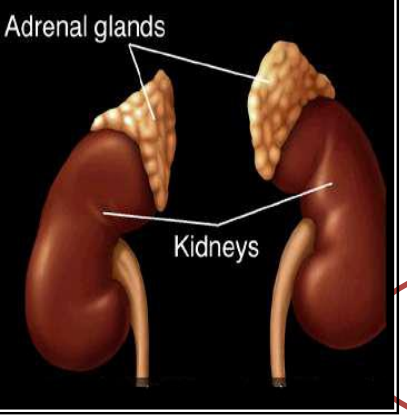
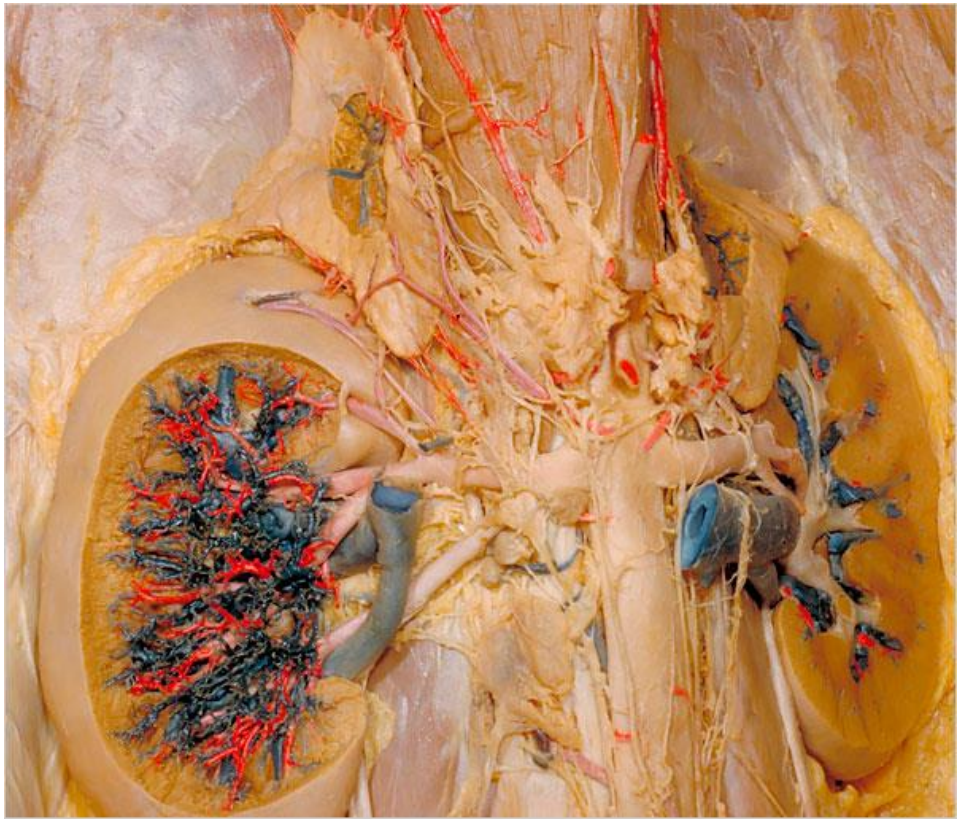
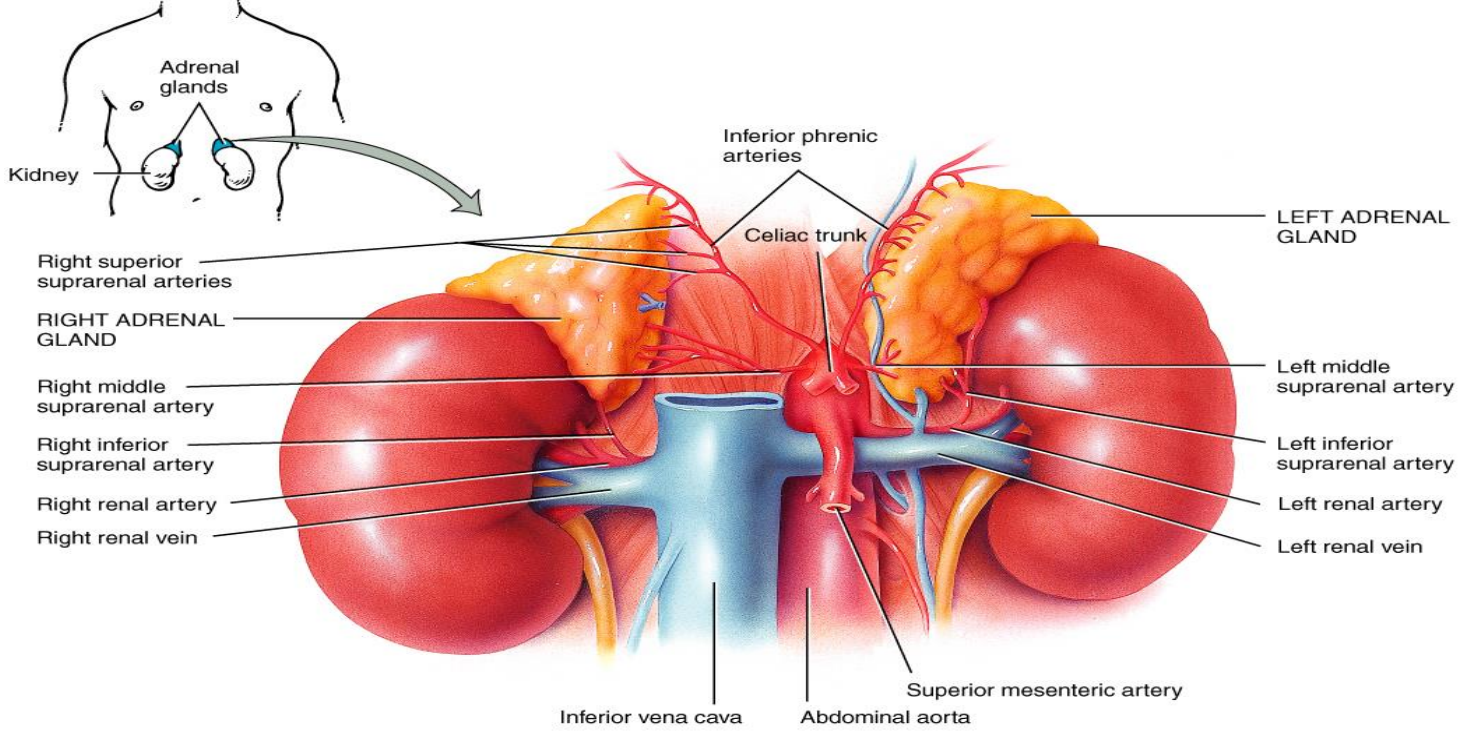
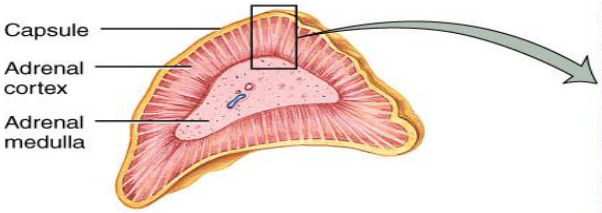


