ENDOCRINE I

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Intended learning outcomes

by the end of this chapter, the students will be able to:

a. Describe the histological structure of the following endocrine glands: Pituitary, Thyroid, Parathyroid.

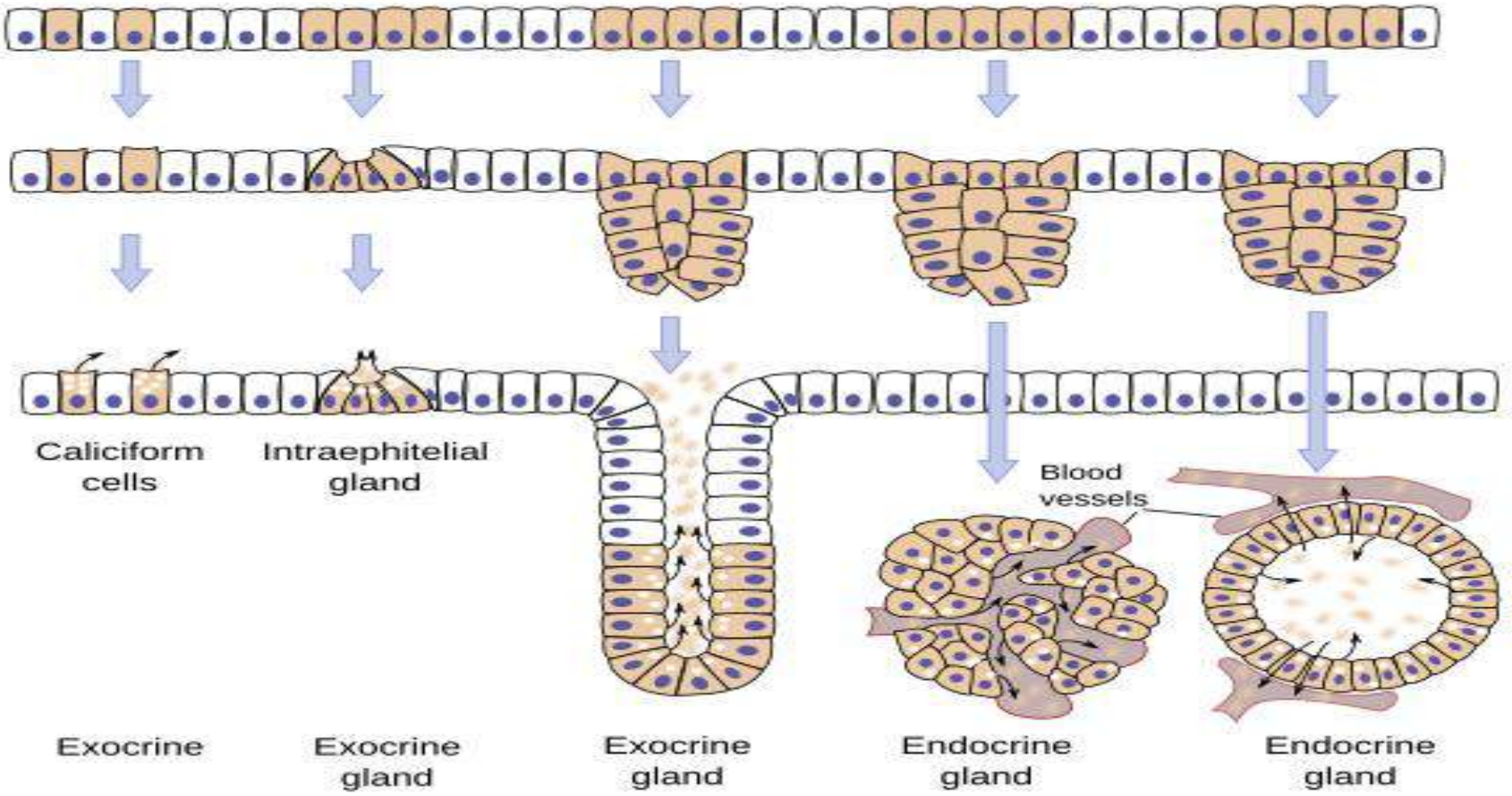
b. Identify different types of cells present in each gland.

c. Relate the composition of each gland to its specific function.

d. Predict the special type of hormones secreted by each gland.

GLANDS

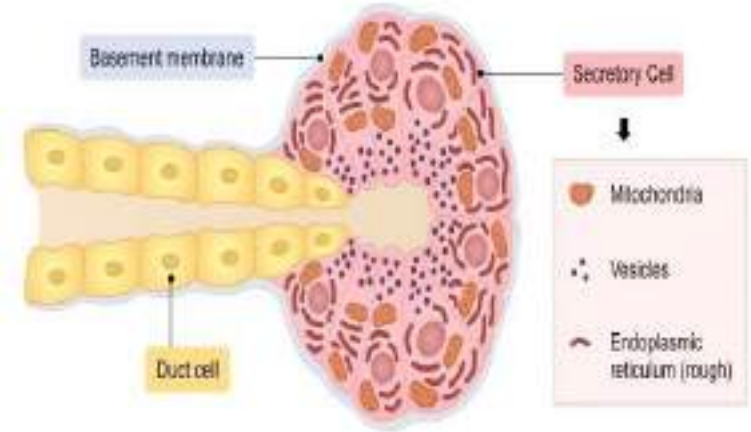
Glands arise from the covering epithelium which proliferates into the underlying connective tissue.



1- The exocrine glands:

- They retain their connection with the surface epithelium from which they originated. This connection takes the form of ducts.

- Exocrine glands have a secretory portion and duct system that transports the secretion.



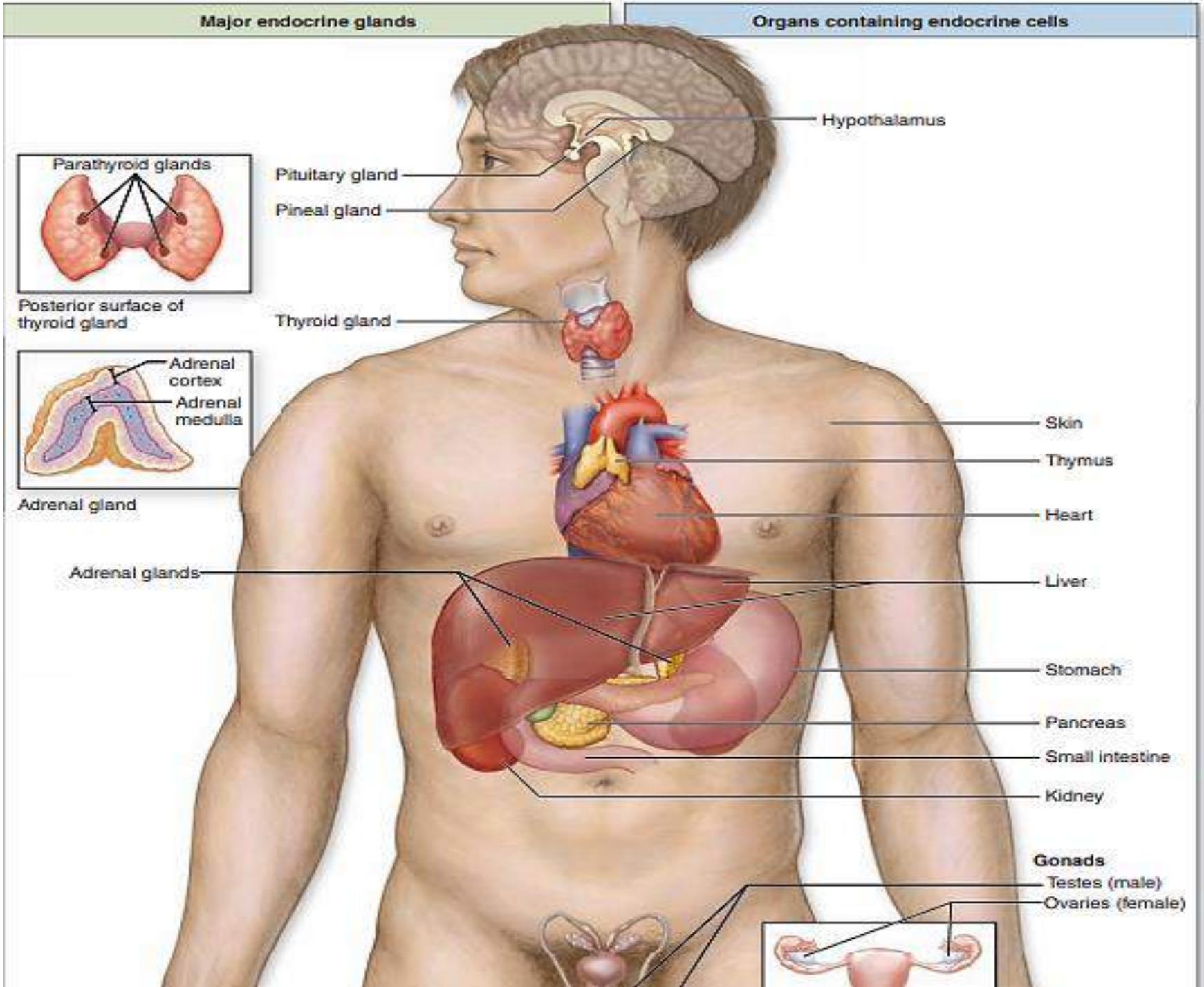
2- The endocrine glands:

- They are glands whose connection with the surface was obliterated, so they are ductless glands and their secretions are transported to the site of action by blood stream.

