

# CHAPTER - 14

## ENDOCRINE SYSTEM

### Points to be covered in this topic

- **14.1 Introduction**
- **14.2 Pituitary gland**
  - 14.2.1 Location and structure
  - 14.2.2 Anterior lobe (Adenohypophysis)
  - 14.2.3 Posterior lobe hormones
- **14.3 Adrenal gland**
  - 14.3.1 Location and structure
  - 14.3.2 Hormones secreted from the adrenal cortex
  - 14.3.3 Hormones secreted from adrenal medulla
- **14.4 Thyroid and parathyroid gland**
  - 14.4.1 Thyroid gland
  - 14.4.2 Parathyroid gland

# CHAPTER - 14

## ENDOCRINE SYSTEM

### Points to be covered in this topic

- **14.5 Pancreases and gonads**
  - 14.5.1 Pancreases
  - 14.5.2 Gonads
- **14.6 Pineal gland**
- **14.7 Thymus gland**
- **14.8 Disorder of endocrine glands**
  - 14.8.1 Pituitary gland
  - 14.8.2 Adrenal gland
  - 14.8.3 Thyroid gland
  - 14.8.4 Pancreatic gland disorder

# ENDOCRINE SYSTEM

## 14.1 INTRODUCTION

- Endocrine gland or ductless gland is a bodily gland that produces hormones and releases them into the bloodstream.
- Hormone is a chemical messenger synthesized by specialized organs that are transported to a site, distant from its origin.

The endocrine system

### ➤ Endocrine glands include:

1. Pituitary gland
2. Adrenal gland
3. Thyroid and parathyroid gland
4. Pancreas and Gonads

## 14.2 PITUITARY GLAND

- Pituitary Gland is an endocrine gland. It regulates the activities of several other endocrine glands, that's why it is also referred as master's gland of endocrine system.

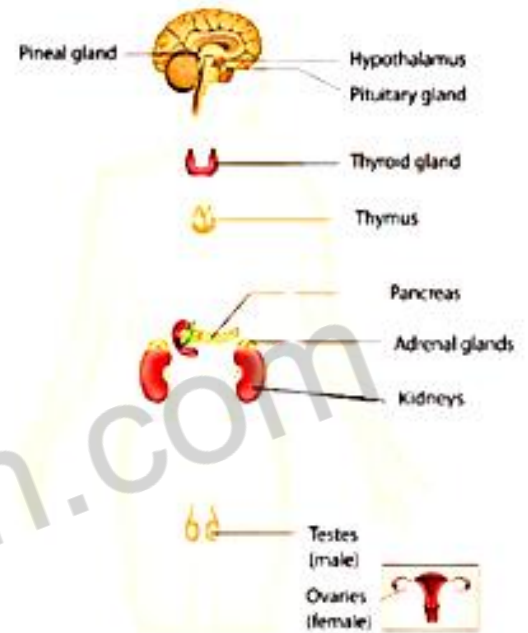


Fig. 14.1: Endocrine system

### 14.2.1 Location and Structure

- Located at the base of brain protruding off the bottom of the hypothalamus.
- It lies in the hypophyseal fossa of the sphenoid bone.
- Oval shaped, about the size of a chickpea and weighs 0.5 grams (0.018 oz.) on average.

