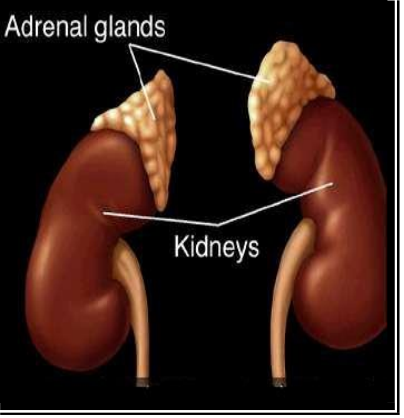
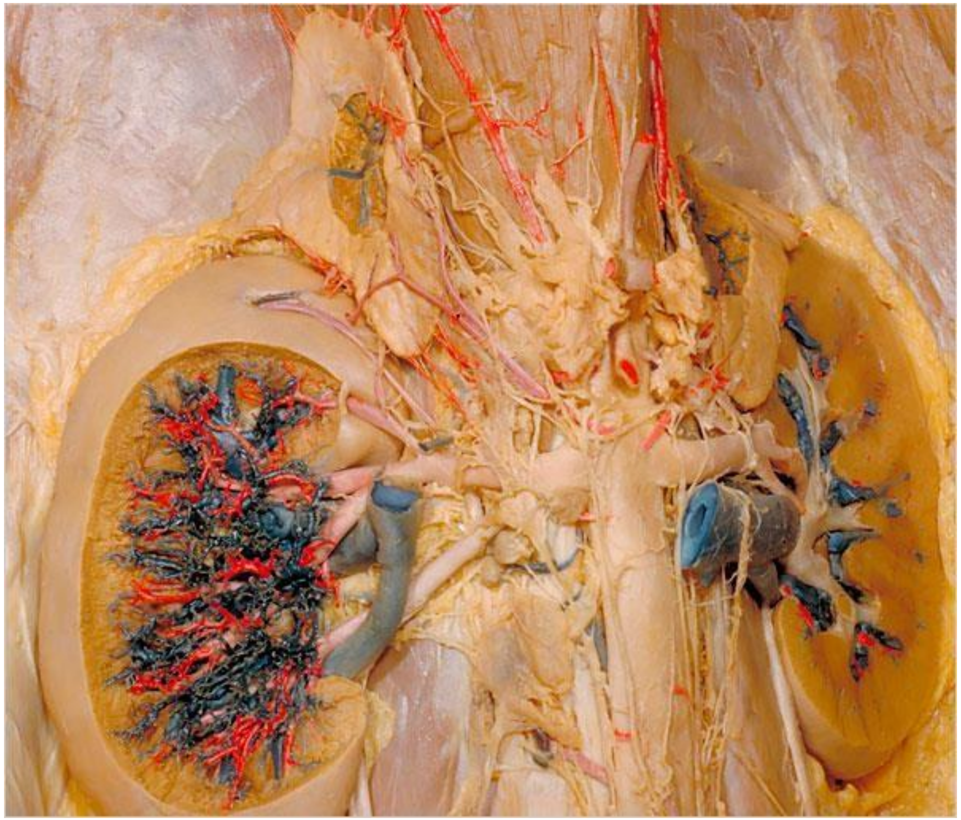
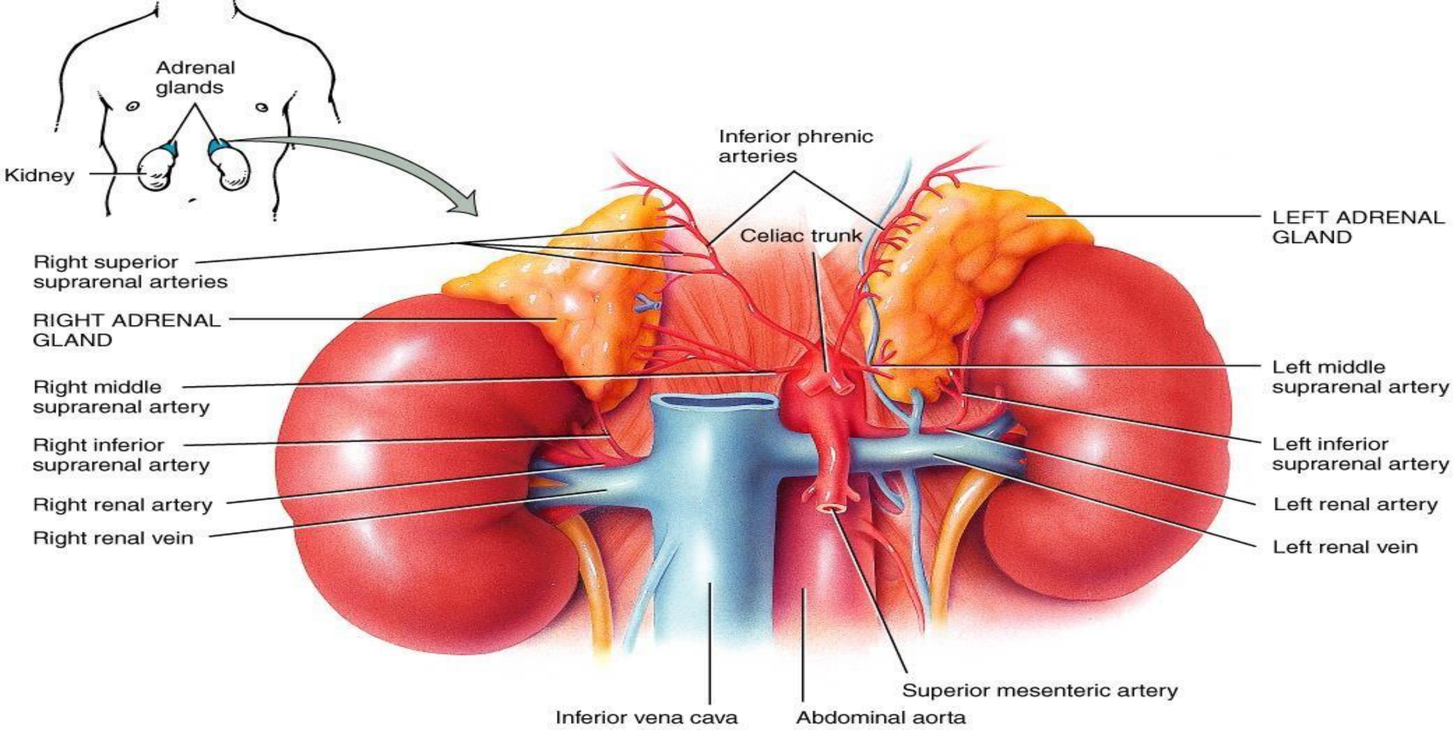


Suprarenal (adrenal) Glands

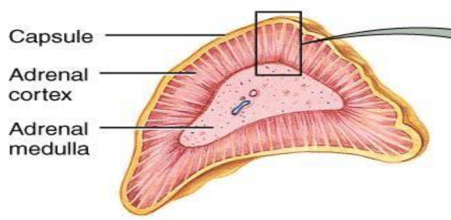


★
This star means "focus on" , the things the doctor said to take form the slide.
-Don't memorize ~~crossed~~ words

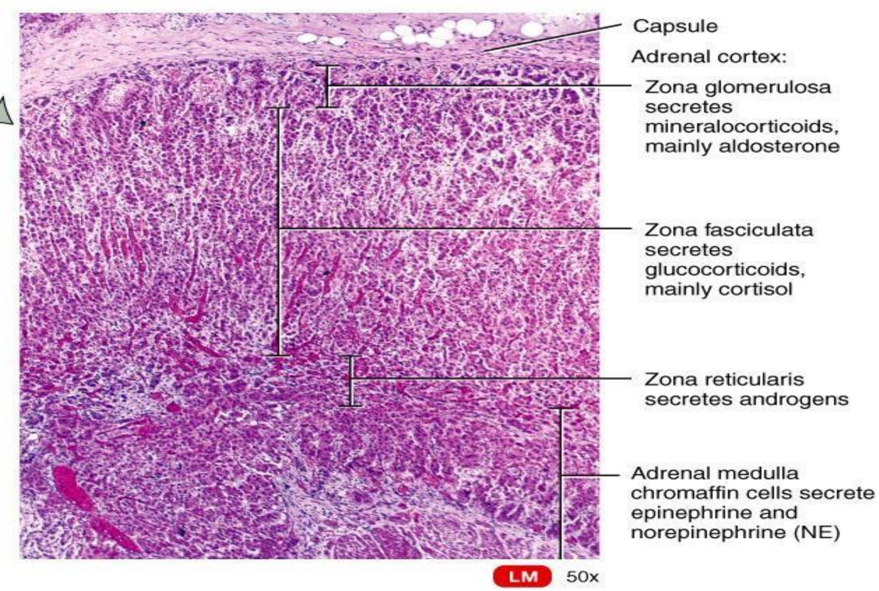
Edited by:
Batool B.



