THE ENDOCRINE SYSTEM

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OPM/ HDCL/ BSME

TOPIC TWO DCM

TOPIC OUTLINE

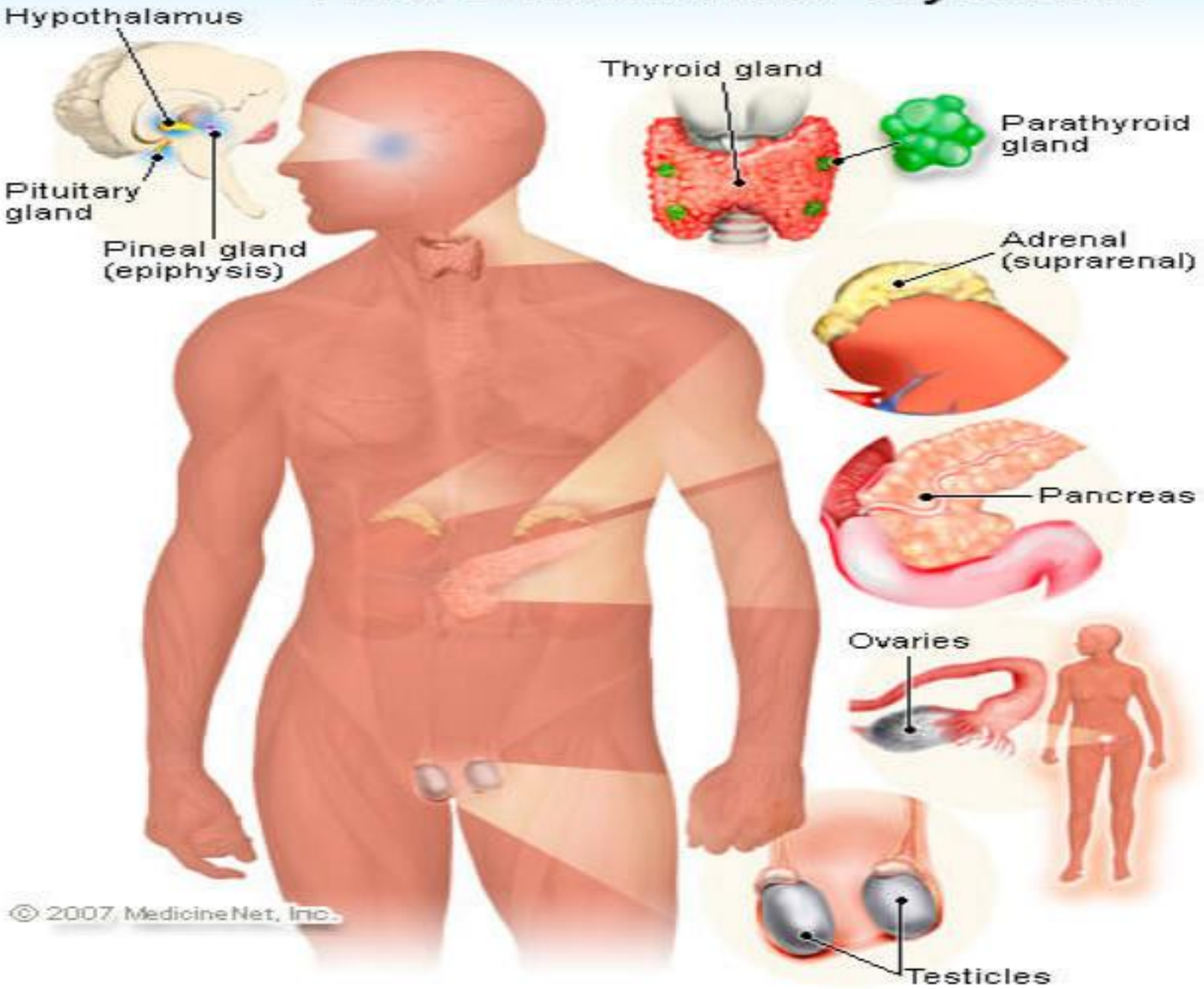
- Definition of common concepts
- Location of different endocrine glands.
- Classification of hormones.
- The anatomy and function of each endocrine gland.
- Common disorders of endocrine gland.

Common concepts

- The endocrine system is composed of all of the glands of the body and the hormones they produce.