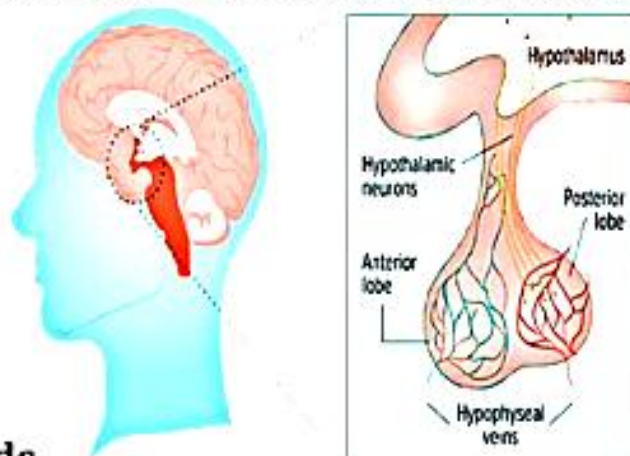


Fig. 14.2: Pituitary glands

✓ **It consist of two lobes:**

1. Anterior lobe (Adenohypophysis)
2. Posterior lobe (Neurohypophysis)

### **14.2.2 Anterior lobe (Adenohypophysis):**

- It is stimulated by hormones secreted by Hypothalamus.

#### **Hormones secreted from anterior pituitary**

##### **i. Growth hormones**

- Growth hormone is the most prevalent anterior pituitary hormones stimulated by growth hormone releasing hormones and suppressed by Growth hormone inhibiting hormone.
- It has anabolic effect.
- Its secretion is highest in childhood and adolescence.

##### ✓ **Functions**

- Controls growth and development of growth and regeneration of all body tissues.
- Stimulates protein synthesis.
- Increases blood glucose.
- It regulates metabolism occurring in liver, intestines and pancreas.

##### **ii. Thyroid stimulating hormones**

- TSH release is controlled by Thyrotropin releasing hormones from hypothalamus.
- Its secretion is controlled by negative feedback mechanism.
- Cold exposure is a powerful promoter of TSH secretion, leading to increased release of TSH and an increase in metabolic rate.

##### ✓ **Functions**

- Stimulates growth and activity of thyroid gland.
- Stimulated thyroid glands secretes two hormones **Thyroxine (T<sub>4</sub>)** and **Triiodothyronine (T<sub>3</sub>)**.

##### **iii. Adrenocorticotrophic hormones (corticotrophin)**

- Synthesis and release of ACTH is controlled by CRH secreted from hypothalamus.
- It is also regulated by negative feedback mechanism.

✓ **Functions**

- Stimulates growth and activity of adrenal cortex.
- Increases the output of adrenocortical steroid hormones, especially cortisol.

iv. **Prolactin**

- Also known as lactogenic hormone that is secreted during pregnancy.
- Prolactin releasing hormone released from hypothalamus increases its level in blood and PIH decreases it.

✓ **Functions**

- This hormone initiate the process of lactation (i.e. –milk secretion from breast).

v. **Gonadotropins**

- Just before reaching puberty, the anterior pituitary gradually secretes two gonadotrophins, or sex hormones.
- This secretion is initiated by gonadotrophin releasing hormones.
- Increased level of hormones at puberty promotes maturation of reproductive organs.
- Two gonadotrophins released are:
  - i. FSH
  - ii. LH

**Table.14.1: Hormones and its functions**

| HORMONES | FUNCTIONS  |
|----------|--|
| FSH      | <ul style="list-style-type: none"><li>• Stimulates sperm production in testis.</li><li>• Stimulates oestrogen secretion by ovaries</li><li>• Ovarian follicles maturation and ovulation.</li></ul> |
| LH       | <ul style="list-style-type: none"><li>• Stimulates secretion of testosterone from testis and progesterone by corpus luteum.</li></ul>  |

**14.2.3 Posterior pituitary hormones**

- ✓ **Hormones secreted from posterior pituitary are :**

- i. Oxytocin
- ii. Vasopressin

### i. Oxytocin

#### ✓ Functions

- It stimulates smooth muscles during the process of baby delivery (parturition).
- It also stimulates lactating breast's muscle which leads to ejection of milk.
- It increase smooth muscle contraction during sexual arousal in males and females.
- It helps in the process of glandular secretion and ejaculation.
- It facilitates sperm movement towards uterine tubes.
- It is responsible for the bonding between mother and baby.

### ii. Vasopressin

- It is also known as anti-diuretic hormone.

