# 21 Endocrine Glands

**Competency**

AN43.2: Identify, describe, and draw the microanatomy of pituitary gland, thyroid, parathyroid gland.

AN43.3: Identify, describe, and draw the microanatomy of pineal gland.

AN47.5: Identify, describe, and draw the microanatomy of suprarenal gland.

**Specific Learning Objectives**

a. Identify the slides of pituitary gland, thyroid, parathyroid gland.

b. Describe the microscopic anatomy and draw a neat labeled diagram of microstructure of pituitary gland, thyroid, parathyroid gland.

c. Describe the microscopic anatomy and draw a neat labeled diagram of microstructure of pineal gland.

d. Describe the microscopic anatomy and draw a neat labeled diagram of microstructure of suprarenal gland.

## Introduction

- They are ductless glands which pour their secretions (hormones) into the blood stream.
- Cells of endocrine glands are arranged in the cords/clumps or follicles surrounded by a rich network of blood capillaries or sinusoids. Sinusoids are typically lined by fenestrated endothelial cells.
- List of endocrine glands is as follows:
  - Pituitary gland.
  - Suprarenal gland.
  - Thyroid gland.
  - Pancreas (partly exocrine and partly endocrine; explained in Chapter 16).

# Pituitary Gland (Hypophysis Cerebri)

## Introduction

- Pituitary gland is suspended from the floor of the third ventricle by infundibulum.
- It has two main parts: adenohypophysis and neurohypophysis. Each of which differ in embryological origin, structure, and function (**Fig. 21.1**).

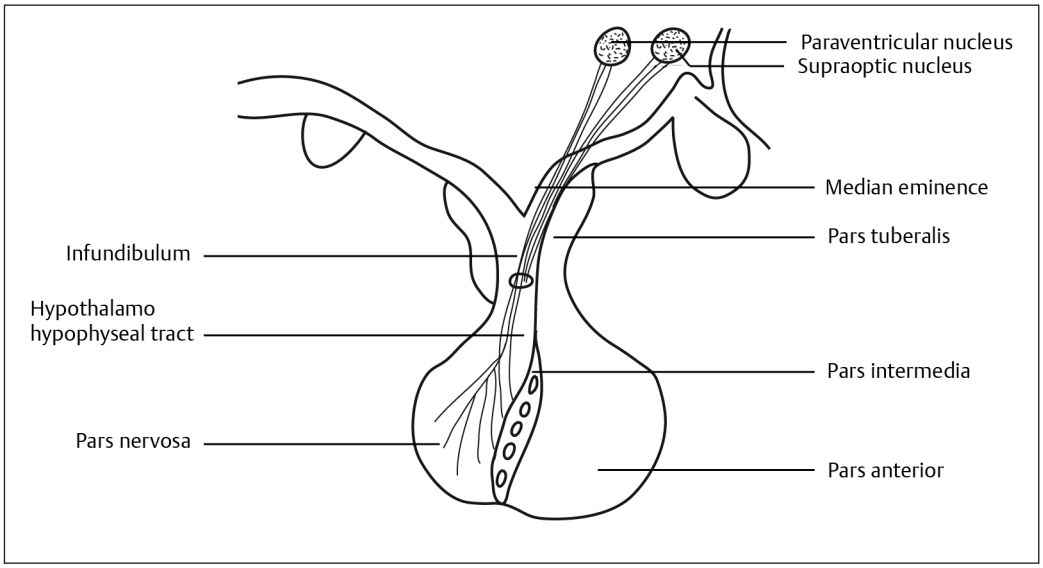


**Fig. 21.1** Schematic diagram of pituitary gland.

# Microscopic Structure of Pituitary Gland

## Adenohypophysis (Anterior Lobe)

- It is divided into three parts (**Figs. 21.2** and **21.3**), namely:
  - Pars anterior/pars distalis.
  - Pars intermedia.
  - Pars tuberalis.
- Pars anterior and pars intermedia are separated by intraglandular cleft.
- Pars tuberalis surrounds the infundibulum.

