

CHEMICAL COORDINATION

UNIT IV

Chapter 11

Chemical Coordination and Integration

Chapter Outline

- 11.1 Endocrine glands and hormones
- 11.2 Human endocrine system
- 11.3 Hypo and hyper activity of endocrine glands and related disorders
- 11.4 Mechanism of hormone action.



Klotho an anti-aging hormone makes people smart enhances cognitive abilities and longevity.

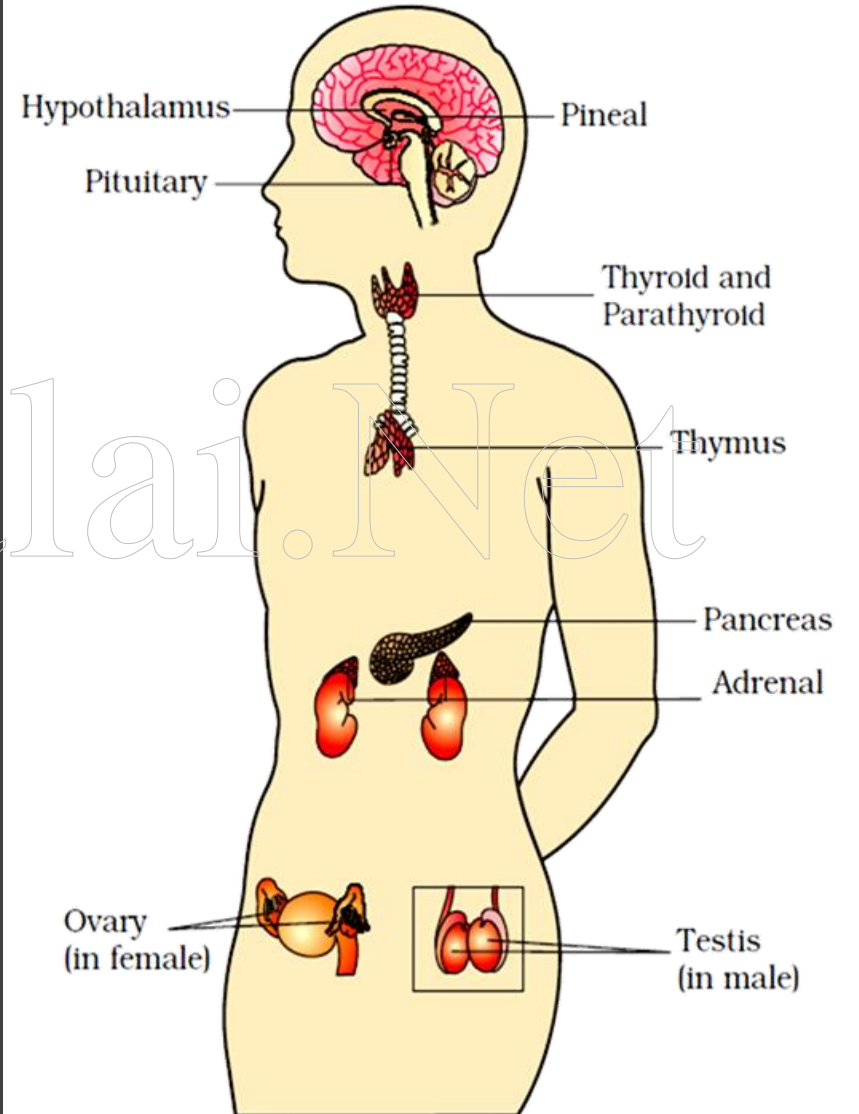


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Learning Objectives:

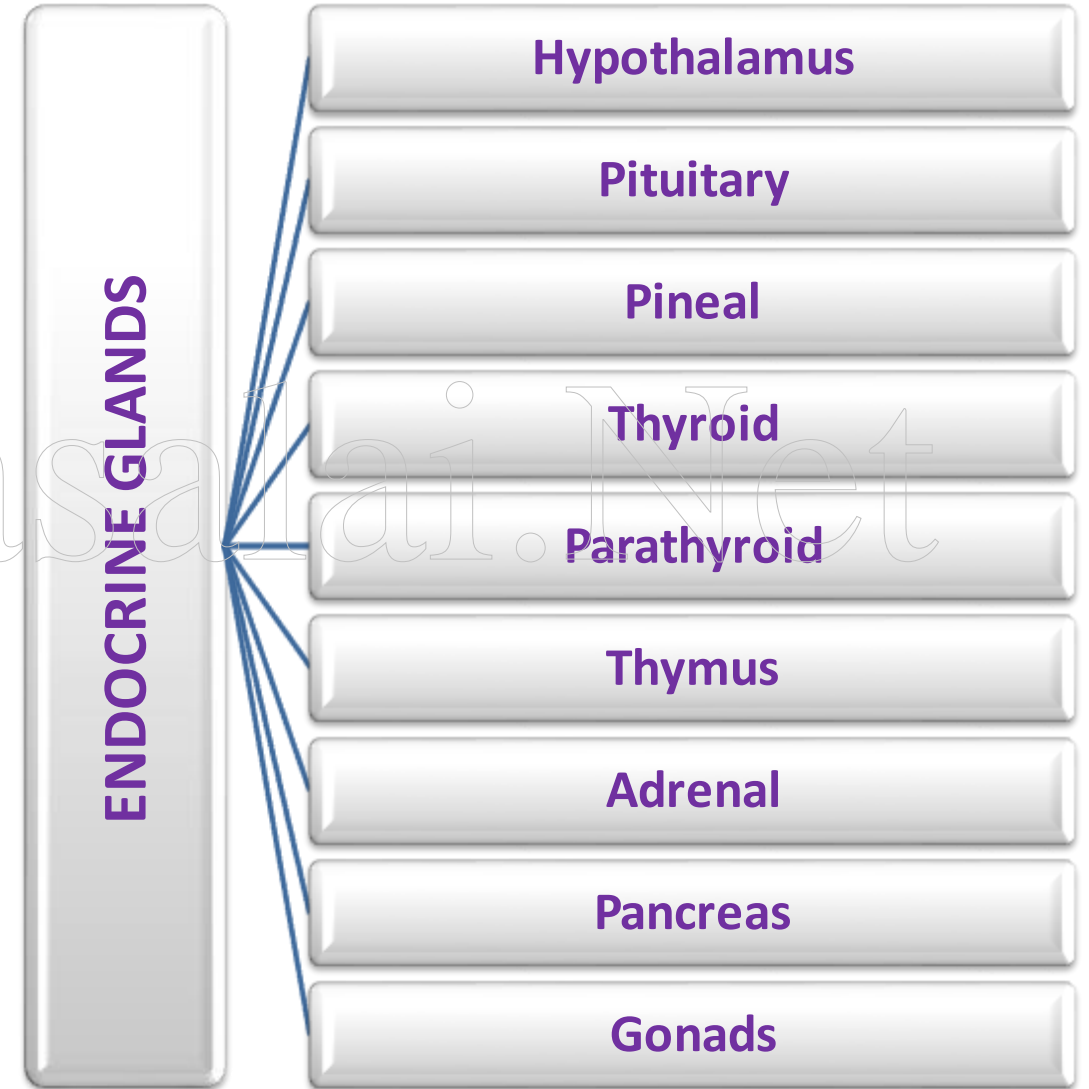
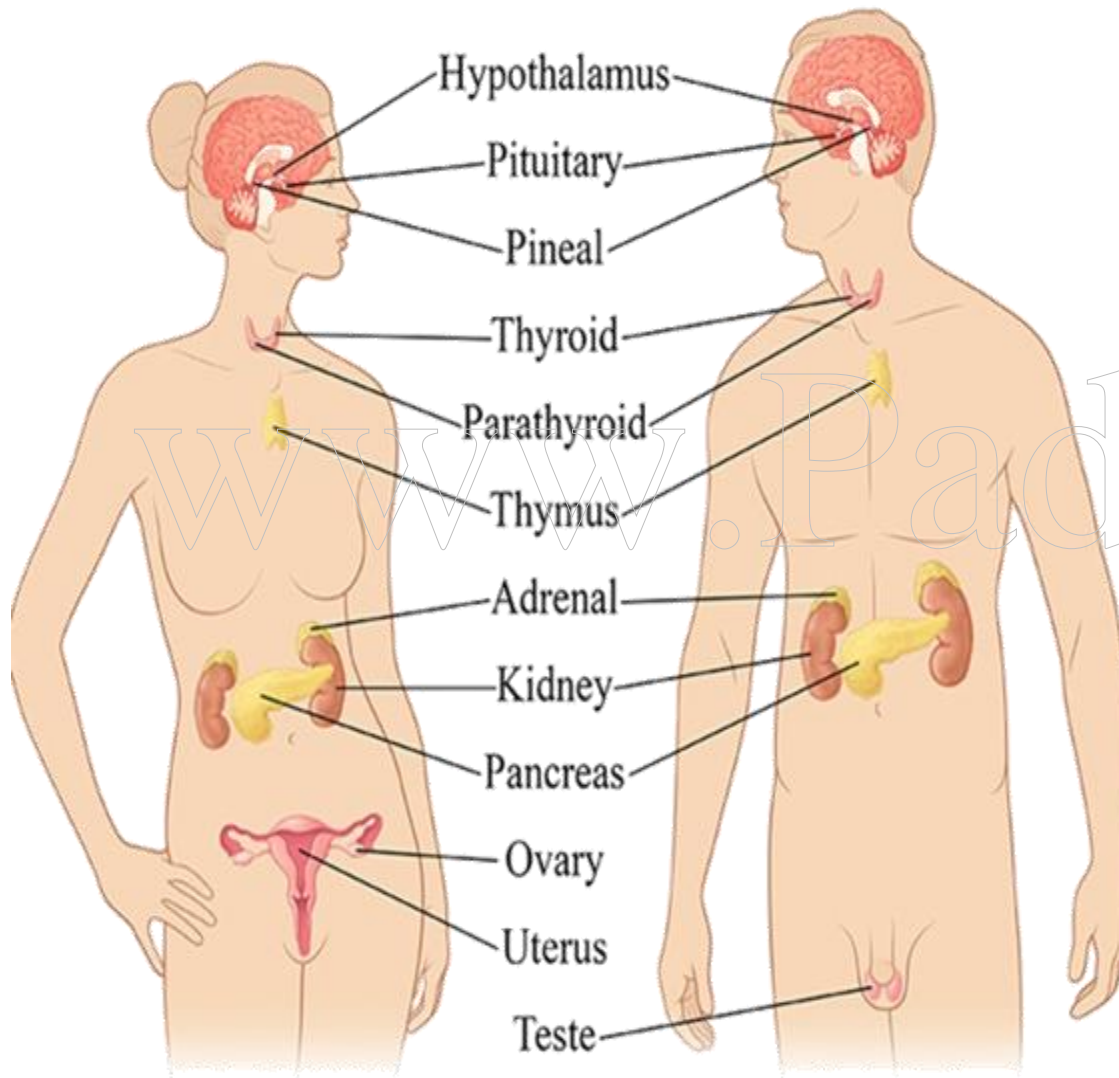
- *Understands the positions of the various endocrine glands and their secretions.*
- *Learns the mechanism of hormone action.*
- *Understands the disorders related to hypo and hyper activity of the endocrine glands.*
- *Learns the role of gastro intestinal hormones.*

CHEMICAL CORDINATION AND INTEGRATION



- While hearing your test marks, some may have **anxiety** and some may **hesitate** to hear and some may be **worried**.
- Do you know the reasons for such immediate changes?
- While seeing any **unexpected happenings**, we get **goose bumps**.
- Do you know the reason, why?
- These are all due to the **biochemical changes** happening **in our body**, Which are created by the **endocrine system**.
- The above mentioned biochemical changes are due to the **hormone adrenalin**
- **ADRENALIN** - **Flight, fright and fight** hormone.

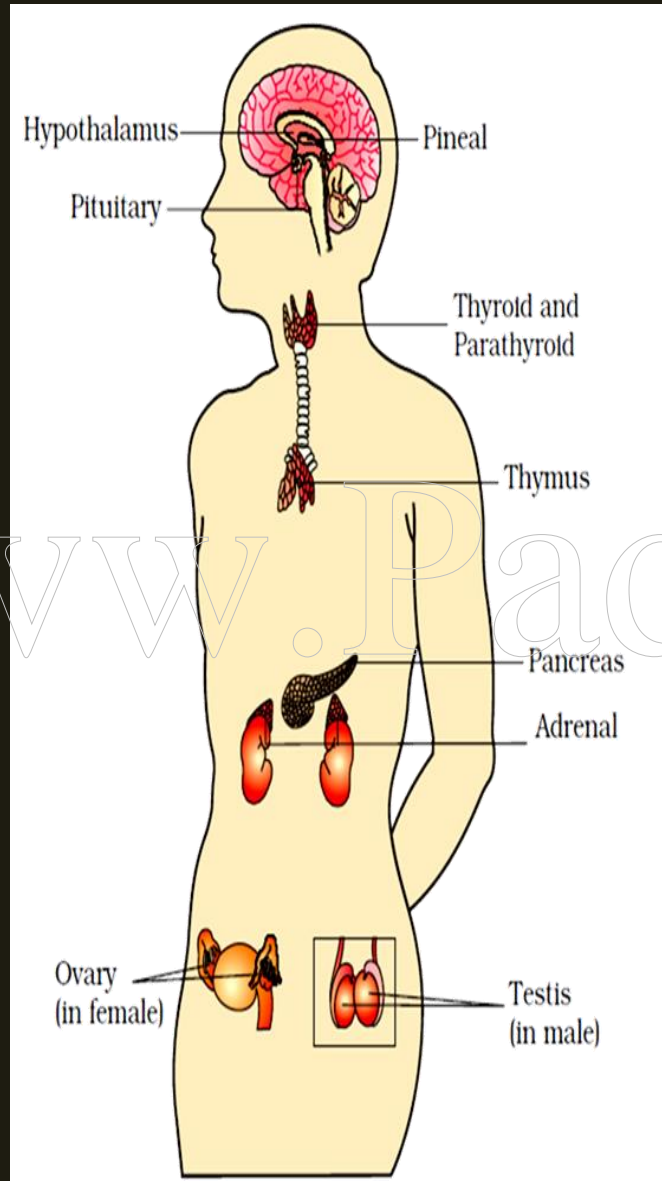
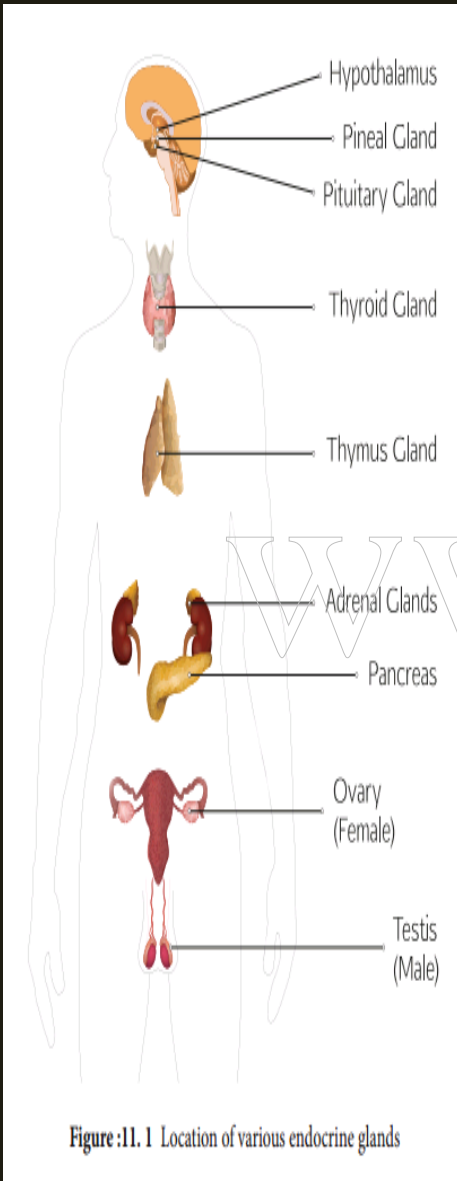
HUMAN ENDOCRINE SYSTEM



ENDOCRINE GLANDS AND HORMONES

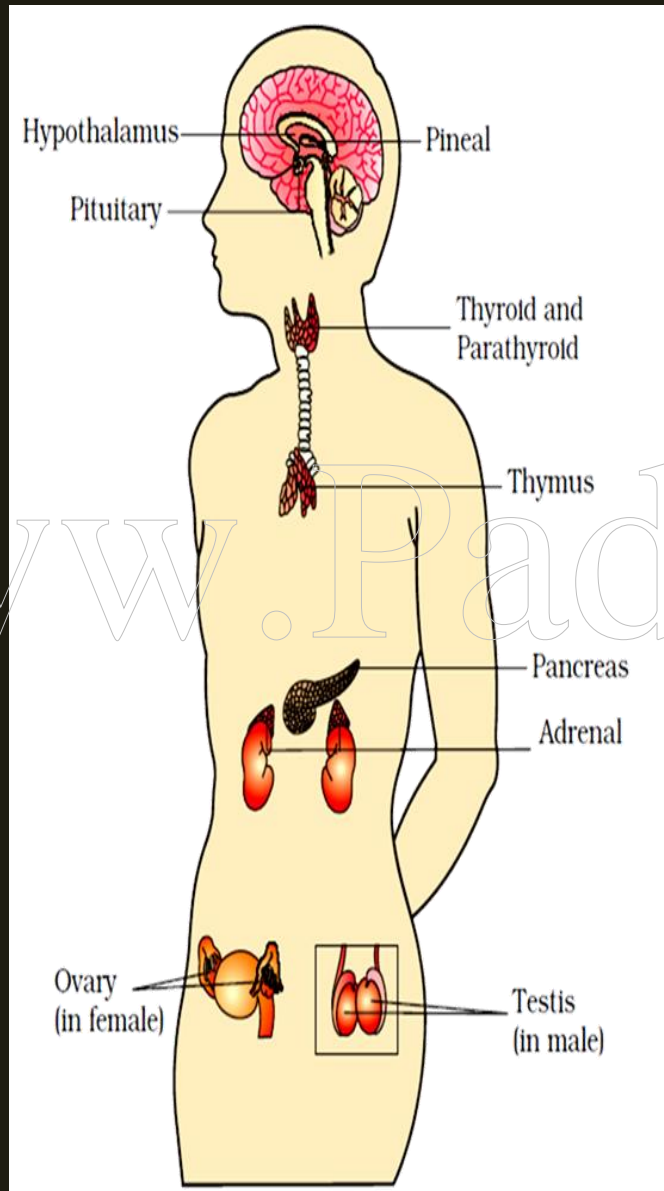
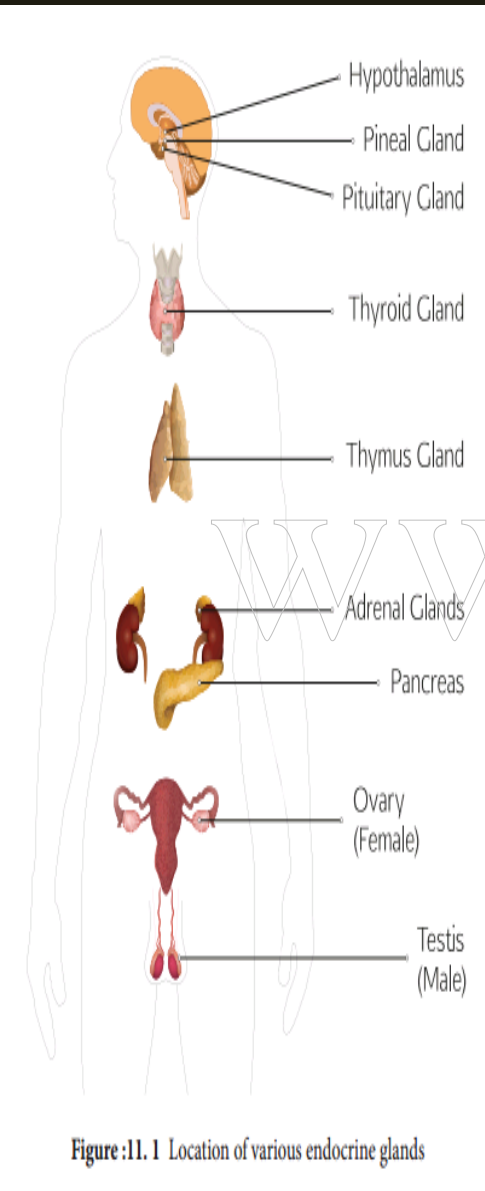
- Physiological functions of our human body is regulated and coordinated by both **neural and endocrine systems**.
- The endocrine system influences the metabolic activities by means of **hormones**.
- Hormone means to **excite**.
- Hormones are **chemical messengers** released into the blood and circulated as **chemical signals** and acts specifically on certain organs or tissues called **target organs** or **target tissues**.
- Hormones may **speed up or slow down or alter the activity** of the target organs.
- The hormones secreted **do not remain permanently in the blood** but are **converted by the liver into inactive compounds and excreted by the kidneys**.

ENDOCRINE GLANDS AND HORMONES



- Hormones are chemical messengers because they act as **organic catalysts and coenzymes to perform specific functions in the target organs.**
- The target organs contain **receptor molecules either on the surface or within the cell.**
- Although different hormones come in contact with cells, only the cells that contain receptor molecules specific for the hormone are **physiologically activated.**
- A single hormone may have **multiple effects on a single target tissue or on different target tissues.**

ENDOCRINE GLANDS AND HORMONES



- Many hormones exhibit long term changes like **growth, puberty and pregnancy.**
- Hormones often **influence many organs and organ system** at the same time.
- **Serious deficiency or excess secretion of hormones leads to disorders.**
- Hormones coordinate different **physical, physiological, mental activities and maintain homeostasis .**
- Hormones are composed of **water soluble proteins or peptides or amines or fat soluble steroids.**

Human endocrine system

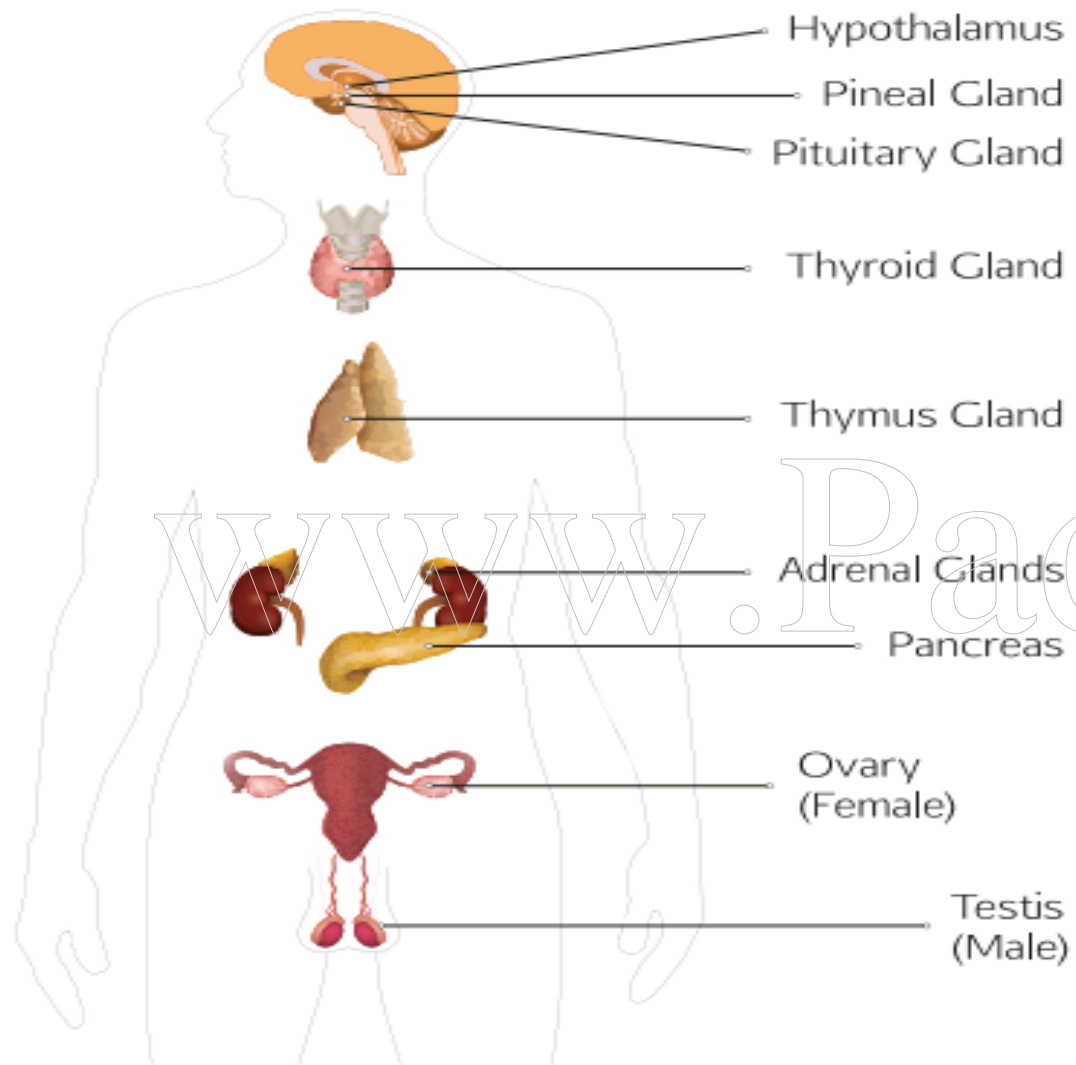
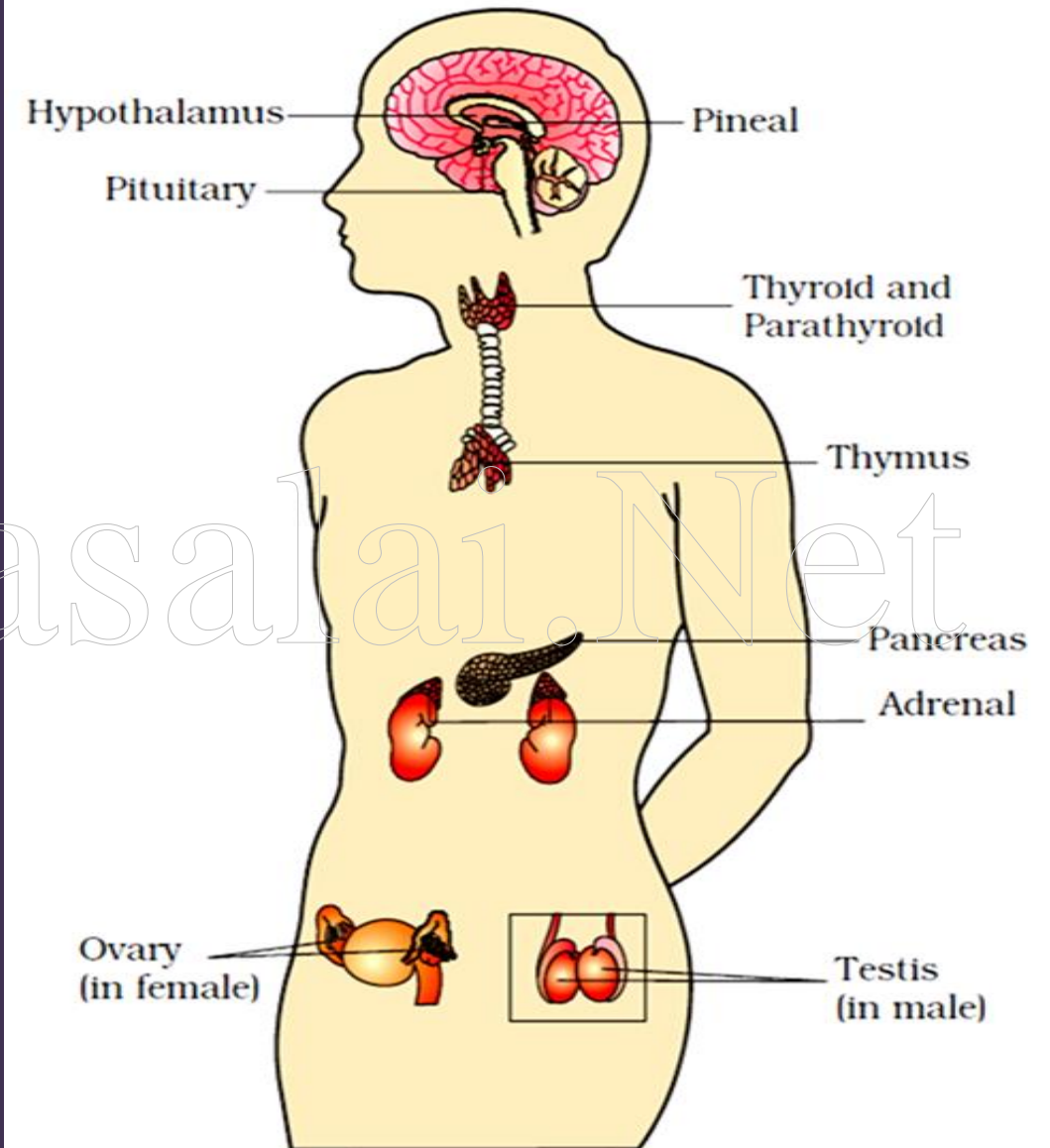
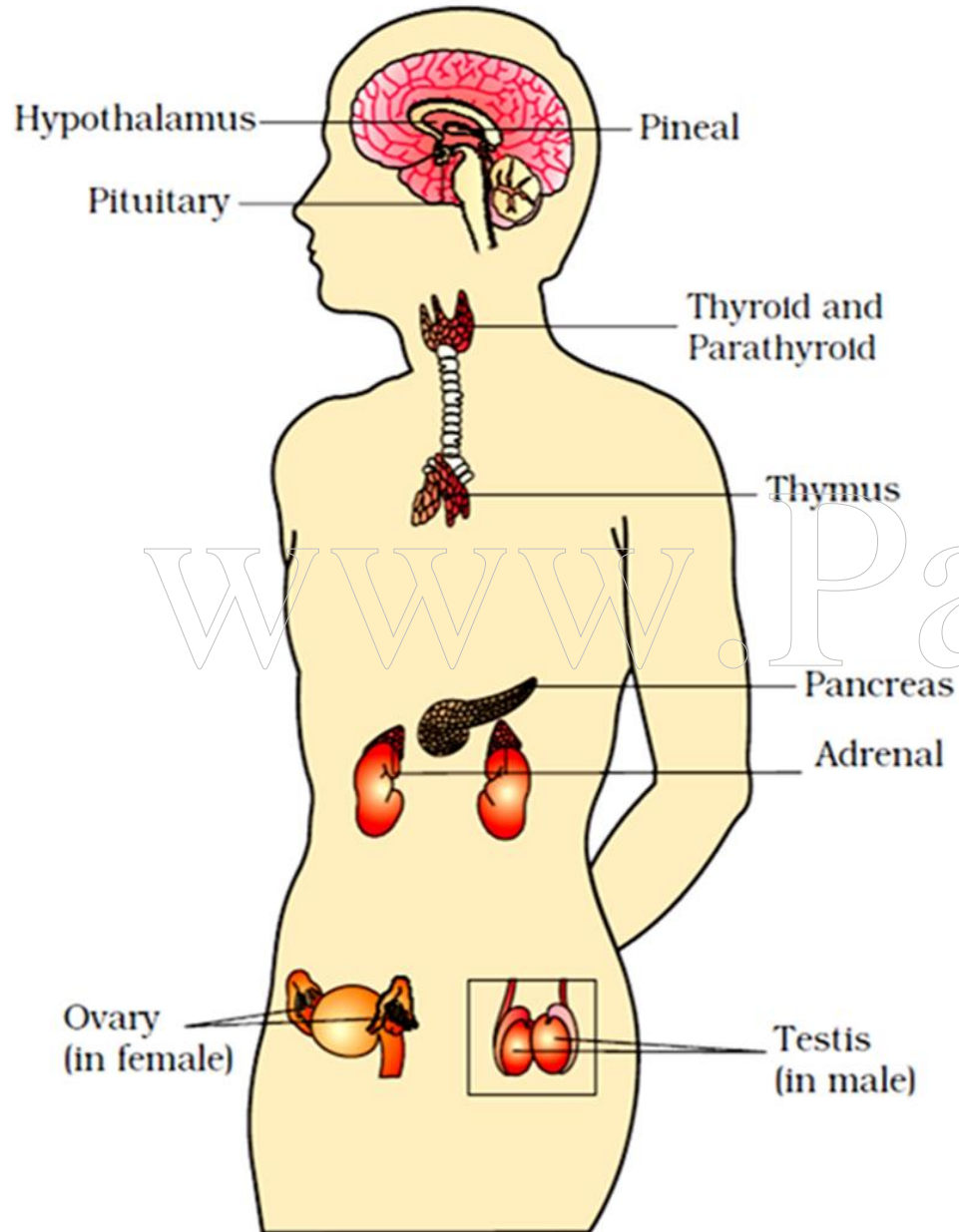