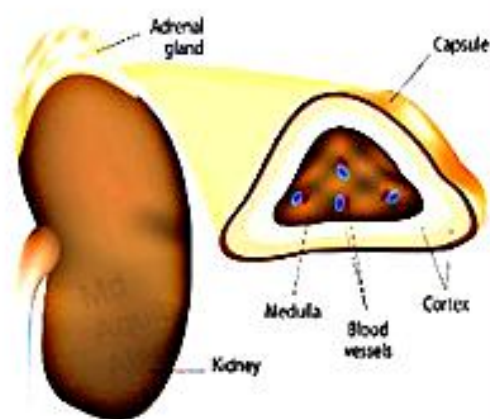
#### ✓ Functions

- ADH is an important hormone that is responsible for water, osmolarity, and blood pressure homeostasis.
- Its function is vital in times of thirst, hemorrhage or in extreme scarcity of water in our body.

## 14.3 ADRENAL GLAND

### 14.3.1 Location and Structure

- Adrenal gland also known as suprarenal gland is a paired gland situated above the kidney.
- It is encapsulated by renal fascia.
- It is Pyramidal in shape.
- Length 5cm, width 3cm and thickness 1 cm.
- It weight is approx 7-10 g.
- They are mainly composed of two parts.
  - i. Adrenal Cortex (Outer part)
  - ii. Adrenal medulla (Inner part)



### 14.3.2 Hormones secreted from the adrenal cortex

- i. Glucocorticoid

ii. Mineralocorticoid

iii. Sex hormones

### **i. Glucocorticoids**

- Glucocorticoids is a steroidal hormone synthesized in the cortex region of adrenal gland.
- Cortisol is main glucocorticoids but small amount of corticosterone and cortisone are also produced.
- Hypothalamus and anterior pituitary controls its secretion.
- Stimulated by ACTH from anterior pituitary and by stress.
- They are mainly concerned with catabolism reaction.

#### ✓ **Functions**

- They exhibits hyperglycemic action.
- It helps in the process of:

**Gluconeogenesis** (formation of sugar certain non-carbohydrate carbon substrates).

**Lipolysis** (breakdown of triglycerides into fatty acids and glycerol).

### **ii. Mineralocorticoids**

- Aldosterone is the main mineralocorticoids secreted from adrenal cortex.
- Aldosterone secretion is controlled by blood potassium level. Angiotensin II also stimulates aldosterone release.

#### ✓ **Functions**

- It helps in maintaining water and electrolyte balance.
- Stimulates sodium reabsorption from renal tubules.
- Initiates Potassium excretion through urine.
- Regulates blood pressure and blood volume.

### **iii. Sex hormones**

- Also known as **gonad corticoids**.
- Androgen (a male sex hormone) is the main gonadocorticoids secreted from adrenal cortex.
- Androgens are crucial for **male sexual and reproductive function**.

### **14.3.3 Hormones secreted from adrenal medulla**

- Adrenal medulla the inner region of adrenal gland and is made up of chromaffin cells.

- The inner region of an adrenal gland, the adrenal medulla, secretes catecholamine that includes epinephrine and norepinephrine. They are also known as stress hormone
- Adrenal medulla secretes two hormones:
  - i. Epinephrine (Adrenaline).
  - ii. Norepinephrine (Noradrenaline)
- ✓ **Functions**
- These two hormones operate similarly.

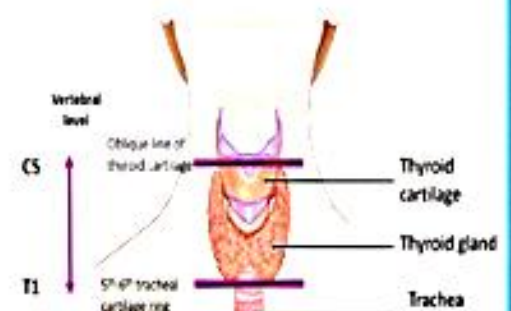
**Table 14.1: Hormones effect on different organs and functions**

