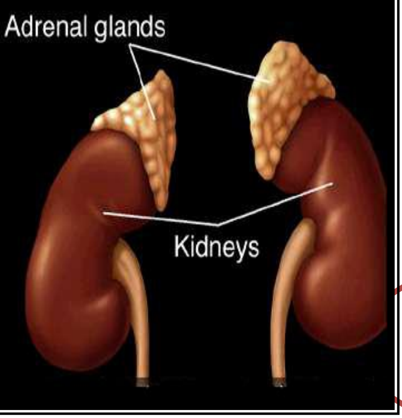
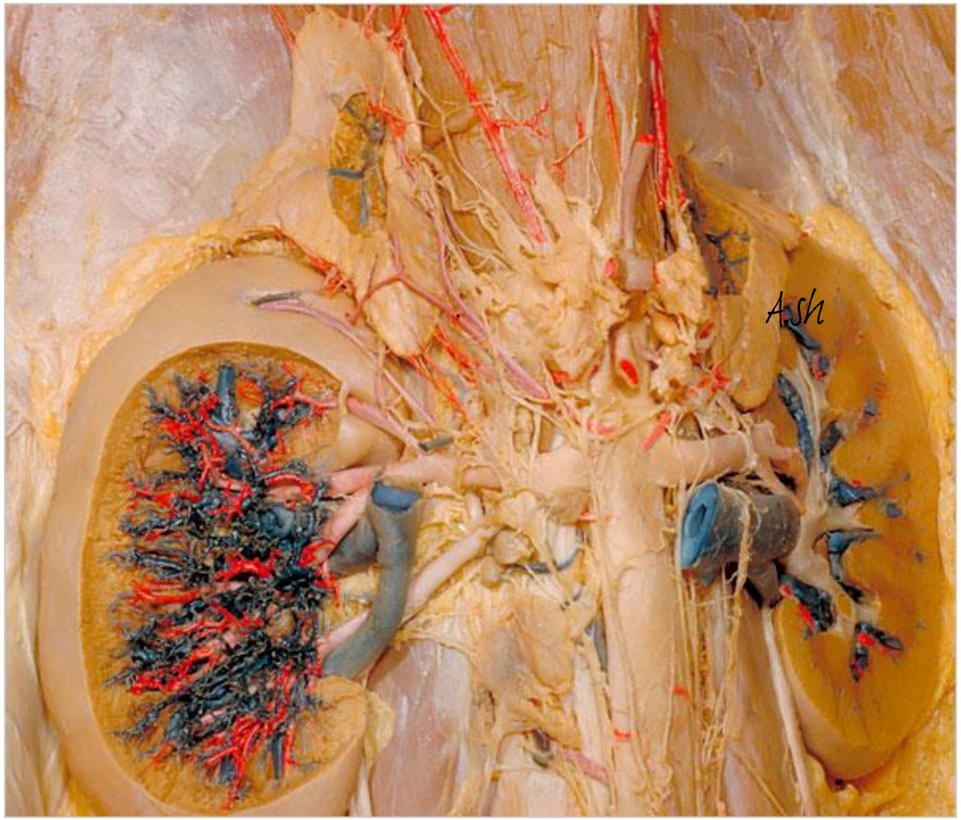
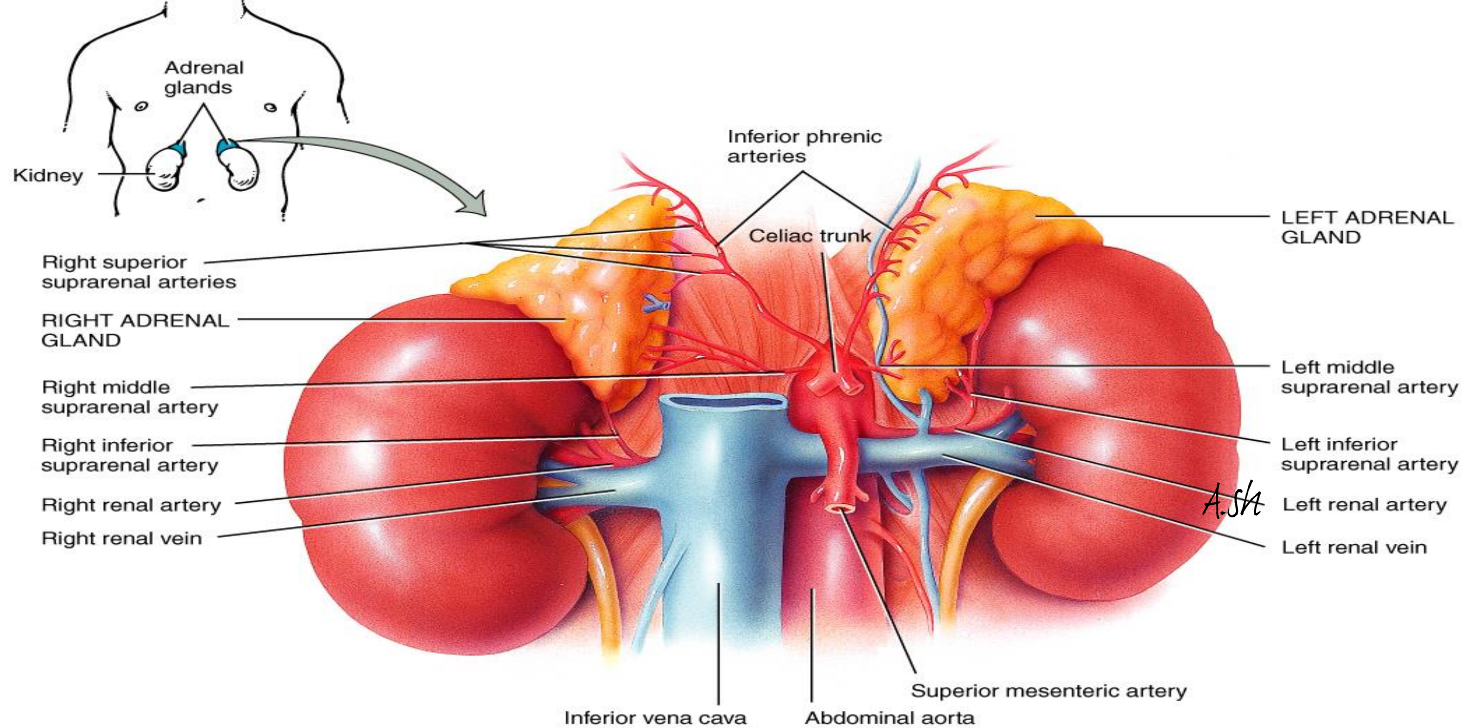
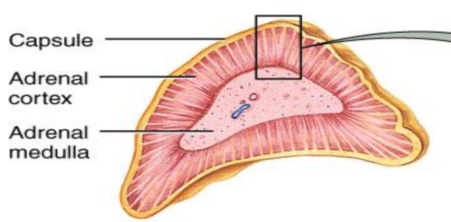


