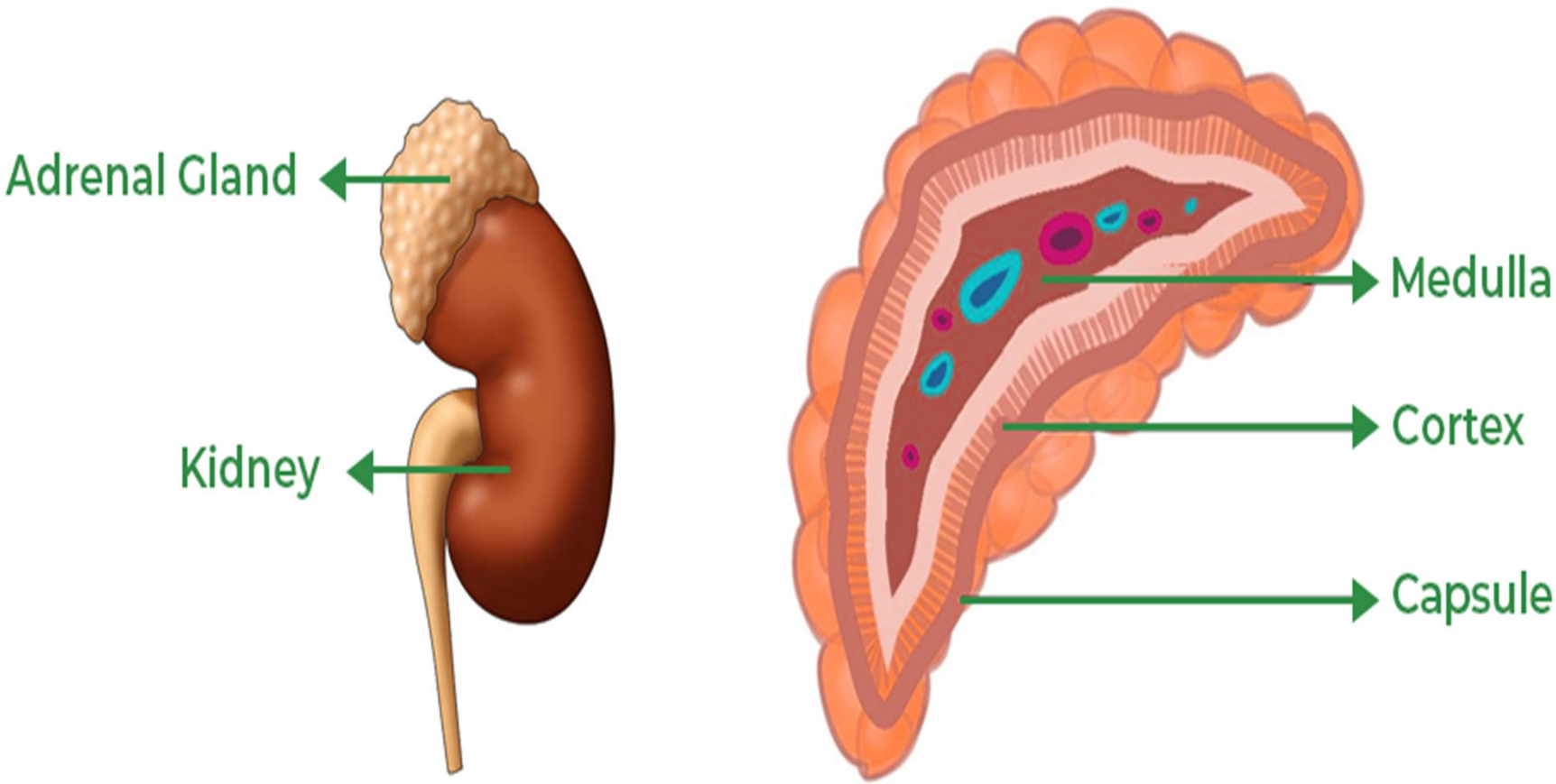
Endocrine System
(Part 3)

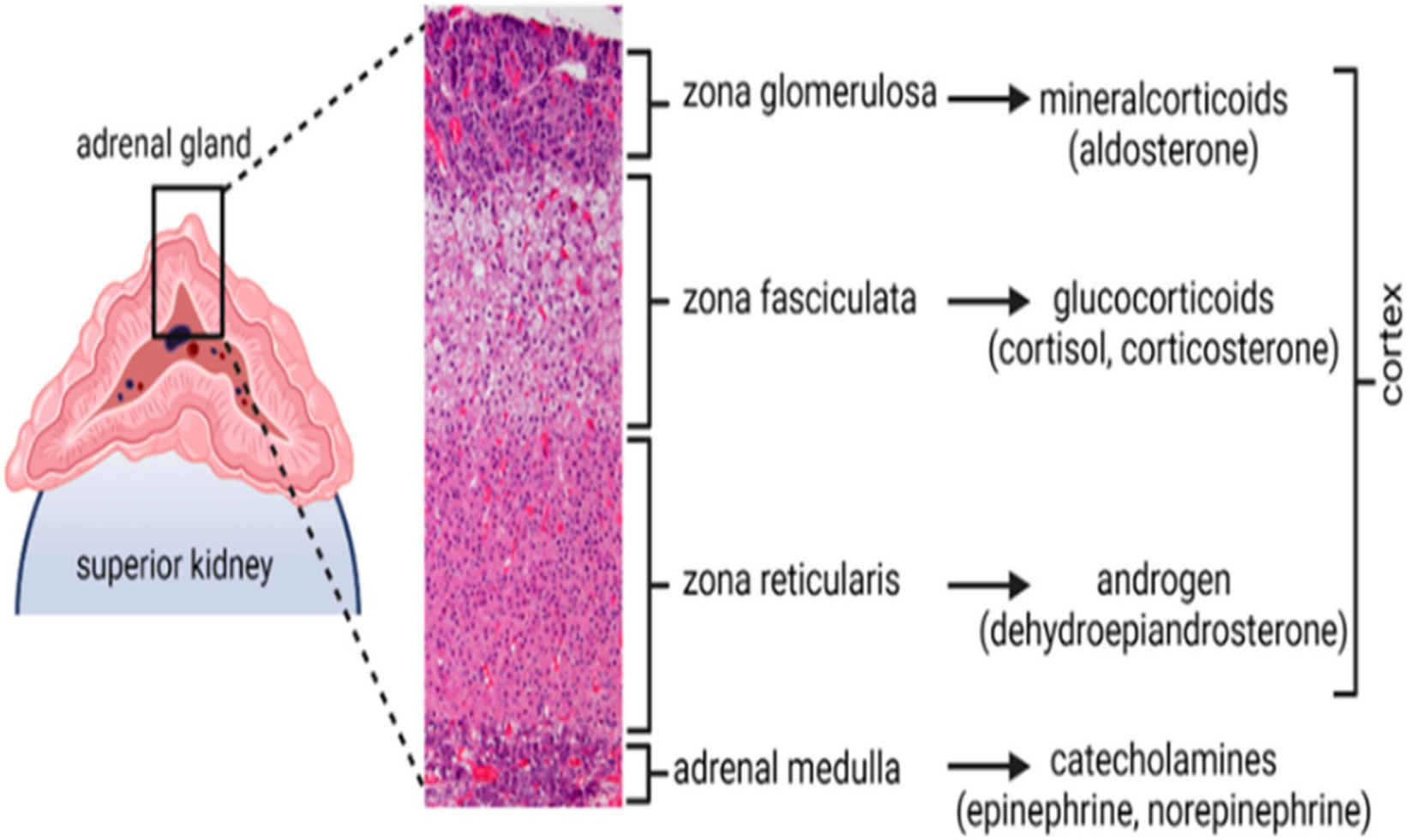
Dr. Hayder Naji Sameer
Msc in Clinical Pharmacy

