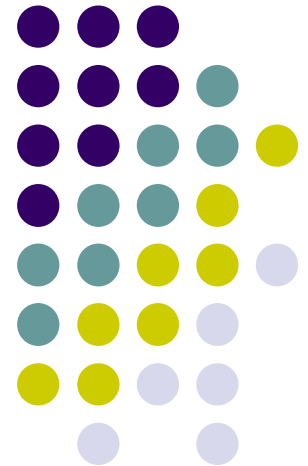


Adrenal glands and hormones

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Adrenal Gland

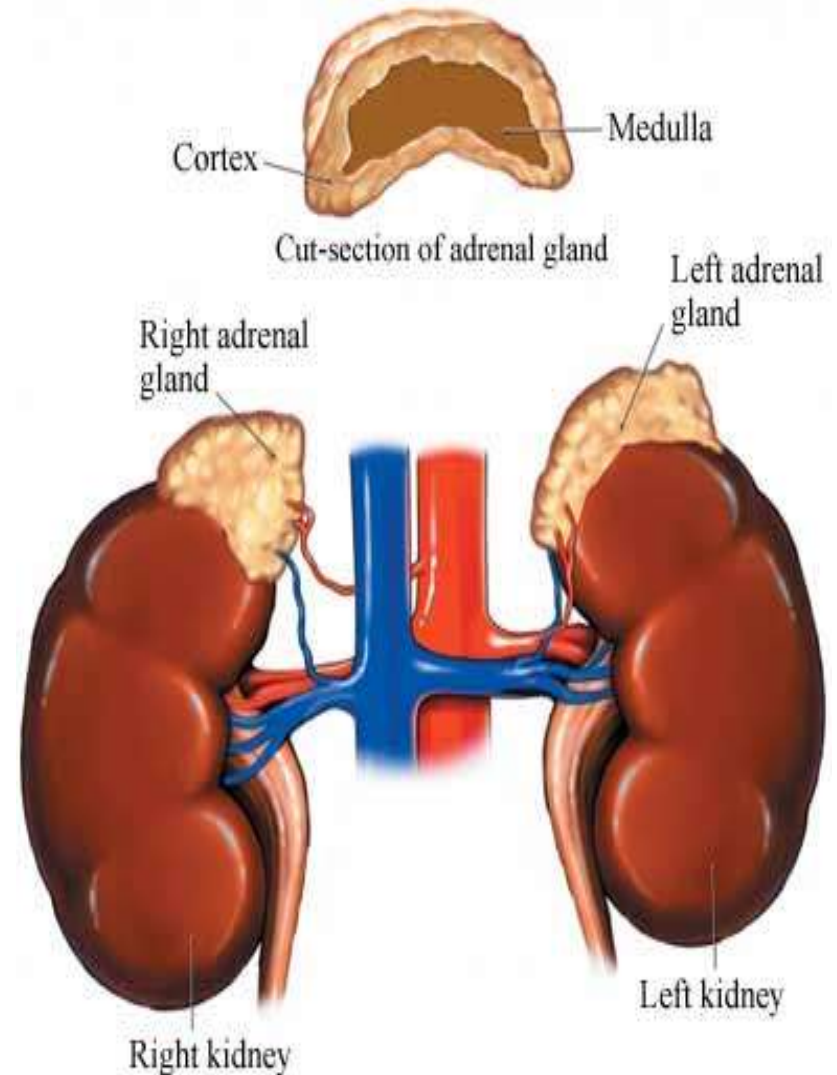


Is located above (or attached to) the upper pole of the kidney near the spine.

The right adrenal is shaped something like a pyramid, whereas the left is shaped more like a half moon.

Each adrenal gland is composed of two endocrine components:

a cortex and a medulla.



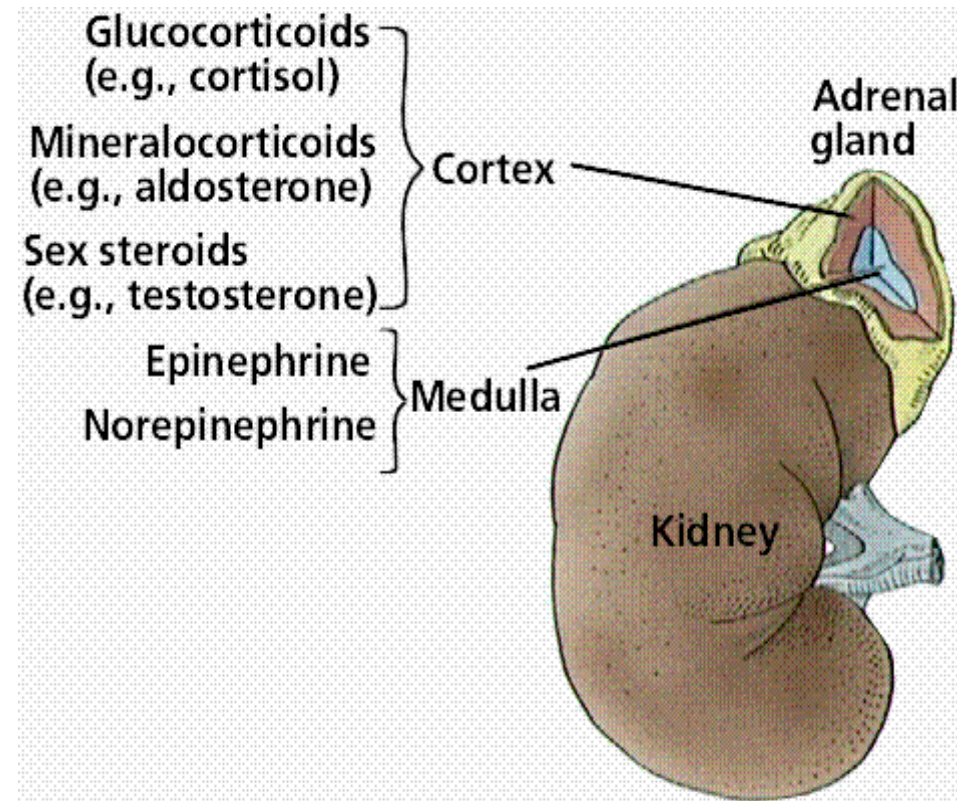
Adrenal cortex (80-90%)– glandular tissue derived from embryonic mesoderm

Adrenal medulla (10-20%)– formed from neural ectoderm, can be considered a modified sympathetic ganglion.

