break down of glycogen to have more glucose ready to be used by the heart and muscles.

SURGICAL SIGNIFICANCE/ TRAUMA

Surgical significance of renal fascia

- The suprarenal glands, together with the kidneys, are enclosed within the renal fascia.
- The suprarenal glands lie in a separate compartment, which allows the two organs to be separated easily at operation.

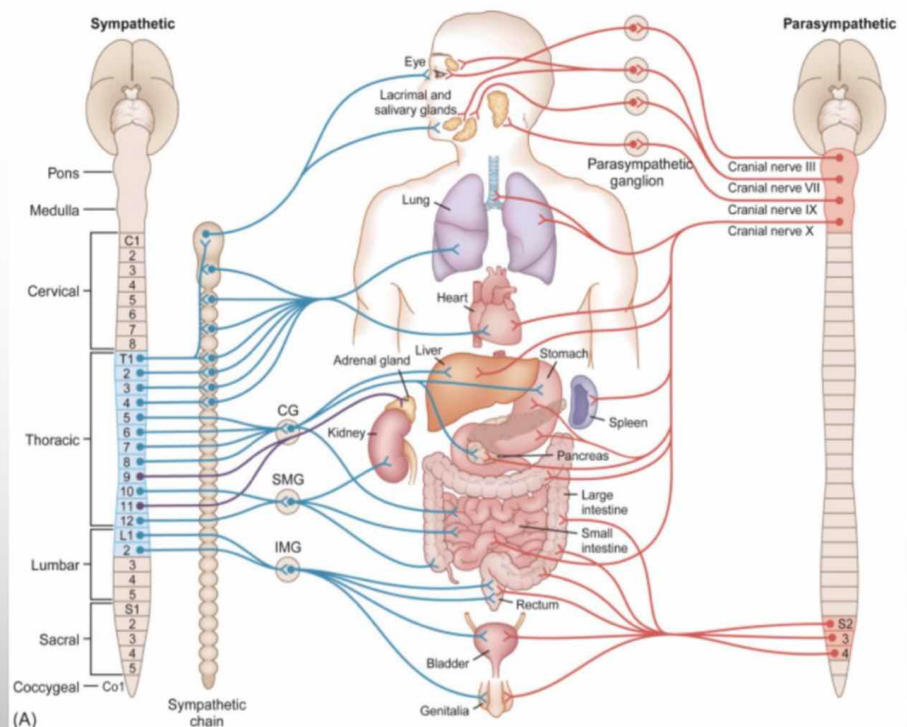
Susceptibility to trauma at birth

- The suprarenal glands are relatively large at birth because of the presence of the fetal cortex.
- 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.

As we mentioned the adrenal gland lies close to the kidneys and is separated by the renal fascia , the gland has its own compartments and can be removed easily from the kidney at operation.

Another important thing we discussed before, in the first few weeks of fetal cortex involution it start to be large then the gland will shrink and would become friable (هش) so any damage could leave a critical impact on the gland and a hemorrhage could take place .

ANS/AG



Good luck

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