(a) Anterior view



Section through left adrenal gland



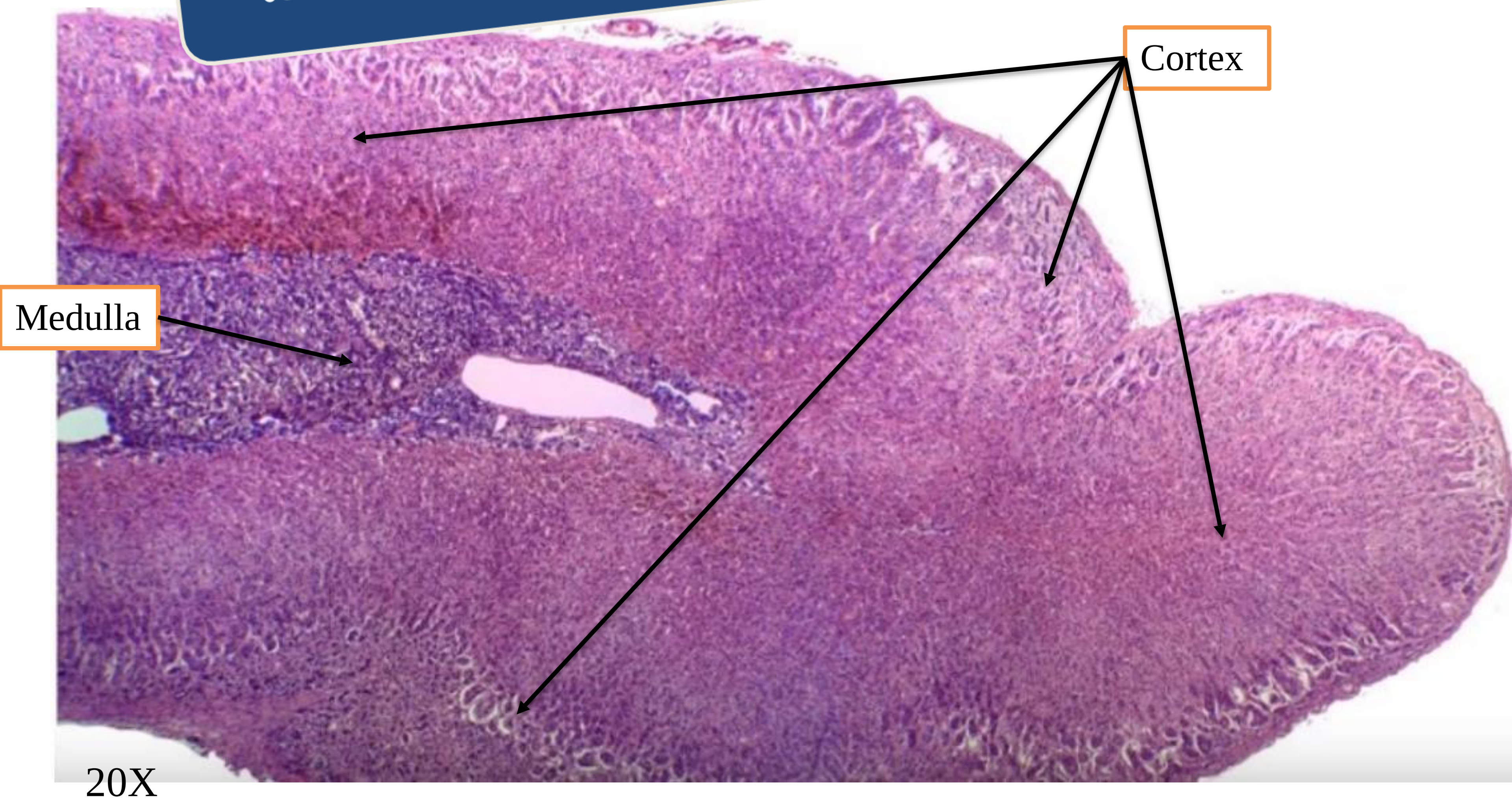
(c) Subdivisions of the adrenal gland

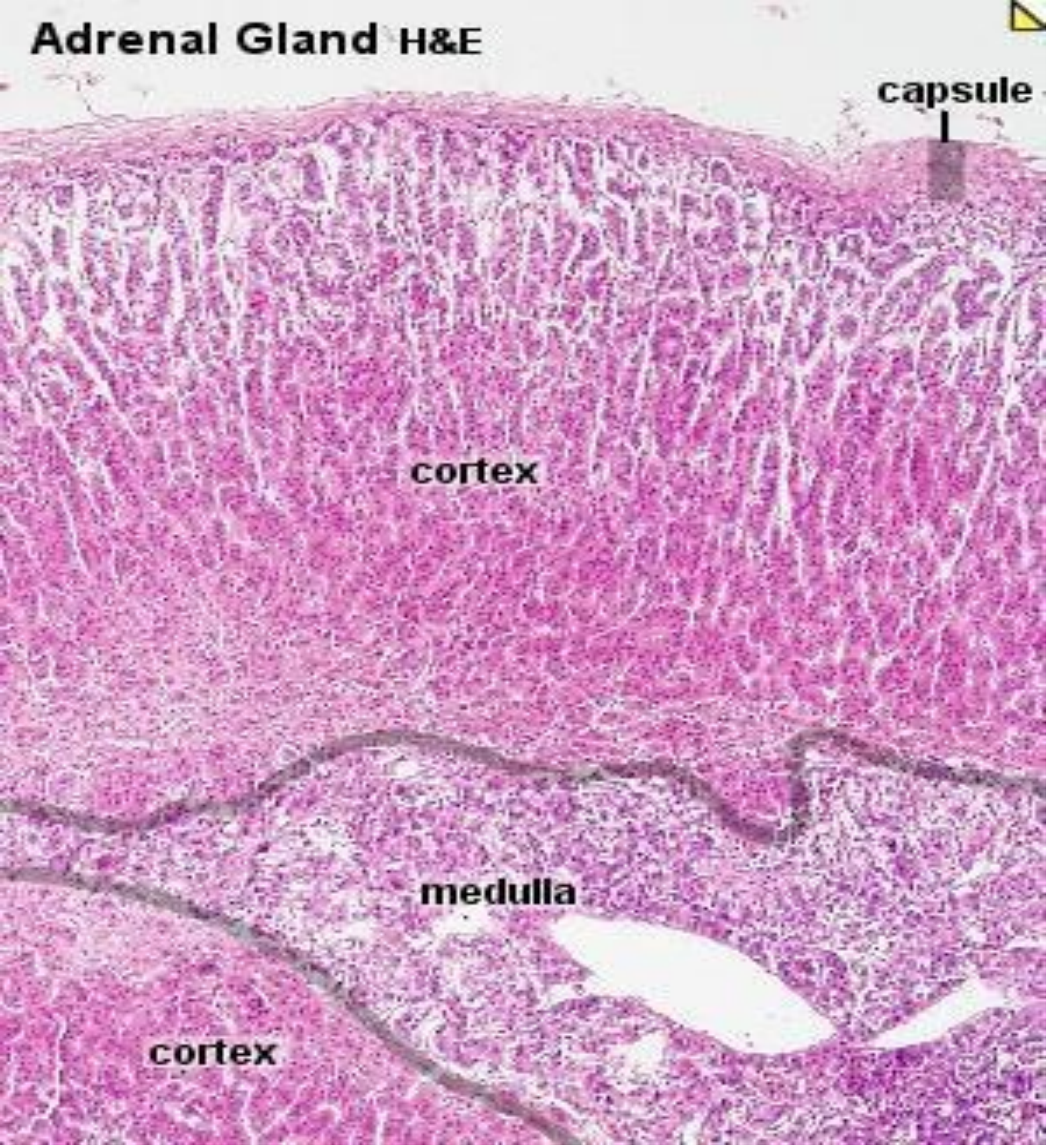
18.15

Previously we said that the adrenal gland is made out of 2 parts: cortex (larger part) and medulla

The gland is divided into an outer cortex- and an inner medulla.

Here it's evident that the cortex is much larger than the medulla





Here with higher magnification you can see that the adrenal gland is an **endocrine gland** having a capsule, and many clumps of cells with blood vessels sandwiched between them. The blood supply here is unique and there is an arrangement in the structure of the adrenal gland.

The cortex **regulates some of the secretions of the medulla.**

you wouldn't see it as cords here and there as we have witnessed in the PT and thyroid glands with different follicles, Here it would reserve these characteristics but we would see these clumps and cords rearrange the cortex into 3 layers

The adrenal cortex is composed of three zones histologically:

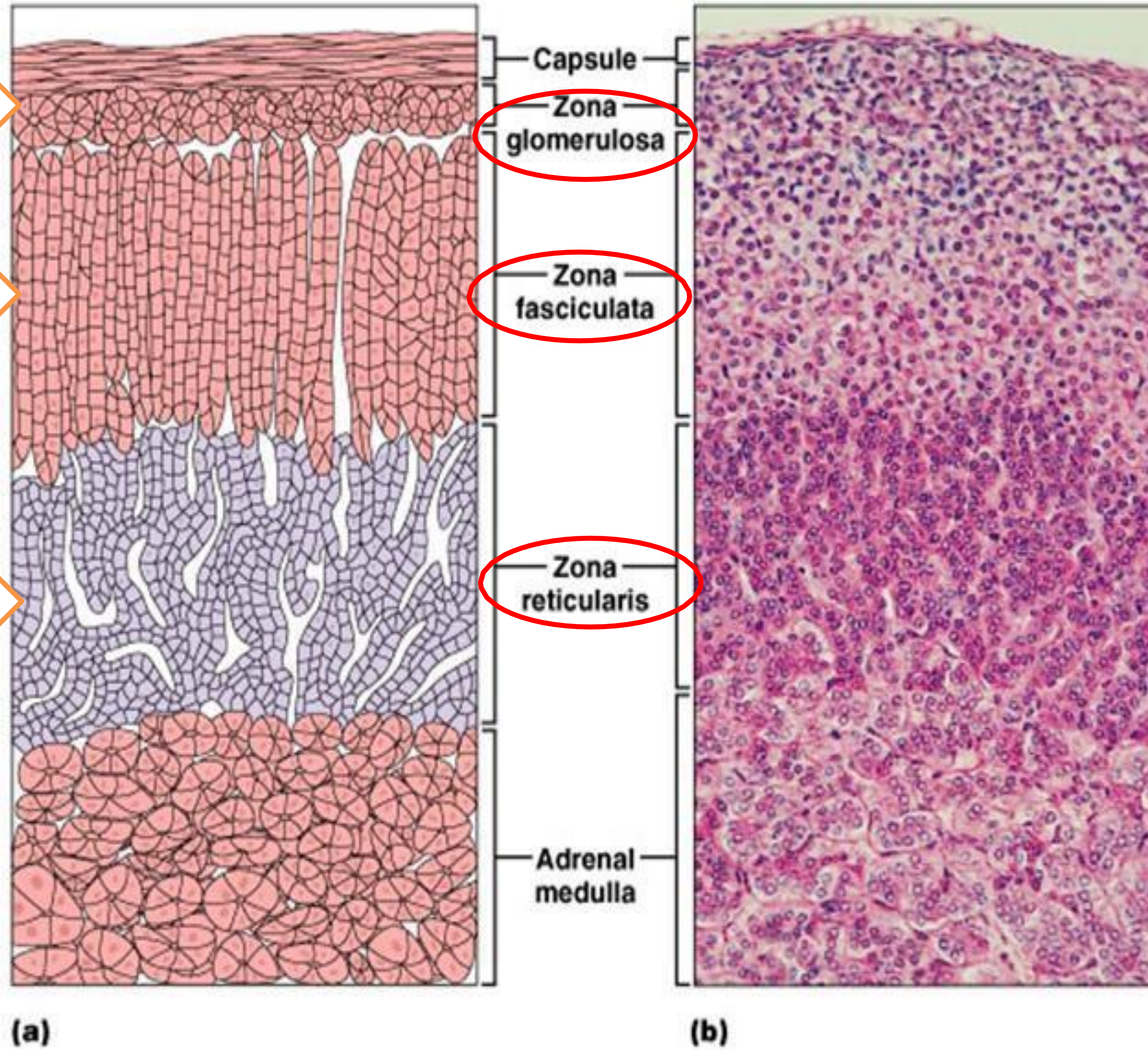
The morphological zonation of the cortex reflects a functional zonation in that

mineralocorticoids are produced in the **zona glomerulosa**

- glucocorticoids are produced in the **zona fascicularis** and reticularis,

sex hormones are produced in the **zona reticularis**

Here we'd see 3 distinct layers,
These are not only functional zonations but also they have embryological origin difference too.



Throw back …

Embryology of the cortex zones:

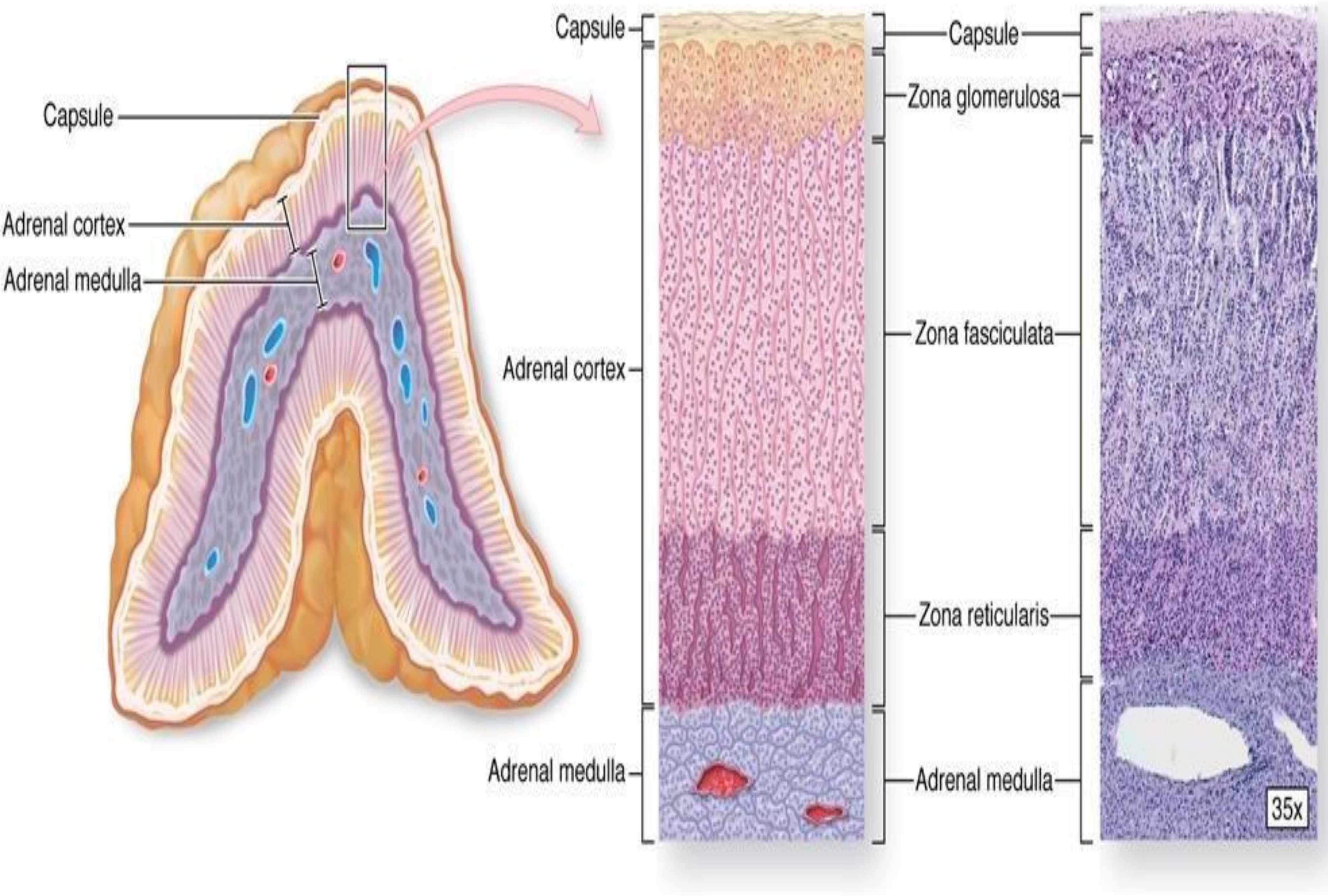
- They come from the intermediate mesoderm (mesodermal origin)

- They migrate in two waves:

First: large cells that form the fetal portion of the cortex (acidophilic)
Later on in the development: followed by another wave of migration, basophilic cells that are smaller that form the future permanent cortex.