- **Endocrine system**; the system comprised of all hormone-secreting cells and endocrine glands.
- The glands are controlled directly by stimulation from the nervous system

The Endocrine System



- Hormones are **chemical messengers, synthesized by** endocrine glands
- Examples of hormones include:

- Thyroid stimulating hormone.
- Testestorone
- Growth hormone
- Follicle stimulating hormone
- Prolactin
- Progestrone
- Anti Diuretic Hormone, etc

- **Local hormones** are those which act locally on neighboring cells or on the exact secreting cell without entering the bloodstream.

- Examples of local hormones include:

- Histamine produced by mast cells released during allergic reactions.
- Prostaglandins are found in most tissues and play a role in uterine contractions, potentiates pain, blood clotting and production of gastric mucus.

- **Circulating hormones;** these hormones pass from their secretory cells or glands into interstitial fluid and then into the blood for transportation.

- Examples include FSH, ADH, Oxytocin, Calcitonin, e.t.c.

- **Target cells;** are body cells with **receptors** to which specific hormones (or neurotransmitters) bind to exert their effects.

- **Exocrine glands** (exo: outside); are glands that secrete their products into ducts which carry the secretions into body cavities, lumen of an organ, or to the outer surface of the body

Classification of hormones

- This is based on solubility of the hormones;

- Includes 2 classes of hormones:
    1) Lipid soluble hormones
    2) Water soluble hormones

1) LIPID-SOLUBLE HORMONES

- Their receptors are located inside target cells.
- Include; thyroid hormones, steroid hormones, and nitric oxide.
- **Steroid hormones** are derived from cholesterol and Secreted by; adrenal cortex, gonads & placenta.
- **Thyroid hormones (T_3 & T_4)**
  - Synthesized by attaching **iodine** to the amino acid **tyrosine**.

- **Nitric oxide (No)** Is both a hormone and a neurotransmitter.
  - Is synthesized under the enzyme **NO synthase**.

2) WATER-SOLUBLE HORMONES

- Their receptors are part of the plasma membrane of target cells (on the cell surface).
- Include:

1. Amine hormones.
2. Peptide hormone.
3. Protein hormones.
4. Eicosanoid hormones.

a). Amine hormones

- Contain an amino group (NH_4^+).
- Synthesized by **decarboxylation** (removing CO_2 molecule) of certain amino acids. Examples:

i. **Catecholamines**; epinephrine, norepinephrine & dopamine are synthesized from the amino acid **tyrosine**.

ii. **Histamine** synthesized by mast cells and platelets; from the amino acid **histidine**.

iii. **Serotonin** & **melatonin** are **tryptophan** derivatives.

b). Peptide hormones

- ✓ Are smaller amino acid polymers.
- ✓ They contain 3-49 amino acid chains.
- ✓ Include;

i. Antidiuretic hormone (ADH) / Vasopressin.

ii. Oxytocin.

b). Protein hormones

- ✓ Are larger amino acid polymers.
- ✓ They contain 50-200 amino acids. Include;

i. Growth hormone
ii. Insulin.
iii. Glycoprotein hormones; protein hormones with attached carbohydrate groups e.g. TSH.

4. Eicosanoid hormones

Are derived from **arachidonic acid**.

Can serve as local hormones and also circulating hormones.

Are 2 major types of eicosanoids.

i. Prostaglandins (PGs).
ii. Leukotrienes (LTs).

- Trial question:

1. Describe the mechanism of hormonal action.

Hint: lipidsoluble

water soluble.

Factors influencing hormonal action

These 3 factors influence the responsiveness of a target cell to a hormone:

- The plasma concentration of the hormone.
- The abundance of the hormone's receptors on the target cell.
- Influence of other hormones for example inhibin.

HORMONAL INTERACTIONS

- **When hormones interact, they produce different effects:**

1. **Synergistic effect**; two hormones working together produce an effect greater than the sum of the individual hormone effects. E.g. epinephrine & norepinephrine, adrenaline & glucagon, etc.

2. **Permissive effect**; a hormone cannot exert its full effects without the presence of another hormone. E.g. thyroid hormones & catecholamines.

3. **Antagonistic effects**; one hormone opposes the actions of another hormone.E.g. insulin & glucagon

REGULATION OF HORMONAL SECRETION

- Essential for preventing **overproduction** or **underproduction** of hormones.

i. **Nervous system signals**; impulses to the adrenal medullae influence the secretion of catecholamines.