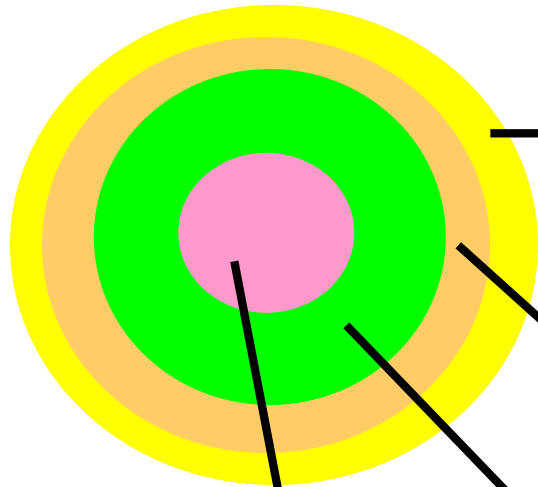
Function:

The medulla and each of the zones in the cortex each produce different hormones that regulate variety of functions in our body.

Mainly regulation of fluid volume and stress response.



Adrenals



CORTEX

Zona Glomerulosa

Mineralocorticoids (Aldosterone)
Na⁺, K⁺ and water homeostasis

Zona Fasciculata

Glucocorticoids (Cortisol)
Glucose homeostasis and many others

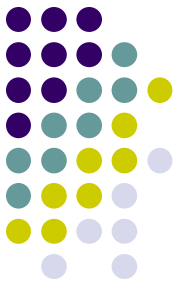
Zona Reticularis

Sex steroids (androgens)

Medulla: “Catecholamines”

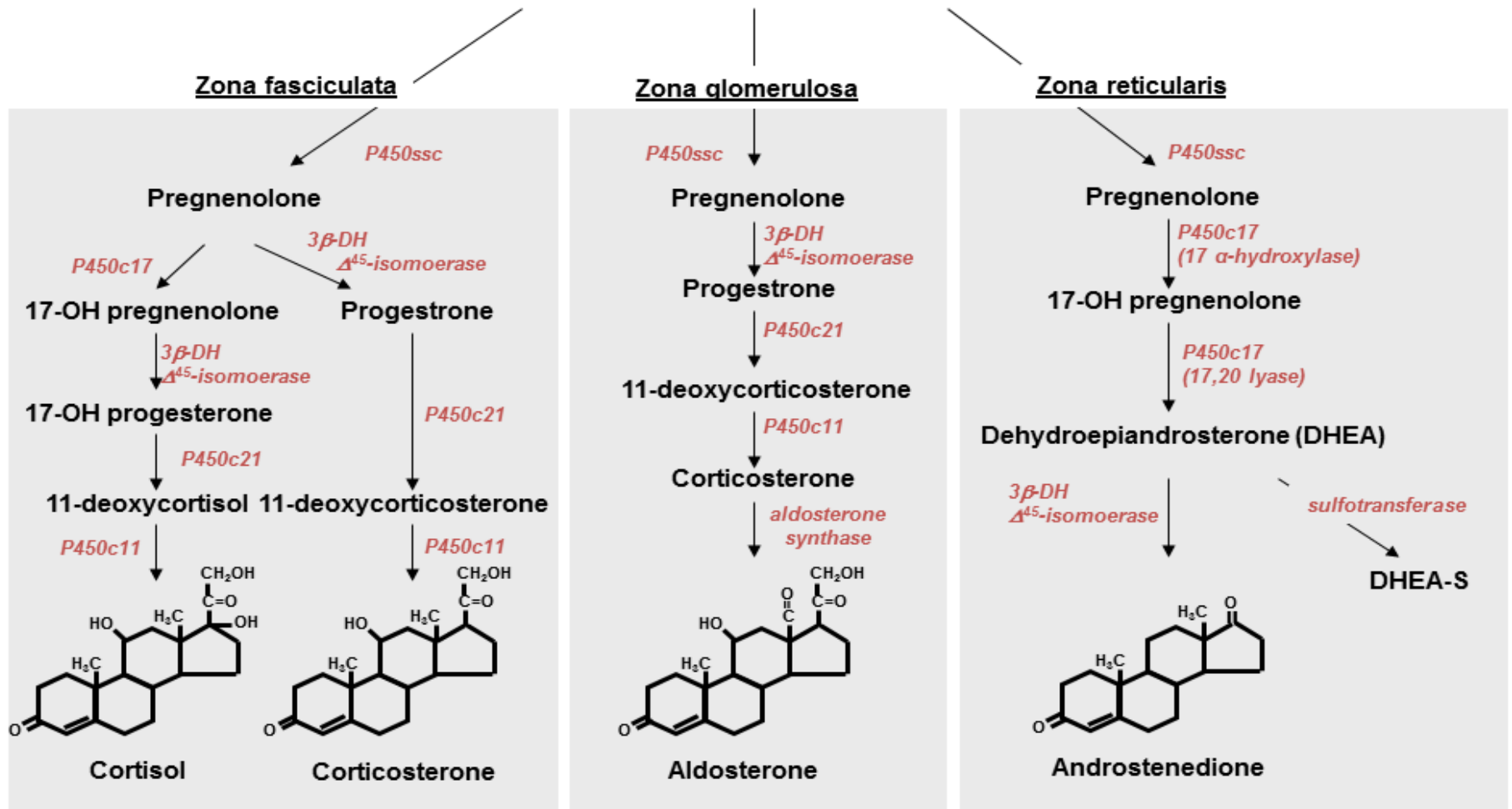
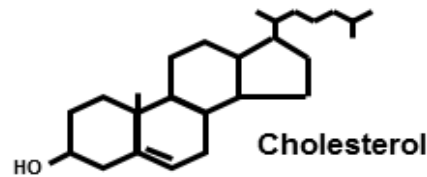
Epinephrine, Norepinephrine, dopamine