➲ The earlier cells form the zona reticularis
➲ The later cells will differentiate into the fasciculata And the glomerulosa

Check the previous and the next slides to see these zonations well


Capsule
Adrenal cortex
Adrenal medulla
Capsule
Adrenal cortex
Adrenal medulla
Capsule
Zona glomerulosa
Zona fasciculata
Zona reticularis
Adrenal medulla
35x

- Hormones produced in the cortex are ***all steroids***

Consequently,

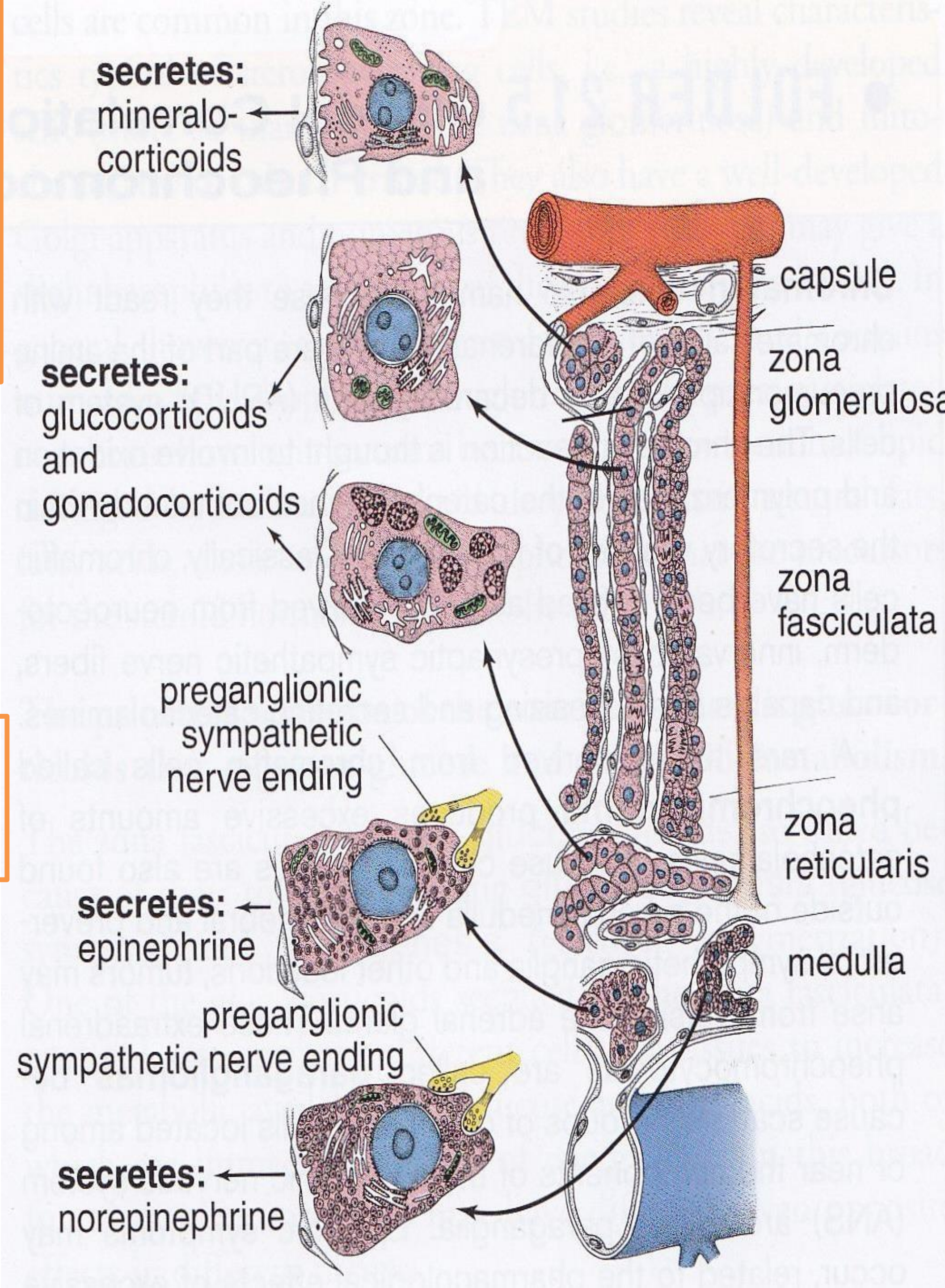
cortical cells contain large amounts of **smooth endoplasmatic reticulum** And **lipid droplets**

- Since the hormones are synthesized in the cortex they are more precisely termed

Corticosteroids

- Corticosteroids are further subdivided into **mineralocorticoids** and **glucocorticoids**

- The most important mineralocorticoid is **aldosterone**, which regulates the resorption of sodium and excretion of potassium in the tubules of the kidney

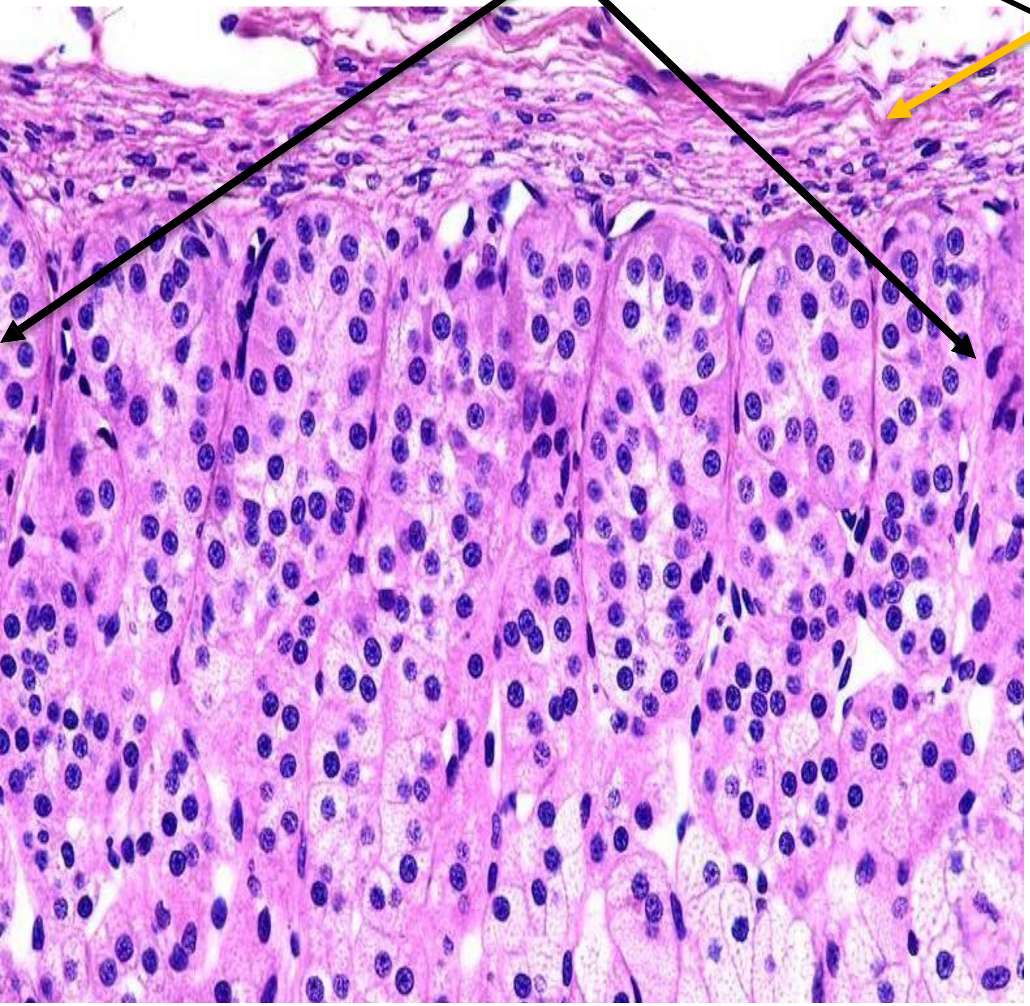


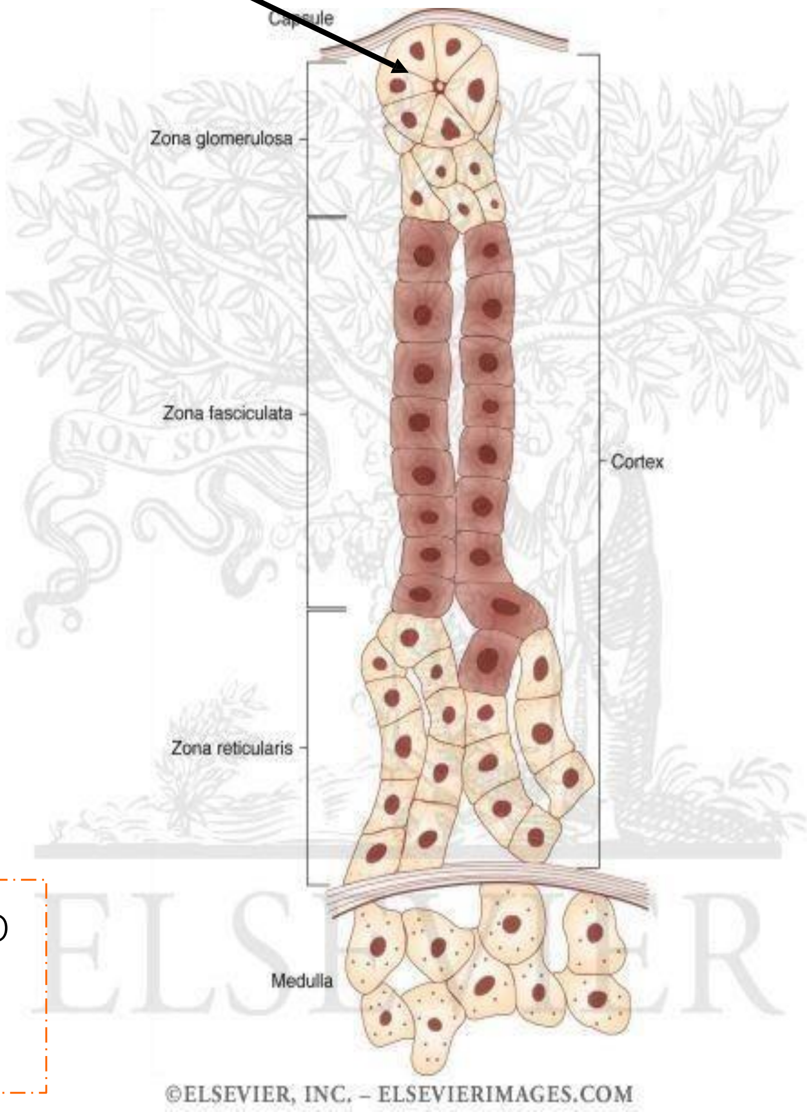
- The most important glucocorticoid is **cortisol**, which has a wide range of effects on most cells of the body. Cortisol effects protein catabolism in almost all cells aside from liver cells, gluconeogenesis, glycogen storage, mobilisation of fat from adipocytes, anti-inflammatory effects, inhibition of allergic reactions).