3- Mixed exocrine and endocrine glands: they contain both types.

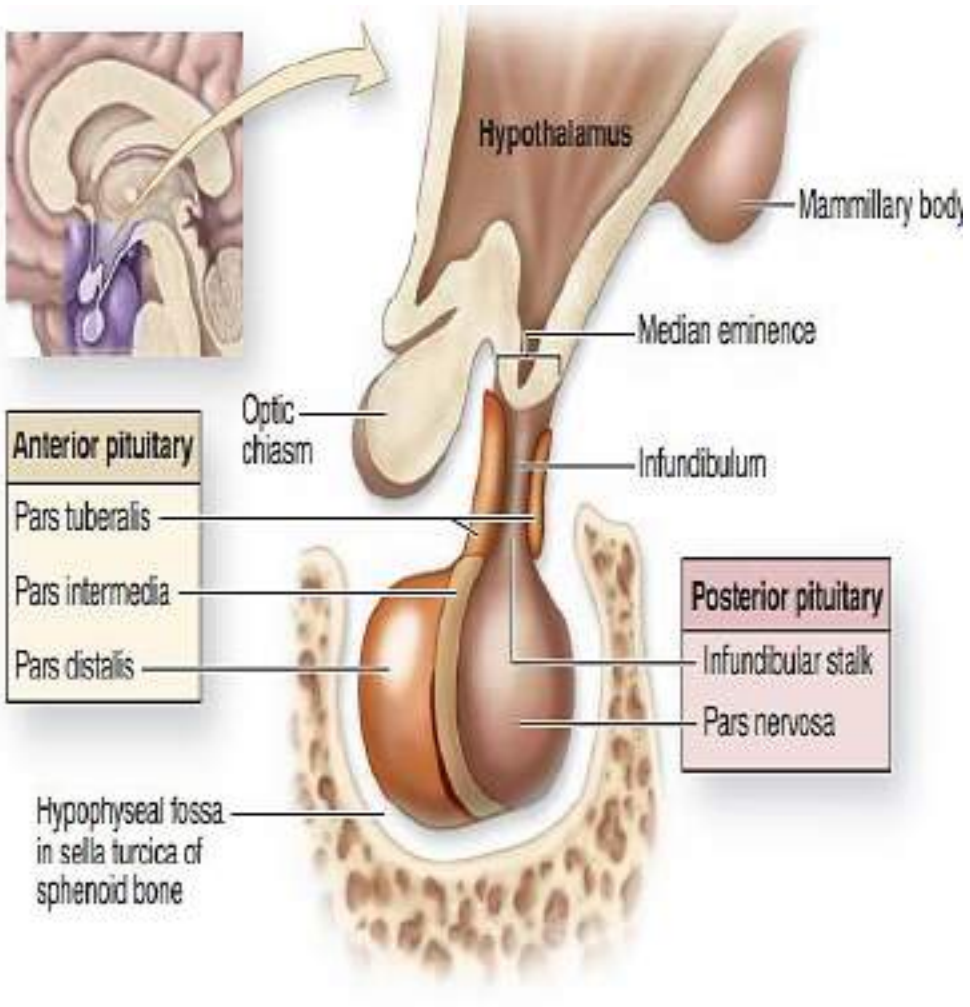
ENDOCRINE SYSTEM

- The endocrine system is the system which deals with the secretion of hormones that regulate the functions of different body tissues and organs. ducts.
- **Hormones** are chemical messengers that exert their effects at sites away from the site of their secretion. The cells on which the hormones act are called **target cells** that have special receptors on their plasma membranes which can recognize the specific hormone.
- **Types of hormones:** Lipid-Derived, Amino Acid derived, Peptide derived


Major endocrine glands
Organs containing endocrine cells
Parathyroid glands
Posterior surface of thyroid gland
Adrenal cortex
Adrenal medulla
Adrenal gland
Hypothalamus
Pituitary gland
Pineal gland
Thyroid gland
Adrenal glands
Skin
Thymus
Heart
Liver
Stomach
Pancreas
Small intestine
Kidney
Gonads
Testes (male)
Ovaries (female)

PITUITARY GLAND
(Hypophysis Cerebri)

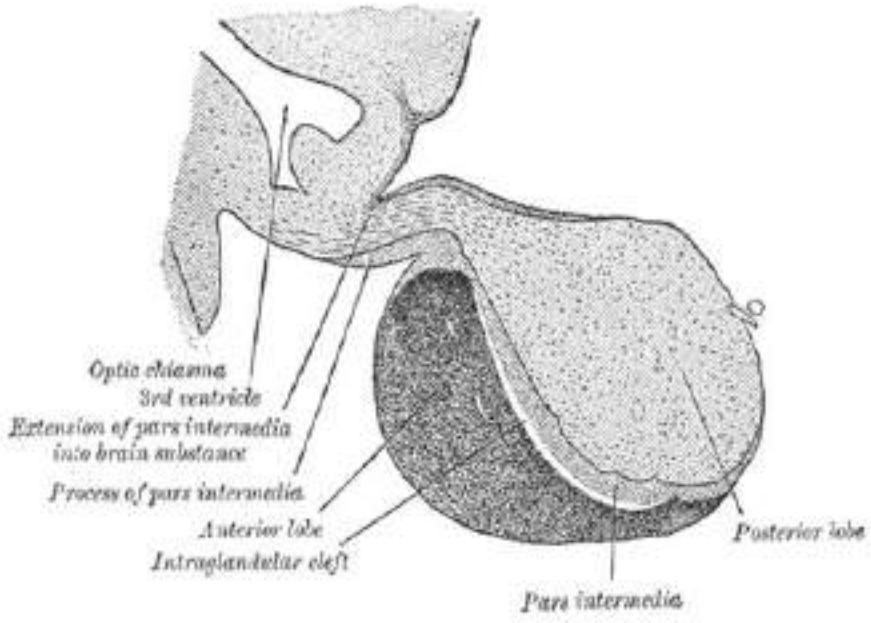
- Hypophysis (physis=growth)
- Site: below the brain in a small cavity on the sphenoid bone, the sella turcica
- The pituitary gland is considered the master endocrine gland because its secretion controls other endocrine glands. The pituitary gland itself is under the control of hypothalamus.

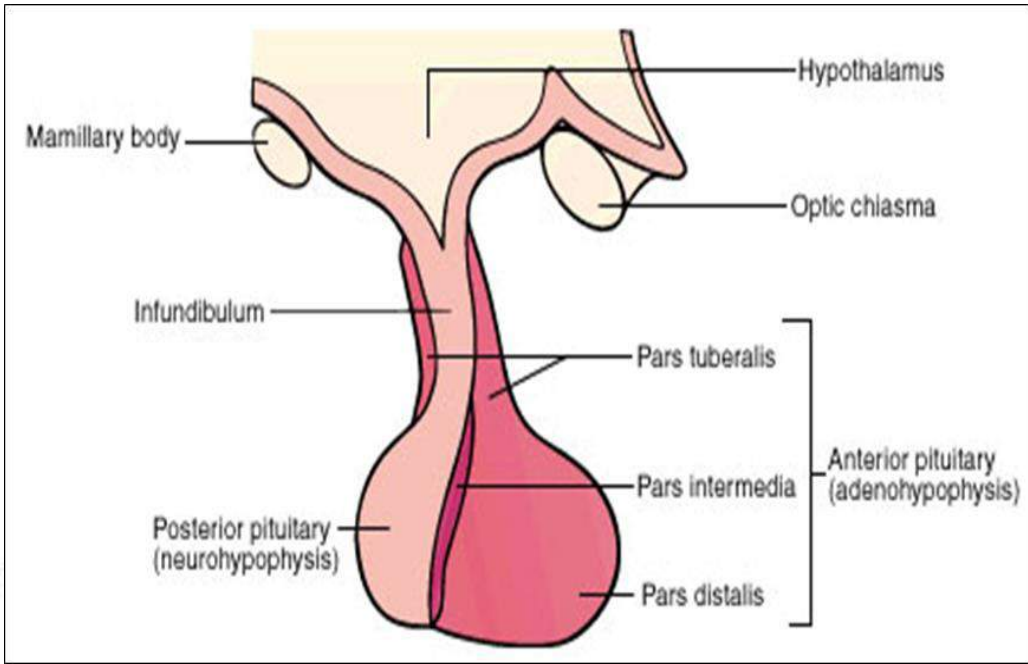


- It has two subdivisions, which develop from different embryologic origin

1. **Adenohypophysis (anterior pituitary):** develops from oral ectoderm
2. **Neurohypophysis (posterior pituitary):** develops from neural ectoderm

- Both the adenohypophysis and the neurohypophysis are joined and covered by C.T. capsule.