Adrenal Cortex

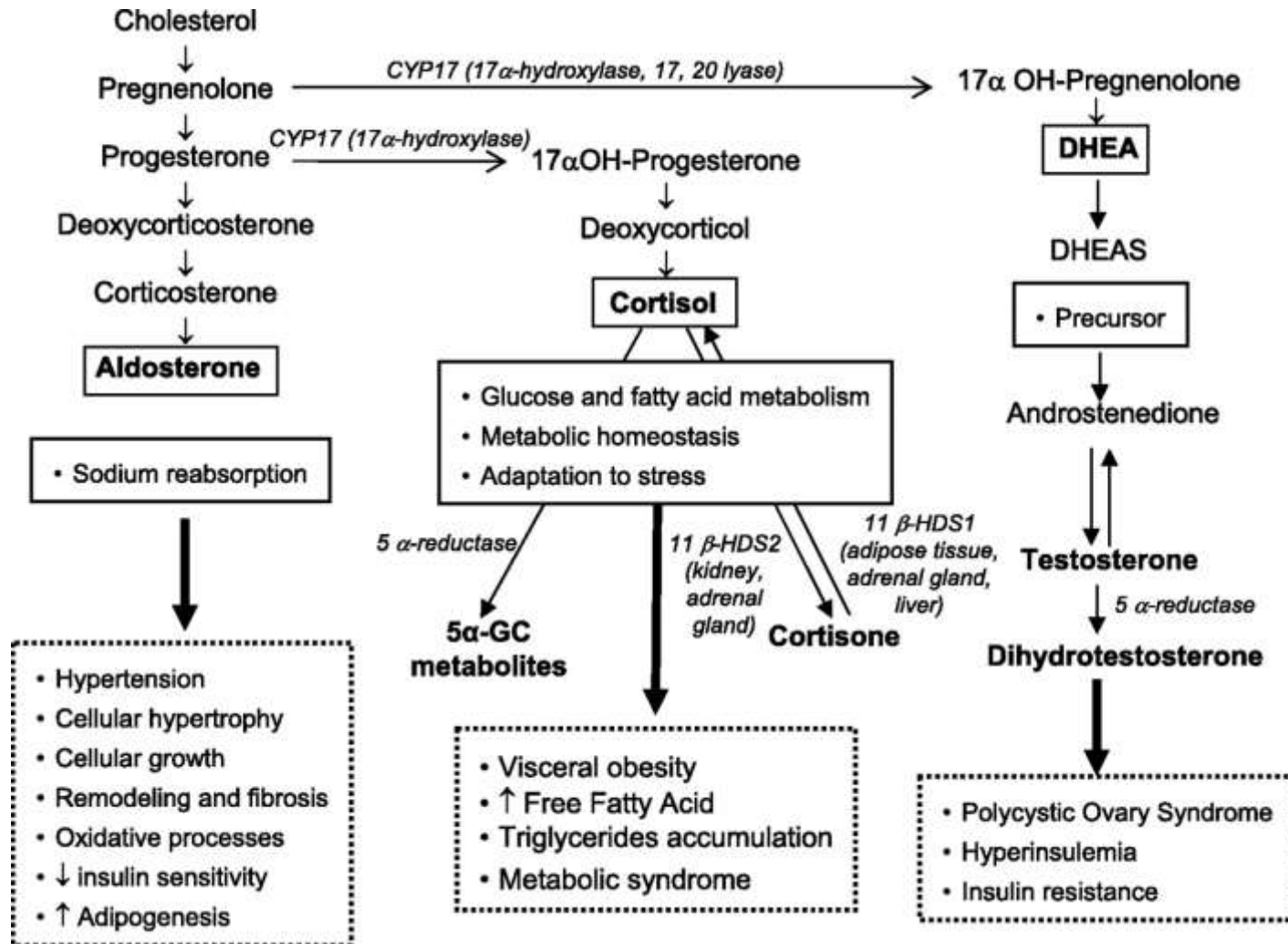


- Synthesizes and releases steroid hormones (corticosteroids)
- Different corticosteroids are produced in each of the **three layers**:
 - *Zona glomerulosa* – mineralocorticoids (mainly aldosterone- Regulate the electrolyte concentrations of extracellular fluids)
 - *Zona fasciculata* – glucocorticoids +Androgens (mainly cortisol and corticosterone)
 - *Zona reticularis* – gonadocorticoids + glucocorticoids (mainly dehydroepiandrosterone DHEA)

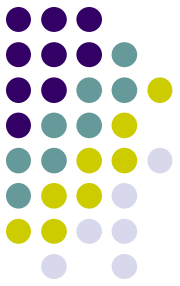
Adrenal Cortex: Steroid Hormone Production



Adrenal gland steroids and their respective actions.