Figure :11. 1 Location of various endocrine glands

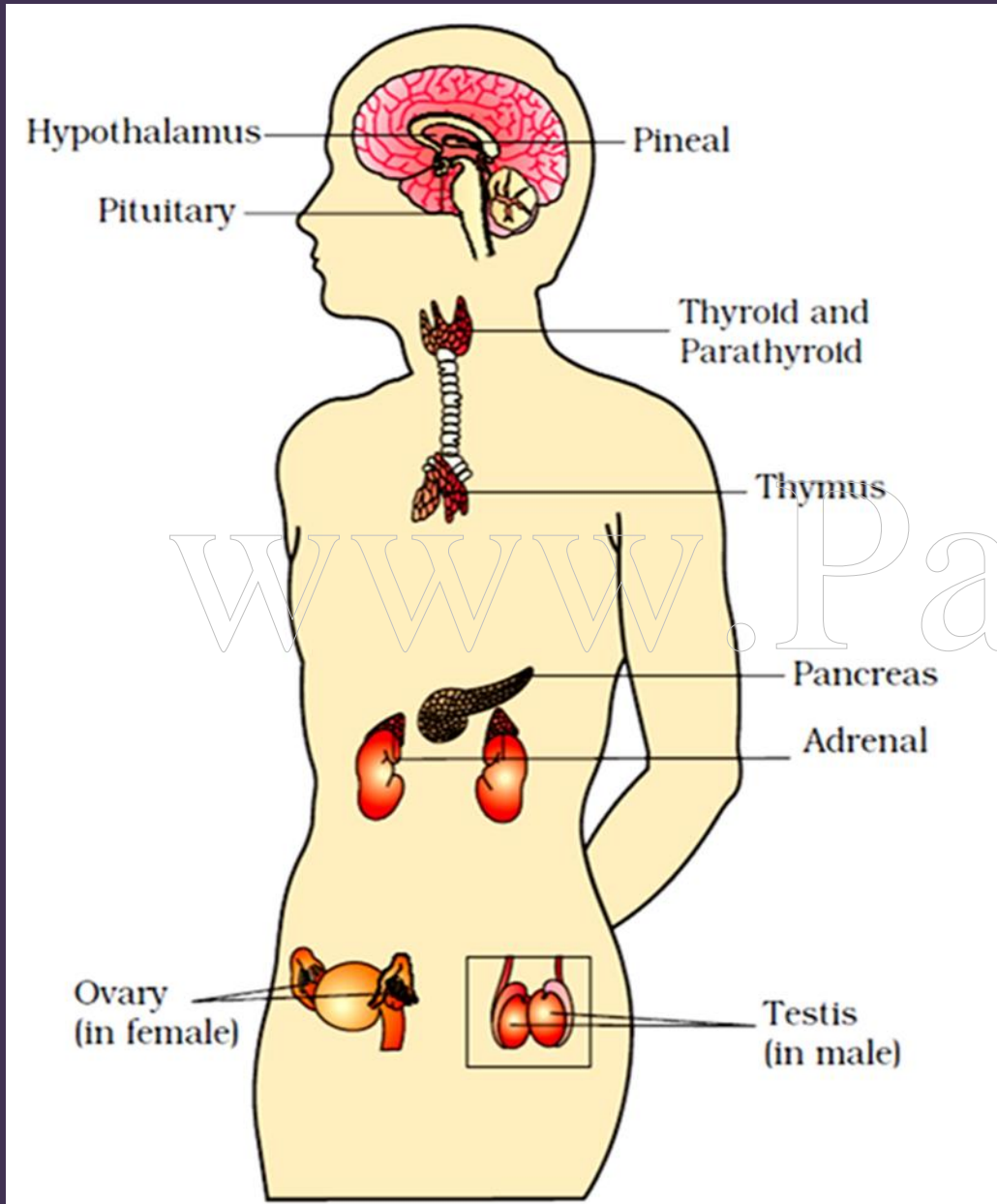


Human endocrine system



- There are two glandular systems such as the **exocrine glands** and the **endocrine glands**.
- The exocrine glands secrete **enzymes, saliva and sweat** and have ducts that carry their substances to the membrane surfaces.
- Example: **salivary gland and gastric gland**.
- The endocrine glands, called **ductless glands** produce **hormones** and lack ducts; they release their hormone to the surrounding **tissue fluid**.
- The hormones circulate around the body and eventually reach the **target organs**.

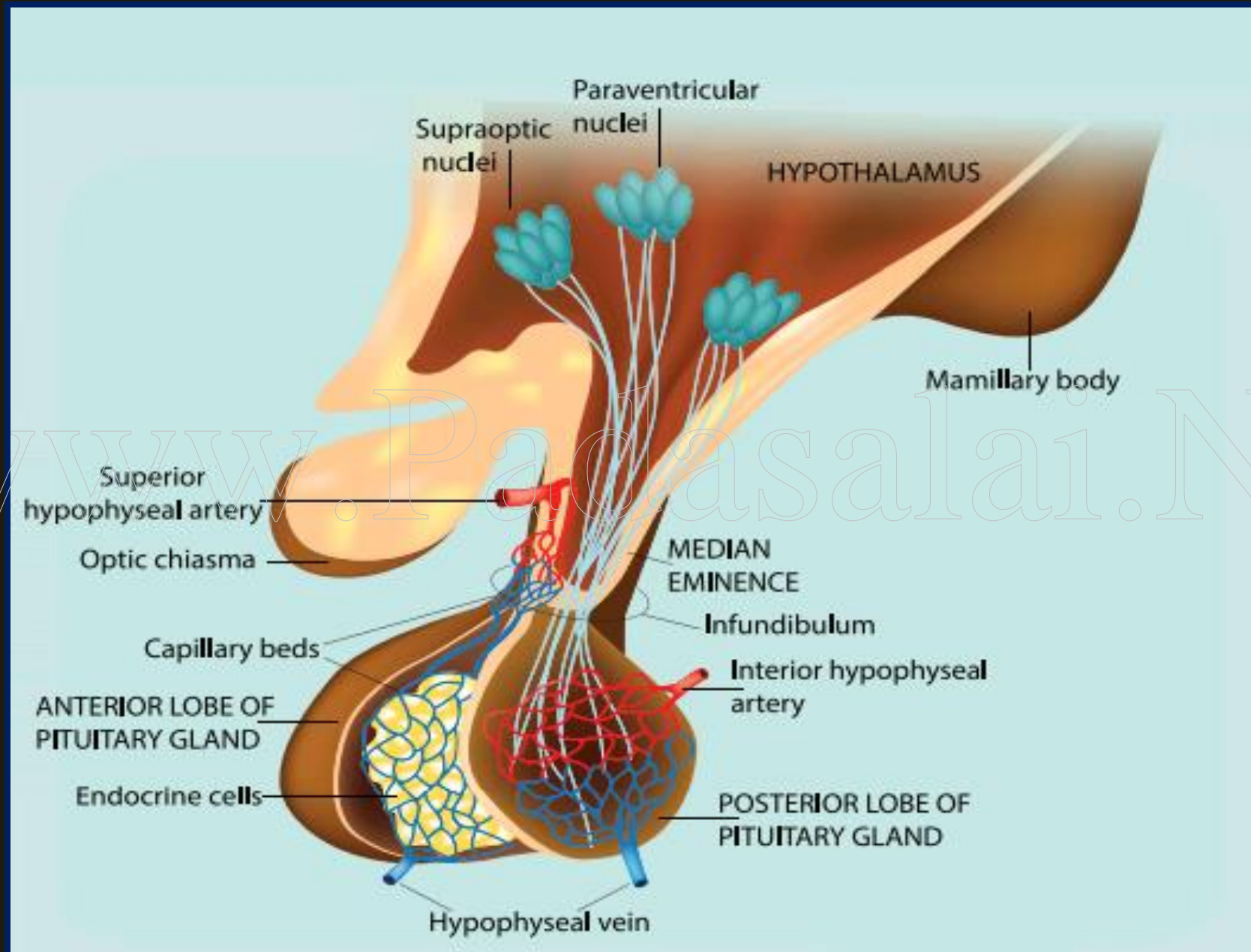
Human endocrine system



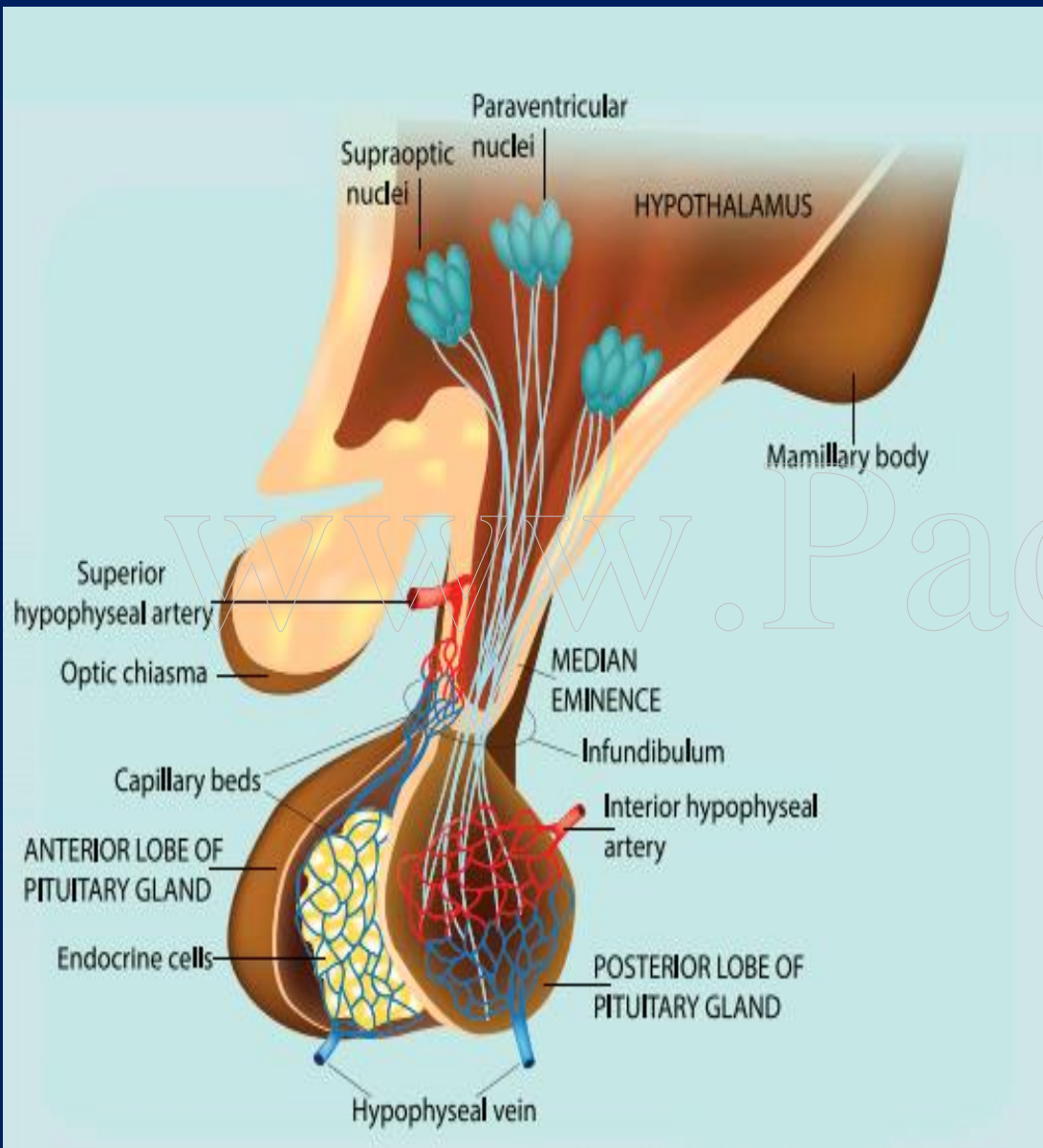
- Endocrine glands include the **pituitary, thyroid, parathyroid, pineal, adrenal, thymus** and are also known as **exclusive endocrine glands**.
- The hypothalamus along with its neural function also produces hormones and is considered as a **neuro endocrine gland**.
- In addition several organs such as **pancreas, gastro intestinal tract epithelium, kidney, heart, gonads and placenta** are also have endocrine tissues and are known as **partial endocrine glands**.

Homeostasis: Maintenance of constant internal environment of the body by the different coordinating system.

hypothalamus

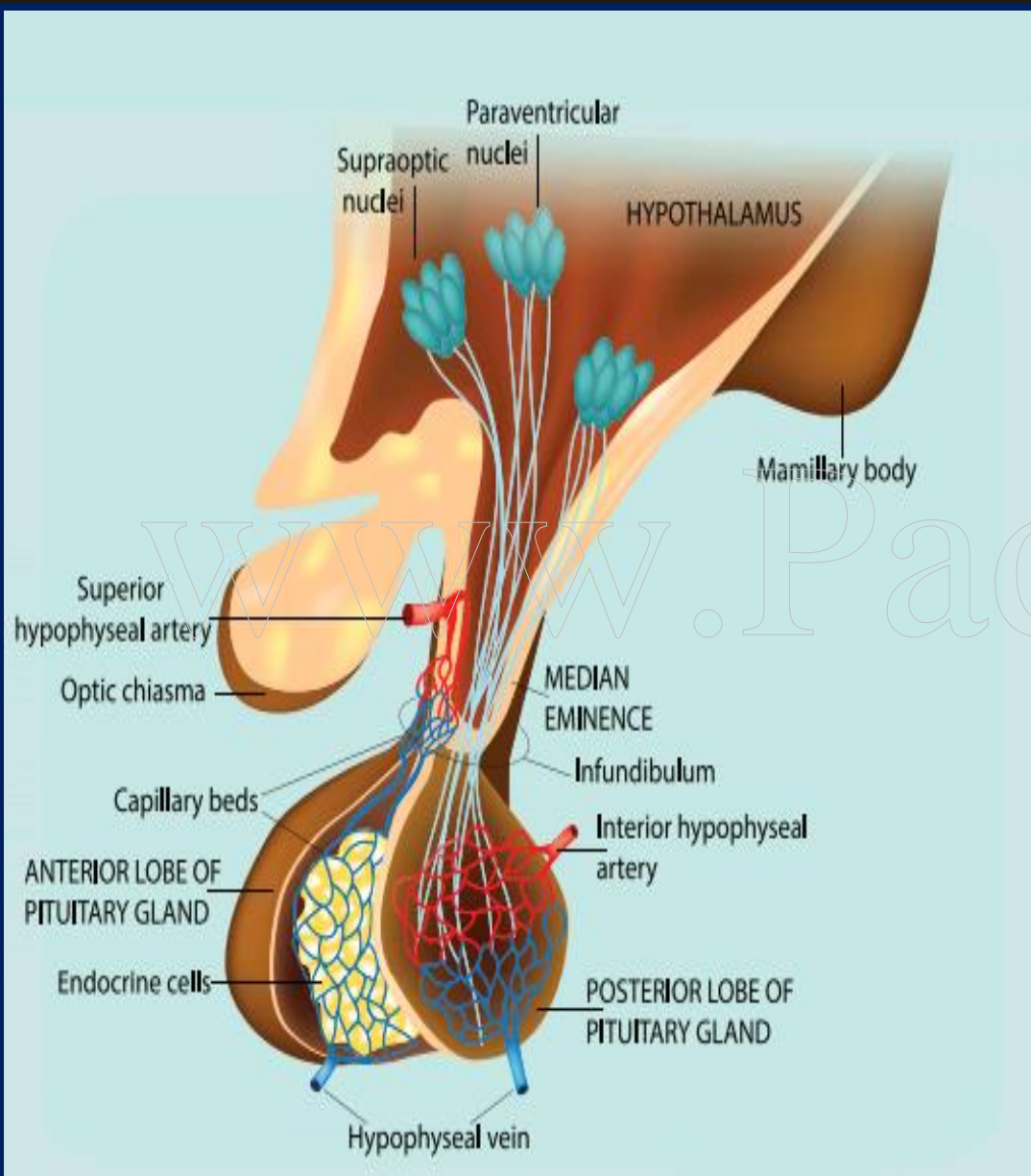


HYPOTHALAMUS



- Hypothalamus is a small **cone shaped** structure that projects downward from the brain ending into the **pituitary stalk**.
- It interlinks both the **nervous system and endocrine system**.
- Though pituitary gland is known as **master endocrine glands** that **controls the other endocrine glands**, but it is, in turn controlled by the **hypothalamus**.
- Hypothalamus contains groups of **neurosecretory cells**.
- It produces neurotransmitters which regulate the **secretions of the pituitary**.
- The hormones produced by the hypothalamus act **either as a releasing hormone or as an inhibitory hormone**.

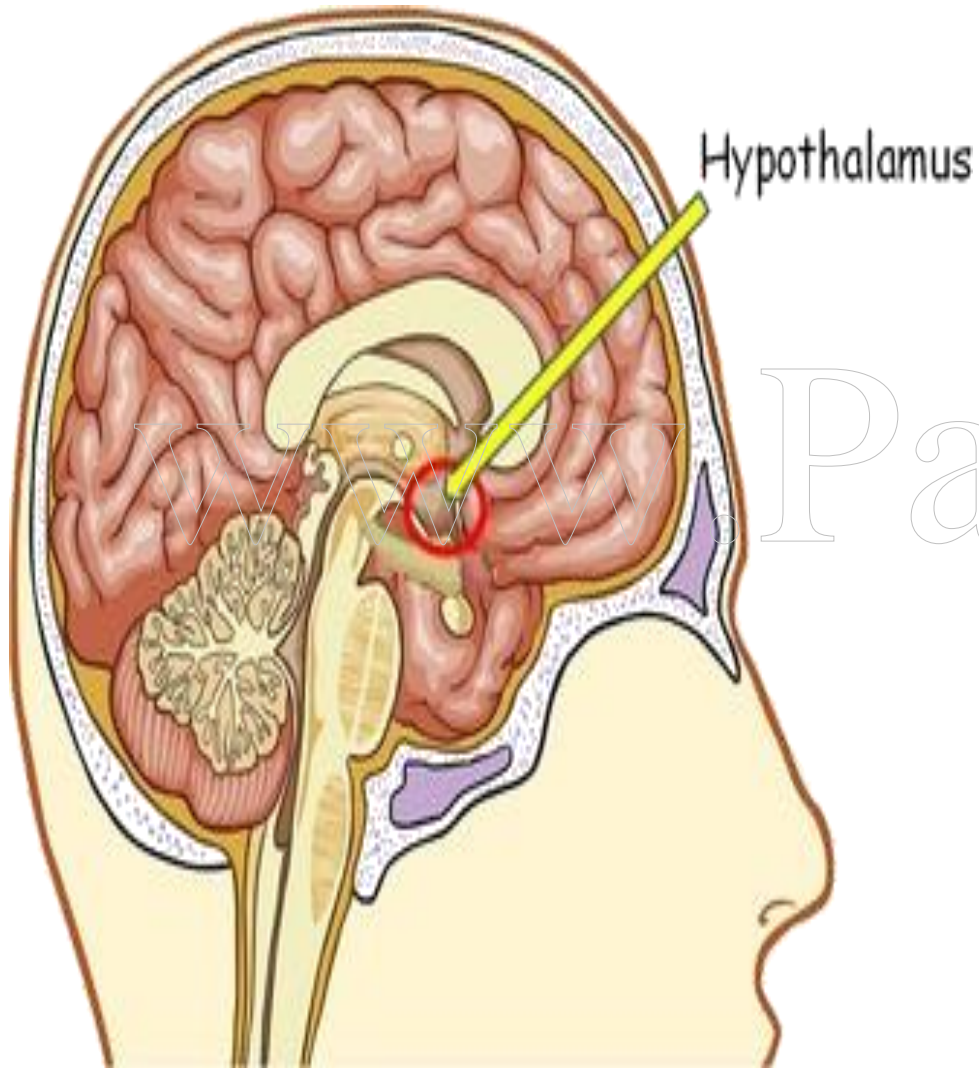
HYPOTHALAMUS



- In the basal region of the brain, the hypothalamic hypophyseal portal blood vessel connects hypothalamus and **anterior pituitary**.
- It allows hypothalamic hormones to control **anterior pituitary secretion**.
- The posterior pituitary is connected with hypothalamus by a nerve bundle called **hypothalamic hypophyseal axis**.
- It produces nerve signal that control the **posterior pituitary secretion**.
- Hypothalamus maintains **homeostasis, blood pressure, body temperature, cardio and fluid electrolyte balance** of the body.
- As the part of limbic system it **influences various emotional responses**.

HUMAN ENDOCRINE SYSTEM

1. HYPOTHALAMUS

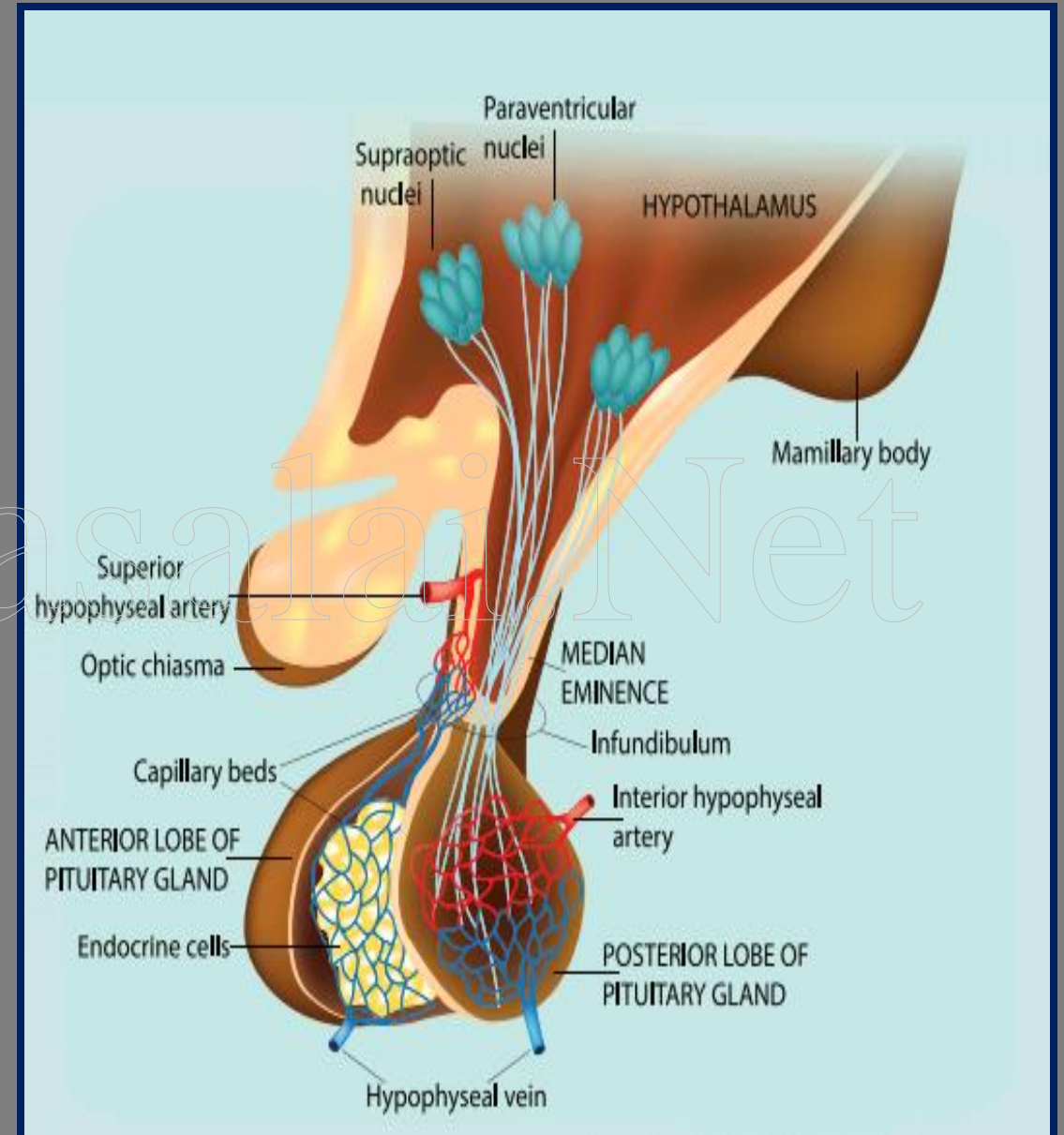
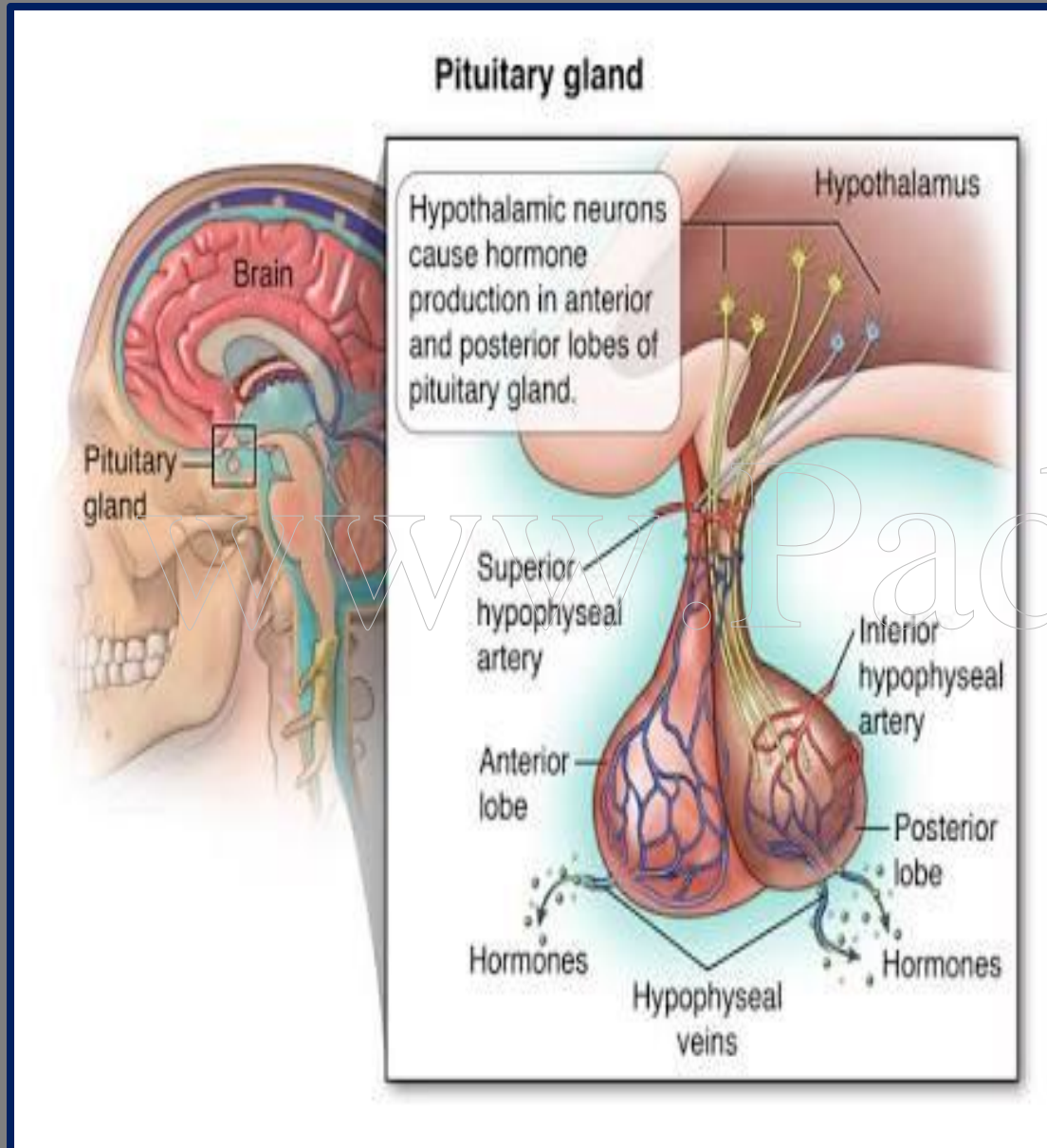


- **Neurosecretory cells (nuclei) of hypothalamus secrete the following types of hormones:**
 - **Releasing hormones**
 - **Inhibiting hormones**
 - **Oxytocin & vasopressin**

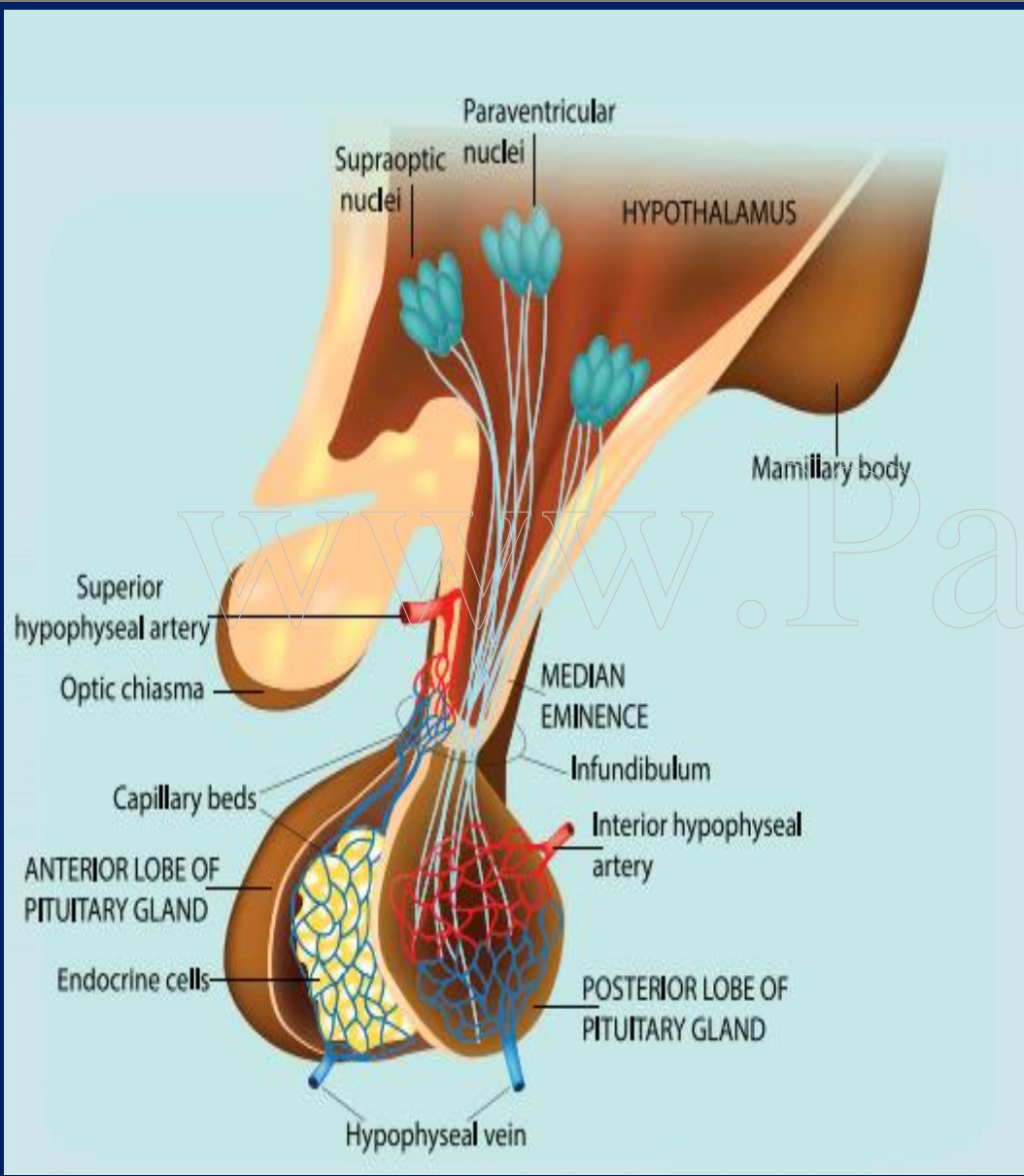
Chemical nature of hormones

Class	Chemical properties	Example
Amines	Small, water soluble derived from tyrosine or tryptophan	Adrenalin, nor adrenalin, melatonin and thyroid hormone
Protein/Peptides	Water soluble	Insulin, glucagon and pituitary hormones
Steroids	Derived from cholesterol mostly lipid soluble	Cortisol, aldosterone, testosterone, oestrogen, progesterone.