1. Adenohypophysis

- The adenohypophysis consists of 3 parts:

A. ***Pars distalis*** (anterior lobe) which comprises the largest part of adenohypophysis and located anteriorly.

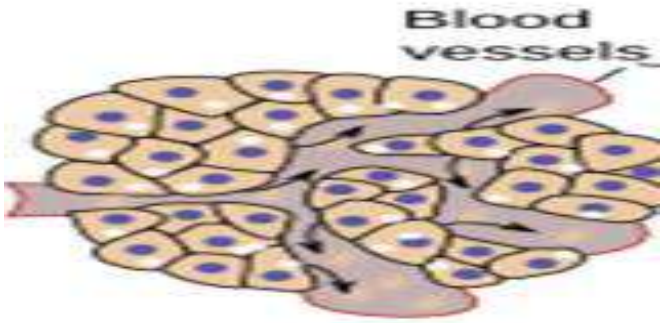
B. ***Pars tuberalis*** is the superior extension of pars distalis that surrounds the neural stalk (the part that connects the pituitary gland to the hypothalamus).

C. ***Pars intermedia*** is the narrowest part lying between pars distalis and pars nervosa and it is separated from the distalis by the cleft.

- **<u>A- Pars distalis</u>:**

- It accounts for 75% of the mass of the hypophysis.

- It is composed of irregular branching cords of parenchymal cells separated by wide fenestrated blood capillaries and sinusoids, supported by fine reticular fibers and few fibroblasts.



- **The parenchymal cells:**

- They are classified according to their staining affinity into:- ***Chromophobes and Chromophils***

Chromophobes:

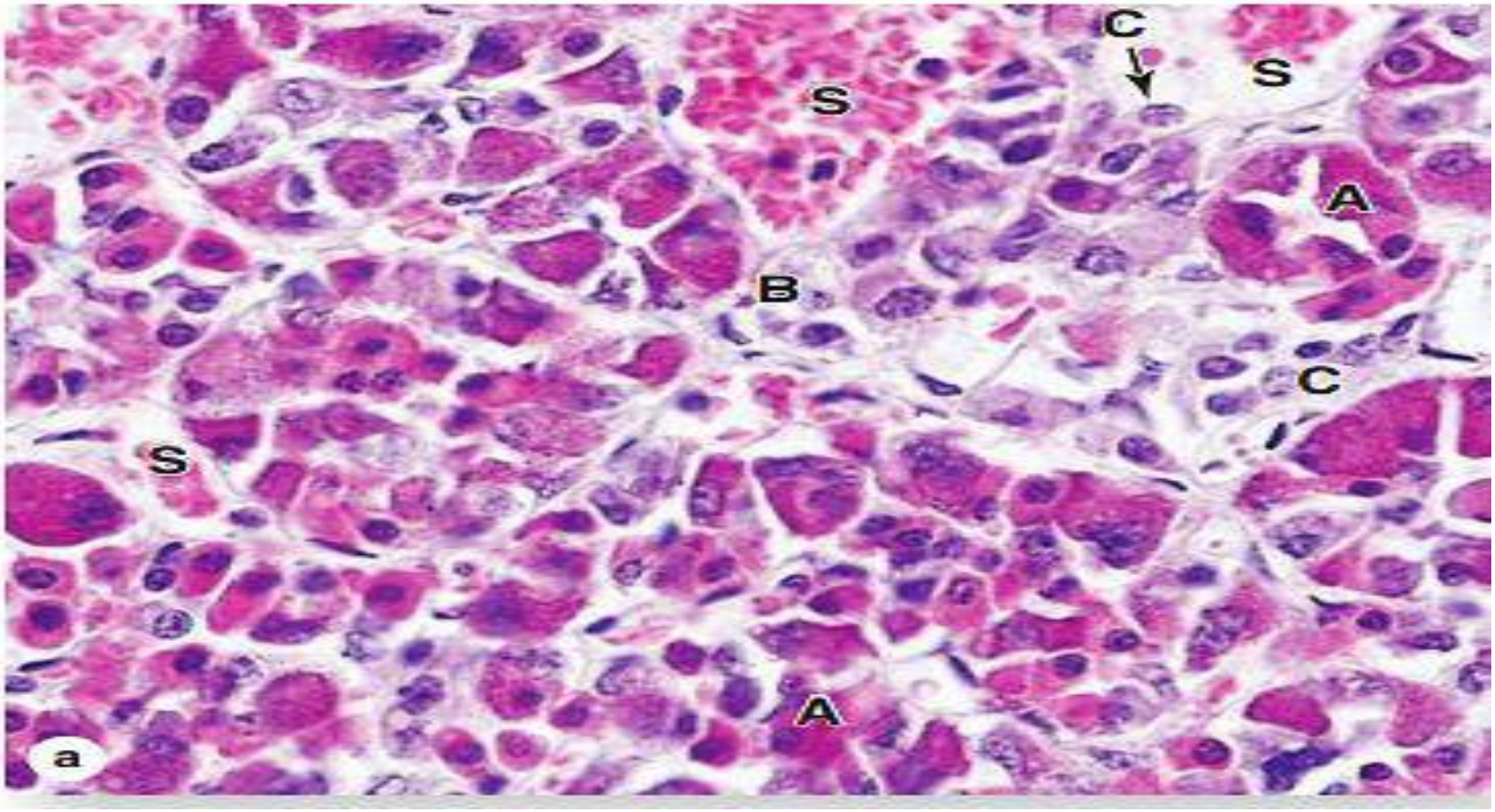
- They are the cells which have no affinity for stains.
- They are about 50% of the cells.
- They are the smallest parenchymal cells in the adenohypophysis.
- By E/M, these cells have few secretory granules in the cytoplasm.
- They represent either nonspecific stem cells or partially degranulated chromophils.

Chromophils:

- They are about 50% of the cells.
- They are the cells that have affinity for stains.
- According to the staining and function they are subdivided into:

❖ **Acidophils** (stain with acid dyes as Eosin, E).

❖ **Basophils** (stain with basic dyes as Hematoxylin, Hx).



- the pars distalis is subdivided into acidophil cells (A), basophils (B), and chromophobes (C) in which the cytoplasm is poorly stained.

A- ACIDOPHILS

- They are the most **abundant cells** in the pars distalis.
- **L/M:** -They are **smaller** in size than basophilis

-The cytoplasm contains large granules that can be seen with L/ M.

-These granules stain orange to **red with eosin or orange G.**

-They give **PAS negative** reaction.

- **E/M:**

- The cytoplasm contains well developed Golgi, mitochondria and abundant rER. The secretory granules have characteristic size, shape and electron density by which the different cell types can be recognized.

- Two types of cells can be detected:

1- Somatotrophs:-

-They are the **most numerous** cells.

-The cytoplasm contains **numerous,** round or oval dense and largest **secretory granules**, 300-400 nm in diameter.

-They have a centrally placed nucleus.

-Function:

They secrete somatotropin (growth hormone).

2- Mammotrophs:

- They are small polygonal cells arranged **individually** rather than clumps or clusters.

- The cells can be distinguished by large **irregular secretory granules** which formed by fusion of smaller granules.

- The granules increase in size during pregnancy and lactation up to 600 nm in diameter.

- ***Function:***

They secrete prolactin hormone which is a protein that promotes mammary gland development during pregnancy and stimulates milk secretion.

B- BASOPHILS

- They are larger in size than acidophilis and few in number (about 10%).

- **LM:**

-The granules stain with basic dyes (blue with Hx)

-They are orange G negative They give PAS positive (glycoprotein).

-Mostly located at periphery of the pars distalis.

- **EM:**

The cytoplasm contains well developed Golgi, mitochondria and few dilated rER.

1- Corticotrophs

- They are round or ovoid, **medium sized cells** with eccentric nucleus and relatively few organelles.
- They have small sparse secretory granules, 250-400 nm in diameter. These granules are located at the extreme periphery of the cell.
- ***Function:*** They secrete adrenocorticotropic hormone (ACTH) which stimulates secretion of the hormones of suprarenal cortex.

2- Thyrotrophs

- They are **large angular** cells deeply embedded within the parenchymal cells and **usually at a distance from sinusoids.**
- They have dark elongated mitochondria and round and eccentric nuclei.
- They have small secretory granules, 150 nm in diameter, **uniform** in size, and tend to be peripherally located within the cell.