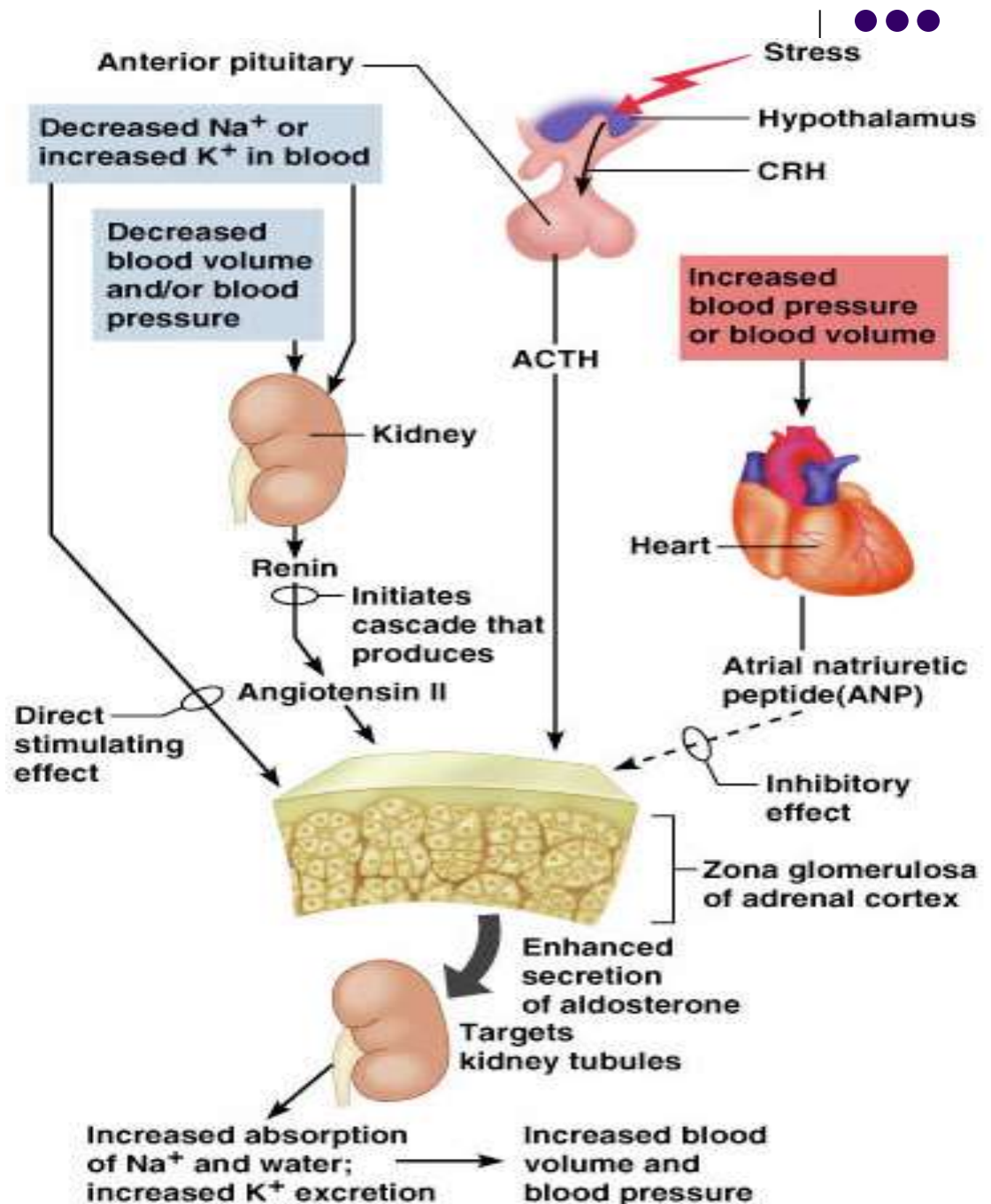


The Four Mechanisms of Aldosterone Secretion



- Renin-angiotensin mechanism – kidneys release renin, which is converted into **angiotensin II** that in turn stimulates aldosterone release
- Plasma concentration of sodium and potassium – directly influences the zona glomerulosa cells
- ACTH – causes small increases of aldosterone during stress
- Atrial natriuretic peptide (ANP) – inhibits activity of the zona glomerulosa