Pituitary gland or Hypophysis

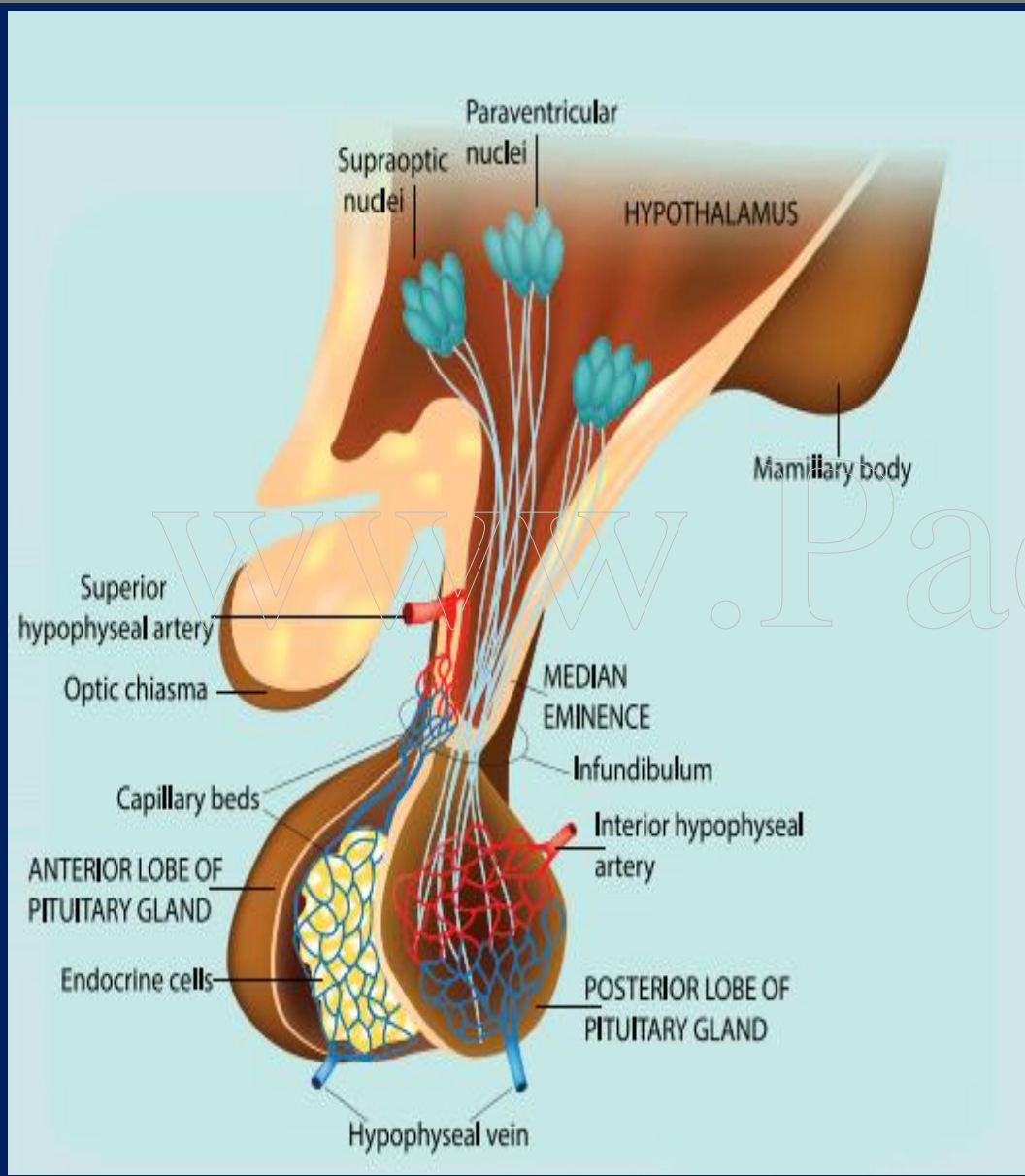


Pituitary gland or Hypophysis



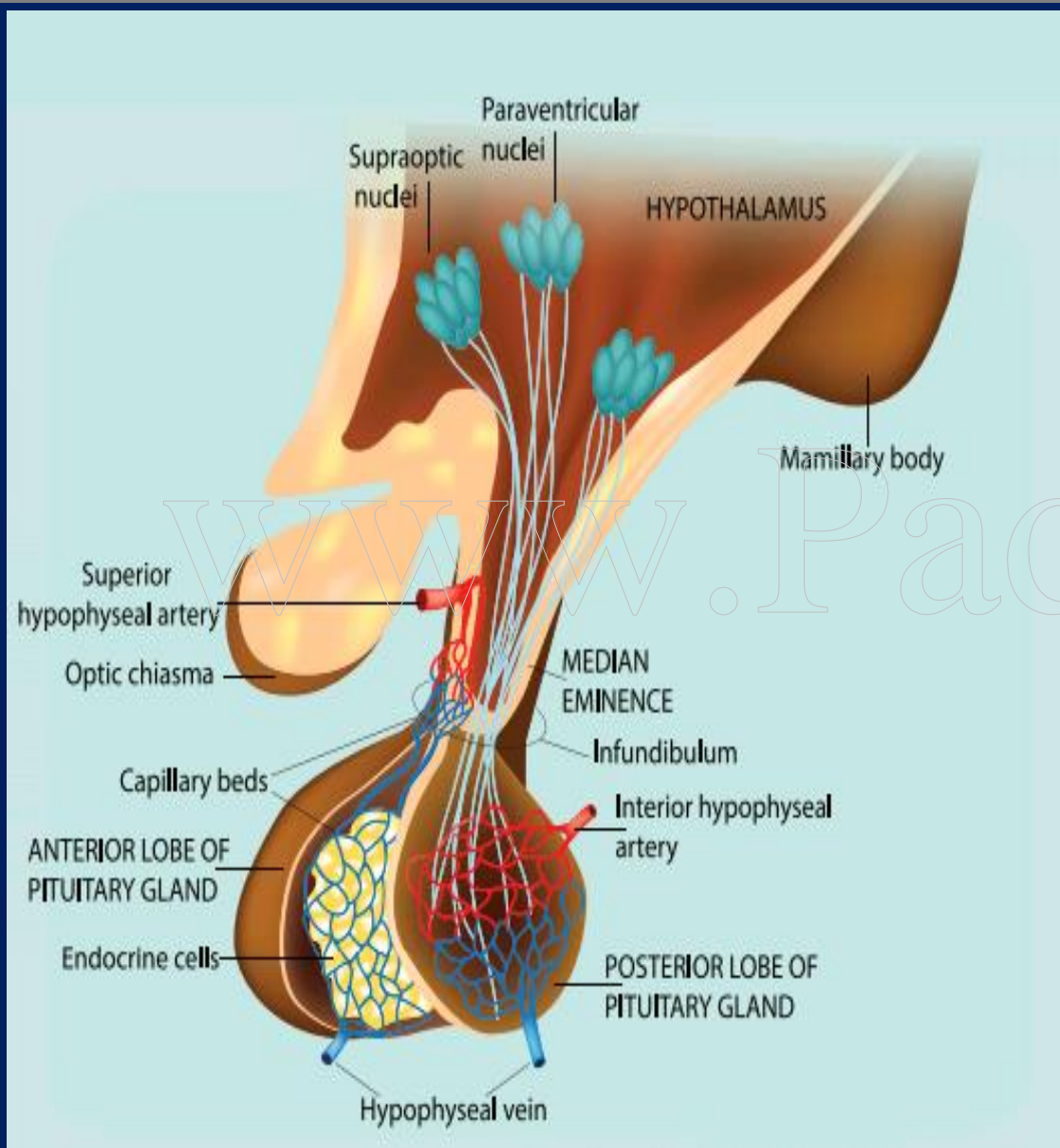
- The pituitary gland is ovoid in shape and is located in the **sella turcica**, a bony cavity of the **sphenoid bone** at the base of brain and connected to the **hypothalamic region of the brain** by a stalk called **infundibulum**.
- It is about one centimetre in diameter and 0.5 gm in weight.
- The pituitary consists of **two lobes**, anterior glandular **adenohypophysis** and posterior neural **neurohypophysis**.

Pituitary gland or Hypophysis



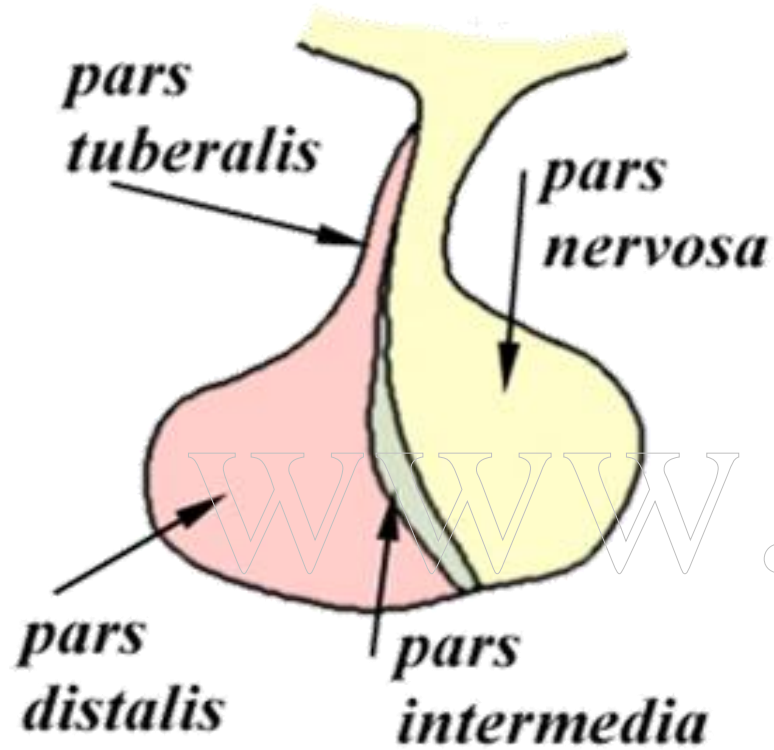
- The anterior lobe originates from the embryonic invagination of pharyngeal epithelium called **Rathke's pouch**.
- The posterior lobe originates from the **base of the brain** as an outgrowth of **hypothalamus**.
- Anatomically the adenohypophysis has **three lobes or zones**.
 1. pars intermedia
 2. pars distalis
 3. pars tuberalis.
- The neurohypophysis is otherwise known as **pars nervosa**.

Pituitary gland or Hypophysis



- The anterior lobe of pituitary secretes **six tropic hormones**.
 1. Growth hormone (GH)
 2. Thyroid stimulating hormone (TSH)
 3. Adreno corticotropic hormone (ACTH)
 4. Follicle stimulating hormone (FSH)
 5. Luteinizing hormone (LH)
 6. Luteotropic hormone (LTH)
- **melanocyte stimulating hormone (MSH)**
 - in lower animals only.
- The posterior lobe of pituitary secretes **two hormones**.
 1. vasopressin
 2. oxytocin.

HUMAN ENDOCRINE SYSTEM



PITUITARY GLAND

i. Pars distalis (Anterior pituitary)

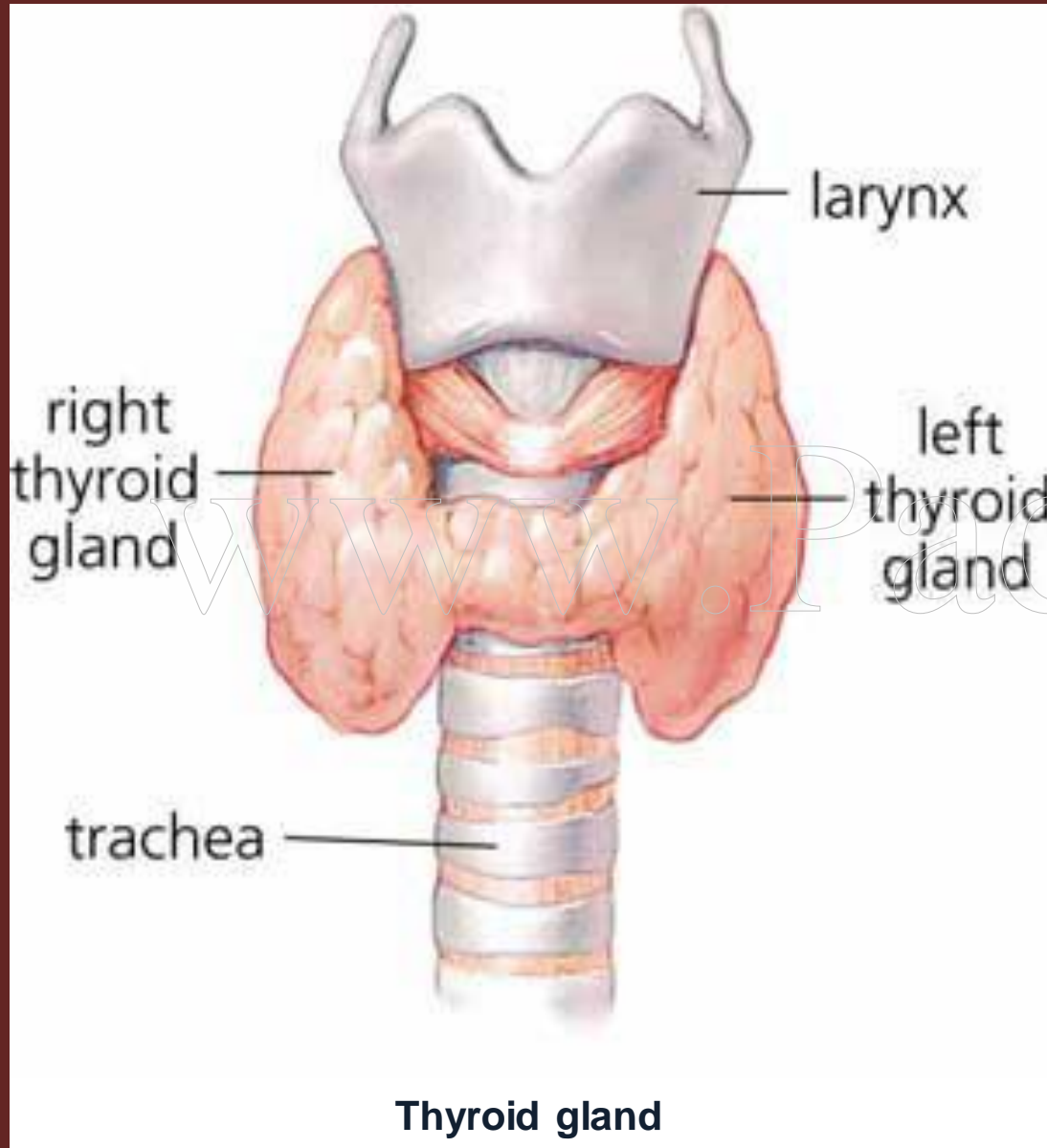
It produces the following hormones:

1. Somatotropin or Growth hormone (GH)
2. Prolactin (PRL)
3. Thyroid stimulating hormone (TSH)
4. Adrenocorticotrophic hormone (ACTH)
5. Luteinizing hormone (LH)
6. Follicle stimulating hormone (FSH)

GROWTH HORMONE – GH

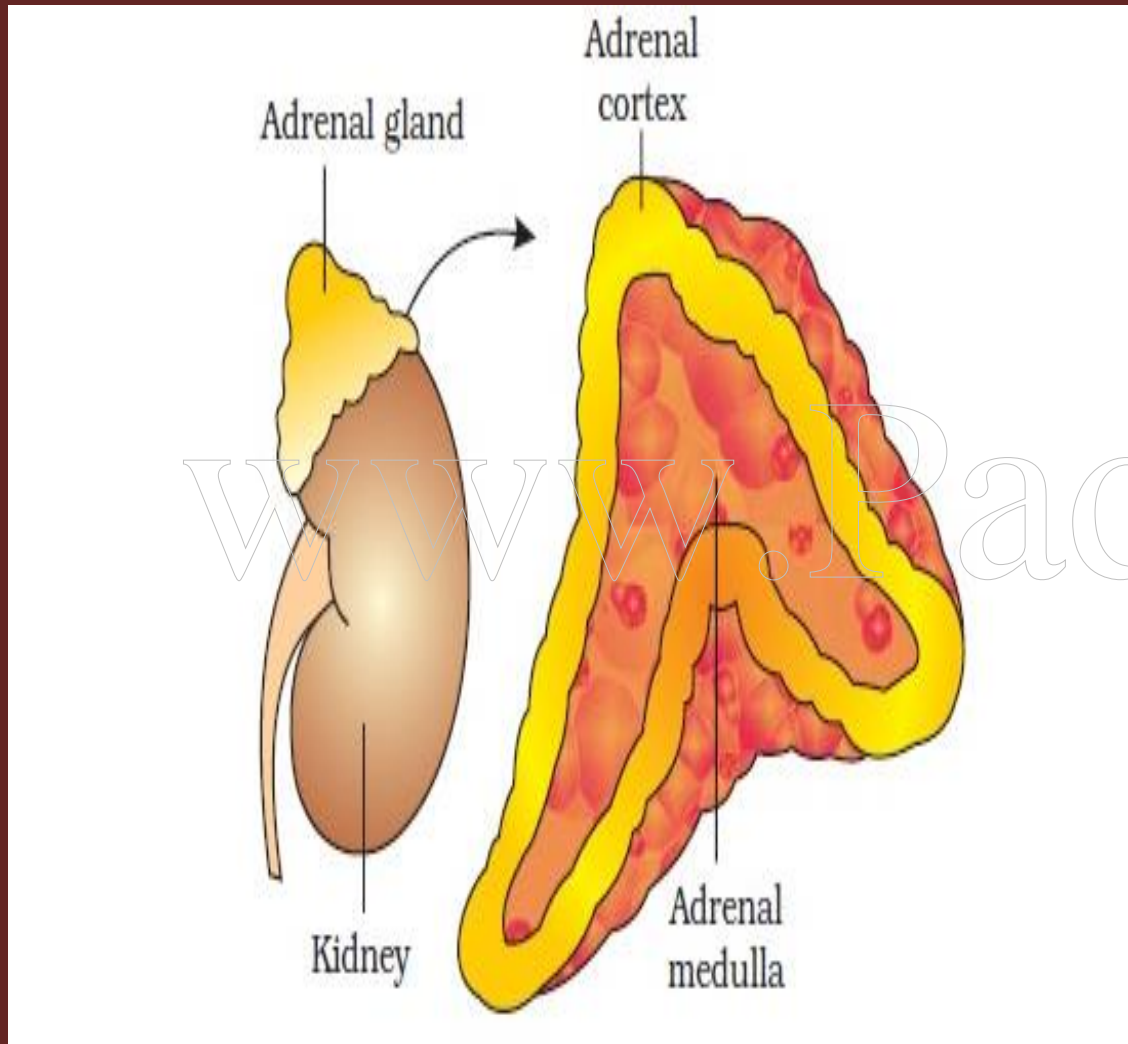
- It is also known as **somatotropic hormone (STH)** or **Somatotropin**.
- It is a **peptide** hormone.
- Growth hormone promotes **growth of all the tissues and metabolic process of the body**.
- It influences the metabolism of **carbohydrates, proteins and lipids and increases the rate of protein biosynthesis** in the cells.
- It stimulates **chondrogenesis** (cartilage formation), **osteogenesis** (bone formation) and helps in the retention of minerals like **nitrogen, potassium, phosphorus, sodium etc.**, in the body.
- GH **increases the release of fatty acid from adipose tissue and decreases the rate of glucose utilization for energy** by the cells.
- Thus it conserves **glucose for glucose dependent tissues**, such as the brain.

THYROID STIMULATING HORMONE (TSH) OR THYROTROPIN



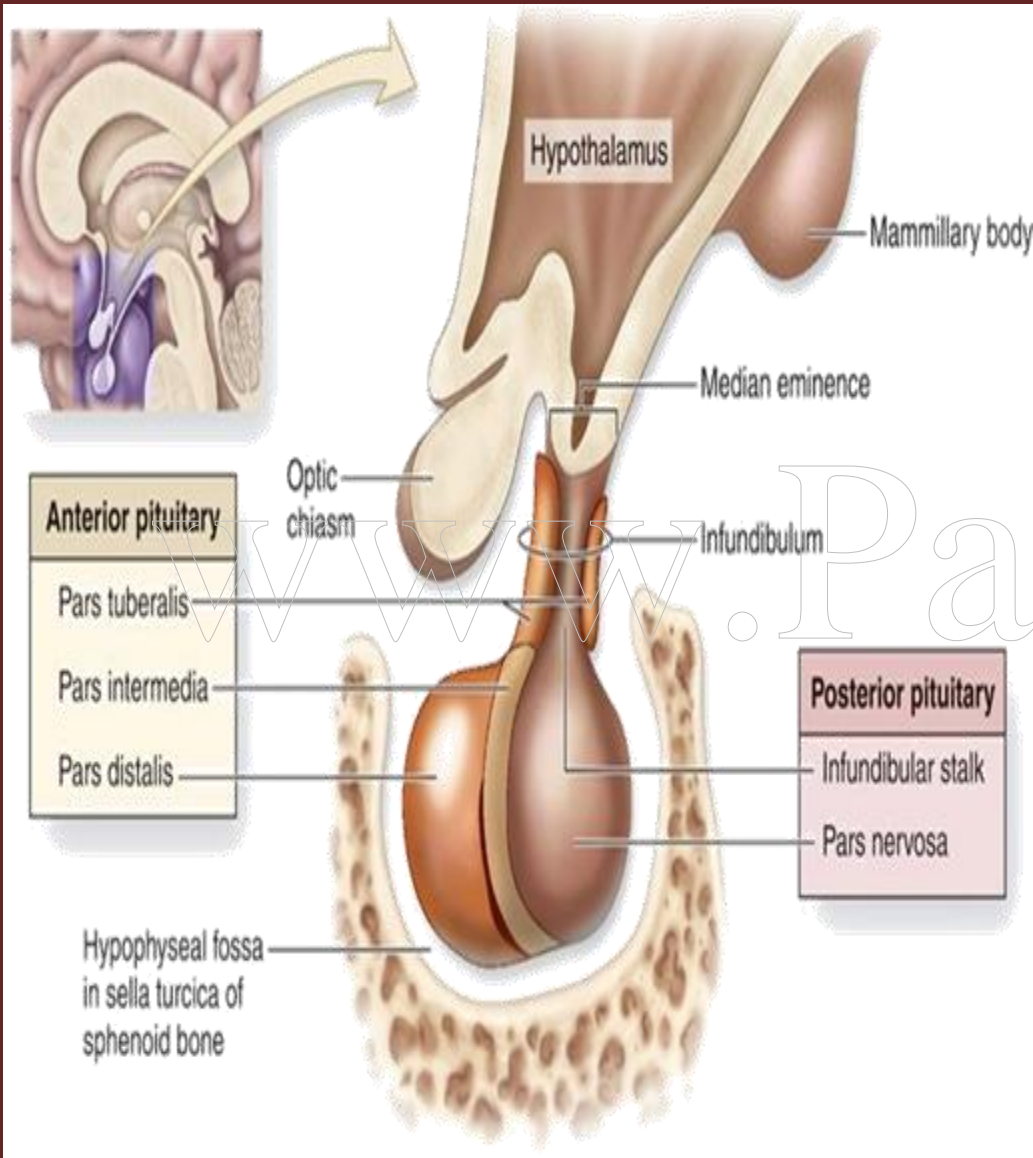
- TSH is a glycoprotein hormone, which stimulates the thyroid gland to secrete **Tri-iodothyronine (T3) and thyroxine (T4)**.
- TSH secretion is regulated by **negative feedback mechanism**.
- Its release from the **anterior pituitary** is induced by the **thyrotropin releasing hormone (TRH)**.
- When **thyroxine level in the blood increases**, TRH acts on both the pituitary and hypothalamus to **inhibit TSH secretion**.

ADRENO CORTICO TROPIC HORMONE(ACTH)



- ACTH is a peptide hormone that stimulates the adrenal cortex to secrete **glucocorticoids and mineralocorticoids**.
- It stimulates melanin synthesis in **melanocytes**, induces the release of **fatty acids from adipose tissues and stimulates insulin secretion**.
- ACTH secretion is regulated by **negative feedback mechanism**.

FOLLICLE STIMULATING HORMONE - FSH

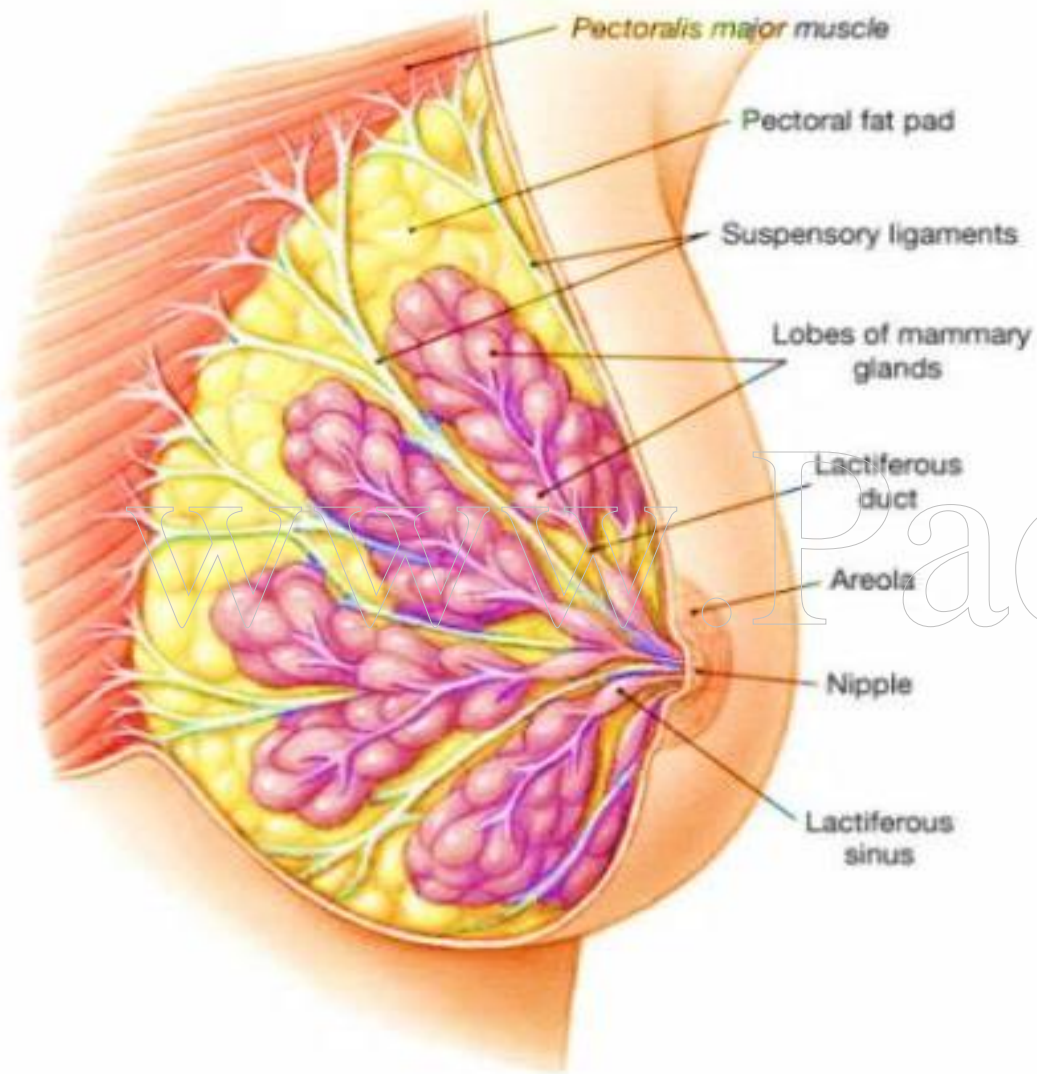


- FSH is a glycoprotein hormone which **regulates the functions of the gonads** (ovary and testis).
- In males, FSH along with androgens acts on the germinal epithelium of seminiferous tubules and stimulates the **production and release of sperms (spermatogenesis)**.
- In females, FSH acts on the ovaries and brings about the **development and maturation of graffian follicles**.

LUTEINIZING HORMONE - LH

- LH is a glycoprotein hormone which is also known as **interstitial cell stimulating hormone (ICSH)**.
- In males, ICSH acts on the interstitial cells of testis to produce the male sex hormone, **testosterone**.
- In females, LH along with FSH **matures the ovarian follicles**.
- LH independently induces **ovulation**, maintains the corpus luteum and promotes synthesis and release of **ovarian hormones**.
- FSH and LH are collectively referred as **gonadotropins**.
- FSH and LH are not produced **during childhood**.
- The secretion of FSH and LH starts only during **pre pubertal period**.