-Function: They secrete thyroid stimulating hormone (TSH). It is a glycoprotein which stimulates thyroid gland

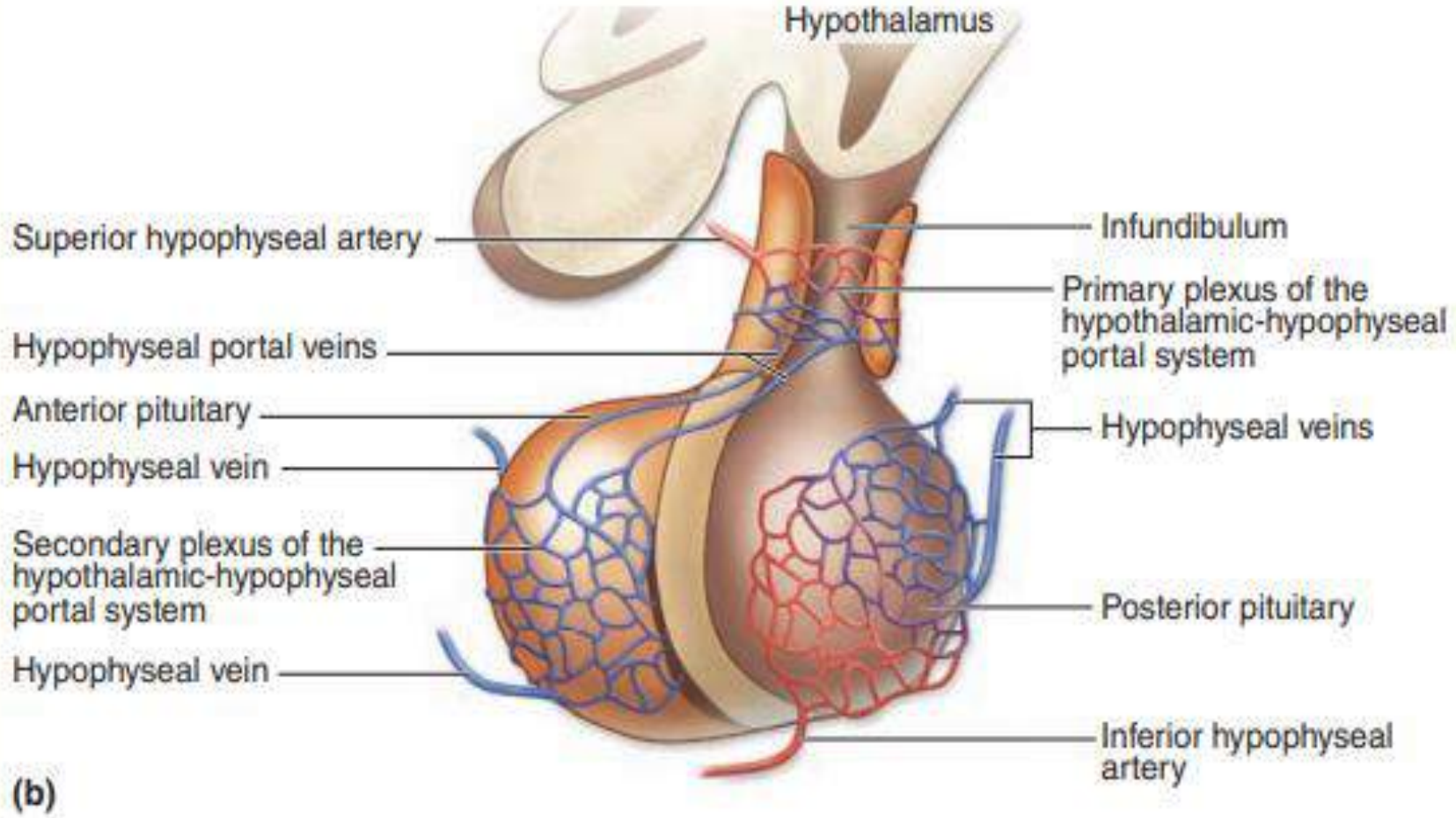
3- Gonadotrophs

-They are **large rounded** cells usually situated **near the sinusoids.**

-Their secretory granules are circular, and **variable** in size and density. They vary from 200 to 400 nm.

-Function: They secrete follicle stimulating hormone (FSH), luteinizing hormones (LH) & interstitial cell stimulating hormone (ICSH).

Blood supply of pituitary
Hypophyseal portal system



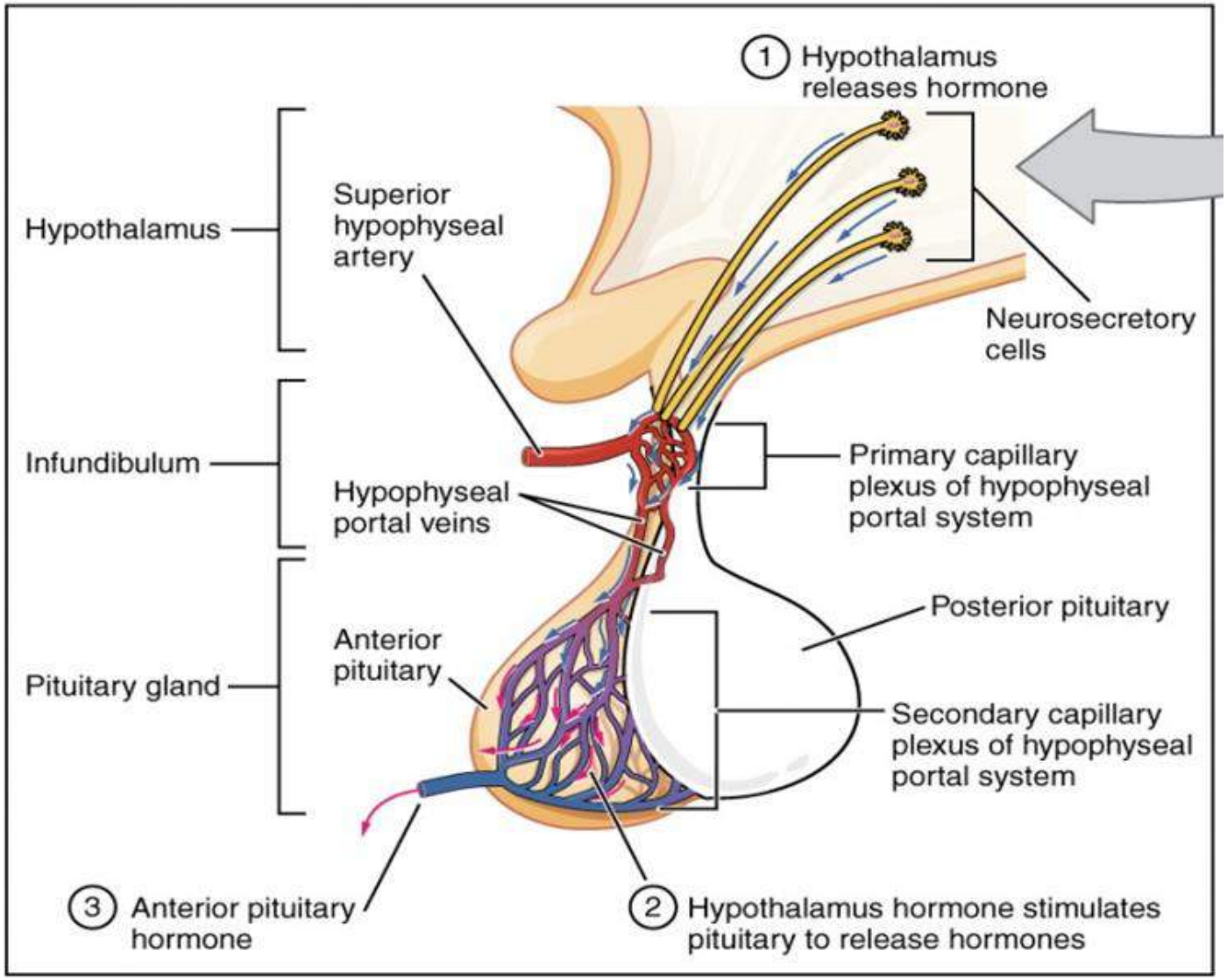
Blood supply of pituitary
Hypophyseal portal system

-Blood supply derives from two groups of vessels coming off the internal carotid artery and drained by the hypophyseal vein. The superior hypophyseal arteries supply the median eminence and the infundibular stalk; the inferior hypophyseal arteries provide blood mainly for the neurohypophysis.

-The superior hypophyseal arteries form a primary capillary plexus of fenestrated capillaries that irrigate the stalk and median eminence.

-They then rejoin to form hypophyseal portal veins that develop a secondary capillary plexus located in the pars distalis.