Suprarenal (adrenal) Glands

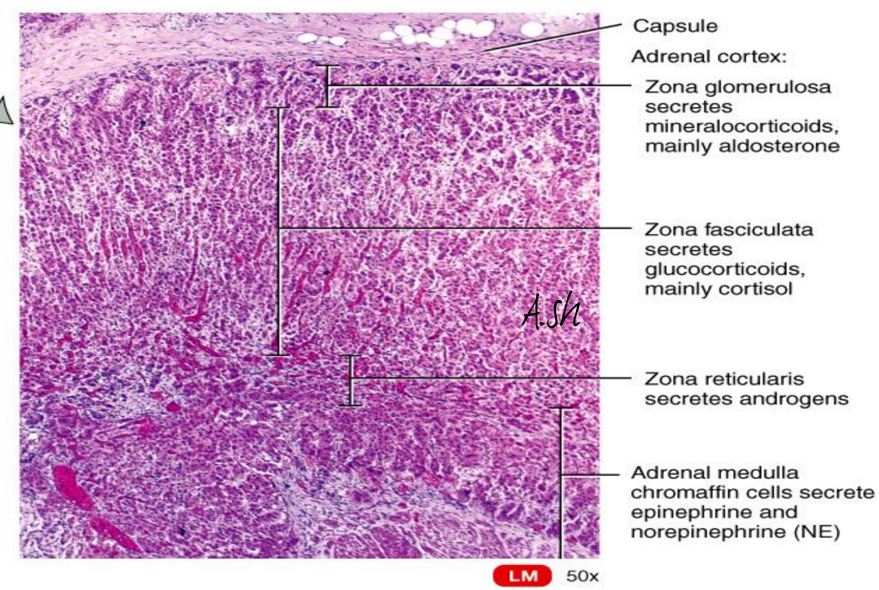




(a) Anterior view



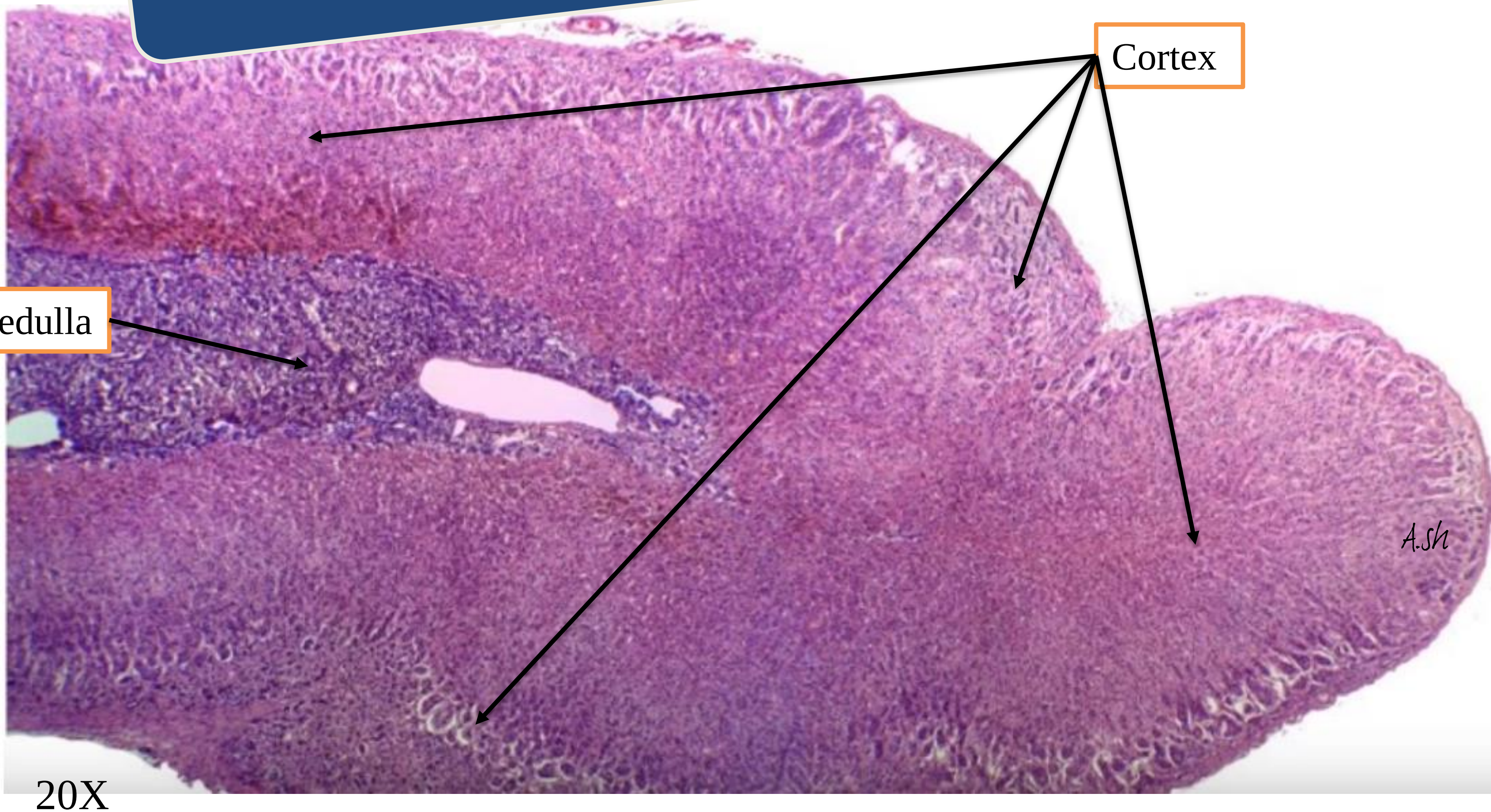
Section through left adrenal gland



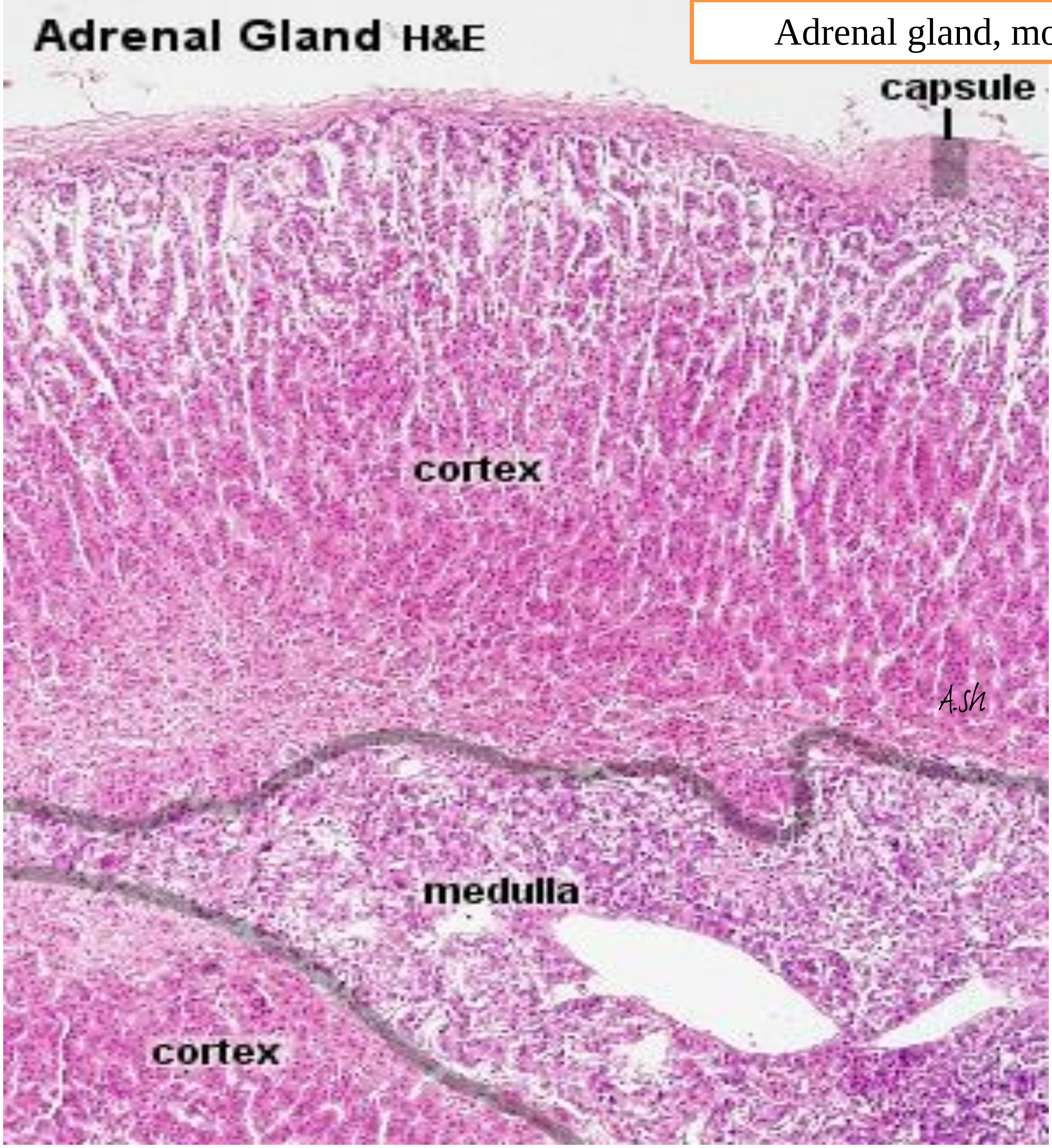
(c) Subdivisions of the adrenal gland

18.15

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



Adrenal gland, monkey - H&E