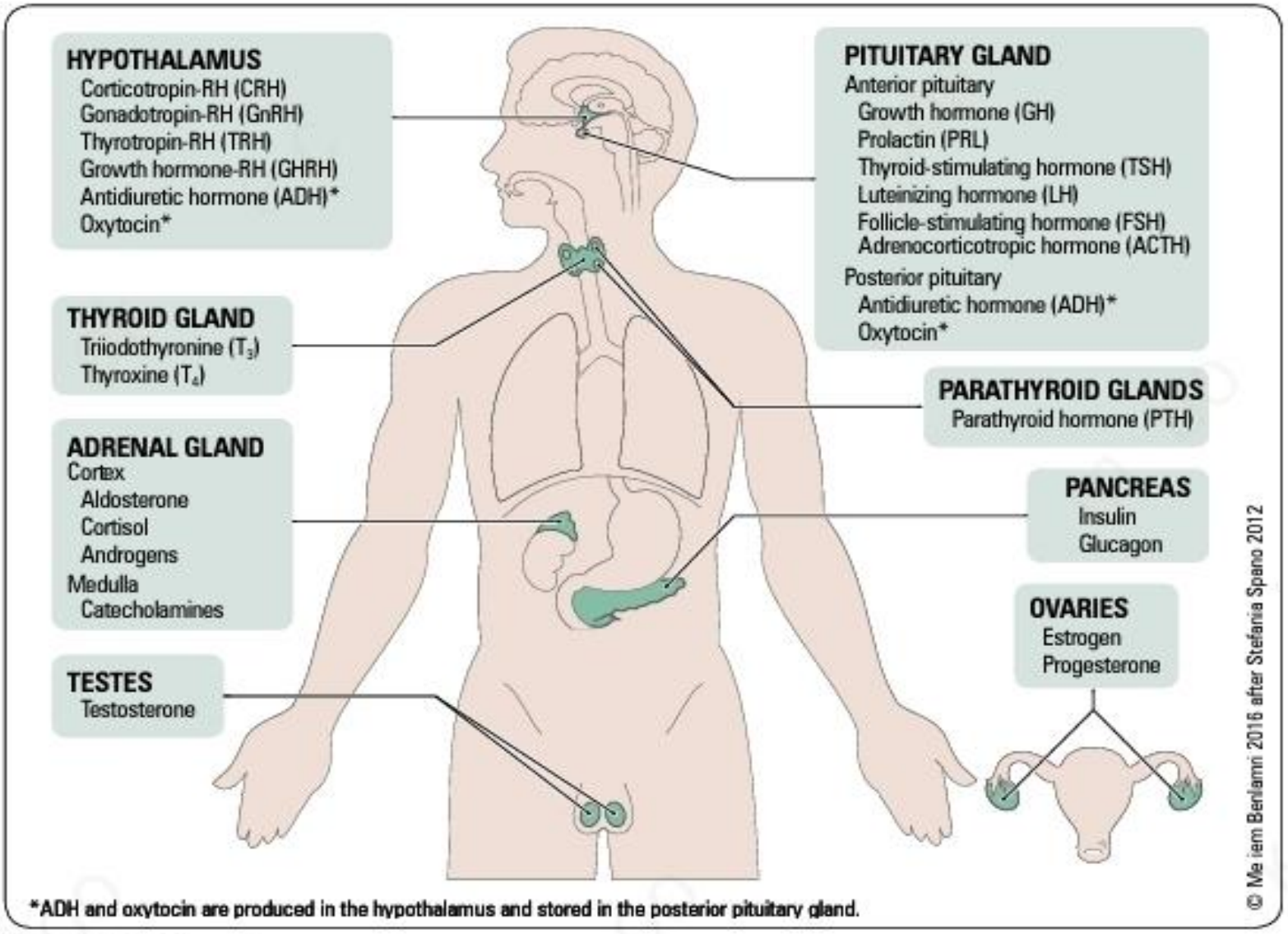
ii. **Chemical changes in blood**; plasma Ca^{2+} levels influence the secretion of PTH.

iii. **Other hormones**; ACTH stimulates the release of cortisol by the adrenal cortex.

- Hormones can be secreted via negative or positive feedback mechanisms.