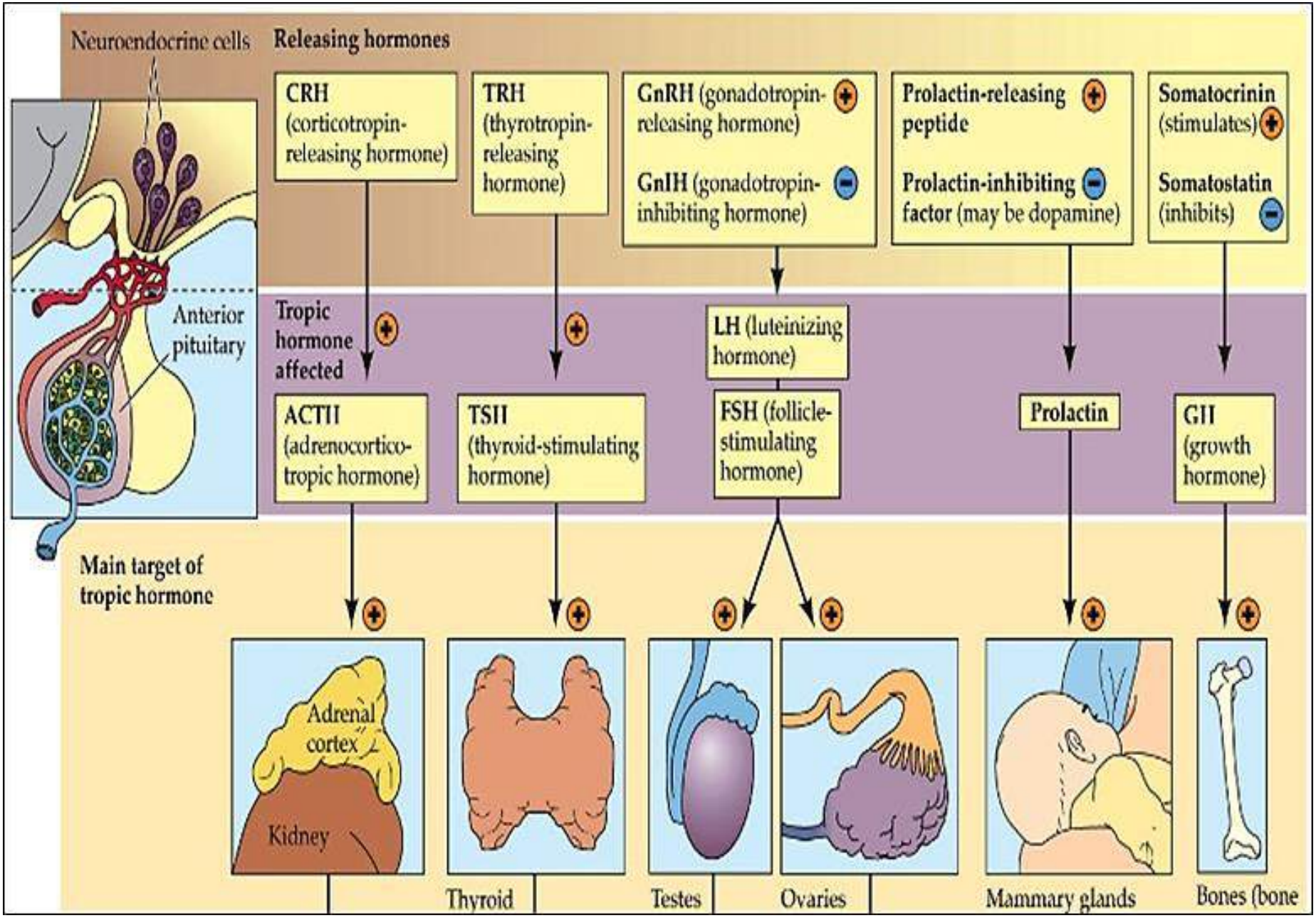
Hypothalamic neurosecretory hormones



Hypothalamic neurosecretory hormones

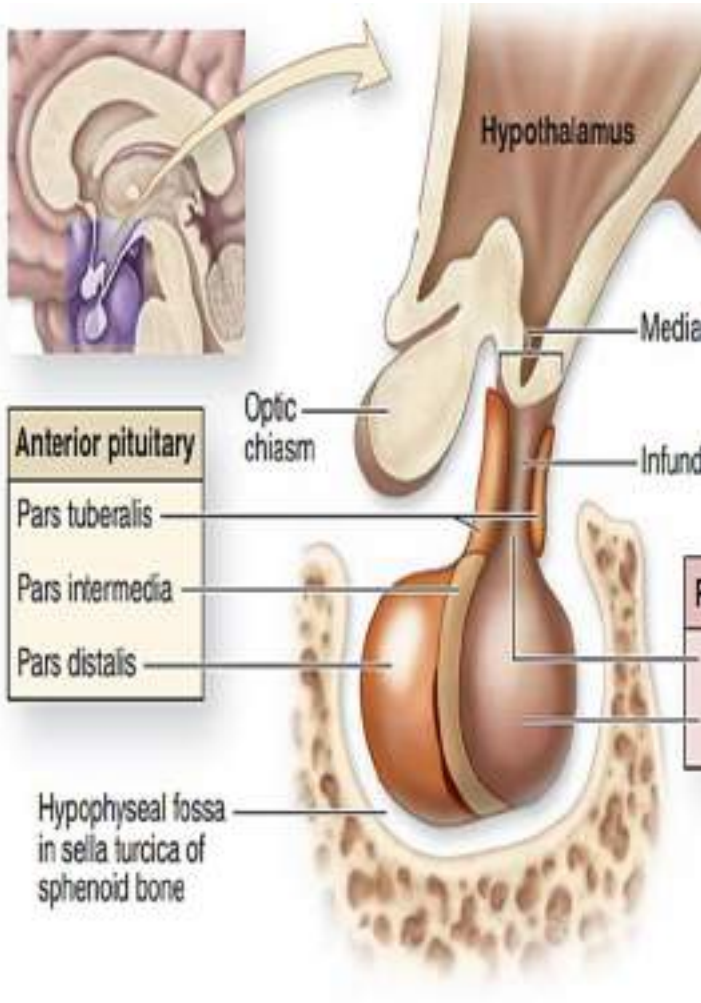
- These hormones consist of peptides or small proteins produced by secretory neurons (nuclei) in the hypothalamus.
- They are transported via neuronal axons to the median eminence where they are stored in the dilated closed ends of the axons, in close contact with primary capillary plexus.
- These hormones enter the primary capillary plexus and are drained by hypophyseal portal veins then to secondary capillary plexus in the pars distalis where the neurosecretory hormones leave the blood, to stimulate or inhibit the parenchymal cells of pars distails.

• Thus, the hypophyseal portal system is the vascular system used for hormonal regulation of the pars distalis by the hypothalamus. These hormones are either releasing or inhibiting hormones (factors)

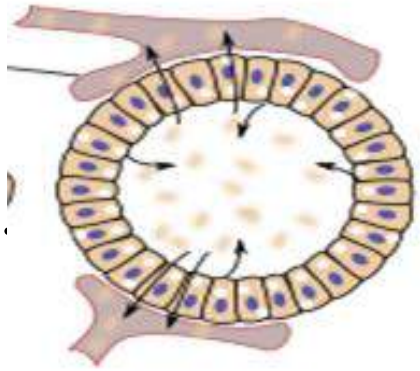

Neuroendocrine cells
Releasing hormones
CRH (corticotropin-releasing hormone)
TRH (thyrotropin-releasing hormone)
GnRH (gonadotropin-releasing hormone)
GnIH (gonadotropin-inhibiting hormone)
Prolactin-releasing peptide
Prolactin-inhibiting factor (may be dopamine)
Somatocrinin (stimulates)
Somatostatin (inhibits)
Anterior pituitary
Tropic hormone affected
ACTH (adrenocorticotropic hormone)
TSH (thyroid-stimulating hormone)
LH (luteinizing hormone)
FSH (follicle-stimulating hormone)
Prolactin
GH (growth hormone)
Main target of tropic hormone
Adrenal cortex
Kidney
Thyroid
Testes
Ovaries
Mammary glands
Bones (bone

B-Pars tuberalis

- It is a funnel-shaped superior extension of the pars distalis surrounding the infundibulum of the neurohypophysis.
- It is highly vascularized by arteries and the hypophyseal portal system.
- Its cells are cuboidal to low columnar epithelial cells with basophilic cytoplasm.
- Most of these cells secrete gonadotropins (FSH & LH).



C-Pars intermedia



This is a thin part between pars distalis and pars nervosa.

- In humans, it is a rudimentary region.
- It is made up of follicles filled with colloid with weakly basophilic cells that contain small secretory granules and blood capillaries.
- *Function:* These basophilic cells secrete melanocyte stimulating hormone (MSH) in amphibian. In humans, it may stimulate the release of prolactin and is therefore referred to as prolactin-releasing factor.

