

10th Science Lesson 16 Notes in English

16] Plant and Animal Hormones

Introduction

- The word hormone is derived from the Greek word "hormon" meaning "to excite".
- The function of control and coordination in plants is performed by chemical substances produced by the plants called **plant hormones**.
- In plants several cells are capable of producing hormones. These phytohormones are transported to different parts of the plants to perform various physiological functions.
- **Endocrine glands** in vertebrate animals possess a diversified communication system to co-ordinate physiological and metabolic functions by **chemical integration**.
- The endocrine system acts through chemical messengers known as hormones which are produced by specialized glands.
- Physiological processes such as digestion, metabolism, growth, development and reproduction are controlled by hormones.

Plant Hormones

- **Plant hormones** are **organic molecules** that are produced at extremely low concentration in plants.
- These molecules control morphological, physiological and biochemical responses.

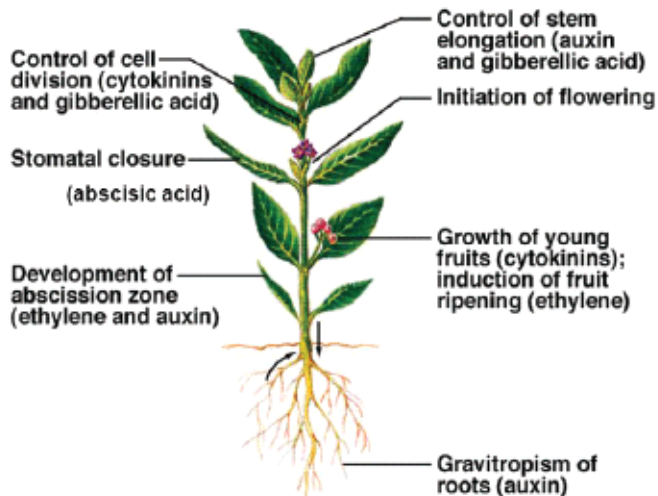
Types of Plant Hormones

There are five major classes of plant hormones.

They are:

1. Auxins
2. Cytokinins
3. Gibberellins
4. Absciscic Acid (ABA)
5. Ethylene

- Among all these plant hormones auxins, cytokinins and gibberellins promote plant growth while absciscic acid and ethylene inhibit plant growth.



Hormonal interaction in plant growth and development

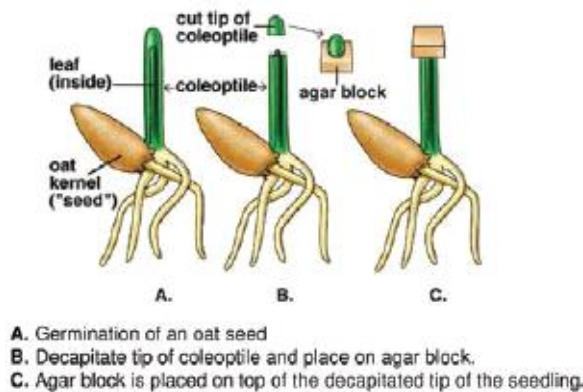
Auxins

- Auxins (Gk. auxein = to grow) were the first plant hormones discovered. The term auxin was introduced by Kogl and Haagen-Smith (1931).
- Auxins are **produced at the tip of stems and roots** from where they migrate to the zone of elongation. Charles Darwin (1880), observed unilateral growth and curvature of canary grass (*Phalaris canariensis*) coleoptiles.
- He came to the conclusion that some 'influence' was transmitted from the tip of the coleoptiles to the basal region. This 'influence' was later identified as Auxin by Went.

Went's Experiment

- Frits Warmolt Went (1903–1990), a Dutch biologist demonstrated the existence and effect of auxin in plants. He did a series of experiments in *Avena* coleoptiles.
- In his first experiment he removed the tips of *Avena* coleoptiles. The cut tips did not grow indicating that the tips produced something essential for growth.
- In his second experiment he placed the agar blocks on the decapitated coleoptile tips. The coleoptile tips did not show any response.
- In his next experiment he placed the detached coleoptile tips on agar blocks.
- After an hour, he discarded the tips and placed this agar block on the decapitated coleoptile.
- It grew straight up indicating that some chemical had diffused from the cut coleoptile tips into the agar block which stimulated the growth.