### Pars Anterior/Pars Distalis

- The cells of pars anterior are arranged in the form of cords separated by fenestrated sinusoids.
- These cells are grouped into two types:
  - Chromophils: Contain darkly stained secretory granules in the cytoplasm.
  - Chromophobes: Granules are not prominent (**Fig. 21.4**).

#### *Chromophil Cells*

- They constitute 50% of the cell population.
- They are classified into acidophils and basophils.
  - *Acidophils/Alpha cell (40%):* They contain granules that stain with acidic dyes.
  - Types of acidophils:
    - *Somatotrophs*: Produce *growth hormone* or *somatotrophic hormone* that stimulate body growth before puberty.
    - *Mammotrophs* (*lactotrophs*): Produce *prolactin*. During pregnancy and lactation, it stimulates the growth and activity of mammary glands.
  - *Basophils/beta cells (10%):* Contain granules that stain with basic dyes.
  - Types of basophils:
    - *Corticotrophs:* Produce adrenocorticotrophic hormone (ACTH). It helps in the release of glucocorticoids from zona fasciculata of suprarenal cortex.

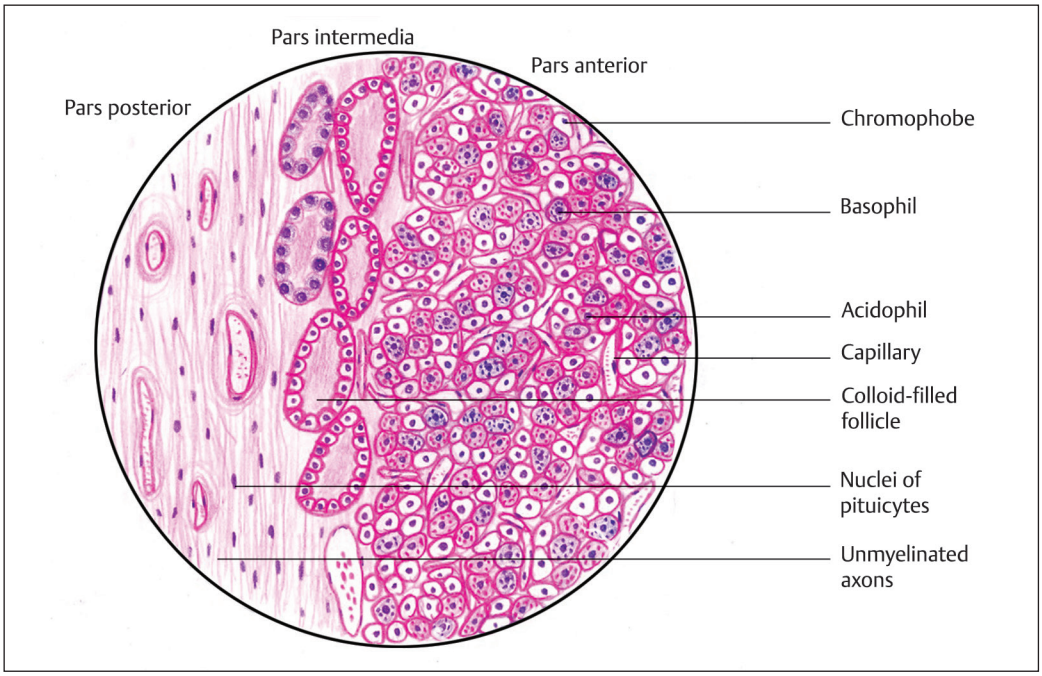


**Fig. 21.2** Diagram of pituitary gland (H&E pencil). H&E, hematoxylin and eosin.

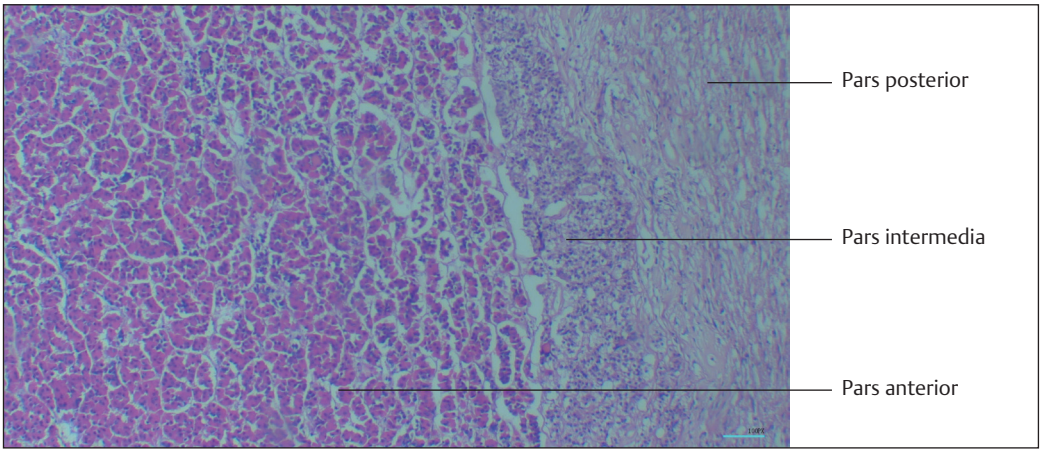


**Fig. 21.3** Section of pituitary gland in low magnification (H&E Stain). H&E, haematoxylin and eosin.

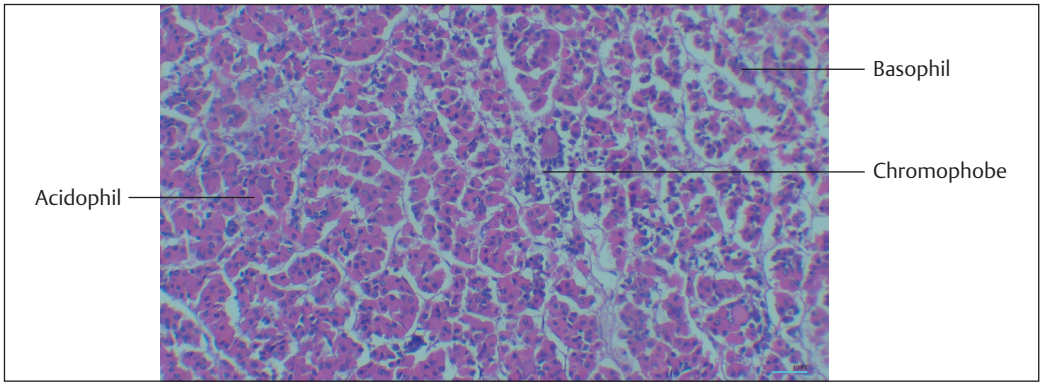