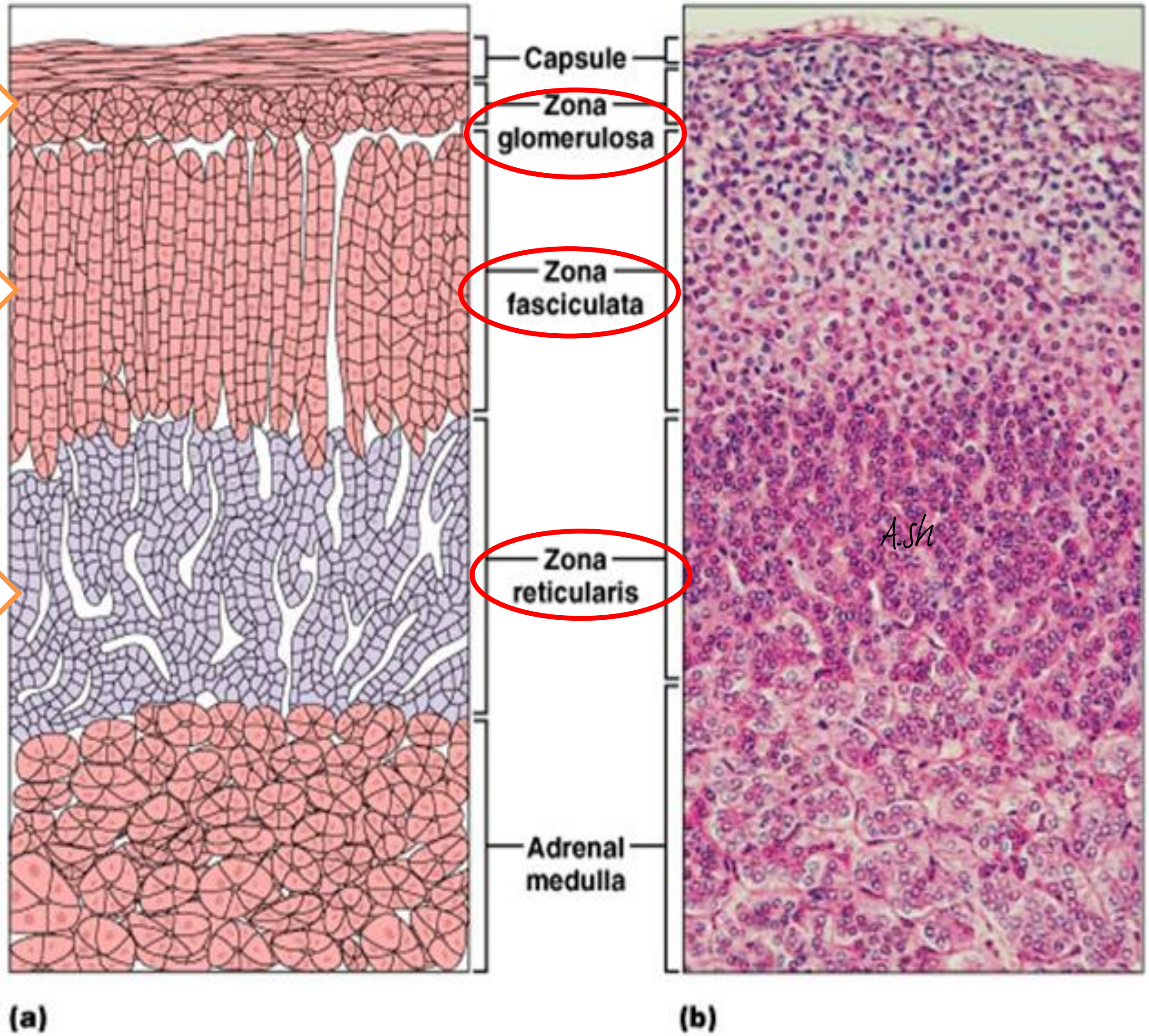
The adrenal cortex is composed of three zones histologically:

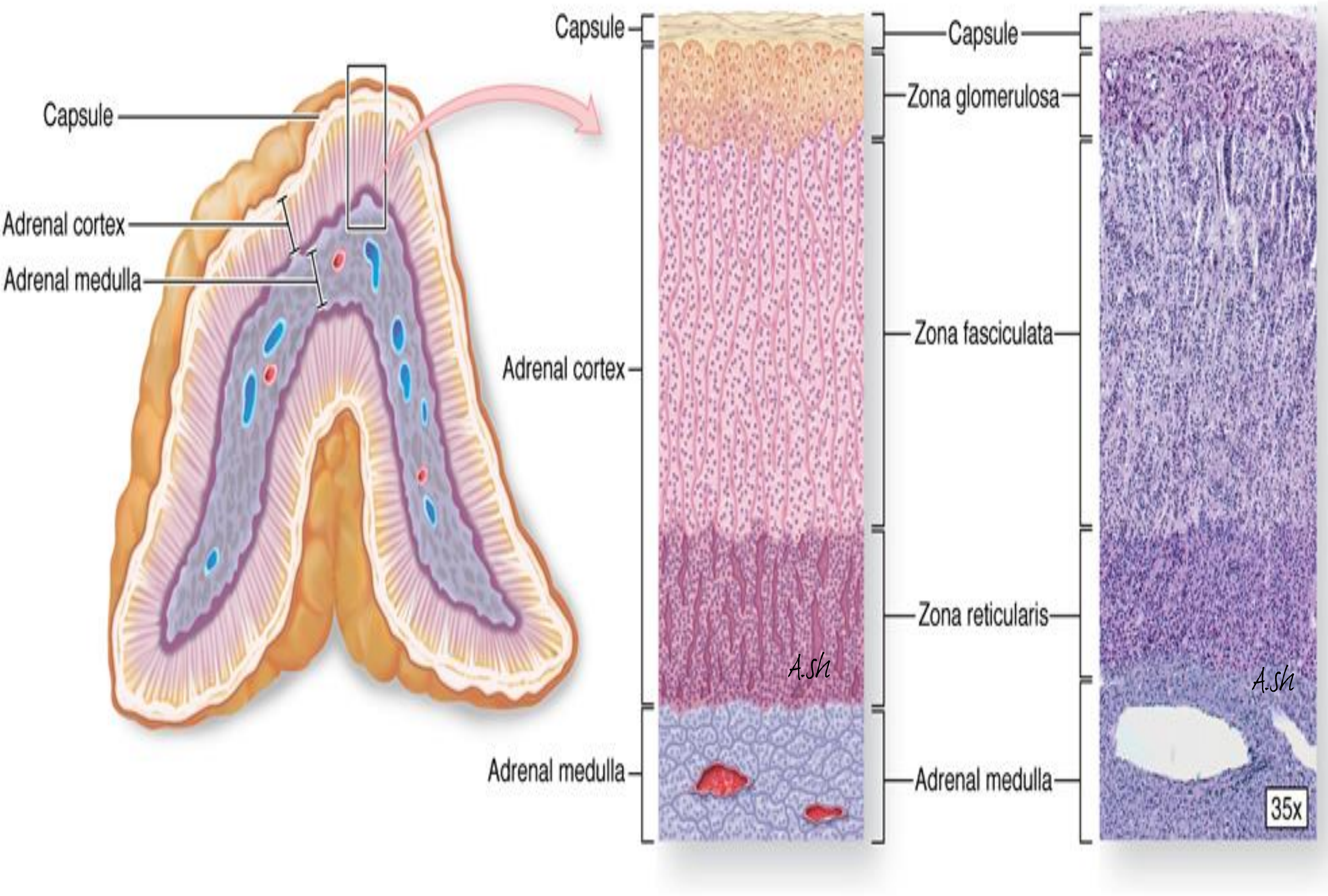
The morphological zonation of the cortex reflects a functional zonation in that

•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
A.sh
Capsule
Zona glomerulosa
Zona fasciculata
Zona reticularis
Adrenal medulla
A.sh
35x