- Small amounts of androgens, estrogens and progesterone are also produced.

Zona glomerulosa

This is the capsule, fibrous tissue





To identify this layer, just think that it's close to the capsule, find the capsule and it'll be right there underneath it

Zona glomerulosa

Is the exclusive site of production of **aldosterone**. ★

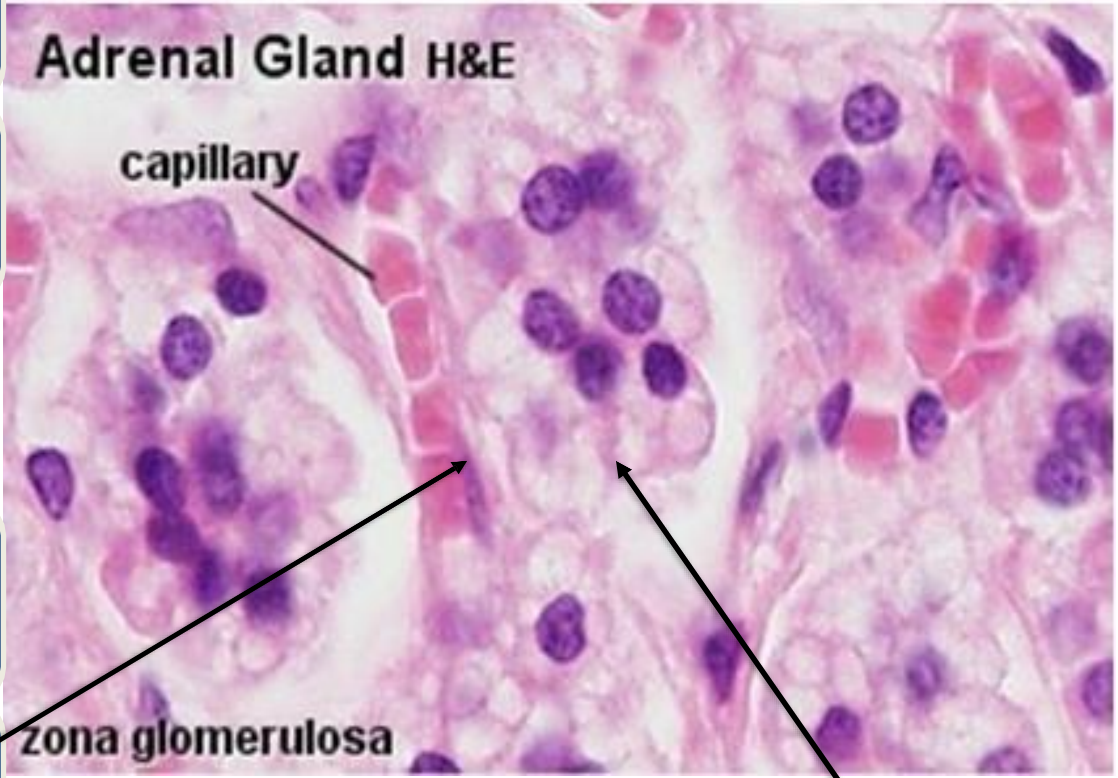
Consists ~ 15% of the cortex.

Cells are arranged in closely packed clusters continuous with the next layer.

Cells **are small pyramidal-columnar with spherical nuclei**.

Clusters of cells are surrounded by fenestrated sinusoidal capillaries.

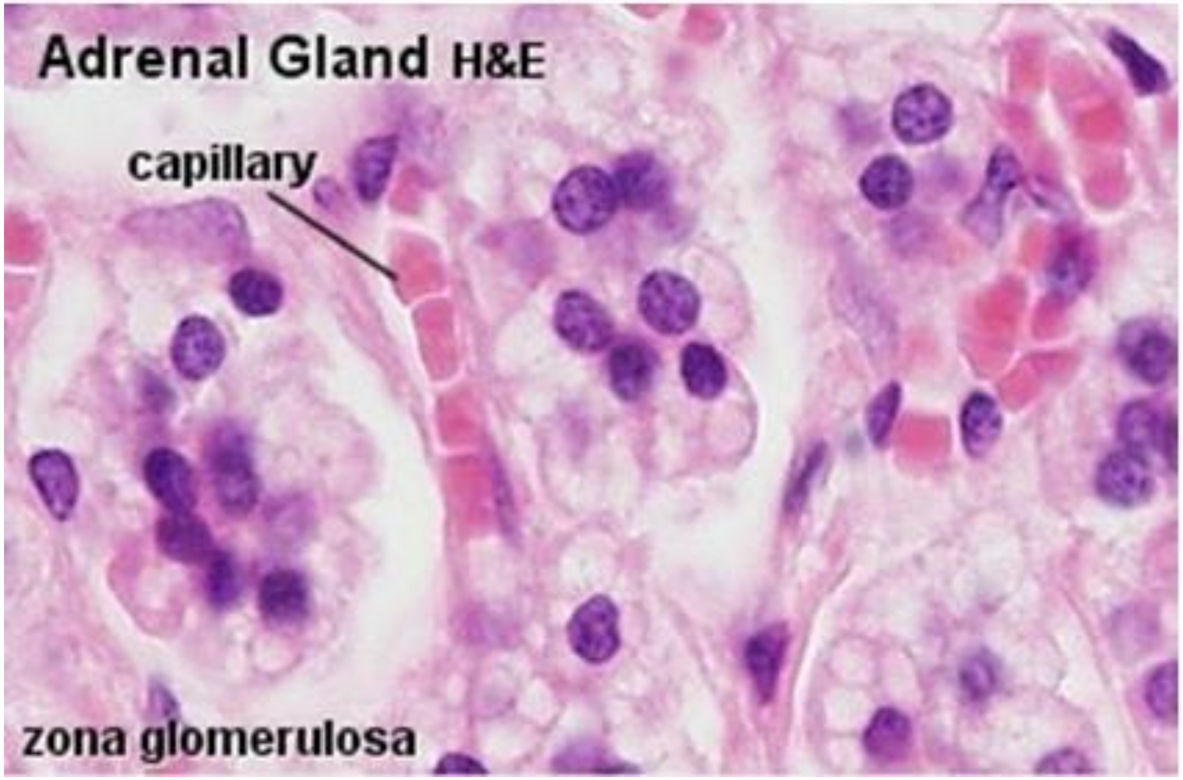
Cells have abundant **sER, large mitochondria with shelf-like cristae, Golgi complex**, few rER, and few **lipid droplets**. **characteristics of steroid cells** ★



Typical endocrine tissue with capillaries sandwiched between groups of cells (here they group in the shape of glomeruli)

Cells of zona glomerulosa; Notice the whitish area in place of the fat droplets

Dr.shatarat


Adrenal Gland H&E
capillary
zona glomerulosa

Zona glomerulosa secretes mineralocorticoids, that function in the regulation of sodium and potassium homeostasis and water balance.

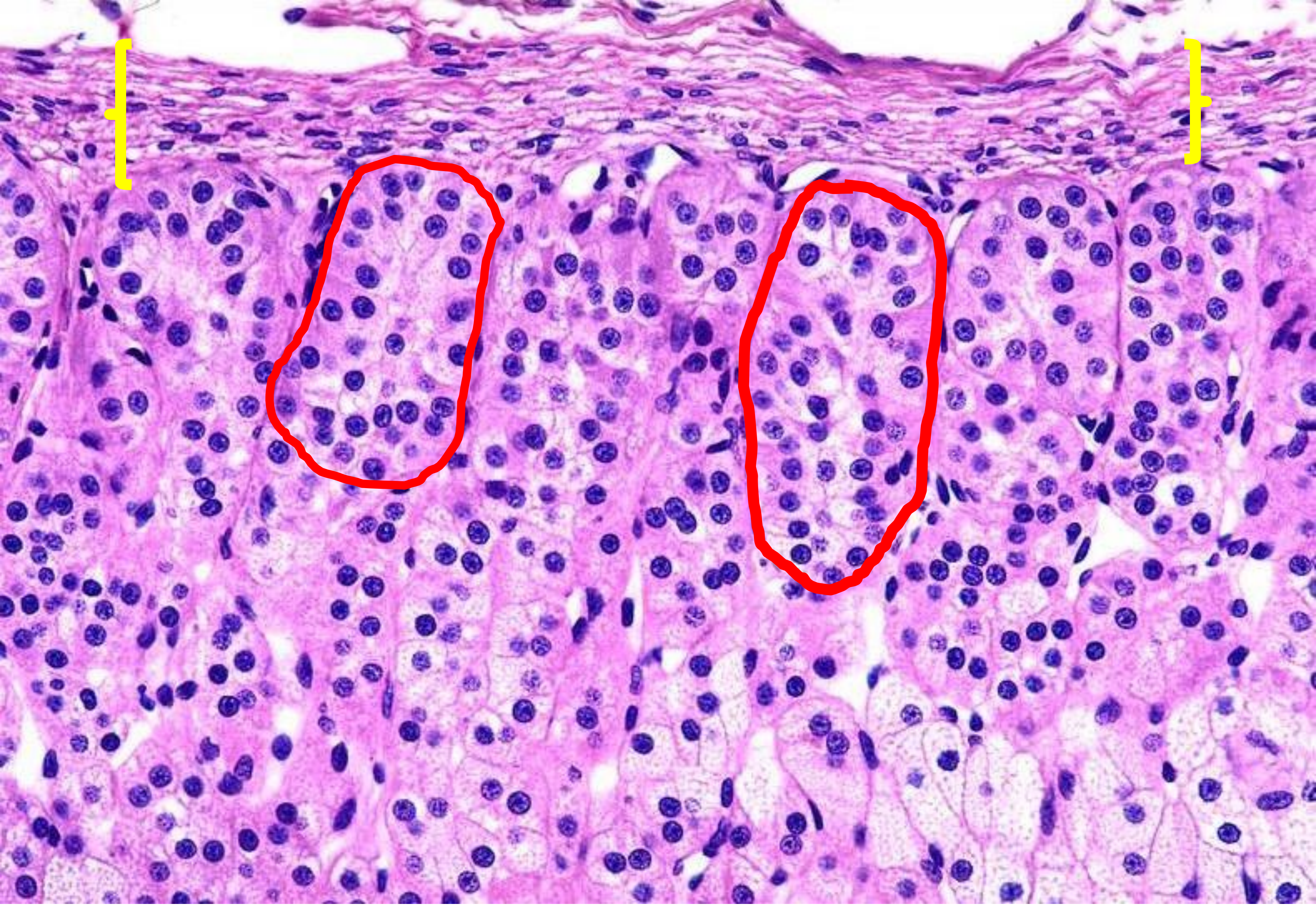
The main mineralocorticoid is aldosterone.