The Adrenal glands

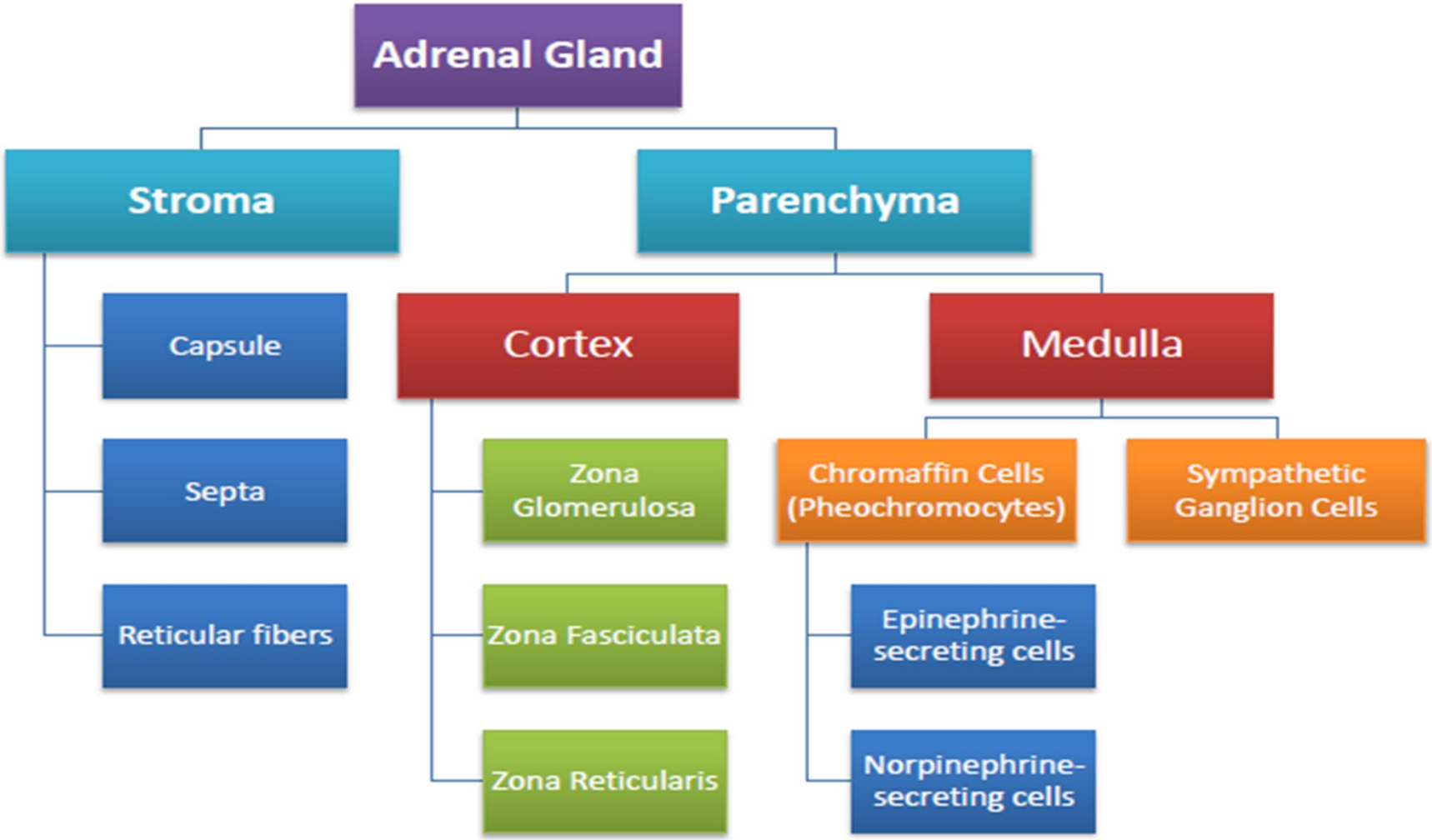
- These are two glands lie near the superior pole of the kidney.
- Each adrenal gland consists of two parts cortex and medulla.

