

DR. Heba Elkaliny

Associate professor of Histology & Cell biology

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: Adrenal, Pineal, islets of Langerhans and DNES.
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.

ADRENAL GLANDS

(Suprarenal glands)

The adrenal glands are paired organs lying near the superior poles of the kidneys, embedded in the perirenal adipose tissue

A) Stroma:

• *Capsule:* It is formed of thick collagenous C.T that covers the suprarenal gland.

• *Trabeculae:* The capsule sends thin C.T septa to the interior of the gland that carry blood vessels and nerves.

• *Fine reticular fibers*: those support the parenchymal cells.



B) Parenchyma: parenchyma is
divided into two histologically and
functionally different regions:

1-Outer yellowish portion accounting for about 80% of the gland called *cortex* develops from mesoderm and secretes steroid hormones.

2- Inner, small, dark, reddish-brown portion called *medulla* develops from the neural crest (ectoderm) and secretes catecholamines.





ADRENAL CORTEX

- Adrenal cortex is subdivided into (GFR) :

Zona glomerulosa: is the outer most, narrow zone that lies beneath the capsule and constitutes 13% of the cortical volume.

Zona fasciculata: is the middle thick zone that constitutes nearly 80% of the cortical volume.

Zona reticularis: is the inner zone that constitutes only

7% of the cortical volume.

Zona glomerulosa:

- L/M:

The cells are columnar or pyramidal in shape arranged in closely packed, rounded or arched clusters surrounded by blood capillaries.

Their nuclei are rounded - The cytoplasm is acidophilic containing some lipid droplets - Mitotic figures may be seen.

- **E/M:** The cells have the typical ultrastructure of steroid secreting cells.



Zona glomerulosa:

- **E/M:** -The cells have **abundant sER**.
- -Golgi complexes
- -Large mitochondria with tubular cristae
- Free ribosomes and some rER.
- -Some lipid droplets and lipofuscin pigments
- are dispersed in the cytoplasm.
- Occasional desmosmes and small gap junctions join cells to each other and some cells have short microvilli.
- The capillaries have wide fenestration.

Function of zona glomerulosa:

Their cells secrete the **mineralocorticoid hormones** mainly aldosterone which controls water and electrolyte balance in the body.



Zona Fasciculata:

- L/M shows:
- -It is the broadest zone.
- -The cells are arranged in long straight cords, one or two cell thick at right angle to the surface of the organ and separated by the fenestrated capillaries.



-Its cells are large and polyhedral in shape with large lightly staining spherical nuclei.

-Their cytoplasm is acidophilic and contains numerous lipid droplets (cholesterol) which dissolve during histological preparation, so their cytoplasm appears pale, foamy and vacuolated. So these cells are called *spongiocytes*.



Zona Fasciculata:

- E/M:

Cells have all the ultrastructural features of *steroid secreting cells* as:

- Function of zona fasciculata:

-These cells secrete mainly **glucocorticoid hormones** (cortisol and corticosterone). The secretion is stimulated by ACTH of pars distalis.

-They secrete also little amount of sex hormones mainly androgens.

Zona reticularis:

- It is the inner most layer.
- The cells are arranged in irregular cords that form a network around blood capillaries.
- Its cells are small in size and polyhedral in shape.



- Their cytoplasm is deeply acidophilic, and contains large amount of lipofuscin pigments and few fat droplets.
- Some cells near the medulla are dark with pyknotic nuclei, suggesting cellular degradation in this layer.
- Function of zona reticularis:
- Synthesis & secretion of androgens and small amounts of glucocorticoids.
- Stimulated by ACTH of pars distalis.

• 2- Adrenal Medulla

- It occupies the center of the adrenal gland.
- Its cells can be regarded as **modified sympathetic postganglionic neurons** that have no axons and no dendrites which is innervated by cholinergic preganglionic sympathetic nerve fibers.
- LM:
- The cells are large, polyhedral in shape with large, pale-staining nuclei.
- Their cytoplasm is basophilic containing fine granules.
- The cells are arranged in clusters or short cords, surrounded by a rich network of capillaries and supported by reticular fibers.



- Its cells are called chromaffin cells (or chromaffin positive) because they develop an intense brown color when exposed to a strong oxidizing agent (chromate salts e.g. potassium dichromate). This is called *chromaffin reaction*. This reaction is specific for cells containing catecholamines.
- In addition to chromaffin cells, there are postganglionic sympathetic ganglion cells which are scattered among the chromaffin cells.

EM:

- The cytoplasm of chromaffin cells has a well developed juxtanuclear Golgi complex, some rER, numerous mitochondria and abundance of electron dense granules. These granules contain either epinephrine (adrenaline) or norepinephrine (noradrenaline). So there are two different cell types:
- One secretes epinephrine and their granules are small, less electron dense and their contents fill the granules.
- The other type secretes norepinephrine and their granules are large, more electron dense and their contents are irregular in shape.

- Both types of granules contain also:
- Protein chromogranins (which may serve as binding proteins for catecholamine).

- ATP.