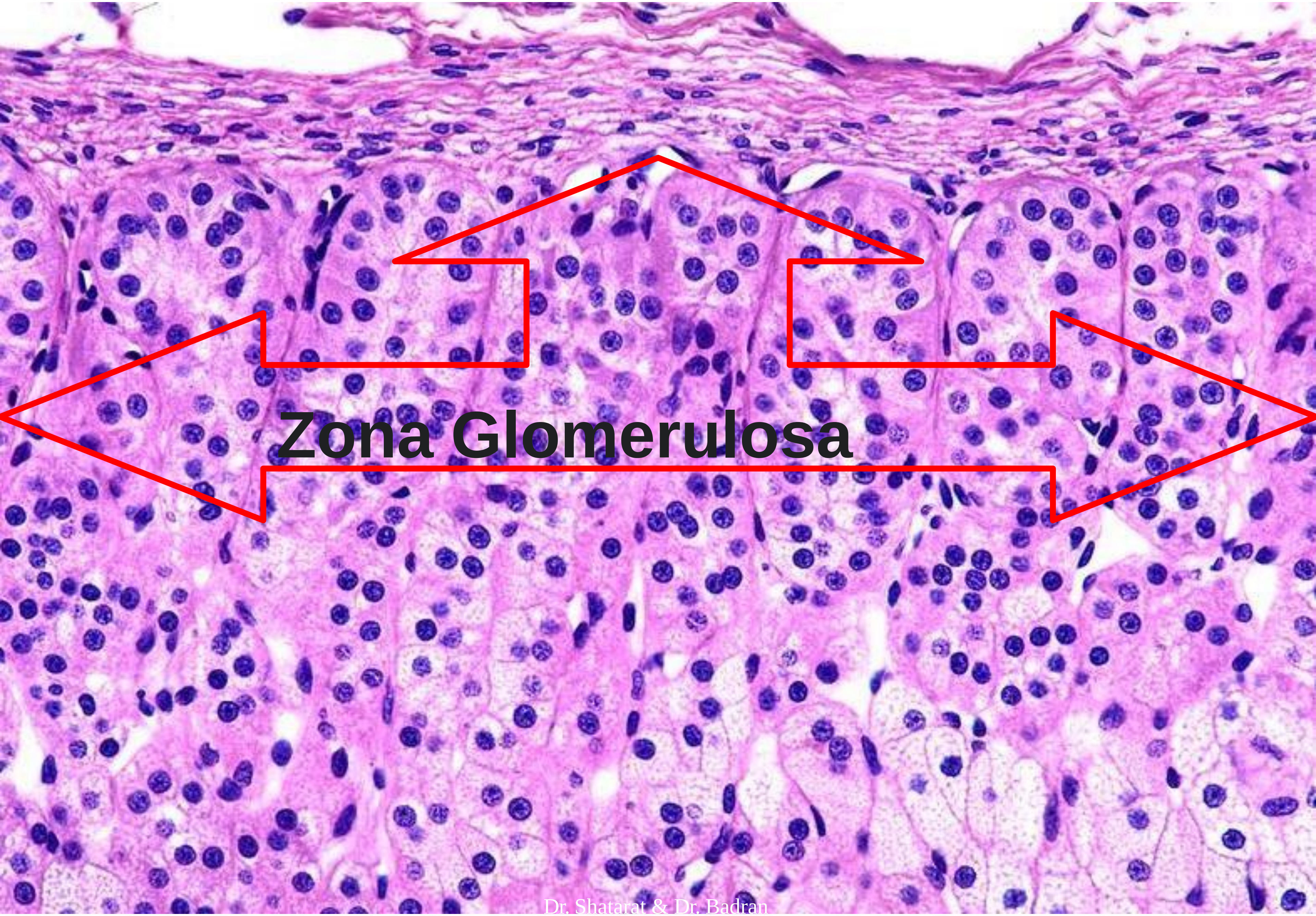
Aldosterone stimulates resorption of sodium from:

- Distal renal tubules.
- Gastric mucosa.
- Salivary glands.
- Sweat glands.

The zona glomerulosa is under the feed back control of the ***renin-angiotensin-aldosterone*** system.

➲ The doctor didn't talk physiology but he insisted that You need to know this feed back mechanism as a doctor because we do use these in lab tests when we investigate certain diseases

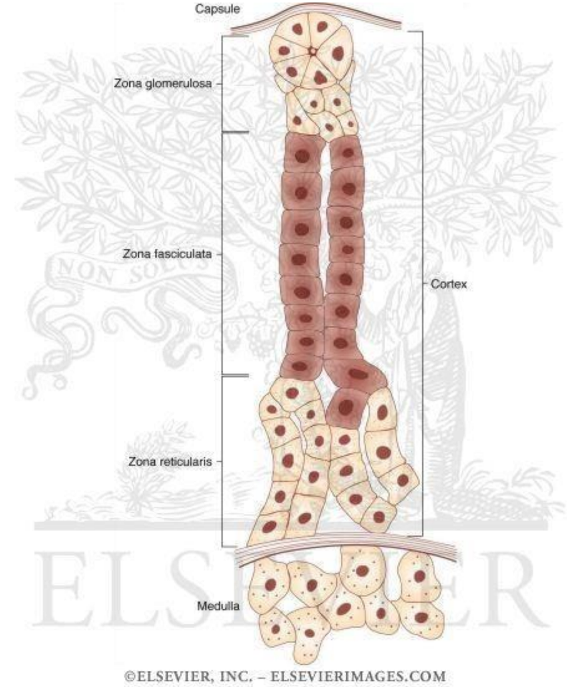


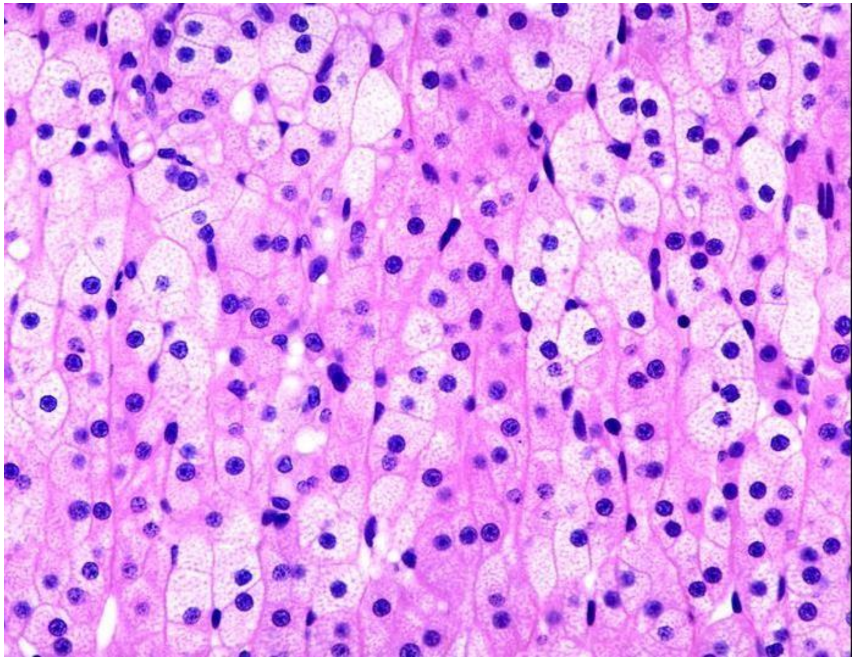

Zona Glomerulosa
Dr. Shatarat & Dr. Badran

Zona Fasciculata

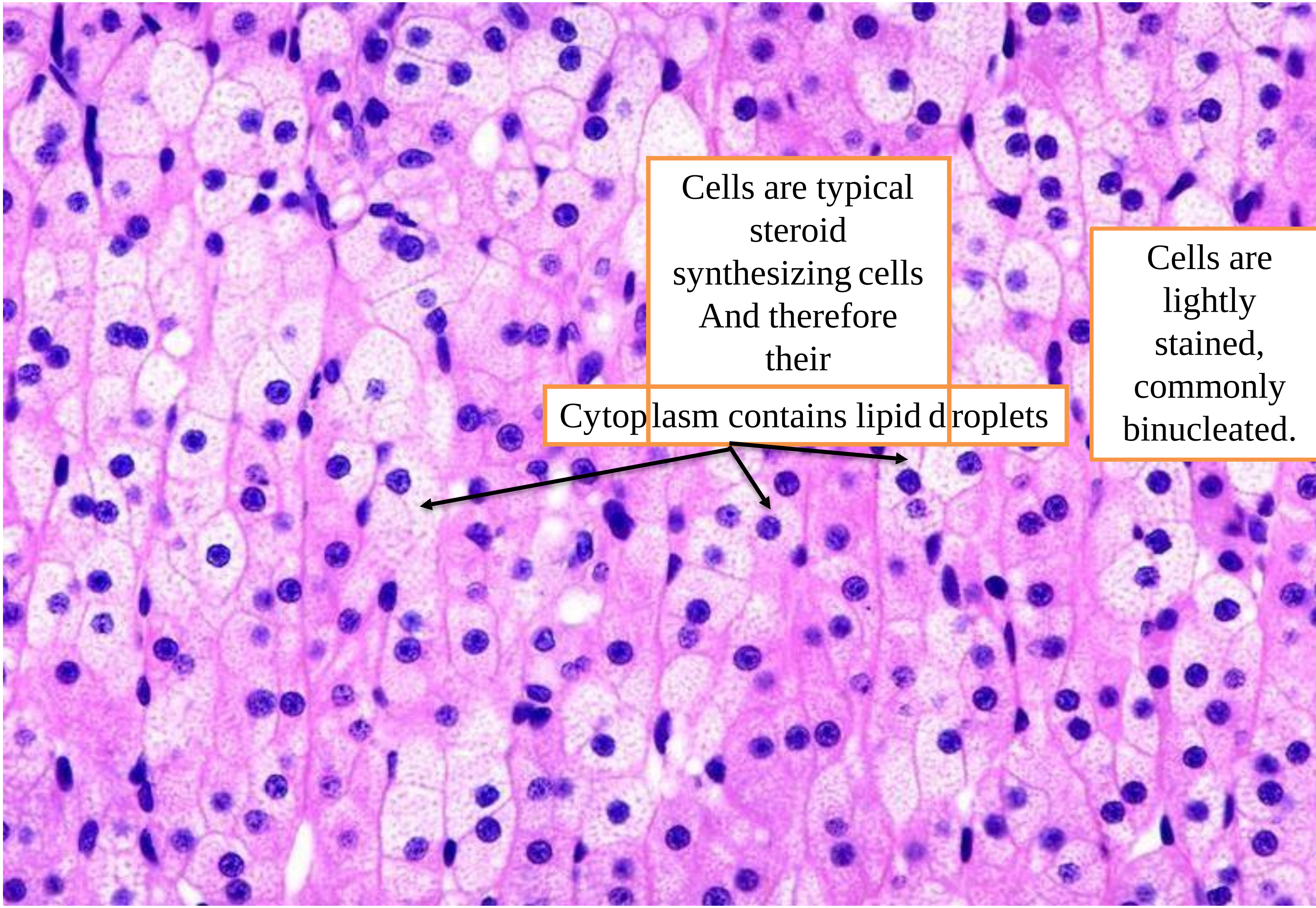
- The **thickest middle zone** that form ~80% of the cortex. ★
- Cells are large polyhedral, arranged in long straight cords 1-2 cells thick.
- **Cords are separated by sinusoidal capillaries. (endocrine cells characterisics)** ★
- Cells are lightly stained, commonly **binucleated**. ★
- Cells are typical **steroid synthesizing cells.** ★
- Cytoplasm contains lipid droplets.
- **Cells secrete glucocorticoids, mainly cortisol.**