**Fig. 21.4** Section of pars anterior in high magnification (H&E Stain). H&E, haematoxylin and eosin.

  - *Thyrotrophs:* Secrete thyroid-stimulating hormone (TSH) that helps in the release of T3 and T4 from thyroid gland into the circulation.
  - *Gonadotrophs:* Secrete follicle-stimulating hormone (FSH) and luteinizing hormone (LH).
- In females, FSH helps in the growth and maturation of ovarian follicle, thereby releasing estrogen. In males, it promotes spermatogenesis.
- In females, LH induces ovulation resulting in the formation of corpus luteum and release of progesterone. In males, it induces the production of testosterone from interstitial cells of Leydig.

### *Chromophobes*

- They constitute 50% of the cell population.
- These are degranulated chromophils. They act as stem cells and give rise to chromophils.
- Chromophobes stain lightly because of few granules.

## Pars Intermedia

- It is poorly developed in humans.
- It consists of colloid-filled follicles surrounded by basophils and chromophobes.
- It produces melanocyte-stimulating hormone in amphibians. In humans, the function is not clear.

## Pars Tuberalis

- It is composed of blood vessels and undifferentiated cells.

# Neurohypophysis (Posterior Lobe)

- It consists of three parts, namely:
  - *Infundibulum*: It is a stalk connecting the pars nervosa with hypothalamus.
  - *Pars nervosa*: It lies posterior to the pars intermedia.
  - *Median eminence*: It is an area where the infundibulum is attached to the third ventricle.

