

**B.Sc ZOOLOGY (HONS)**

**DEGREE III**

**PAPER V**

**ADRENAL GLAND**

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# Adrenal gland

The adrenal gland was first described by **Eustachius** in 1563. The adrenal glands are two in number. These are located on the top of kidneys like caps, one on each. Due to its position this is also known as **suprarenal gland**. Each gland is surrounded by a capsule of fibrous connective tissue and remains embedded in fatty tissue.

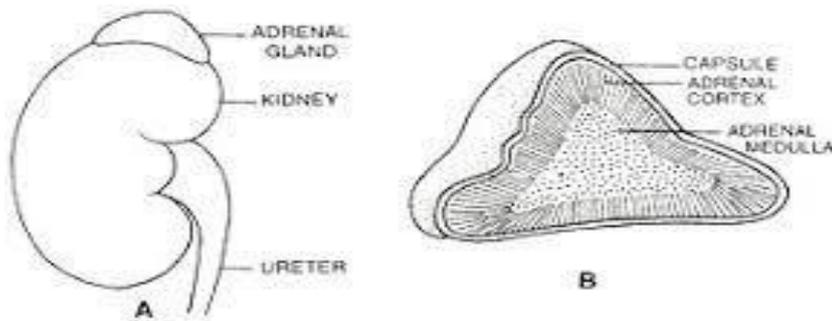


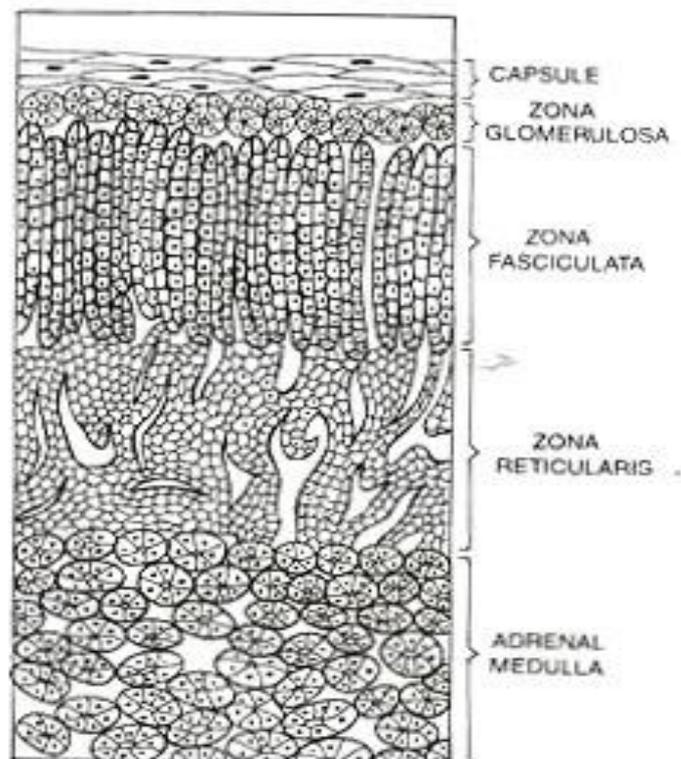
Fig: (A) position of Adrenal gland (B) T.S Of Adrenal gland

Each adrenal gland is composed of two parts, namely cortex and medulla. Cortex forms the outer portion whereas medulla forms inner portion of the gland. These two parts are quite different in both structural and functional nature. The adrenal glands are dual in origin, the cortex develops from mesoderm whereas the medulla develops from ectoderm of neural crest. However, these two components of adrenal gland are tightly packed together. The cortex secretes various type of steroid hormones or corticosteroids or cortins whereas medulla secretes catecholamine.