Described before: sER, fat droplets



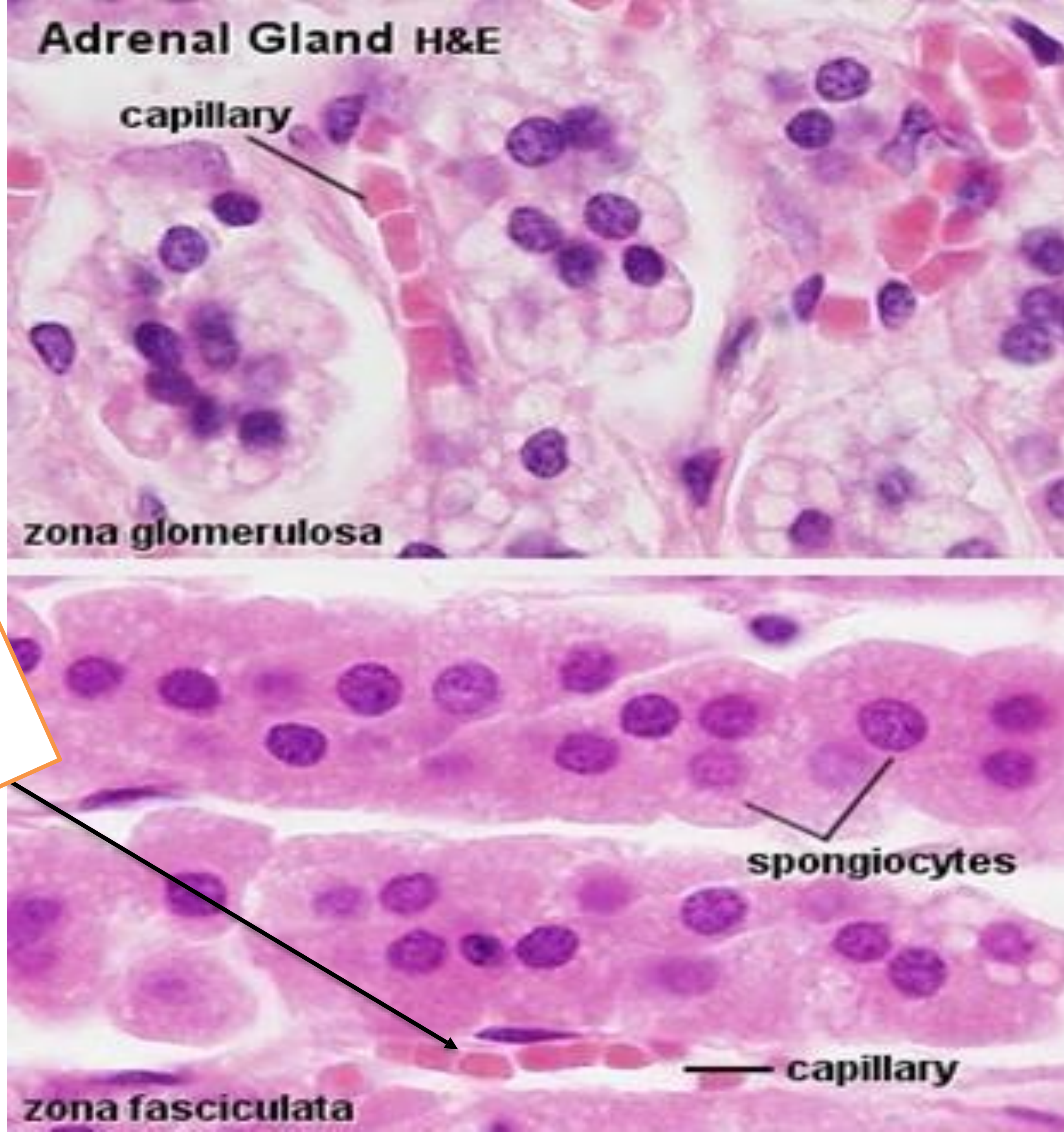


You don't need to memorize the shape of the cells, but you need to know their significant characteristics, are they steroid secreting, are they protein secreting?


Cells are typical
steroid
synthesizing cells
And therefore
their
Cytoplasm contains lipid droplets
Cells are
lightly
stained,
commonly
binucleated.

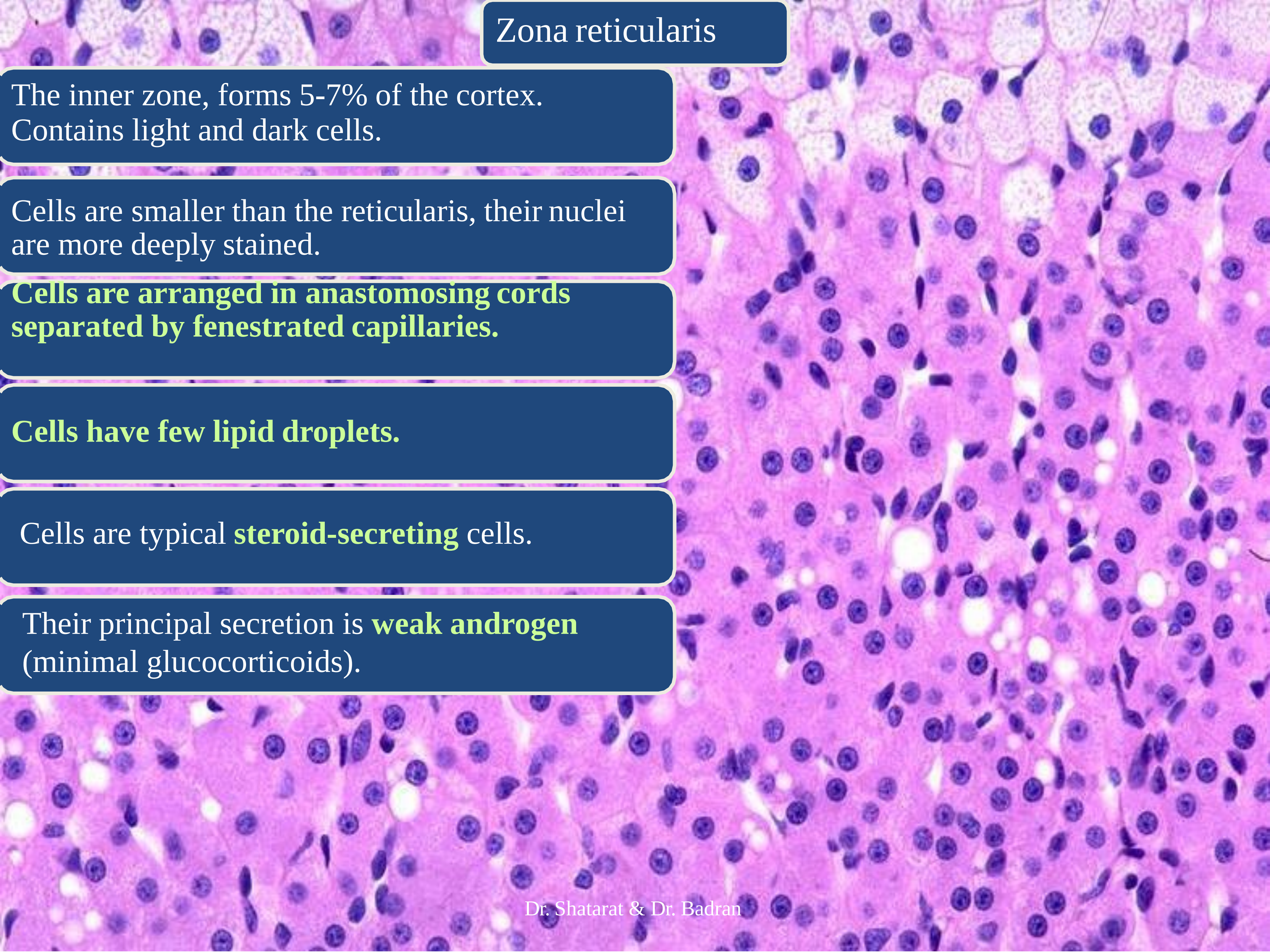
Until now we know that the first and second layers (glomerulosa, fasciculata) preserve the endocrine tissue features.
The third does too

Cords are separated by sinusoidal capillaries



Glucocorticoids may have different, even opposite effects in different tissues:

- In the liver:
  - ↑ conversion of aminoacids to glucose.
  - ↑ polymerization of glucose to glycogen.
  - ↑ uptake of aminoacids and fatty acids.
- In adipose tissue: ↑ breakdown of lipids to glycerol and free fatty acids.
- In other tissues: ↓ rate of glucose use and ↑ oxidation of fatty acids.
- In cells: ↓ protein synthesis and ↑ protein catabolism.



Zona reticularis

The inner zone, forms 5-7% of the cortex.
Contains light and dark cells.

Cells are smaller than the reticularis, their nuclei are more deeply stained.

Cells are arranged in anastomosing cords separated by fenestrated capillaries.

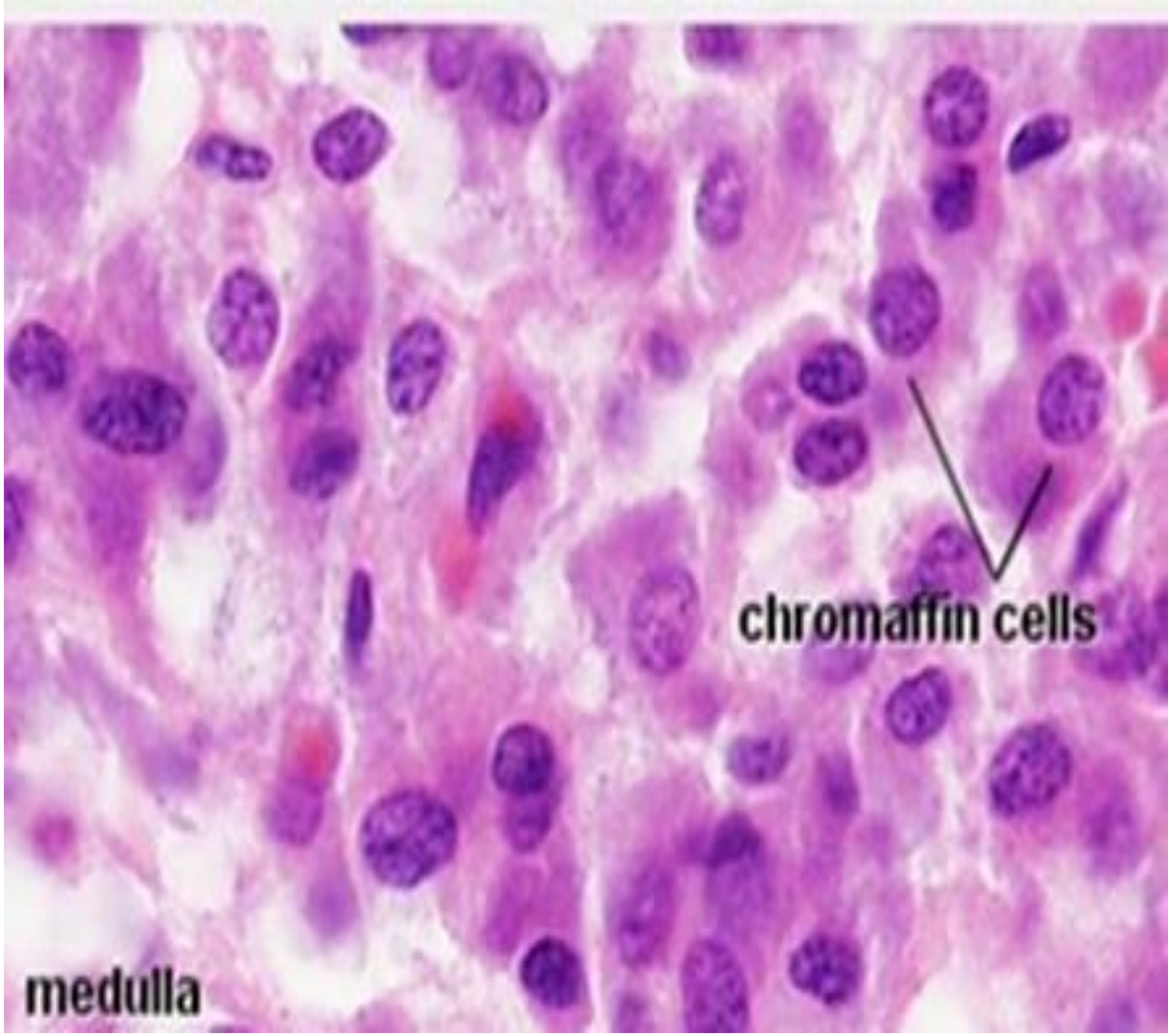
Cells have few lipid droplets.

Cells are typical **steroid-secreting** cells.

Their principal secretion is **weak androgen** (minimal glucocorticoids).

Medulla

- The medulla is not sharply delimited from the cortex. Some times a section of the medulla would show intermingling with the cortex
- Cells are arranged in strands or small clusters.
- Capillaries and venules in the intervening spaces.
- The cytoplasm of the cells is weakly basophilic.
- **They are *called chromaffin* cells because the granules of these cells can be stained with *potassium bichromate***



Throwback …
In embryogenesis the medulla was formed by the migration of neural crest cells

Neural crest cells form all the ganglia in the body.
Neural crest cells as they migrate and settle in the medulla they lose their branching, axons and they become what we call chromaffin cells, because they stain with potassium bichromate or chromium.

Adrenal medulla

You can say it's an endocrine tissue

Composed of large, pale staining epithelioid cells; **chromaffin cells**, connective tissue, sinusoidal capillaries and nerves.