| ORGANS OR FUNCTIONS              | EPINEPHRINE   | NOREPINEPHRINE  |
|----------------------------------|---|---|
| <b>Heart</b>                     | Increases rate and force of contraction                                     | Increases rate and force of contraction   |
| <b>Blood vessels</b>             | Dilates skeletal muscle vessels, decreasing blood flow resistance           | Increases skeletal muscle blood flow because of constriction of blood vessels in skin and viscera |
| <b>Systemic blood pressure</b>   | Increases somewhat because of increased cardiac output                      | Increases greatly because of vasoconstriction   |
| <b>Airways</b>                   | Dilates   | Dilates slightly  |
| <b>Reticular brain formation</b> | Activates   | Little effect on blood sugar concentration  |
| <b>Liver</b>                     | Promotes glycogen to glucose breakdown; increases blood sugar concentration | Little effect on blood sugar concentration  |
| <b>Metabolic rate</b>            | Increases   | Increases   |

## 14.4 THYROID AND PARATHYROID GLAND

### 14.4.1 Thyroid Gland

- Thyroid gland is a highly vascularized small gland surrounded by fibrous capsule.
- It is located beneath the skin that resembles a butterfly.





- Situated in neck in front of larynx and trachea at the level of 5<sup>th</sup>, 6<sup>th</sup> and 7<sup>th</sup> cervical and first thoracic vertebrae and weighs approximately 25g.

### ➤ Hormones secreted from the thyroid Gland

1. Thyroid gland
2. Calcitonin

#### i. Thyroid Hormone

- Follicular cells secrete Thyroxine (T<sub>3</sub>) and Triiodothyronine (T<sub>4</sub>) In collectively known as thyroid hormones.

#### ✓ Functions

- It promotes physical and mental growth.
- It helps in growth and development of brain during fetal life.
- Stimulates protein synthesis.
- Increases lipolysis and cholesterol excretion.
- It is important for normal reproductive behavior.

#### ii. Calcitonin

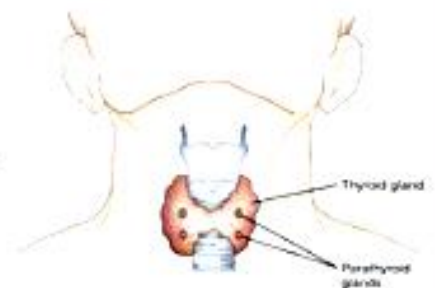
- Parafollicular or C-cells of thyroid gland secrete Calcitonin.
- Increase in blood calcium level stimulates calcitonin release.

#### ✓ Functions

- Inhibits calcium reabsorption by renal tubules.
- It reduces blood calcium level by acting on bone and kidneys.

### 14.4.2 Parathyroid gland

- They are small glands having four in number and are located on the four lobes of thyroid glands.
- They are encapsulated by a layer of fine connective tissue and weighs around 50 mg.



### ➤ Hormones secreted from parathyroid gland

#### 1. Parathyroid hormone

#### ✓ Functions

- It regulates the amounts of calcium, phosphorus and magnesium in the bones and blood.

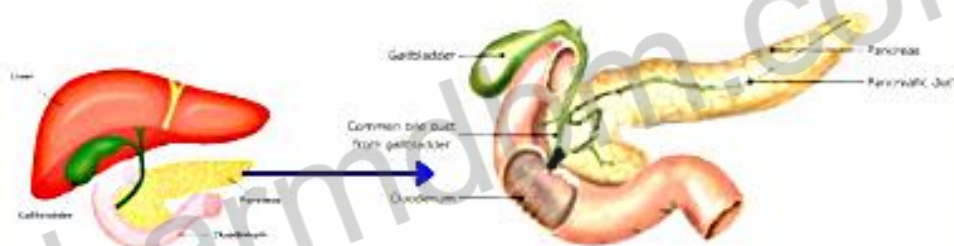
- Parathyroid along with calcitonin helps in maintaining blood calcium level.