LUTEOTROPIC HORMONE - LTH



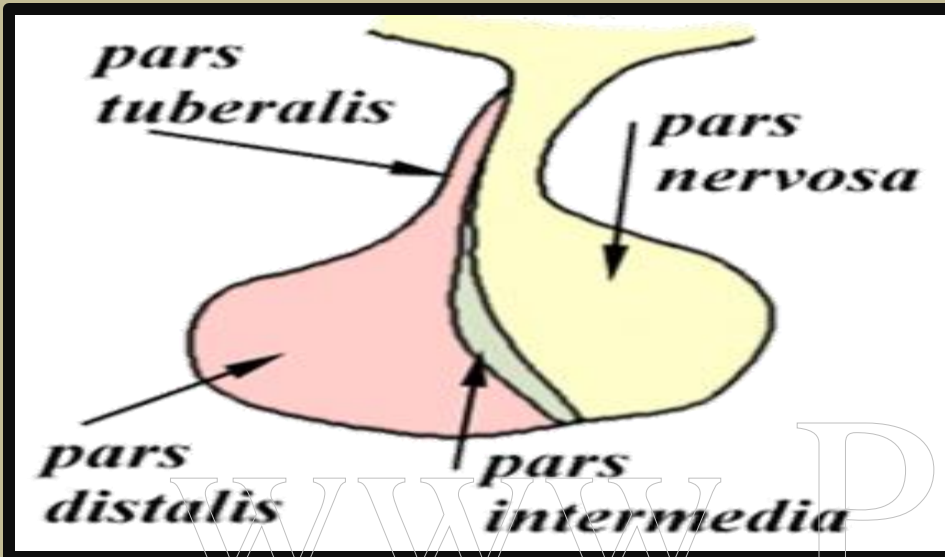
Mammary gland

- LTH is also called **luteotropin** or **lactogenic hormone** or **prolactin** or **mammotropin**.
- It is a **protein hormone** which **stimulates milk secretion** after the child birth in females.
- High **prolactin secretion** during lactation **suppresses LH secretion and ovulation** since it induces the **corpus luteum** hence named as **luteotropic hormone**.

THE MAJOR HYPOTHALAMIC HORMONES AND THEIR FUNCTIONS

S.No.	Hormones	Functions
1.	Thyrotropin releasing hormone (TRH)	Stimulates the secretion of TSH
2.	Gonadotropin releasing hormone(GnRH)	Stimulates the secretion of FSH
3.	Corticotropin releasing hormone (CRH)	Stimulates the secretion of ACTH
4.	Growth hormone releasing hormone (GHRH)	Stimulates the secretion of GH
5.	Prolactin releasing hormone (PRH)	Stimulates the secretion of Prolactin
6.	Luteinizing hormone releasing hormone (LHRH)	Stimulates the secretion of LH
7.	MSH releasing hormone	Stimulates the secretion of MSH
8.	Growth hormone-inhibiting hormone (GHIH)	Inhibits the secretion of GH
9.	Prolactin inhibiting hormone (PIH)	Inhibits the secretion of Prolactin
10.	MSH inhibiting hormone	Inhibits the secretion of MSH

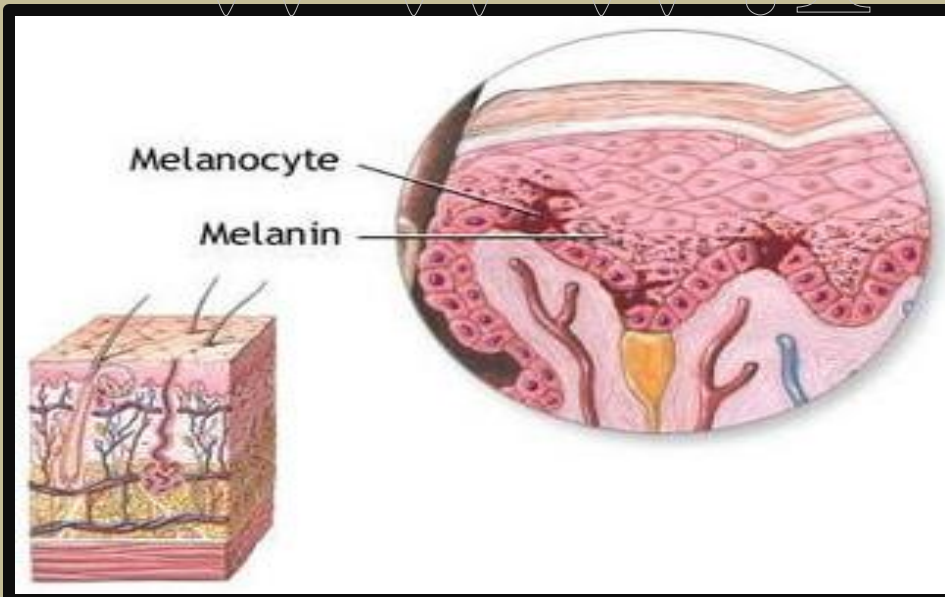
HUMAN ENDOCRINE SYSTEM



2. PITUITARY GLAND

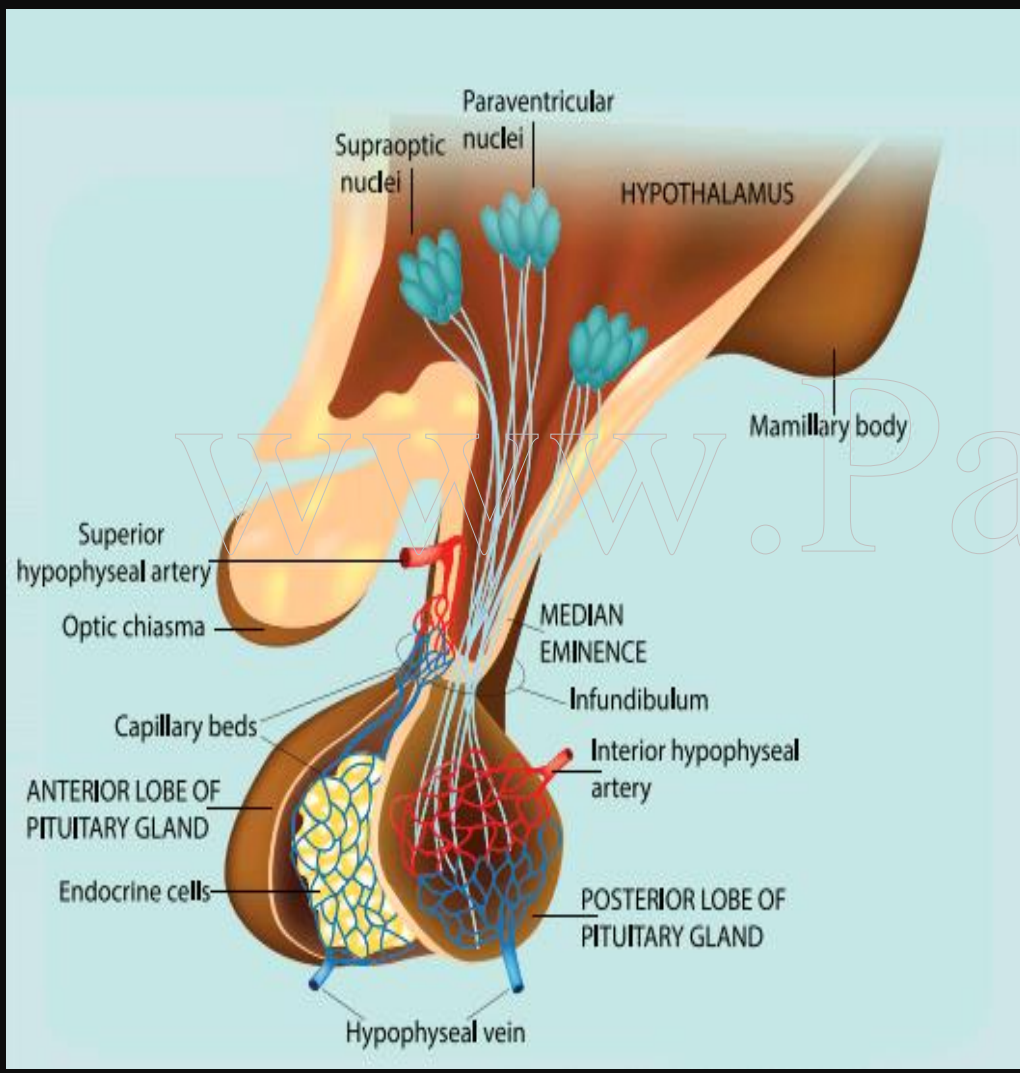
ii. Pars intermedia

- In human, it is almost merged with pars distalis.
- It produces **Melanocyte stimulating hormone (MSH)**.
- MSH acts on melanocytes to regulate pigmentation of skin.



- In mammals, the role of pars intermedia is insignificant, but in other vertebrates it secretes **melanocyte stimulating hormone (MSH)**. MSH induces pigmentation in skin.

Pituitary gland or Hypophysis



Pituitary gland is located in a depression in the sphenoid bone of skull below the brain, so is also called hypothalamus cerebri. Discuss the following :

- Pituitary gland is commonly called “master gland” of the body.
- Discuss the role of hypothalamus and pituitary as a coordinated unit in maintaining physiological processes.
- How does the posterior lobe of pituitary help in osmoregulation?

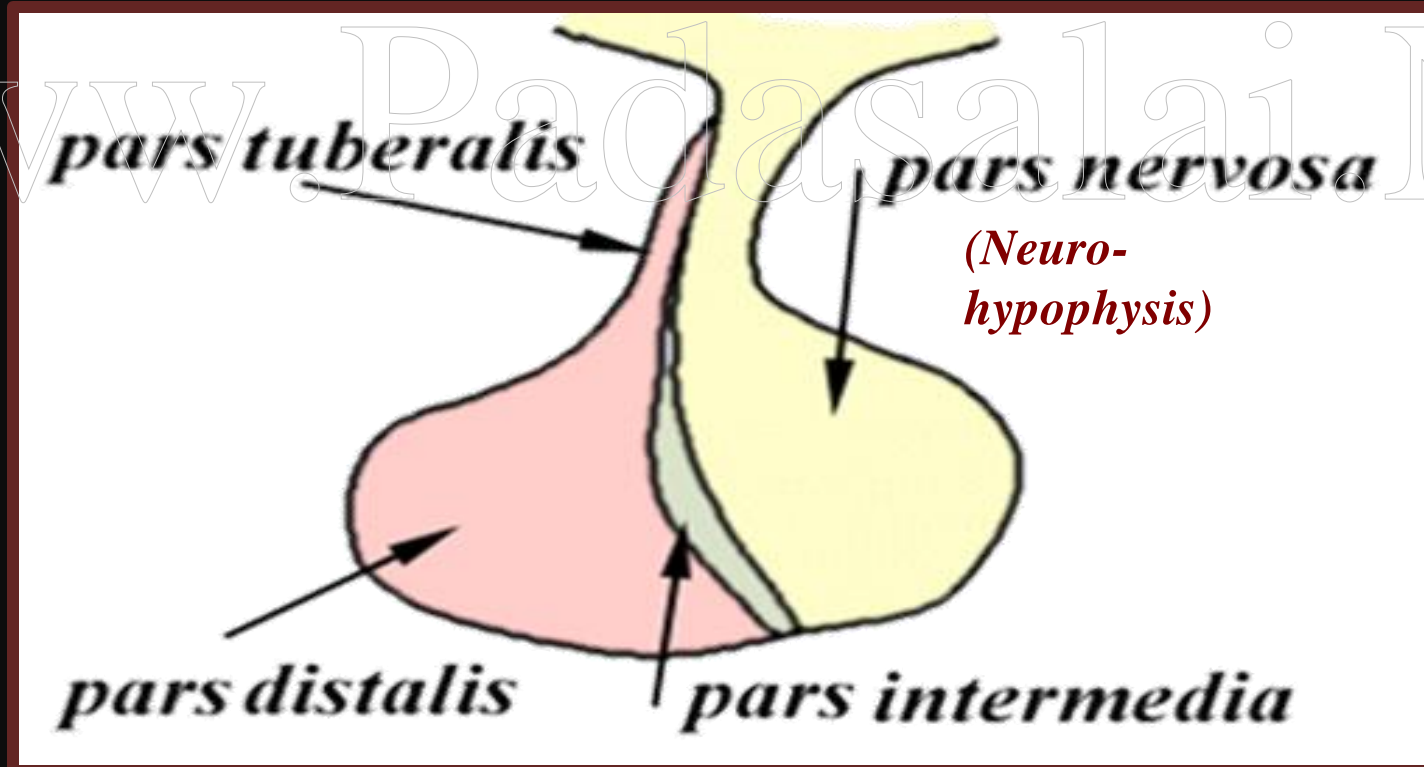
Vasopressin and oxytocin are composed of nine amino acids and are almost identical and they differ in only two amino acids and yet they have dramatically different physiological effects.

Amino acid sequence of vasopressin: cysteine-tyrosine-phenyl alanine-glutamine-asparagine-cysteine-proline-arginine-glycine.

Amino acid sequence of oxytocin: cysteine-tyrosine-isoleucine-glutamine-asparagine-cysteine-proline-leucine-glycine.

HORMONES OF NEUROHYPOPHYSIS

1. Vasopressin or antidiuretic hormone (ADH)
2. Oxytocin (means quick birth)



VASOPRESSIN OR ANTIDIURETIC HORMONE (ADH)

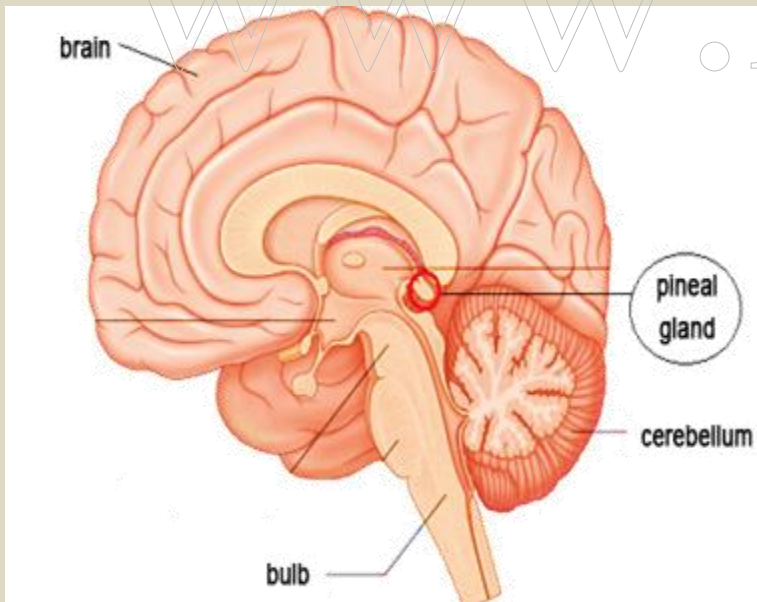
- ADH is a **peptide hormone**.
- Which promotes reabsorption of water and electrolytes by distal tubules of nephron and there by **reduces loss of water through urine**.
- Hence it is called as **anti diuretic hormone**.
- It also causes constriction of blood vessels when released in large amount and **increases blood pressure**.
- ADH deficiency causes ***Diabetes insipidus*** which induces the production of **large amount of urine**.

OXYTOCIN - (MEANS QUICK BIRTH)

- It is a **peptide hormone** which stimulates vigorous **contraction of the smooth muscles of uterus during child birth** and **ejection of milk from the mammary glands**.



PINEAL GLAND

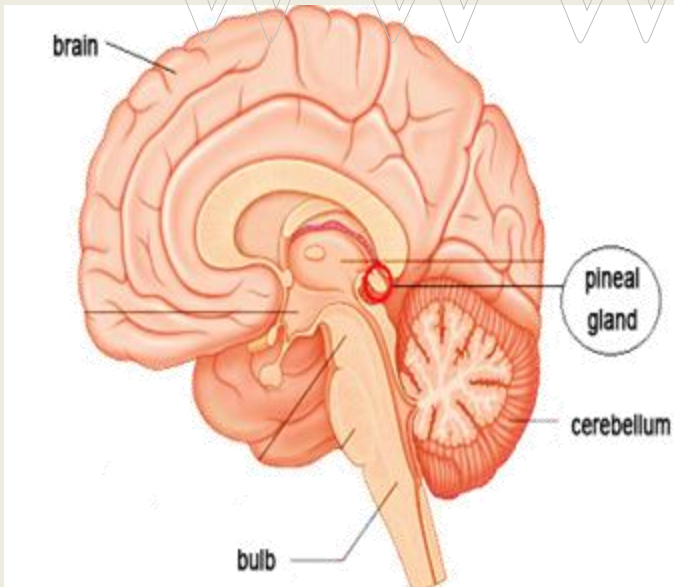


- It is located on dorsal side of forebrain.
- It secretes **melatonin**.

Functions of melatonin:

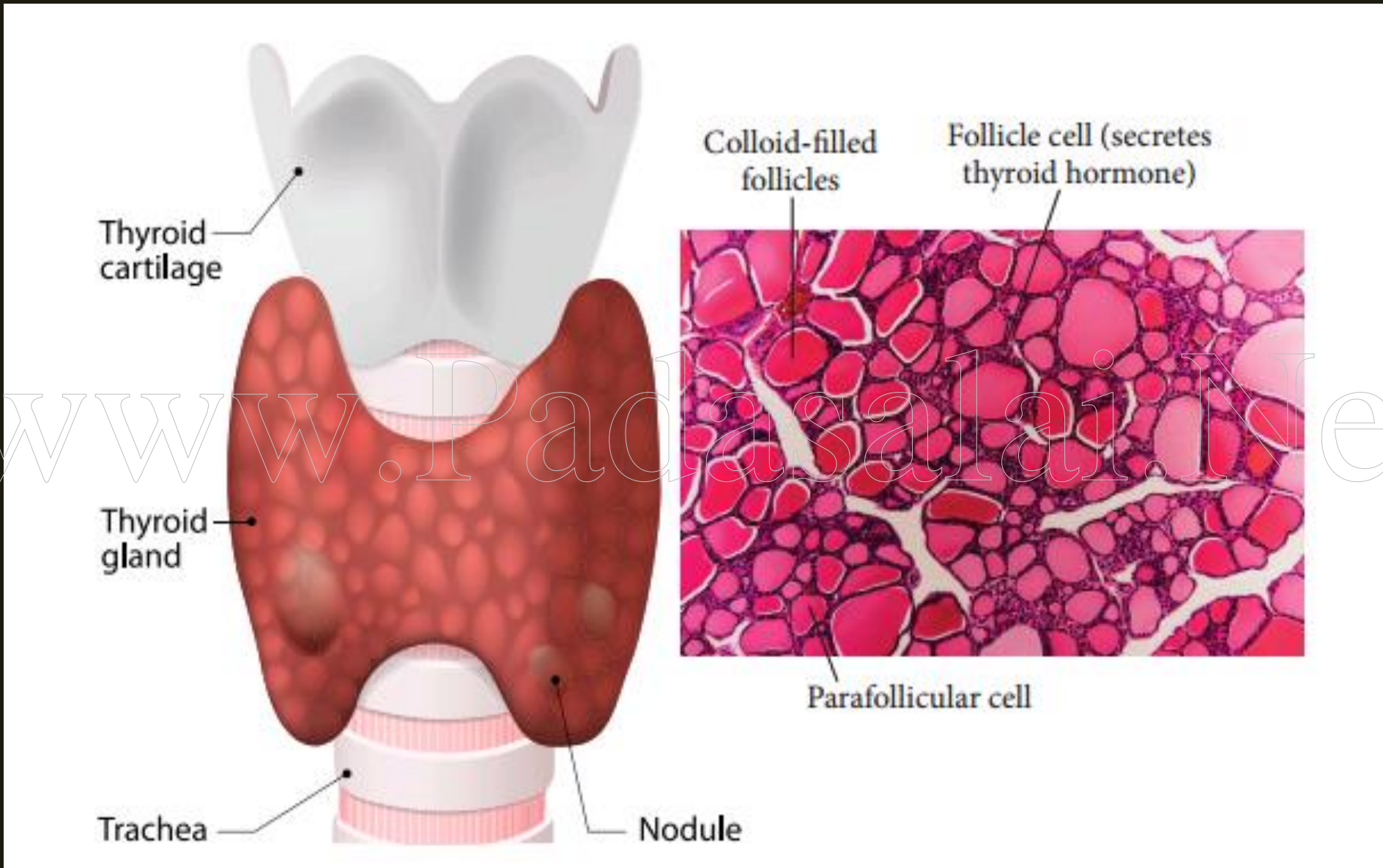
- **Regulates diurnal (24-hour) rhythm of body.**
- **E.g. maintenance of sleep-wake cycle, body temperature etc.**
- **Influences metabolism, pigmentation & menstrual cycle.**
- **Influences our defense capability.**

PINEAL GLAND

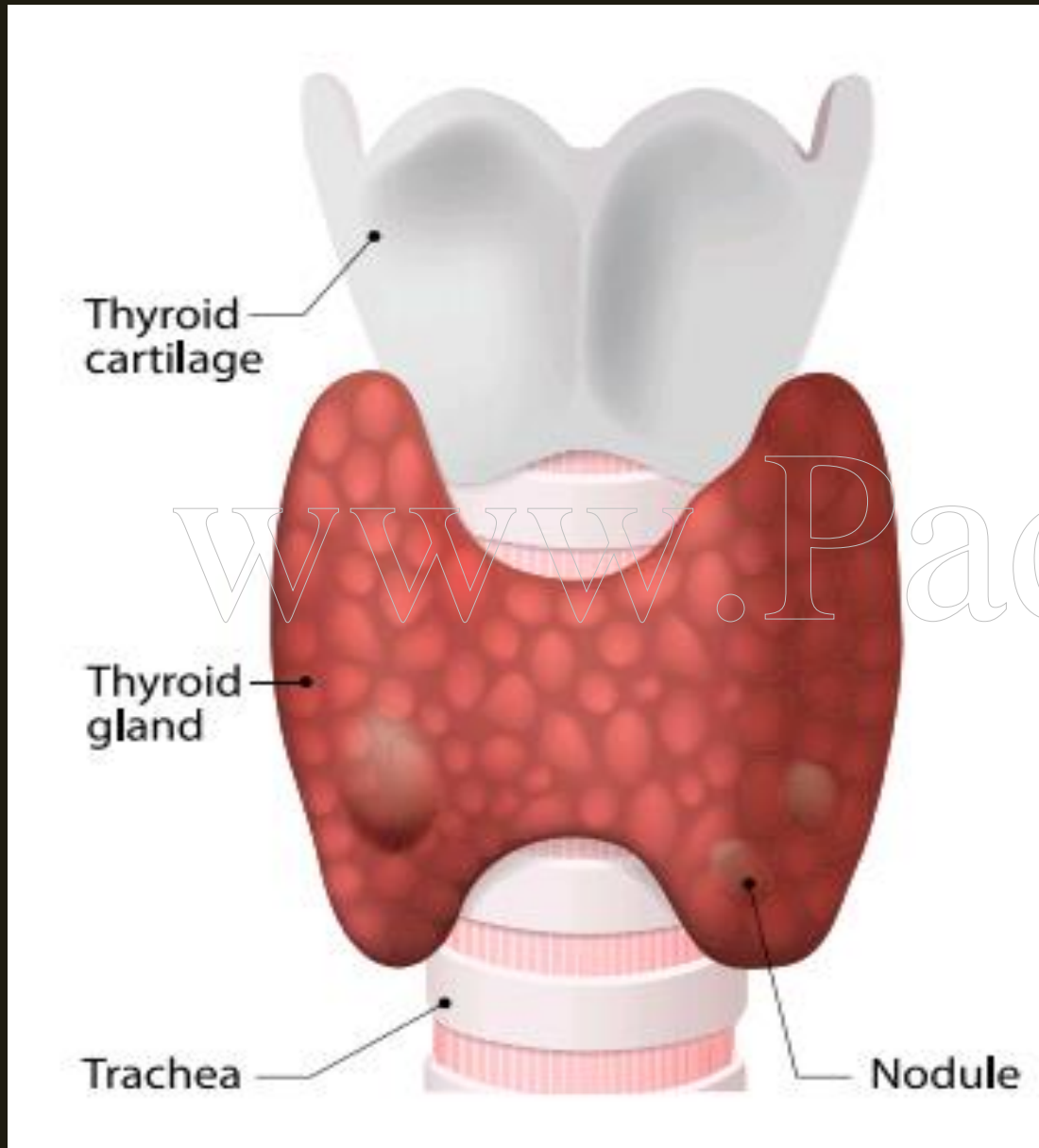


- In human, the **pineal gland or epiphysis cerebri or conarium** is located behind the third ventricle of brain and is formed of **parenchymal cells and interstitial cells**.
- It secretes the hormone, **melatonin**, which plays a central role in the regulation of circadian rhythm of our body and maintains the **normal sleep wake cycle**.
- It also regulates the timing of **sexual maturation of gonads**.
- In addition melatonin also influences **metabolism, pigmentation, menstrual cycle and defence mechanism of our body**.

THYROID GLAND

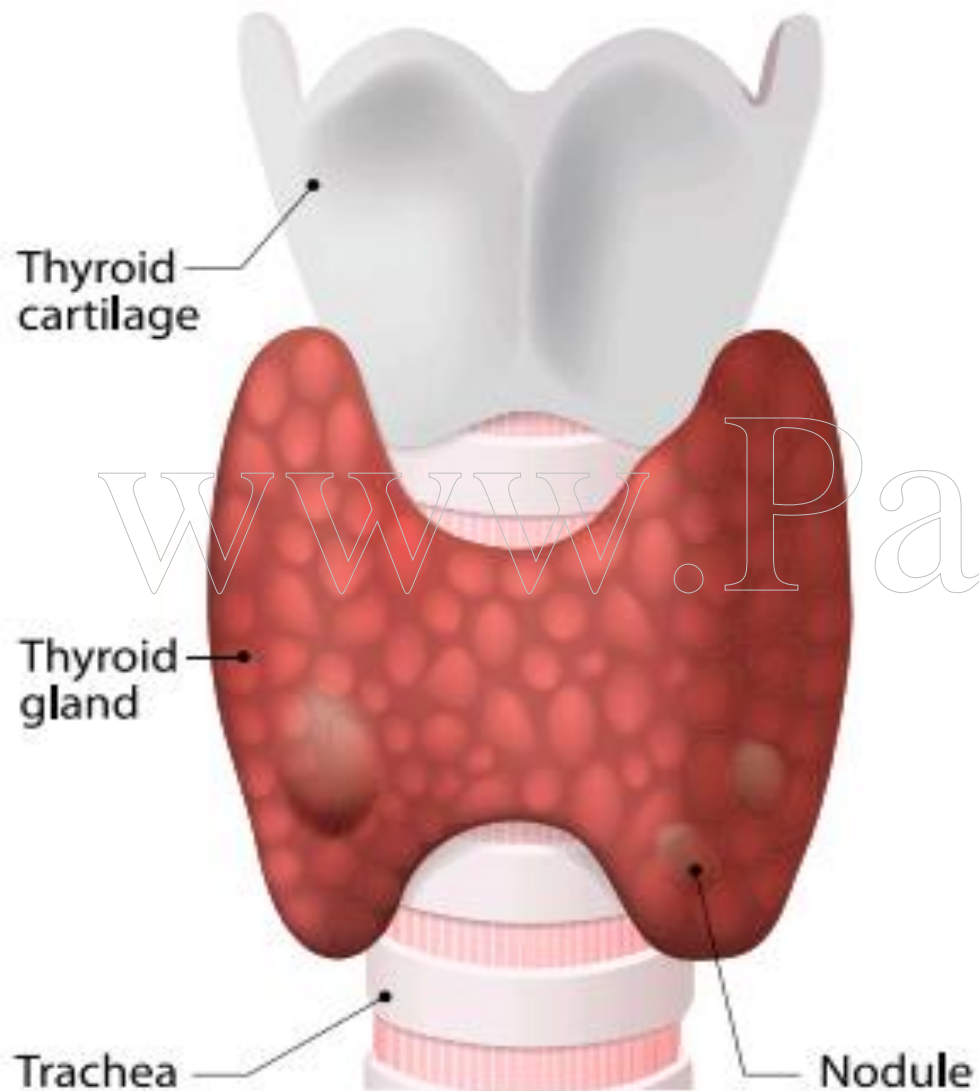


THYROID GLAND



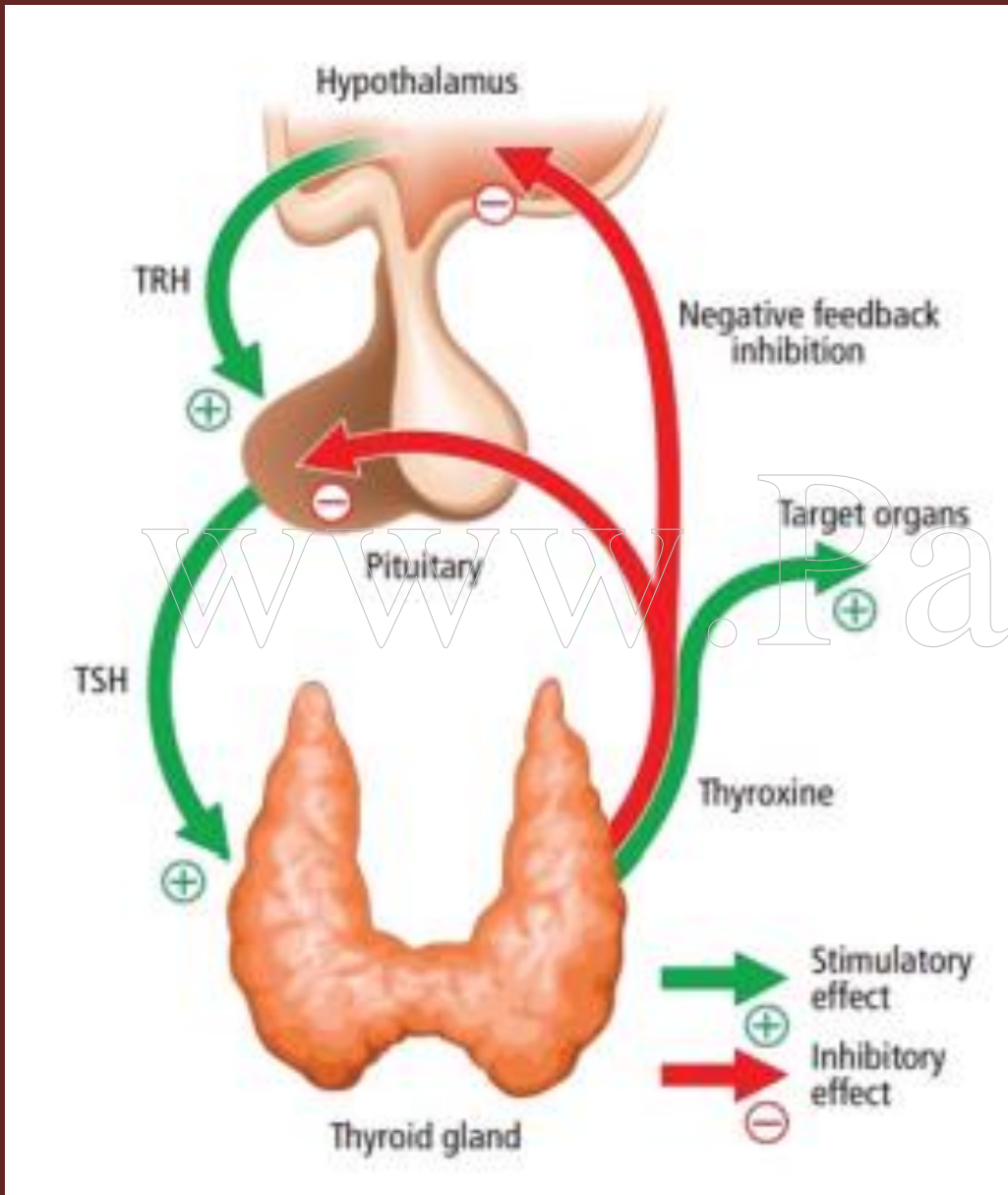
- The **butterfly shaped thyroid gland** is a bilobed gland located below the larynx on each side of upper trachea.
- It is the **largest endocrine gland** in the body.
- Its two lateral lobes are connected by a median tissue mass called **isthmus**.
- Each lobe is made up of **many lobules**.
- The lobules consist of follicles called **acini** (acinus in singular).
- Each acinus is lined with **glandular, cuboidal or squamous epithelial cells**.
- The lumen of acinus is filled with colloid, a thick glycoprotein mixture consisting of **thyroglobulin molecules**.

