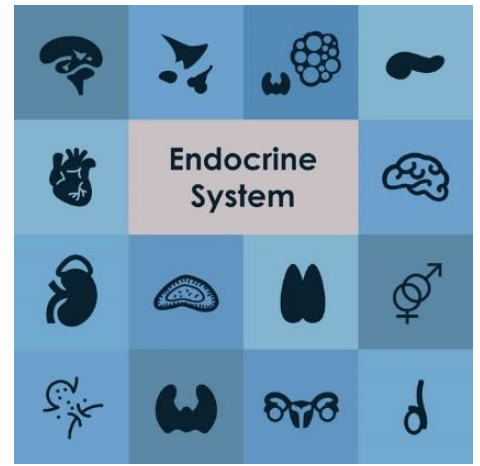




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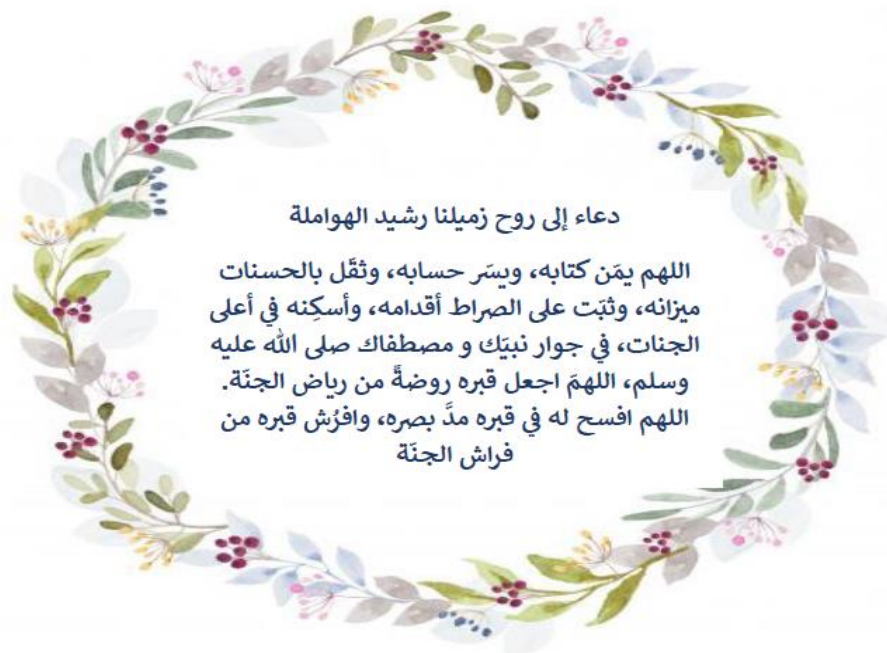
Sheet no. 3