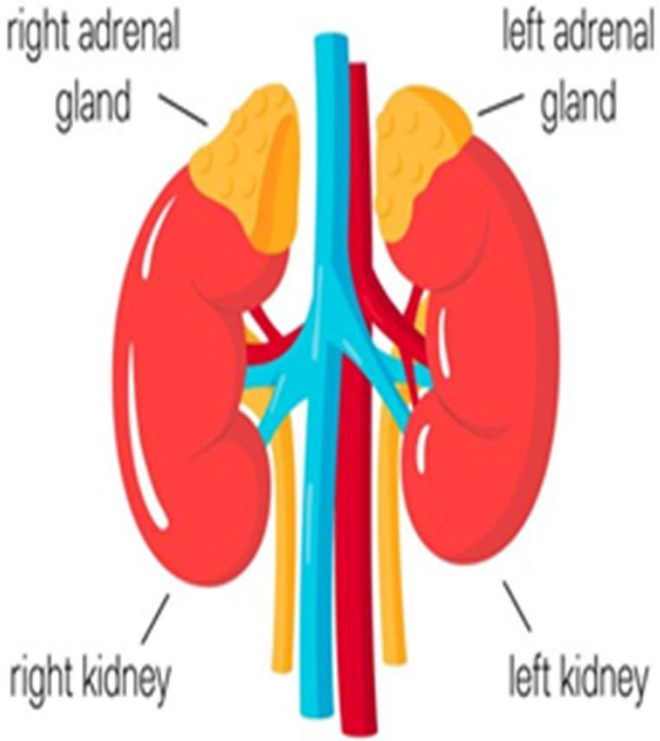

Adrenal Gland
Kidney
Medulla
Cortex
Capsule

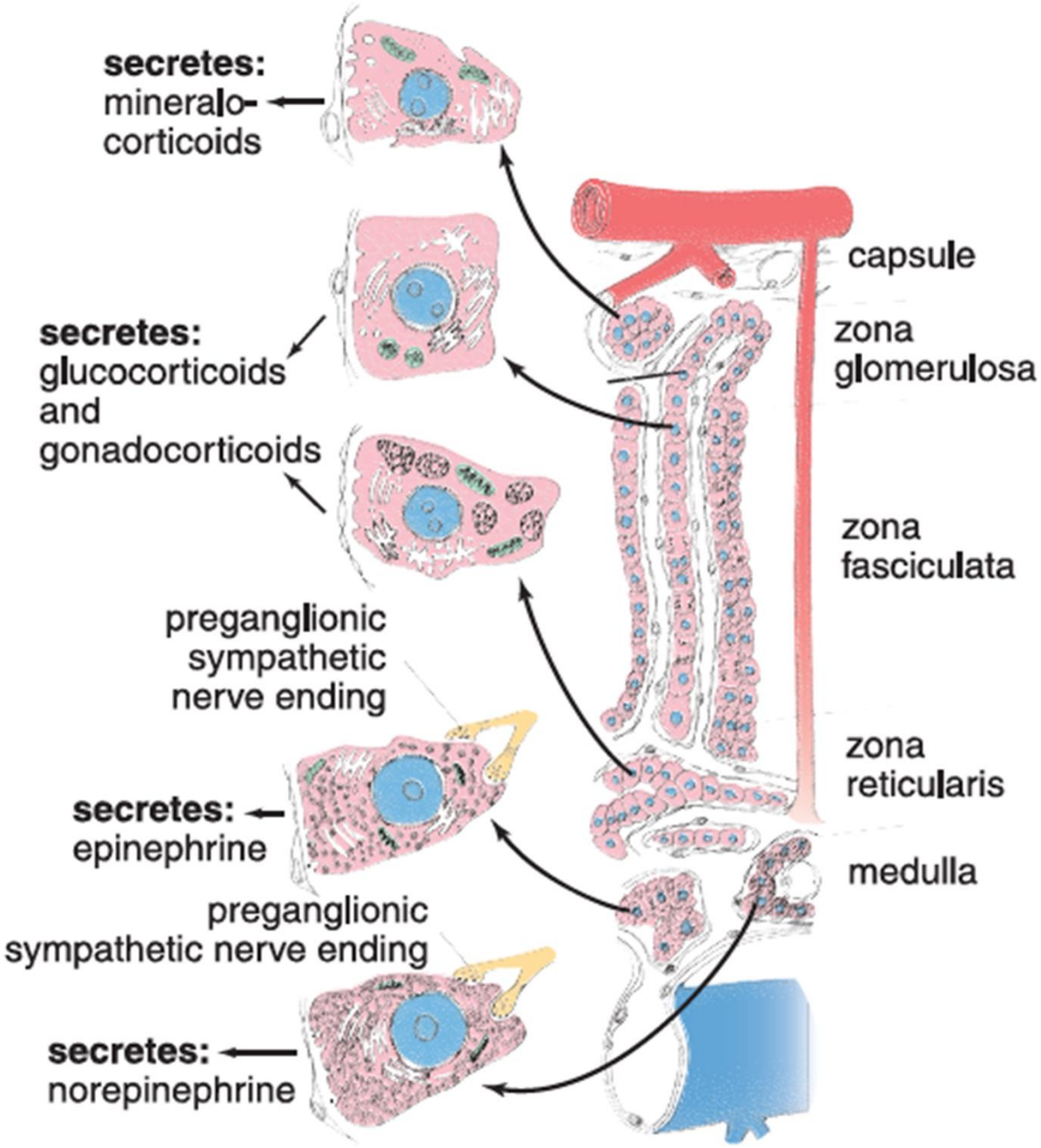
Adrenal gland Function



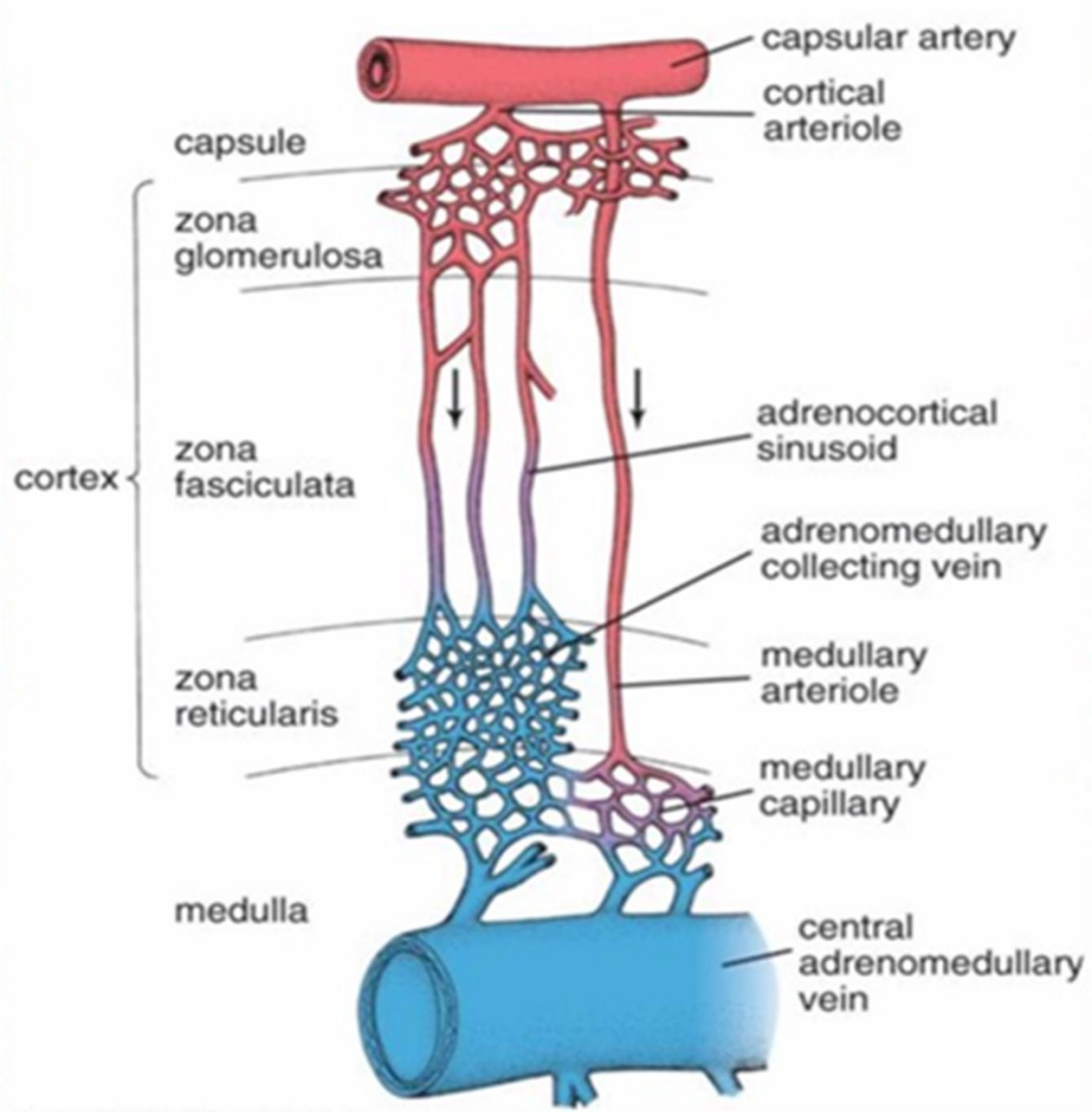
The Structure of Adrenal gland



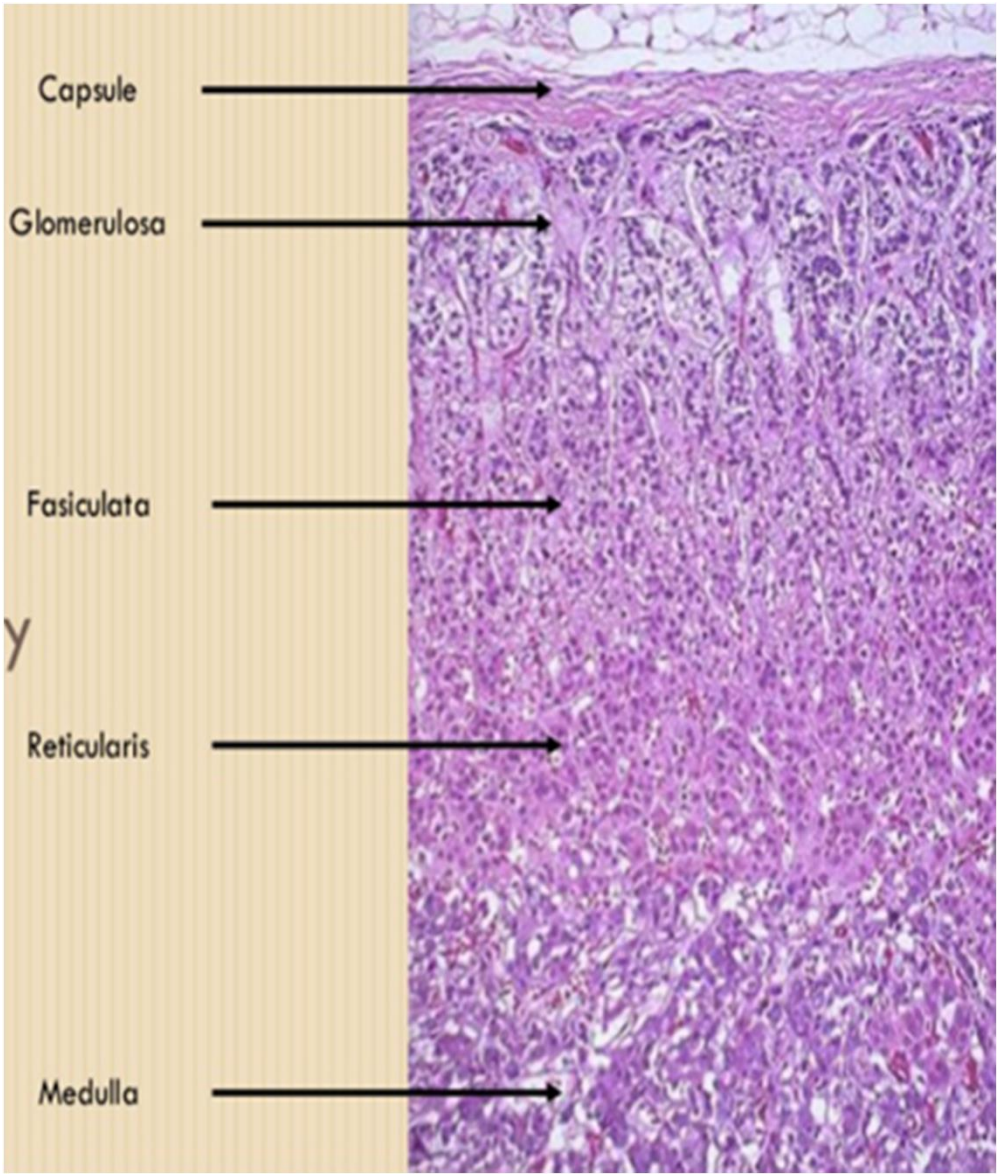

right adrenal gland
left adrenal gland
right kidney
left kidney


secretes: mineralo-corticoids
secretes: glucocorticoids and gonadocorticoids
preganglionic sympathetic nerve ending
secretes: epinephrine
preganglionic sympathetic nerve ending
secretes: norepinephrine
capsule
zona glomerulosa
zona fasciculata
zona reticularis
medulla