## Pars Nervosa/Pars Posterior

- It consists of unmyelinated nerve fibers.
- These unmyelinated nerve fibers are the axons of neurons located in the *supraoptic* and *paraventricular* nuclei of hypothalamus.
- In between the axons special types of supporting cells (neuroglial cells) known as *pituicytes* are seen.
- Supraoptic nuclei secrete *vasopressin/antidiuretic hormone* (*ADH*) that controls the water reabsorption in distal convoluted tubule and collecting duct.
- Paraventricular nuclei secrete *oxytocin*. Oxytocin causes smooth muscles of uterus to contract during labor, and it also helps

in *milk ejection reflex* because of contraction of myoepithelial cells in mammary gland during suckling.
- The hormones secreted by these nuclei travel through the axons of pars posterior and get stored at their dilated nerve terminals known as *Herring bodies*.
- From Herring bodies they are released into sinusoids of pars posterior (*Hypothalamo-hypophyseal tract*).
- Hence, pars posterior does not secrete the hormones instead stores the hormone synthesized by the hypothalamus (**Fig. 21.5**).

# Suprarenal Gland/ Adrenal Gland

## Introduction

- These are endocrine glands located in the upper pole of each kidney.
- Suprarenal gland is surrounded by connective tissue capsule from which septa extend into the substance of the gland.
- It is divided into two distinct parts which differ structurally, functionally, and embryologically.
- It comprises a superficial part called *cortex* and a deep part called *medulla*.

## Suprarenal Cortex

- It comprises three cellular zones (**Figs. 21.6–21.8**), namely:
  - Zona glomerulosa:
    - It is the outer zone deep to capsule (subcapsular).
    - It forms one-fifth of cortex.
    - It comprises small polyhedral/ columnar cells arranged as inverted U-shaped arches or acini-like groups. The cells have deep-staining nuclei with basophilic cytoplasm.

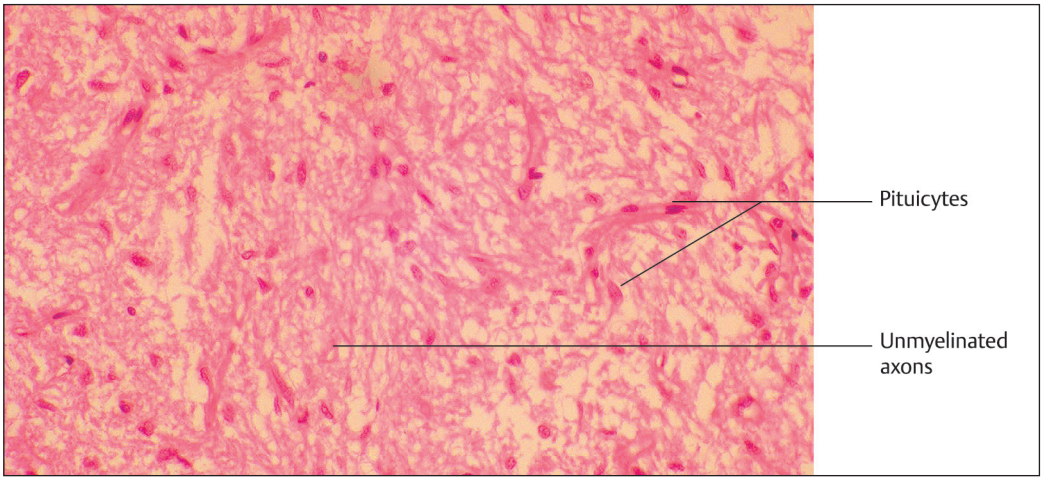


**Fig. 21.5** Section of pars posterior in high magnification (H&E stain). H&E, hematoxylin and eosin.

**Identification Points (Figs. 21.3–21.5)**

1. Pars anterior is made up of chromophobes and chromophils arranged in the form of cords separated by sinusoids.
2. Pars intermedia contains colloid-filled follicles.
3. Pars posterior is made up of unmyelinated axons and pituicytes.