Lecture Date: 28-12-2020

Lecture Title: Anatomy, Embryology, and Histology of the Adrenal Gland

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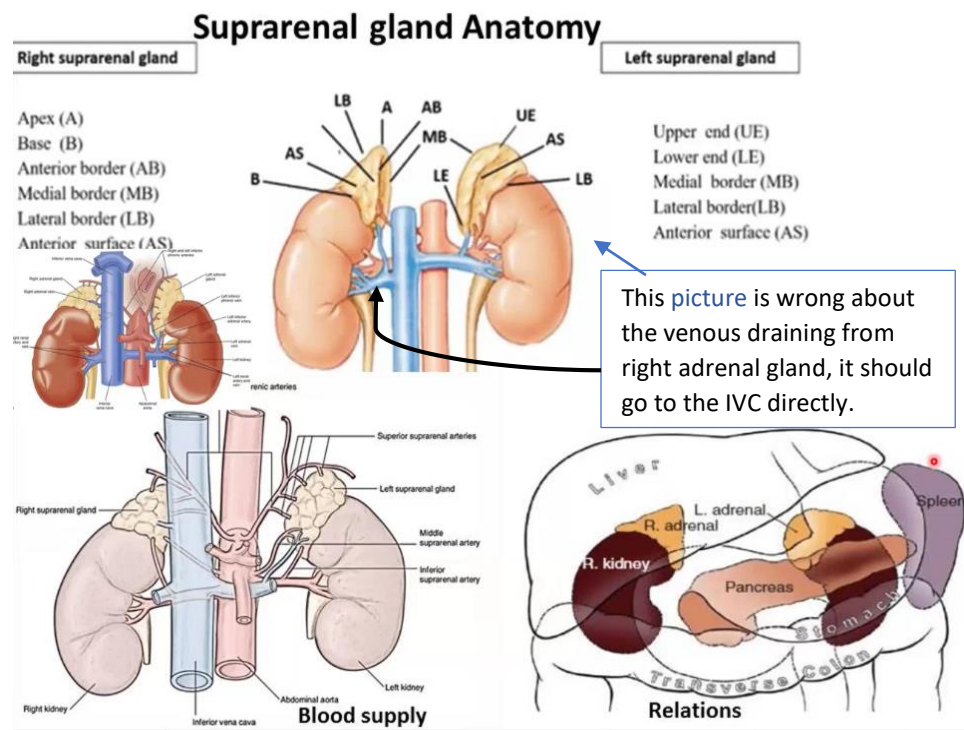
- **endocrine system** is a complex system that is distributed all over the body, but we are going to discuss only five major glands:

1. Pituitary gland
2. Thyroid gland
3. Parathyroid gland
4. Adrenal gland
5. Pancreas

But as we said endocrine cells can be found in other places in the body such as the lung, skin and kidney.

- The suprarenal (adrenal) glands are two yellowish organs that lie on the top of the upper poles of the kidneys.
- The **right** suprarenal gland is pyramidal in shape while the **left** one is crescentic
- The right suprarenal gland is capping (sitting on top) the right kidney while the left one is extended from the upper pole of the kidney downwards towards the hilum of the kidney.
- Each suprarenal gland is composed of outer cortex (yellowish part) and inner medulla (dark brown)
- Relations:
 - Right adrenal gland: related anteriorly to the Liver and to the IVC at its left side.
 - Posterior to it is the diaphragm.
 - Left adrenal gland: related anteriorly to the stomach, pancreas and the lesser sac.
 - Posterior to it is the diaphragm.

✓ Lesser sac is a peritoneal cavity.
- Blood supply: they receive arterial blood from three resources (same on both sides):
 1. Branch of inferior phrenic artery.
 2. Aortic branch.
 3. Branch of renal artery.
- Venous return:
 - Right adrenal gland: Drains into IVC directly.
 - Left adrenal gland: Drains into Left renal vein.
- Lymphatic drainage: into paraaortic lymph nodes (around the aorta).
- Nerve supply: sympathetic innervation from sympathetic trunk through splanchnic nerve.



Histology of the Adrenal cortex

- Adrenal gland has outer adrenal cortex and inner adrenal medulla.
- All the hormones secreted by adrenal **cortex** are steroid hormones, which are all based on **cholesterol**. Secretory cells contain triglyceride droplets. The cortex can be divided into three regions:

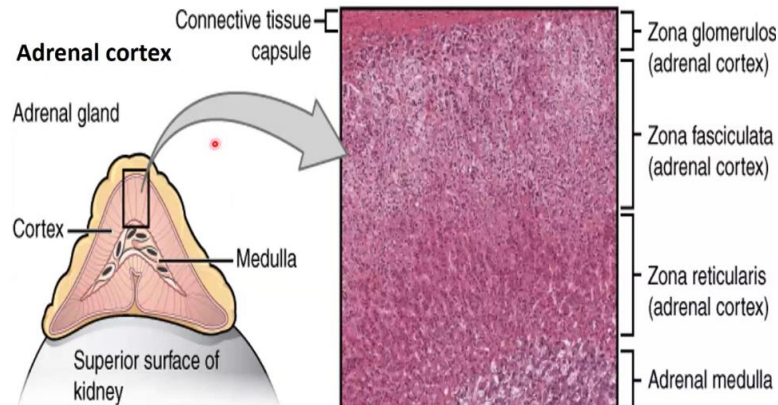
1. Zona glomerulosa (**outer layer**).
2. Zona fasciculata.
3. Zona reticularis.