ANATOMY OF ENDOCRINE GLANDS

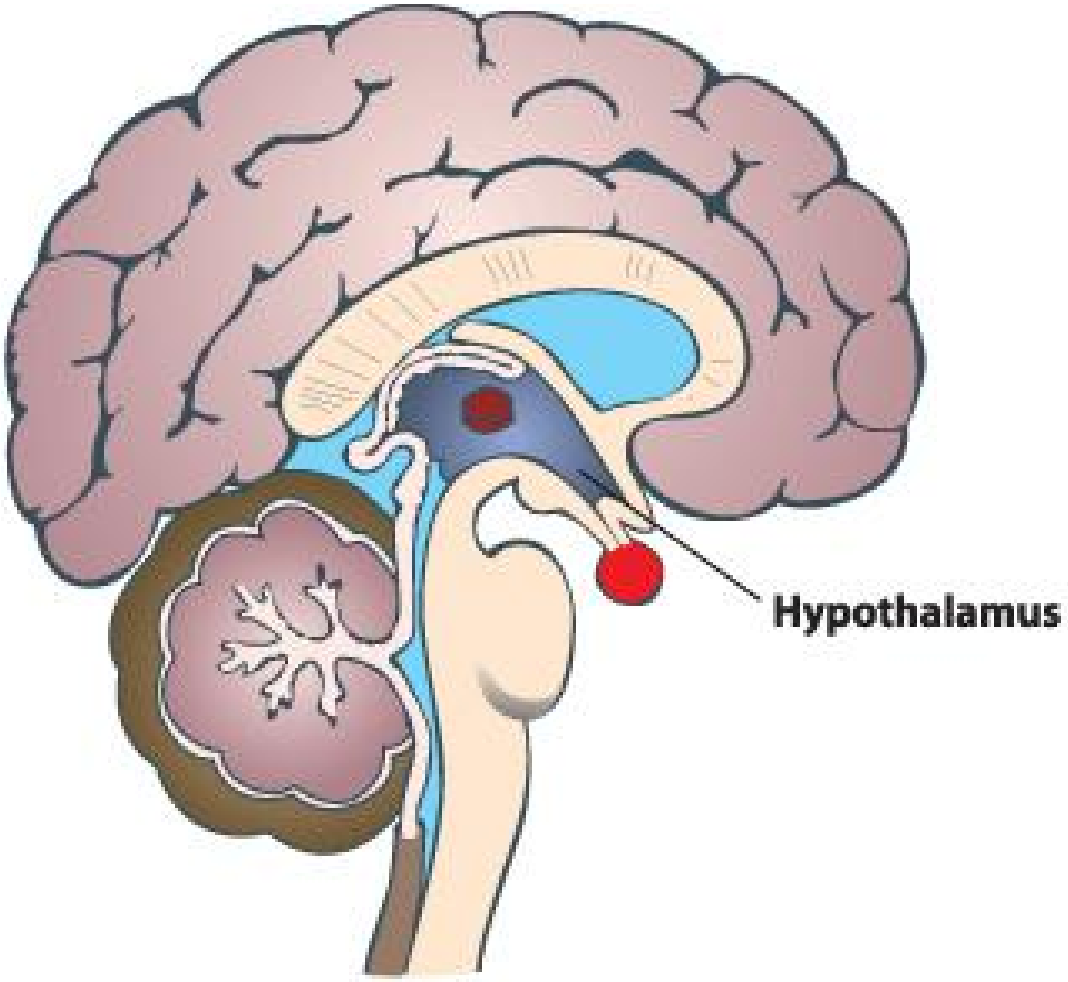
Major Endocrine Organs



THE HYPOTHALAMUS

- The **hypothalamus** is a part of the **brain** located superior and anterior to the brain stem and inferior to the **thalamus**.
- It is responsible for the direct control of the endocrine system through the pituitary gland.
- The hypothalamus contains special cells called **neurosecretory** cells—neurons that secrete hormones:

Hypothalamus



- The hypothalamus contains special cells called neurosecretory cells (neurons that secrete hormones):

- Thyrotropin-releasing hormone (TRH)
- Growth hormone-releasing hormone (GHRH)
- Growth hormone-inhibiting hormone (GHIH)
- Gonadotropin-releasing hormone (GnRH)
- Corticotropin-releasing hormone (CRH)
- Oxytocin
- Antidiuretic hormone (ADH)

- All of the releasing and inhibiting hormones affect the function of the **anterior pituitary** gland.
- The last two hormones—oxytocin and antidiuretic hormone—are produced by the hypothalamus and transported to the **posterior pituitary**, where they are stored and later released.

