

# Adrenal glands

**B.Sc Second year Zoology (Honours ) Paper - 4**

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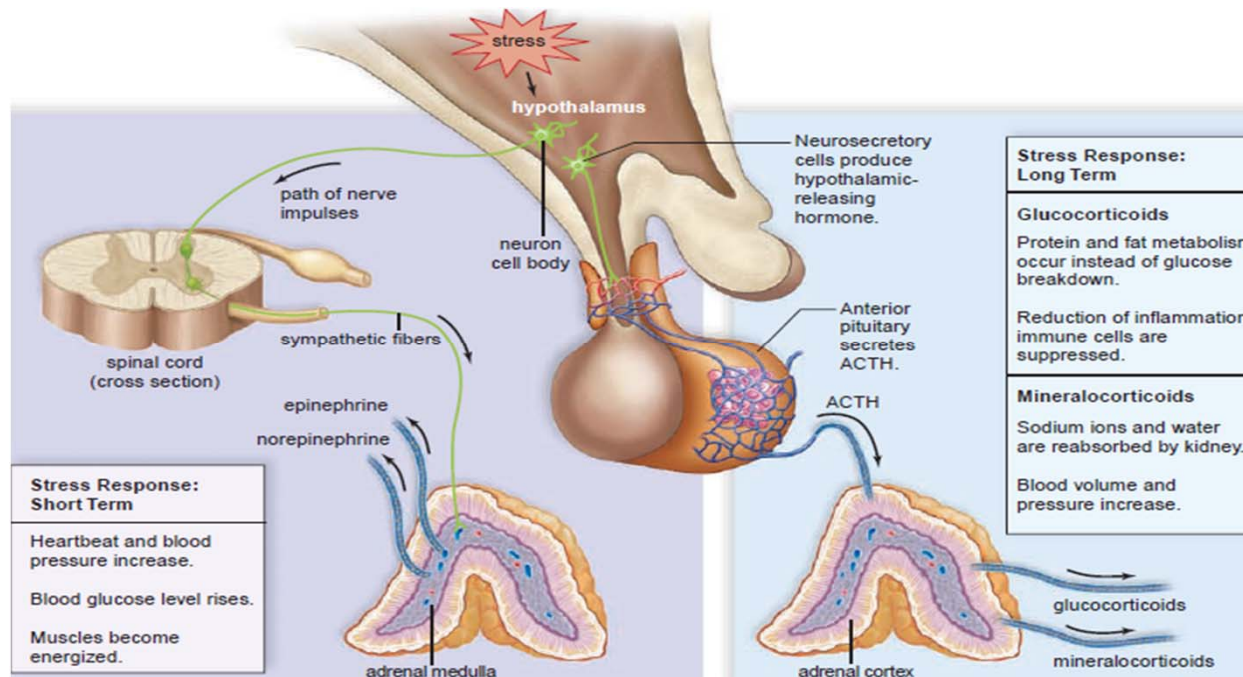
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## Adrenal Glands

- The adrenal glands sit atop the kidneys. Each adrenal gland consists of an inner portion called the adrenal medulla and an outer portion called the adrenal cortex.

- These portions, like the anterior and the posterior pituitary, are two functionally distinct endocrine glands. The adrenal medulla is under nervous control.
- Portions of the adrenal cortex are under the control of **corticotropin-releasing hormone (CRH)** from the hypothalamus and **ACTH, an anterior pituitary hormone**.