- From his experiments Went concluded that a chemical diffusing from the tip of coleoptiles was responsible for growth, and he named it as "**Auxin**" meaning '**to grow**'.



Went's Experiment

- Types of Auxins:** Auxins are classified into two types, namely natural auxins and synthetic auxins.

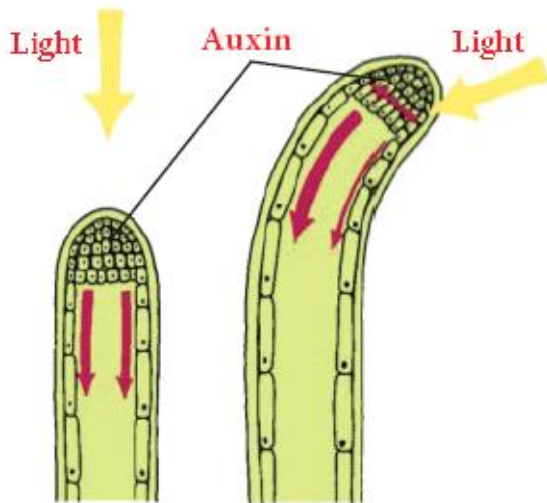
1. **Natural Auxins:** Auxins produced by the plants are called natural auxins.

Example: IAA (Indole – 3 - Acetic Acid)

2. **Synthetic Auxins:** Artificially synthesized auxins that have properties like auxins are called as synthetic auxins. Example: 2, 4 D (2, 4 Dichlorophenoxy Acetic Acid).

- Physiological effects of auxins:** Auxins bring about a variety of physiological effects in different parts of the plant body.

- Auxins promote the **elongation of stems** and **coleoptiles** which makes them to grow.
- Auxins **induce root formation** at low concentration and inhibit it at higher concentration.
- The auxins produced by the apical buds suppress growth of lateral buds. This is called **apical dominance**.
- Seedless fruits without fertilization are induced by the external application of auxins. (**Parthenocarpy**). Examples: Watermelon, Grapes, Lime etc.
- Auxins **prevent** the formation of **abscission layer**.



Cytokinins

- Cytokinins (Cytos - cell; kinesis - division) are the plant hormones that **promote cell division** or cytokinesis in plant cells.
- It was first isolated from Herring fish sperm. Zeatin was the cytokinin isolated from Zea mays. Cytokinin is found abundantly in liquid endosperm of coconut.

Physiological effects of cytokinins

1. Cytokinin induces **cell division** (cytokinesis) in the presence of auxins.
2. Cytokinin also causes **cell enlargement**.
3. Both auxins and cytokinins are essential for the formation of new organs from the callus in tissue culture (**Morphogenesis**).
4. Cytokinins promote the growth of **lateral buds** even in the presence of apical bud.
5. Application of cytokinin delays the process of ageing in plants. This is called **Richmond Lang effect**.

Gibberellins

- Gibberellins are the most abundantly found plant hormones.
- Kurosawa (1926) observed **Bakanae disease** or **foolish seedling disease** in rice crops. This internodal elongation in rice was caused by fungus Gibberella fujikuroi. The active substance was identified as **Gibberellic acid**.

Physiological effects of gibberellins

1. Application of gibberellins on plants stimulates extraordinary **elongation of internode**. E.g. Corn and Pea.



Bolting

2. Treatment of rosette plants with gibberellins induces sudden shoot elongation followed by flowering. This is called **bolting**.

3. Gibberellins promote the **production of male flowers** in monoecious plants (Cucurbits).

4. Gibberellins **break dormancy** of potato tubers.

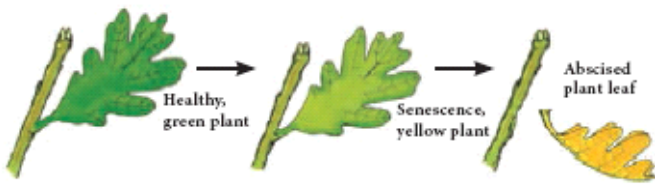
5. Gibberellins are efficient than auxins in inducing the formation of seedless fruit **Parthenocarpic fruits** (Development of fruits without fertilization) e.g. Tomato.