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

Consequently,

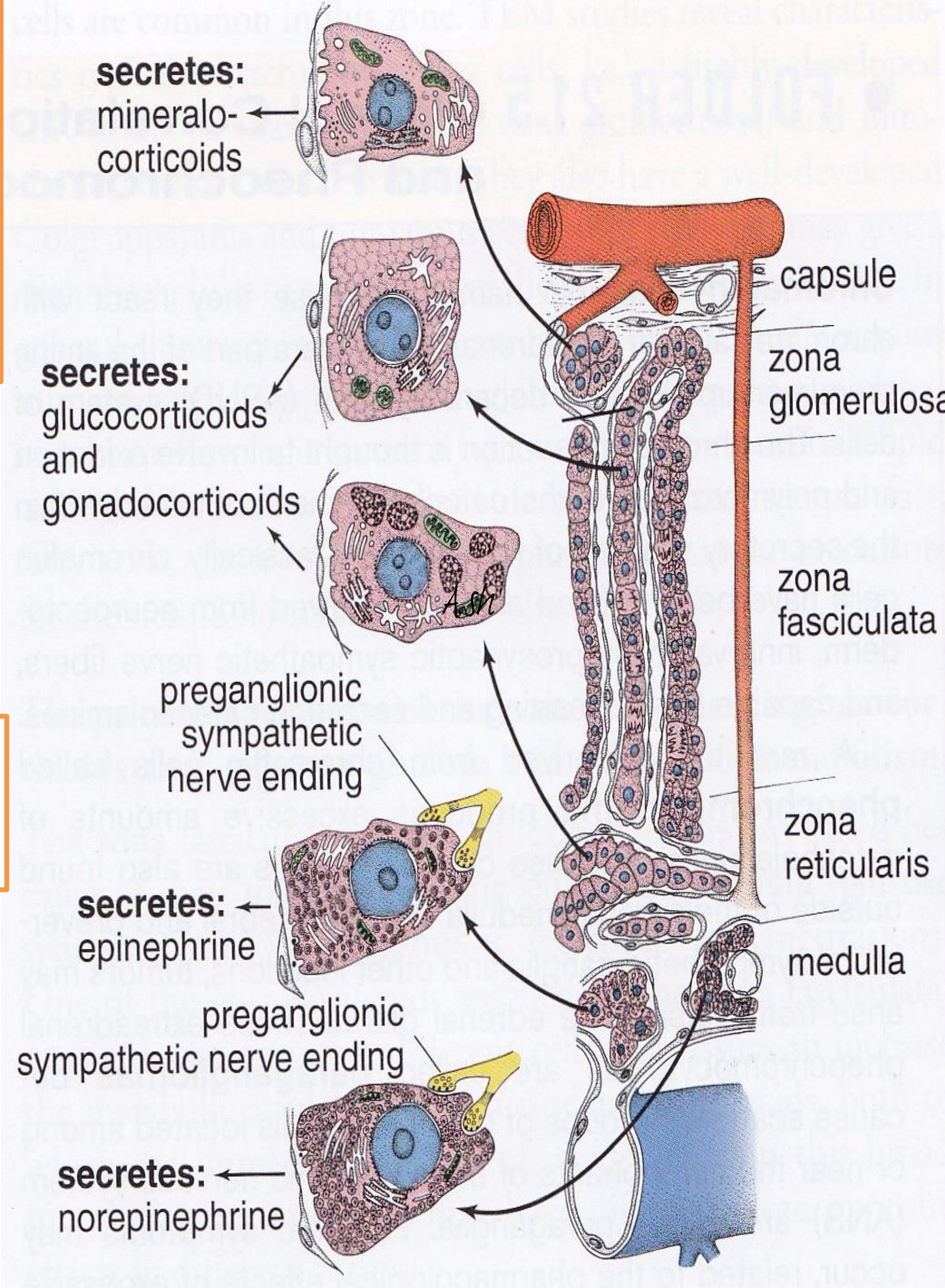
cortical cells contain large amounts of **smooth endoplasmatic reticulum** And **lipid droplets**

➢ 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

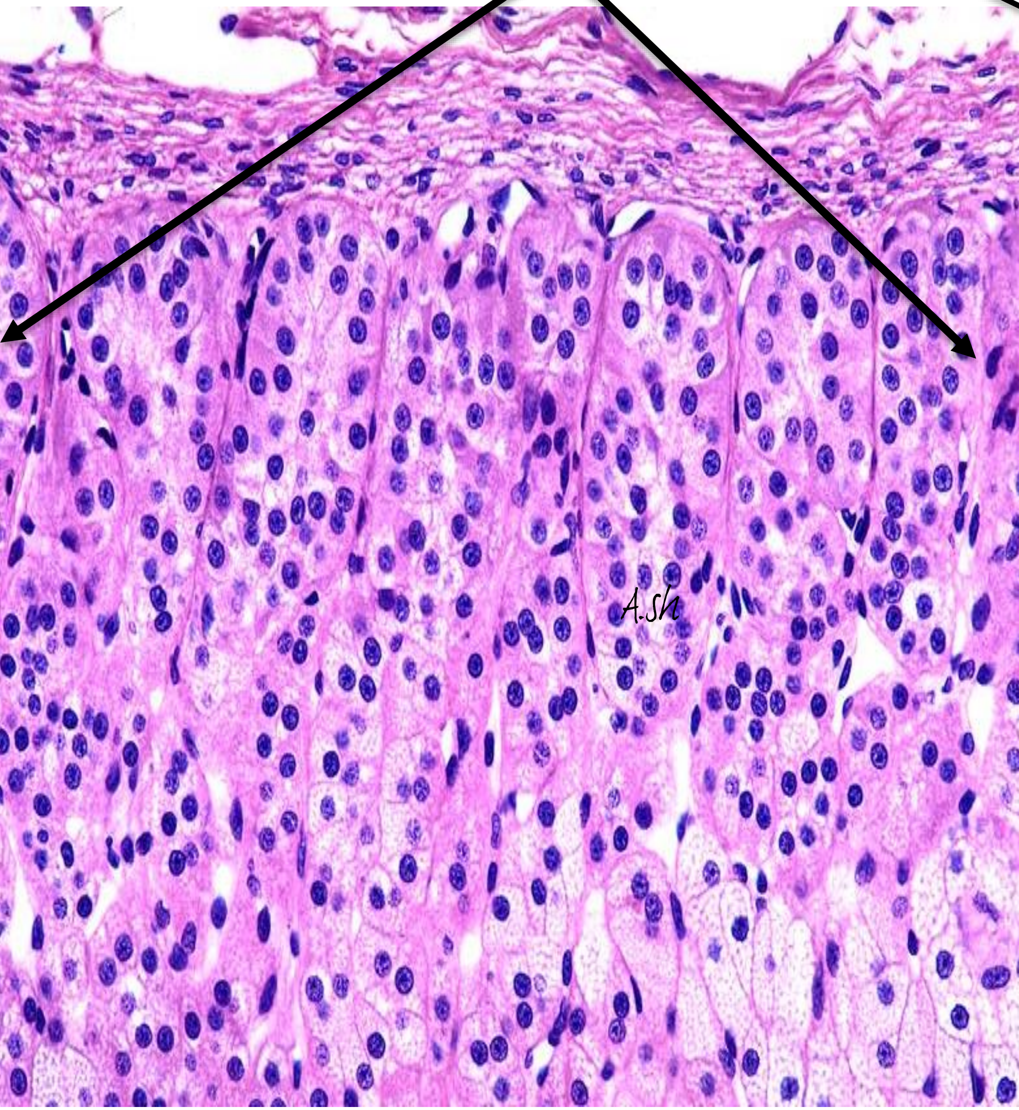


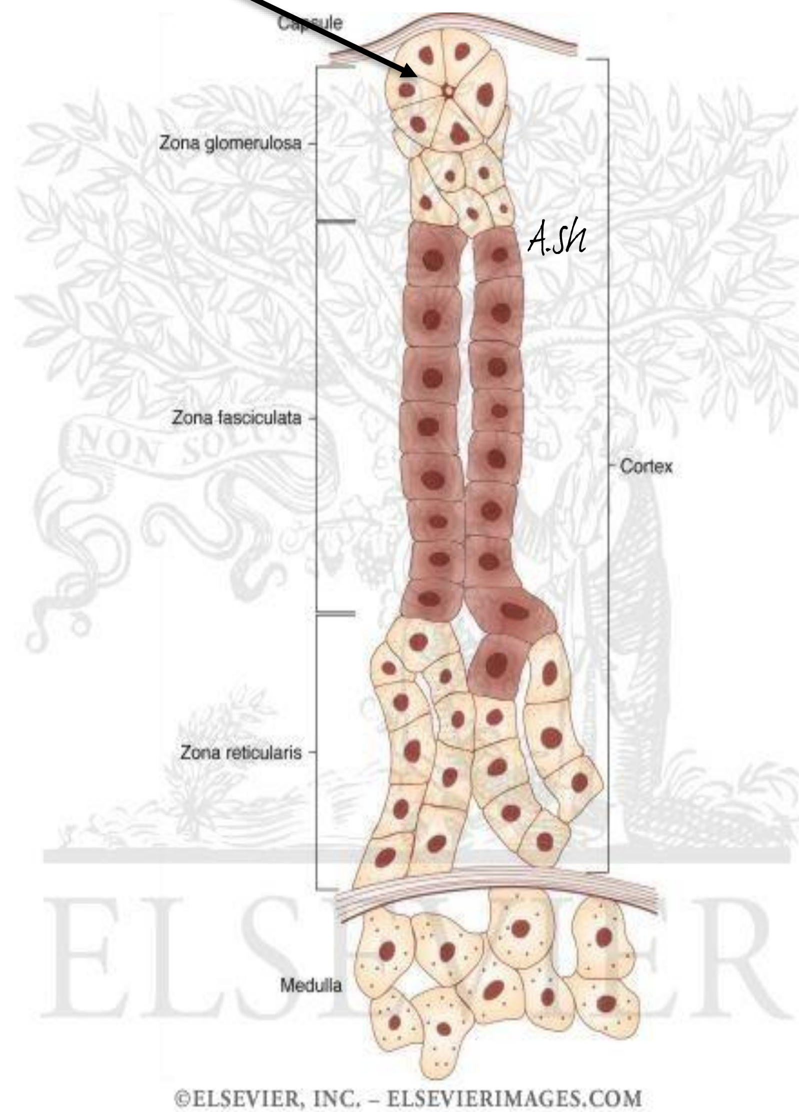
- The most important glucocorticoids is cortisol, which has a wide range of effects on most cells of the body. Cortisol effects protein catabolism in almost all cells aside from liver cells, gluconeogenesis, glycogen storage, mobilisation of fat from adipocytes, anti-inflammatory effects, inhibition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

A.Sh

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

Zona glomerulosa





Zona glomerulosa

Is the exclusive site of production of aldosterone.