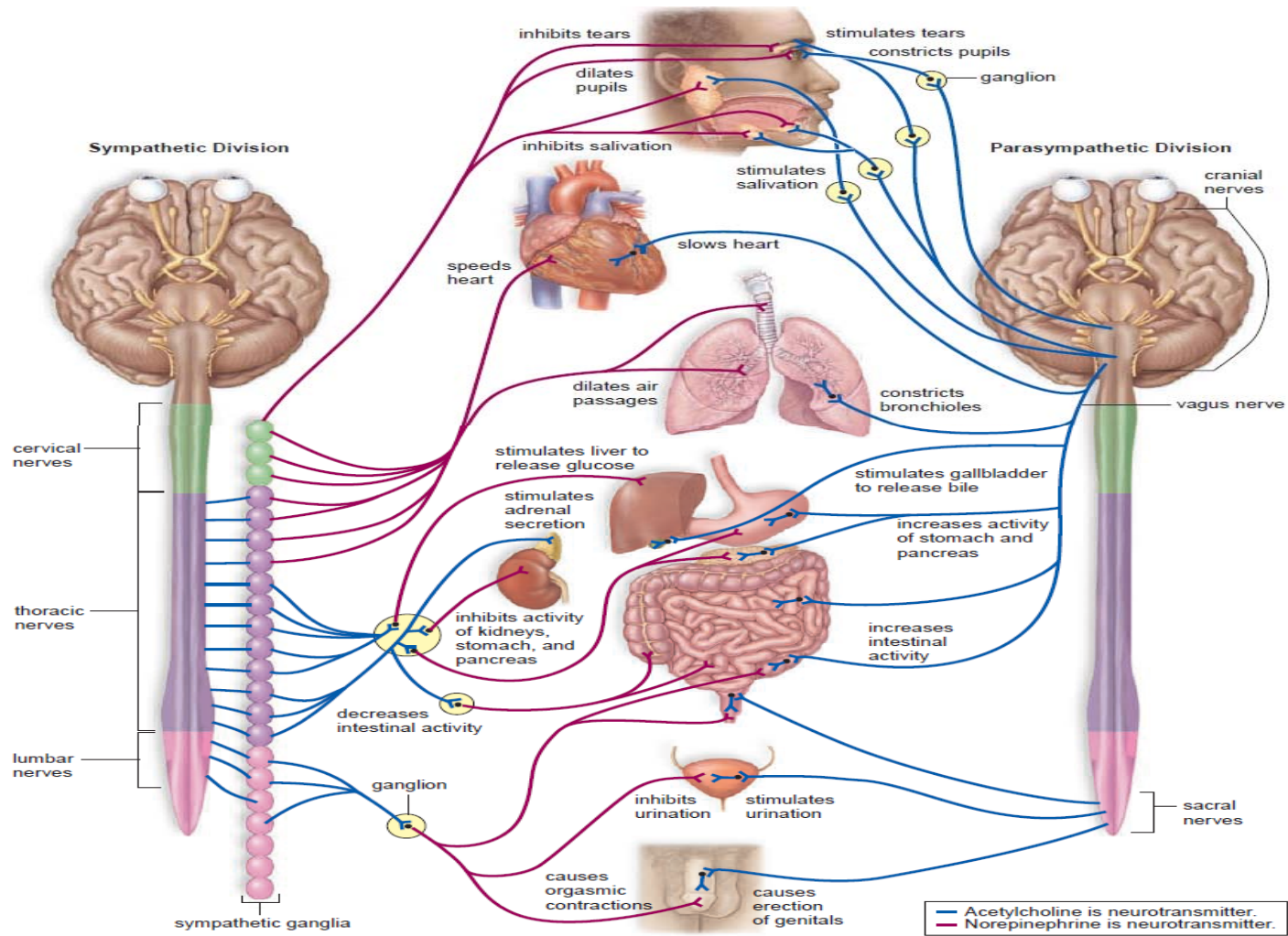
- Stress of all types, including emotional and physical trauma, prompts the hypothalamus to stimulate a portion of the adrenal glands.

### **Adrenal Medulla**

- The hypothalamus initiates nerve signals that travel by way of the brain stem, spinal cord, and preganglionic sympathetic nerve fibers to the adrenal medulla.
- These signals stimulate the adrenal medulla to secrete its hormones. The cells of the adrenal medulla are thought to be modified postganglionic neurons.
- **Epinephrine (adrenaline) and norepinephrine (NE)** (nor-adrenaline) are the hormones produced by the adrenal medulla.

### **Adrenal Cortex**

- In contrast, the hormones produced by the adrenal cortex provide a long-term response to stress .
- The two major types of hormones produced by the adrenal cortex are the **glucocorticoids** and the **mineralocorticoids**.



- The adrenal cortex also secretes a small amount of male sex hormone and a small amount of female sex hormone. This is the case in both males and females.