- Hormones secreted from adrenal **medulla** are catecholamines.
- They are peptide (amino acid) based hormones – nor-adrenaline and adrenalin.

- Adrenal gland alone is covered by a capsule (capsule of the adrenal gland)**

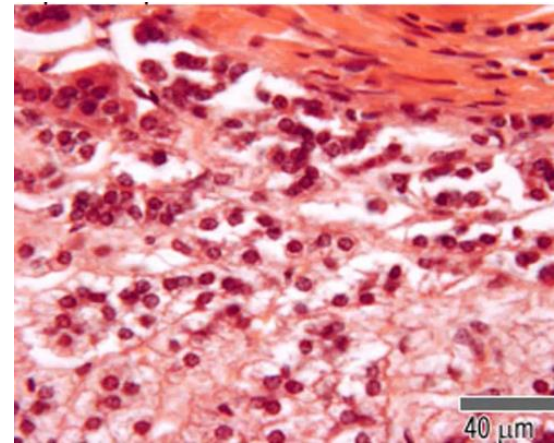
- Adrenal gland and the kidney are covered by a fascia called the perinephric fascia.**

- The kidney and the adrenal gland are separated by perinephric fat.**



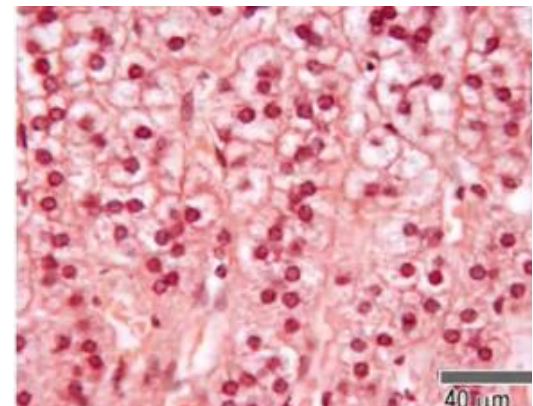
1. Zona glomerulosa:

- the outermost zone of the adrenal cortex secretes **mineralocorticoids**. These hormones are important for fluid homeostasis. These include aldosterone, which regulates absorption/uptake of K^+ and Na^+ levels in the kidney.
- The secretory cells are arranged in irregular **ovoid clusters** that are surrounded by trabeculae which contain capillaries.
- The nuclei stain strongly, and the cytoplasm is darker than that of the next zone, the zona fasciculata, as there are fewer lipid droplets in these cells than cells in zona fasciculata.



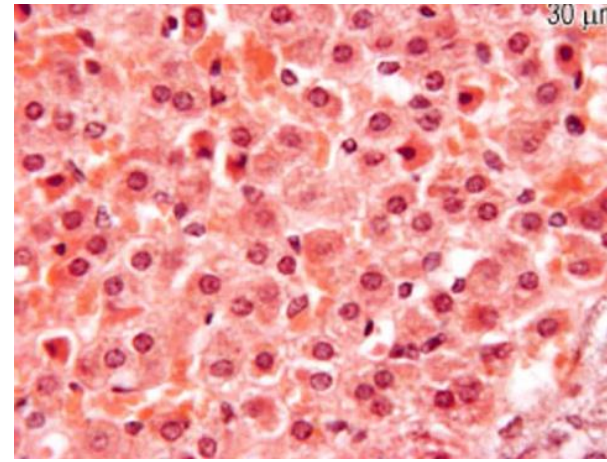
2. Zona fasciculata:

- the middle zone of the adrenal cortex secretes **glucocorticoids** which are important for **carbohydrate, protein and lipid metabolism**.
- An example is **cortisol** which **raises blood glucose** and **cellular synthesis of glycogen**. Its secretion is controlled by a hormone from the pituitary – ACTH (**adreno-cortico-trophic hormone**).
- The secretory cells are arranged in cords, often one cell thick, **surrounded by fine strands** of supporting tissue.
- The nuclei of these cells stain strongly**, and the cytoplasm is **rich** in Smooth Endoplasmic Reticulum, mitochondria and lipid droplets. **The cytoplasm looks pale and foamy** due to the presence of lipid droplets.