The chromaffin cells are ***modified neurons.***

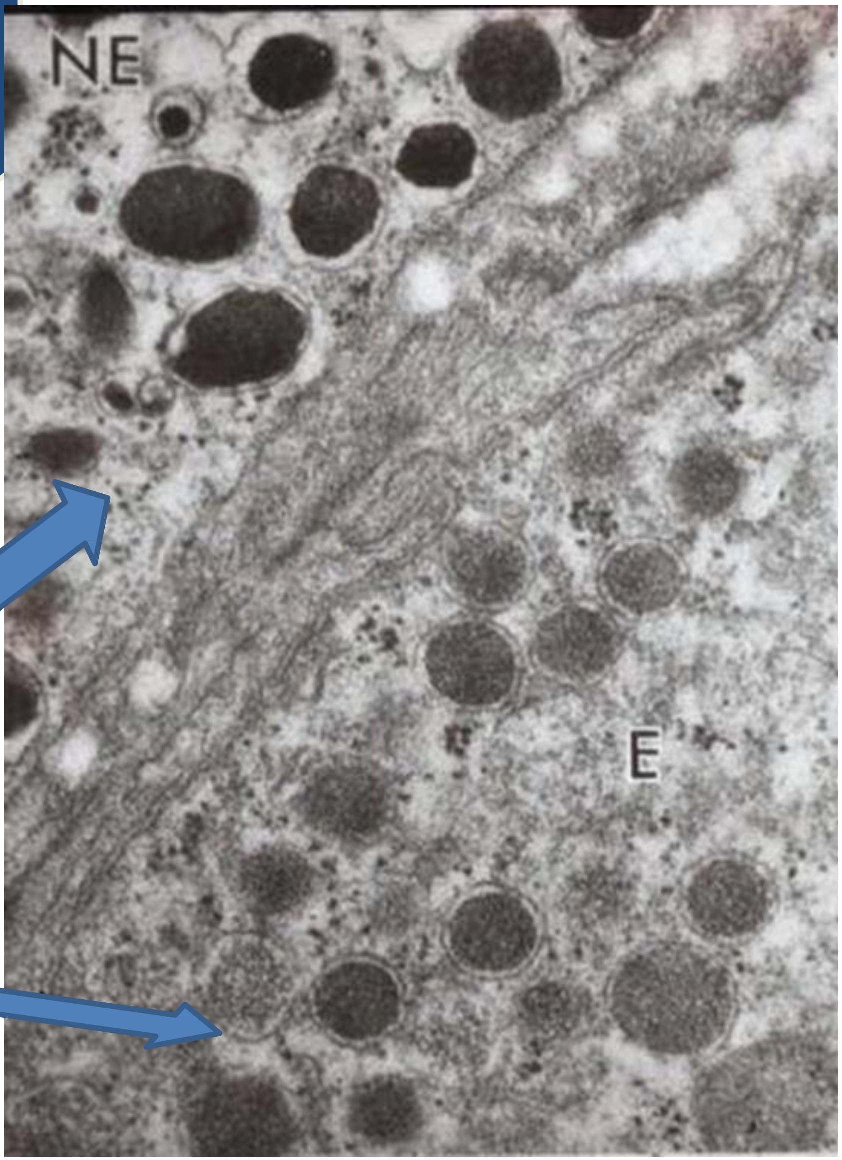
Myelinated, presynaptic nerves **pass directly to chromaffin cells**. "That come from the anterolateral horns of the spinal cord, and they pass through sympathetic chain without any interruption then they continue to the medulla, some do work near ganglia"

Check the previous lecture about the innervation of the medulla

Chromaffin cells

E.M shows that there are two types of chromaffin cells:

- Cells containing large dense core vesicles → secrete norepinephrine.
- Cells containing small homogeneous less dense vesicles → secrete epinephrine.



Glucocorticoids secreted in the cortex induce the conversion of norepinephrine to epinephrine in chromaffin cells.

Here we discuss the relationship between the cortex and the medulla

Most of chromaffin cells at the cortico-medullary junction secrete epinephrine.

Norepinephrine-secreting cells are also found in paraganglia (collections of catecholamine-secreting cells adjacent to the autonomic ganglia) and in various viscera. The conversion of norepinephrine to epinephrine (adrenalin) **occurs only in chromaffin cells of the adrenal medulla**

Because the association between the cortex and the medulla permits that

About 80% of the catecholamine secreted from the adrenal is epinephrine

Cortisol helps in the transformation of norepinephrine into epinephrine *follows the previous slide

The catecholamines, in concert with the glucocorticoids, prepare the body for the “fight-or-flight” response.

Sudden release of catecholamines establishes conditions for maximum use of energy.

An example to remember for the rest of your career on sympathetic and parasympathetic response: (not for examination)

Sympathetic

Imagine that you open a room in the darkness and all of a sudden a lion is looking at you

How would you describe your reaction?

You're frightened

Your eyes are open widely, your pupils are dilated

Your heart is racing (accelerating)

Your respiration is increased

Your metabolism is increased so that you can run away

If anyone offers you food while you're running you'll just say no, because all your digestive system is turned off

When you're asked about the sympathetic influence in any organ just remember this.

Parasympathetic

Imagine you're eating **Mansaf** and describe yourself

You barely can open your eyes (relaxed eyes)

Your pupils are small

You can't even remember what you're doing

Your heart rate is decreased

Your respiratory rate is decreased

Your metabolism is deceased

However, one system is on full action THE DIGESTIVE SYSTEM

Read for knowledge , not examination material

The adrenal gland can do all that to your body, your brain senses danger, sends messages to the hypothalamus, which sends messages to the lateral horns of the spinal cord and from there you have preganglionic sympathetic nerves coming directly to your adrenal gland without any interruption, reaching chromaffin cells, which have this large amount of epinephrine and norepinephrine to be secreted through the venous drainage; that was designed to squeeze all of that to a location near the heart not fat away from the IVC which immediately send it to the right atrium and from there it should be pumped to the whole body within less than seconds

This is the fight response at its best orchestrated by the adrenal gland

Medullary chromaffin cells

are innervated by ***preganglionic sympathetic neurons***,

They trigger epinephrine and norepinephrine release during stress and intense emotional reactions.

Epinephrine increases:

- heart rate
- dilates bronchioles,
- dilates arteries of cardiac and skeletal muscle.

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***. Together these effects augment the capability for defensive reactions or escape of stressors, the fight-or-flight response.

During normal activity the adrenal medulla continuously secretes small quantities of these hormones.

PINEAL GLAND

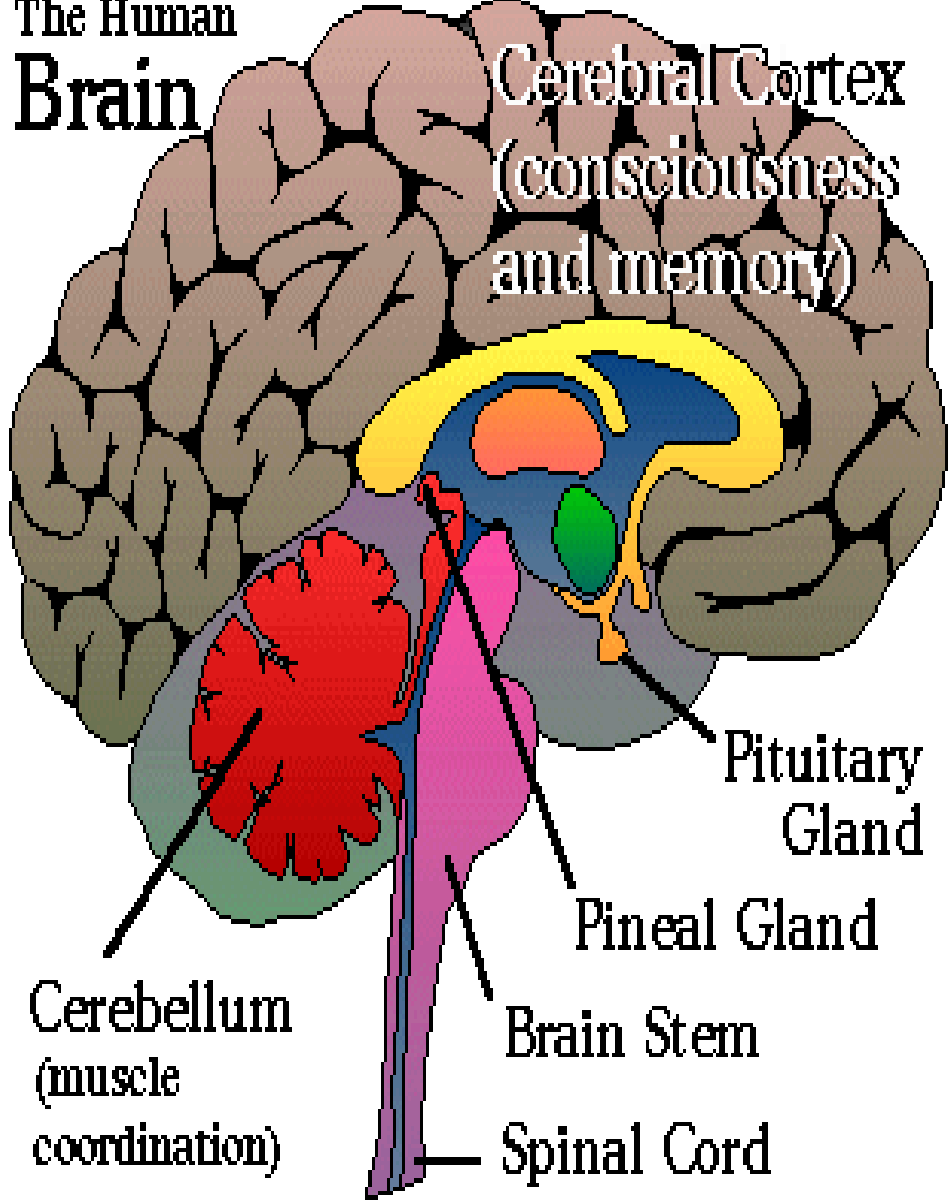
PINEAL GLAND

Also called pineal body, **epiphysis** cerebri
is an endocrine or neuroendocrine gland that regulates daily body rhythm.

It develops from **neuroectoderm** **of the posterior portion of the roof of the diencephalon and remains attached to the brain by a short stalk**.

In humans, it is located at the posterior wall of the third ventricle near the center of the brain.

The pineal gland is a flattened, pine cone–shaped structure
It measures 5 to 8 mm high and 3 to5 mm in diameter and weighs between 100 and 200 mg.



➲The doctor will not ask about this because it's brainy stuff, and brainy stuff is for next year

The pineal gland contains two types of parenchymal cells:

Pinealocytes
Interstitial (glial) cells.
Like CNS; neurons and supportive cells

Pinealocytes are the chief cells of the pineal gland. They are arranged in clumps or cords within lobules formed by connective tissue septa that extend into the gland from the pia mater that covers its surface.