Abscisic Acid

- Absciscic acid (ABA) is a **growth inhibitor** which **regulates abscission** and **dormancy**.
- It increases tolerance of plants to various kinds of stress. So, it is also called as **stress hormone**.
- It is found in the chloroplast of plants.

Physiological effects of abscisic acid

1. ABA promotes the process of **abscission** (separation of leaves, flowers and fruits from the branch).
2. During water stress and drought conditions ABA **causes stomatal closure**.



Senescence and abscission

3. ABA **promotes senescence** in leaves by causing loss of chlorophyll.
4. ABA **induces bud dormancy** towards the approach of winter in trees like birch.
5. ABA is a powerful **inhibitor of lateral bud growth** in tomato.

Ethylene

- Ethylene is a **gaseous plant hormone**. It is a **growth inhibitor**. It is mainly concerned with maturation and ripening of fruits.
- Maximum synthesis of ethylene occurs during ripening of fruits like apples, bananas and melons

Physiological effects of ethylene

1. Ethylene promotes the **ripening of fruits**. E.g. Tomato, Apple, Mango, Banana, etc.



Ethylene

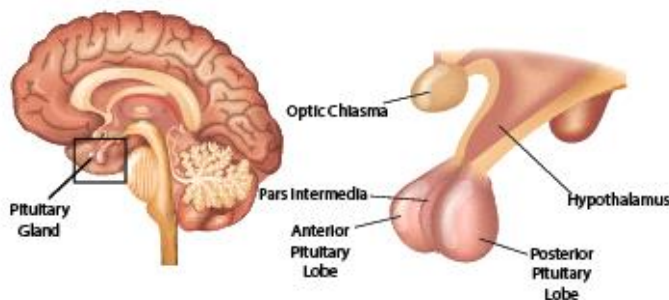
2. Ethylene **inhibits** the **elongation** of stem and root in dicots.
3. Ethylene hastens the **senescence** of leaves and flowers.
4. Ethylene stimulates **formation of abscission zone** in leaves, flowers and fruits. This leads to premature shedding.
5. Ethylene **breaks the dormancy** of buds, seeds and storage organs.

Human Endocrine Glands

- Endocrine glands in animals possess a versatile communication system to coordinate biological functions.
- Exocrine glands and endocrine glands are two kinds of glands found in animals.
- Endocrine glands are found in different regions of the body of animals as well as human beings. These glands are called **ductless glands**. Their secretions are called **hormones** which are produced in **minute quantities**.
- The secretions diffuse into the blood stream and are carried to the distant parts of the body. They act on specific organs which are referred to as **target organs**.
- Exocrine glands have specific ducts to carry their secretions e.g. salivary glands, mammary glands, sweat glands.
- Endocrine glands present in human and other vertebrates are
 - a. Pituitary gland
 - b. Thyroid gland
 - c. Parathyroid gland
 - d. Pancreas (Islets of Langerhans)
 - e. Adrenal gland (Adrenal cortex and Adrenal medulla)
 - f. Gonads (Testes and Ovary)
 - g. Thymus gland

Pituitary Gland

- The **pituitary gland** or **hypophysis** is a pea shaped compact mass of cells located at the base of the midbrain attached to the hypothalamus by a **pituitary stalk**.
- The pituitary gland is anatomically composed of two lobes and performs different functions.
- They are the anterior lobe (**adenohypophysis**) and the posterior lobe (**neurohypophysis**). The intermediate lobe is non-existent in humans.