- **Cortex:**

From outward to inward cortex is composed of following three layers

1. **Zona glomerulosa:** It forms the outermost layer of adrenal cortex. It is composed of basophilic columnar epithelial cells. These cells remain arranged concentrically in groups.
2. **Zona fasciculata:** This forms the middle and comparatively thick layer. This layer is composed of polygonal basophilic cells. The cells remain arranged in radial rows just in manner of radius of circle. These possesses inter radial spaces known as sinusoidal spaces the cells contain huge quantity of lipid and also known as spongioblast.
3. **Zona reticularis:** This forms the innermost layer of the cortex. It is composed of round cells arranged in net like fashion having wide blood is spaces. These are provided with less quantity of lipid.



**Fig: histology of Adrenal gland.**

- **Medulla:**

The medulla is separated from the cortex by a thin layer of connective tissue in mammal. But both these parts are intermixed in birds. This is made of irregular chromaffin cells arranged in spherical groups. In between them are found nerve cells, nerve fibers and blood capillaries.

## **HORMONES SECRETED BY ADRENAL CORTEX:**

1. **C-21 steroids:** have a 2 carbon chain at position 17, possesses glucocorticoids and mineralocorticoids activity. When these have a hydroxyl group at position 17 in addition to side chain, then often called 17 hydroxycorticocoids or 17-OH corticosteroids.
2. **C-19 steroids:** have an oxygenation or hydroxyl group at position 17, have androgenic activity. Most of C-19 steroids have a keto (=O) group at position 17 and therefore called 17 ketosteroids or 17 corticosteroids. .

### **Functionally, corticosteroids are of three types:**

1. **Glucocorticoids:** Cortisol, Cortisone, Corticosterone;
2. **Mineralocorticoids:** Aldosterone, 11- decortisol and 11- decorticosterone.
3. **Cortical sex hormones:** Androgens and Estrogens.

## **FUNCTIONS OF MINERALOCORTICIDS:**

1. Aldosterone promotes renal reabsorption of  $\text{Na}^+$  and  $\text{K}^+$ , particularly in distal tubules, collecting tubules and a part of loop of Henle.
2. Aldosterone checks the loss of sodium through saliva, sweat and gastric juice.
3. Aldosterone promotes renal excretion of potassium. Increase concentration of sodium and chloride in the blood, lymph and tissue fluid raise the osmotic pressure. This ultimately increases the blood pressure.

**HYPOSECRETION OF ALDOSTERONE** causes excretion of Sodium and retention of Potassium. It causes decrease in water retaining capacity leading to decrease in plasma volume (hemo concentration). It consequently causes slow flow of blood and decrease Oxygen uptake and carrying capacity. Hence it is called **life saving hormone**.

**HYPERSECRETION OF ALDOSTERONE** causes blood alkalosis, known as **Conn's disease**.

**Hypoglycemic alkalosis** (high concentration of sodium) leads to excessive increase in plasma volume and causes edema, high blood pressure which sometimes may lead to cardiac failure. **Hypokalemia alkalosis** (low

concentration of Potassium) causes extreme muscular weakness, sometimes it may lead to muscle paralysis. The secretion of Aldosterone is dependent upon the ratio of concentration of Sodium and Potassium ions. The low blood pressure state induces juxtaglomerular cells of kidney to produce rennin. Rennin stimulates liver to secrete Angiotensinogen which in turn is converted first into Angiotensin I and then into Angiotensin II. This stimulates more release of Aldosterone by zona glomerulosa.

## **FUNCTIONS OF GLUCOCORTICOIDS**

- I. Glucocorticoids increase the concentration of sugar in blood. These promote gluconeogenesis. These depress uptake of glucose in muscle and adipose tissue and glycolysis.
- II. Glucocorticoids promote catabolism of protein and depress Protein synthesis.
- III. It promotes metabolization of fatty acids from fat depot and metabolism of fat. Activation of production of glucose from various sources provides enough energy to overcome trouble caused by fright, bleeding infection, extreme cold and heat etc. Hypo secretion of glucocorticoids raises the blood sugar level and causes **steroid diabetes**.
- IV. Glucocorticoids have the property to reduce the number of eosinophils hence these are also known as **anti- allergy hormones**.