Endocrine tissue

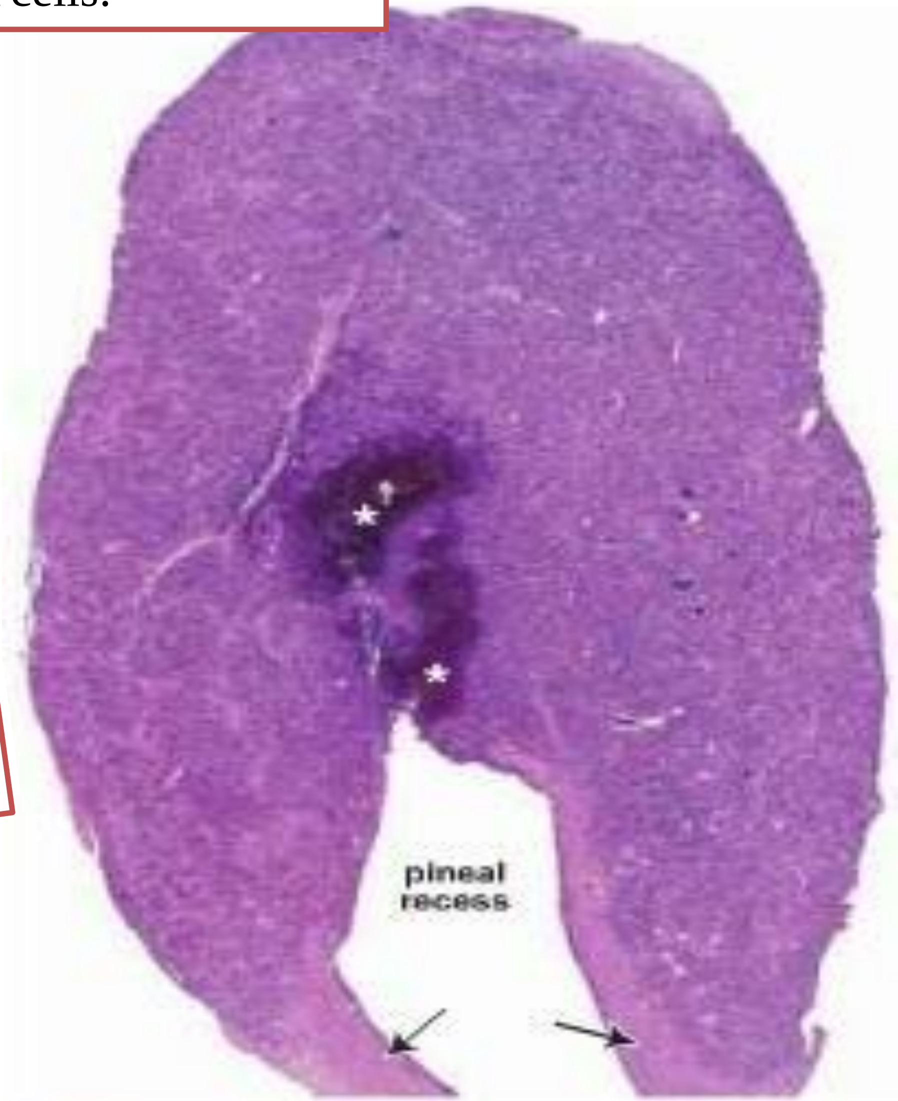
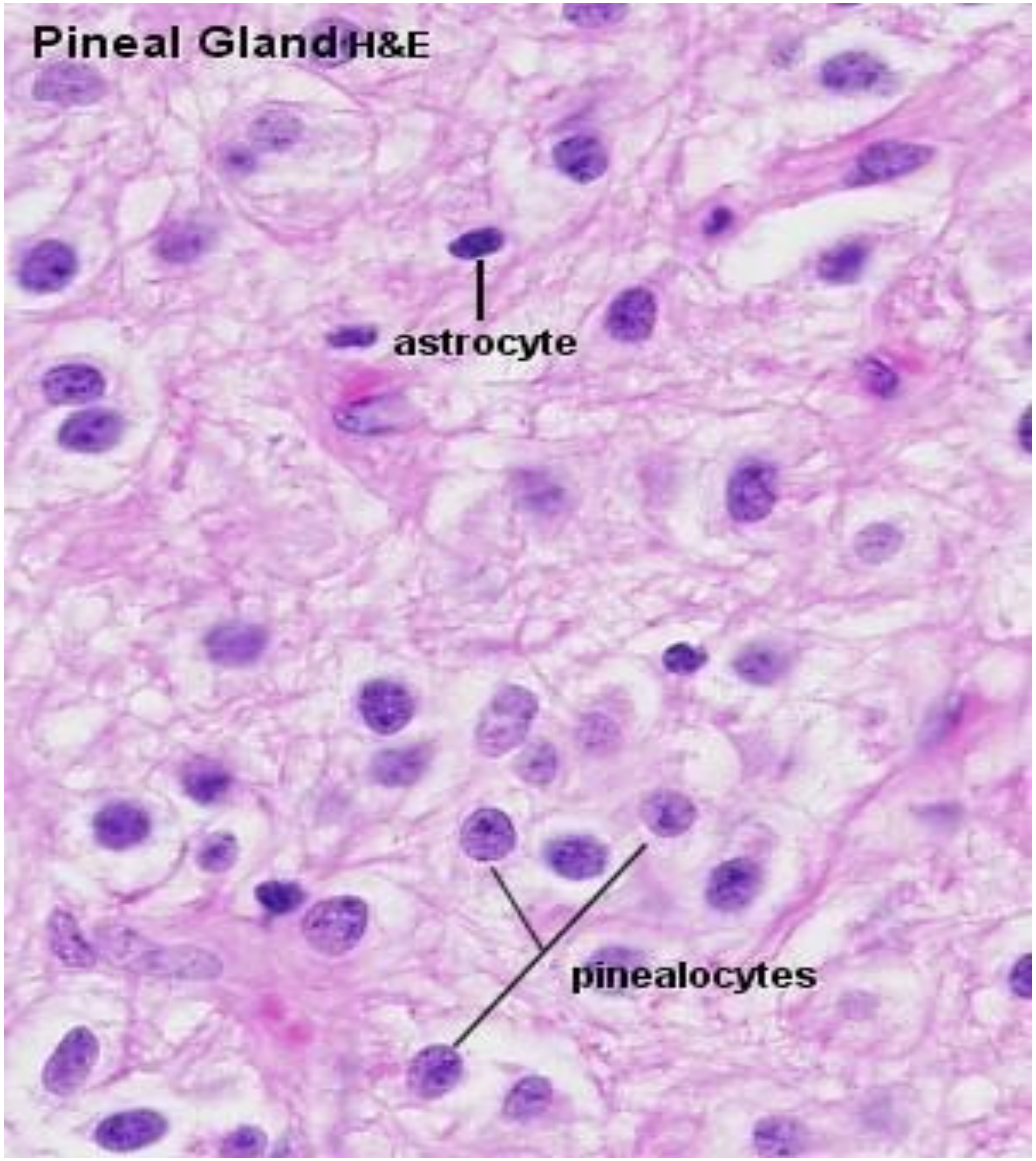


FIGURE 21.11 • Photomicrograph of infant pineal gland. This H&E–stained section is from a median cut through the pine cone–shaped gland. The conical anterior end of the gland is at the top of the micrograph. The arrows indicate the part of the gland that connects with the posterior commissure. The gland is formed by an evagination of the posterior portion of the roof of the third ventricle (diencephalon). The dark areas indicated by asterisks are caused by bleeding within the gland. ×25.

Pineal gland, sheep - H&E

Read only

The parenchyma of the pineal gland looks rather homogeneous at low magnification. A few blood vessels are visible criss-crossing through the gland. At higher magnification three types of nuclei can be distinguished. Small dark nuclei belong to the astrocytes found in the pineal gland. Pinealocytes have larger, lighter and round nuclei, which are surrounded by a broad rim of light cytoplasm. Most nuclei present are the nuclei of pinealocytes. Endothelial cell nuclei are found in association with the vessels and capillaries traversing the tissue. Both pinealocytes and astrocytes have long processes which give the tissue between the nuclei its "stringy" appearance.

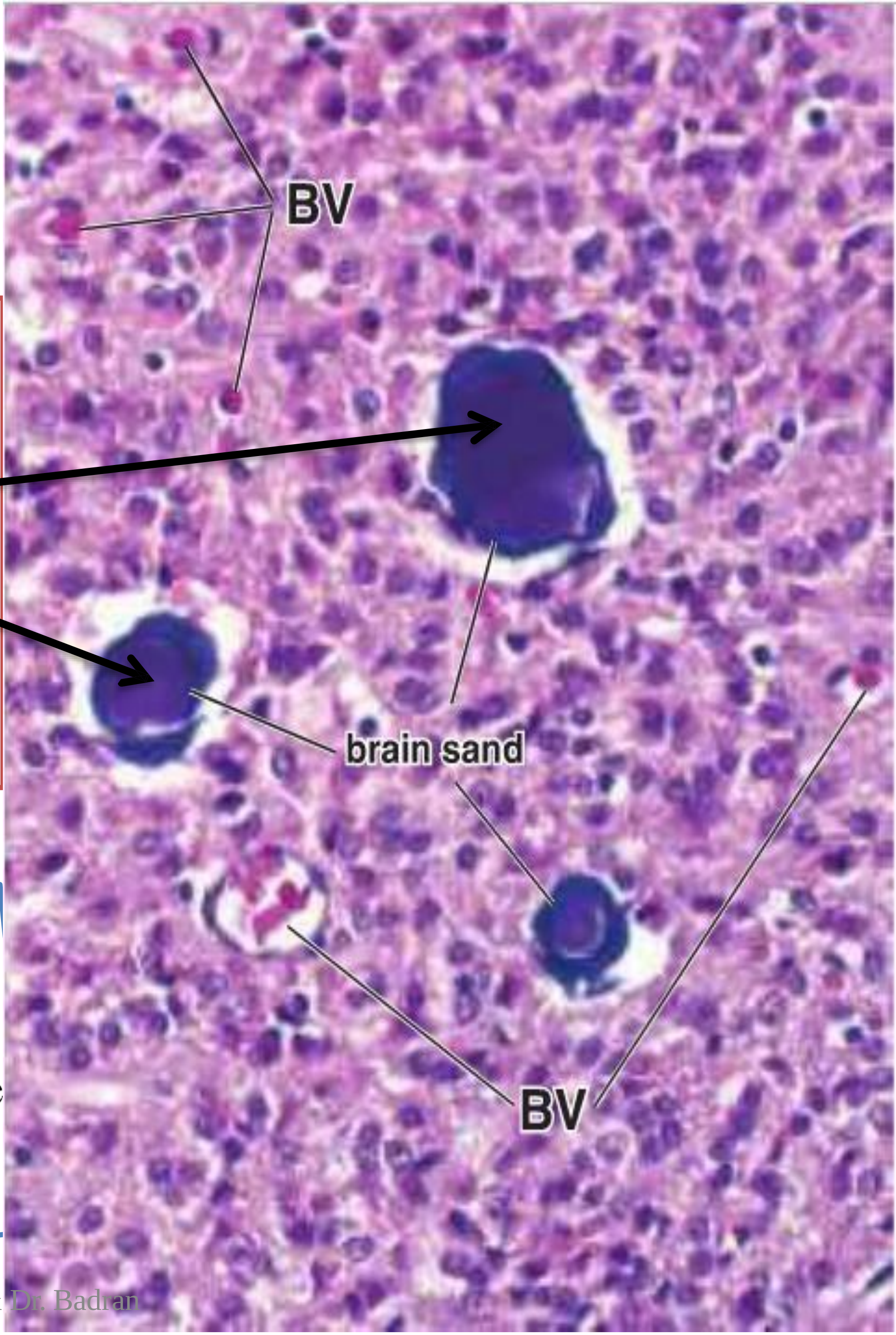


The interstitial (glial) cells constitute about 5% of the cells in the gland.

In addition to the two cell types,
the human pineal gland is characterized by the presence of calcified concretions called

★ **brain sand**

~~It appears to be derived from precipitation of calcium phosphates and carbonates on carrier proteins that are released into the cytoplasm when the pineal secretions are exocytosed~~



The concretions are recognizable in childhood and increase in number with age.
Because they are opaque to X-rays and located in the midline of the brain, they serve as convenient markers in radiographic and computed **tomography (CT) studies** ★

Hormone	Composition	Source	Major Functions
Melatonin ★	Indolamine (*N*-acetyl-5-methoxytryptamine)	Pinealocytes	Regulates daily body rhythms and day/night cycle (circadian rhythms); inhibits secretion of GnRH and regulates steroidogenic activity of the gonads particularly as related to the menstrual cycle; in animals, influences seasonal sexual activity

Know the hormone and the major functions and the info in the box

The pineal gland is a photosensitive organ and an important time keeper and regulator of the day/night cycle (circadian rhythm).
It obtains information about light and dark cycles from the retina via the
retinohypothalamic tract

Retina is connected to the hypothalamus connected to the pineal gland

Read and enjoy

Melatonin

- is released in the dark and regulates reproductive function in mammals by inhibiting the steroidogenic activity of the gonads
- Production of gonadal steroids is decreased by the inhibitory action of melatonin on neurosecretory neurons located in the hypothalamus (arcuate nucleus) that produce GnRH.
- Inhibition of GnRH causes a decrease in the release of FSH and LH from the anterior lobe of the pituitary gland. In addition to melatonin, extracts of pineal glands from many animals contain numerous neurotransmitters, such as serotonin, norepinephrine, dopamine, and histamine, and hypothalamic-regulating hormones, such as somatostatin and TRH.
- Clinically, tumors that destroy the pineal gland are associated with precocious (early-onset) puberty.
- Animal studies demonstrate that information relating to the length of daylight reaches the pineal gland from photoreceptors in the retina.
- The pineal gland thus influences seasonal sexual activity. Recent studies in humans suggest that the pineal gland has a role in adjusting to sudden changes in day length, such as those experienced by travelers who suffer from jet lag.
- In addition, the pineal gland may play a role in altering emotional responses to the reduced length of day during winter in temperate and subarctic zones known as seasonal affective disorder (SAD)