Pituitary Gland

- The pituitary gland forms the major endocrine gland in most vertebrates. It regulates and controls other endocrine glands and so is called as the **"Master gland"**.
- **Hormones secreted by the anterior lobe (Adenohypophysis) of pituitary**
- The anterior pituitary is composed of different types of cells and secrete hormones which stimulates the production of hormones by other endocrine glands. The hormones secreted by anterior pituitary are
 - a. Growth Hormone
 - b. Thyroid stimulating Hormone
 - c. Adrenocorticotrophic Hormone
 - d. Gonadotropic Hormone which comprises the Follicle Stimulating Hormone and Luteinizing Hormone
 - e. Prolactin

a. Growth hormone (GH)

- GH promotes the development and enlargement of all tissues of the body. It stimulates the growth of muscles, cartilage and long bones. It controls the cell metabolism.
- The improper secretion of this hormone leads to the following conditions.

Dwarfism:

- It is caused by decreased secretion of growth hormone in children. The characteristic features are stunted growth, delayed skeletal formation and mental disability.

Gigantism:

- Over secretion of growth hormone leads to gigantism in children. It is characterized by overgrowth of all body tissues and organs.
- Individuals attain abnormal increase in height.

Acromegaly:

- Excess secretion of growth hormone in adults may lead to abnormal enlargement of head, face, hands and feet.

b. Thyroid stimulating hormone (TSH)

- TSH controls the growth of thyroid gland, coordinates its activities and hormone secretion.

c. Adrenocorticotrophic hormone (ACTH)

- ACTH stimulates adrenal cortex of the adrenal gland for the production of its hormones.
- It also influences protein synthesis in the adrenal cortex.

d. Gonadotropic hormones (GTH)

- The gonadotropic hormones are follicle stimulating hormone and luteinizing hormone which are essential for the normal development of gonads.

Follicle stimulating hormone (FSH)

- In male, it stimulates the germinal epithelium of testes for formation of sperms.
- In female it initiates the growth of ovarian follicles and its development in ovary.

Luteinizing hormone (LH)

- In male, it promotes the Leydig cells of the testes to secrete male sex hormone testosterone.
- In female, it causes ovulation (rupture of mature graafian follicle), responsible for the development of corpus luteum and production of female sex hormones estrogen and progesterone.

e. Prolactin (PRL)

- PRL is also called **lactogenic hormone**. This hormone initiates development of mammary glands during pregnancy and stimulates the production of milk after child birth.

Hormones secreted by the posterior lobe (Neurohypophysis) of pituitary

The hormones secreted by the posterior pituitary are

- a. Vasopressin or Antidiuretic hormone
- b. Oxytocin

a. Vasopressin or Antidiuretic hormone (ADH)

- In kidney tubules it increases reabsorption of water. It reduces loss of water through urine and hence the name antidiuretic hormone.
- Deficiency of ADH reduces reabsorption of water and causes an increase in urine output (polyuria). This deficiency disorder is called **Diabetes insipidus**.

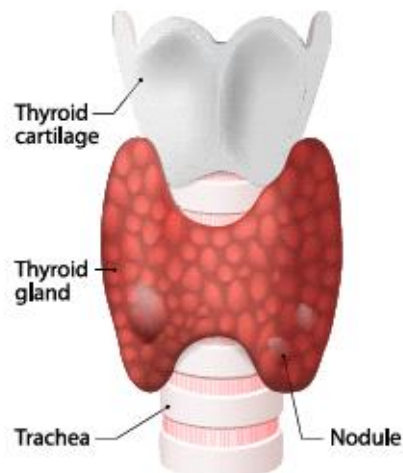
b. Oxytocin

- It helps in the contraction of the smooth muscles of uterus at the time of child birth and milk ejection from the mammary gland after child birth.

Thyroid Gland

- The thyroid gland is composed of two distinct lobes lying one on either side of the trachea.
- The two lobes are connected by means of a narrow band of tissue known as the **isthmus**.
- This gland is composed of glandular follicles and lined by cuboidal epithelium. The follicles are filled with colloid material called **thyroglobulin**.
- An amino acid **tyrosine** and **iodine** are involved in the formation of thyroid hormone.
- The hormones secreted by the thyroid gland are

- a. Triiodothyronine (T3)
- b. Tetraiodothyronine or Thyroxine (T4)



Thyroid Gland

Functions of thyroid hormones

The functions of thyroid hormones are

- Production of energy by maintaining the **Basal Metabolic Rate (BMR)** of the body.
- Helps to maintain normal body temperature.
- Influences the activity of central nervous system.
- Controls growth of the body and bone formation.
- Essential for normal physical, mental and personality development.