- Dopamine β -hydroxylase (which converts dopamine to norepinephrine).
- Opiate-like peptides (encephalins).
- Unlike the cortex which does not store steroids, cells of medulla accumulate and store their hormones in granules.
- Epinephrine and norepinephrine are released to the blood in large quantities during intense emotional reactions, such as fright, and produce vasoconstriction, increased blood pressure, changes in heart rate, and elevated blood glucose levels.

- Norepinephrine-secreting cells are also found in paraganglia (collections of catecholamine-secreting cells adjacent to the autonomic ganglia) and in various viscera.
- The conversion of norepinephrine to epinephrine (adrenalin) occurs only in chromaffin cells of the adrenal medulla. About 80% of the catecholamine secreted from the adrenal is epinephrine.

ISLETS OF LANGERHANS

- Islets of Langerhans represent the endocrine portion of the pancreas.
- They appear in ordinary sections as pale rounded clusters of secretory epithelial cells embedded within darkly stained exocrine pancreatic acini.
- There may be more than one million islets in human pancreas which are more abundant in the tail region.



<u>Structure</u> :

L/M:

- Stroma: A fine capsule of reticular fibers surrounds each islet, separating it from the adjacent exocrine pancreatic tissue.
- *Parenchyma:* Each islet consists of lightly stained polygonal or rounded cells, arranged in cords separated by a network of fenestrated blood capillaries
- Using immunocytochemical methods, 4 types of cells have been located in the islets



E/M:

- The cells have the ultrastructure of cells synthesizing polypeptides. They contain rER, well developed Golgi, mitochondria as well as the specific secretory granules. Their nuclei are large and vesicular.
- **α** or **A** cells secrete primarily glucagon and are usually located peripherally.
- β or B cells produce insulin (L. insula, island), are the most numerous, and are located centrally.
- δ or D cells, secreting somatostatin, are scattered and much less abundant.
- A minor fourth cell type, more common in islets located within the head of the pancreas, are **PP cells**, which secrete pancreatic polypeptide.
- Gap junctions between cells are present to help in the transfer of the ionic changes associated with autonomic discharge to other cells.

Pineal Gland

-The pineal gland, also known as the **epiphysis cerebri**, regulates the daily rhythms of bodily activities.

-A small pine cone-shaped organ, approximately 5-8 mm by 3-5 mm, the pineal gland develops from neuroectoderm in the posterior wall of the third ventricle and remains attached to the brain by a short stalk.



• The pineal gland is covered by connective tissue of the pia mater, from which septa containing small blood vessels subdivide variously sized lobules.

• Pineal gland contains two parenchymal cells:

1. Prominent and abundant secretory cells called **pinealocytes** have slightly basophilic cytoplasm and irregular euchromatic nuclei. Ultrastructurally pinealocytes are seen to have secretory vesicles, many mitochondria, and long cytoplasmic processes which end in dilatations near capillaries, indicating an endocrine function. These cells produce melatonin, a low molecular-weight tryptophan derivative.

2. <u>interstitial glial cells</u> that are <u>modified astrocytes</u>, staining positively for glial fibrillary acidic protein, which represent about 5% of the cells. These have elongated nuclei more <u>heavily stained</u> than those of pinealocytes and are usually found in perivascular areas and between the groups of pinealocytes.



A characteristic feature of the pineal gland is the presence of variously sized concretions of calcium and magnesium salts called corpora arenacea, or brain sand, which form as extracellular protein deposits become mineralized. Such concretions appear during childhood and gradually increase in number and size with age, with no apparent effect on the gland's function.

Unmyelinated sympathetic nerve fibers enter the pineal gland and end among pinealocytes, with some forming synapses.

Melatonin release from pinealocytes is promoted by darkness and inhibited by daylight. The resulting diurnal fluctuation in blood melatonin levels induces rhythmic changes in the activity of the hypothalamus, pituitary gland, and other endocrine tissues that characterize the circadian (24 hours, day/night) rhythm of physiological functions and behaviors.

DIFFUSE NEUROENDOCRINE SYSTEM

- They are small granules-containing cells that exist individually or in small groups.
- They are <u>endocrine</u> cells present among non-endocrine cells.

Origin: They are <u>endodermal</u> in origin

Sites: these cells are wide spread throughout the body.

Characters:

- These cells synthesize and release polypeptide hormones or amines (epinephrine, norepinephrine & serotonin) with hormonal activity.
- These cells are able to take up amine precursors and exhibit amino acid decarboxylase activity. This explain its old name <u>APUD cells</u> (amine precursor uptake and decarboxylation), but as not all of these cells are able to concentrate amine precursors, the APUD name has been replaced by **DNES** cells (diffuse neuroendocrine system).

L/M:

- Many DNES cells are stained by solutions of chromium salts and have therefore called <u>enterochromaffin cells</u> or stained with silver salts, so they are also called <u>argentaffin or argyrophil cells</u>, or can be identified by immunocytochemical methods.

Е/М:

- Small amount of **RER**.
- Supranuclear Golgi.
- Basal secretory granules.