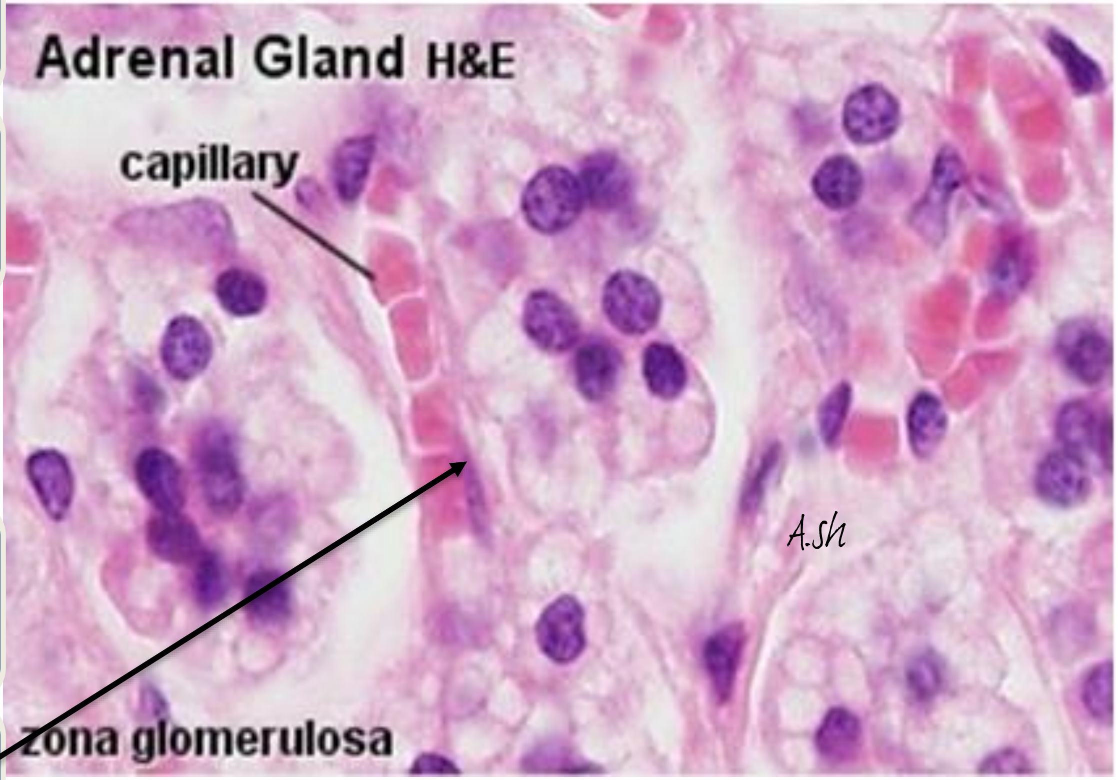
Consists ~ 15% of the cortex.

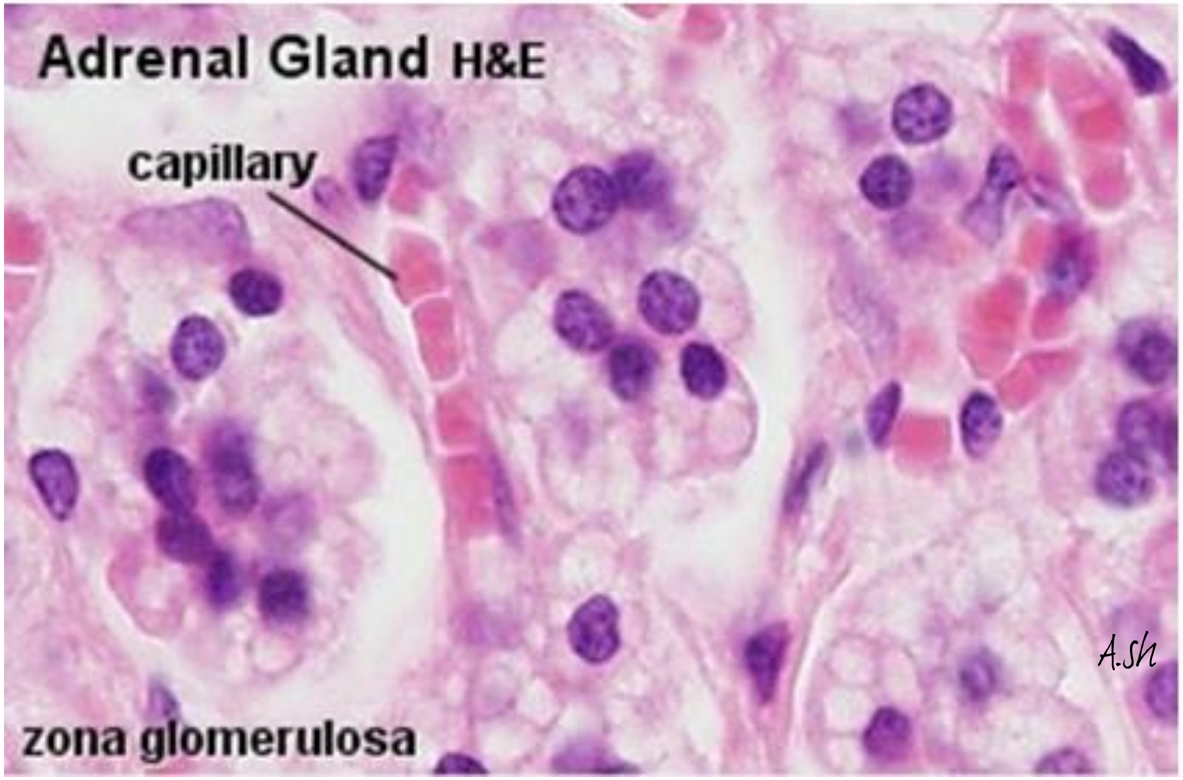
Cells are arranged in closely packed clusters continuous with the next layer.