### ***Glucocorticoids***

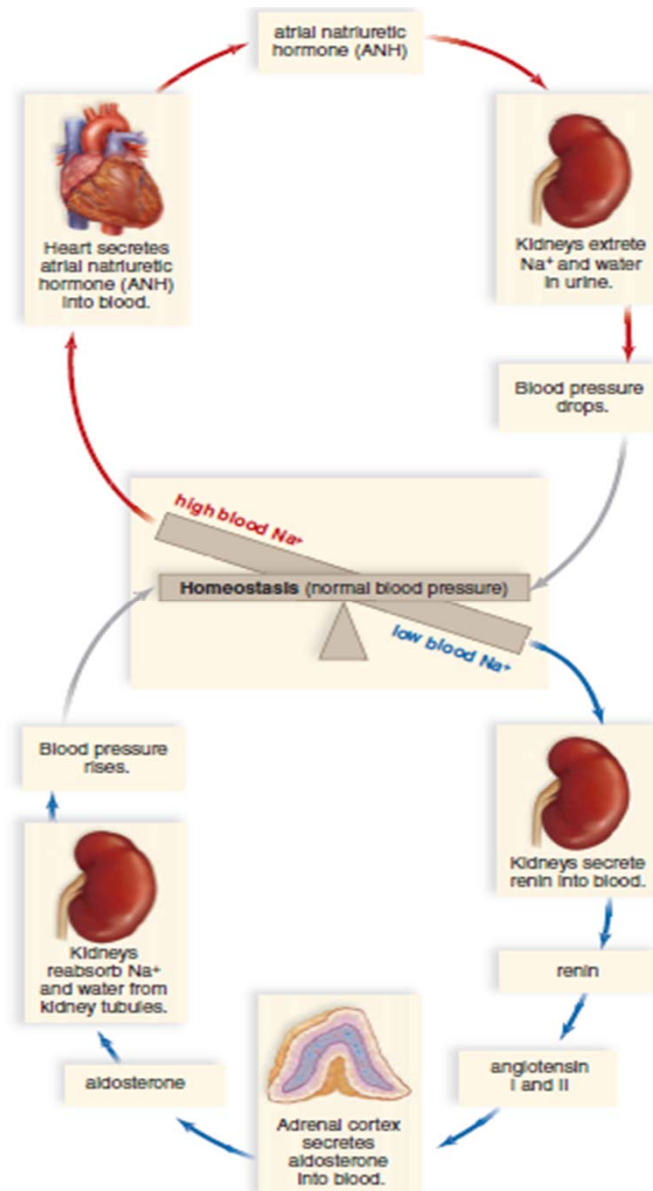
- The glucocorticoids, secretion is controlled by ACTH (anterior pituitary). It regulates carbohydrate, protein, and fat metabolism.
- **Cortisol** is a glucocorticoid that is active in the stress response and the repair of damaged tissues in the body.
- Glucocorticoids raise the **blood glucose level** in at least two ways.
  - (1) They promote the breakdown of muscle proteins to amino acids, taken up by the liver from the bloodstream. The liver then converts these excess amino acids to glucose, which enters the blood.
  - (2) They promote the metabolism of fatty acid rather than carbohydrates, and this spares glucose.
- The glucocorticoids also **counteract (oppose) the inflammatory response that leads to pain and swelling**

- Very high levels of glucocorticoids in the blood can suppress the body's defense system, including the inflammatory response that occurs at infection sites.

### ***Mineralocorticoids***

- Aldosterone is the most important of the mineralocorticoids.
- Aldosterone primarily targets the kidney, where it promotes renal absorption of sodium ions (Na<sup>+</sup>) and renal excretion of potassium ions (K<sup>+</sup>).
- The secretion of mineralocorticoids is not controlled by the anterior pituitary. When the blood sodium level and pressure are low, the kidneys secrete **renin.**
- Renin is an enzyme that converts the plasma protein (blood) angiotensinogen to **angiotensin I.** Angiotensin I is changed to **angiotensin II** by a converting enzyme found in lung capillaries.
- **Angiotensin II** stimulates the adrenal cortex to release **aldosterone.** The effect of this system, called the **renin–angiotensin–aldosterone** system, is to raise blood pressure in two ways.

- Angiotensin II constricts the arterioles, and aldosterone causes the kidneys to reabsorb sodium ions ( $\text{Na}^+$ ).
- When the blood sodium level rises, water is reabsorbed, in part, because the hypothalamus secretes ADH.
- Reabsorption means that water enters kidney capillaries and, thus, the blood.
- Then blood pressure increases to normal.
- Recall that we studied the role of the kidneys in maintaining blood pressure. At that time, we mentioned that if the





blood pressure rises due to the reabsorption of sodium ions ( $\text{Na}^+$ ), the atria of the heart are apt to stretch.

- Due to a great increase in blood volume, cardiac cells release a chemical called **atrial natriuretic hormone (ANH)**, which inhibits the secretion of aldosterone from the adrenal cortex.
- The effect of this ANH is to cause *natriuresis*, the excretion of sodium ions ( $\text{Na}^+$ ).
- *When* sodium ions are excreted, so is water therefore, blood pressure lowers to normal.

### **Malfunction of the Adrenal Cortex**

- When the blood level of glucocorticoids (steroid) is low due to hyposecretion , a person develops **Addison disease**. The presence of excessive but ineffective ACTH causes a bronzing of the skin because ACTH, like MSH, can lead to a buildup of melanin.

- Even a mild infection can lead to death.
- In some cases, hyposecretion of aldosterone results in a **loss of sodium and water**. Low blood pressure and, possibly, severe dehydration can develop as a result. Left untreated, Addison disease can be fatal.
- When the level of **glucocorticoids (cortisol)** is high due to hypersecretion, a person develops **Cushing syndrome**.
- The excess glucocorticoids result in a tendency toward diabetes mellitus as muscle protein is metabolized and subcutaneous fat is deposited in the midsection. The result is a **swollen “moon” face** and an obese trunk, with arms and legs of normal size.





a.

b.

- Children show obesity and poor growth in height.
- Depending on the cause and duration of the Cushing syndrome, some people may have more dramatic changes. These include masculinization (to produce certain male secondary sex characteristics in a female) with increased blood pressure and weight gain. Cushing syndrome may be treated by the use of cortisol-inhibiting drugs.