Adrenal gland Blood Supply



Adrenal gland Histology



Adrenal Cortex

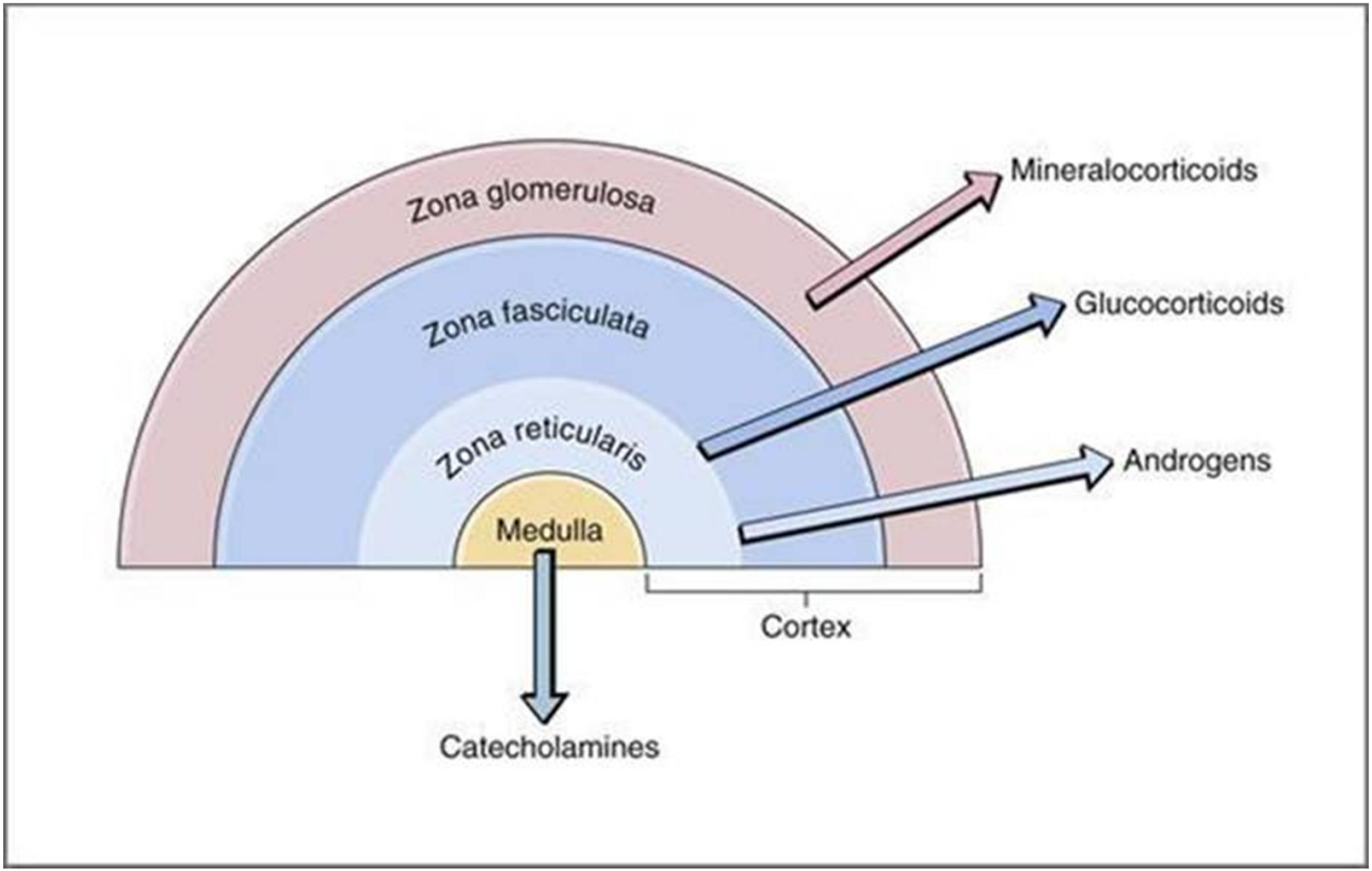
Adrenal cortex

- The adrenal cortex is divided into three zones on the basis of the arrangement of its cells.

a) Zona glomerulosa, the narrow outer zone that constitutes up to 15% of the cortical volume.

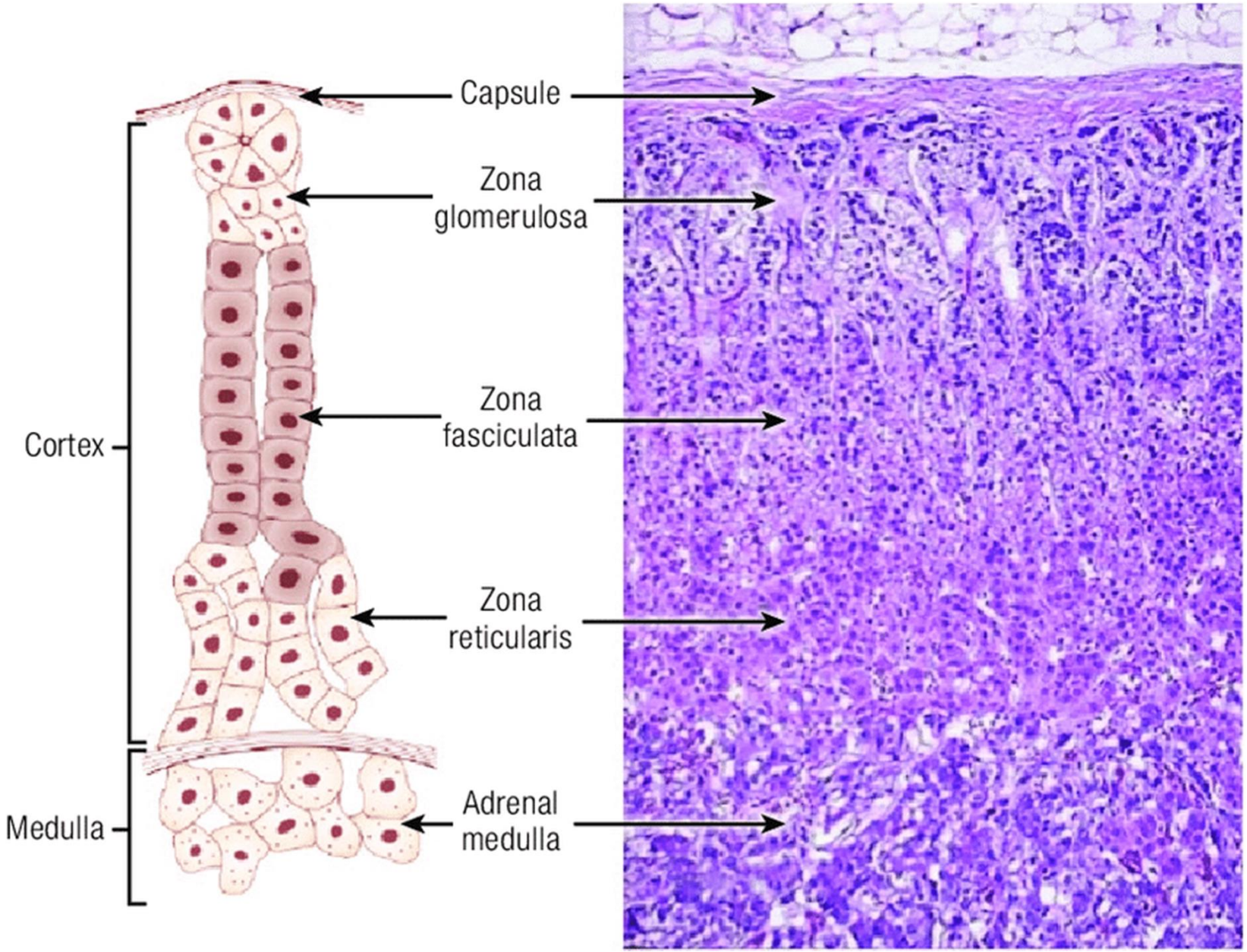
b) Zona fasciculata, the thick middle zone that constitutes nearly 80% of the cortical volume.

c) Zona reticularis, the inner zone that constitutes only 5% to 7% of the cortical volume but is thicker than the glomerulosa because of its more central location.


Zona glomerulosa
Zona fasciculata
Zona reticularis
Medulla
Mineralocorticoids
Glucocorticoids
Androgens
Cortex
Catecholamines

Zona Glomerulosa (ZG)