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
A.sh
zona glomerulosa

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

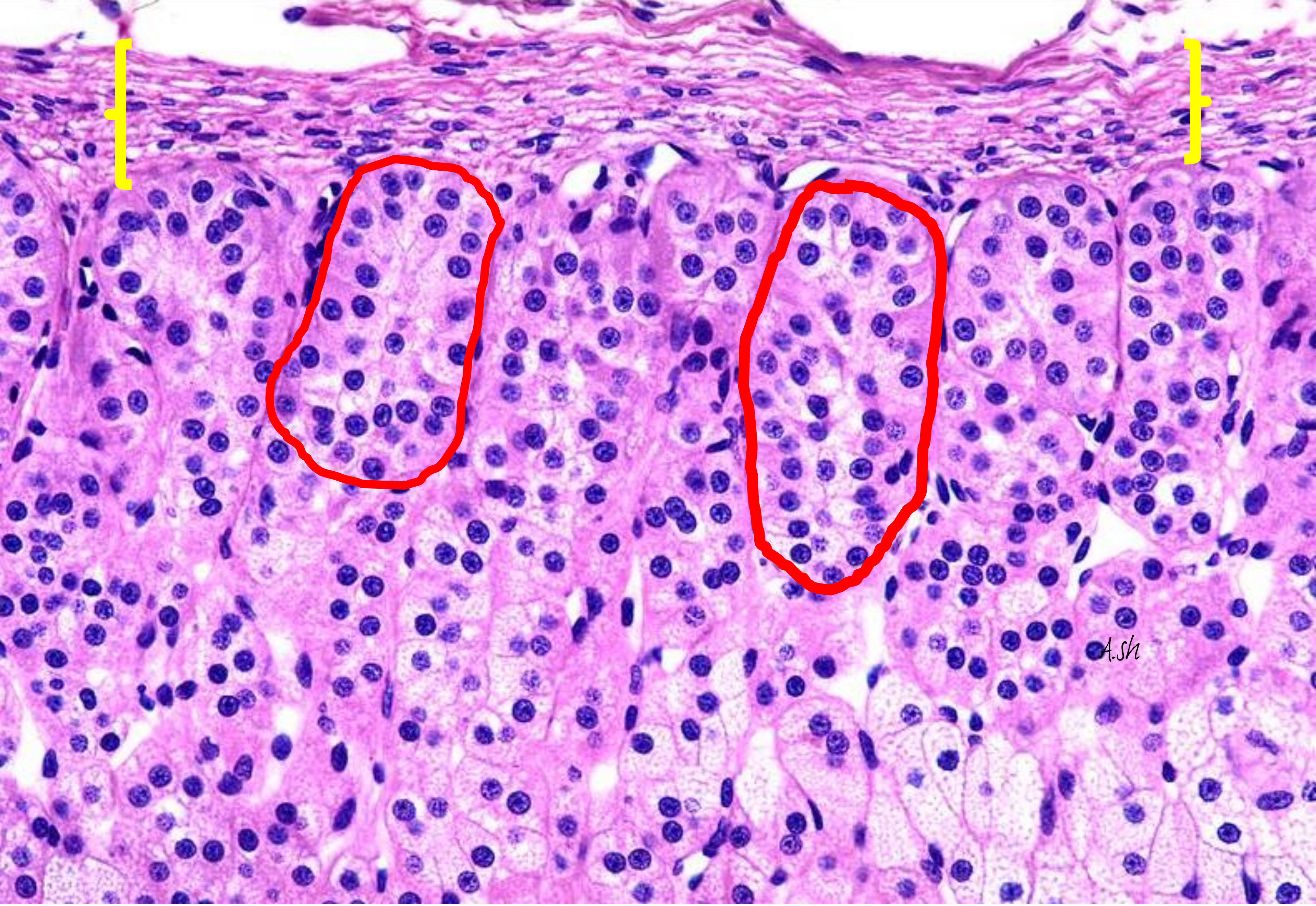
The main mineralocorticoid is aldosterone.

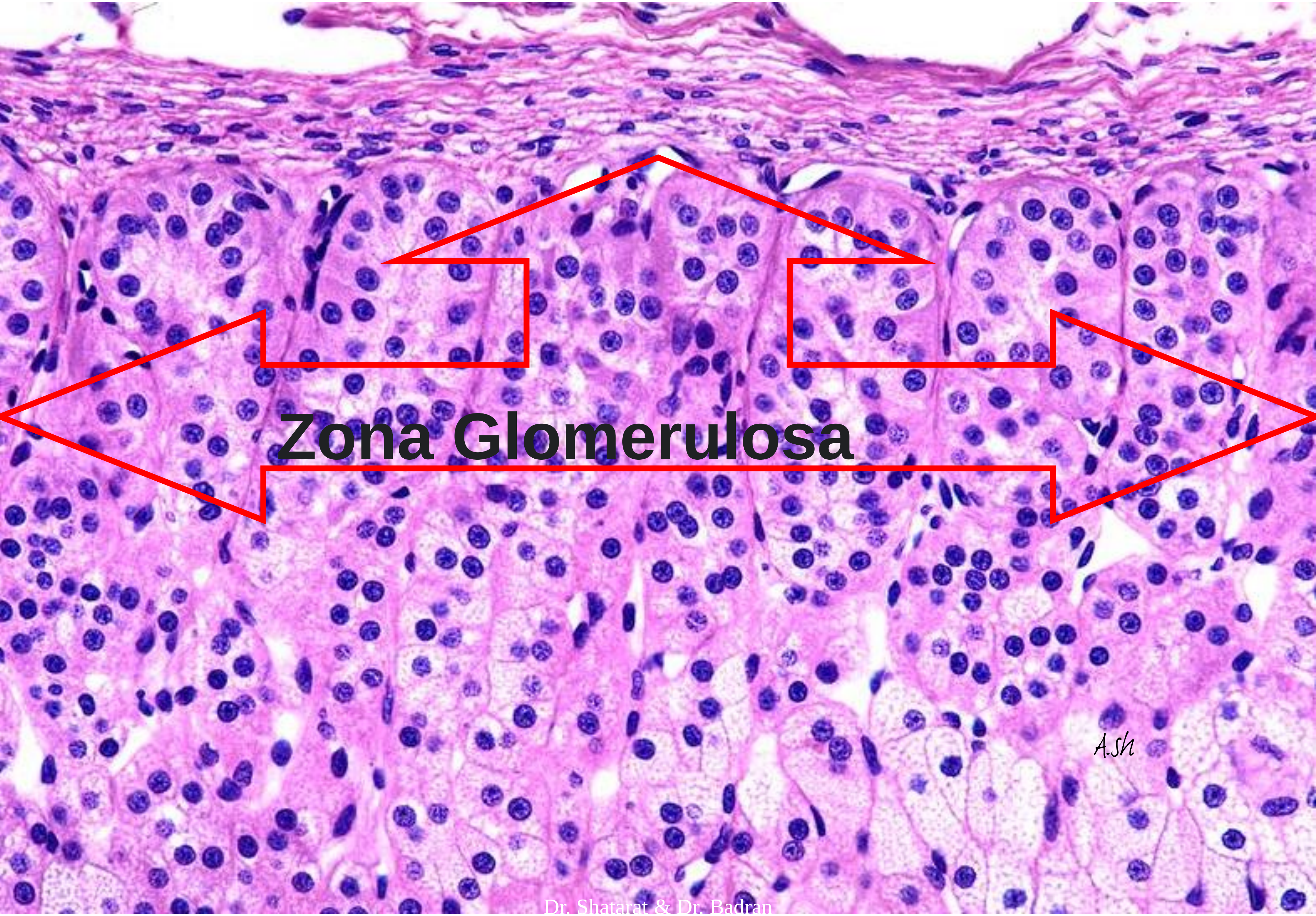
Aldosterone stimulates resorption of sodium from:

A.Sh

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

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


A.sh


Zona Glomerulosa
A.Sh

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.

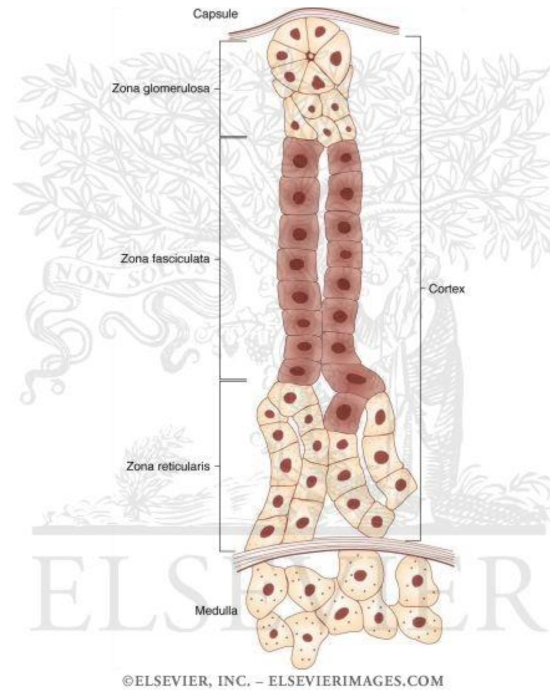
Cords are separated by sinusoidal capillaries.