3. Zona reticularis:

- the innermost layer of the cortex. It secretes **sex hormones (androgen)**, and small amounts of **glucocorticoids**.
- Some **brown pigment** is seen in some of these cells – **this is lipofuscin**, probably an insoluble degradation product of organelle turnover – an 'age' pigment.
- **The cytoplasm of the cells in this region stains more darkly, and contains fewer lipid droplets.**

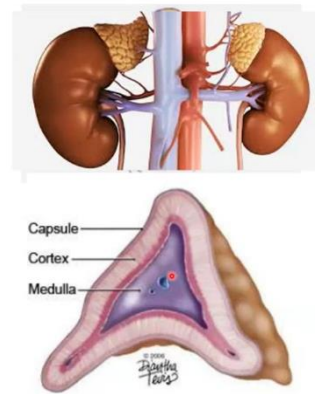


Histology of the Adrenal medulla

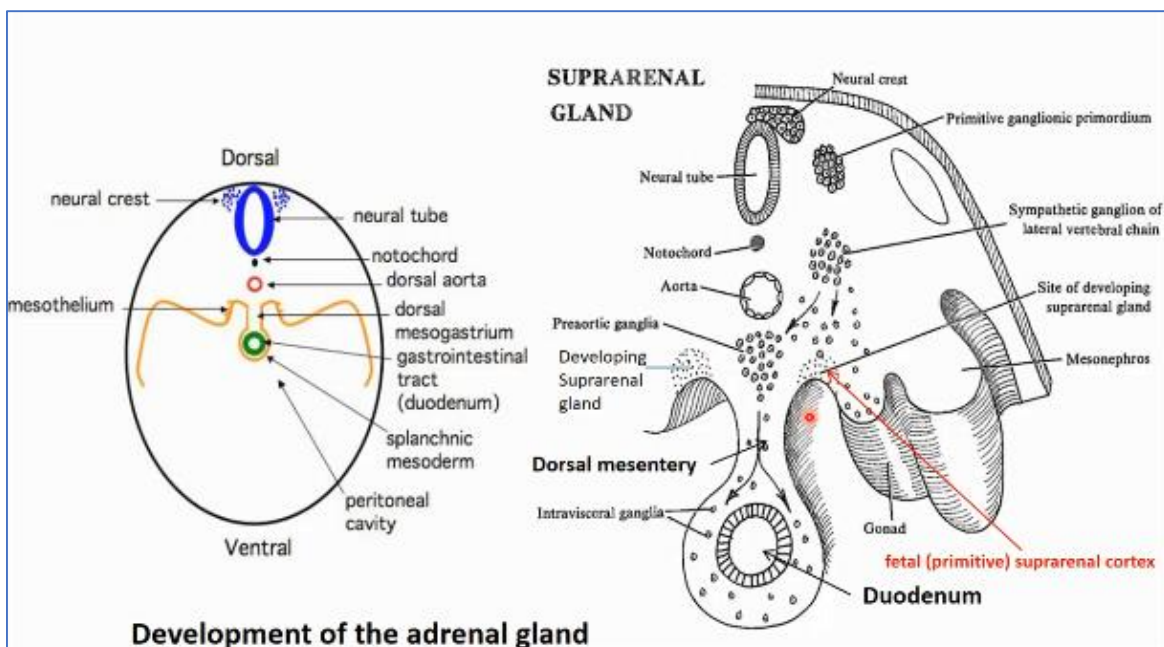
- The adrenal medulla is at the interface between the neural and endocrine systems and has features of both.
- **Hormones of the adrenal medulla are the catecholamines**, which also **function as classical neurotransmitters** in the autonomic nervous tissue (found in the sympathetic ganglion). **The adrenal medulla itself is modified neural tissue and its activity is regulated by a direct neural input.**
- So, the medulla functions like a modified sympathetic ganglion. However, the catecholamines of the adrenal medulla are **released into blood**, rather than a synaptic cleft, and act at sites distant from the site of secretion, by activating specific receptor. So, **the adrenal medulla also functions like a conventional endocrine gland.**
- Adrenal medulla contains chromaffin cell (pheochromocytes) which are **columnar basophilic staining cells** (the cortex cells are acidophilic); **they contain small granules. They don't contain stored lipid.** The medulla **contains many venous channels** which drain blood from the sinusoids of the cortex, the blood pass through the medulla, and drain into the medullary vein. **Which drains into the IVC directly or the renal vein (depends on which side is the adrenal gland).**
- **Cells are actively secreting the peptide (amino acid) based hormones – nor-adrenaline and adrenaline** (catecholamines), which are stored in the granule.
- Secretion of these hormones is controlled by the sympathetic nervous system (**fight and flight**). **The targets** of these hormones are the **adrenergic receptors** in the heart, blood vessels, bronchioles, visceral muscle, skeletal muscle, and in the liver, where they promote **glycolysis (breakdown of glycogen)**.
- **Tumor of the adrenal medulla is pheochromocytoma**, which is characterized by hypersecretion of catecholamines.