Neurohypophysis

The neurohypophysis (posterior pituitary) consists of:

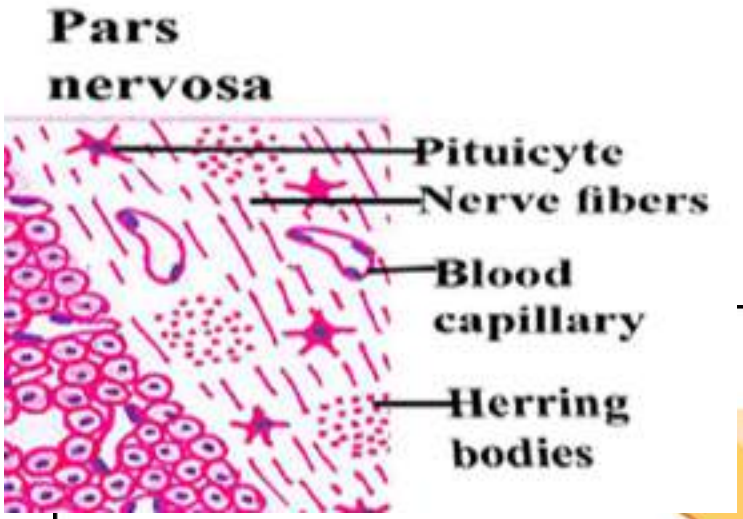
- ***Pars nervosa***: it is the large part of neurohypophysis which is connected to the base of the brain by the infundibulum or the neural stalk.
- ***Infundibulum*** or neural stalk: it is the small part which is composed of: the stem & median eminence.

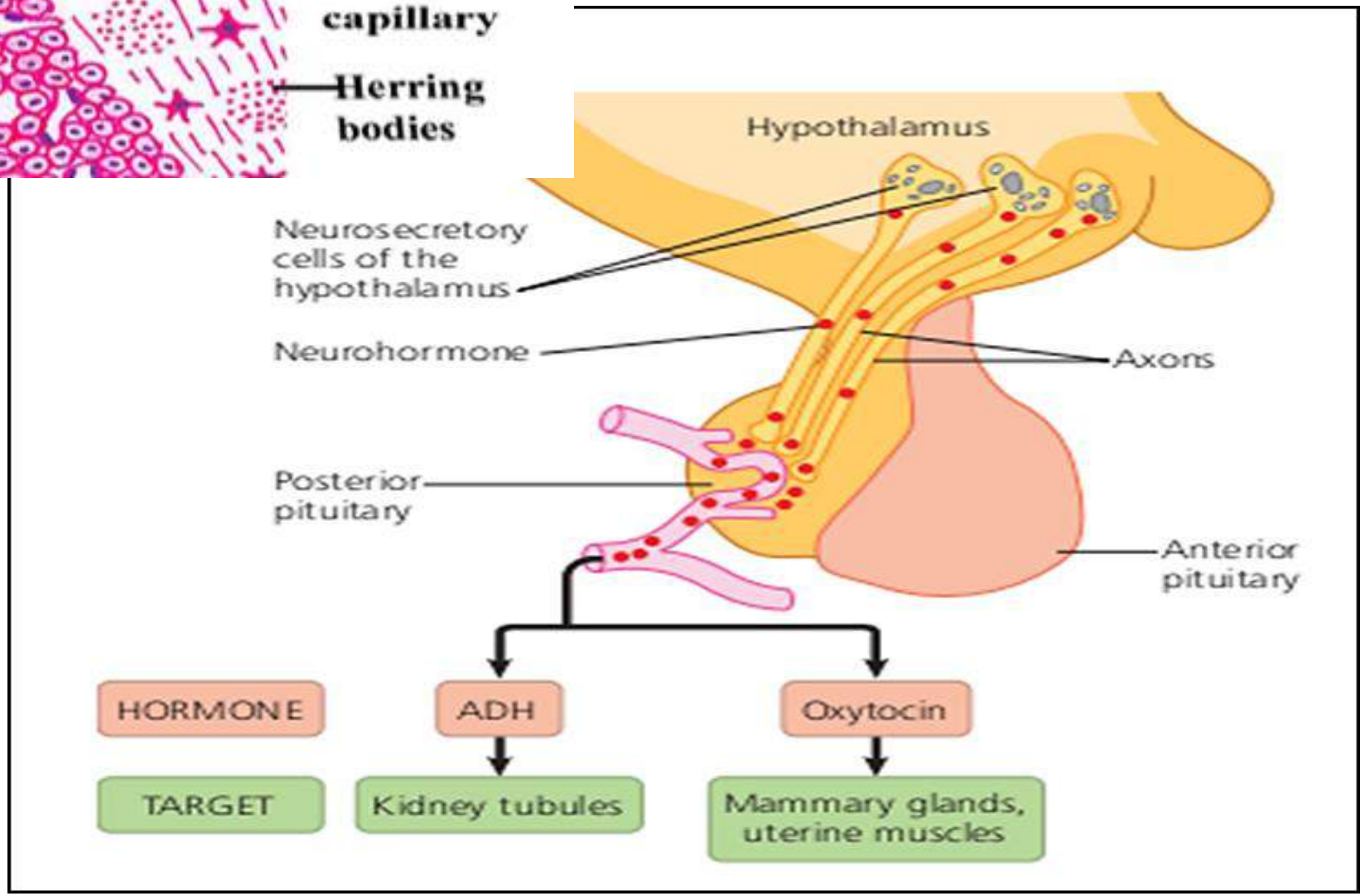
Pars nervosa:

- It appears pale in Hx &E sections.
- It contains no secretory cells.
- It is composed of:

1. **Nerve fibers** which are distal terminals of axons of the hypothalamo-hypophyseal tract.

Neurohypophysis





2. **Herring bodies,** which represent accumulations of neurosecretion (acidophilic material) in the dilated axon terminals of nerve fibers.

3. **Supportive cells** which are glial-like cells known as **pituicytes**. They are highly branched cells and contain lipid droplets, some pigments and intermediate filaments. Their cytoplasmic processes form gap junctions with each other.

4. Wide fenestrated **blood capillaries** and sinusoids.

Function:

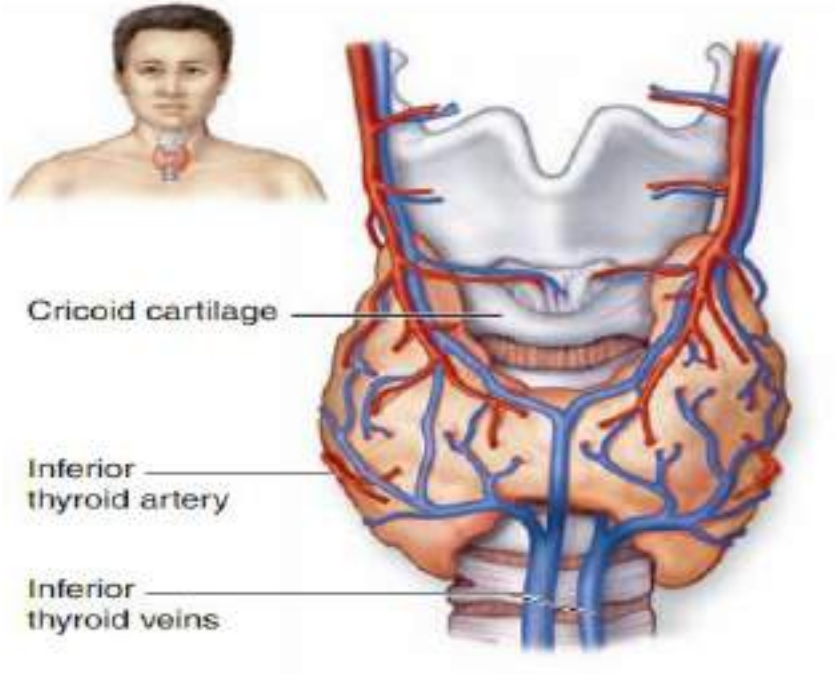
- Pars nervosa secretes oxytocin and vasopressin (antidiuretic hormone or ADH).

- These hormones are synthesized in the nerve cell bodies in **paraventricular and supraoptic nuclei** of the hypothalamus, and then travel within the axons of hypothalamo-hypophyseal tract to reach pars nervosa.

- The secretion accumulates as Herring bodies and passes through the fenestrated capillaries to blood stream.

THYROID GLAND

- The thyroid is a bilobed endocrine gland located in the neck, anterior to the larynx and upper trachea.
- The right and left lobes are connected by a thin band of thyroid tissue, called the isthmus.