THYROID GLAND



- Hormones of the thyroid gland are often called the **major metabolic hormones**.
- The follicular cells of thyroid gland secrete two hormones namely **tri-iodothyronine (T3)** and **thyroxine or tetra-iodothyronine (T4)**.
- The parafollicular cells or 'C' cells of thyroid gland secrete a hormone called **thyrocalcitonin**.
- **Iodine is essential** for the normal synthesis of thyroid hormones.

THYROID GLAND



- **Thyroid releasing hormone from the hypothalamus stimulates the adenohypophysis to secrete TSH, which inturn stimulates the thyroid gland to secrete the thyroid hormones.**
- **Thyroid hormones show a negative feedback effect on the hypothalamus and pituitary.**

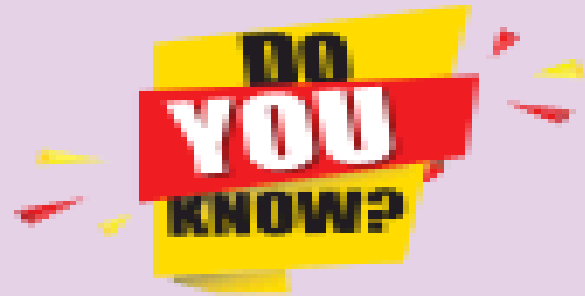
FUNCTIONS OF THYROXINE OR TETRAIODOTHYRONINE -T4

- Thyroxine **regulates the basal metabolic rate (BMR) and body heat production.**
- It stimulates **protein synthesis and promotes growth.**
- It is essential for the **development of skeletal and nervous system.**
- Thyroxine plays an important role in **maintaining blood pressure.**
- It **reduces serum cholesterol levels, Optimum levels of thyroxine in blood is necessary for gonadial functions.**

FUNCTIONS OF THYROCALCITONIN -TCT

- TCT is a **polypeptide hormone**, which regulates the **blood calcium and phosphate levels**.
- It reduces the **blood calcium level and opposes the effects of parathyroid hormone**.

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Melatonin is secreted at night, Light falling on the retina of eye decreases melatonin

production.

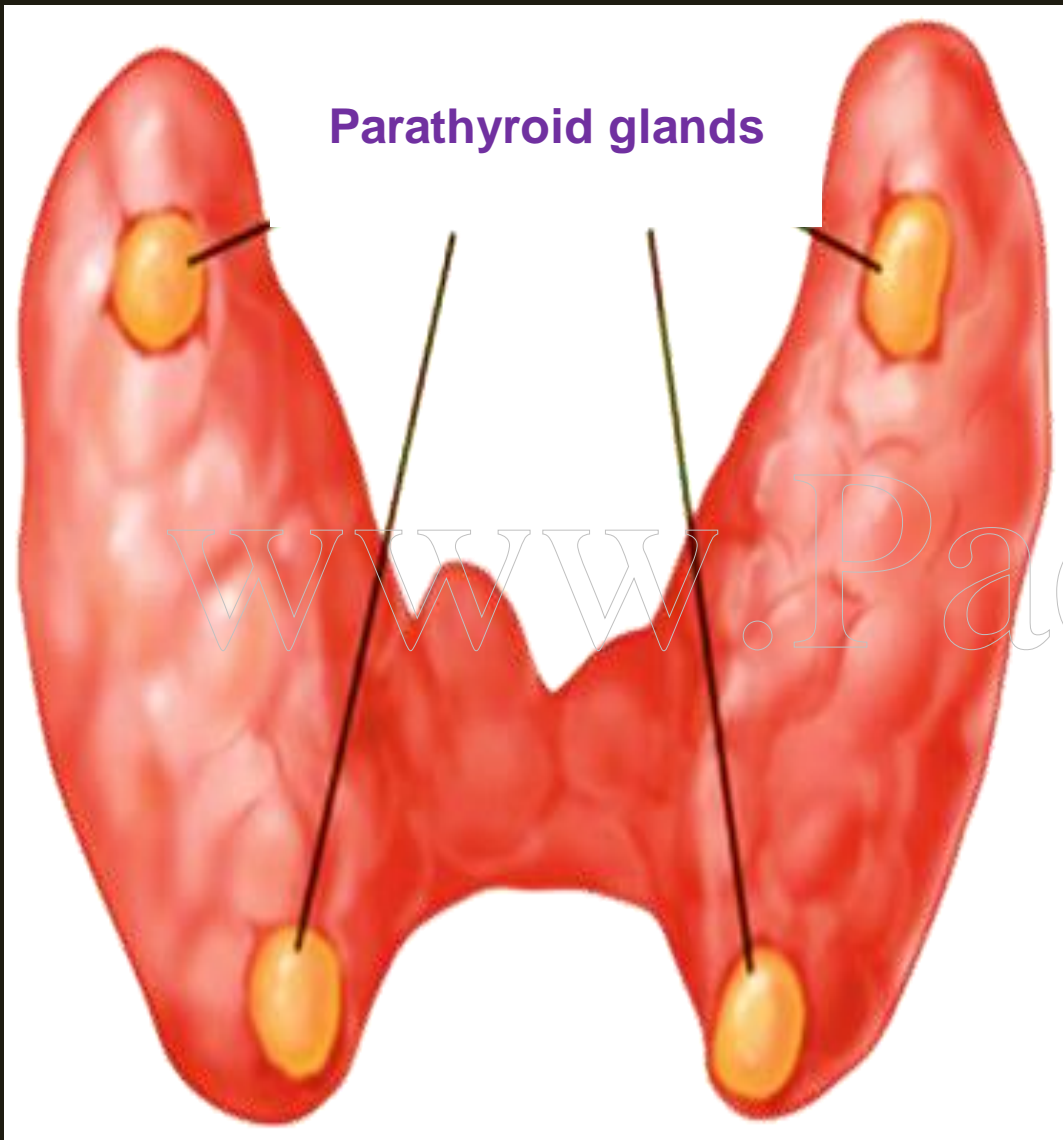
Circadian rhythm is the 24 hour cycle of biological activities associated with natural periods of light and darkness. Example sleep wake cycle, body temperature, appetite etc.

**Sporadic goitre is a genetic disease
and is not caused by iodine or
thyroxine deficiency.**



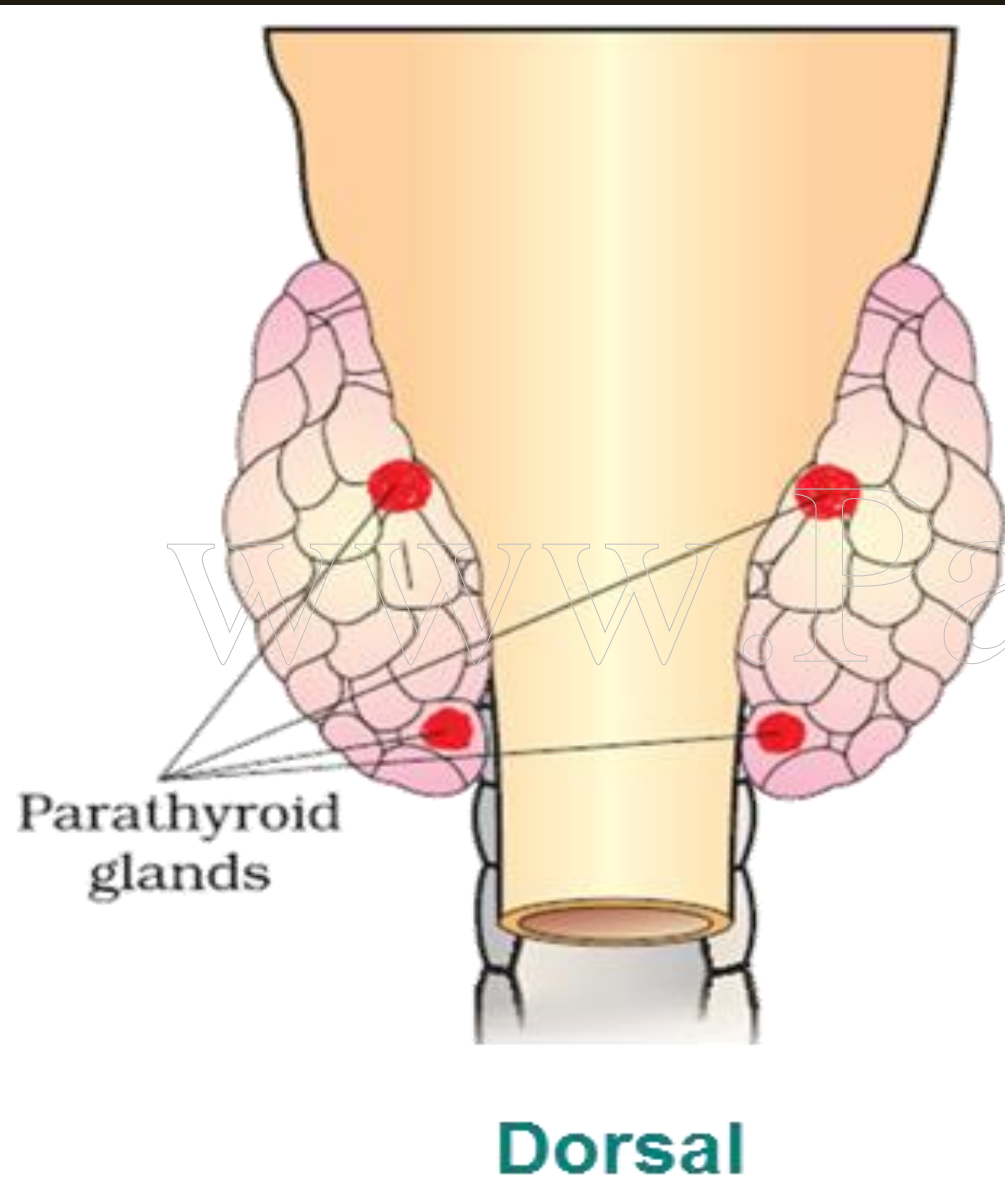
Iodine is required for formation of thyroxine: To produce normal quantities of thyroxine, about 1mg/week of iodine is required. To prevent iodine deficiency common table salt is iodised with 1 part sodium iodide to every 1,00,000 parts of sodium chloride

PARATHYROID GLAND



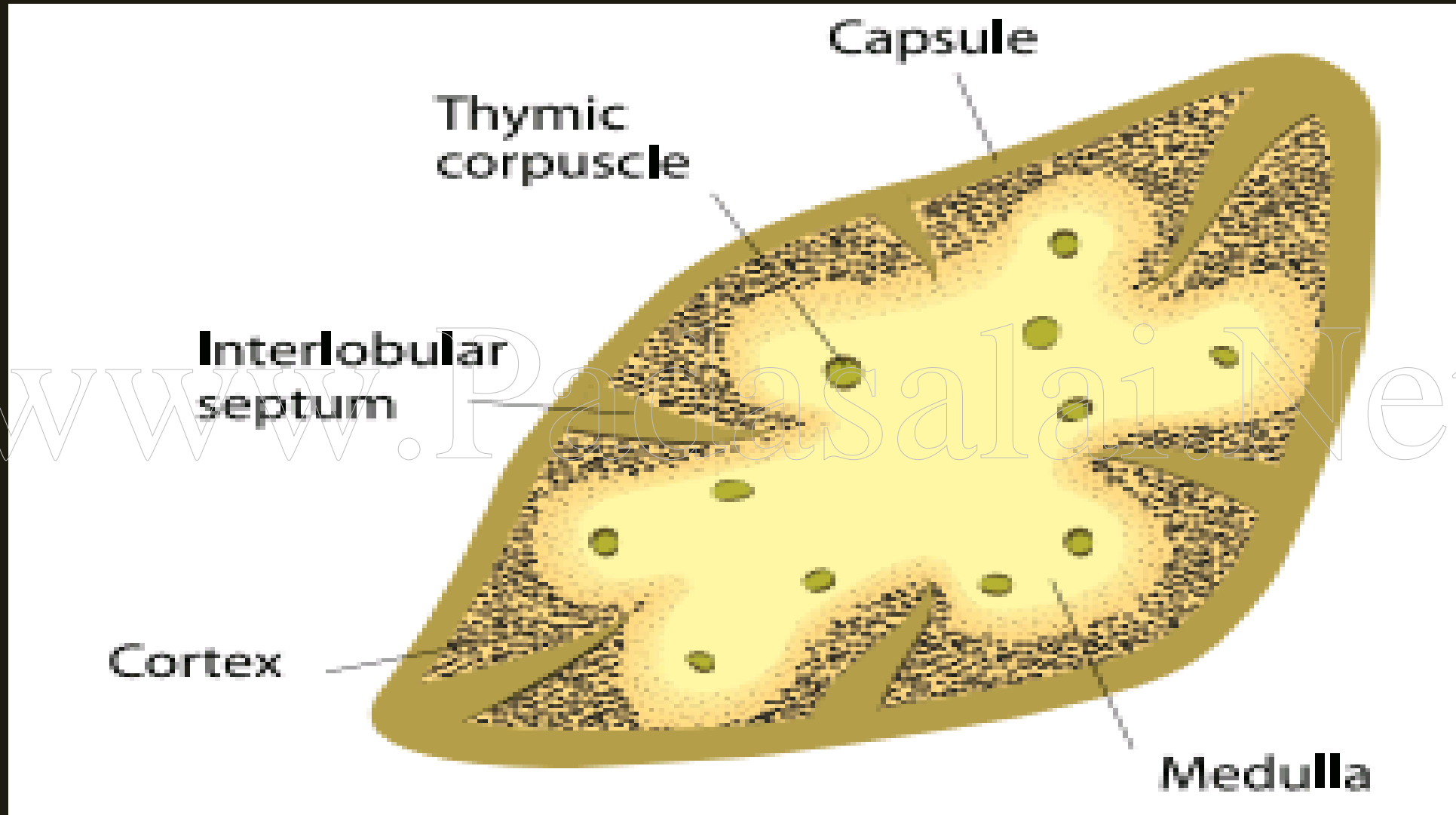
- In human, **four tiny parathyroid glands** are found in the posterior wall of the thyroid glands.
- This gland is composed of two types of cells, **the chief cells and oxyphil cells.**
- The chief cells secrete **parathyroid hormone (PTH)** and the **functions of oxyphil cells are not known.**

PARATHYROID HORMONE OR PARATHORMONE -PTH

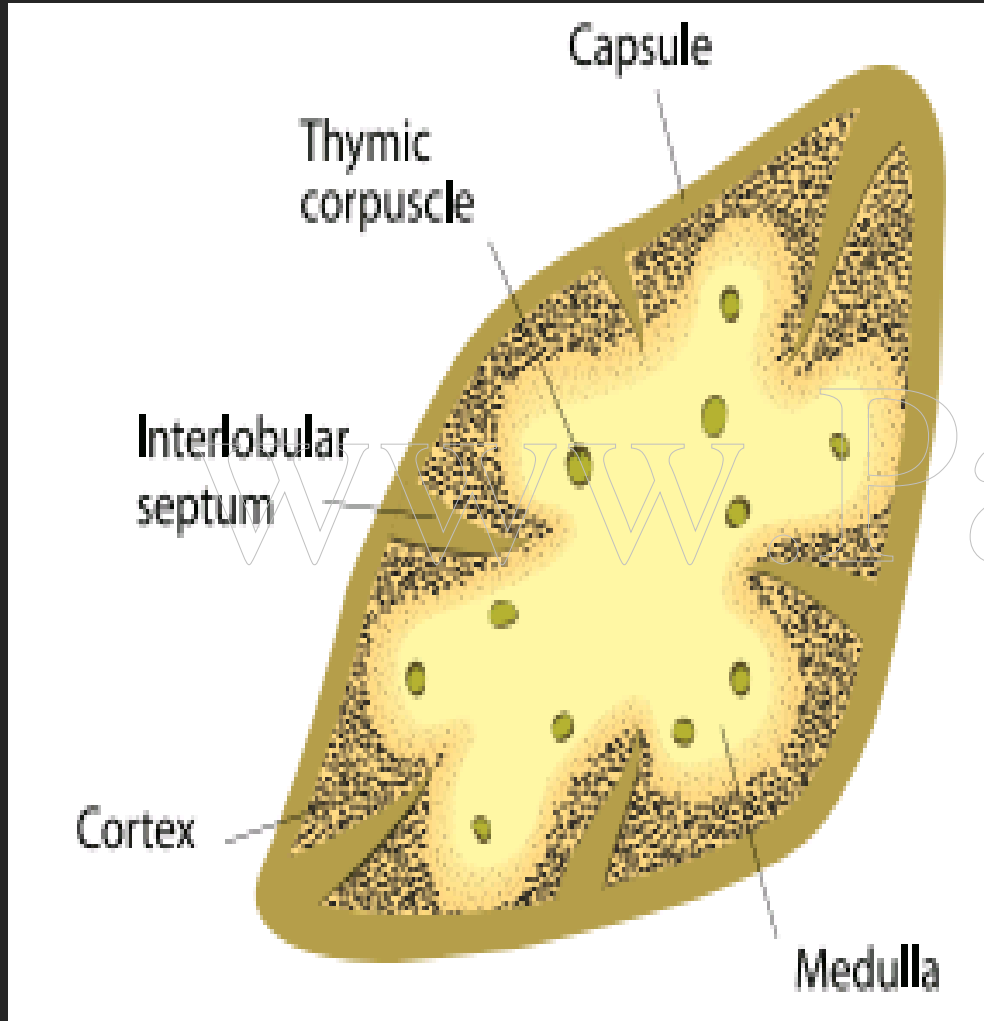


- PTH is a **hypercalcemic hormone**.
- It is a peptide hormone involved in **controlling the calcium and phosphate homeostasis**.
- The secretion of PTH is controlled by **calcium level in the blood**.
- It increases the blood calcium level by stimulating **osteoclasts to dissolve the bone matrix**.
- As a result **calcium and phosphate** are released into the blood.
- PTH enhances the **reabsorption of calcium** and **excretion of phosphates by the renal tubules** and promotes **activation of vitamin D to increase calcium absorption by intestinal mucosal cells**.

THYMUS GLAND

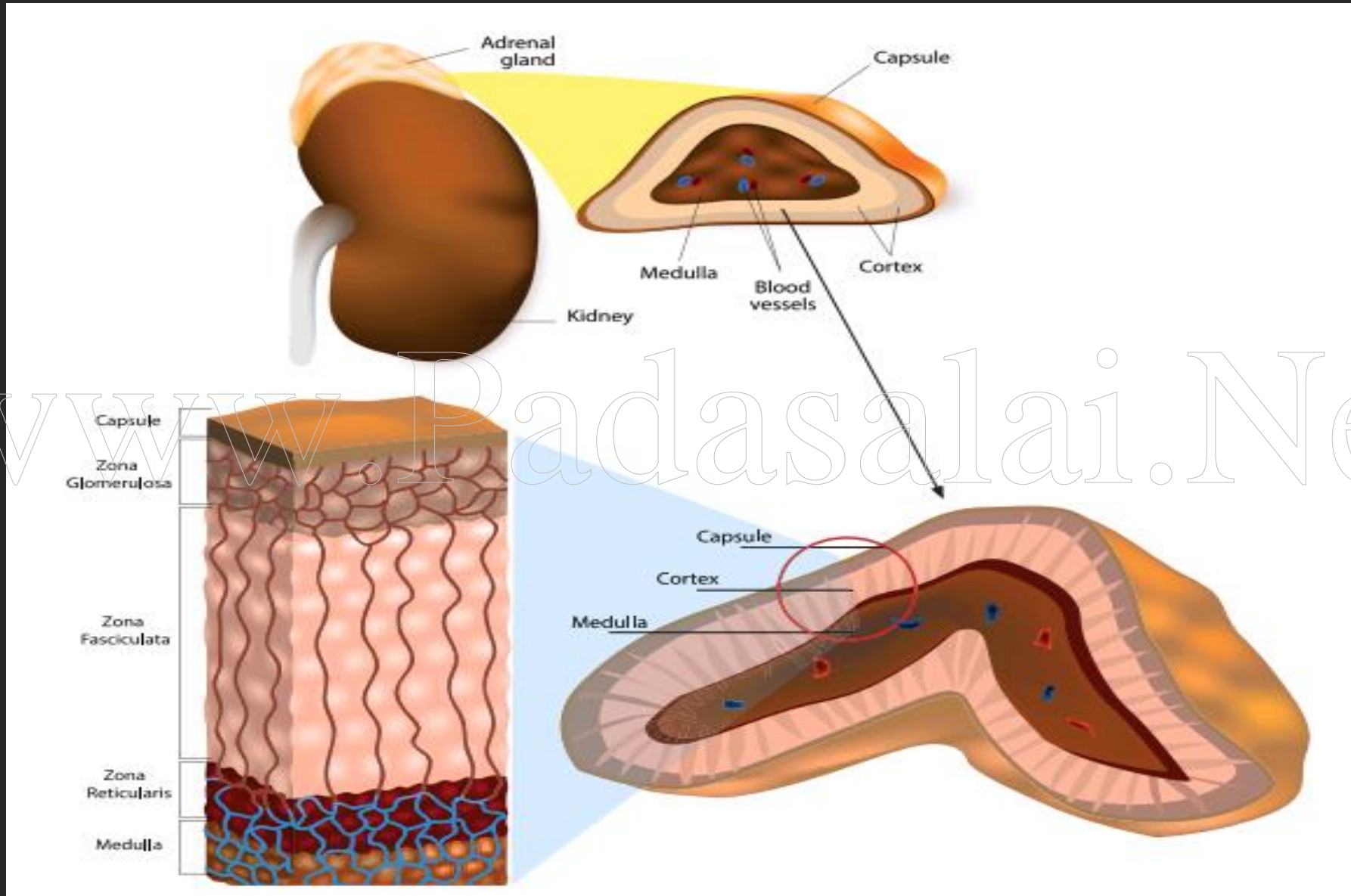


THYMUS GLAND



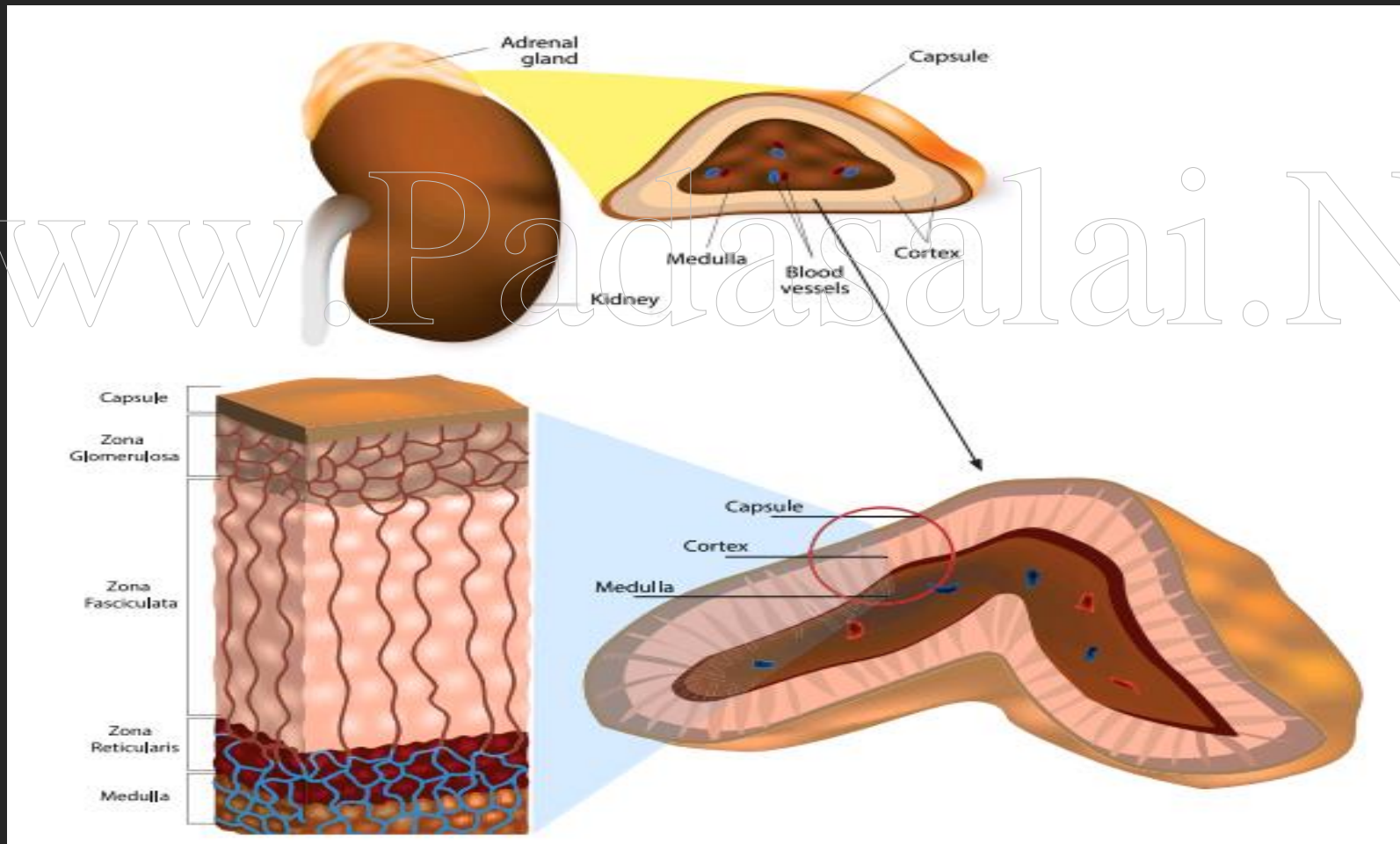
- Thymus gland is **partially an endocrine and partially a lymphoid organ.**
- It is a **bilobed structure** located just above the heart and aorta, behind the sternum.
- It is covered by fibrous capsule and anatomically it is divisible into an **outer cortex and an inner medulla.**
- It secretes four hormones such as **thymulin, thymosin, thymopoietin and thymic humoral factor (THF).**
- The primary function of thymus is the production of immuno competent '**T' lymphocytes which provides cell mediated immunity.**

ADRENAL GLAND

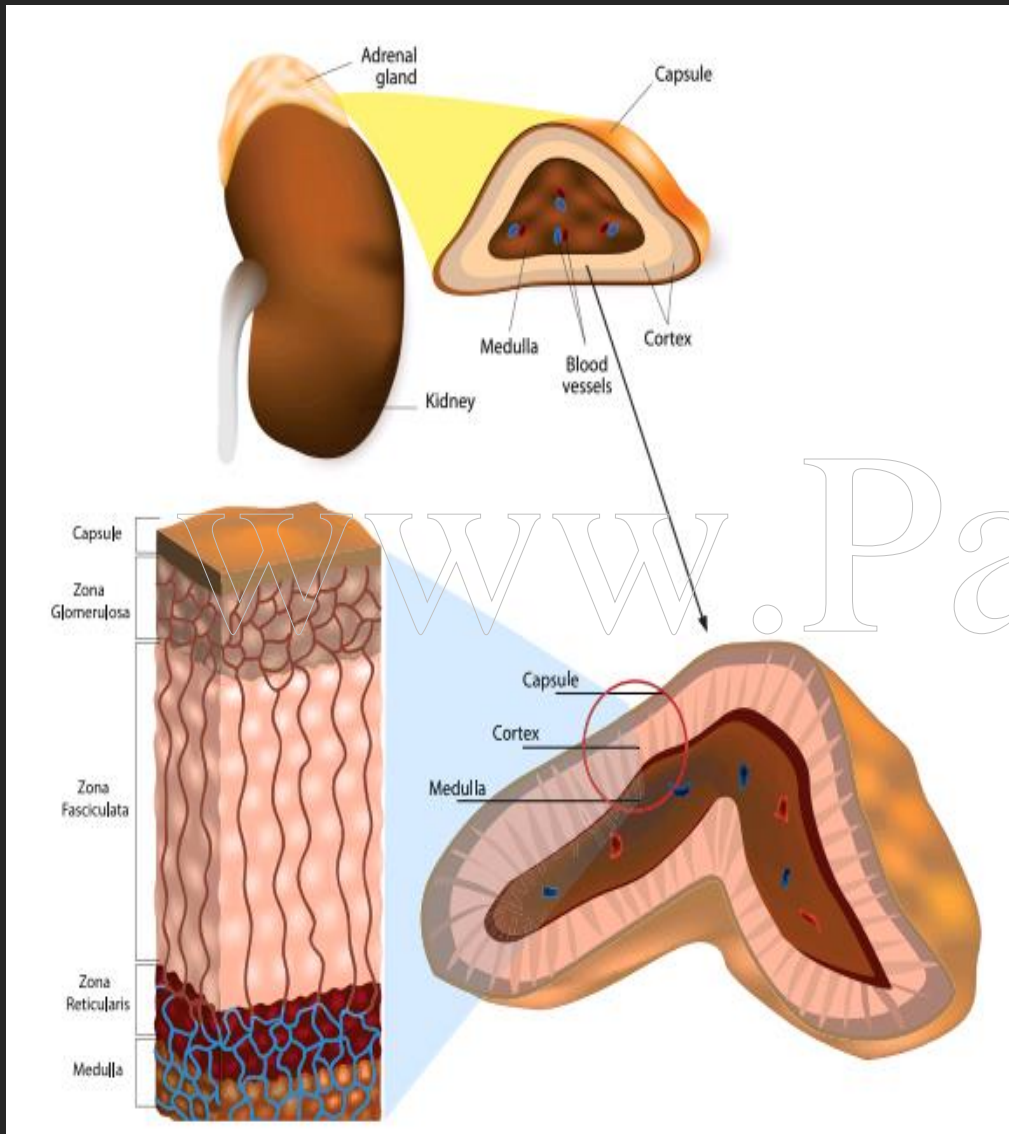


ADRENAL GLAND

- A pair of adrenal glands are located at the anterior end of the kidneys, hence also called **suprarenal glands**.
- Anatomically the **outer region is the cortex and the inner region is the medulla**.