Suprarenal (adrenal) Glands

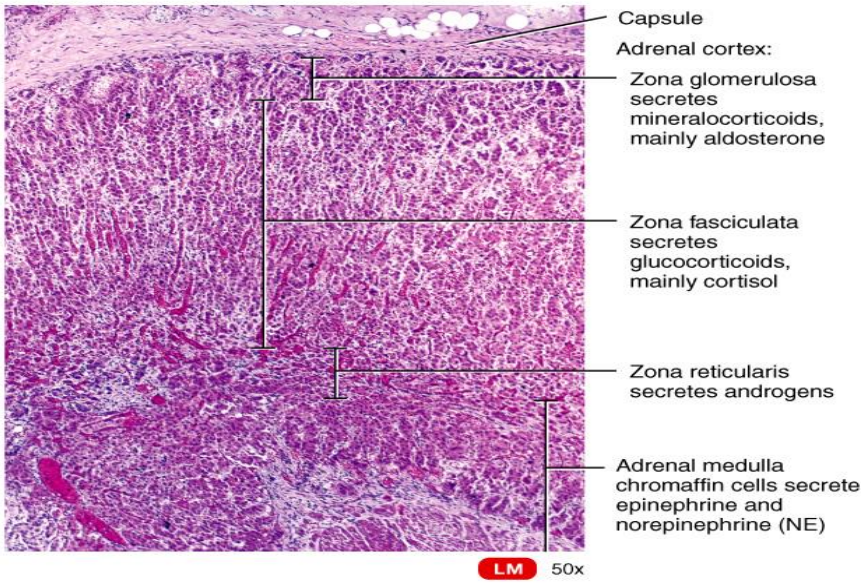




(a) Anterior view

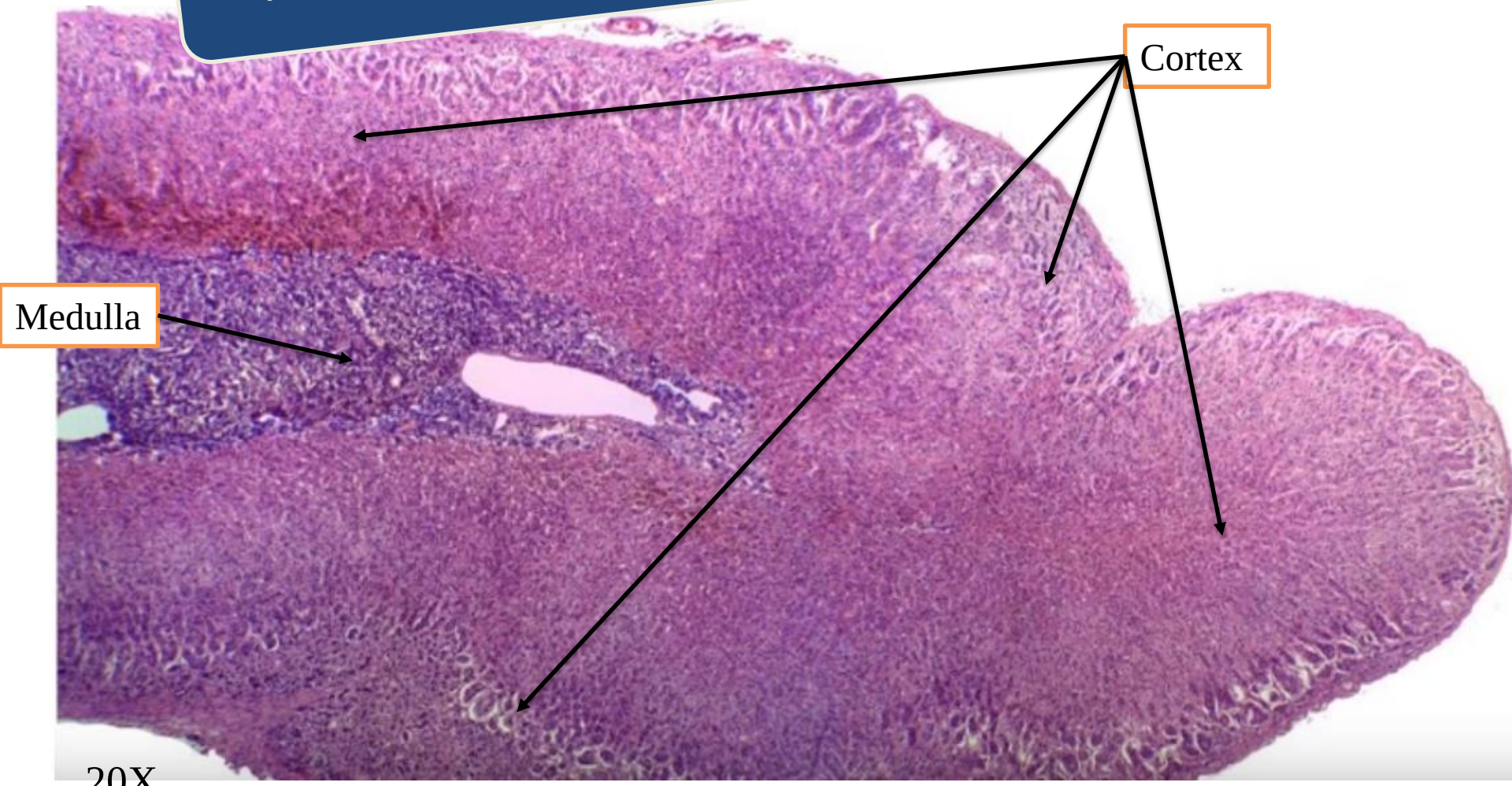


Section through left adrenal gland

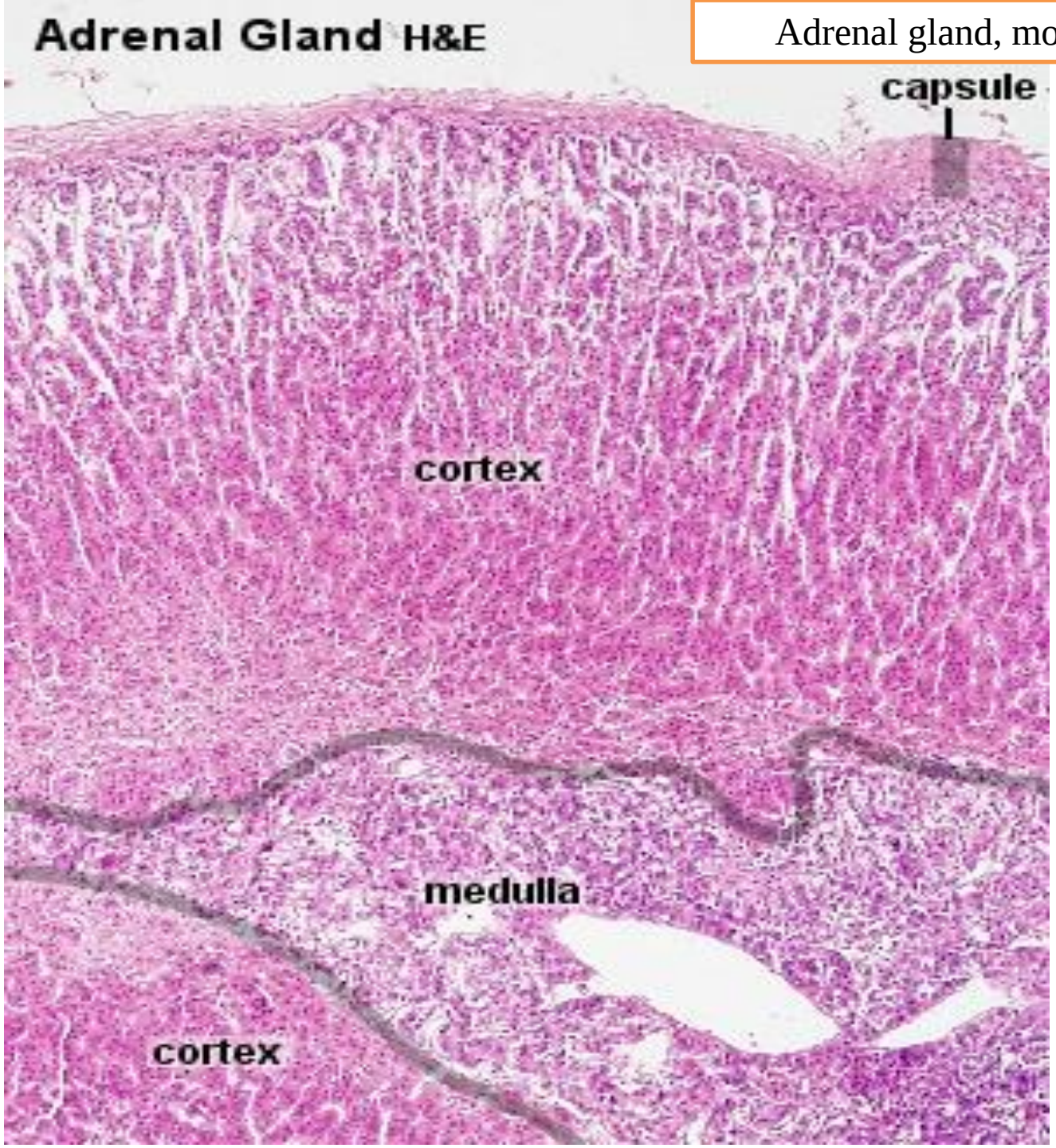


(c) Subdivisions of the adrenal gland

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



Adrenal gland, monkey - H&E



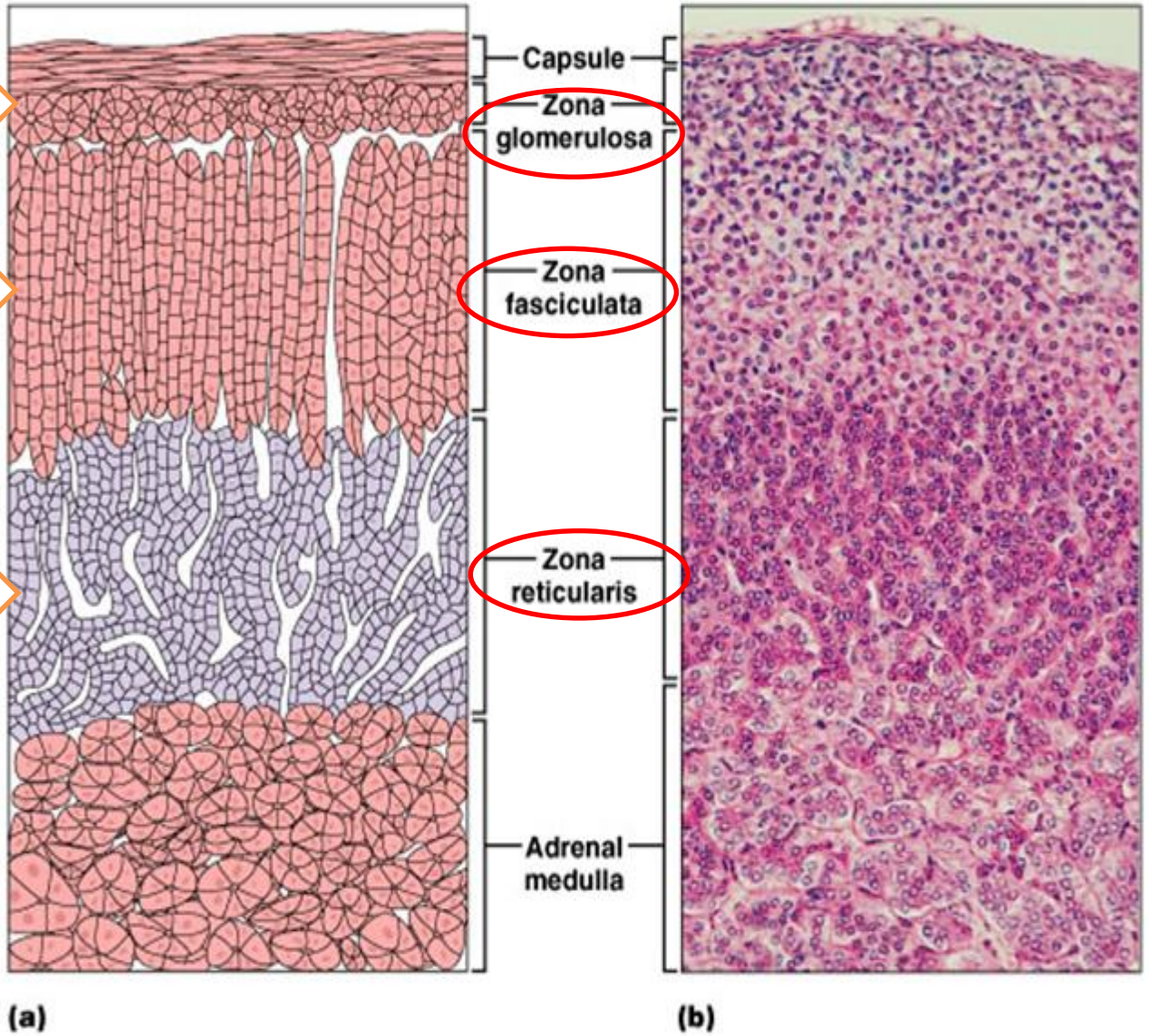
The adrenal cortex is composed of three zones histologically:

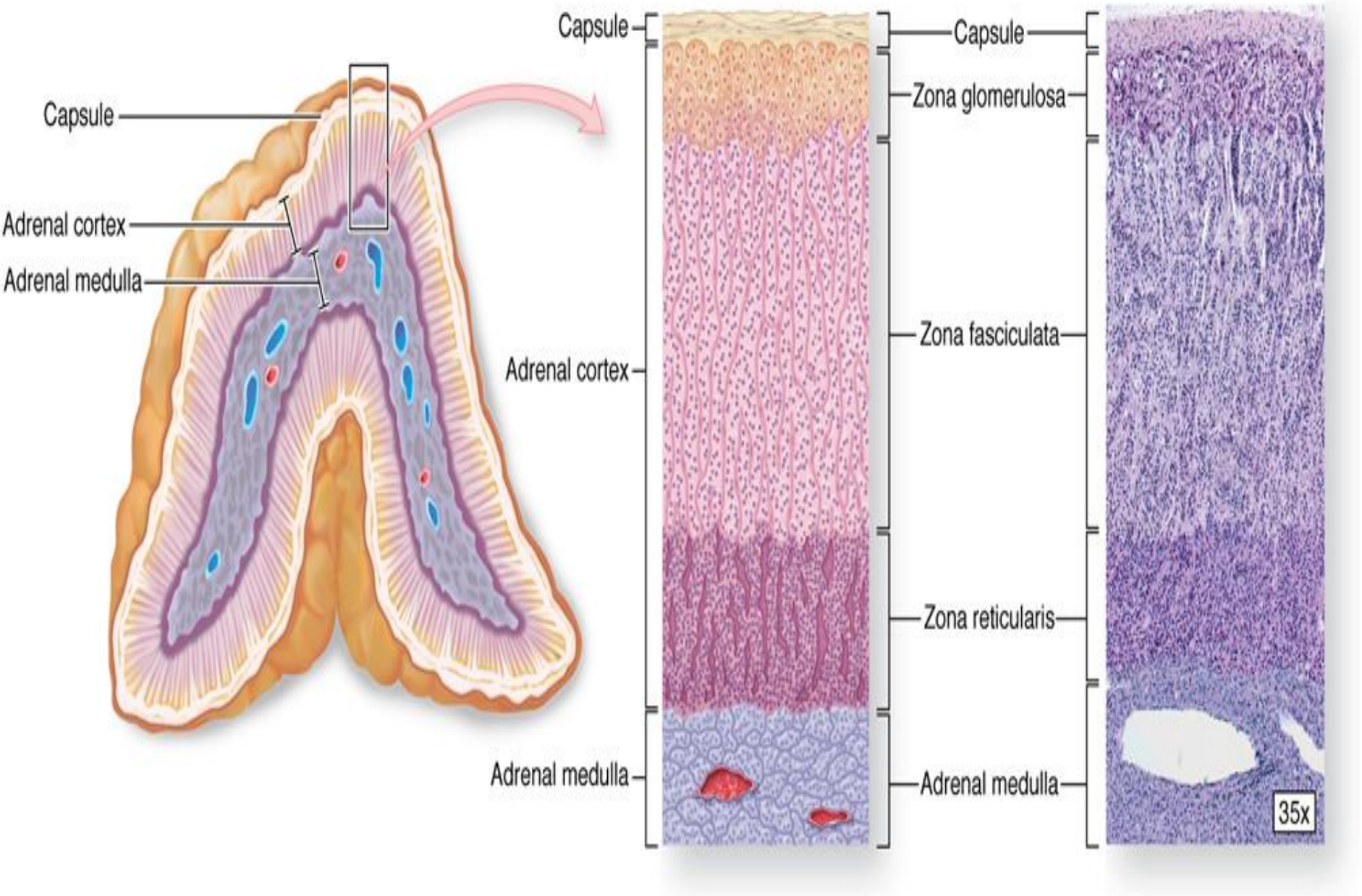
The morphological zonation of the cortex reflects a functional zonation in that

•mineralocorticoids are produced in the zona **glomerulosa**

•glucocorticoids are produced in the zona **fascicularis** and reticularis,.

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




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

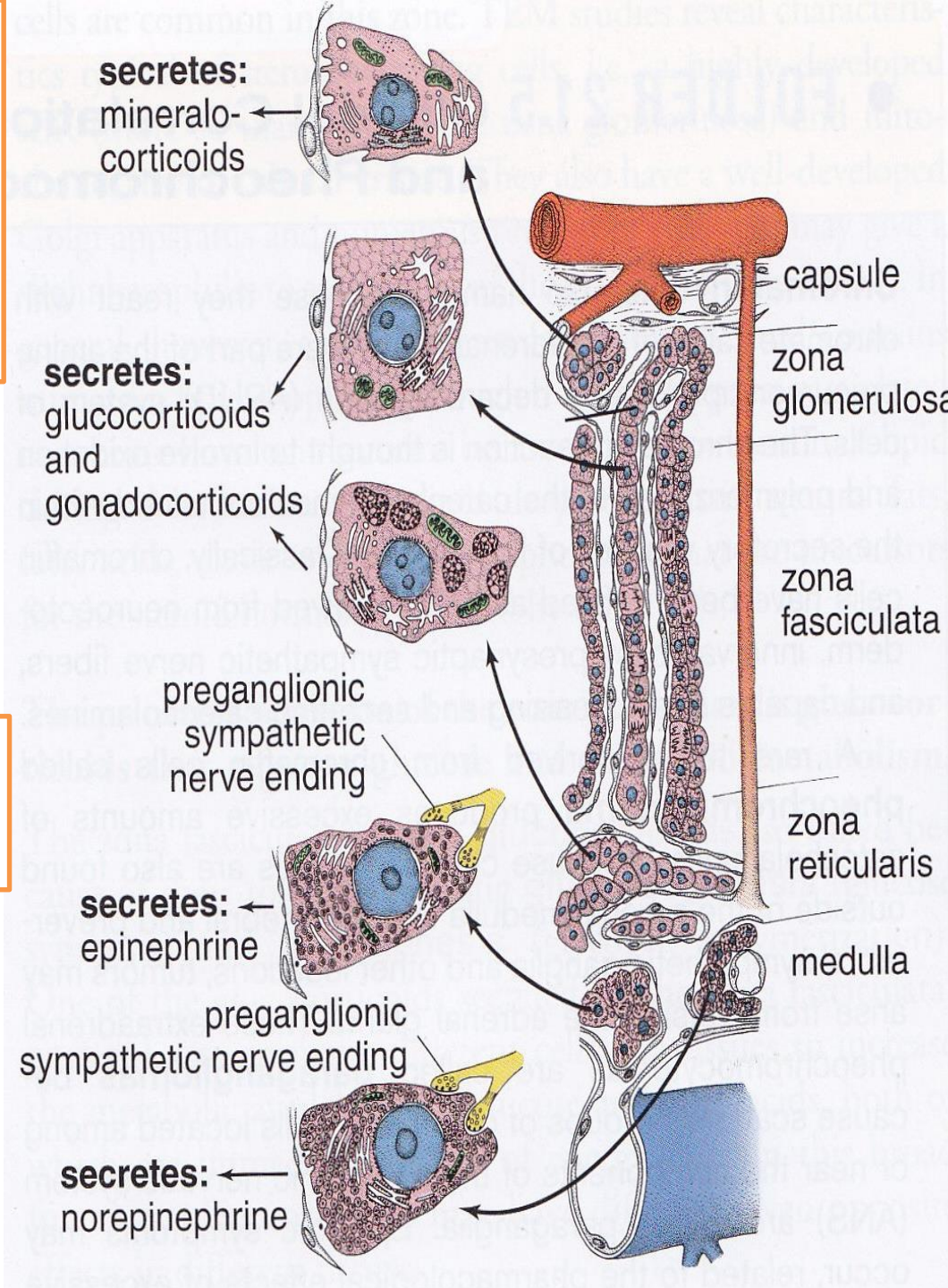
lipid droplets

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

Corticosteroids

- Corticosteroids are further subdivided into mineralocorticoids and glucocorticoids

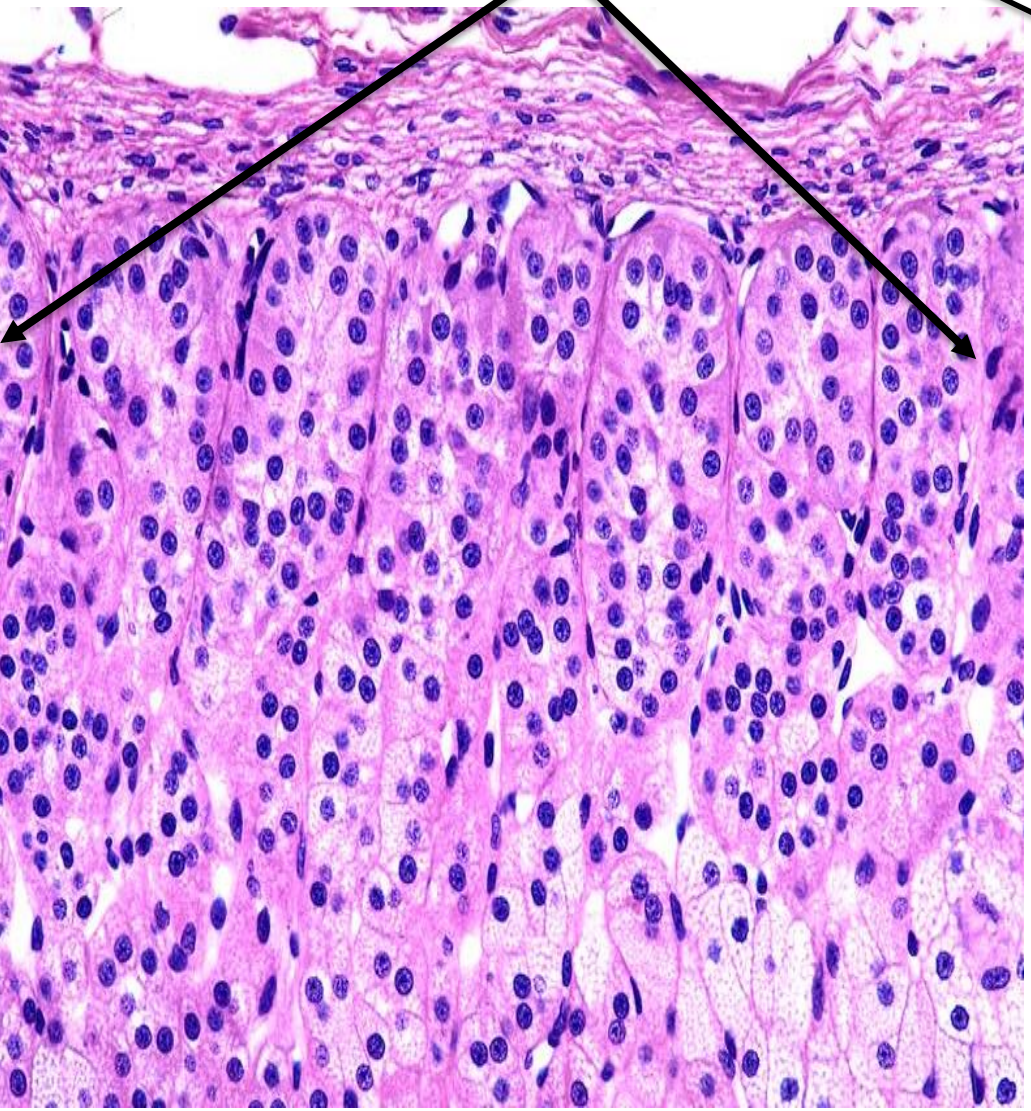
- The most important mineralocorticoid is aldosterone, which regulates the resorption of sodium and excretion of potassium in the tubules of the kidney