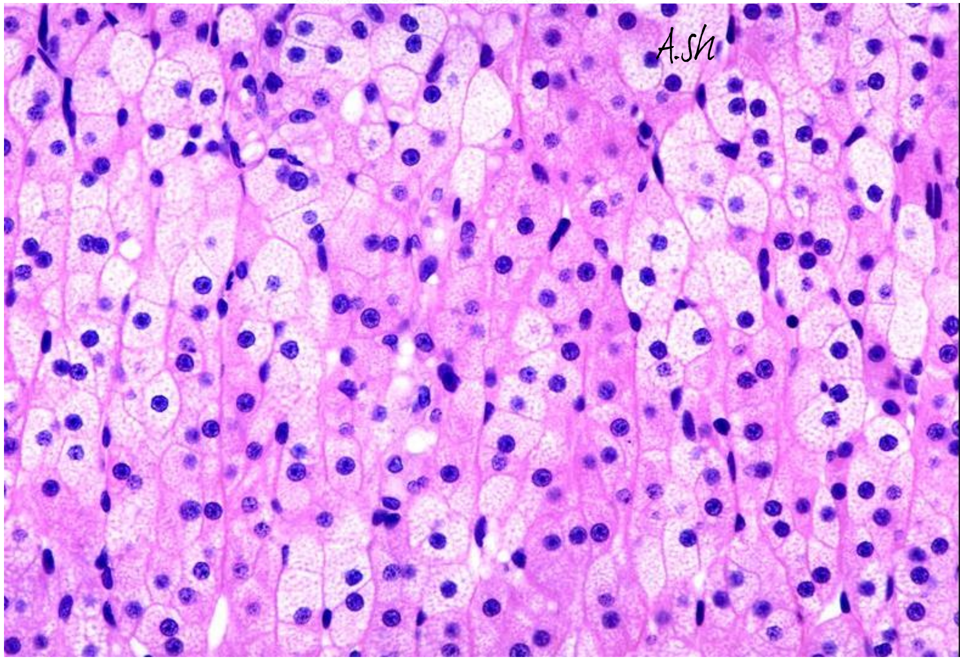
Cells are lightly stained, commonly binucleated.

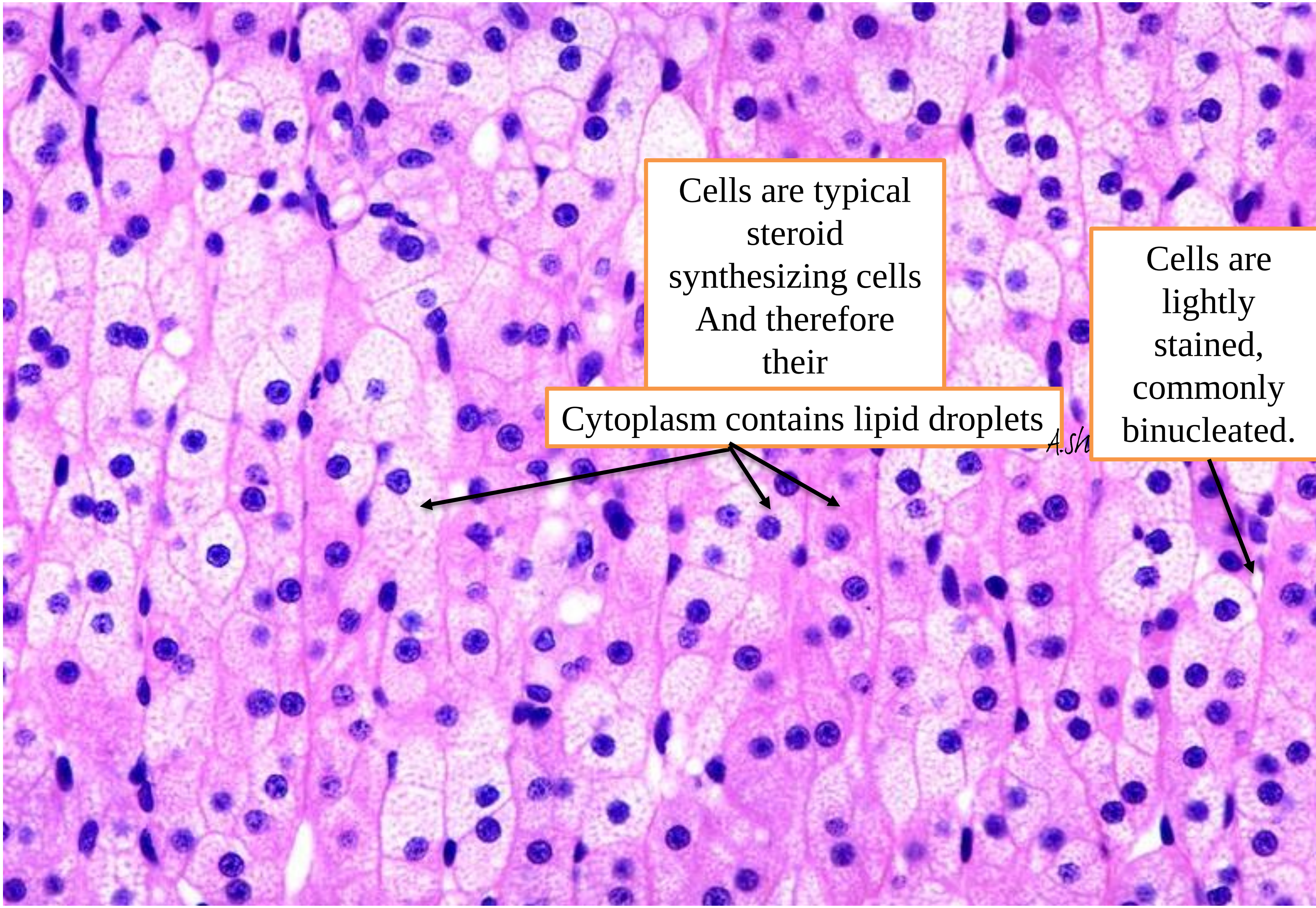
Cells are typical steroid synthesizing cells.

Cytoplasm contains lipid droplets.

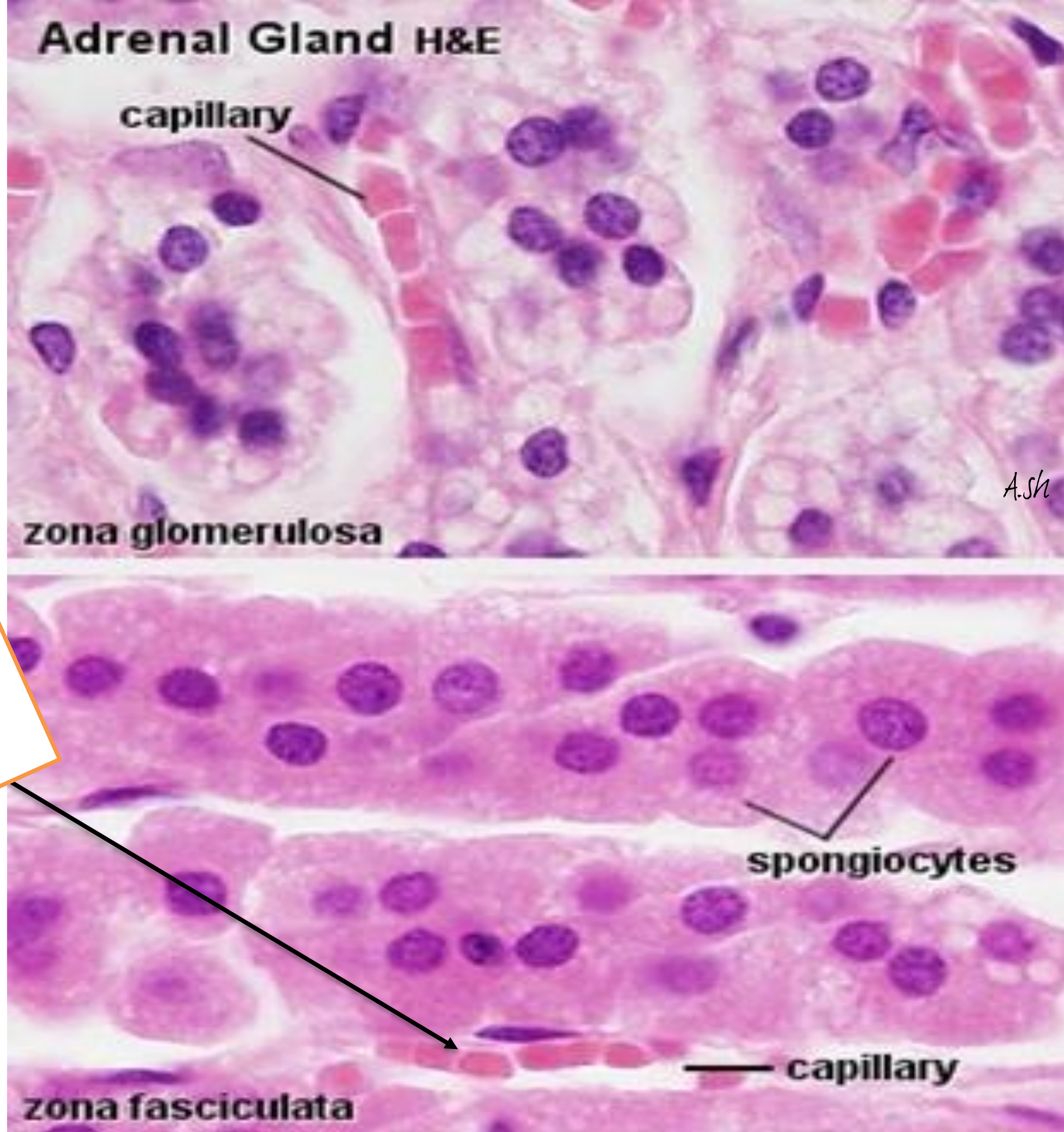
Cells secrete glucocorticoids, mainly cortisol.