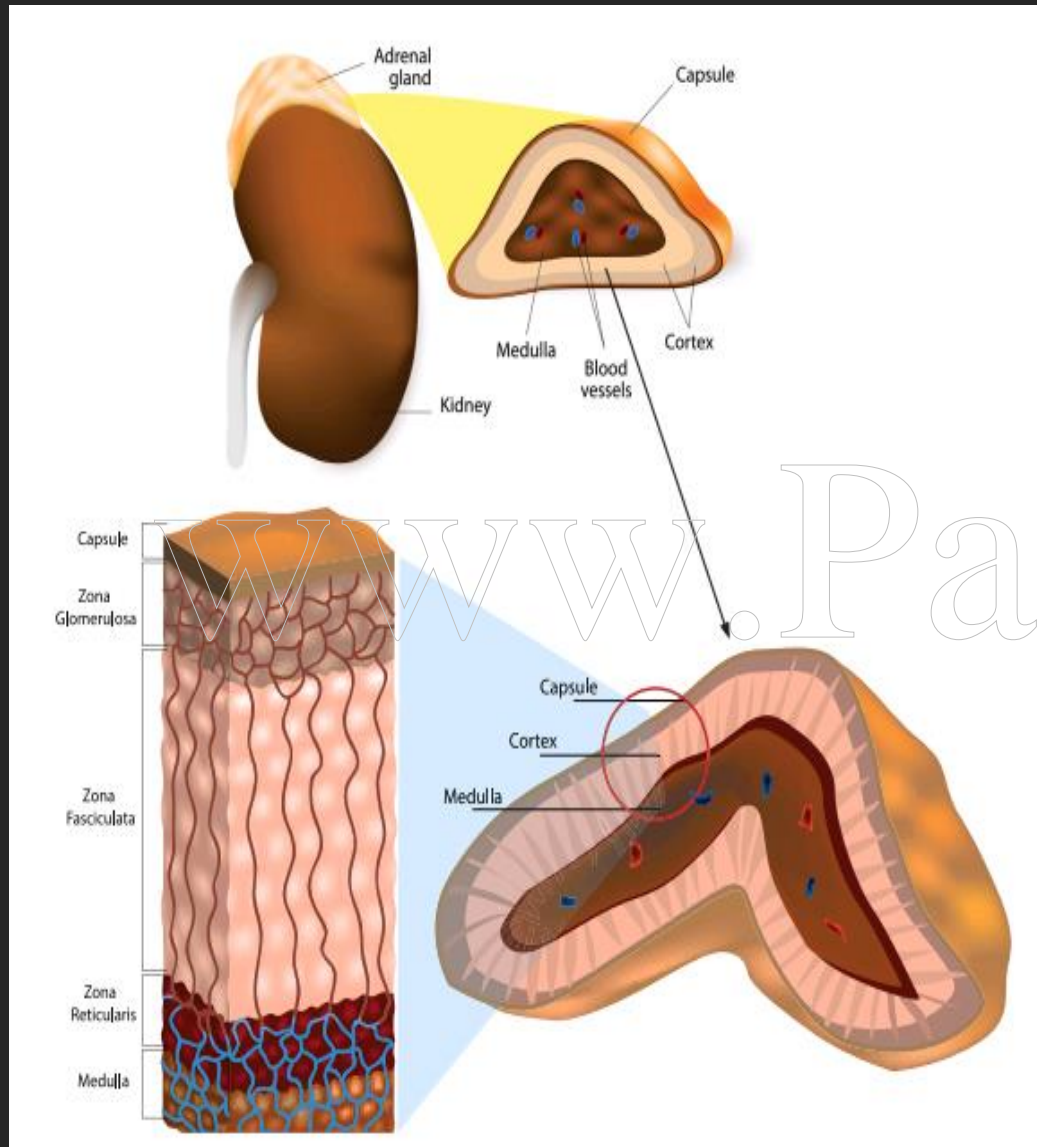
ADRENAL GLAND



ADRENAL CORTEX:

- Histologically the adrenal cortex has three distinct zones, **zona glomerulosa, zona fasciculata and zona reticularis.**
- **Zona glomerulosa** an outer thin layer constitutes about **15% of adrenal cortex, and secretes mineralocorticoids.**
- **Zona fasciculata**, the middle widest layer constitutes about **75% of adrenal cortex and secretes glucocorticoids such as cortisol, corticosterone and trace amounts of adrenal androgen and oestrogen.**
- **Zona reticularis**, an inner zone of adrenal cortex constitute about **10% of adrenal cortex and secretes the adrenal androgen, trace amount of oestrogen and glucocorticoids.**

ADRENAL GLAND



Adrenal medulla:

- It is the central part of adrenal gland and is composed of **ovoid and columnar cells**, which are found around the **network of blood capillaries**.
- **Adrenalin** (epinephrine) and **nor adrenalin** (nor epinephrine) are the two hormones **secreted by the adrenal medulla**.
- Both adrenalin and nor adrenalin are **catecholamines**.

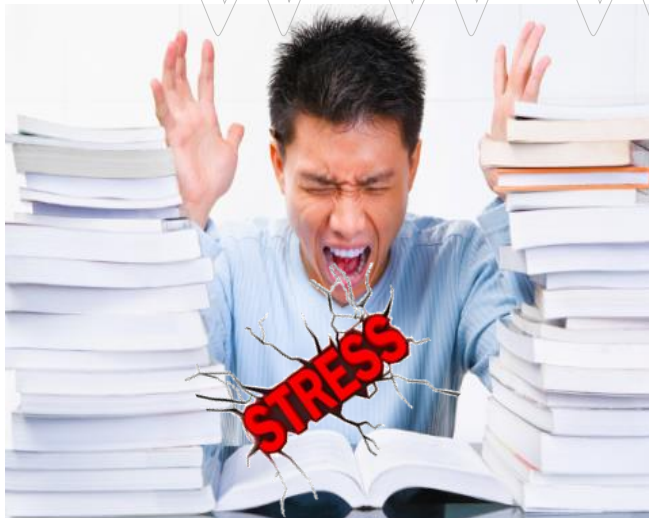
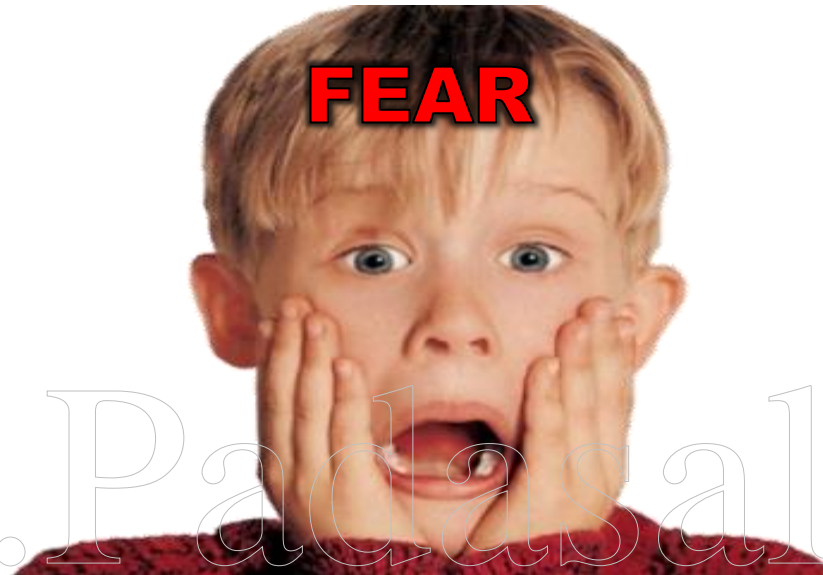
FUNCTION OF ADRENAL HURMONE

1. Glucocorticoids stimulate **gluconeogenesis, lipolysis and proteolysis** (the life saving activity).
2. Cortisol is a glucocorticoid involved in **maintaining cardio vascular and kidney function**.
3. It produces **anti-inflammatory reactions** and **suppresses the immune response**.
4. It stimulates the **RBC production**.
5. It is also known as **stress combat hormone**.
6. Mineralocorticoids **regulates water and electrolyte balance of our body**.
7. Aldosterone stimulates the **reabsorption of sodium and water** and **eliminates potassium and phosphate ions through excretion**, thus it helps in **maintaining electrolytes, osmotic pressure and blood pressure**.

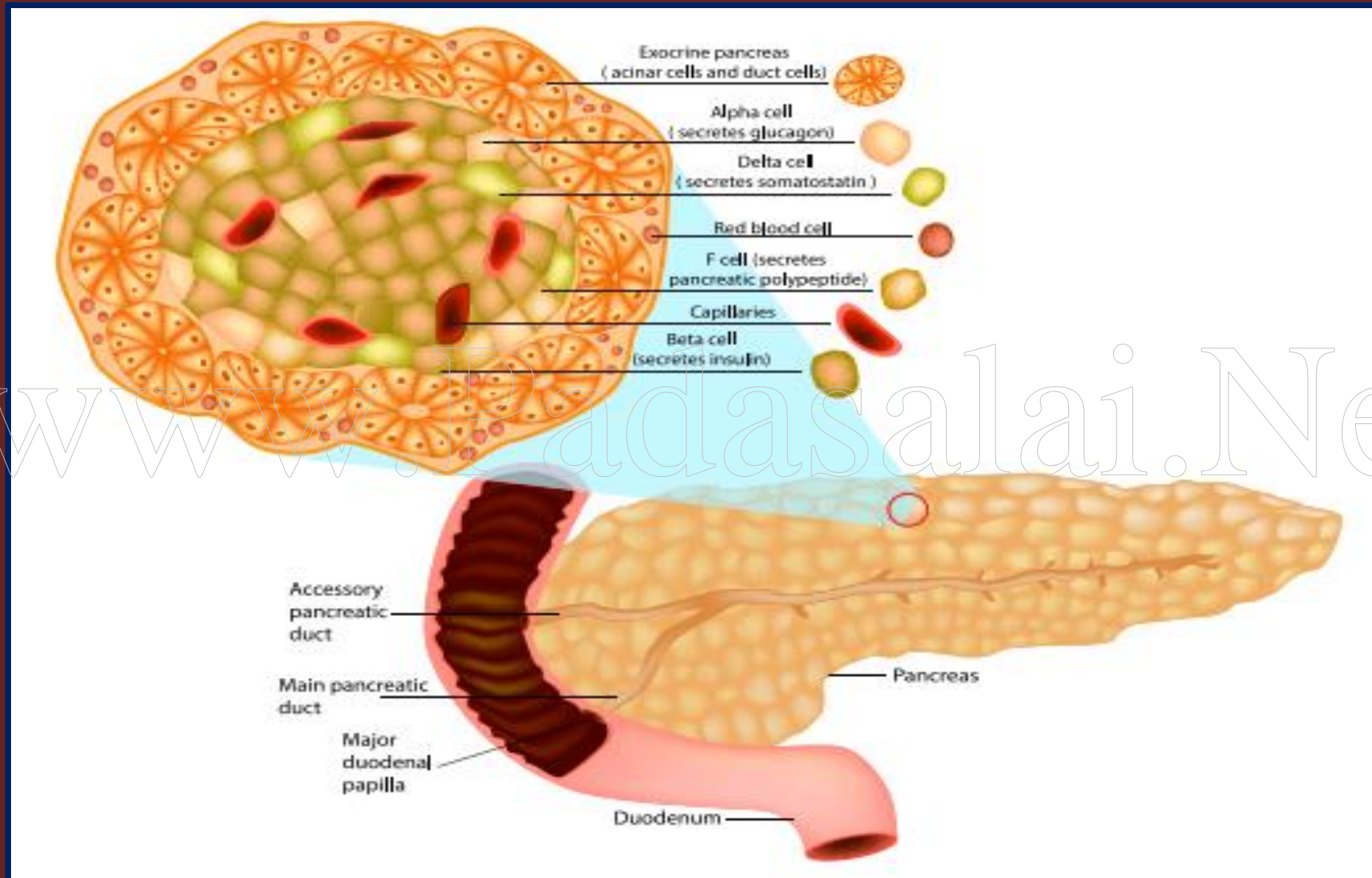
FUNCTION OF ADRENAL HURMONE

8. Adrenal androgen plays a role in hair growth in the axial region, pubis and face during puberty.
9. The adrenal medulla secretes the hormones **adrenalin and noradrenalin** and referred as “3F hormone” (fight, flight and fright hormone).
10. Adrenalin increases **liver glycogen breakdown into glucose** and **increases the release of fatty acids from fat cells.**
11. During emergency it increases **heart beat rate and blood pressure.**
12. It stimulates the **smooth muscles of cutaneous and visceral arteries to decrease blood flow.**
13. It increases blood flow to the **skeletal muscles** there by **incrases the metabolic rate of skeletal muscles, cardiac muscles and nervous tissue.**

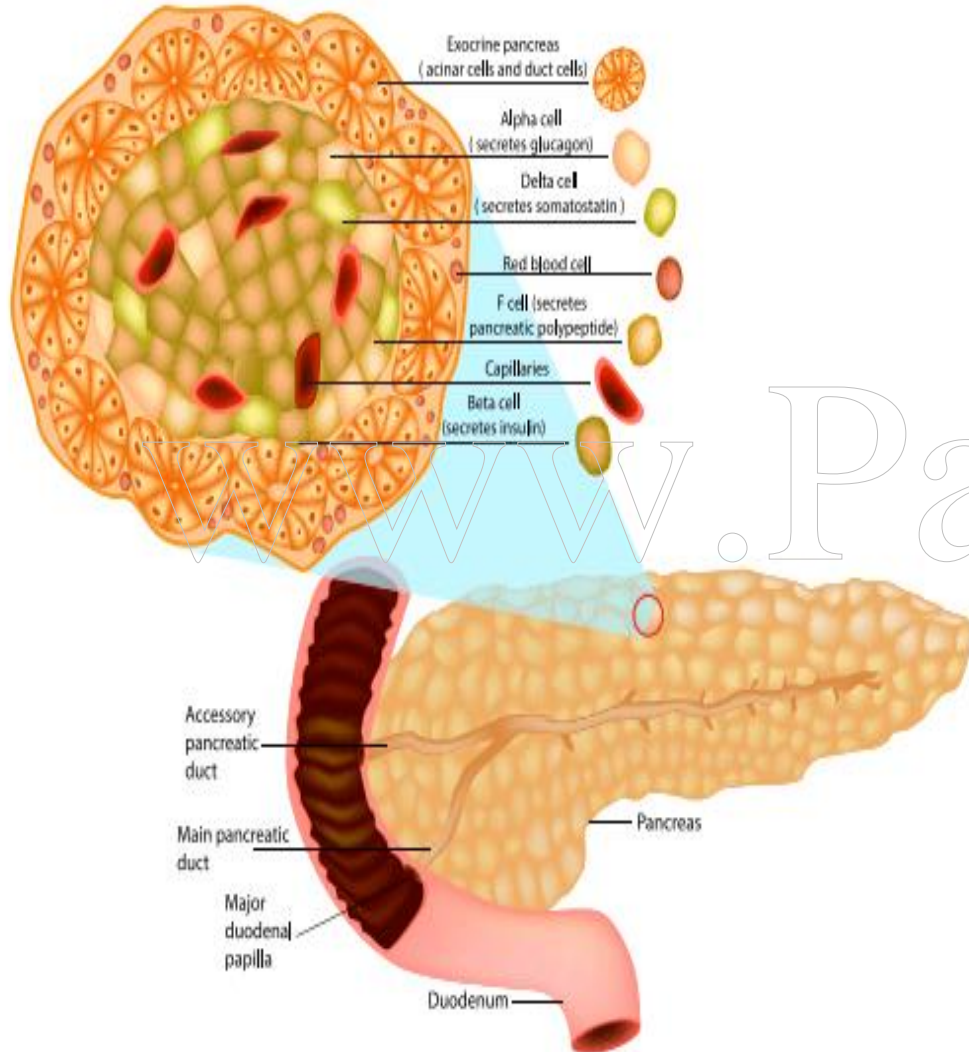
ADRENAL HURMONE - 3F hormone (Flight, Fight & Fright hormone)



PANCREAS



PANCREAS



- Pancreas is a composite gland which performs both **exocrine** and **endocrine** functions.
- It is located just below the stomach as a **leaf like structure**.
- The pancreas is composed of two major tissues such the **acini** and **islets of langerhans**.
 - **Acini** secretes digestive enzymes and the **islets of langerhans** secretes hormones like insulin and glucagon.
- Human pancreas has **one to two million islets of langerhans**.
- In each islet about **60% cells are beta cells**, **25% cells are alpha cells** and **10% cells are delta cells**.
- The **alpha** cells secrete **glucagon**, the **beta** cells secrete **insulin** and **delta** cells secrete **somatostatin**.

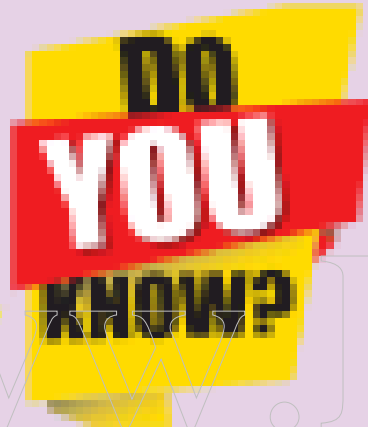
INSULIN

- Insulin is a **peptide hormone** and plays an important role in **glucose homeostasis**.
- It's main effect is to **lower blood glucose levels** by **increasing the uptake of glucose into the body cells**, especially muscle and fat cells.
- Insulin also **inhibits the breakdown of glycogen to glucose**, the **conversion of amino acids or fats to glucose**, so insulin is rightly called a **hypoglycemic hormone**.

GLUCAGON

- Glucagon is a **polypeptide hormone**.
- It is a potent **hyperglycaemic hormone** that **acts on the liver and promotes the breakdown of glycogen to glucose (Glycogenolysis), synthesis of glucose from lactic acid and from non-carbohydrate molecules (Gluconeogenesis)**.
- Glucagon releases glucose **from the liver cells**, increasing the **blood glucose levels**.
- Since glucagon **reduces the cellular uptake and utilisation of glucose** it is called a **hyperglycemic hormone**.
- **Prolonged hyperglycemia** leads to the disorder called **diabetes mellitus**.

Humulin N: Human insulin is produced by recombinant DNA technology (genetic engineering) and administered to diabetic patients as injection and not by oral consumption. Reason: Digestive enzymes digest it.

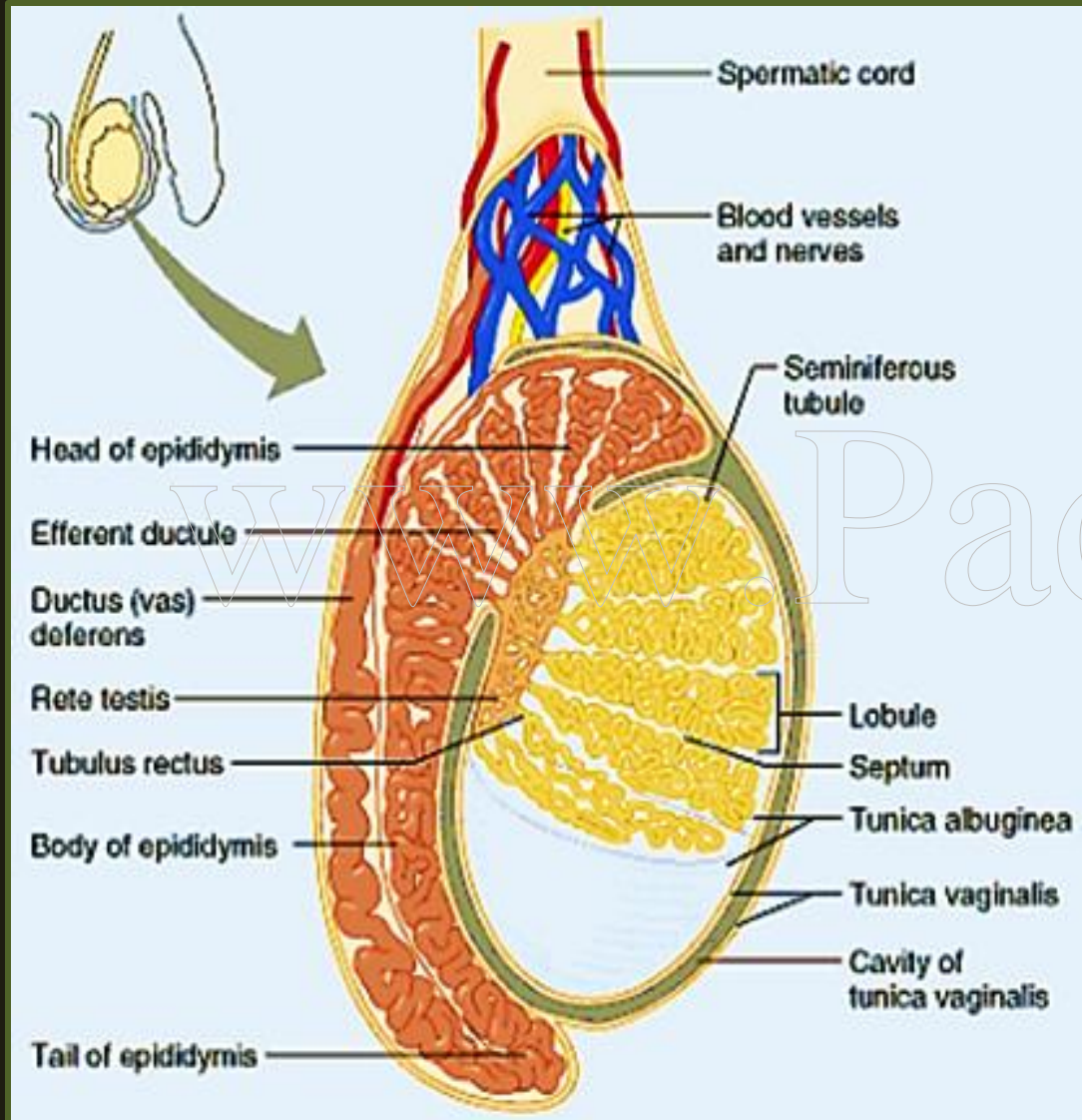


Insulin: The half life period of insulin (in plasma) is 6 minutes
It is cleared from the circulation within 10-15 minutes

Endocrine glands control and coordinate the body functions through secreting certain chemical messengers called hormones. Due to certain physiological reasons, the blood glucose level of an otherwise normal person.

- a. Give the possible cause for the increases in blood glucose level.
- b. What is the chemical nature of this hormone? Discuss its role in the body.
- c. How can this condition be reversed?

GONADS - TESTIS

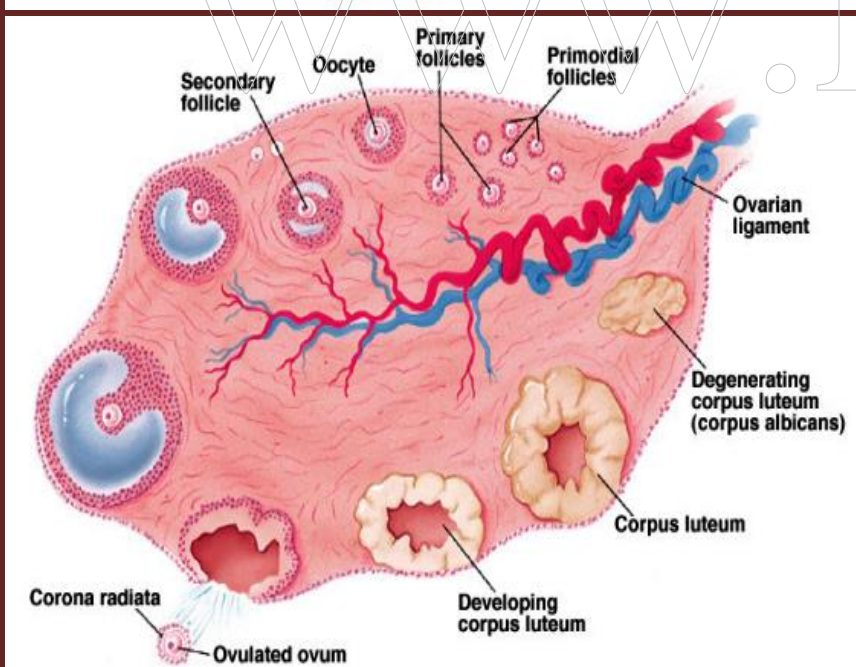
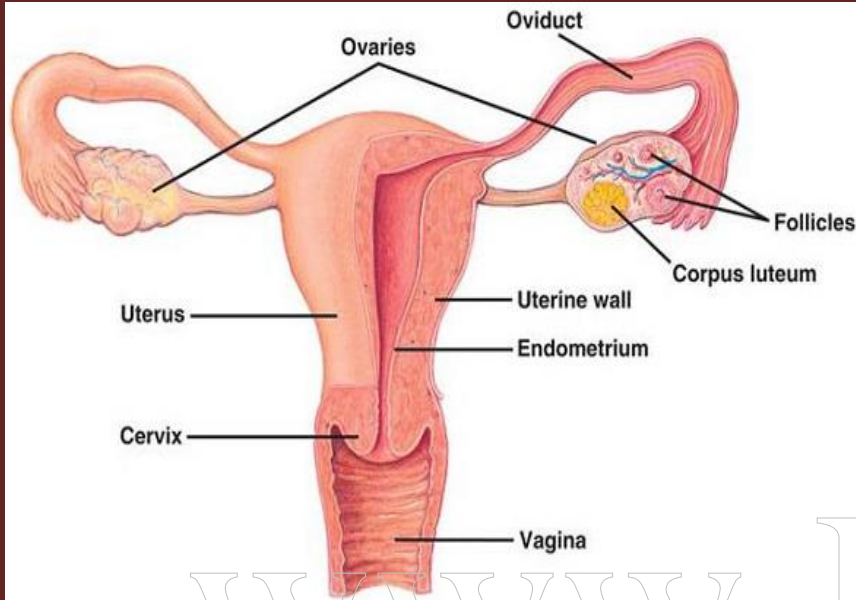


- A pair of testis is present in the **scrotal sac of males**.
- The testis functions as a **sex organ and also as an endocrine gland**.
- The testis is composed of **seminiferous tubules and interstitial cells or Leydig cells**.
- The **Leydig cells secrete several male sex hormones**, collectively called **androgens, mainly testosterone**.

FUNCTIONS OF TESTOSTERONE

1. Under the influence of FSH and LH, testosterone initiates **maturation of male reproductive organs.**
2. The appearance of **secondary sexual characters, muscular growth, growth of facial and axillary hair, masculine voice and male sexual behaviour.**
3. It enhances the total bone matrix and plays a stimulating role in the **process of spermatogenesis.**

GONADS - OVARY



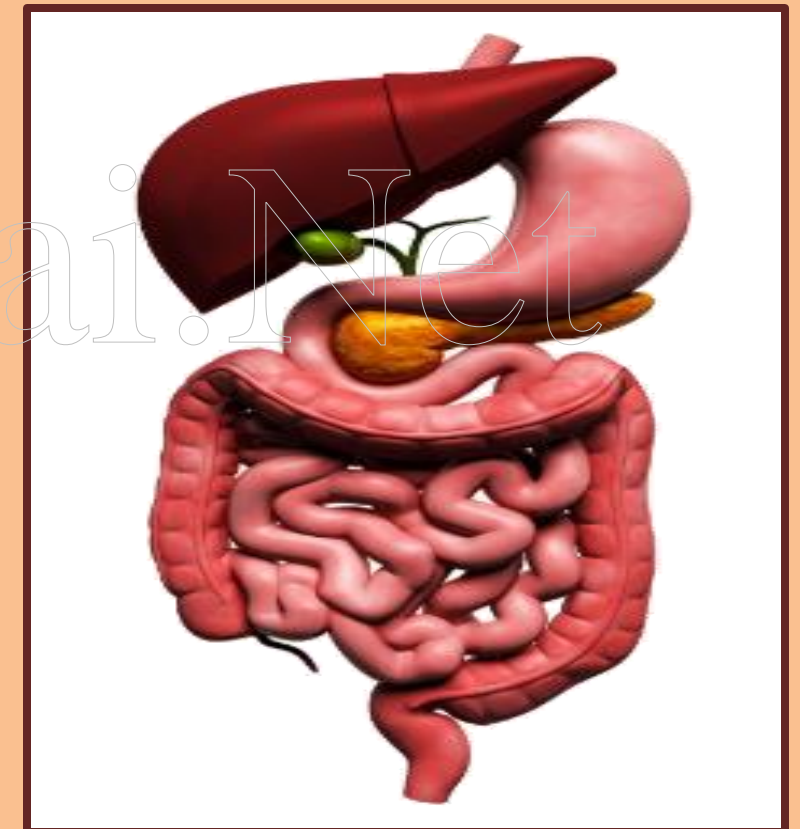
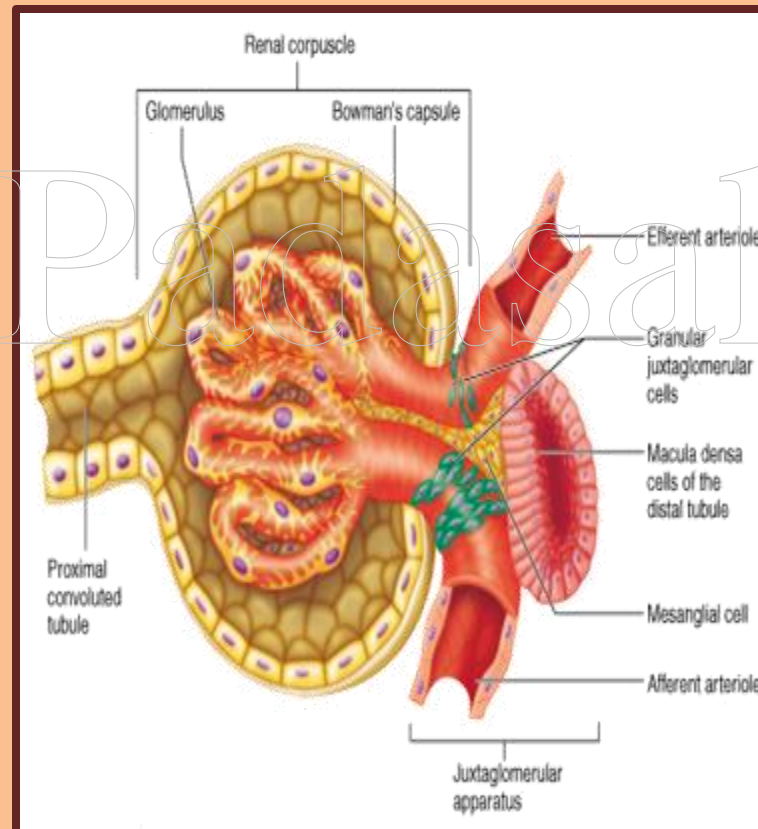
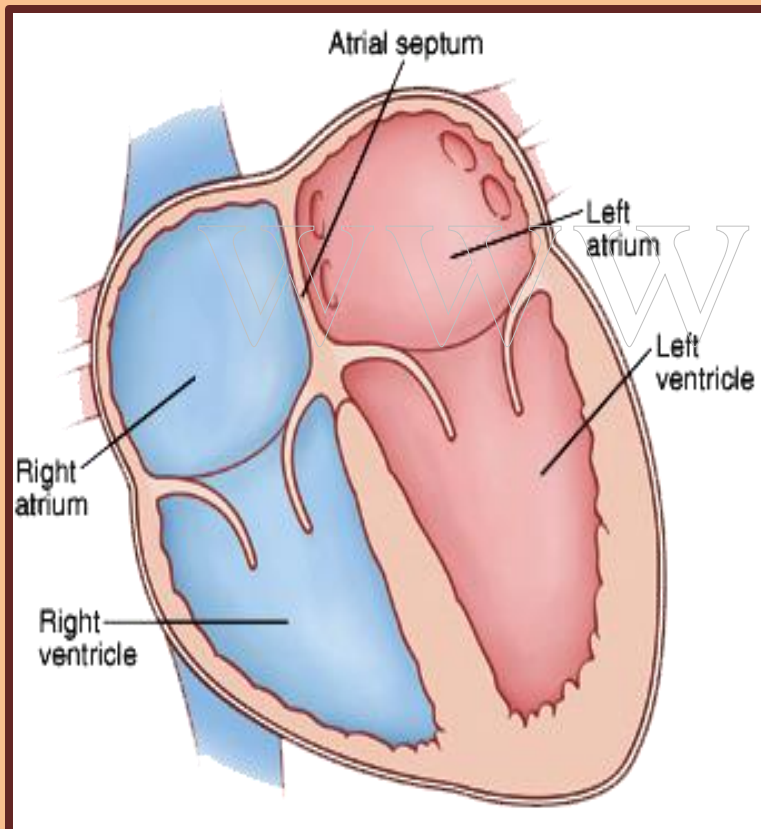
- Females have a pair of ovaries located in the **pelvic region of the abdomen**.
- The ovary is composed of **ovarian follicles and stromal tissues**.
- It produces the **eggs or ova**.
- The ovaries secrete the **steroid hormones oestrogen and progesterone**.
- Oestrogen is responsible for the **maturation of reproductive organs and the development of secondary sexual characters at puberty**.
- Along with progesterone, oestrogens promotes breast development and initiate the **cyclic changes during menstrual cycle**.
- Progesterone prepares the uterus for **implantation of the fertilized ovum**.
- It decreases the **uterine contraction during pregnancy** and **stimulates the development of mammary glands and milk secretion**.
- It is responsible for premenstrual changes in the uterus and is **essential for the formation of placenta**.