Structure

A- Stroma

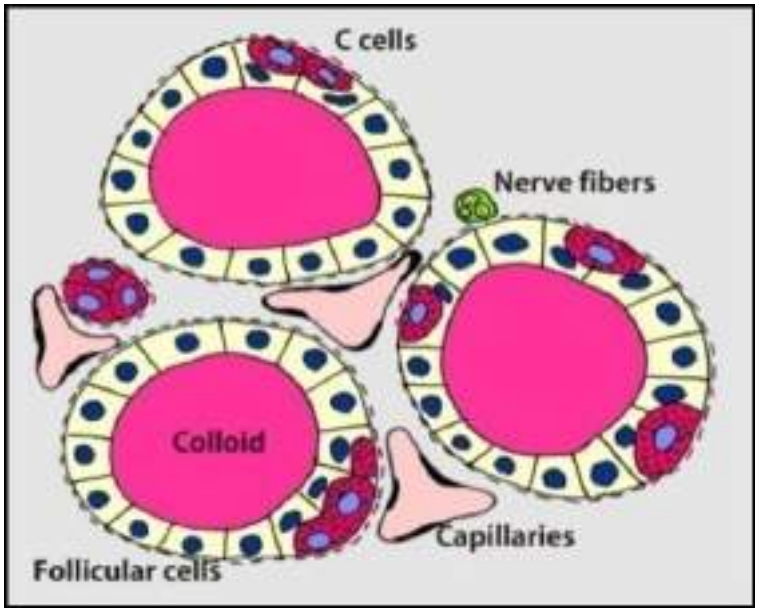
1- Capsule: The gland is covered by true thin C.T. capsule.

2- Septa or trabeculae: The capsule sends fine fibrous incomplete septa containing blood and lymph vessels and vasomotor nerves to the parenchyma surrounding the irregular lobules.

3. Reticular network

- **B- Parenchyma (thyroid follicle):**

- The thyroid follicles are the structural and functional units of the thyroid gland.
- The follicles are rounded in shape and surrounded by thin basal lamina.
- These follicles are lined with simple cuboidal epithelial cells called follicular cells (derived from endoderm) and few short parafollicular (C) cells (derived from ectoderm)
- Both follicular and parafollicular cells surround a central lumen filled with homogenous acidophilic material called colloid.
- Colloid is a glycoprotein called thyroglobulin which is synthesized and secreted by the follicular cells. It contains thyroid hormones. It gives PAS positive reaction.



1- Follicular cells (principal cells):

- **L/M**: They are the majority. They are simple cuboidal cells with central rounded nuclei and basophilic cytoplasm resting on basal lamina. In hyperactive follicles they are simple columnar, while if the gland is inactive the cells are simple squamous.
- **E/M**: The follicular cells exhibit all the characteristic of cells that synthesize, secrete, absorb, and digest proteins: The cytoplasm is rich in rER, well developed Golgi (supranuclear), apical secretory vesicles, elongated mitochondria, lysosomes and residual bodies. The luminal surface of the cell membrane has few short microvilli.
- ***Function:*** Follicular cells secrete thyroid hormones (thyroxine and tri-iodothyonin).

- ***2. Para follicular or C (Clear) cells:***

- Are found as a part of the follicular epithelium or as isolated clusters between thyroid follicles.
- They are few**.** They rest on the basement membrane of the follicles but they do not reach the lumen**.** They are present on the inner aspect of the basement membrane and separated from the lumen by the follicular cells.
- **L/M:** They are large, rounded, pale staining cells with central rounded nuclei.

- **E/M:** Moderate rER, elongated mitochondria, well developed Golgi and small dense secretory granules containing calcitonin hormone.

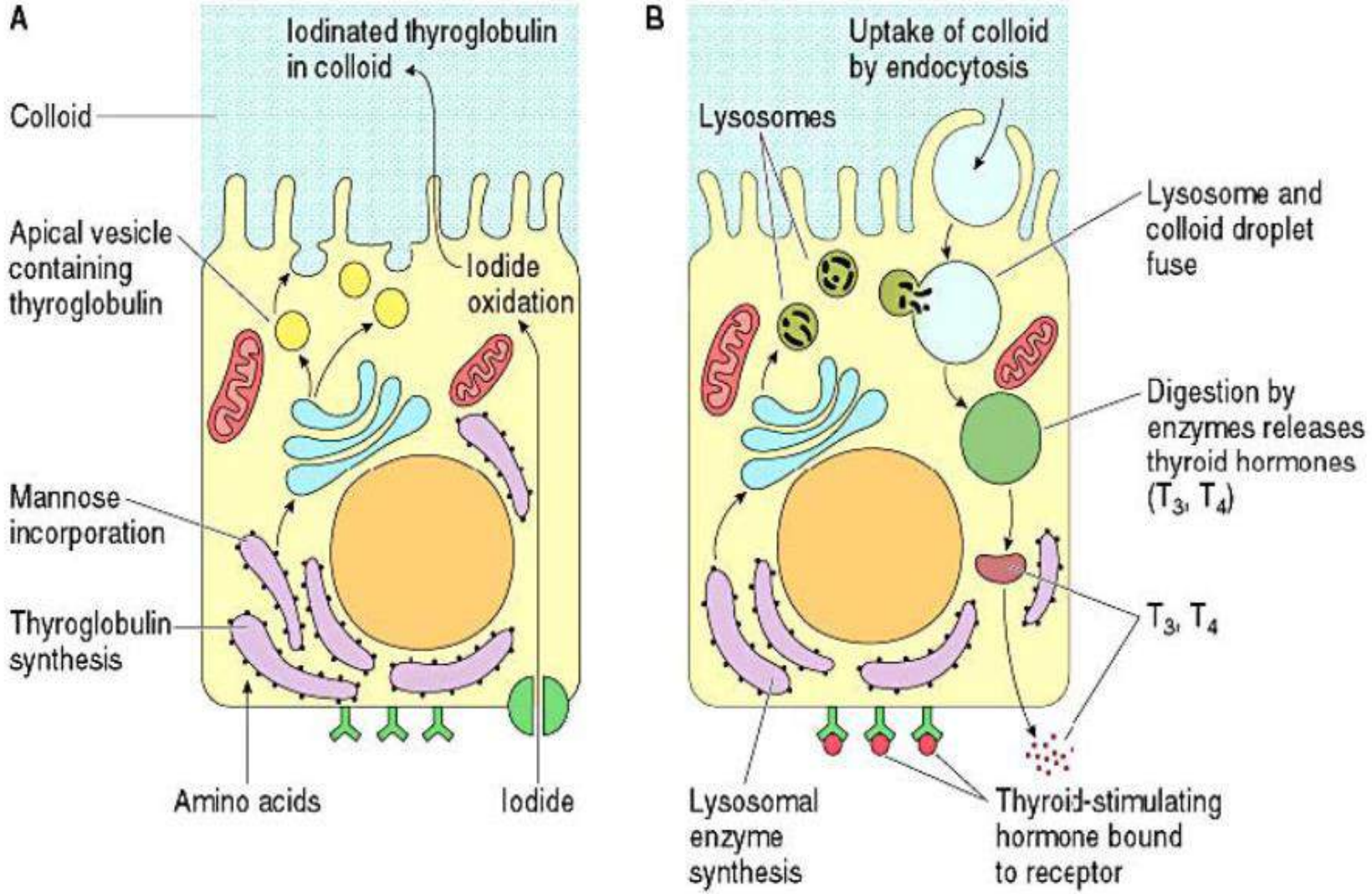


Figure 13–9 Schematic diagram of the synthesis and iodination of thyroglobulin (*A*) and release of thyroid hormone (*B*).

- **synthesis & release of thyroid hormones [T3andT4]:**

I- Formation of glycoprotein (Thyroglobulin):

1. Amino acids containing tyrosine are absorbed from the blood capillaries at the basal surface of follicular cells.
2. **RER** synthesizes polypeptide from amino acids.
3. Mannose (carbohydrate) is added in rER & galactose is added in **Golgi.**
4. The glycoprotein (thyroglobulin) is accumulated and packed in secretory vesicles of Golgi then reach the lumen by exocytosis, stored as **colloid**

II- Uptake of iodide and oxidation:

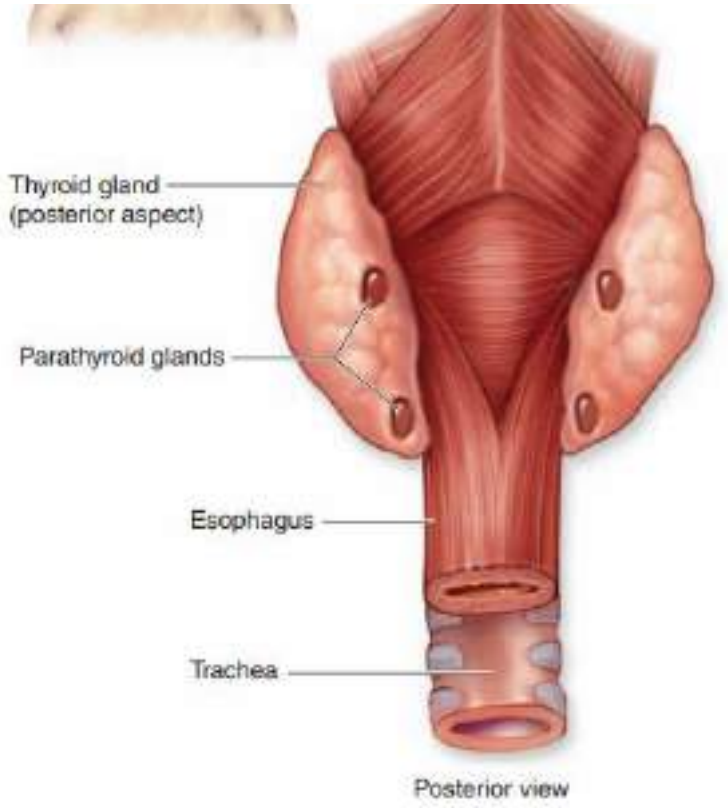
1. At the same time iodide is absorbed from blood by the follicular cells and transported actively by iodide pump.
2. Follicular cells produce peroxidase enzyme which oxidize the iodide to iodine.
3. Iodine passes out the cell into the follicular cavity to iodinate the thyroglobulin (iodination).