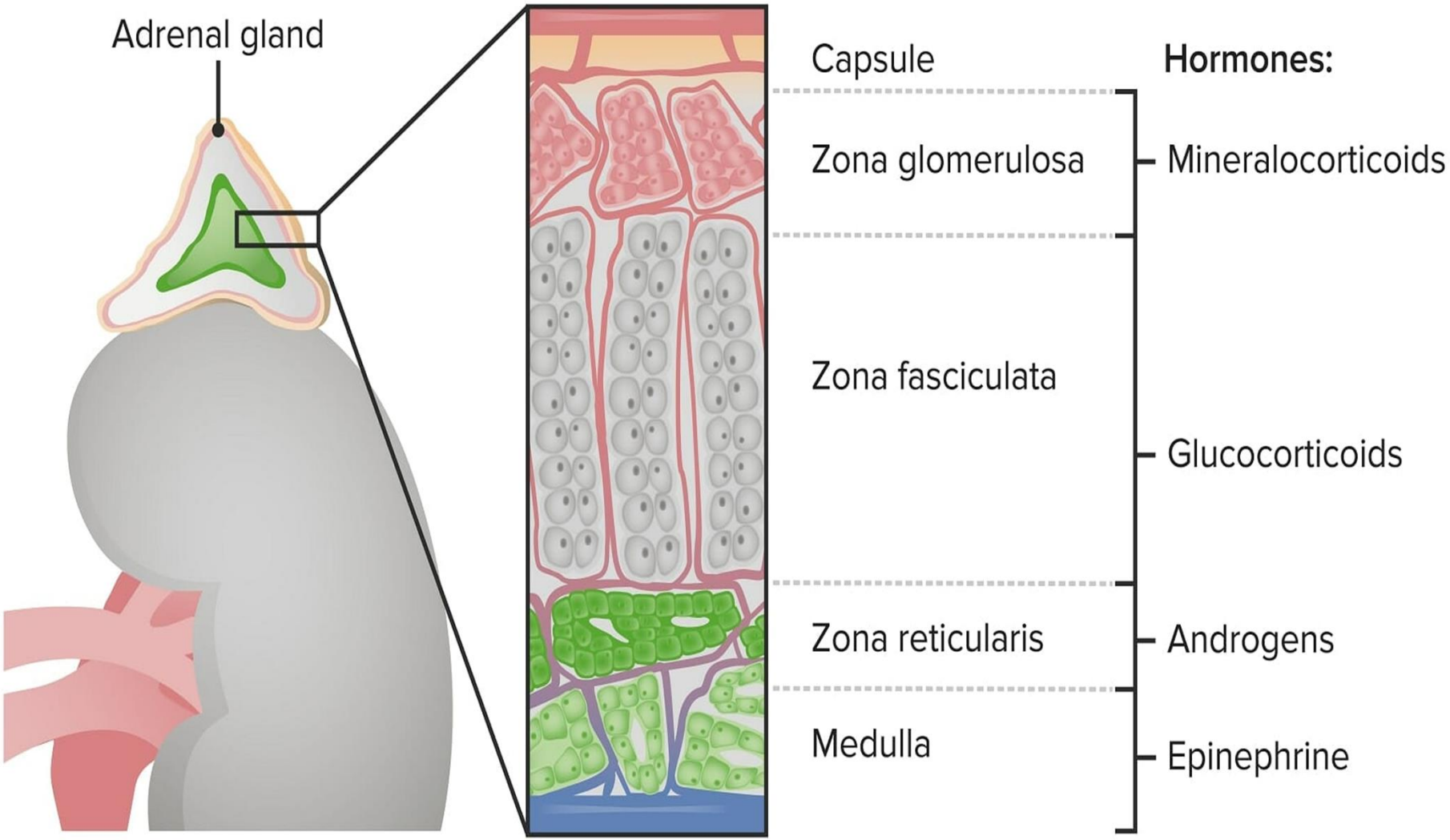
- The cells of the zona glomerulosa are arranged in closely packed ovoid clusters and curved columns that are continuous with the cellular cords in the zona fasciculata.
- A rich network of fenestrated sinusoidal capillaries surrounds each cell cluster.
- Shape of cells: columnar
- Cytoplasm: acidophilic and slightly vaculated


Capsule
Zona glomerulosa
Zona fasciculata
Zona reticularis
Adrenal medulla
Cortex
Medulla

ZG

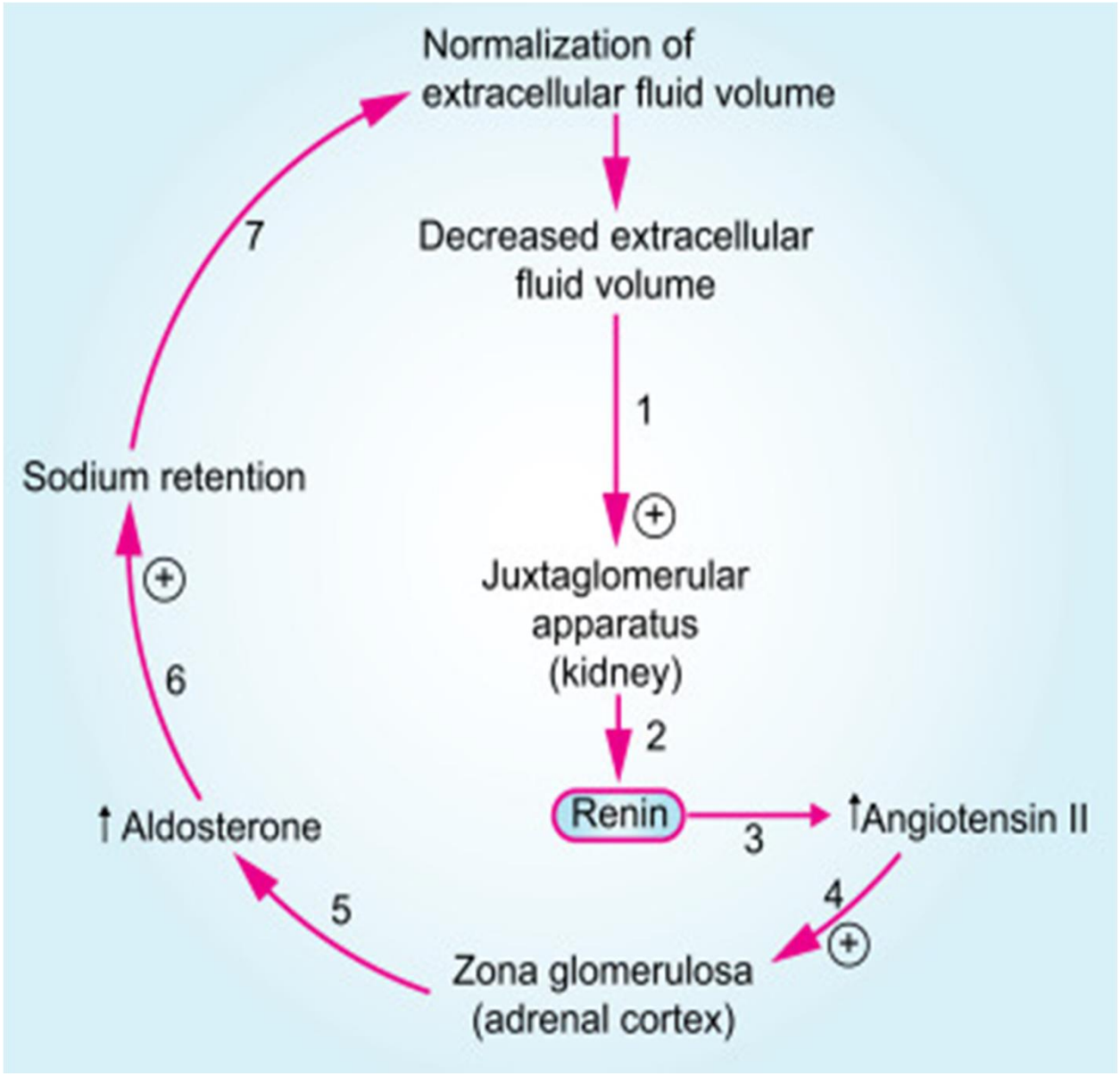
- The cells have abundant smooth-surfaced endoplasmic reticulum (sER), multiple Golgi complexes, large mitochondria with shelf-like cristae, free ribosomes, and some rER. Lipid droplets are sparse.

ZG Function


Adrenal gland
Capsule
Hormones:
Zona glomerulosa
Mineralocorticoids
Zona fasciculata
Glucocorticoids
Zona reticularis
Androgens
Medulla
Epinephrine