THE PITUITARY GLAND

- The pituitary gland, also known as the hypophysis,
- A small pea-sized lump of tissue connected to the inferior portion of the hypothalamus of the brain.
- Many blood vessels surround the pituitary gland to carry the hormones it releases throughout the body.
- It is located in the sella turcica or the hypophyseal fossa.

DIVISIONS OF THE PITUITARY GLAND

- The pituitary gland is actually made of 2 completely separate structures:

- the **posterior** and

- **anterior** pituitary glands.

- the anterior lobe makes up75% of the total pituitary weight.

Is made up of epithelial tissue; with 2 parts:

i. The pars distalis;

Is the larger portion.

ii. Pars tuberalis;

Forms a sheath around the infundibulum.

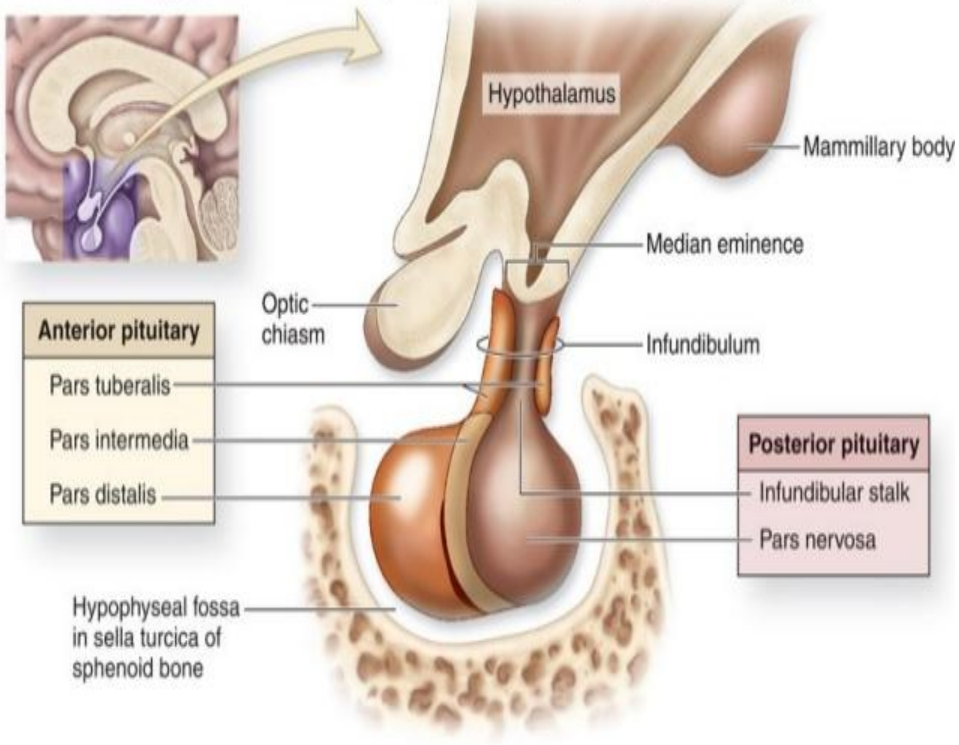
- The posterior lobe is Composed of neural tissue and has 2 parts:

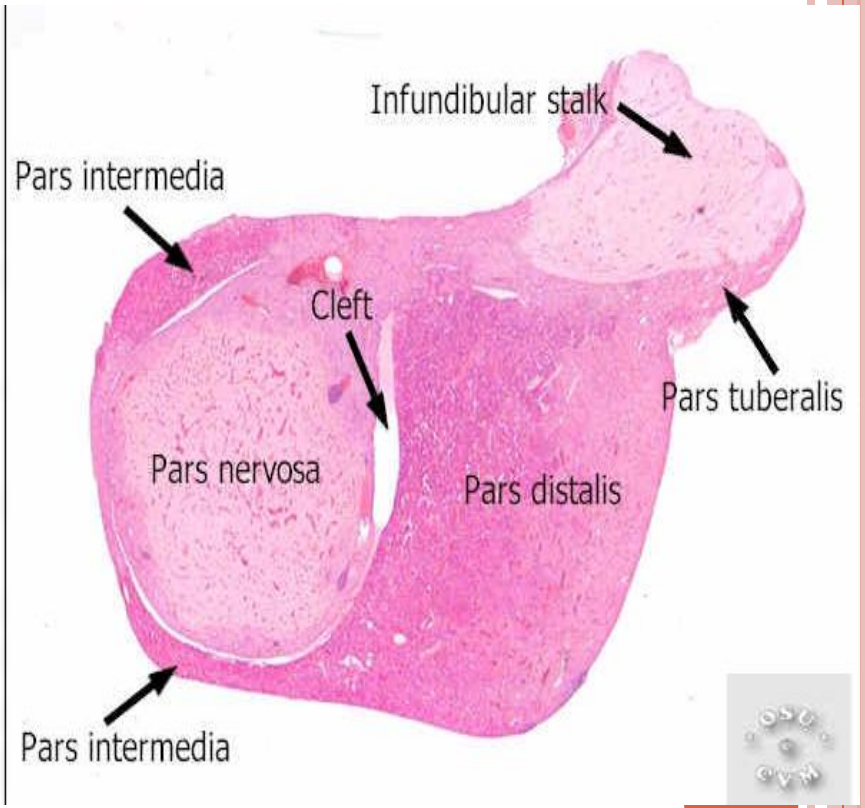
i. **The pars nervosa;**

The larger bulbar portion.

ii. **The infundibulum**.

Pituitary Gland…





Hormones of anterior pituitary

- The anterior pituitary produces 6 important hormones which stimulate or inhibit secretion by other endocrine glands (target organs)

1. Thyroid stimulating hormone (TSH), as its name suggests, is a tropic hormone responsible for the stimulation of the thyroid gland.

2. Adrenocorticotropic hormone (ACTH) stimulates the adrenal cortex, the outer part of the adrenal gland, to produce its hormones.(glucocorticoids)

3. Follicle stimulating hormone (FSH) stimulates the follicle cells of the gonads to produce gametes—ova in females and sperm in males.

4. Luteinizing hormone (LH) stimulates the gonads to produce the sex hormones—estrogens in females and testosterone in males.

5. Human growth hormone (HGH) affects many target cells throughout the body by stimulating their growth, repair, and reproduction.

6. Prolactin (PRL) has many effects on the body, chief of which is that it stimulates the **mammary glands** of the breast to produce milk.

HORMONES OF THE POSTERIOR PITUITARY

1. Oxytocin

- triggers uterine contractions during childbirth
- release of milk during breastfeeding.
- Helps to reduce PPH.

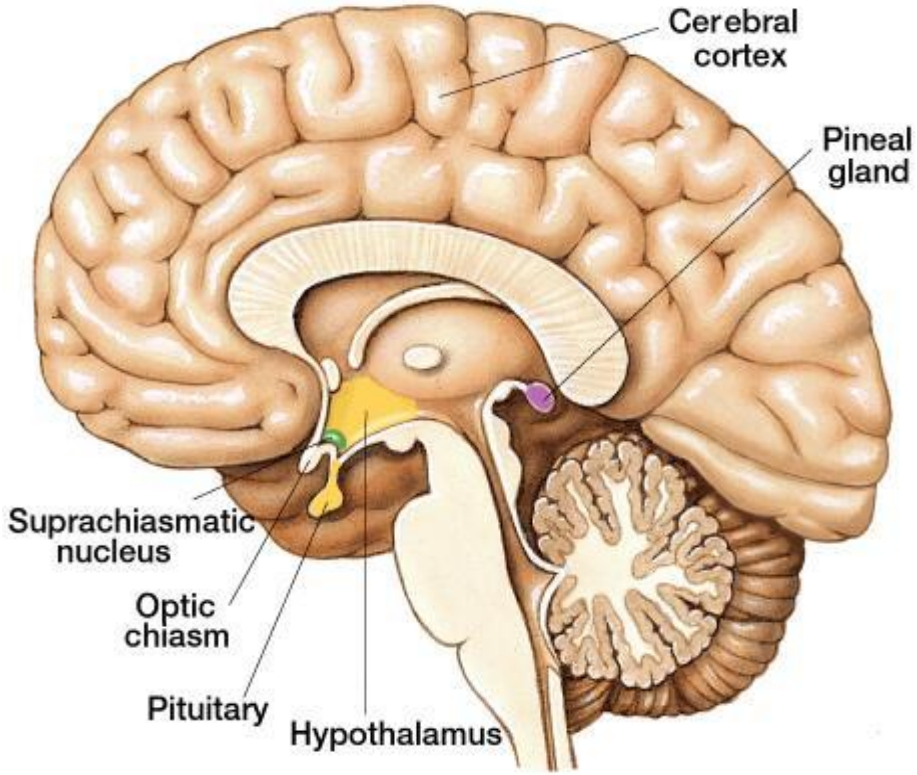
2. Antidiuretic hormone (ADH)