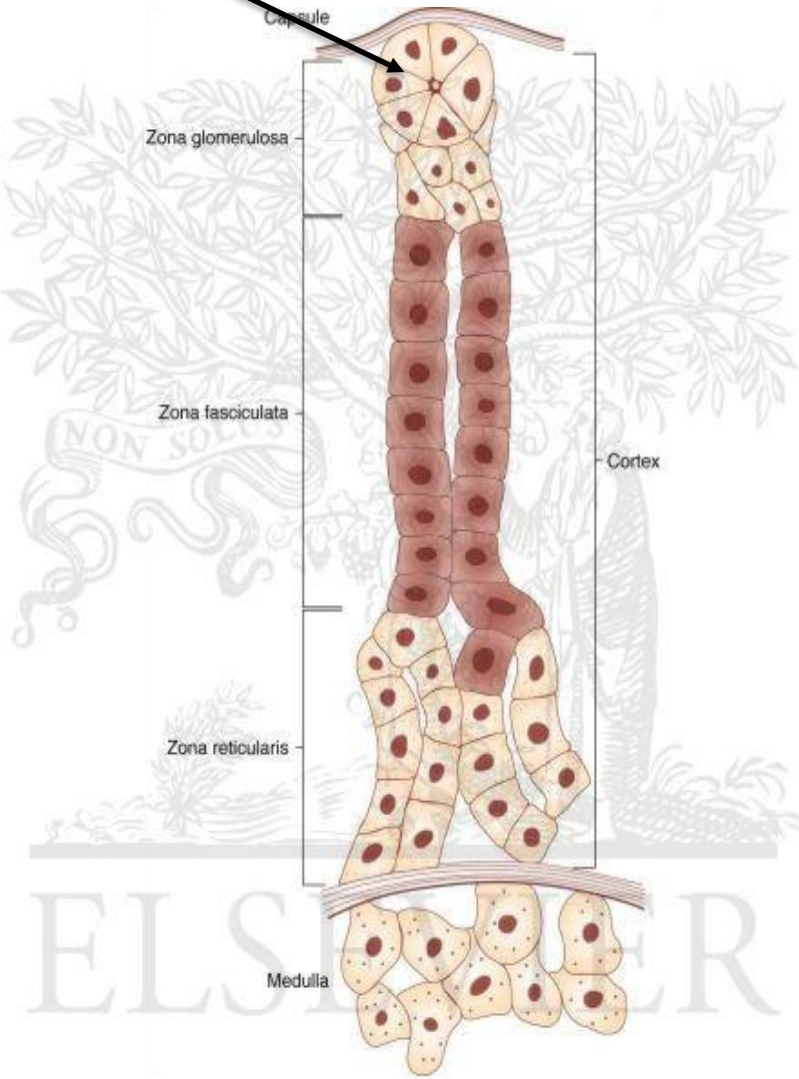


- The most important glucocorticoids is cortisol, which has a wide range of effects on most cells of the body. Cortisol effects protein catabolism in almost all cells aside from liver cells, gluconeogenesis, glycogen storage, mobilisation of fat from adipocytes, anti-inflammatory effects, inhibition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

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

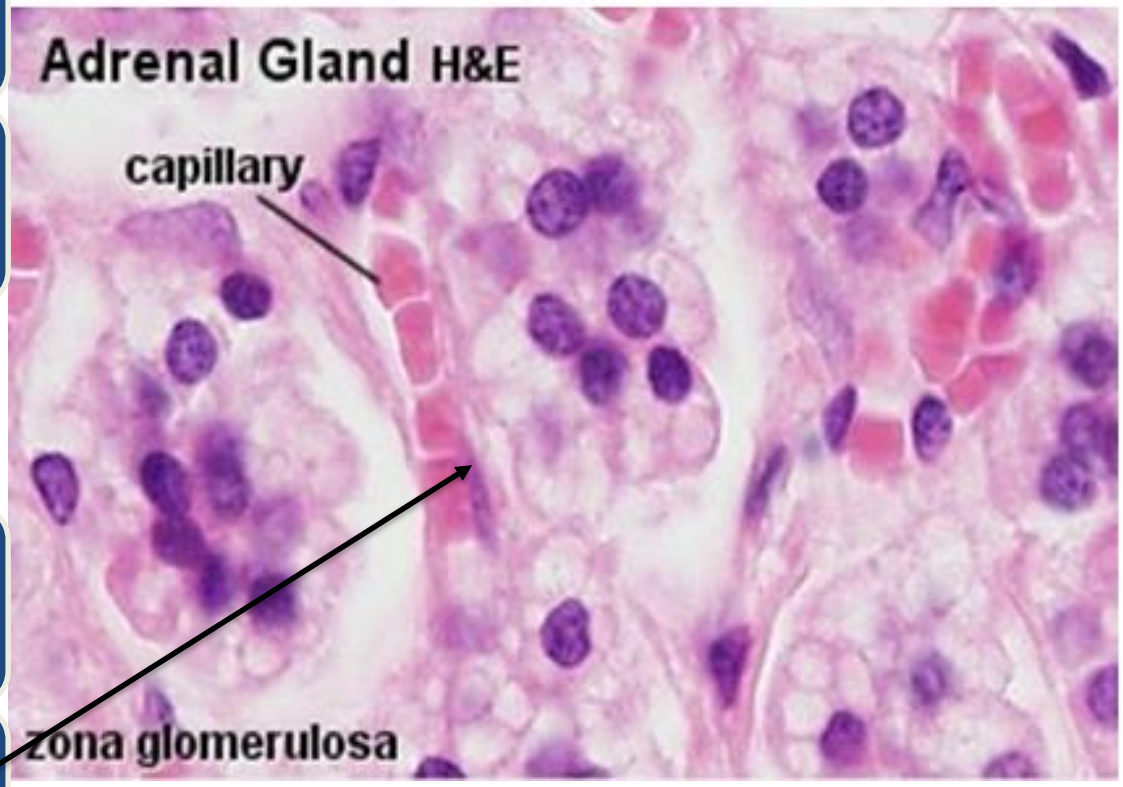
Zona glomerulosa

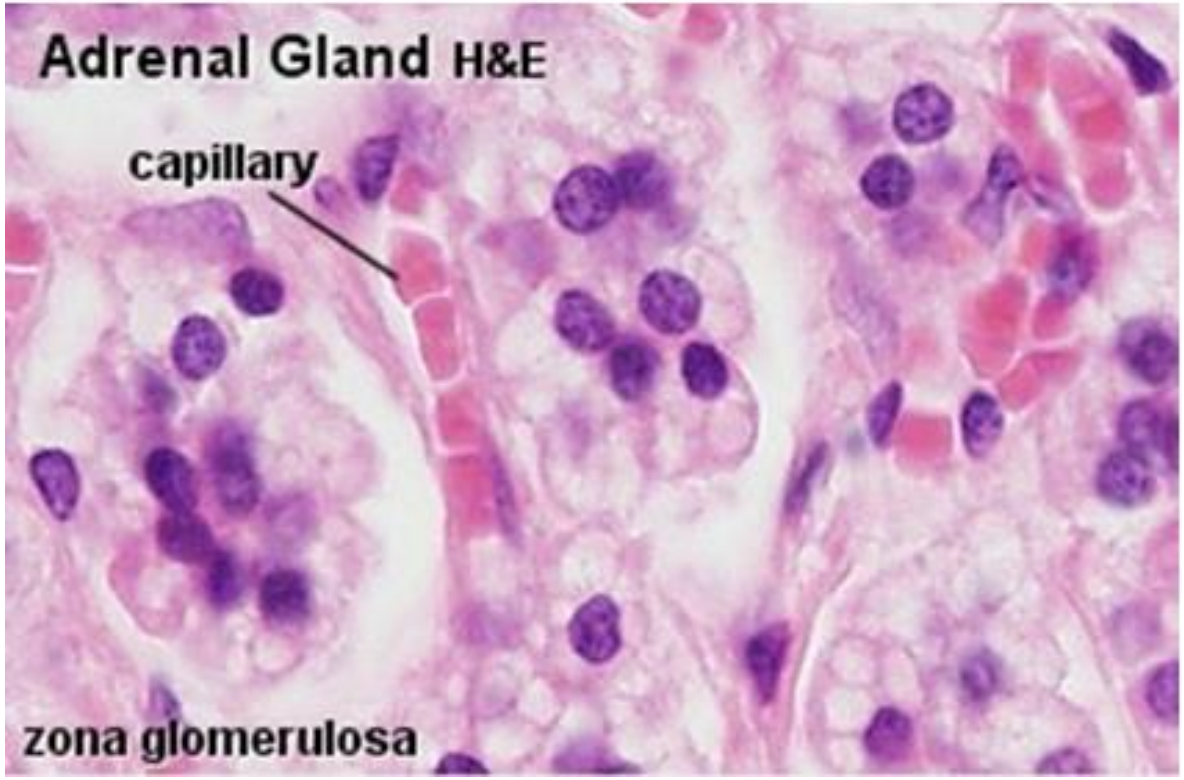




Zona glomerulosa

- 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.