Embryology of the Suprarenal gland

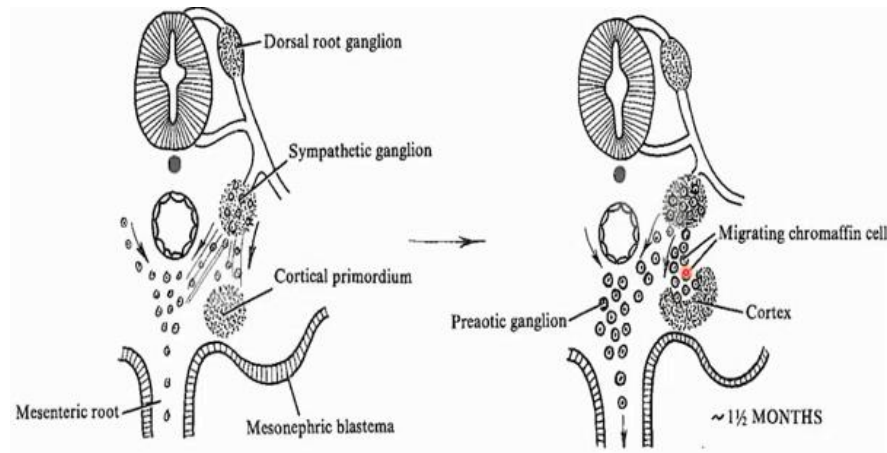
- Lie on the *superior* aspect of the *kidneys*
- Consist of *two endocrine organs*
 - a. *Inner adrenal medulla*
 - b. *Outer adrenal cortex*
- *Distinct embryological origins*
 - a. Medulla- chromaffin cells derived from the ectodermal cells of the *neural crest*
 - b. Cortex- *mesodermal* origin