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:

A.Sh

- 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.

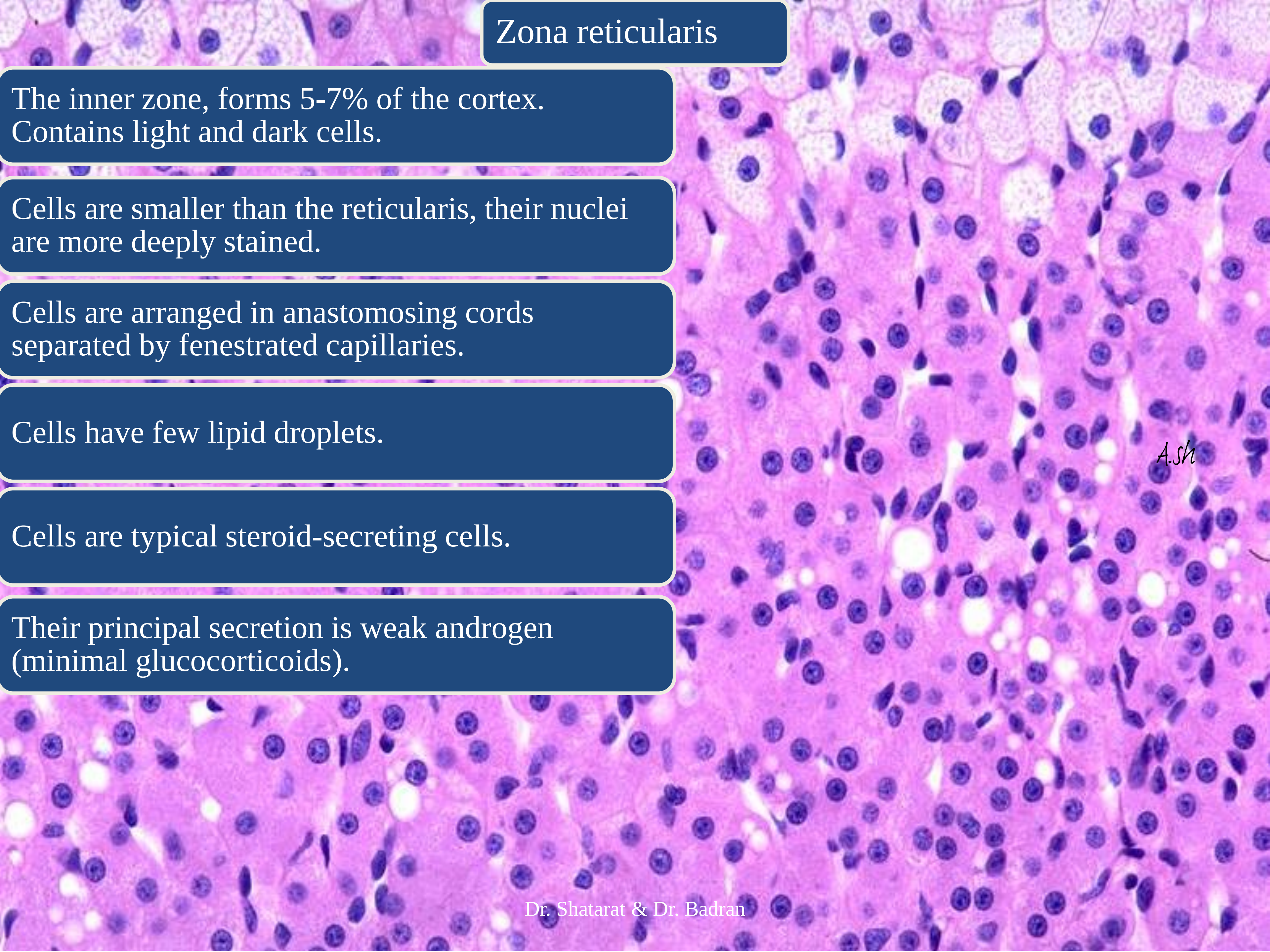
Cells are smaller than the reticularis, their nuclei are more deeply stained.

Cells are arranged in anastomosing cords separated by fenestrated capillaries.

Cells have few lipid droplets.

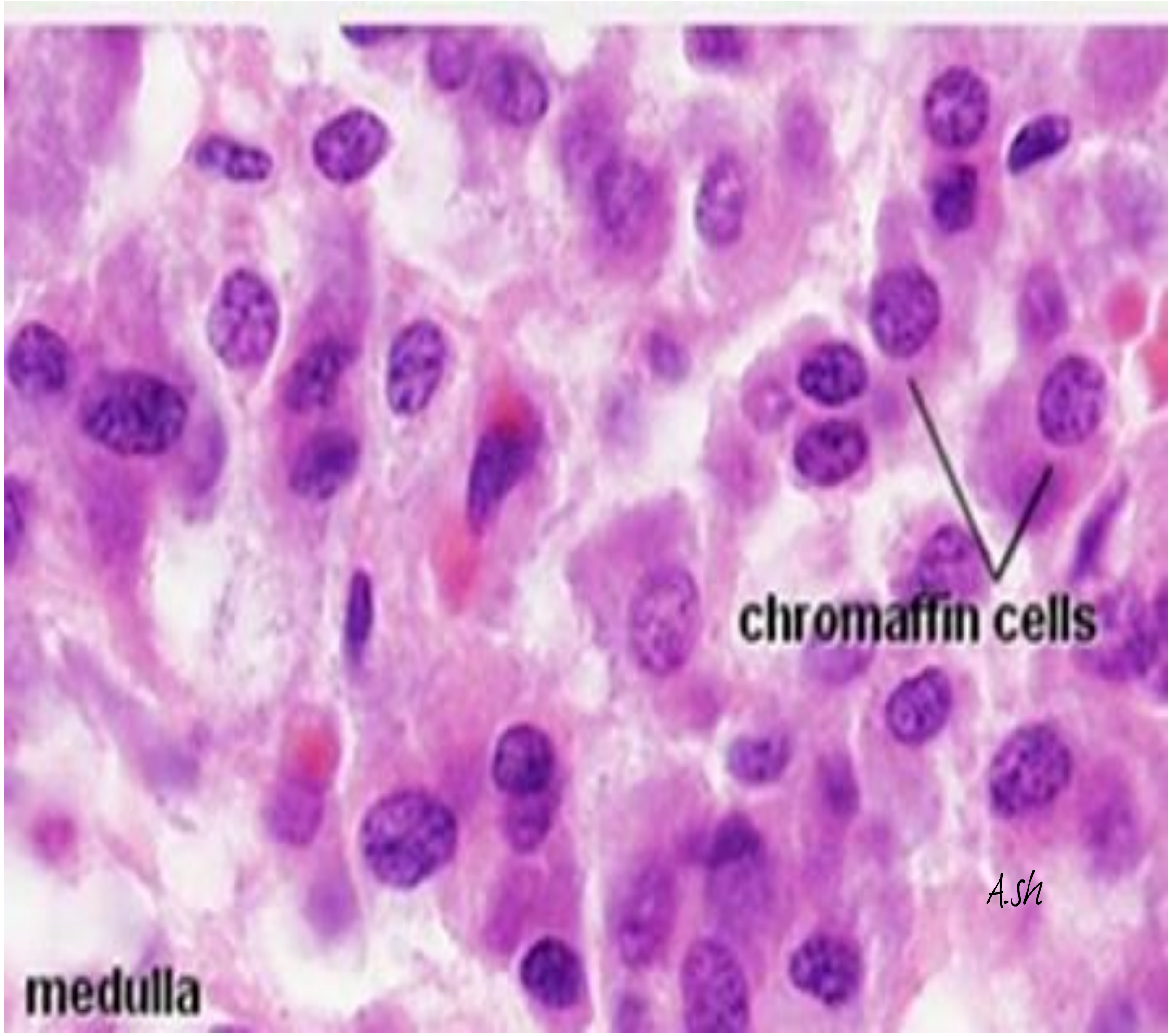
Cells are typical steroid-secreting cells.

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.

A.Sh

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**

<u>About 80% of the catecholamine secreted from the adrenal is epinephrine</u>

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

A.Sh

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.

A.Sh

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.