Adrenal Gland H&E
capillary
zona glomerulosa

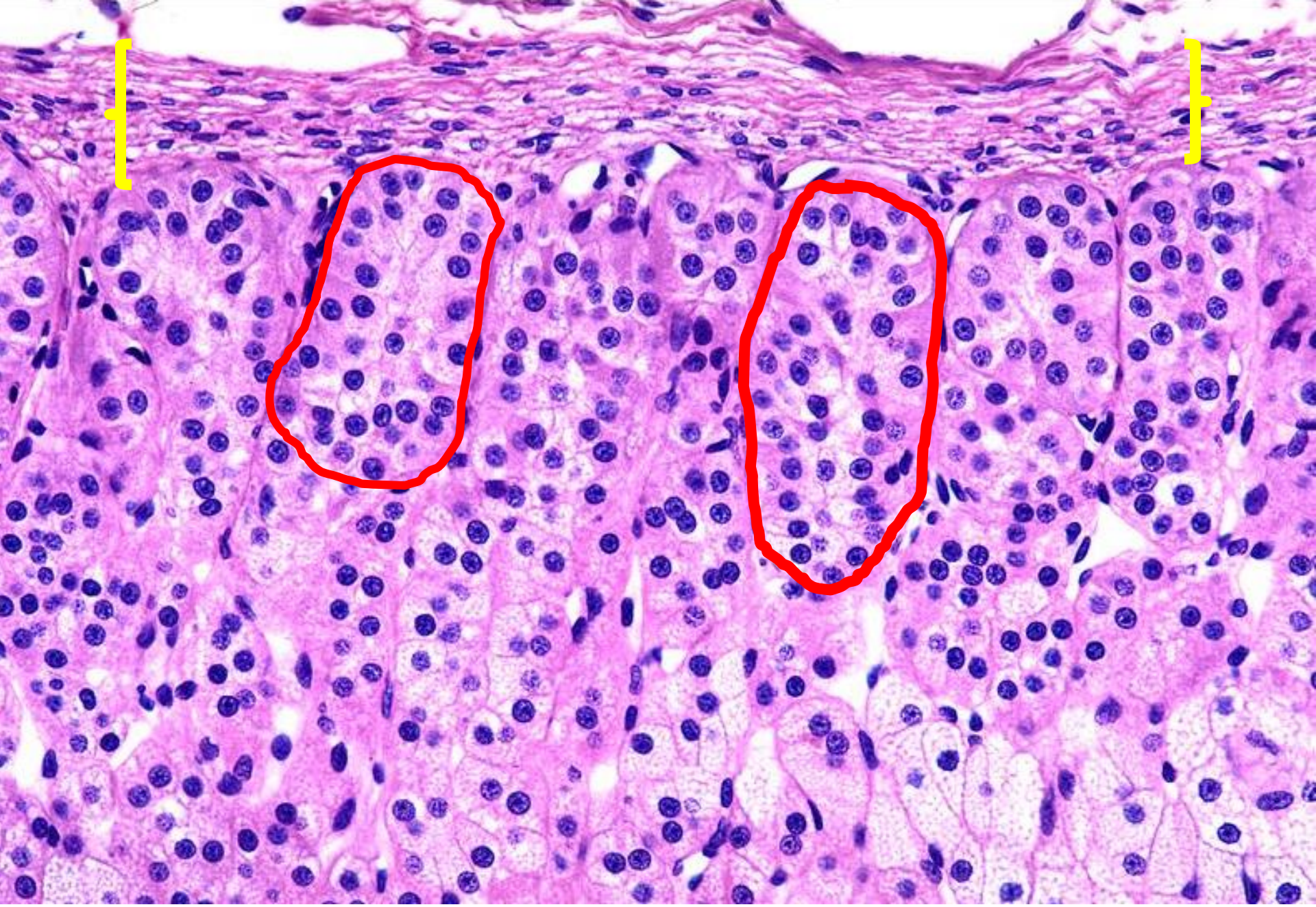
Zona glomerulosa secretes mineralocorticoids, that function in the regulation of sodium and potassium homeostasis and water balance.

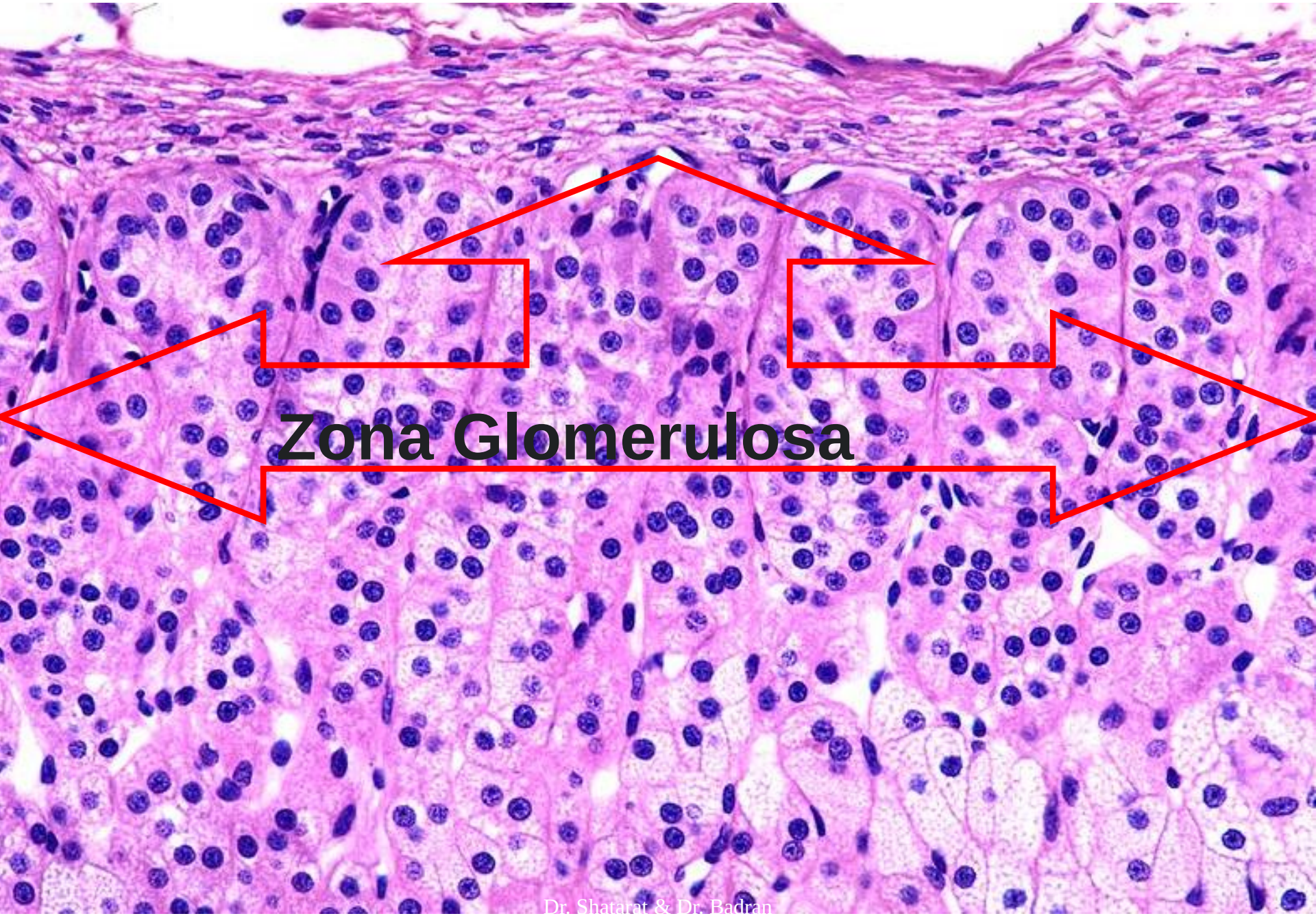
The main mineralocorticoid is aldosterone.

Aldosterone stimulates resorption of sodium from:

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

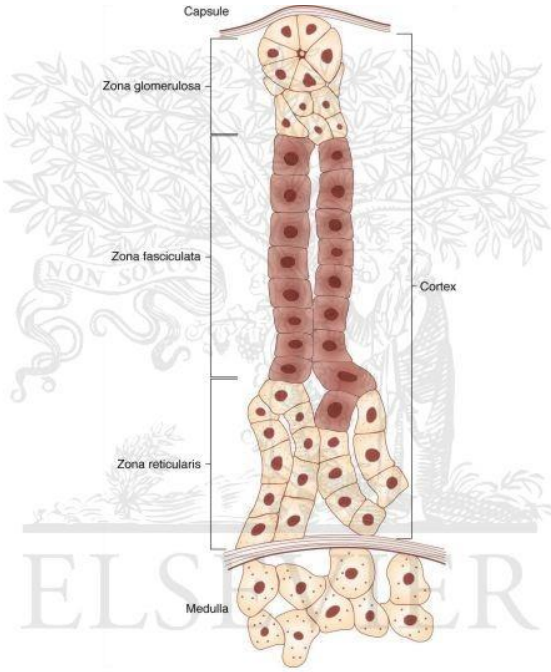
The zona glomerulosa is under the feed back control of the ***renin-angiotensin-aldosterone*** system.