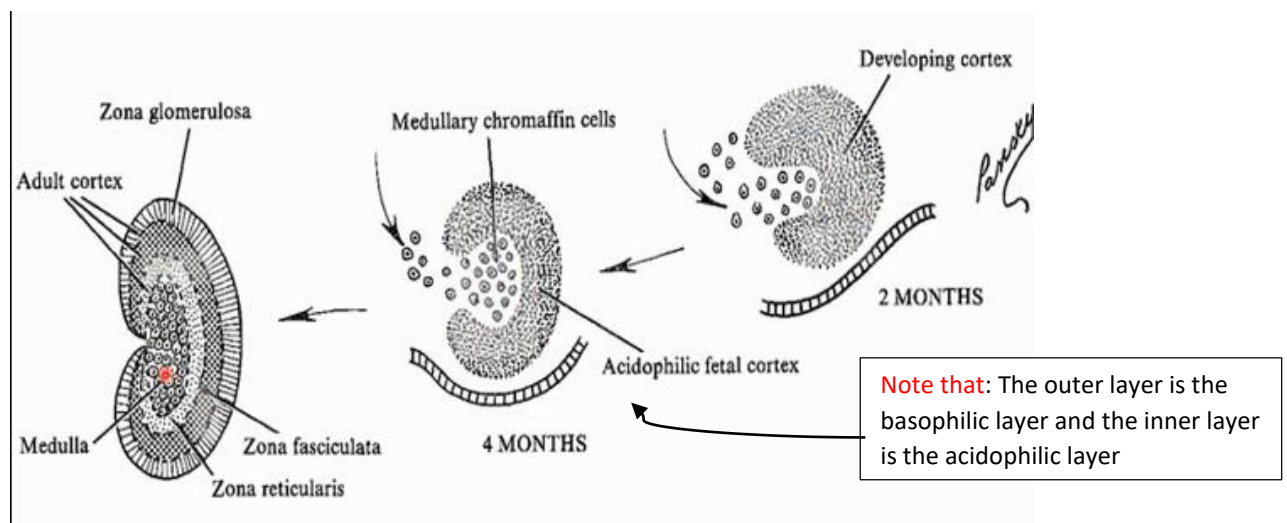
- The embryology of the kidney is through 3 stages:
 - 1- Pronephros
 - 2- **Mesonephros**
 - 3- Metanephros (the functional kidney).
- On the beginning of 2nd month (8mm fetus) and under the induction by **mesonephric** duct, the mesothelial (coelomic epithelial inside the peritoneal cavity) cells proliferate and penetrate the underlying mesenchyme. They multiply quickly and **differentiate** into large acidophilic cells which surround the **medullary primordium** and form the **fetal (primitive) suprarenal cortex**.
- At the end of the 3rd month, a **second wave** of cells from the **coelomic epithelium (mesothelium)** penetrates the mesenchyme and surrounds the original acidophilic cell mass. These smaller **basophilic cells** form the **definitive cortex of the gland**. The small basophilic cells will form the future **zona glomerulosa** and **zona fasciculata** of the **definitive cortex**.
- After birth, the **fetal (primitive) cortex** regresses rapidly, except for its outer layer which differentiates into the **zona reticularis**
- Prior to the 5th month of fetal life, the cortex appears to develop autonomously (by **mesonephric** duct). After this time, its development depends on hypophyseal corticotrophic hormone (ATCH) (from Pituitary gland)



- The **medullary primordium** occurs at **about day 45** of gestation. **Cells originating in the sympathetic system from the sympathetic chain (neural crest cells) appear** in the region near the developing mesodermal cortical primordium.