The Four Mechanisms of Aldosterone Secretion



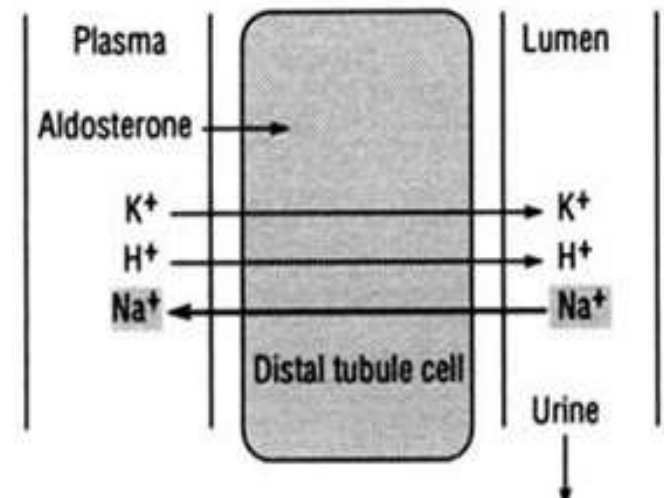
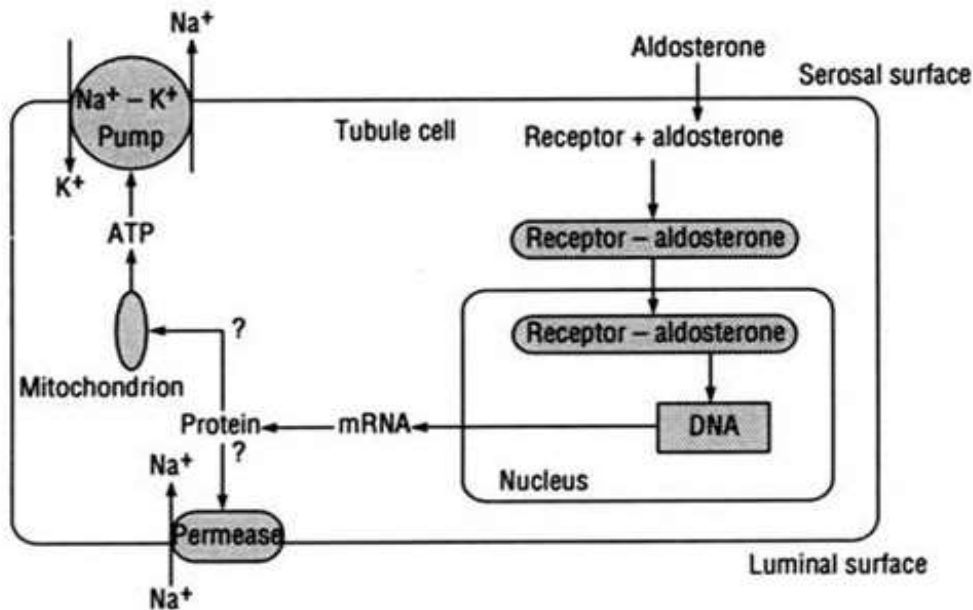
Biochemical actions of adrenocorticosteroids

A. Mineralocorticoids: **aldosterone**

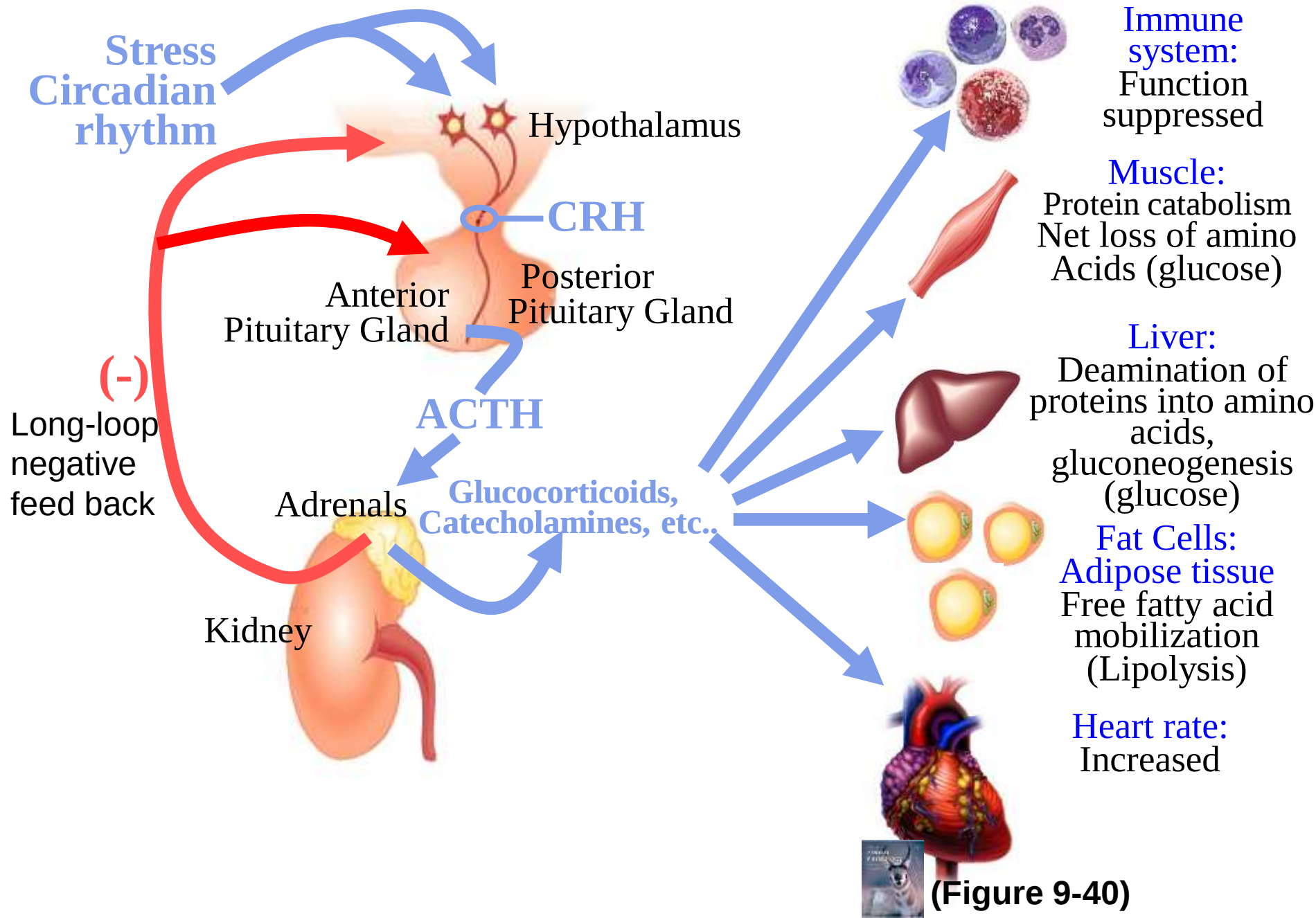
It promotes Na^+ reabsorption at the distal convoluted tubules of kidney. Na^+ retention is accompanied by corresponding excretion of K^+ , H^+ and NH_4^+ ions.