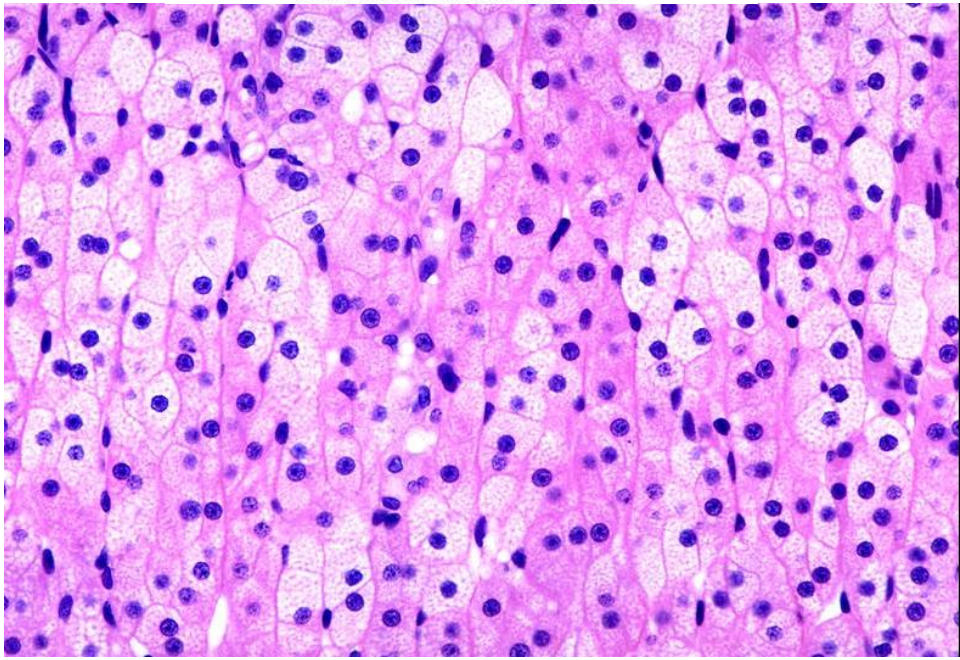


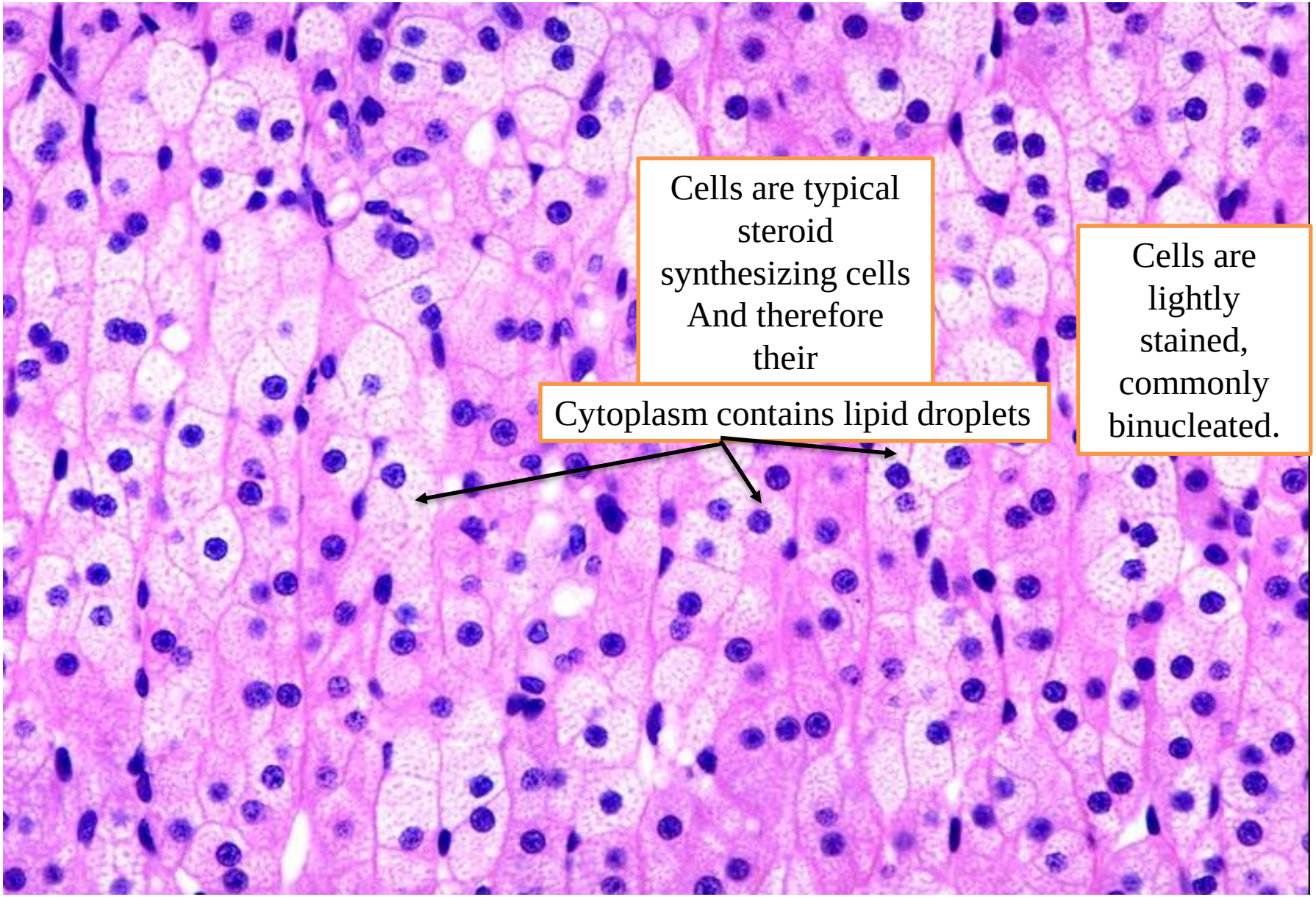

Zona Glomerulosa

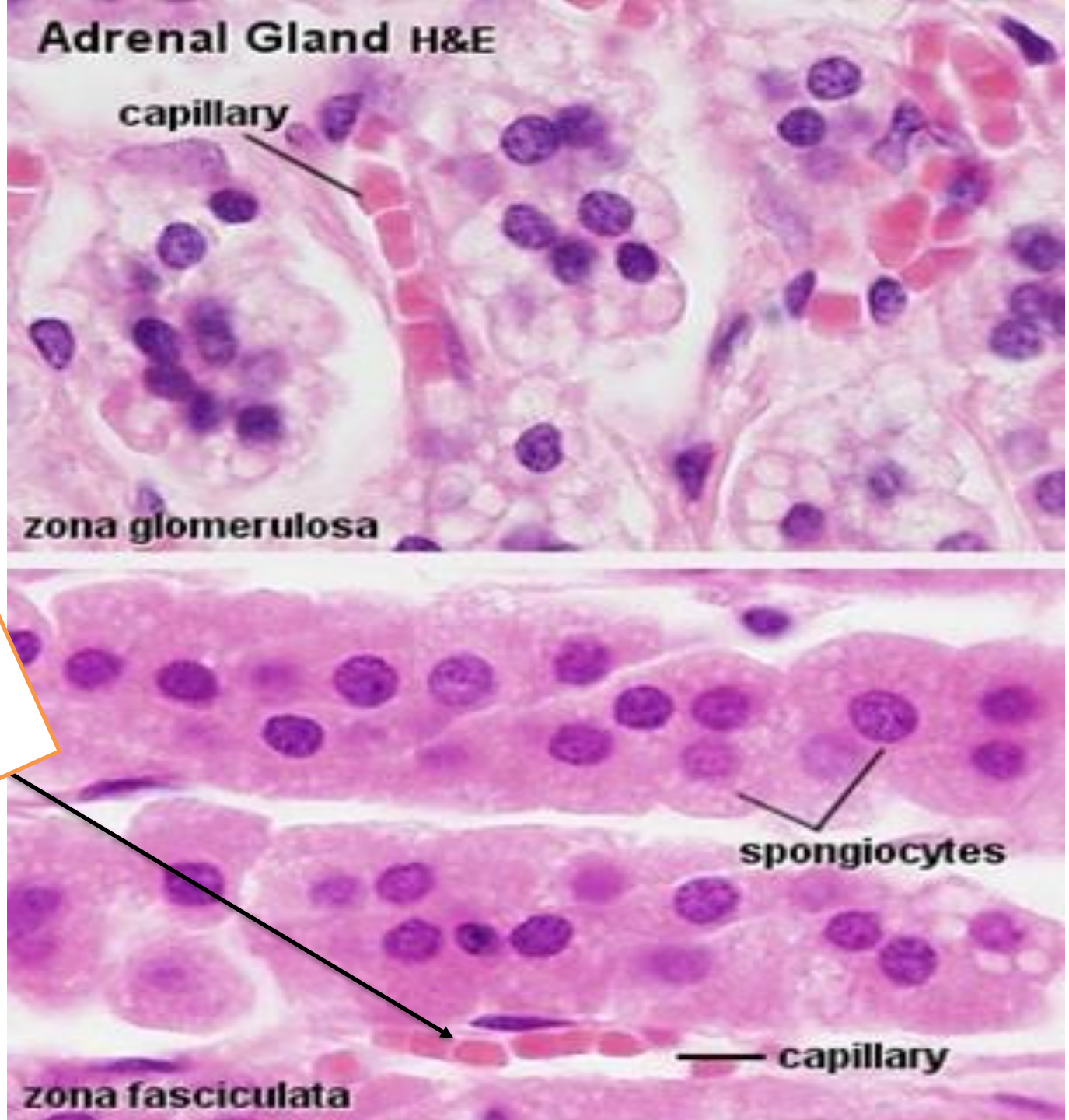
Zona Fasciculata

- 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.
- Cells are lightly stained, commonly binucleated.
- Cells are typical steroid synthesizing cells.
- Cytoplasm contains lipid droplets.
- Cells secrete glucocorticoids, mainly cortisol.






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



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.