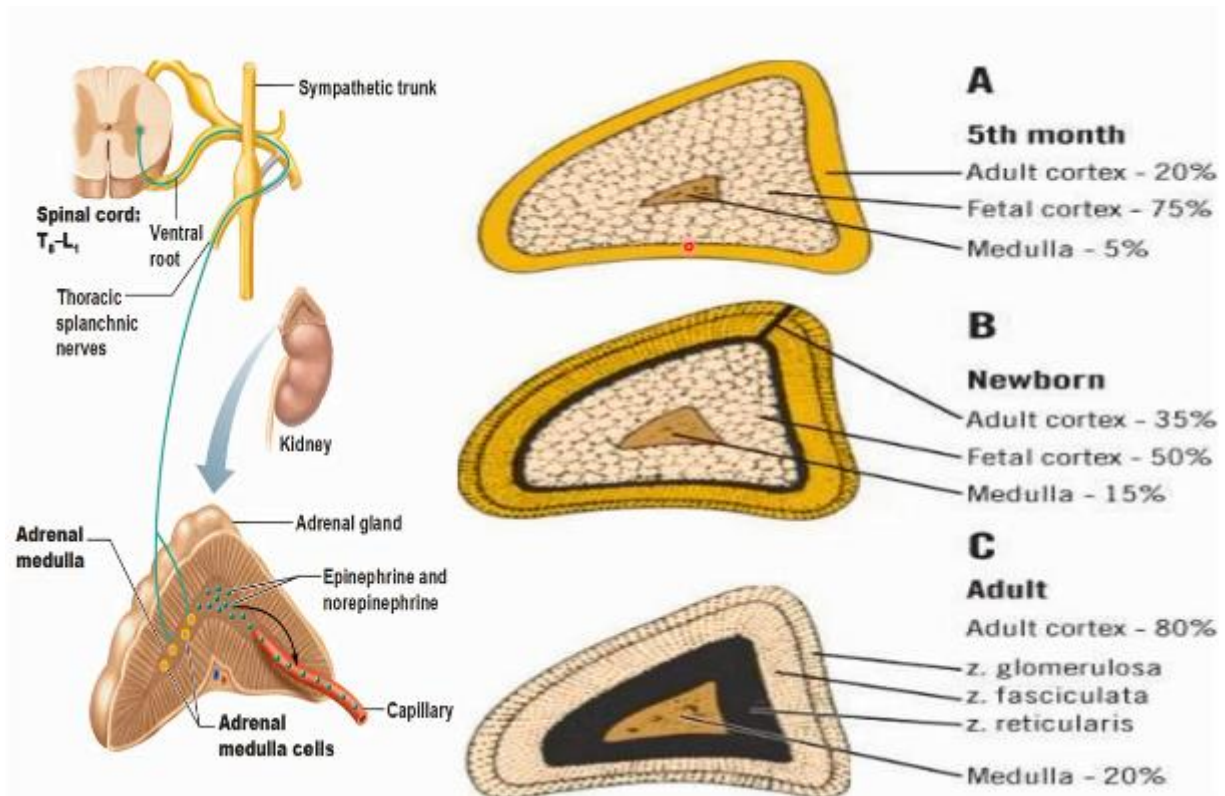


- While the fetal cortex is forming, the sympathetic cells **invade its medial aspect and are arranged in clusters and cords**. These cells give rise to the **medulla** of the suprarenal gland. These **cells** do not form nerve processes, **they stain yellow-brown with chrome salts and are called chromaffin cells**. The staining is probably due to the oxidation of epinephrine and norepinephrine within the cells by the staining chrome salts.



- **At birth, the medulla** is only slightly developed and is **not yet functional**. **Development of the definitive cortex** and its physiologic activity is regulated by ACTH, and it is not completely differentiated until 18 to 21 months after birth.
- **The adrenal arteries** take their major origin from the abdominal aortic system
- **Innervation of the adrenal gland:** the adrenal medulla consists of irregularly shaped cells grouped around blood vessels. These adrenal medullary cells are modified postganglionic neurons, they are intimately connected with the sympathetic nervous system (splanchnic nerves). They secrete epinephrine and norepinephrine in the blood. The targets of these hormones are the adrenergic receptors on body organs
- The adrenal glands in a newborn baby are much larger as a proportion of the body size than in an adult. For example, at age three months the glands are four times the size of the kidneys.
- **The size of the cortex** decreases relatively by age of 1 year after birth, mainly because of shrinkage of the cortex. The **fetal (primitive) cortex** regresses rapidly, except for its outer layer which differentiates into the **zona reticularis of the cortex**.

- **Conclusion:** fetal adrenal glands grow rapidly and at term are similar in weight to adult adrenals. From birth to 1 year their mass is reduced as they undergo a process of differentiation. Growth then remains slow until age 7 years. Thereafter, growth accelerates and the adrenals reach adult weight by the end of puberty.



Thank You