- It is also known as **personality hormone**.
- Regulates cell metabolism.

Thyroid Dysfunction

- When the thyroid gland fails to secrete the normal level of hormones, the condition is called **thyroid dysfunction**. It leads to the following conditions

Hypothyroidism

- It is caused due to the decreased secretion of the thyroid hormones. The abnormal conditions are simple goitre, cretinism and myxoedema.

Goitre

- It is caused due to the inadequate supply of iodine in our diet. This is commonly prevalent in Himalayan regions due to low level of iodine content in the soil.
- It leads to the enlargement of thyroid gland which protrudes as a marked swelling in the neck and is called as **goitre**.

Cretinism

- It is caused due to decreased secretion of the thyroid hormones in children. The conditions are stunted growth, mental defect, lack of skeletal development and deformed bones. They are called as **cretins**.

Myxoedema

- It is caused by deficiency of thyroid hormones in adults. They are mentally sluggish, increase in body weight, puffiness of the face and hand, oedematous appearance.

Hyperthyroidism

- It is caused due to the excess secretion of the thyroid hormones which leads to Grave's disease. The symptoms are protrusion of the eyeballs (Exophthalmia), increased metabolic rate, high body temperature, profuse sweating, loss of body weight and nervousness.

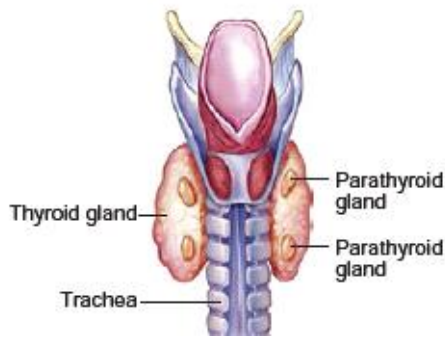
Parathyroid Gland

- The parathyroid glands are four small oval bodies that are situated on the posterior surface of the thyroid lobes.

- The **chief cells** of the gland are mainly concerned with secretion of **parathormone**.

Functions of Parathormone

- The parathormone regulates calcium and phosphorus metabolism in the body. They act on bone, kidney and intestine to maintain blood calcium levels.



Parathyroid Gland

Parathyroid Dysfunction

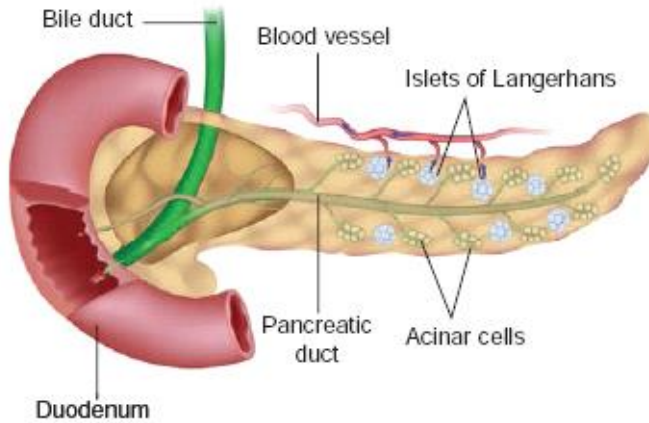
- The secretion of parathyroid hormone can be altered due to the following conditions.

Removal of parathyroid glands during thyroidectomy (removal of thyroid) causes decreased secretion of parathormone. The conditions are

- Muscle spasm known as **Tetany** (sustained contraction of muscles in face, larynx, hands and feet).
- Painful cramps of the limb muscles.

Pancreas (Islets of Langerhans)

- Pancreas is an elongated, yellowish gland situated in the loop of stomach and duodenum.
- It is **exocrine** and **endocrine** in nature. The exocrine pancreas secretes pancreatic juice which plays a role in digestion while; the endocrine portion is made up of Islets of Langerhans.
- The Islets of Langerhans consists of two types of cells namely alpha cells and beta cells.
- The **alpha cells** secrete **glucagon** and **beta cells** secrete **insulin**.