Increases transcription of Na/K pump.

Increases the expression of apical Na channels and an Na/K/Cl cotransporter



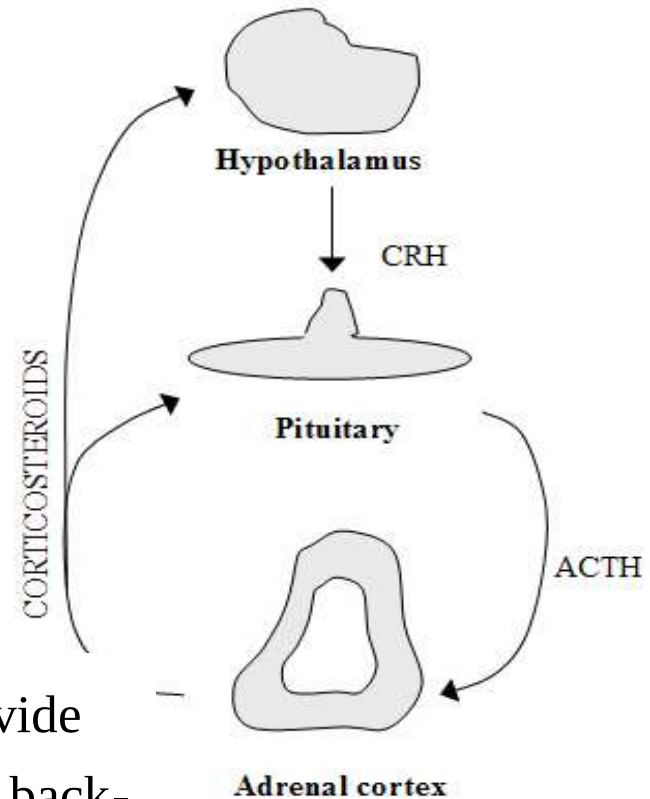
Hypothalamus Pituitary Adrenal (HPA) axis



(Figure 9-40)

❖ The Hypothalamus/Pituitary/Adrenal (HPA) Axis

- The HPA axis or HPA system, a negative feedback system, is one of the most important elements of homeostasis.
- The HPA Axis adjusts cortisol level according to the needs of the body, under normal and stressed conditions, via ACTH.

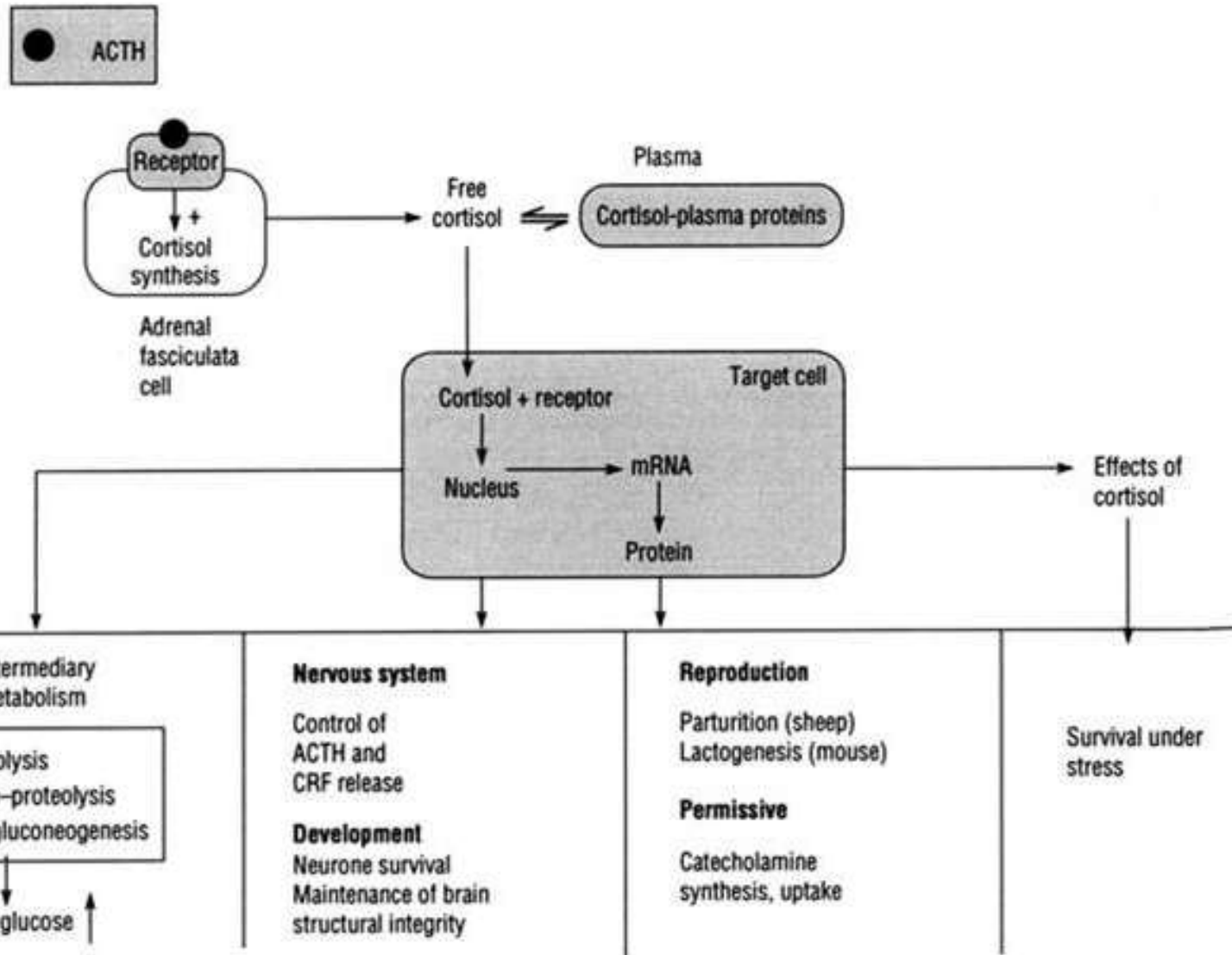
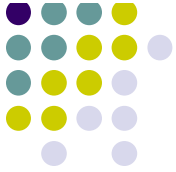