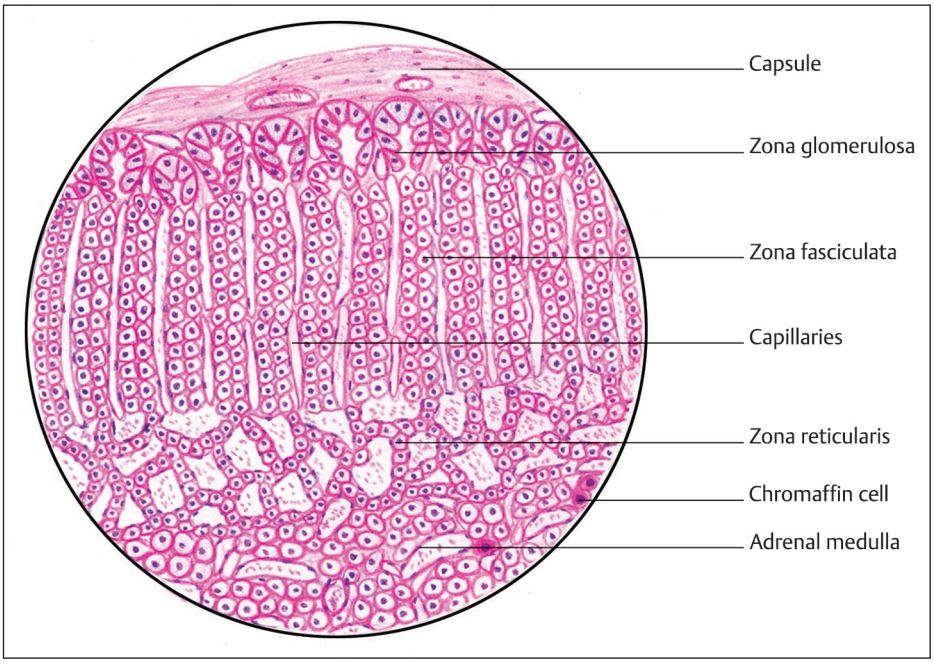


**Fig. 21.6** Diagram of suprarenal gland (H&E pencil). H&E, hematoxylin and eosin.

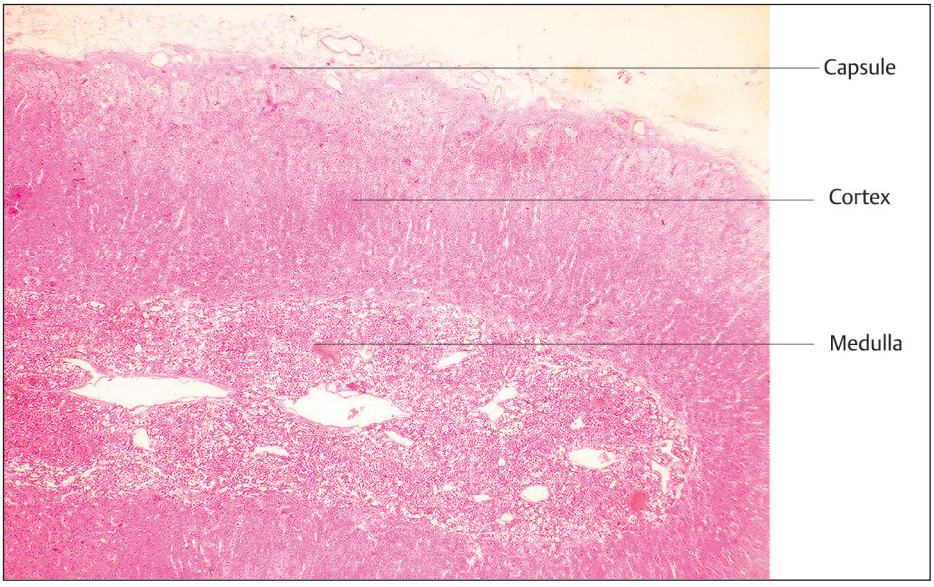


**Fig. 21.7** Section of suprarenal gland in low magnification (4×) (H&E stain). H&E, hematoxylin and eosin.

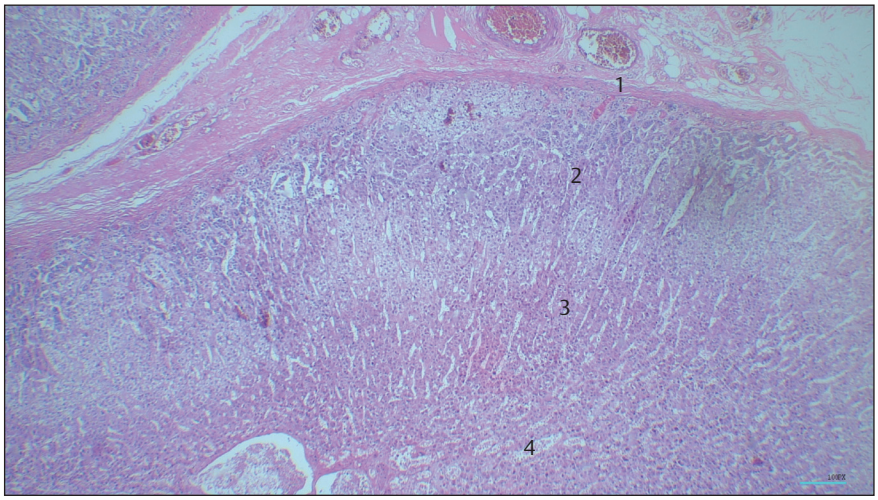


**Fig. 21.8** Section of suprarenal gland in low magnification (10×) (H&E Stain). H&E, haematoxylin and eosin.
Note: 1, capsule; 2, zona glomerulosa; 3, zona fasciculata; 4, zona reticularis.

- Zona fasciculata:
  - It forms three-fifth of cortex.
  - It consists of polyhedral cells arranged in straight columns that are two-cell thick. Sinusoids are present in between the columns. The cells are polyhedral with basophilic cytoplasm with many lipid droplets giving them a vacuolated appearance.
- Zona reticularis:
  - It forms inner one-fifth of cortex.
  - It is made up of small irregular anastomosing cords of cells separated by sinusoids containing lipofuscin pigment. The cells are smaller, acidophilic with less lipid droplets.

## Hormones Secreted by Cortex

- Zona glomerulosa secretes *mineralocorticoid*. For example, *aldosterone* that regulates electrolyte and water balance.
- Zona fasciculata secretes *glucocorticoids*. For example, *cortisol* that plays an important role in metabolism of carbohydrates, proteins, and fat.
- Zona reticularis secretes *sex hormones*.

## Suprarenal Medulla

- It is composed of groups and columns of chromaffin cells (pheochromocytes) separated by wide sinusoids.