Pancreas

Functions of Pancreatic hormones

A balance between insulin and glucagon production is necessary to maintain blood glucose concentration.

Insulin

- Insulin helps in the conversion of glucose into glycogen which is stored in liver and skeletal muscles.
- It promotes the transport of glucose into the cells.
- It decreases the concentration of glucose in blood.

Glucagon

- Glucagon helps in the breakdown of glycogen to glucose in the liver.
- It increases blood glucose levels.

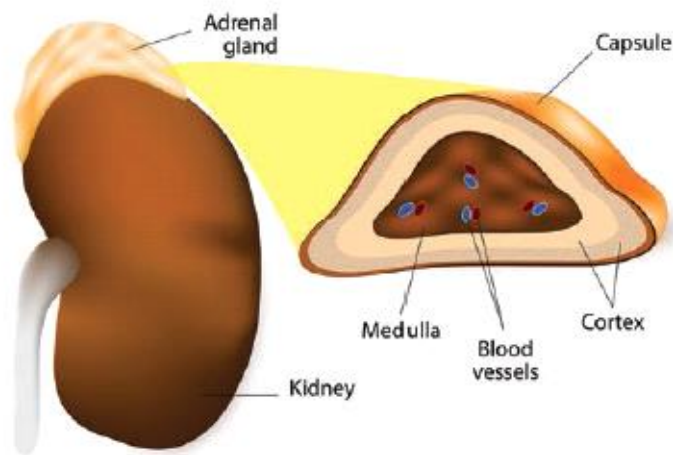
Diabetes mellitus

- The deficiency of insulin causes **Diabetes mellitus**. It is characterised by
- Increase in blood sugar level (Hyperglycemia).
- Excretion of excess glucose in the urine (Glycosuria).
- Frequent urination (Polyuria).
- Increased thirst (Polydipsia).

- Increase in appetite (Polyphagia).

Adrenal Gland

- The adrenal glands are located above each kidney. They are also called **supra renal glands**.
- The outer part is the adrenal cortex and the inner part is the adrenal medulla. The two distinct parts are structurally and functionally different.



Adrenal Gland

Adrenal Cortex

The adrenal cortex consists of three layers of cells. They are **zona glomerulosa**, **zona fasciculata** and **zona reticularis**

Hormones of Adrenal Cortex

The hormones secreted by the adrenal cortex are corticosteroids. They are classified into

- a. Glucocorticoids
- b. Mineralocorticoids

Functions of adrenocortical hormones

Glucocorticoids

The glucocorticoids secreted by the zona fasciculata are **cortisol** and **corticosterone**

- They regulate cell metabolism.
- It stimulates the formation of glucose from glycogen in the liver.

- It is an anti-inflammatory and anti-allergic agent.

Mineralocorticoids

The mineralocorticoids secreted by zona glomerulosa is **aldosterone**

- It helps to reabsorb sodium ions from the renal tubules.
- It causes increased excretion of potassium ions.
- It regulates electrolyte balance, body fluid volume, osmotic pressure and blood pressure.

Adrenal Medulla

- The adrenal medulla is composed of **chromaffin cells**. They are richly supplied with sympathetic and parasympathetic nerves.

Hormones of Adrenal Medulla

It secretes two hormones namely

- a. Epinephrine (Adrenaline)
- b. Norepinephrine (Noradrenaline)

- They are together called as “**Emergency hormones**”. It is produced during conditions of stress and emotion. Hence it is also referred as “flight, fright and fight hormone”.

Functions of adrenal medullary hormones

Epinephrine (Adrenaline)

- It promotes the conversion of glycogen to glucose in liver and muscles.
- It increases heart beat and blood pressure.
- It increases the rate of respiration by dilation of bronchi and trachea.
- It causes dilation of the pupil in eye.
- It decreases blood flow through the skin.

Norepinephrine (Noradrenalin)

- Most of its actions are similar to those of epinephrine.

Reproductive Glands (Gonads)

- The sex glands are of two types the **testes** and the **ovaries**. The testes are present in male, while the ovaries are present in female.