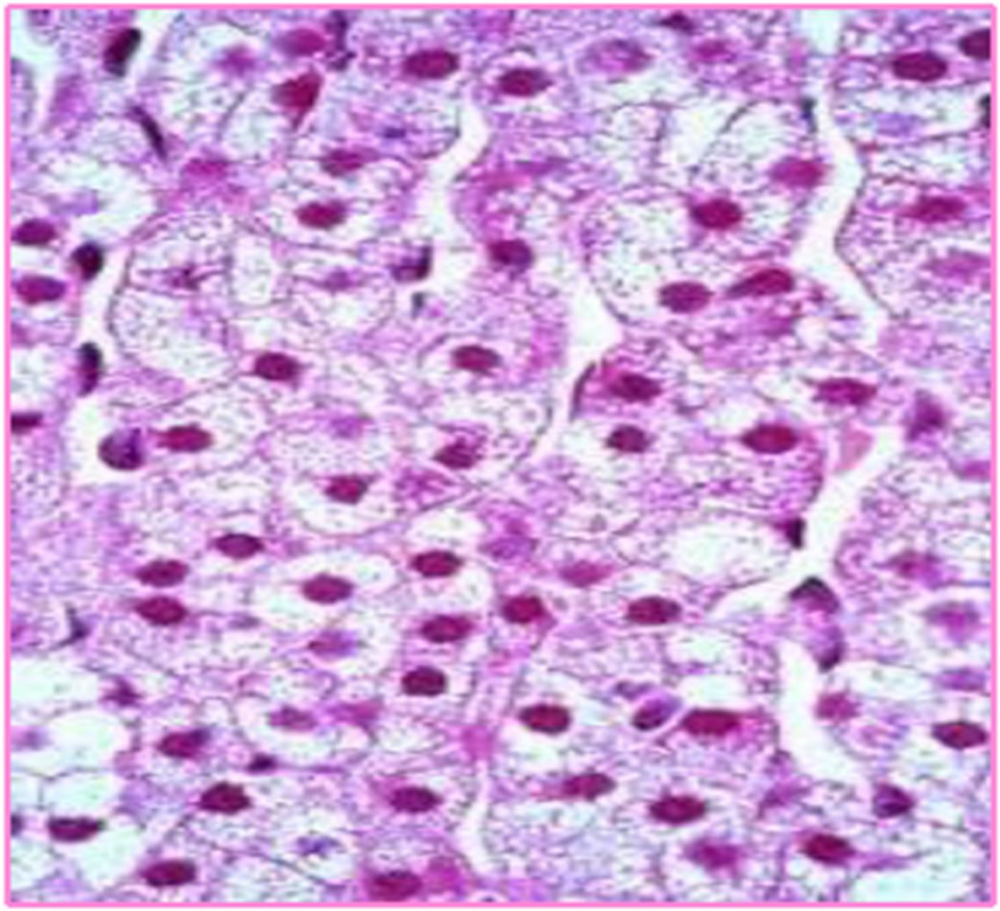
- The cells of the zona glomerulosa secrete mineralocorticoids, compounds that function in the regulation of sodium and potassium homeostasis and water balance.
- The principal secretion, aldosterone, acts on the distal tubules of the nephron in the kidney, the gastric mucosa, and the salivary and sweat glands to stimulate resorption of sodium at these sites, as well as to stimulate excretion of potassium by the kidney.

Control of ZG secretion

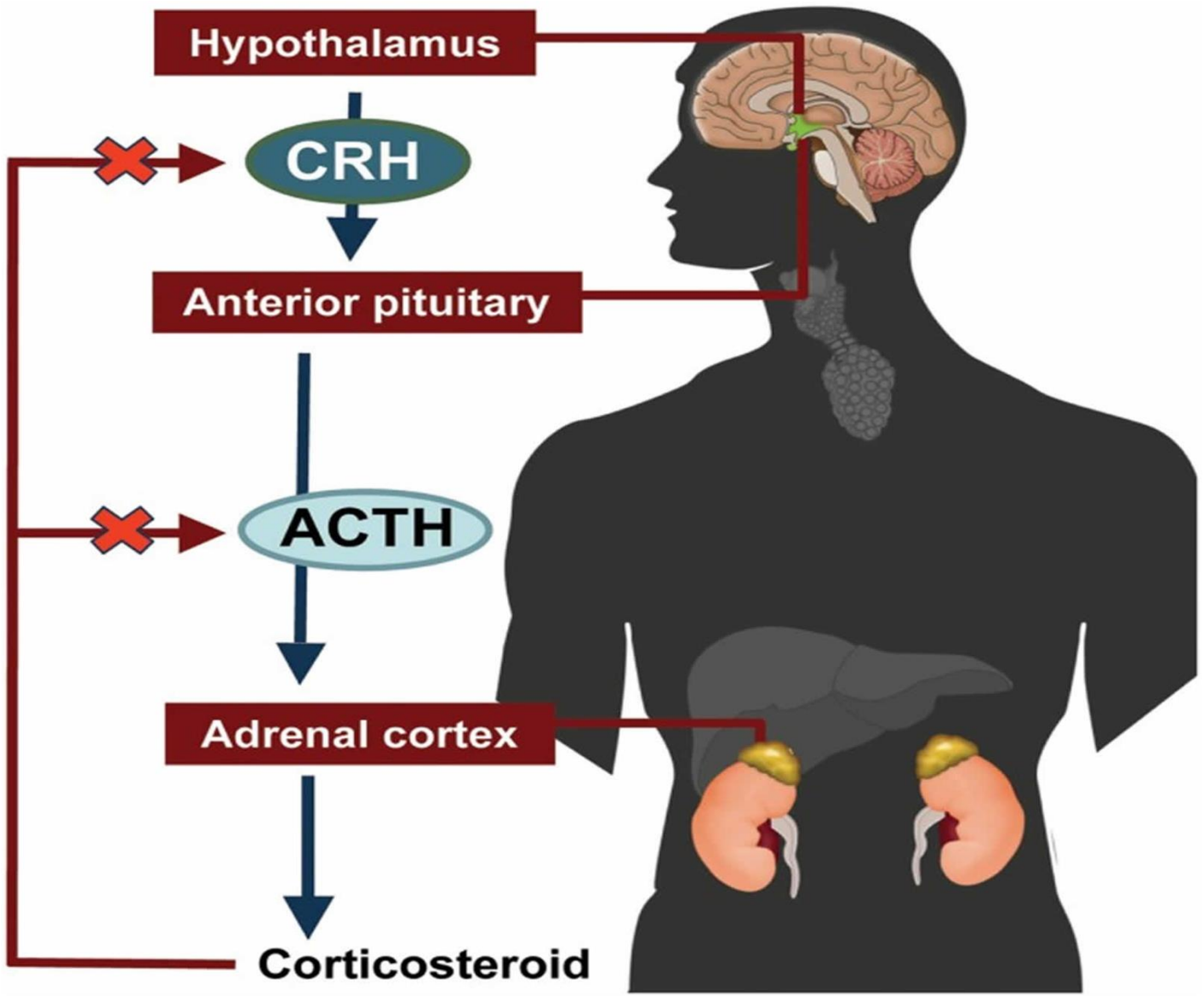


Zona Fasciculata (ZF)

- It consists of long cords of large polyhedral cells, one or two cells thick, separated by fenestrated sinusoidal capillaries.
- The cells are most densely filled with cytoplasmic lipid droplets and, as a result of lipid dissolution during tissue preparation, often appear vacuolated or spongy in common histological preparations. Because of their vacuolization, the cells of the fasciculata are also called spongyocytes.



Control of ZF Secretion



- Glucocorticoids play important role in regulating gluconeogenesis (glucose synthesis) and glycogenesis (glycogen polymerization).
- Also, the glucocorticoids secreted by the zona fasciculata, cortisol acts on many different cells and tissues to increase the metabolic availability of glucose and fatty acids, both of which are immediate sources of energy.

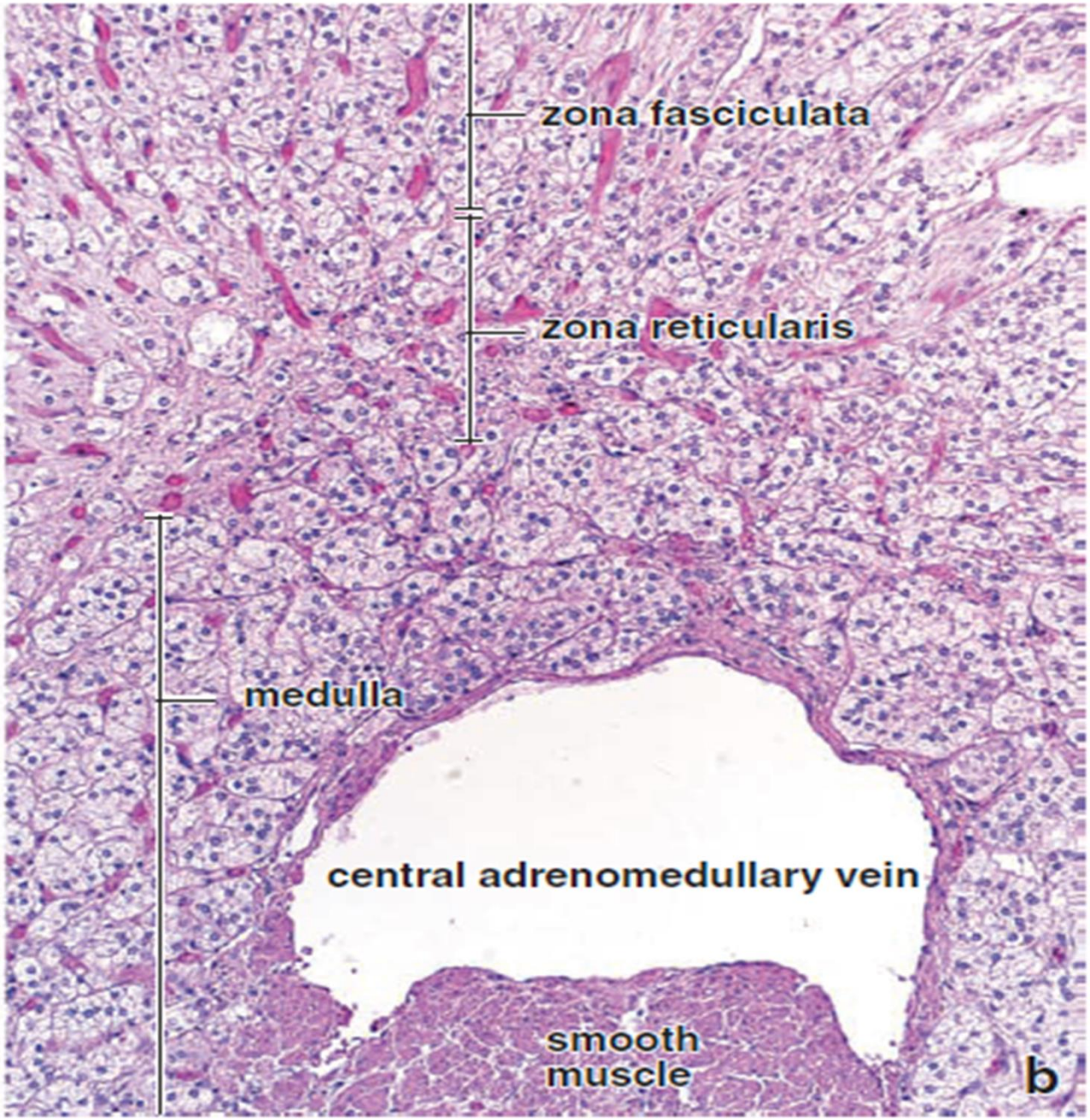
Zona Reticularis (ZR)