Stress: During stress cortisol must simultaneously provide more blood glucose, mobilize fats and proteins for a back-up supply of glucose, modify immune reactions, heartbeat, blood pressure, brain alertness and nervous system responsiveness.

If cortisol level cannot rise in response to these needs, maintaining body under stress is nearly impossible.

Biochemical actions of adrenocorticosteroids

B. Glucocorticoids: **Cortisol**



Biochemical actions of adrenocorticosteroids

B. Glucocorticoids: **Cortisol**



- 1. Effects on glucose metabolism:** They promote gluconeogenesis
- 2. Effects on lipid metabolism:** Increase lipolysis in adipose tissue
- 3. Effects on protein and nucleic acid metabolism:** They promote transcription and protein synthesis in liver.
- 4. Effects on water and electrolyte metabolism:** Decrease glomerular filtration rate causing water retention in the body.
- 5. Effects on immune system:** Cortisol suppress the immune response.
- 6. Effects on cardiovascular system:** regulating sodium and potassium in the heart cells and increasing the strength of contraction of the heart muscle.
- 7. Effects on central nervous system:** It influence the changes of behavior, mood electrical activity of neurons in the brain .

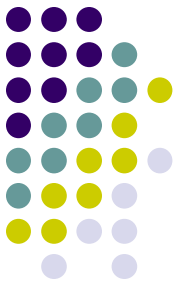
Biochemical actions of adrenocorticosteroids

C. GONADOCORTICOIDS : (Sex Corticoids)



1. The gonadocorticoids are the class of steroids produced by the innermost zone of the adrenal cortex, the zona reticularis.
2. These steroids are the male androgens such as **testosterone** and the female estrogens.
3. Their secretion during development, childhood, and after menopause does contribute to normal metabolism.
4. However, excessive production of adrenal androgens can cause premature puberty in young boys.

Disorders of Adrenal Cortex.



Congenital adrenal hyperplasia (CAH)

Addison's disease

Cushing's syndrome

Aldosteronism or Conn's disease

Adrenal virilism

Hirsutism

Gynaecomastia

The Adrenal Medulla

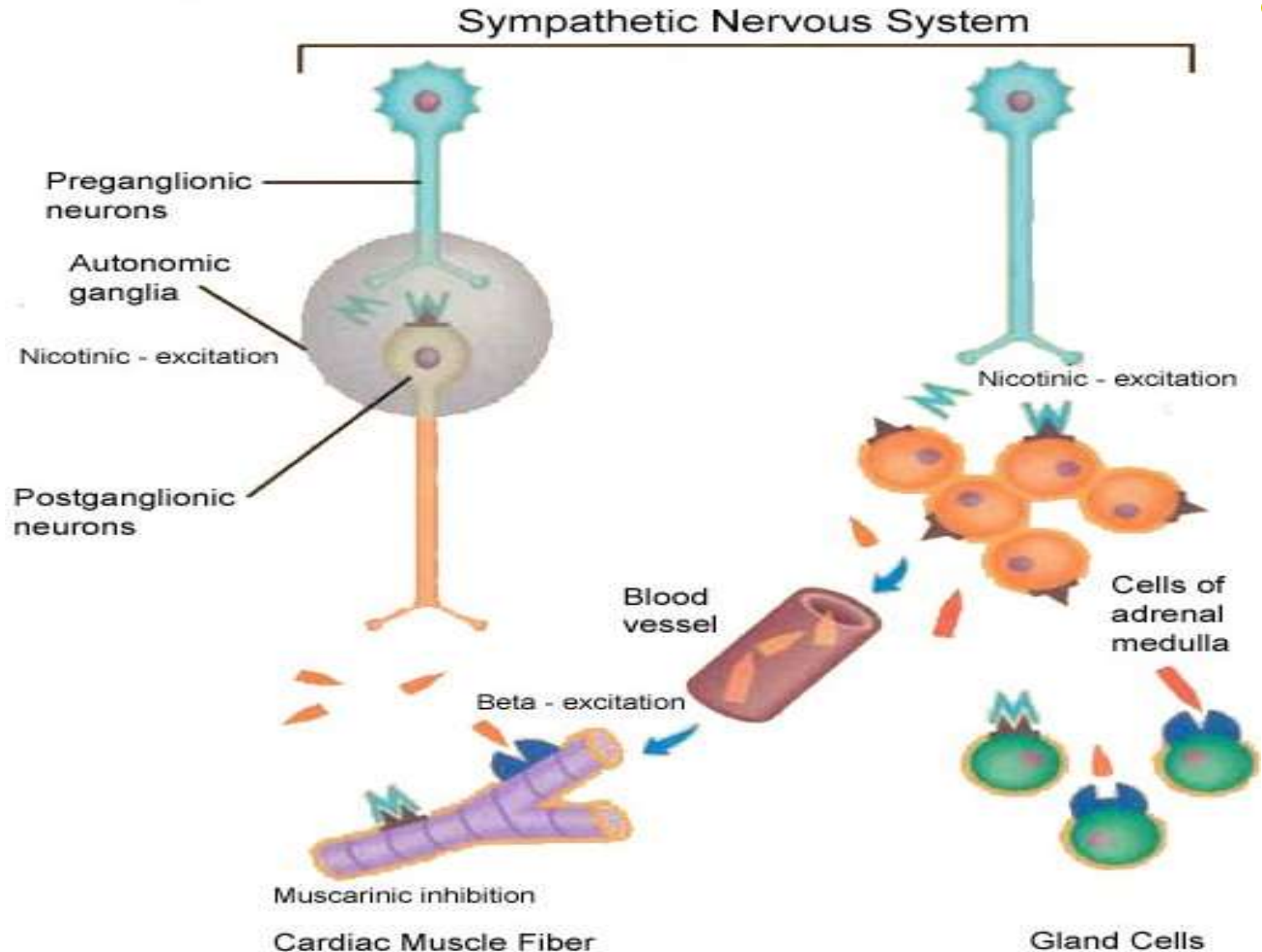
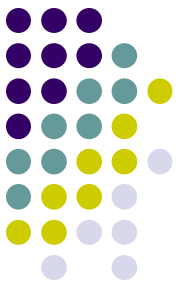
The functional unit of the adrenal medulla is the chromaffin cell, which functions as a neuroendocrine cell.