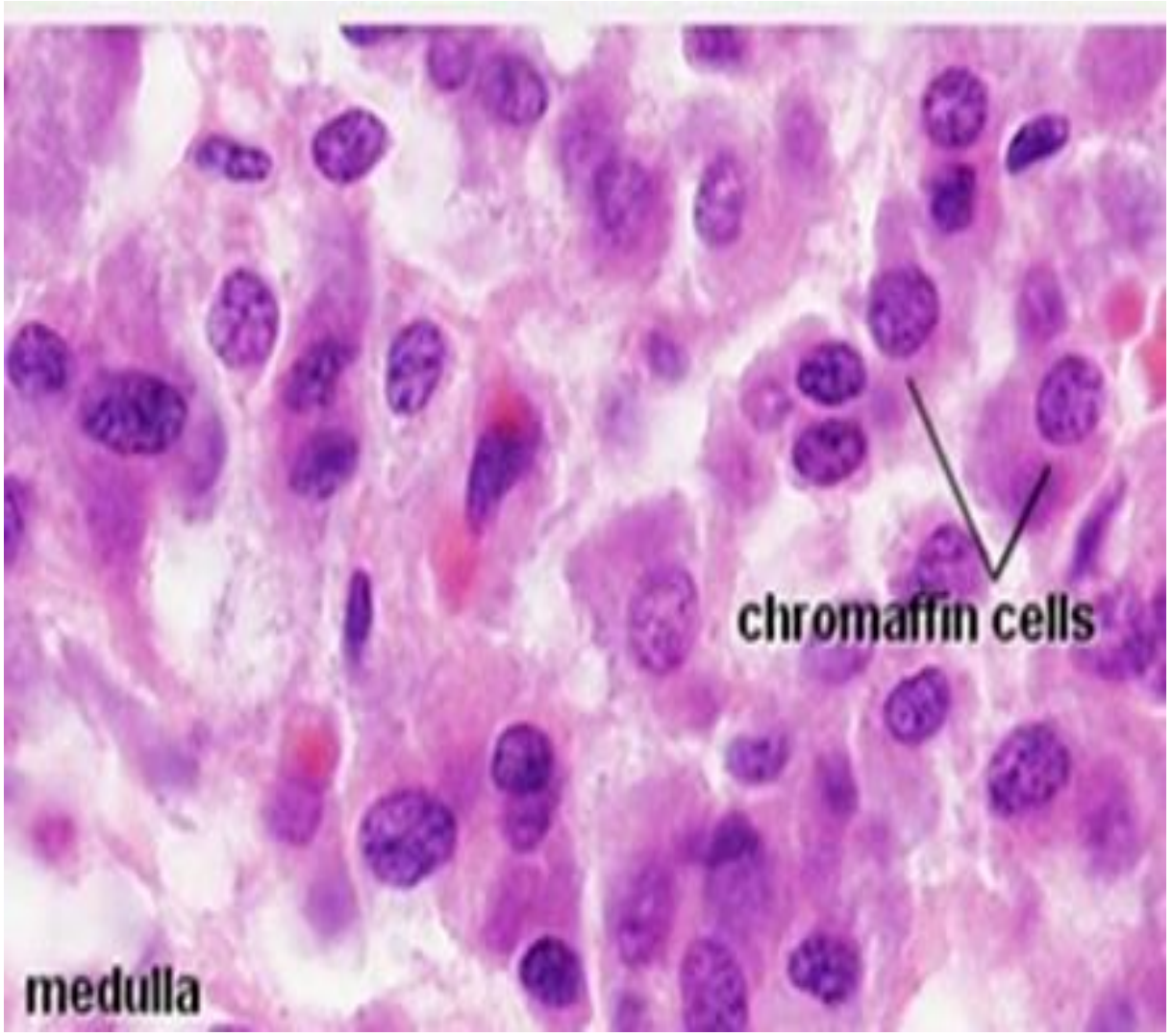
Cells have few lipid droplets.

Cells are typical steroid-secreting cells.

Their principal secretion is weak androgen (minimal glucocorticoids).

Medulla

- The medulla is not sharply delimited from the cortex.
- 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***

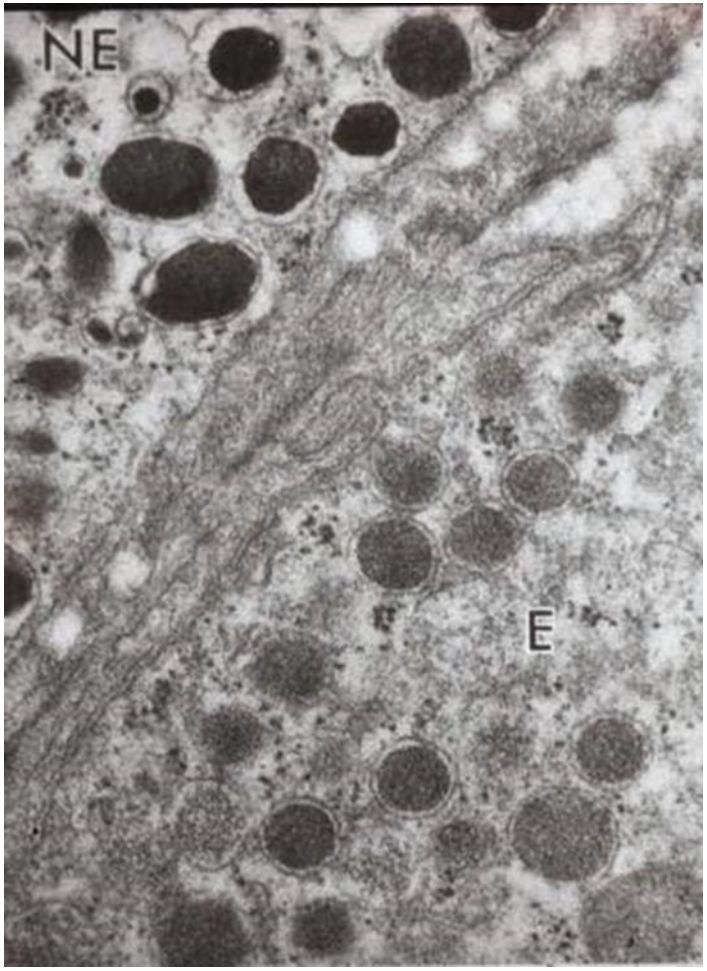


Adrenal medulla

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.



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.

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**

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

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.

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

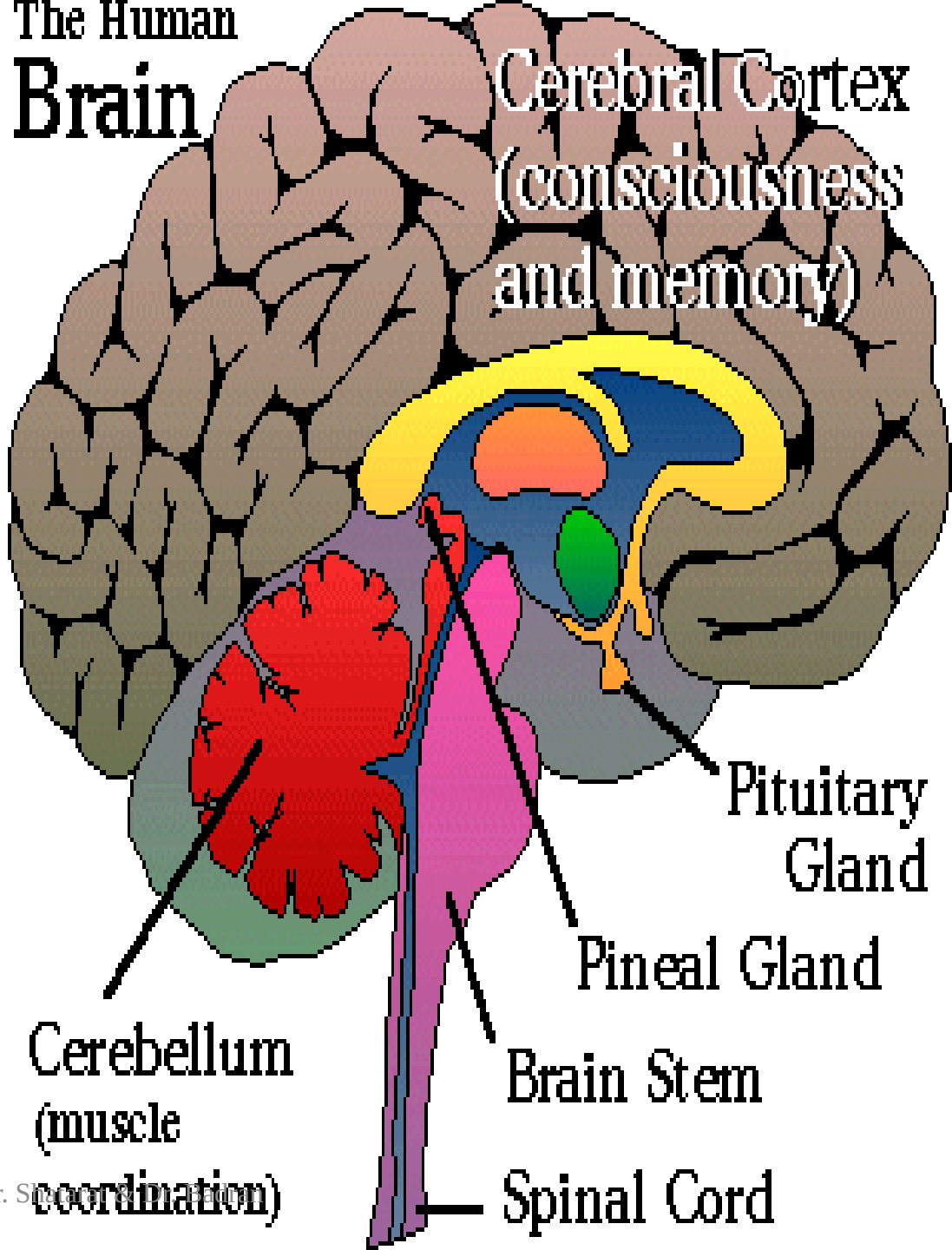
PINEAL GLAND

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 pineal gland contains two types of parenchymal cells:

Pinealocytes
Interstitial (glial) 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.