- It consists of smaller cells disposed in a network of irregular cords interwoven with wide capillaries.
- The cells are usually more heavily stained than those of the other zones because they contain fewer lipid droplets and more lipofuscin pigment.
- The zona reticularis is also regulated by the feedback control of the CRH–ACTH system

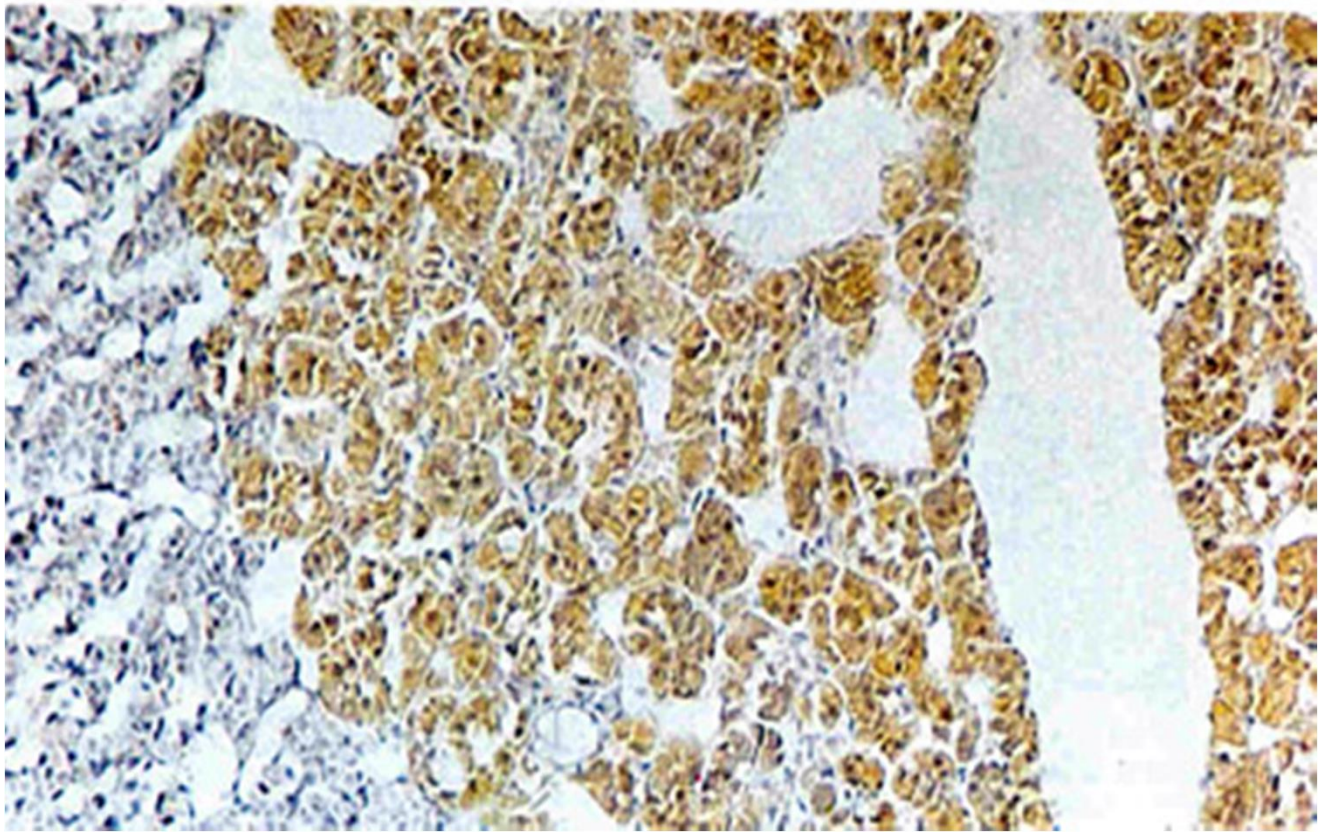
Adrenal Medulla

Adrenal Medulla

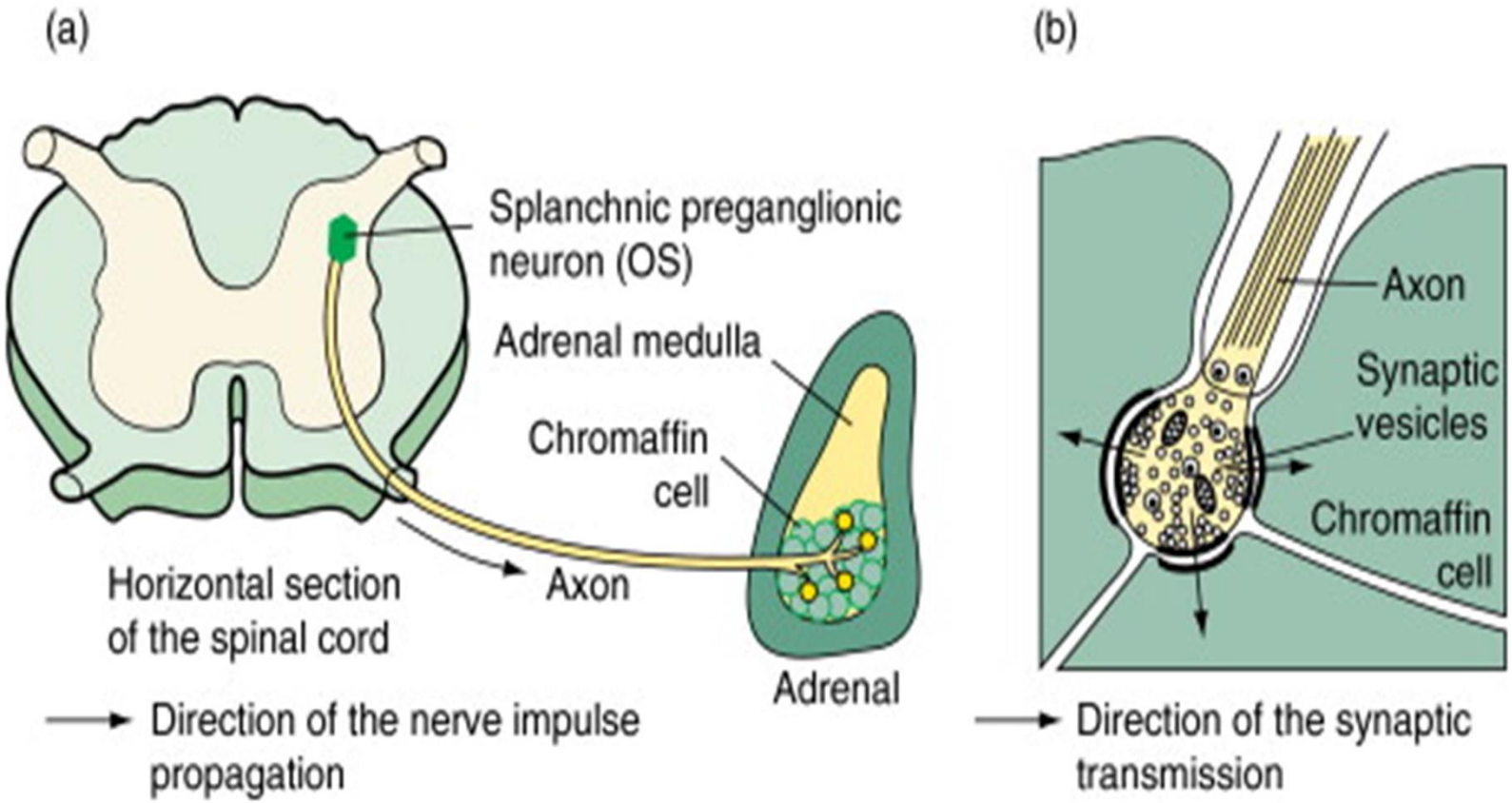
- The adrenal medulla is composed of large, pale-staining polyhedral cells arranged in cords or clumps and supported by a reticular fiber network.
- ***Chromaffin cells*** can be considered modified sympathetic postganglionic neurons, lacking axons and dendrites and specialized as secretory cells.