Identify the peaks of FSH, LH, Oestrogen and Progesterone hormones through out the menstrual cycle.

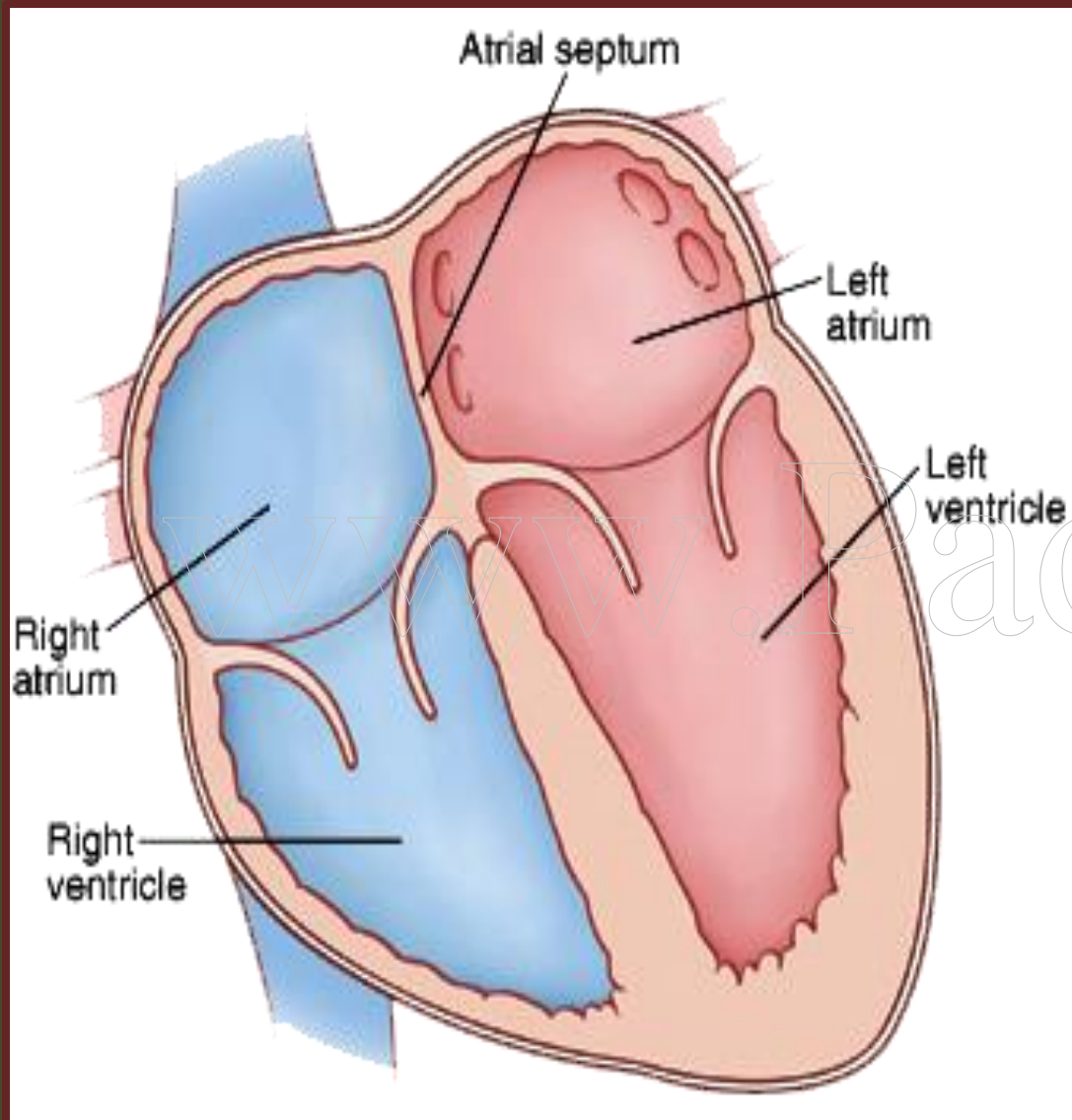
Urine pregnancy test is done to test the presence of HCG in the urine. HCG can be detected in the urine one or two weeks after conception.

HORMONES OF HEART, KIDNEY AND GASTRO INTESTINAL TRACT

❖ Some tissues of the **heart**, **kidney** and **gastro intestinal tract** acts as partial endocrine glands.

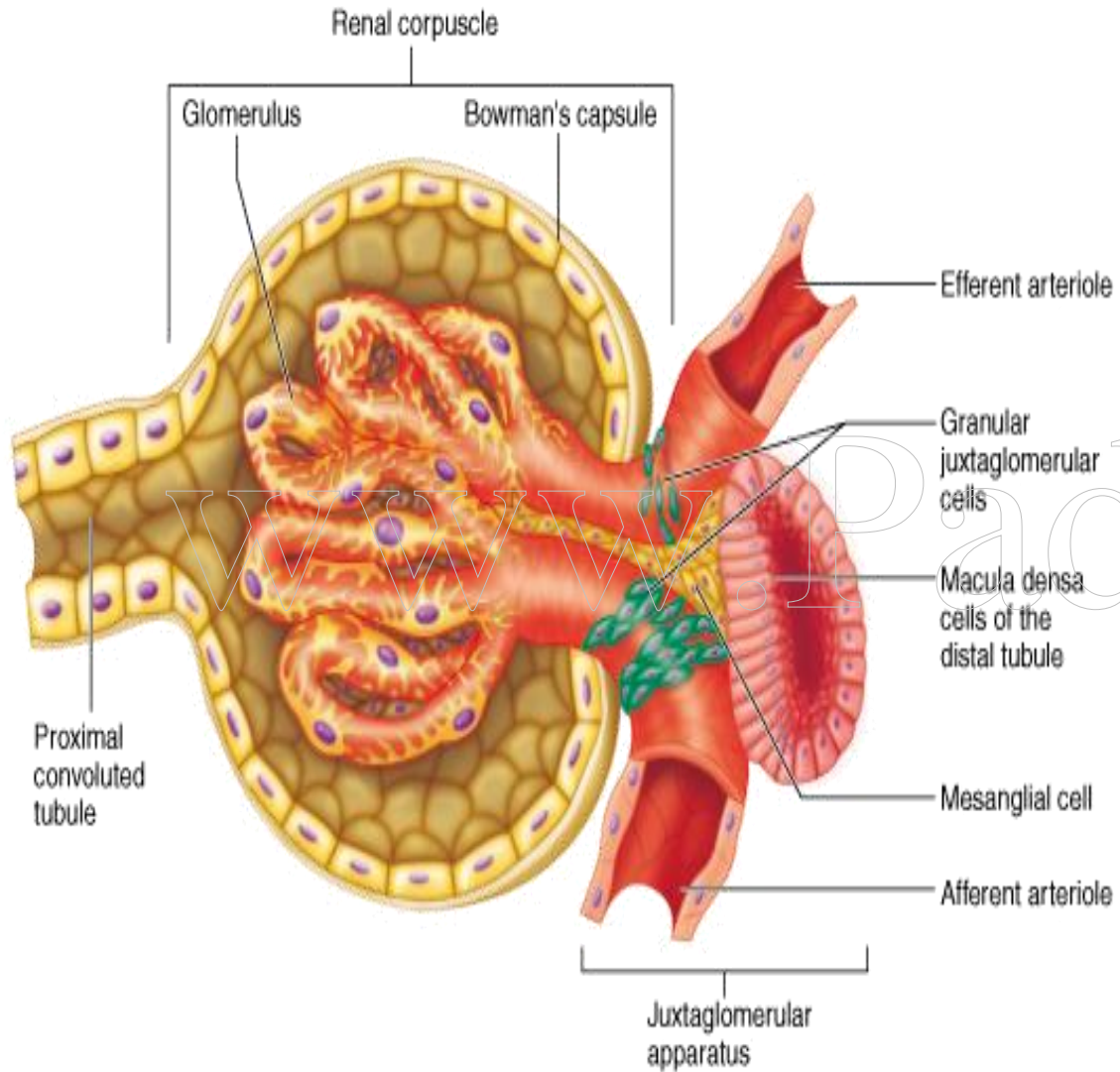


HORMONES OF HEART



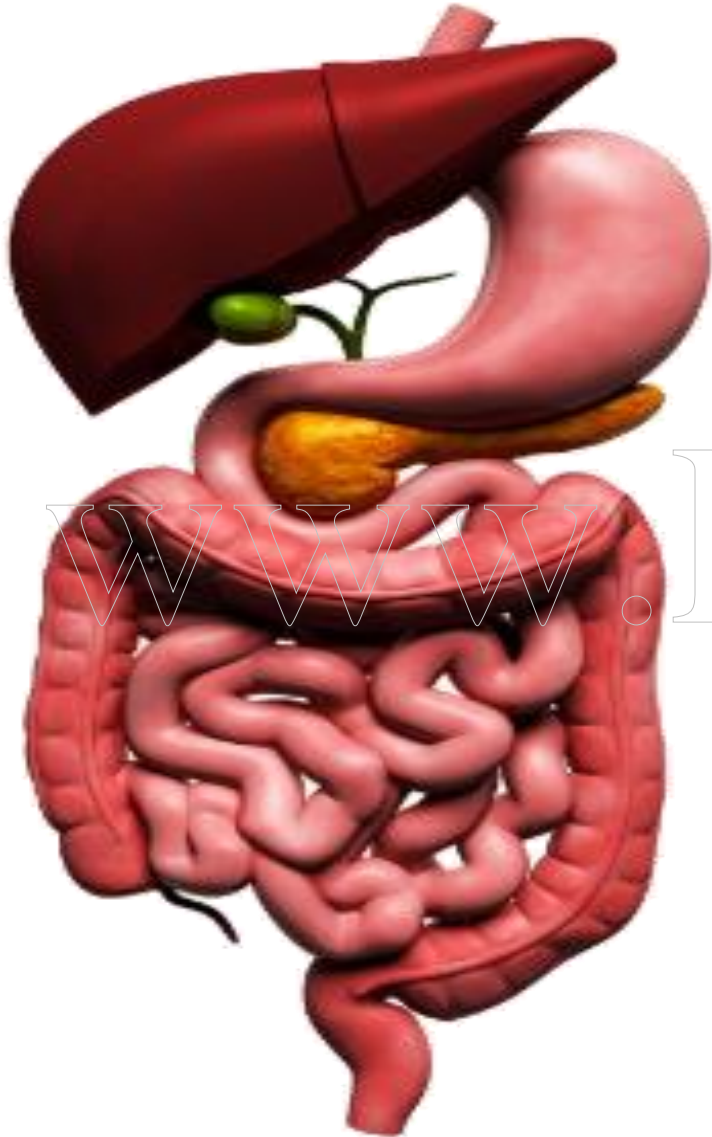
- In the heart, cardiocytes on the atrial wall's secretes an important peptide hormone called **atrial natriuretic factor (ANF)**.
- When blood pressure is increased, ANF is secreted and causes dilation of the blood vessels to **reduce the blood pressure**.

HORMONES OF KIDNEY



- In kidneys, hormones such as **renin, erythropoietin and calcitriol** are secreted.
- **Renin** is secreted by **juxta glomerular cells (JGA)**, which increases blood pressure when angiotensin is formed in blood.
- **Erythropoietin** is also secreted by the **JGA cells** of the kidney and **stimulates erythropoiesis (formation of RBC) in bone marrow**.
- **Calcitriol** is secreted by **proximal tubules of nephron**.
- It is an **active form of vitamin D3** which promotes calcium and phosphorus absorption from intestine and accelerates bone formation.

GASTRO INTESTINAL TRACT HORMONES



- Group of specialized endocrine cells present in gastro-intestinal tract secretes hormones such as **gastrin, cholecystokinin (CCK), secretin and gastric inhibitory peptides (GIP)**.
- Gastrin acts on the **gastric glands** and stimulates the secretion of **HCl and pepsinogen**.
- Cholecystokinin (CCK) is secreted by **duodenum** in response to the **presence of fat and acid in the diet**.
- It acts on the **gall bladder** to release bile into duodenum and stimulates the **secretion of pancreatic enzymes and its discharge**.
- Secretin acts on **acini cells of pancreas** to secrete **bicarbonate ions and water to neutralize the acidity**.
- Gastric inhibitory peptide (GIP) inhibits **gastric secretion and motility**.

HYPO AND HYPER ACTIVITY OF ENDOCRINE GLANDS AND RELATED DISORDERS

- The **hyper secretion and hypo secretion of hormones** leads to several disorders

1. Dwarfism
2. Gigantism
3. Acromegaly
4. Cretinism
5. Myxedema
6. Grave's disease
7. Simple goitre
8. Tetany
9. Hyperparathyroidism
10. Addison's disease
11. Cushing's syndrome
12. Hypoglycaemia
13. Hyperglycaemia
14. Diabetes insipidus

DWARFISM



➤ Dwarfism is due to **hyposecretion of growth**

hormone (GH) in children, skeletal growth and

sexual maturity is arrested.

➤ They attain a maximum height of **4 feet only.**

GIGANTISM



➤ Gigantism is due to **hypersecretion of growth**

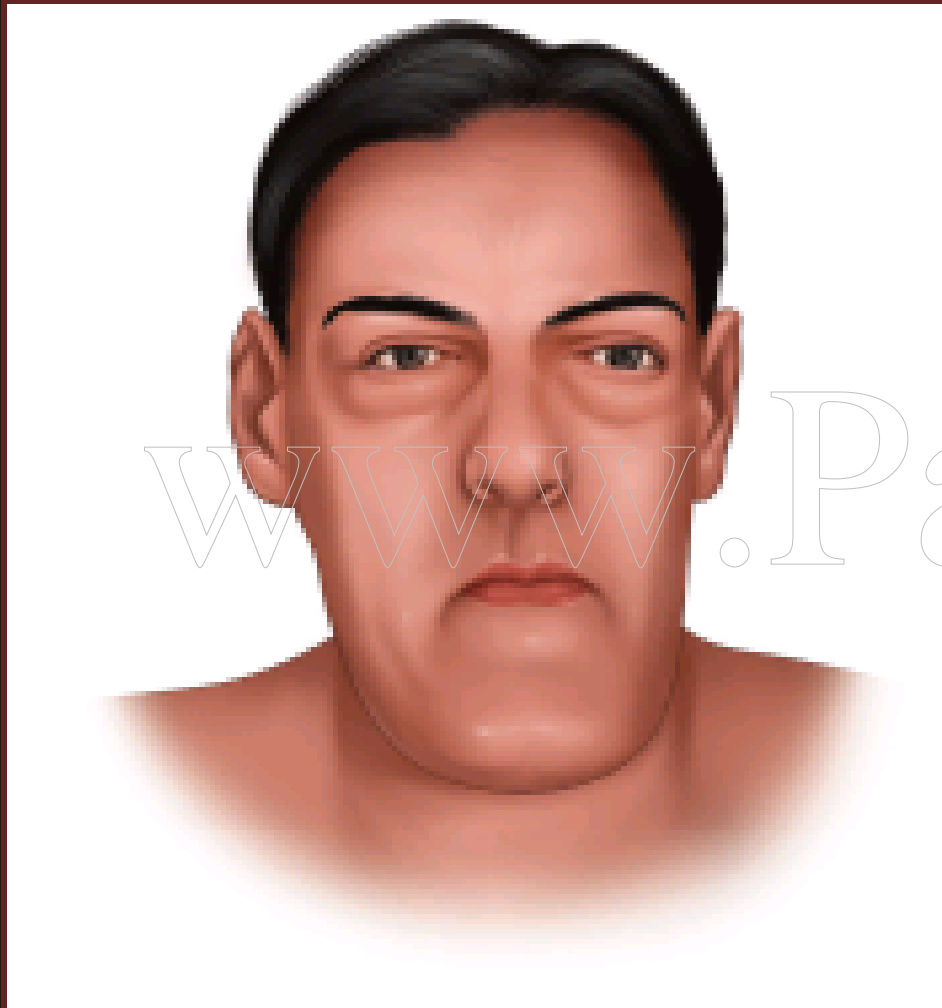
hormone (GH) in children.

➤ **Overgrowth of skeletal structure occurs (up to 8 feet)**

and the visceral growth is not appropriate with that

of limbs.

ACROMEGALY



❖ Acromegaly is due to excessive secretion of growth hormone in adults.

symptoms of acromegaly

1. Over growth of **hand bones, feet bones and jaw bones.**
2. **Malfunctioning** of gonads.
3. Enlargement of **viscera, tongue, lungs, heart, liver, spleen.**
4. Enlargement of **endocrine gland** like **thyroid, adrenal etc.,**

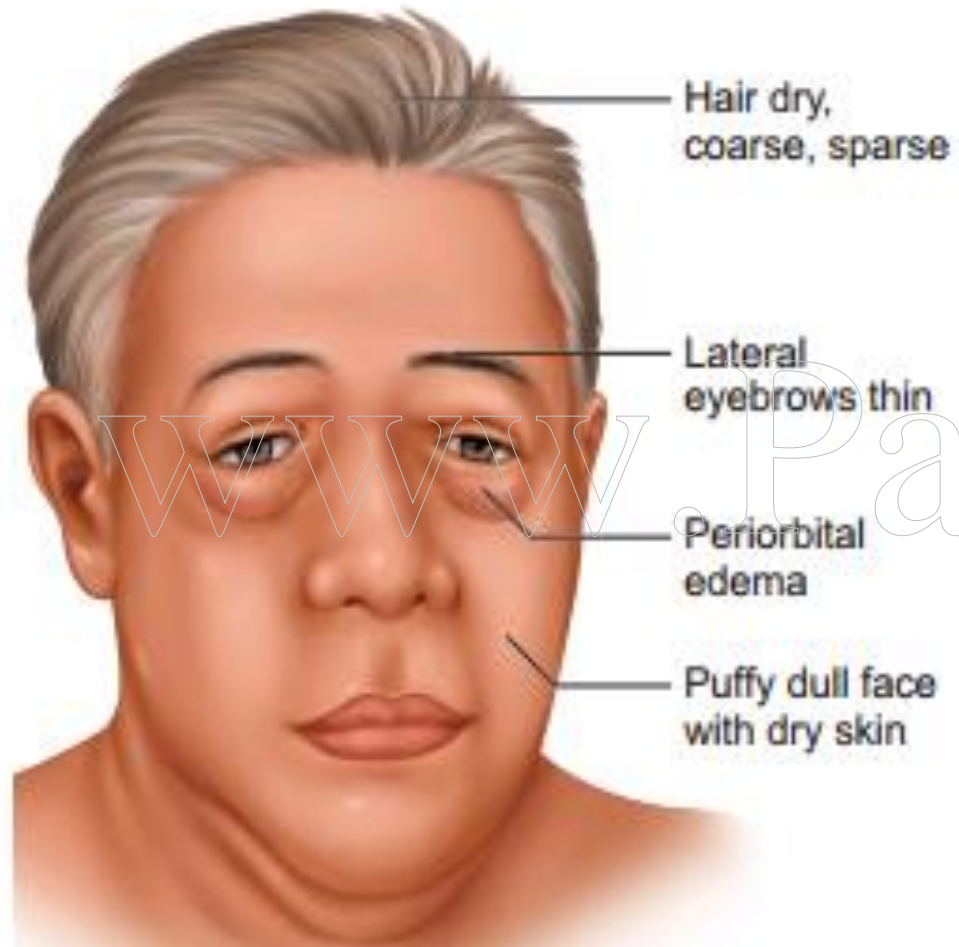
CRETINISM



❖ In infants, **hypothyroidism causes cretinism.**
symptoms of cretinism

1. A cretin shows retarded skeletal growth
2. Absence of sexual maturity
3. Retarded mental ability
4. Thick wrinkled skin
5. Protruded enlarged tongue
6. Bloated face
7. Thick and short limbs
8. Low BMR
9. Slow pulse rate
10. Subnormal body temperature
11. Elevated blood cholesterol levels

MYXODEMA



- ❖ Hyposecretion of thyroid in adults causes **myxedema**.
- ❖ It is otherwise called **Gull's disease**.

symptoms of myxedema

1. Decreased mental activity
2. Memory loss
3. Slowness of movement
4. Slowness of speech
5. General weakness of body
6. Dry coarse skin
7. Scarce hair
8. Puffy appearance,
9. Disturbed sexual function,
10. Low BMR,
11. Poor appetite,
12. Subnormal body temperature.

GRAVE'S DISEASE



- ❖ Grave's disease also called as **Thyrotoxicosis or Exophthalmic goitre**.
- ❖ This disease is caused due to hyper secretion of thyroid.

symptoms of Grave's disease

1. Enlargement of thyroid gland
2. Increased BMR (50% - 100%)
3. Elevated respiratory and excretory rates
4. Increased heart beat,
5. High BP
6. Increased body temperature
7. Protrusion of eyeball
8. Weakness of eye muscles
9. Weight loss.

SIMPLE GOITRE



❖ Simple goitre is also known as **Endemic goitre**.

❖ It is caused due to **hyposecretion of thyroxine**.

Symptoms of simple goitre

1. Enlargement of thyroid gland
2. Fall in serum thyroxine level
3. Increased TSH secretion.

TETANY

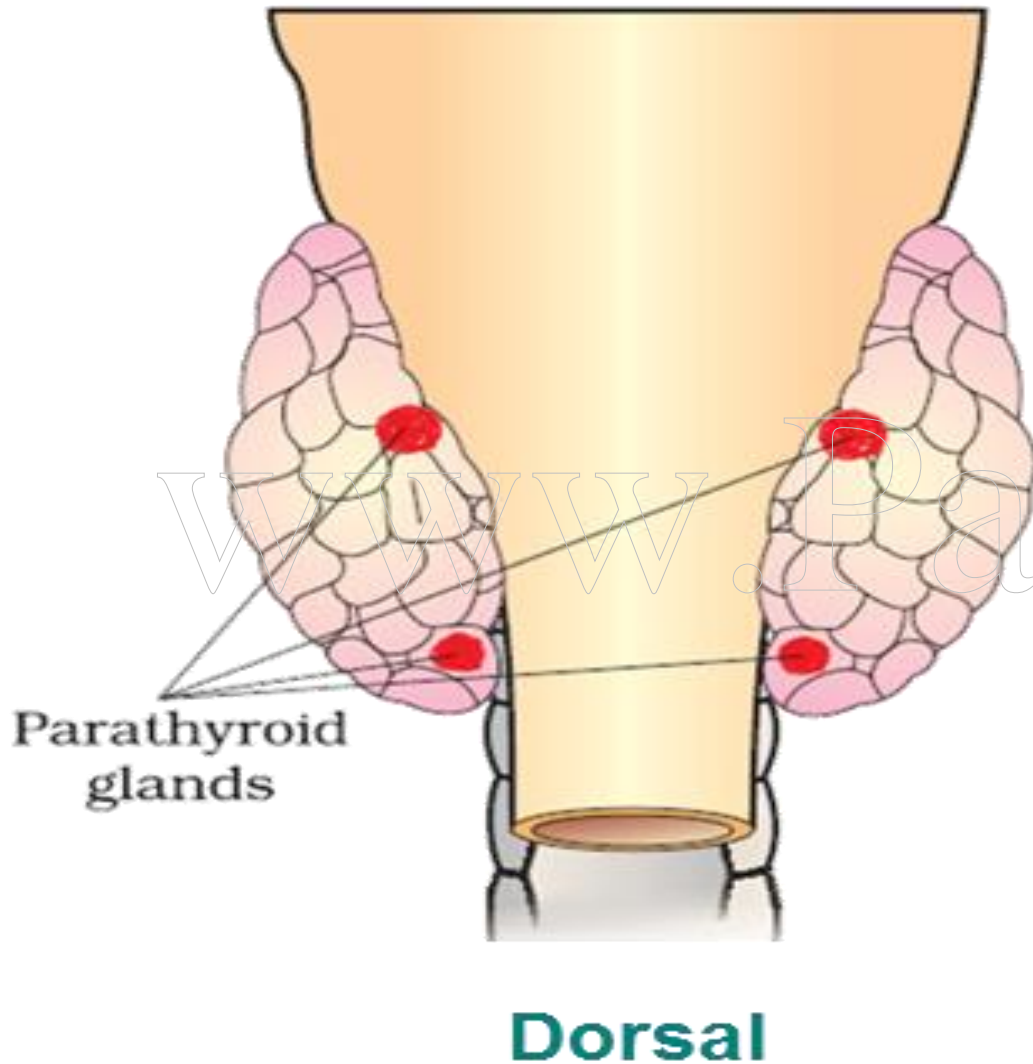


- Tetany is caused due to the **hyposcretion of parathyroid hormone (PTH)**.
- Due to hyposcretion of PTH serum **calcium level decreases** (Hypocalcemia), as a result **serum phosphate level increases**.
- Calcium and phosphate **excretion level decreases**.

Symptoms of tetany

1. Generalized convulsion
2. Locking of jaws
3. Increased heart beat rate
4. Increased body temperature
5. Muscular spasm

HYPERPARATHYROIDISM



❖ Hyperparathyroidism is caused due to excess **PTH in blood**.

Symptoms of hyperparathyroidism

1. **Demineralisation of bone**
2. **Cyst formation**
3. **Softening of bone**
4. **Loss of muscle tone**
5. **General weakness**
6. **Renal disorders**

ADDISON'S DISEASE

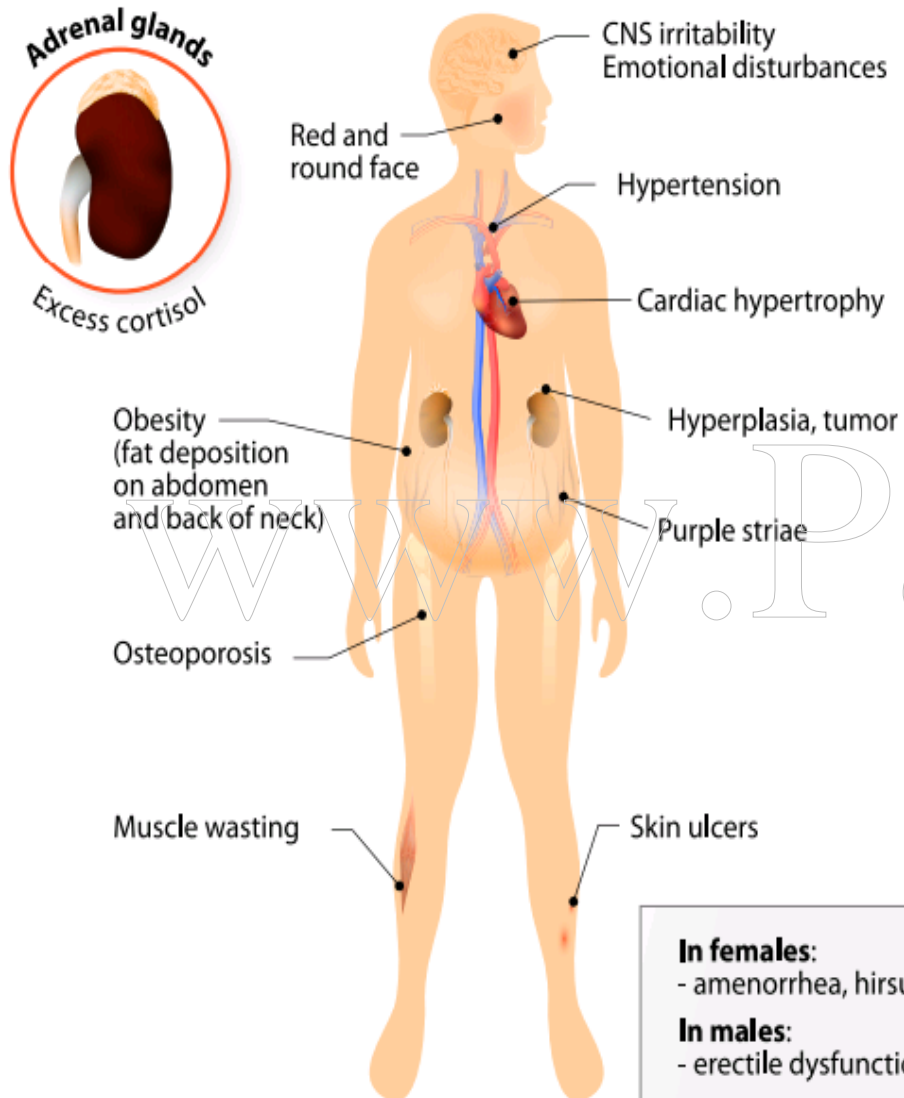


- ❖ Addison's disease is caused due to **hyposecretion of glucocorticoids and mineralocorticoids** from the adrenal cortex.
- ❖ Reduced aldosterone secretion **increases urinary excretion of Na, Cl and water and decreases potassium excretion** leading to **dehydration**.