Testes

- Testes are the reproductive glands of the males. They are composed of seminiferous tubules, Leydig cells and Sertoli cells.
- **Leydig cells** from the endocrine part of the testes.
- They secrete the male sex hormone called **testosterone**.

Functions of testosterone

- It influences the process of spermatogenesis.
- It stimulates protein synthesis and controls muscular growth.
- It is responsible for the development of secondary sexual characters (distribution of hair on body and face, deep voice pattern, etc).

Ovary

- The ovaries are the female gonads located in the pelvic cavity of the abdomen.

They secrete the female sex hormones

- a. Estrogen
- b. Progesterone

- **Estrogen** is produced by the **Graafian follicles** of the ovary and **progesterone** from the **corpus luteum** that is formed in the ovary from the ruptured follicle during ovulation.

Functions of estrogens

- It brings about the changes that occur during puberty.
- It initiates the process of oogenesis.
- It stimulates the maturation of ovarian follicles in the ovary.

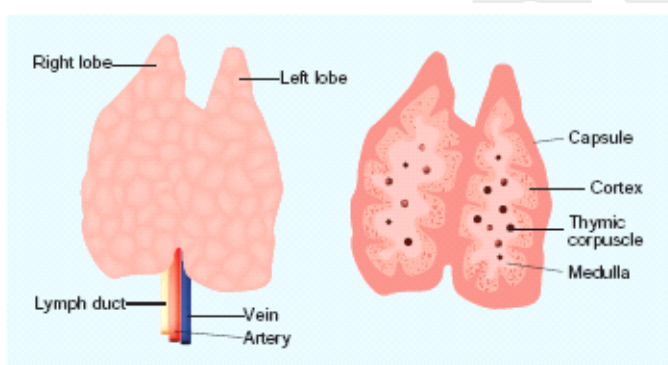
- It promotes the development of secondary sexual characters (breast development, high pitched voice etc).

Functions of progesterone

- It is responsible for the premenstrual changes of the uterus.
- It prepares the uterus for the implantation of the embryo.
- It maintains pregnancy.
- It is essential for the formation of placenta.

Thymus Gland

- Thymus is partly an endocrine gland and partly a lymphoid gland. It is located in the upper part of the chest covering the lower end of trachea.
- **Thymosin** is the hormone secreted by thymus.



Thymus Gland

Functions of Thymosin

- It has a stimulatory effect on the immune function.
- It stimulates the production and differentiation of lymphocytes.

More to know:

- Phenyl Acetic Acid (PAA) and Indole 3 Acetonitrile (IAN) are natural auxins. Indole 3 Butyric Acid (IBA), Indole-3- Propionic Acid, α -Naphthalene Acetic Acid (NAA), 2, 4, 5-T (2,4,5 Trichlorophenoxy Acetic Acid) are some of the synthetic auxins.

- The branch of biology which deals with the study of the endocrine glands and its physiology is known as '**Endocrinology**'. **Thomas Addison** is known as Father of Endocrinology. English physiologists **W. M. Bayliss** and **E. H. Starling** introduced the term **hormone** in 1909. They first discovered the hormone secretin.
- Melatonin is a hormone produced by the pineal gland. It is known as a 'time messenger'.
- It signals night time information throughout the body.
- Exposure to light at night, especially short-wavelength light, can decrease melatonin production interrupting sleep. Suppression of melatonin has been implicated in sleep disturbances and related metabolic disorders.
- Edward C. Kendal in 1914 first crystallized thyroxine hormone. Charles Harrington and George Barger identified the molecular structure of thyroxine in 1927. Thyroid gland requires "120 µg" of iodine everyday for the production of thyroxine.
- Human insulin was first discovered by Fredrick Banting, Charles Best and MacLeod in 1921. Insulin was first used in treatment of diabetes on 11th January 1922.
- The **cortisol** hormone of adrenal cortex serves to maintain the body in living condition and recover it from the severe effects of stress reactions. Thus an increased output of cortisol is "life saving" in "shock conditions". It is also known as life-saving hormone.