V. It decreases the number of lymphocytes and inhibits inflammation hence these are also known as **anti-inflammatory hormones**.

VI. Glucocorticoids have the property to promote retention of water and sodium by renal tubule.

Secretion of glucocorticoids is under the control of ACTH of Pituitary gland. It is increased during injury, chilly cold, excessive heating, poisoning, hemorrhage and mental stress.

### **FUNCTIONS OF CORTICAL SEX HORMONES:**

Androgens and estrogens play main role in development of accessory sexual glands and secondary sexual characters before puberty. This is also become of prime importance in the old age when secretion of these hormones from the sex glands is ceased.

Hypo secretion of androgens called **adrenal virilism** in women and precocious sexual development in children. This causes more prominent muscularization female followed by growth of beard, atrophy of breasts and inhibition of ovulation.

### **HORMONE SECRETED BY ADRENAL MEDULLA:**

Adrenal medulla secretes Epinephrine, nor-Epinephrine and Dopamine. These are collectively known as **Catecholamine**.

Nor- epinephrine or non- adrenaline is formed by hydroxylation and decarboxylation of Tyrosine. Epinephrine or Adrenaline is formed by methylation of nor-Epinephrine. Dopamine is intermediary.

As Catecholamines are unable to penetrate blood brain barrier, nor-epinephrine is also synthesized within the brain tissue and acts locally. For this the enzyme phenylethanolamine-N-methyl transferase that catalyzes the formation of epinephrine from nor-epinephrine is found in both medulla and brain in appreciable quantity.

## **FUNCTIONS OF CATECHOLAMINES:**

1. Epinephrine promotes glycogenolysis in liver and muscles .As a result glucose level in blood is raised. It also increases BMR.
2. Epinephrine acts on adipose tissue and releases free fatty acids into the circulation.
3. It also raises systolic blood pressure by increasing the rate of heartbeat and cardiac output.
4. Nor-epinephrine causes vasoconstriction of blood vessels. So it raises the systolic as well as diastolic blood pressure without affecting the rate of heartbeat i.e. normalizes the heartbeat and cardiac output.
5. Epinephrine causes relaxation of smooth muscles of stomach, intestine, bronchioles and urinary bladder. Hence it is valuable in the treatment of asthmatic attacks.

These hormones are secreted under the control of sympathetic nerve fibers to get rid off several physical and mental stresses in emergency hence these hormones are known as **hormones of emergency** or hormones of fright, fight and flight.

**HYPOGLYCEMIA**, state of emotional excitement, performance of muscular action, cooling of the body, stimulation by secretory nerve increases the secretion of adrenaline and nor-adrenaline hormones.

**HYPOSECRETION** of adrenaline and not adrenaline causes headache, sweating, vomiting diarrhea, anxiety and high blood pressure. The latter sometimes causes cardiac failure and brain hemorrhage.

### **ABNORMALITY IN ADRENAL GLAND:**

Deficiency in the secretion of hormones by the adrenal cortex is recognized as a disease known as **Addison's disease**. This disease is characterized by the appearance of brown coloured patches on the skin, particularly of hands, neck and face; hence this disease is also known as **Bronze disease**.

Appearance of bronzed coloured patches on the skin is followed by loss of general appetite, low body temperature and blood pressure, muscular weakness nausea, vomiting, diarrhea and low gastric acidity. This makes the patient very sensitive to cold and pain as well as susceptible to infections.

Hypo secretion of Cortisol (Glucocorticoids) which may be due to a tumor of the adrenal cortex causes **Cushing's syndrome**. It is characterized by high blood sugar, appearance of sugar in urine, rise in plasma  $\text{Na}^+$ , fall in plasma  $\text{K}^+$ , rise in blood volume, high blood pressure, and obesity in abdominal region, wasting of muscles of thighs and pectoral and pelvic girdles.

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