## 14.5 PANCREAS AND GONADS

### 14.5.1 Pancreas

#### ➤ Location and structures

- Pancreas a mixed gland of our body is located in the curves of the duodenum and is surrounded by various organs like liver, small intestine and spleen.
- It is Spongy, measuring about 12.5-15 cm in length and weighs approx. 75g.
- Pancreas 95% is exocrine (produces pancreatic enzyme)
- And rest 5% is endocrine known as islets of Langerhans (produces hormones like insulin and glucagon).
- There are around 1-2 million pancreatic cells which mainly contains three types of hormone secreting cells.



**Fig.14.2: Pancreas**

#### ➤ Hormones secreted from the pancreas

##### i. Glucagon

- Secreted by alpha cells of pancreas.
- Secretion stimulated by decrease blood glucose level, exercise and protein meals.

##### ✓ Functions

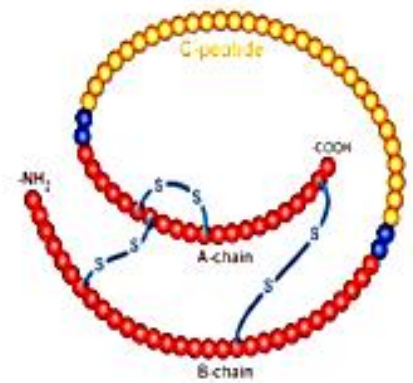
- Glucagon raises blood glucose level by increasing breakdown of glycogen into glucose in liver.
- It helps in the process of gluconeogenesis.

##### ii. Insulin

- Insulin is secreted by beta cells of pancreatic cells is a polypeptide hormone consisting of 51 amino acids.

## ✓ Functions

- Maintains normal blood glucose level by regulating the metabolism of proteins, fats, and carbohydrates.
- It facilitates the uptake of glucose by cells.
- Increases the process of glycogenesis.
- Promotes lipogenesis.
- Decreases glycogenolysis.
- Prevents protein and fat breakdown



**Fig.14.3: Insulin**

## ii. Somatostatin

- Secreted by delta cells of pancreatic cells.
- It is inhibited by pancreatic polypeptide.

## ✓ Functions

- Inhibits secretion of pancreatic hormones insulin and glucagon.
- It also inhibits gastric secretion in GIT.

## 14.5.2 Gonads

- Gametes (sperm in males and oocytes in females) producing organ is known as gonads.
- It includes:

### i. Testis (Male gonads)

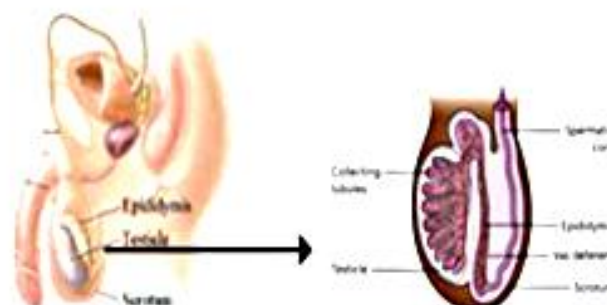
### ii. Ovaries (Female gonads)

## i. Testis

- Testis is the male sex gland.
- They are paired, small, oval shaped reproductive gland, lying inside the scrotum just behind the penis.
- They are about 4.5 cm long, 3cm wide and 2 cm thick and weighs around 15-19 g.