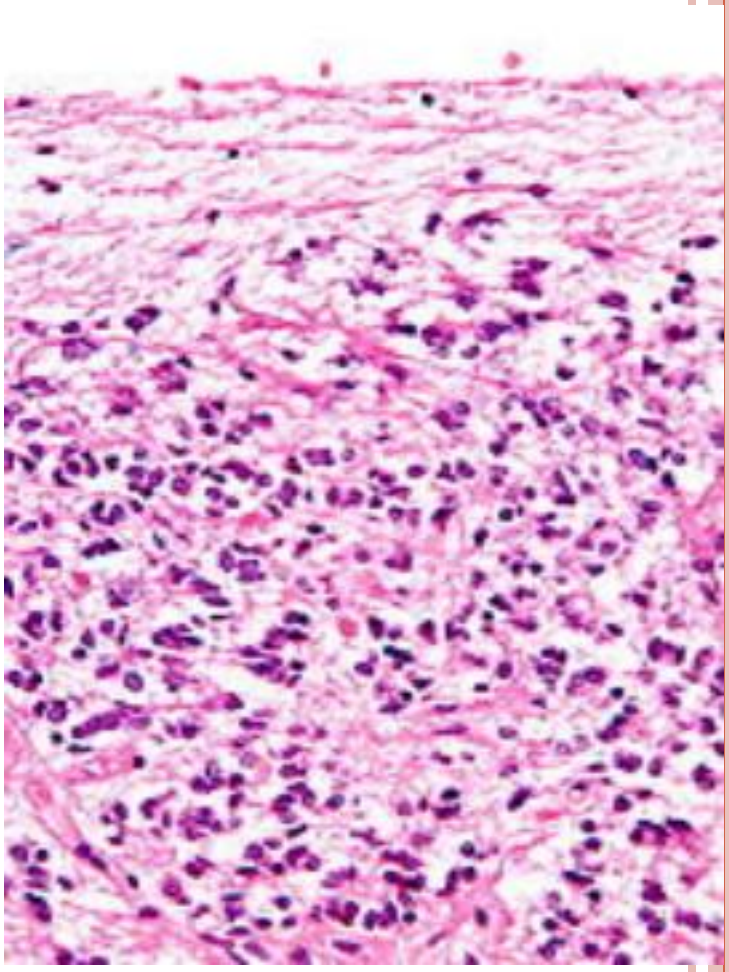
- prevents water loss in the body by increasing the re-uptake of water in the kidneys and reducing blood flow to sweat glands

Pineal Gland

- This is a small pinecone-shaped mass of glandular tissue found just posterior to the thalamus of the brain.
- The pineal gland produces the hormone melatonin that helps to regulate the human sleep-wake cycle (circadian rhythm).
- It contains masses of neuroglia & secretory cells called **pinealocytes**.
- The activity of the pineal gland is inhibited by stimulation from the photoreceptors of the retina.
- Low levels of melatonin are then secreted during the day & higher levels secreted at night.