zona fasciculata
zona reticularis
medulla
central adrenomedullary vein
smooth muscle
b

Chromaffin Cells Histology
(Chromaffin Reaction)

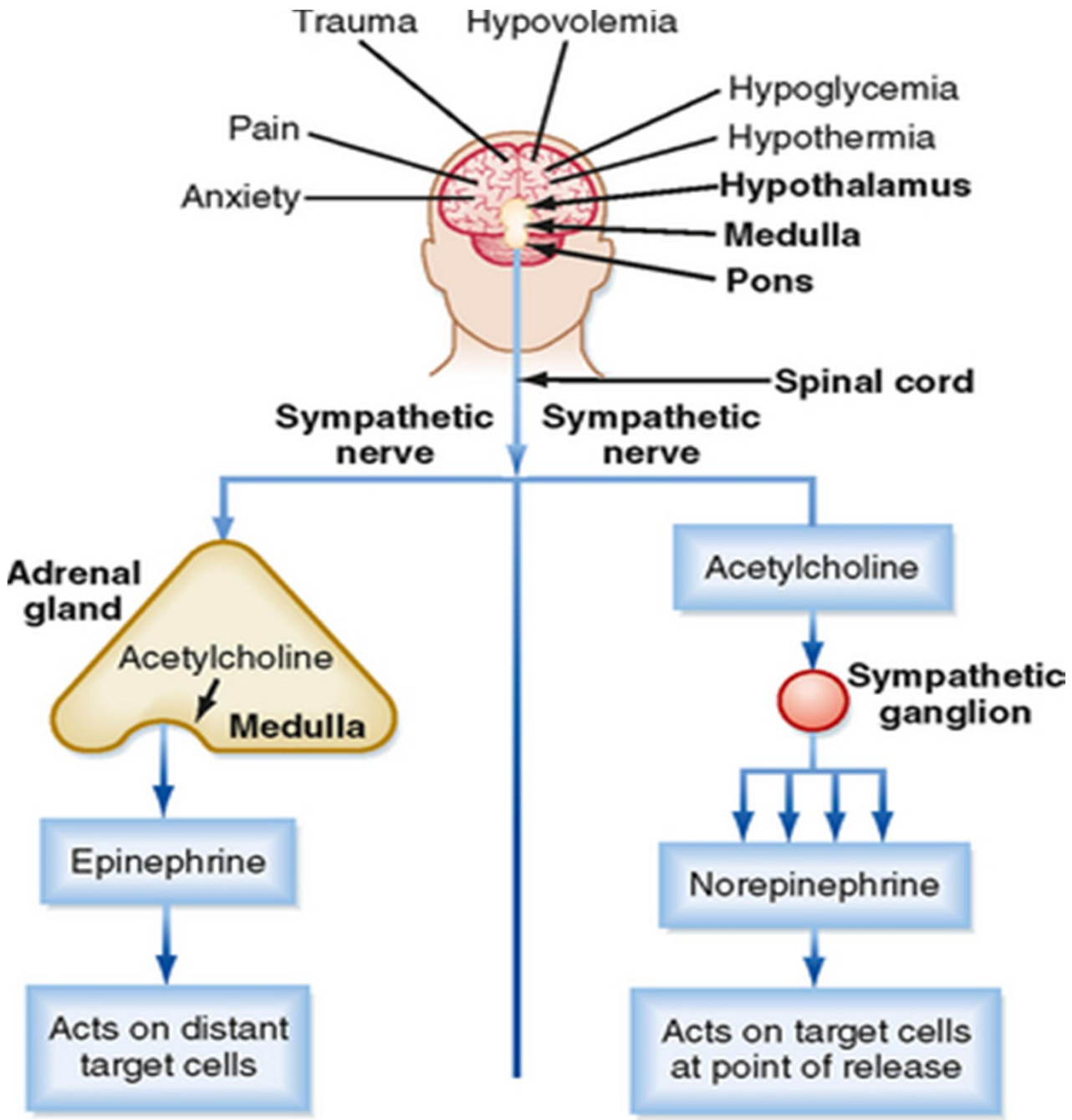


Preganglionic and Postganglionic Cells



- Unlike cells of the cortex, medullary chromaffin cells contain many electron-dense granules for hormone storage and secretion. These granules contain one or the other of the catecholamines, epinephrine(adrenalin) or norepinephrine (noradrenaline).
- Medullary chromaffin cells are innervated by cholinergic endings of preganglionic sympathetic neurons, from which impulses trigger hormone release by exocytosis.

- Experimental studies reveal that when chromaffin cells are grown in culture, they extend axon-like processes. However, axonal growth can be inhibited by glucocorticoids hormones secreted by the adrenal cortex.
- Thus, the hormones of the adrenal cortex exert control over the morphology of the chromaffin cells and prevent them from forming neural processes. Chromaffin cells therefore more closely resemble typical endocrine cells, in that their secretory product enters the bloodstream via the fenestrated capillaries.


Trauma
Hypovolemia
Hypoglycemia
Hypothermia
Pain
Anxiety
Hypothalamus
Medulla
Pons
Spinal cord
Sympathetic nerve
Sympathetic nerve
Adrenal gland
Acetylcholine
Medulla
Epinephrine
Acts on distant target cells
Acetylcholine
Sympathetic ganglion
Norepinephrine
Acts on target cells at point of release

- Epinephrine & norepinephrine are released to the blood in large quantities during intense emotional reactions, such as fright, and produce vasoconstriction, increased blood pressure, changes in heart rate, and metabolic effects such as elevated blood glucose.
- These effects facilitate various defensive reactions to the stressor (the fight-or-flight response). During normal activity, the adrenal medulla continuously secretes small quantities of the hormones.

- ***Ganglion cells*** are also present in the medulla. Their axons extend peripherally to the parenchyma of the adrenal cortex to modulate its secretory activity and innervate blood vessels, and extend outside the gland to the splanchnic nerves innervating abdominal organs.

Summary

Hormone	Composition	Source	Major Functions
Adrenal cortex			
Mineralocorticoids (95% of mineralocorticoid activity in aldosterone)	Steriod hormones (cholesterol derivatives)	Parenchymal cells of the zona glomerulosa	Aid in controlling electrolyte homeostasis (act on distal tubule of kidney to increase sodium reabsorption and decrease potassium reabsorption); function in maintaining the osmotic balance in the urine and in preventing serum acidosis
Glucocorticoids (corticosterone, and cortisol; 95% of glucocorticoid activity in cortisol)	Steriod hormones (cholesterol derivatives)	Parenchymal cells of the zona fasciculata (and to a lesser extent of the zona reticularis)	Promote normal metabolism, particularly carbohydrate metabolism (increase rate of amino acid transport to live, promote removal of protein from skeletal muscle and its transport to liver, reduce rate of glucose metabolism by cells and stimulate glycogen synthesis by liver, stimulate mobilization of fats from storage deposits for energy use); provide resistance to stress; suppress inflammatory response and some allergic reactions

Summary

Gonadocorticoids (dehydroepiandrosterone [DHEA] is a major sex steroid produced in both men and women)	Steriod hormones (cholesterol derivatives)	Parenchymal cells of the zona reticularis (and to a lesser extent of the zona fasciculata)	Induce weak masculinizing effect; at normal serum levels usually their function is insignificant
Adrenal medulla			
Norepinephrine and epinephrine (in human, 80% epinephrine)	Catecholamines (amino acid derivatives)	Chromaffin cells	Sympathomimetic (produce effects similar to those induced by the sympathetic division of the autonomic nervous system)[a]; increase heart rate, increase blood pressure, reduce blood flow to viscera and skin; stimulate conversion of glycogen to glucose; increase sweating; induce dilation of bronchioles; increase rate of respiration; decrease digestion; decrease enzyme production by digestive system glands; decrease urine production

Pancreas

- **Beta cells** of Langerhans islets secret **Insulin**.
- The function of insulin is to help body cells to absorb glucose.
- **Alpha cells** secret **Glucagon.**
- The function of the glucagon is to release glucose.

Thank You