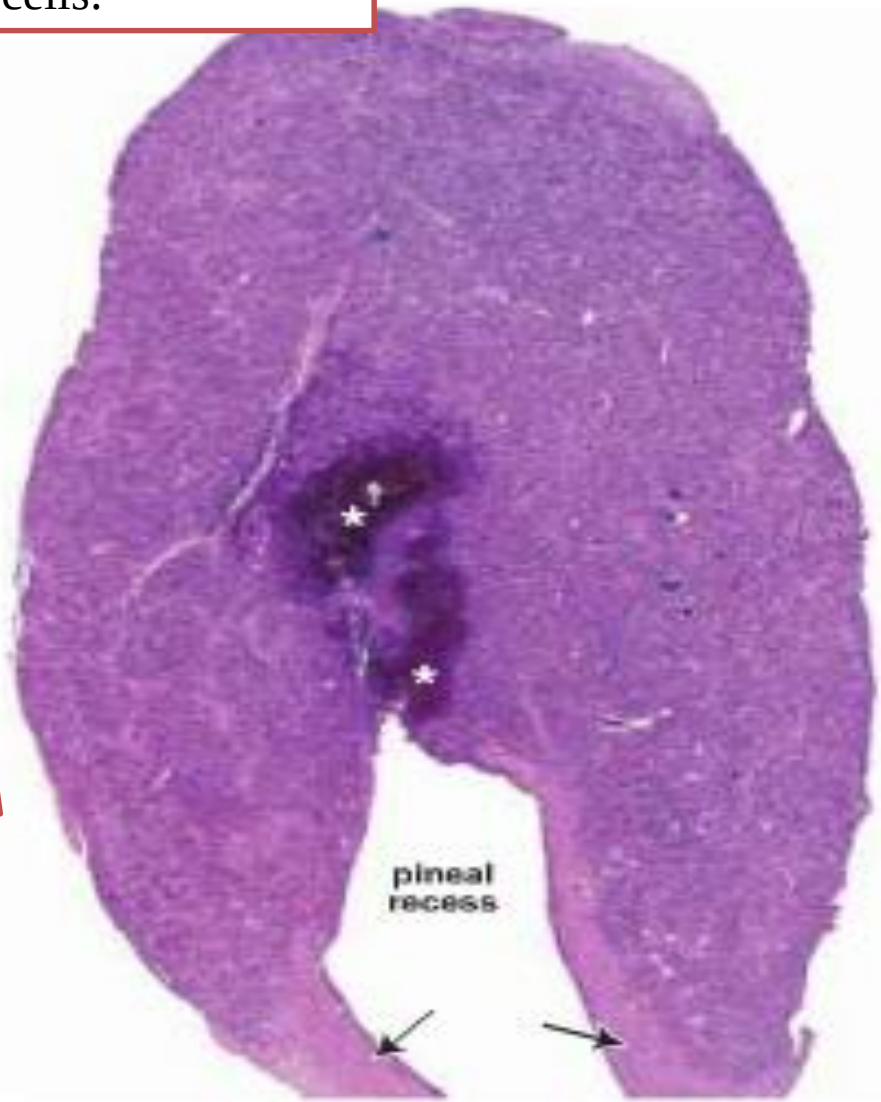
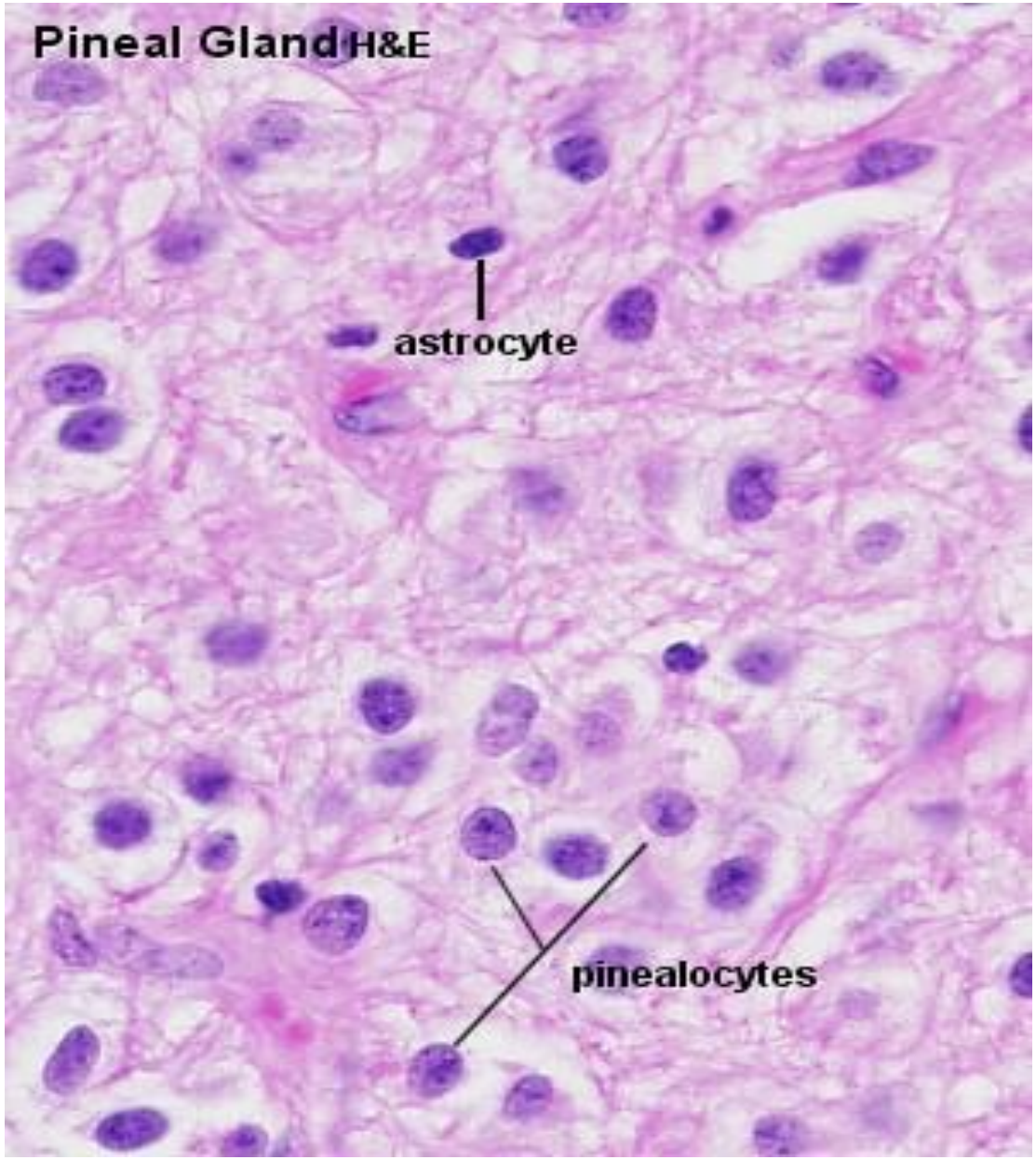


FIGURE 21.11 - **Photomicrograph of infant pineal gland.** This H&E–stained section is from a median cut through the pine cone–shaped gland. The conical anterior end of the gland is at the top of the micrograph. The arrows indicate the part of the gland that connects with the posterior commissure. The 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.



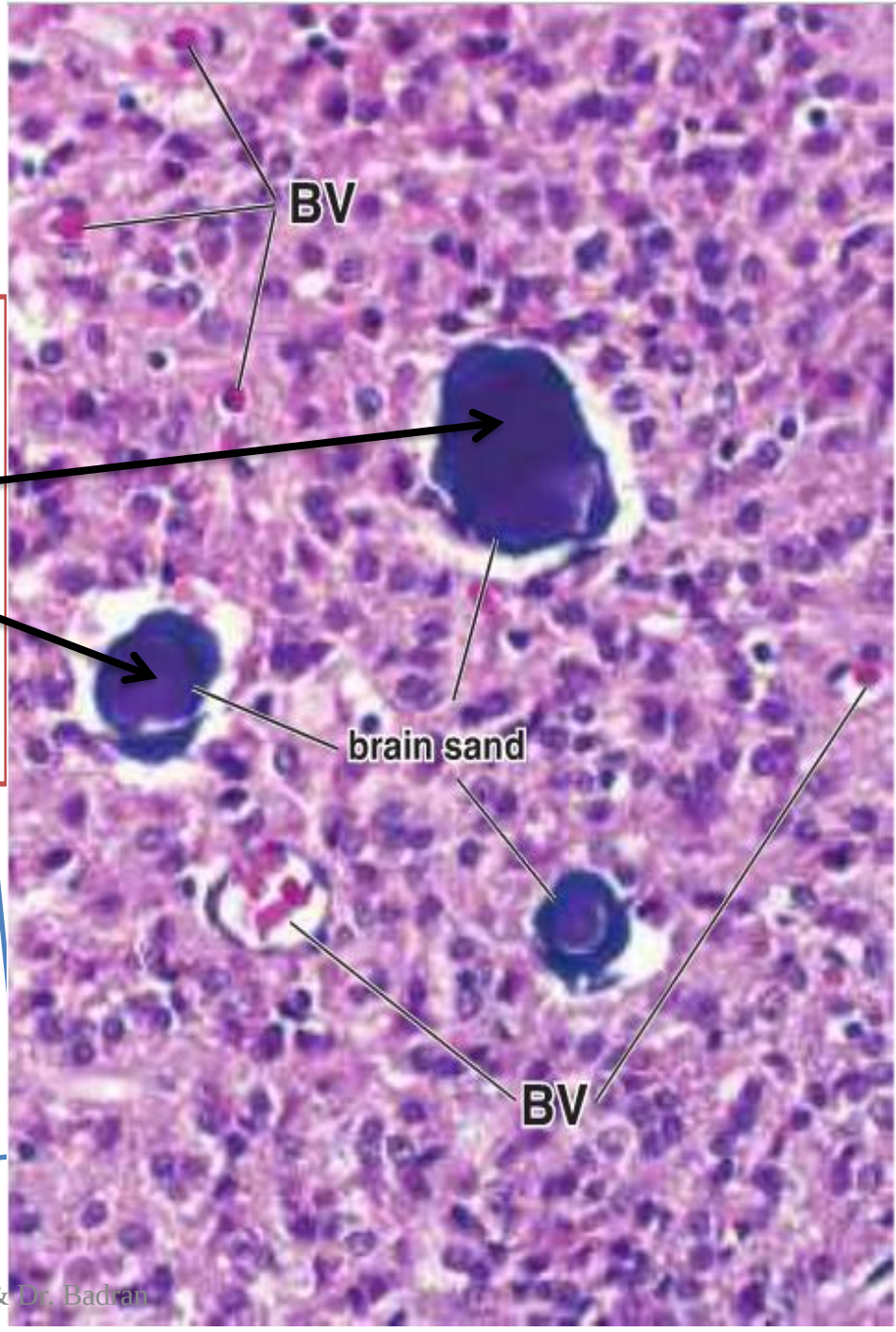
The interstitial (glial) cells constitute about 5% of the cells in the gland.

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

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

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)