It secretes the hormones, **epinephrine** (adrenaline) and **norepinephrine** (noradrenalin), dopamine in response to stimulation by sympathetic preganglionic neurons. They are also called catecholamines.

The adrenal medulla consists of masses of neurons that are *part of the sympathetic branch of the autonomic nervous system*.

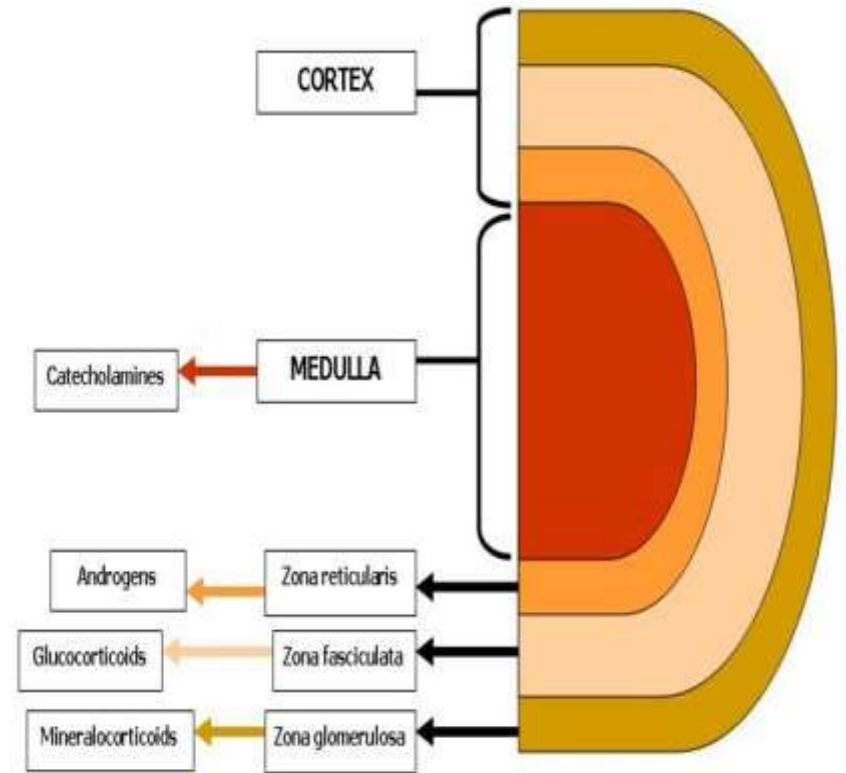
Instead of releasing their neurotransmitters at a synapse, these neurons release them into the blood. Thus, although part of the nervous system, the adrenal medulla functions as an endocrine gland.

The sympathetic branch of the autonomic nervous system.



Catecholamines Biosynthesis & Secretion

1. Tyrosine is precursor for the synthesis of catecholamines.
2. Release of catecholamines is stimulated by nerve impulses, and receptors for catecholamines are widely distributed throughout the body.



3. Chromaffin cells cells receive direct innervation from sympathetic preganglionic neurons. The catecholamine are produced in response to fight, fright and flight (3F). These include emergencies like shock, cold, fatigue, emotional condition like anger.

Biochemical function of catecholamine

1. **Effect on carbohydrate metabolism:** Increased plasma glucose levels.
2. **Effect on lipid metabolism:** Enhance the breakdown of TAG in adipose tissue.
3. **Effect on physiological function:**
Catecholamines increases heart rate, blood pressure and oxygen consumption. They cause blood vessel constriction.

Disorders of Adrenal Medulla.

Phaeochromocytoma (PCC): A neuroendocrine tumor of the medulla of the adrenal glands.

Neuronlastoma, a neuroendocrine tumor of any neural crest tissue of the sympathetic nervous system.

Ganglioneuroma, a tumor in the nerve cells of the peripheral nervous system.