- ***III- Formation of thyroid hormone:***
    1. Tyrosyle group of thyroglobulin combines with iodine to form mono-iodotyrosyle then di-iodotyrosyle.
    2. Formation of inactive T3 & T4.
- ***IV- Secretion of thyroid hormone:***

1. Under the effect of TSH, thyroid follicular cells take up iodinated thyroglobulin (inactive T3 & T4) from the lumen by pinocytosis.
2. Pinocytotic vesicles fuse with primary lysosomes containing protease enzymes.
3. The lysosomal enzymes transfer molecules (Inactive T3&T4) into two active forms of thyroid hormones T3&T4.
4. T3 and T4 diffuse out the secondary lysosomes and pass through basal cell membrane to reach the blood stream through the wide fenestrated capillaries.
5. T4 is more abundant (90% of circulating thyroid hormones) and less potent while T3 is less abundant and more potent.

PARATHYROID GLANDS

- Parathyroid glands are four ovoid small glands.
- - They are located behind the thyroid gland, one at each end of the upper and lower poles.



- **Structure and function**

A. Connective tissue stroma:

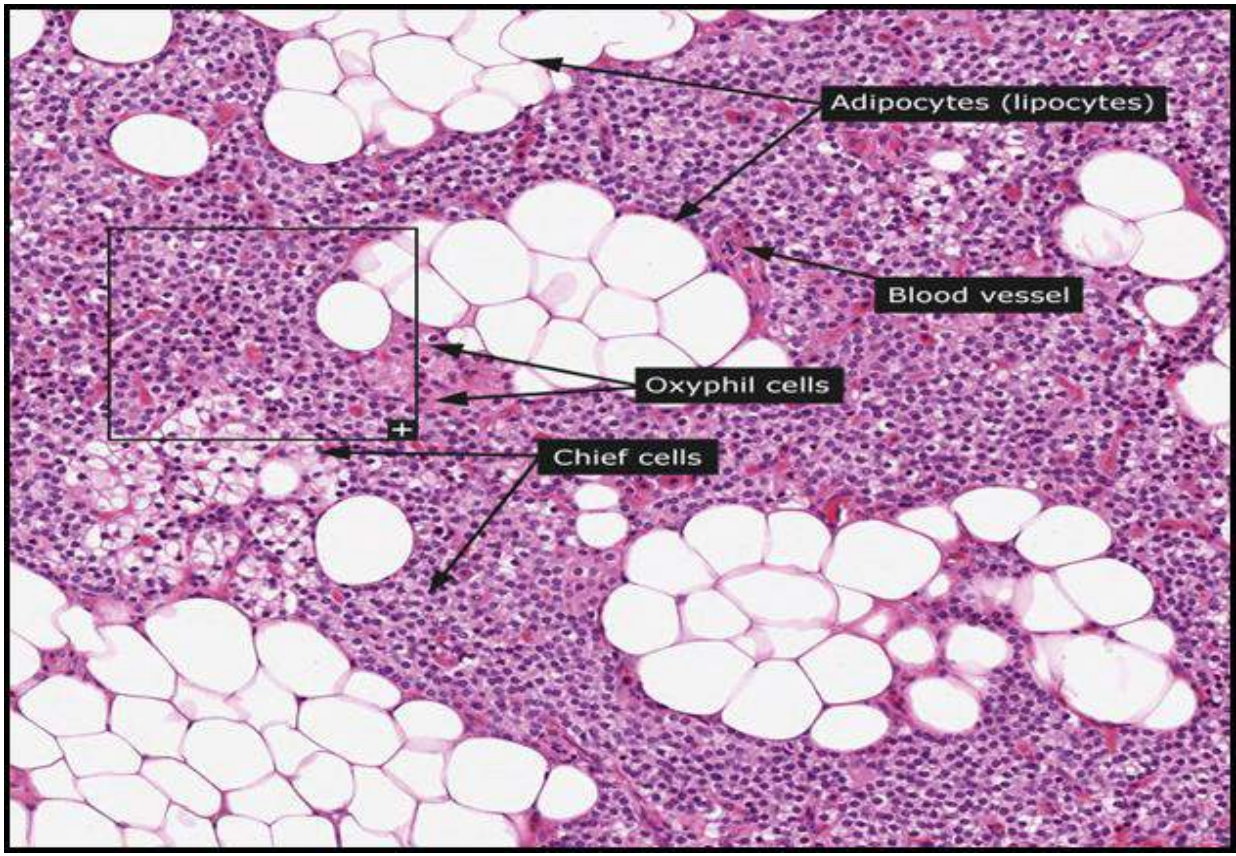
- Each parathyroid gland is enveloped by thin C.T capsule.
- From C.T capsule, septa extend to the interior of the gland, accompanied by blood vessels, lymphatics and vasomotor nerves dividing the gland into indistinct lobules.
- Reticular fibers extend in-between the parenchymal cells and capillaries.

B. Parenchyma:

- It is arranged into irregular cords or clusters of epithelial cells
- With increasing age, secretory cells are replaced with adipocytes, which constitute more than 50% of the gland in older people.
- The parenchyma of the parathyroid is composed of two cell types:

1- Chief (Principal) cells.

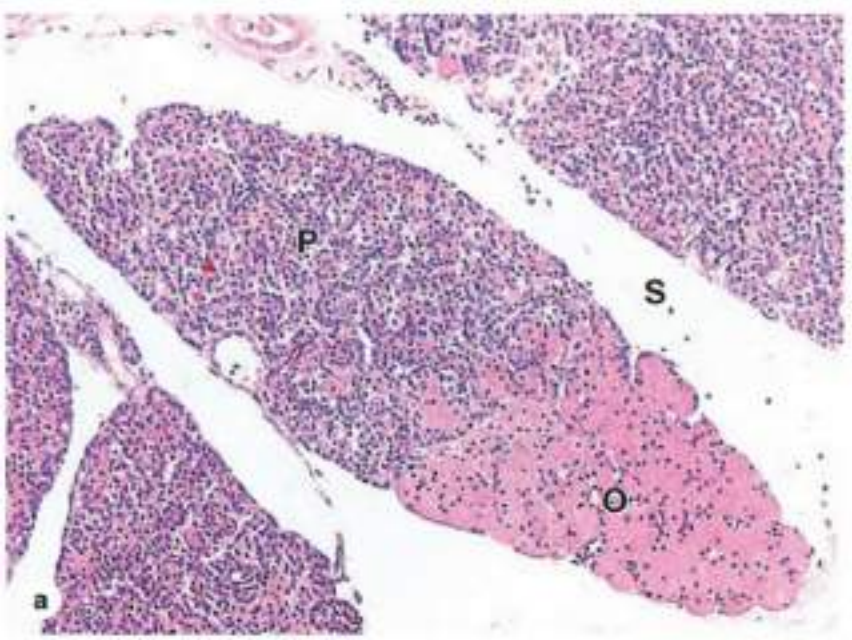
2- Oxyphil cells.



1- Chief (principal) cells:

- They are the most numerous cells in the parenchyma.

L/M: They are small, polygonal cells, with central rounded vesicular nuclei, and pale-staining, slightly acidophilic cytoplasm because it contains glycogen.



E/M:

- Juxtanuclear Golgi complex, Elongated mitochondria with numerous cristae and Abundant rER.
- Lipofuscin pigment, glycogen and lipid droplets.
- Smaller dense granules represent the secretory granules containing parathyroid hormone (PTH).

2- Oxyphil cells:

- **LM:**

- They are few in number, larger in size with small deeply stained nuclei.
- Their cytoplasm is more acidophilic than chief cells, with small dense stained nuclei.
- They are present singly or in clusters and increase in number with age.

- **E/M**:

- Reveals abundant mitochondria, small Golgi complex & little rER.
- Glycogen as well as lipid droplets are also located in the cytoplasm in between the mitochondria.
- There are secretory granules.

- Their function is unknown. They may be considered as immature chief cells.


Thank
you