Symptoms of Addison's disease

1. Muscular weakness
2. Low BP
3. Loss of appetite
4. Vomiting
5. Hyper pigmentation of skin
6. Low metabolic rate
7. Subnormal temperature
8. Reduced blood volume
9. Weight loss

CUSHING'S SYNDROME

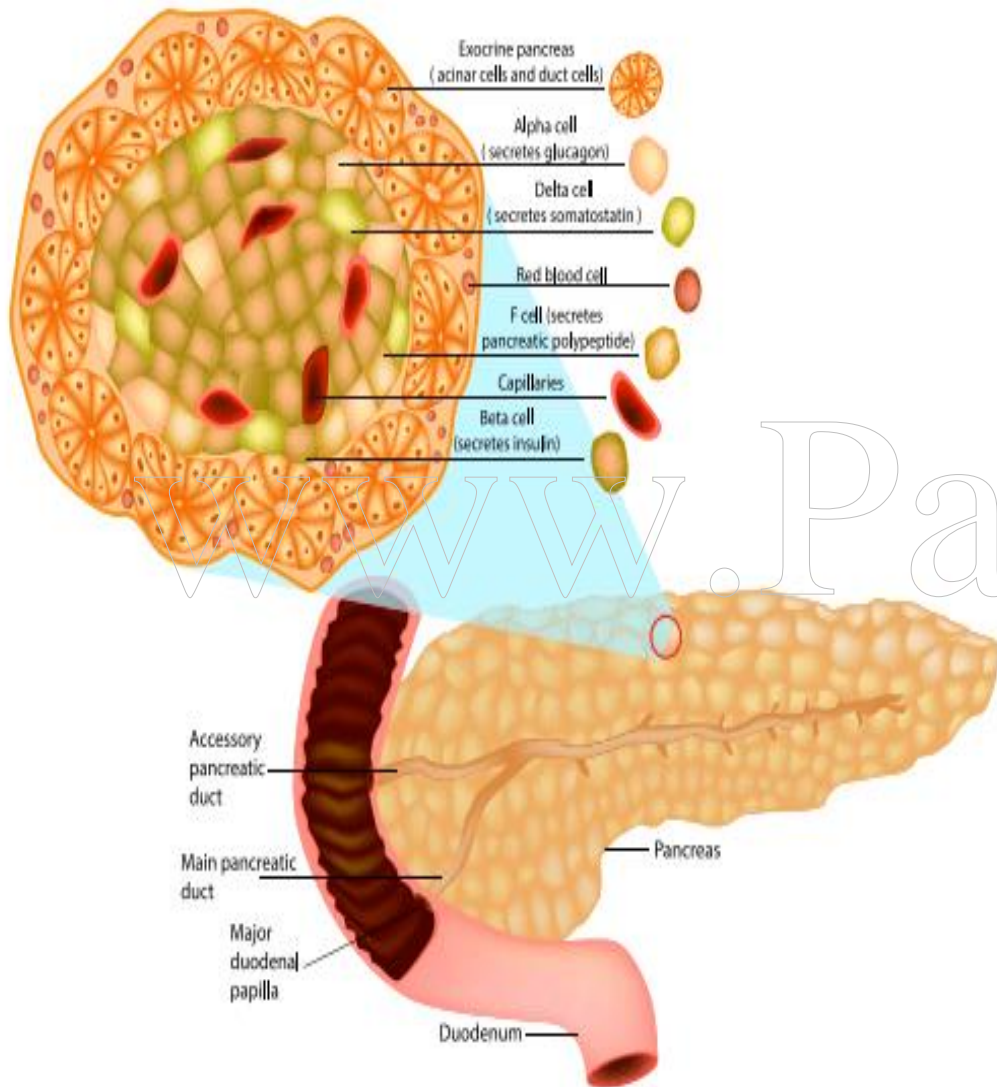


❖ Cushing's syndrome is caused due to **excess secretion of cortisol**.

Symptoms of Cushing's syndrome

1. Obesity of the face and trunk.
2. Redness of face, hand and feet.
3. Thin skin.
4. Excessive hair growth.
5. Loss of minerals from bone (osteoporosis)
6. Systolic hypertension are features of Cushing's syndrome.
7. Suppression of sexual function like atrophy of gonads.

HYPOGLYCAEMIA



- ❖ Hypoglycaemia is due to **increased secretion of insulin** thereby **blood glucose level decreases**.
- ❖ In this disorder **blood glucose level lowers than normal fasting index**.

Symptoms of hypoglycaemia

1. Increased heartbeat
2. Weakness
3. Nervousness
4. Headache
5. Confusion
6. Lack of co-ordination
7. Slurred speech
8. Serious brain defects like epilepsy and coma occurs.

HYPERGLYCAEMIA

- Hyperglycaemia is otherwise known as **Diabetes mellitus**.
- It is caused due to **reduced secretion of insulin**.
- As the result, **blood glucose level is elevated**.
- Diabetes mellitus is of **two types, Type I Diabetes and Type II Diabetes**.
- Type I diabetes is also known **Insulin dependent diabetes**, caused by the **lack of insulin secretion due to illness or viral infections**.
- Type II diabetes is also known as **Non- Insulin dependent diabetes**, caused due to **reduced sensitivity to insulin**, often called as **insulin resistance**.

SYMPTOMS OF DIABETES

1. Polyurea - excessive urination.
2. Polyphagia - excessive intake of food.
3. Polydipsia - excessive consumption liquids due to thirst
4. Ketosis - breakdown of fat into glucose results in accumulation of ketone bodies in blood.
5. Gluconeogenesis - Conversion of non- carbohydrate form like amino acids and fat into glucose.

DIABATES INSIPIDUS

- Diabetes insipidus is caused due to **hyposcretion of vasopressin** (ADH) from neurohypophysis.

- The symptom includes **frequent urination** (polyurea) and **excessive consumption of liquids** due to thirst (polydipsia)



Avoid use of synthetic soft drinks

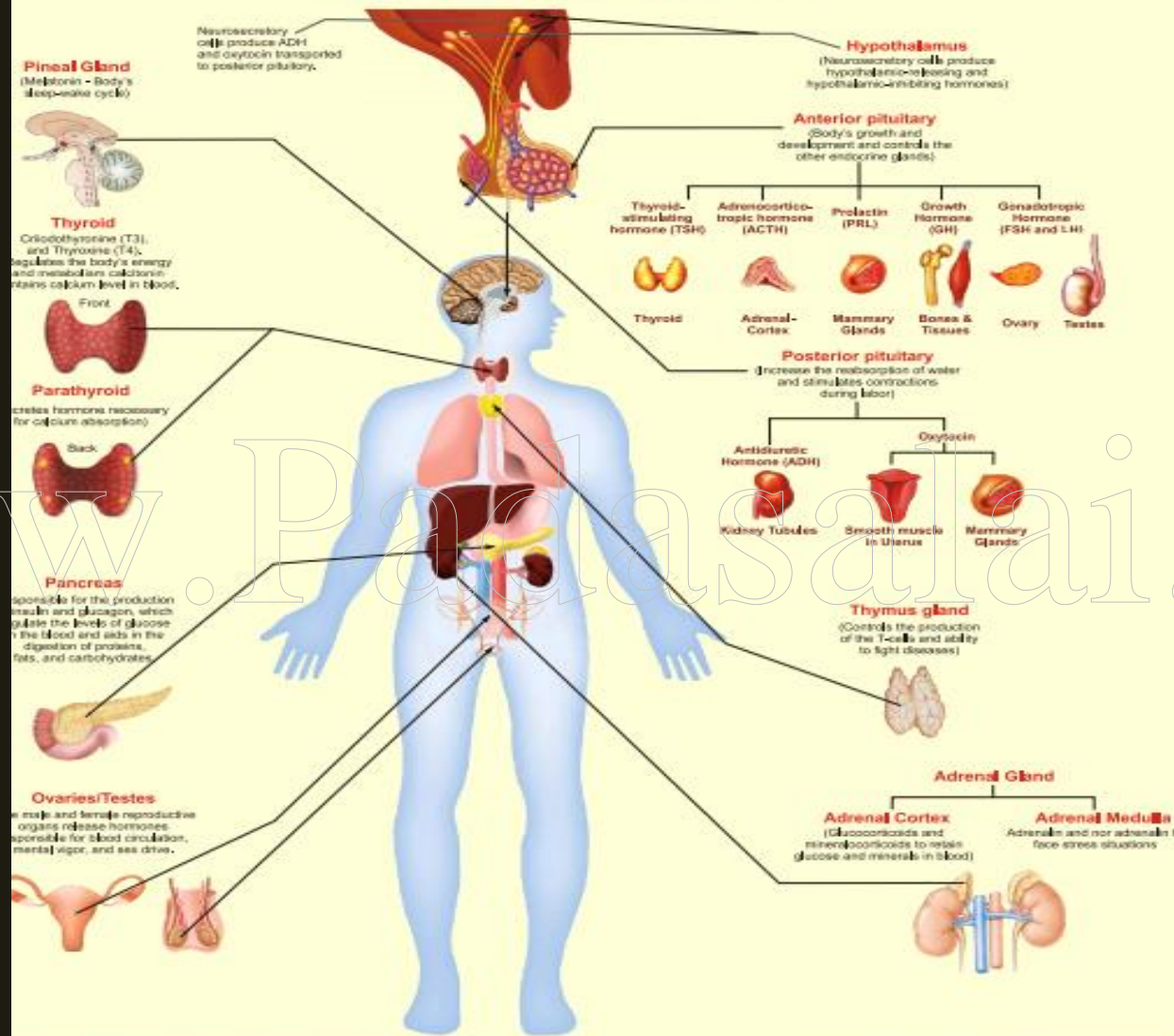
The branded soft drinks damage our endocrine system. While consuming soft drinks, the sugar level increases in blood which leads to elevated insulin secretion to reduce the blood glucose level. The elevated insulin level diminishes immunity and cause obesity, cardio-vascular disorders etc.

Normal blood glucose level:

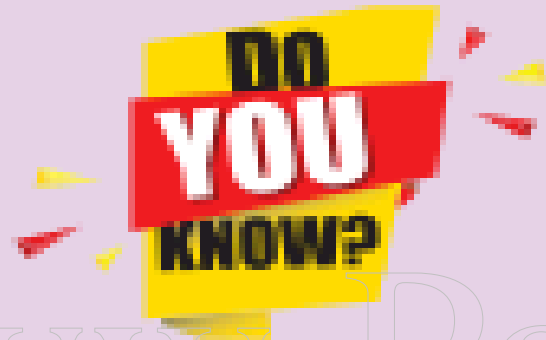
Preprandial : 70 – 110 mg/dl (Before food) – (Fasting)

Postprandial : 110 – 140 mg/dl (About two hours after food)

Location of major endocrine glands - their secretions and storage,



Hypothalamus found deep inside the brain, its products are releasing and inhibiting hormones and controls the pituitary. Together, the hypothalamus and pituitary control the other endocrine glands in our body to make the hormones that control and co-ordinates various physical and physiological activities.



Alcohol consumption has widespread effect on endocrine system. Alcohol impairs the regulation of blood glucose level, reduces testosterone level and increases the risk of osteoporosis.

MECHANISM OF HORMONE ACTION

- Hormones **circulate in the blood** but their **concentration can increase or decrease based on the requirement of the body.**
- This is controlled by **feedback mechanisms.**
- These mechanisms **control the secretion of endocrine glands** by stimulating the hypothalamus, pituitary or both, which in turn governs the secretion of a particular hormone.
- In **positive feedback**, the **secretion of the hormone increases** whereas in **negative feedback** further **secretion of hormone slows down.**
- **Feedback mechanisms** are the key factors for **maintaining homeostasis** in our body.
- Hormones are classified into **three major groups** as **peptide hormones**, **steroid hormones** and **amino acid derived hormones** based on their chemical structure.

PEPTIDE HORMONES

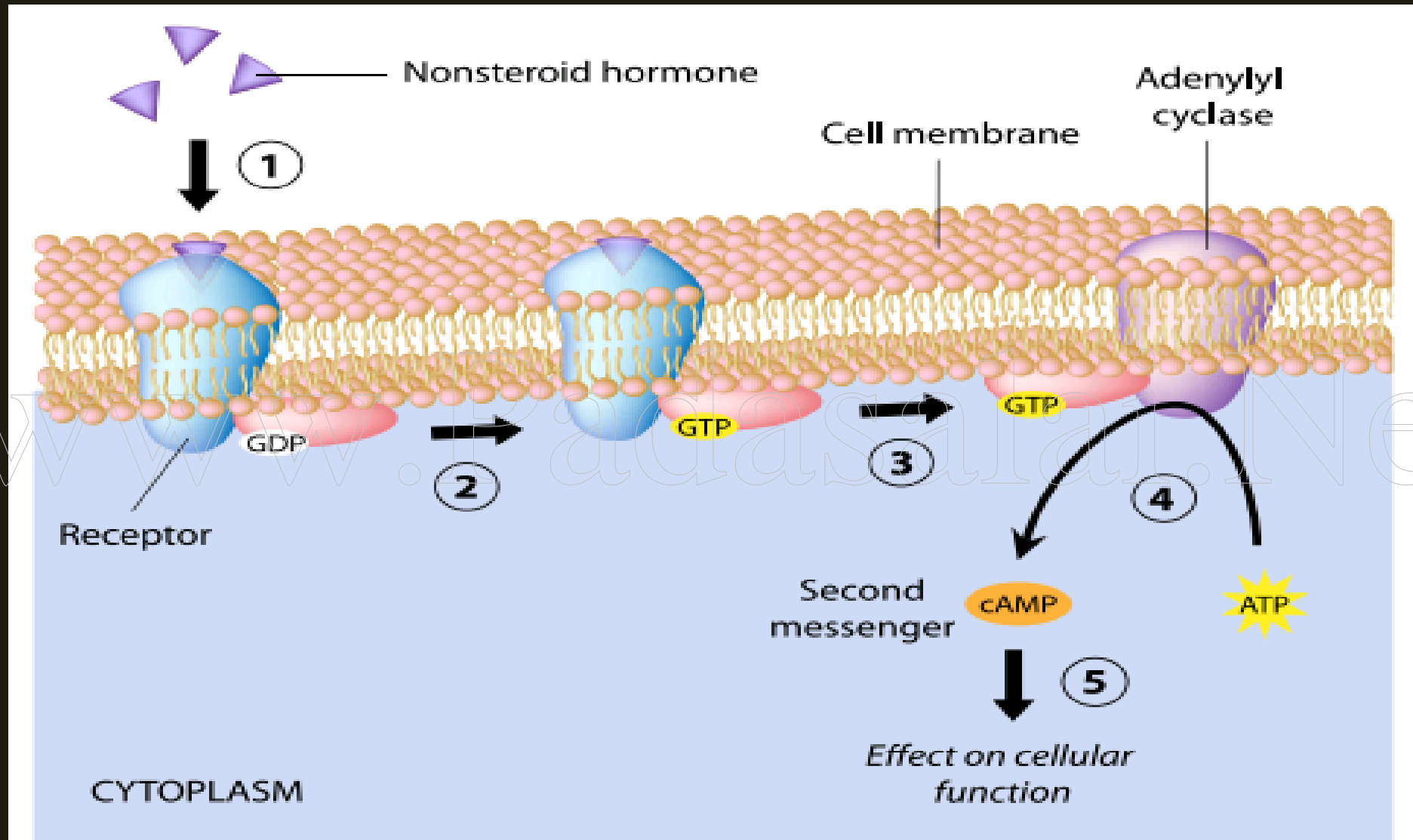
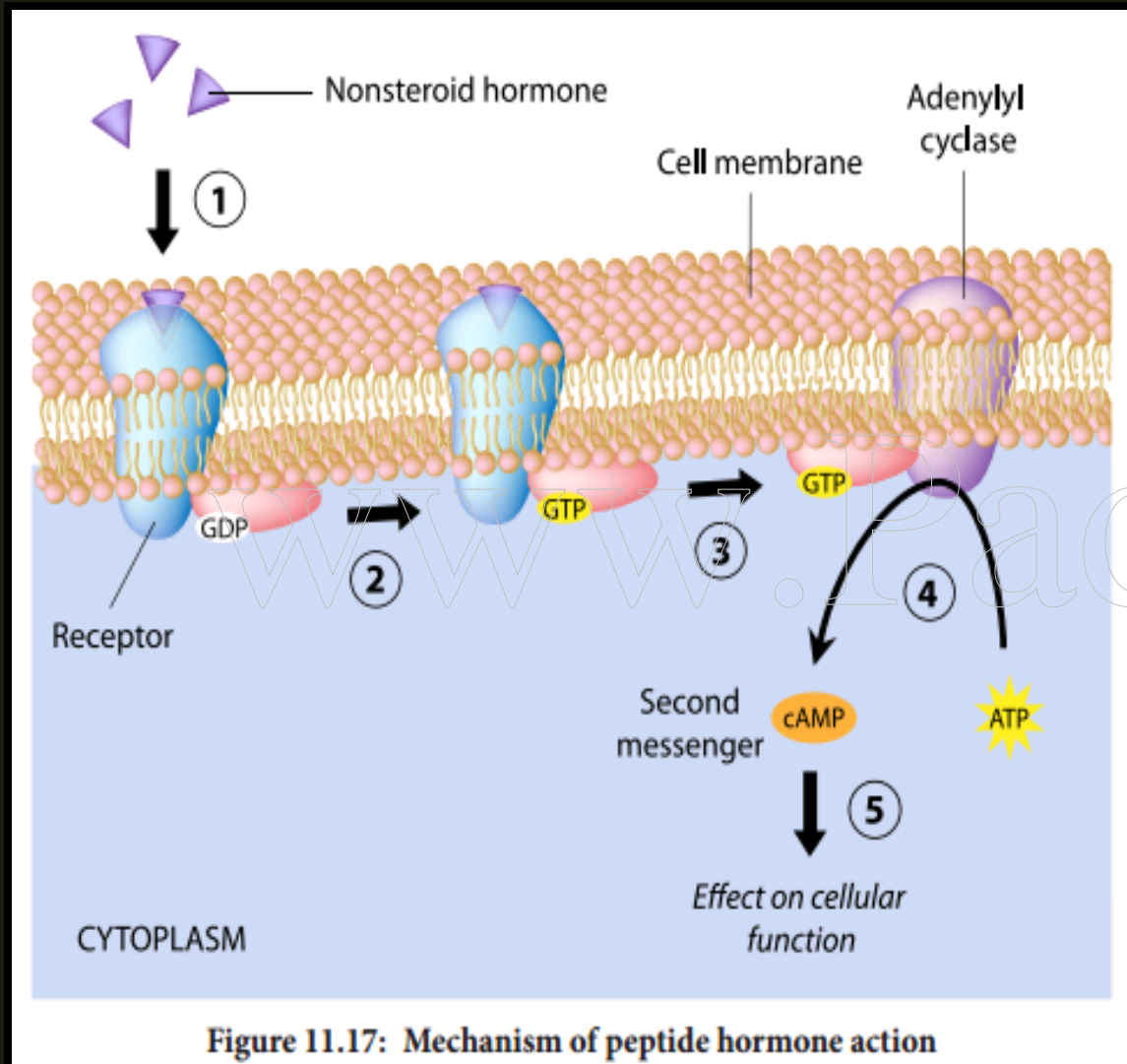


Figure 11.17: Mechanism of peptide hormone action

PEPTIDE HORMONES



- Peptide hormones **cannot cross the phospholipid cell membrane** and bind to the receptors on the exterior cell surface.
- They are **transported to the golgi**, which is the site of modification.
- It acts as a **first messenger** in the cell.
- Hormones on binding to their receptors do not enter the target cell but generate the production of **second messengers such as cyclic AMP (c AMP)**, which in turn regulates cellular metabolism.
- This is catalyzed by the enzyme **adenylate cyclase**.

PEPTIDE HORMONES

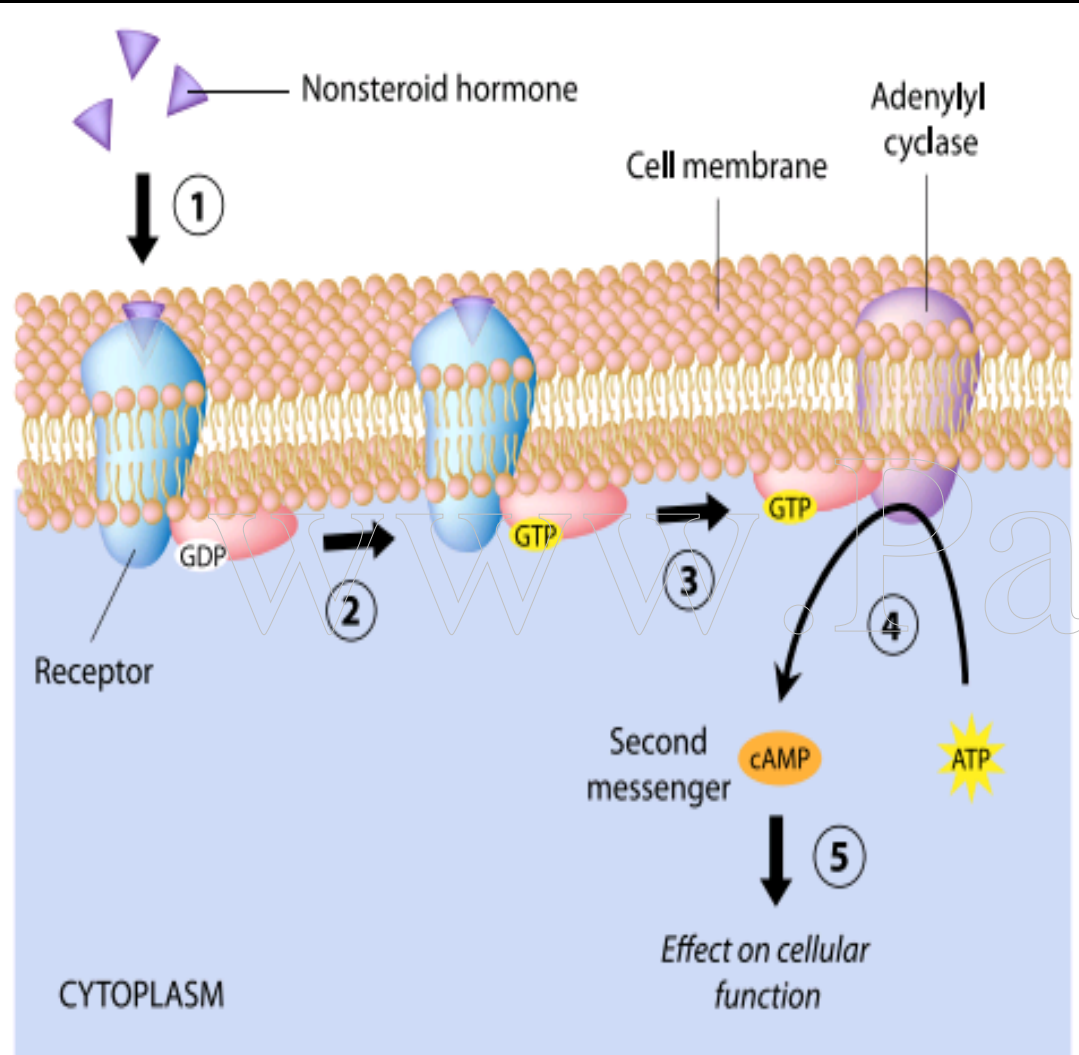
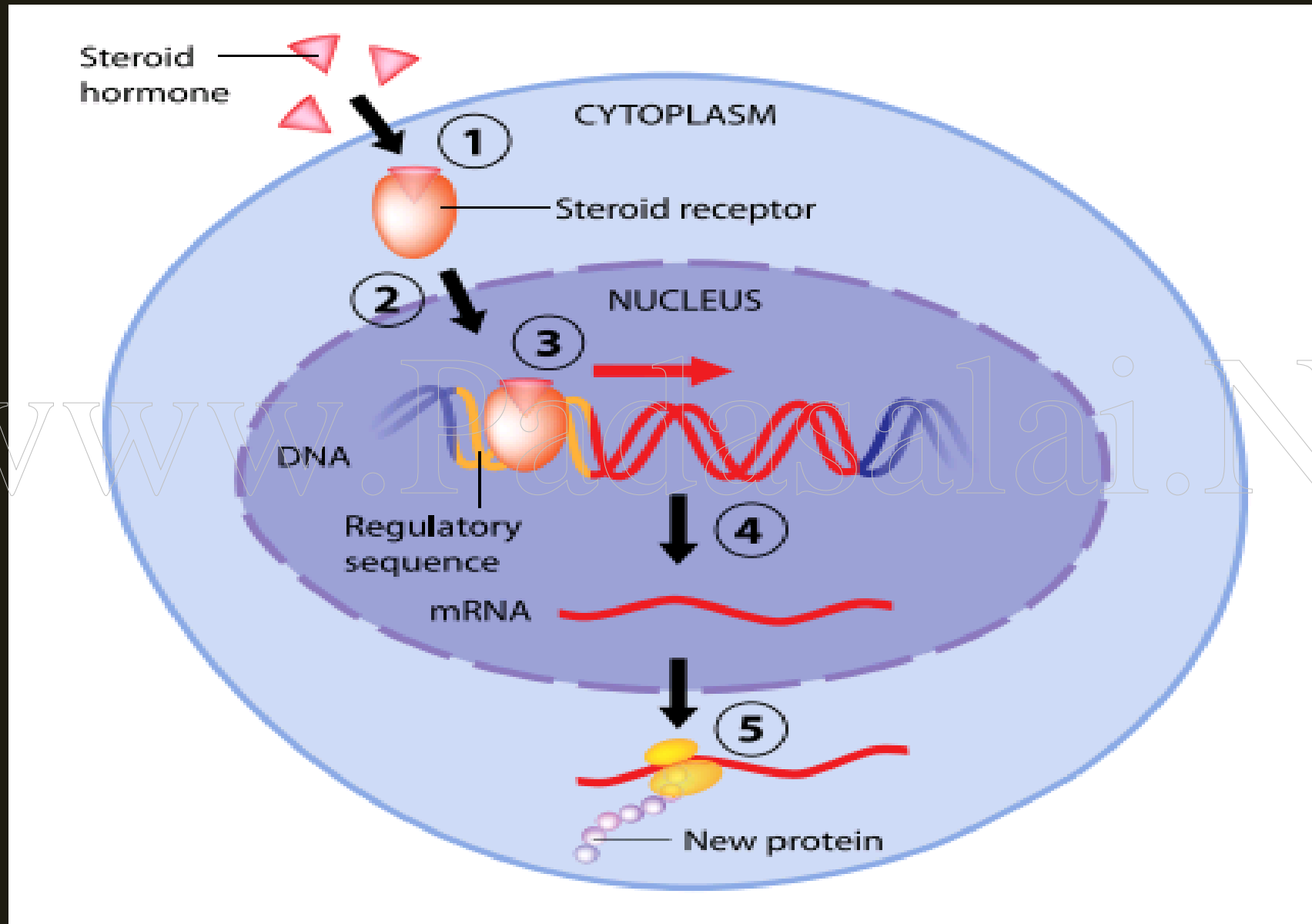


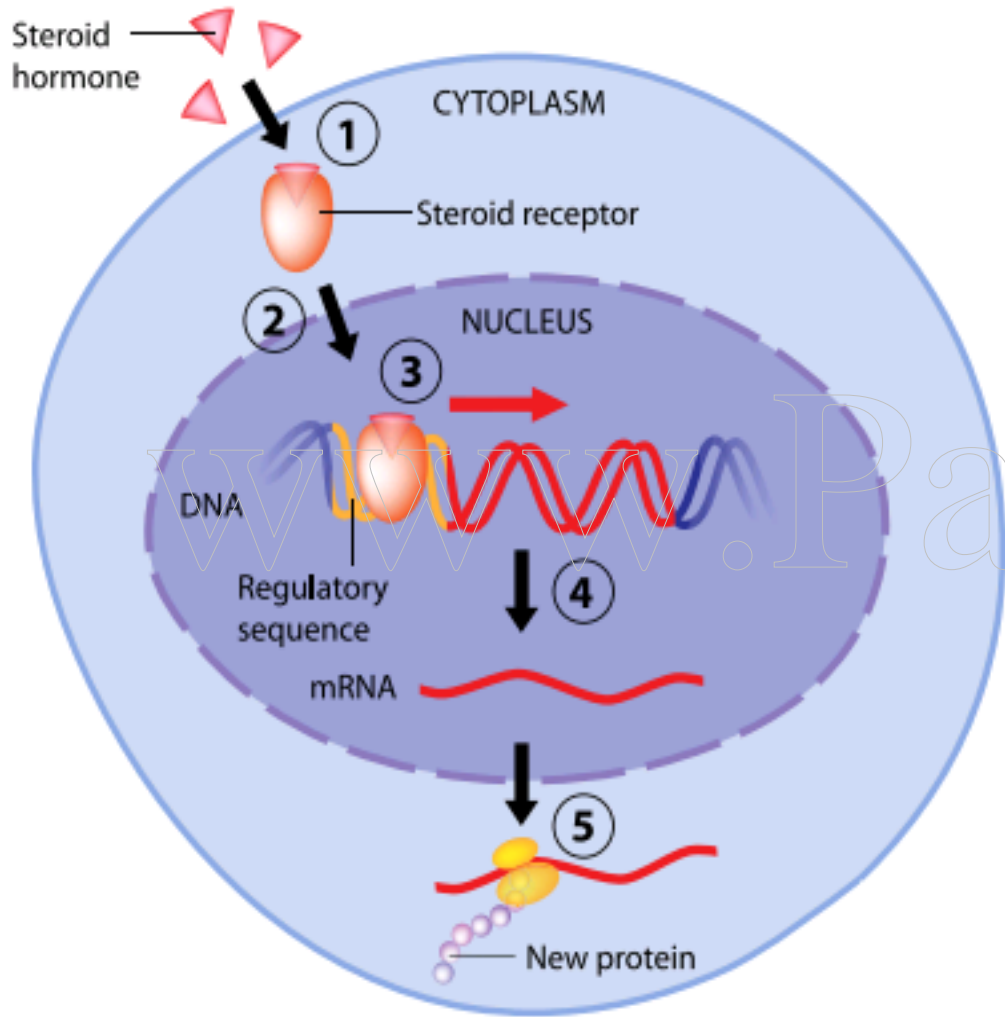
Figure 11.17: Mechanism of peptide hormone action

- The interaction between the hormone at the surface and the effect brought out by cAMP within the cell is known as **signaling cascade**.
- At each step there is a **possibility of amplification**.
 1. One hormone molecule may **bind to multiple receptor molecules** before it is degraded.
 2. Each receptor may **activate several adenylyl cyclases** each of which make much cAMP.
 3. Thus there is **more signal after** each step.
- The actions of cAMP are terminated by **phosphodiesterases**.
- The effect of peptide hormones like insulin, glucagon, somatotropin are usually short lived because they work through **second messenger system**.

STEROID HORMONES



MECHANISM OF STEROID HORMONE ACTION



- Steroid hormones can **easily cross the cell membrane**, and **bind to their receptors**, which are **intracellular or intranuclear**.
- Upon binding to the receptors, they **pair up with another receptor – hormone complex** (dimerize).
- This dimer can then **bind to DNA** and alter its transcription.
- The effect of steroid hormones such as **aldosterone, oestrogen, FSH** are **long lived**, as they alter the amount of mRNA and protein in a cell.

AMINO ACID DERIVED HORMONES

- Amino acid derived hormones are **derived from one or two aminoacid** with a few additional modifications.
- Thyroid hormone is synthesised from **tyrosine** and includes the addition of several iodine atoms.
- Epinephrine an **amino acid derivative** may function through **second messenger system like peptide hormones** or they may actually enter the cell and function like steroid hormones.



Avoid use of steroid components

The abuse of anabolic steroids can cause serious health problems like high BP, heart diseases, liver damage, cancer, stroke and blood clots. Other side effects of steroid use includes nausea, vomiting, ligament and tendon injuries, head ache, joint pain, muscle cramps, diarrhoea, sleep problem etc.

Basal metabolic rate (BMR): The amount of energy needed to keep the body at rest.

நன்றி வணக்கம்

பா.சீனிவாசன்

முதுகலை விலங்கியல் ஆசிரியர்

நடராசன் தமயந்தி மேல் நிலைப் பள்ளி

நாகப்பட்டினம்

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