**Fig. 14.3: Gonads**

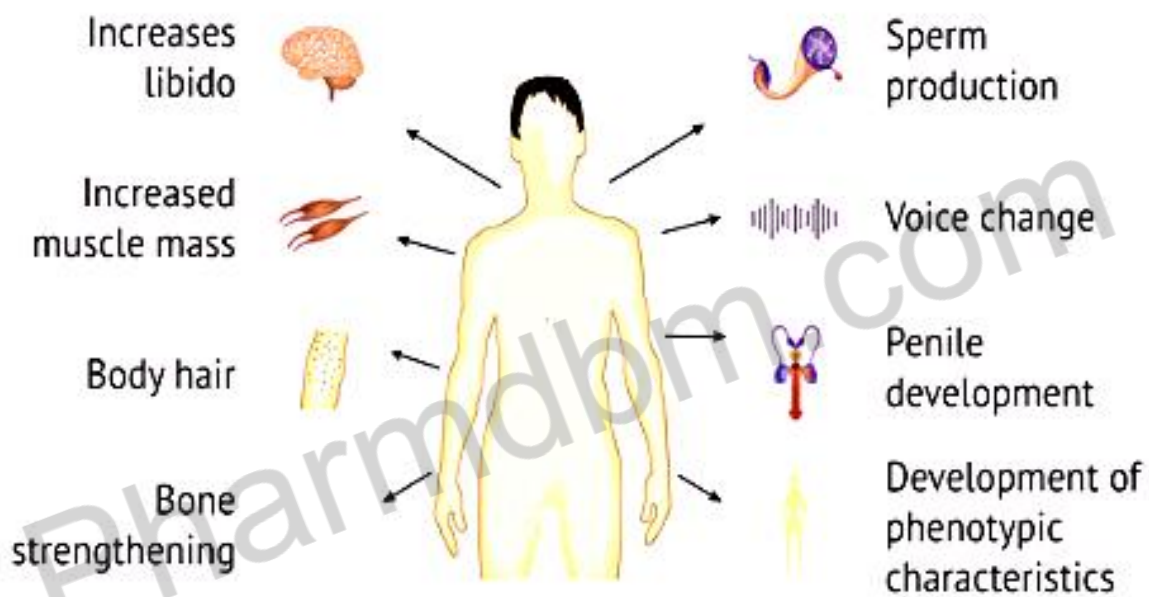


## ➤ Hormones secreted from the testis

- Testosterone, an androgenic hormone.

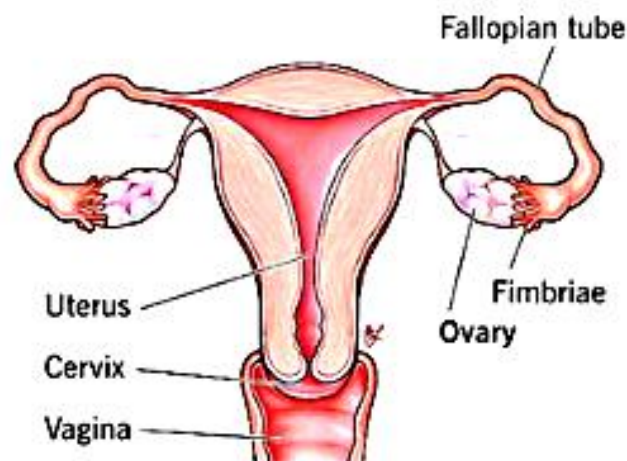
### ✓ Functions

- It helps in the process of spermatogenesis (i.e. -sperm production)
- Development of secondary sexual characters (like growth of pubic hairs, beards, deepening of voice etc.).
- It helps in maintaining masculinity in males.
- It increases muscle mass and libido.
- It provides strength to bones.
- Inhibits secretion of FSH by producing inhibin.



## ii. Ovaries

- The ovaries are paired, small, oval-shaped female gonads (glands) located on either side of uterus.
- It lies on lateral walls of pelvis. And measures around (2.5 to 3.5 cm long, 2 cm wide and 1 cm thick.)



## ➤ Hormones secreted from ovaries

- i. Estrogen
- ii. Progesterone
- iii. Relaxin

### ✓ Functions

#### • Estrogen:

- i. Plays key role in the development of female secondary sexual characters like breasts, endometrium, regulation of the menstrual cycle etc.