Pineal Gland…

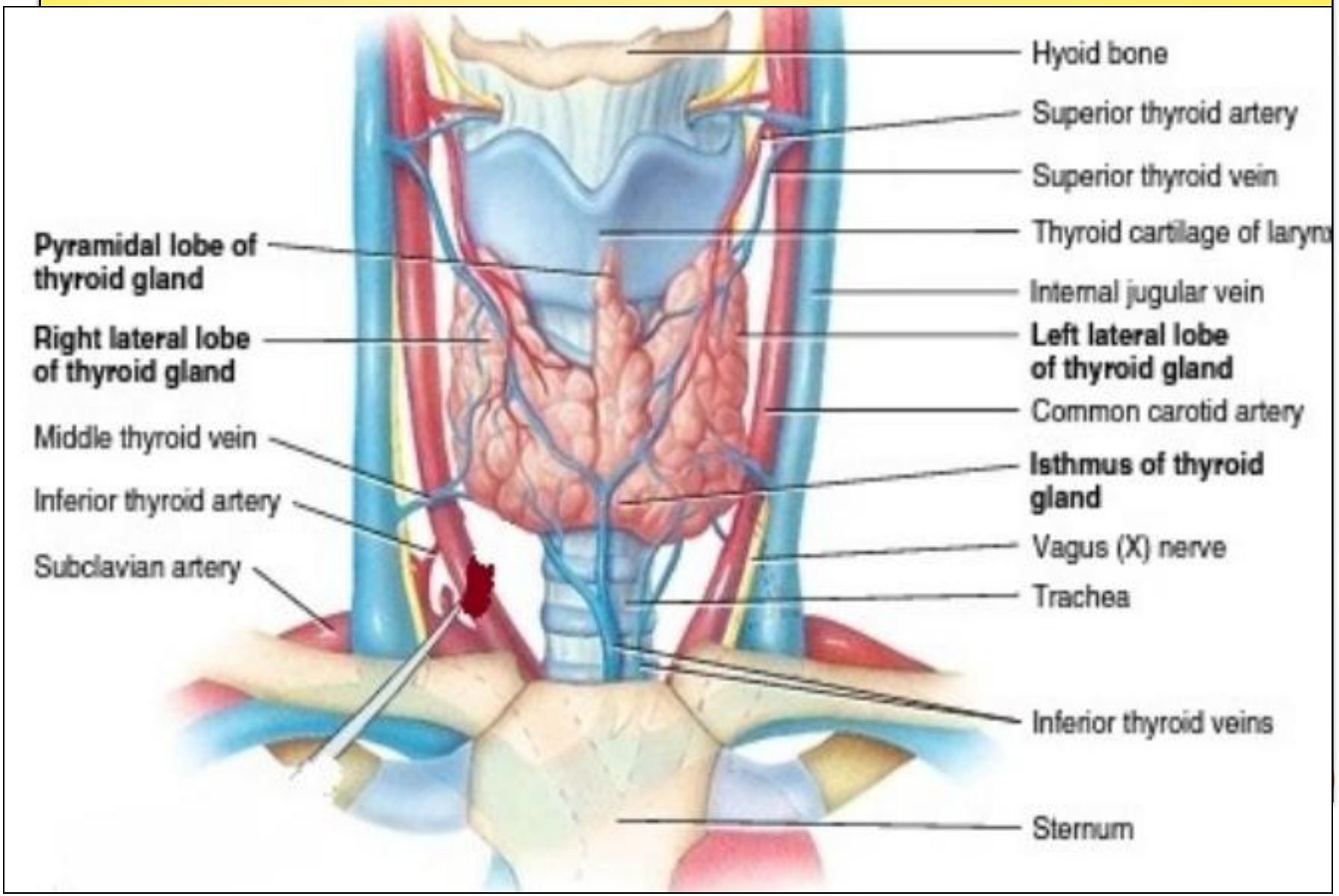




The thyroid gland

- The **thyroid gland** is a butterfly-shaped gland located at the base of the neck and wrapped around the lateral sides of the trachea.

The Thyroid Gland



The thyroid gland produces 3 major hormones:

- Calcitonin
- Triiodothyronine (T3)
- Thyroxine (T4)

- Thyroid gland is composed of large number of closed **follicles.** These follicles are lined with cuboidal epithelial cells, which are called the follicular cells

- **Follicular cells** secrete tetraiodothyronine (thyroxine) and tri-iodothyronine
- Situated between follicles are a few cells; **Parafollicular cells** / C cells which secrete calcitonin.

Role of thyroid hormones

- Calcitonin functions to reduce the concentration of calcium ions in the blood by aiding the absorption of calcium into the matrix of bones.
- The hormones T3 and T4 work together to regulate the body's metabolic rate. Increased levels of T3 and T4 lead to increased cellular activity and energy usage in the body.

- T3 and T4 also Promote the formation of ossification centers in developing bones.
- Deficiency of thyroid hormones during fetal development, infancy, or childhood causes severe mental retardation and stunted bone growth.

SUB TOPIC SUMMARY

- We are now able to:
- Define the common concepts used in endocrine system.
- Locate the various endocrine glands and the hormones produced,
- Classify the hormones chemically with examples.
- State the hormones produced by:
- 1. hypothalamus and their roles
- 2. pituitary gland and their roles
- 3. thyroid glands and their functions.

- Thank you for participating..