#### • Progesterone:

- ii. It helps in regulating menstruation (prepare endometrium for egg implantation and growth).
- iii. Supports pregnancy (thickens uterine lining).
- iv. Promotes growth and development of breast.

#### • Relaxin:

- v. Released during pregnancy and increases flexibility of pubic symphysis.
- vi. And also dilates uterine cervix during labor and delivery.

## 14.6 PINEAL GLAND

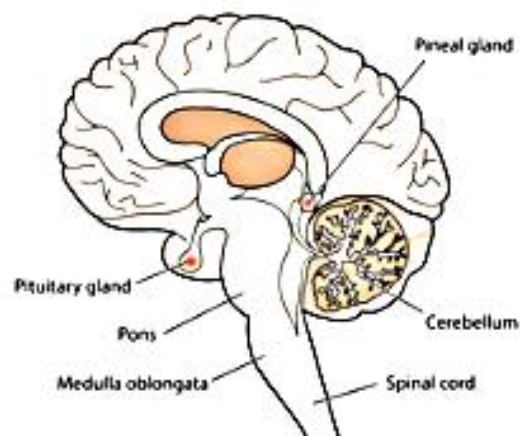
- It is an important endocrine gland in higher vertebrates.
- The name is derived from its pinecone like structure.
- It is also known as 'third eye' as this gland
- This gland is embryologically derived from neuroectoderm of diencephalic roof.

### ➤ Location:

- The pineal gland is located in the center of the brain, sandwiched between the left and right hemispheres.

### ➤ Structure

- Shape- Similar a pinecone, flattened stalk like structure hence it is called epiphysis.
- Length- 0.8 cm
- Weights-0.1 gram



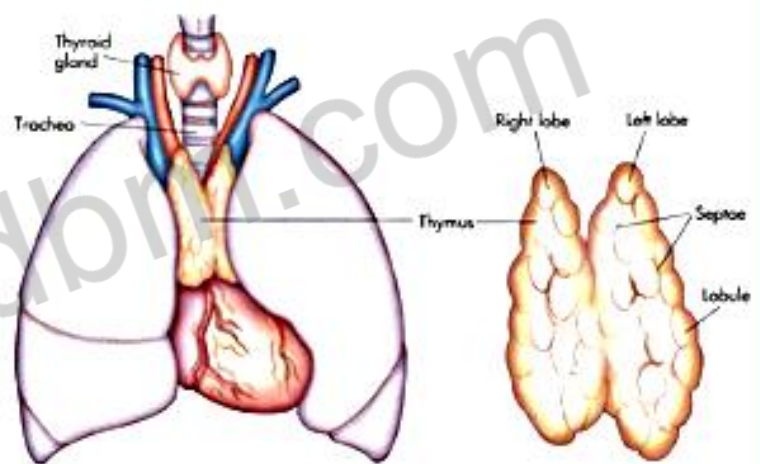
**Fig.14.4: Pineal gland**

## ➤ Function

- It regulates the body's circadian rhythms.
- Circadian rhythms are the daily rhythms of the body, including signals that make someone feel tired, sleep, wake up.
- Secretion is of melatonin control by -The amount of light entering the eye stimulating the optic pathways.
- Pineal gland releases greater amounts of melatonin when it is dark, which points to melatonin's role in sleep.
- Bone metabolism.
- Inhibition of growth and development the sex organs before puberty.
- Sense of direction.
- Drug metabolism.

## 14.7 THYMUS GLAND

- The thymus gland is a small organ behind the breastbone that plays an important function both in the immune system and endocrine system. Though the thymus begins to atrophy (decay) during puberty, its effect in "training" T lymphocytes to fight infections and even cancer lasts for a lifetime.



**Fig.14.5: Thymus gland**

## ➤ Location

- It is located in the upper front of chest, directly behind your sternum and between your lungs.

## ➤ Structure

- ✓ Shape- Triangular in shape.
- ✓ Colour- Pinkish-gray
- ✓ Weight-10-15 gm at birth & grows until puberty

## ➤ Functions

### Development and maturation of T lymphocytes cell

- T Lymphocyte is the type of white blood cell that is an essential of the immune system in our body

## 14.8 DISORDERS OF ENDOCRINE GLANDS:

### 14.8.1 Pituitary Gland

#### i. Gigantism

- Caused due to hyper secretion of growth hormones.

#### ii. Acromegaly

- It is a condition in which there is hyper secretion of growth hormones in adulthood.

#### iii. Dwarfism

- Hypo secretion of human growth hormone leads to dwarfism.



**Gigantism**



**Acromegaly**



**Dwarfism**

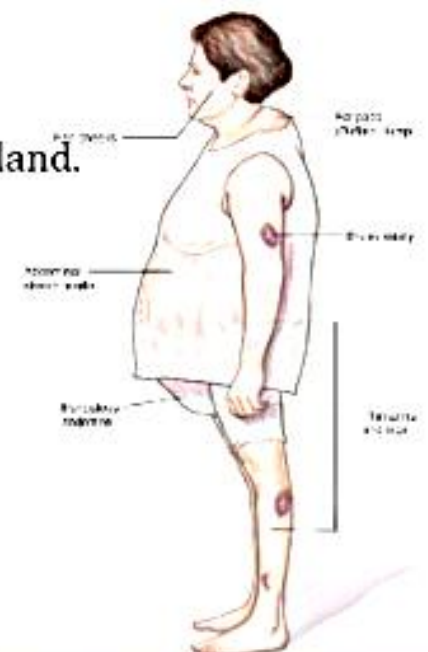
### 14.8.2 Adrenal Gland

#### i. Cushing syndrome

- Cushing syndrome is a disorder that result in overproduction of cortisol hormone.
- ✓ Its characteristic features include:
  - i. Fatty hump between shoulders.
  - ii. Rounded face.
  - iii. Pink or purple stretch marks on skin.
  - iv. It may be caused due to tumour of adrenal gland.

#### ii. Addison's disease

- It is caused due to hypo secretion of glucocorticoids and aldosterone (chronic adrenocortical insufficiency).
- This can be due to destruction of adrenal cortex or sudden withdraw of systemic corticosteroid therapy.



### 14.8.3 Thyroid gland

#### i. Cretinism

Extreme hypo secretion of thyroid hormones during fetal life or childhood leads to cretinism.

#### ii. Grave's disease

- Hyper secretion of thyroid glands leads to grave's disease. Hyper secretion occurs due to increase in the size of thyroid gland.
- It is organ specific autoimmune disorder.
- It is more common in females than males.



Graves' disease



Cretinism

### 14.8.4 Pancreatic Gland Disorders

#### i. Diabetes mellitus

- It is a metabolic disorder, involving elevated blood sugar level.

#### ✓ Sign and symptoms includes:

- Increased glucose level (Hyperglycemia).
- Loss of glucose in urine (Glycosuria).
- Excessive thirst (Polyuria).

#### ✓ It is of two types:

- Type-I Diabetes Mellitus
- Type-II Diabetes Mellitus

#### ➤ Type-I Diabetes Mellitus

- Also termed as insulin dependent diabetes is autoimmune condition that may begin in childhood.
- In this there is severe deficiency or absence of insulin secretion due to beta islets cells destruction.
- Insulin is not synthesized.
- Insulin treatment is required.

#### Symptoms of Diabetes



Increased thirst.



Slow-healing cuts and sores.



Fatigue.



Blurred vision.



Frequent urination.



Unexplained weight loss.



## ➤ **Type-II Diabetes Mellitus**

- Also termed as non-insulin dependent diabetes mellitus.
- Most common form of diabetes accounting more than 90% cases.
- In this pancreas synthesizes insulin but not in sufficient amount.
- Treatment involves diet and oral medications, insulin injection may be required in 20% of patients.

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