- Chromaffin cells are columnar polyhedral cells with basophilic cytoplasm.
- Chromaffin cells are so called because of their reaction to dichromate fixatives (granules of these cells stain yellow with chromium salt—*chromaffin reaction*).
- *Chromaffin cells are modified postganglionic sympathetic neurons derived from neural crest.*
- Apart from chromaffin cells, ganglion cells are also present in medulla.
- Cells of medulla secrete *adrenalin* and *noradrenalin*.

# Thyroid Gland

## Introduction

- It is a bilobed endocrine gland located in the neck in front of larynx and trachea.

## Microscopic Structure of Thyroid Gland

- It is surrounded by connective tissue capsule.
- Septa arising from capsule divide the gland into many lobes and lobules.
- Each lobule is made up of aggregation of follicles.
- Each follicle is lined by follicular cells resting on a basement membrane.
- Each follicle has a center filled with colloid. Colloids are eosinophilic containing iodinated thyroglobulin.
- Follicular cells vary in shape, depending on the level of activity which is controlled by TSH.
- *Resting* or *inactive* follicles are lined by squamous epithelium with abundant colloid.
- *Moderately active* follicles are lined by cuboidal epithelium with moderate colloid.
- *Highly active* follicles are lined by columnar epithelium and colloid is scanty.
- Follicular cells secrete two hormones: triiodothyronine (T3) and tetraiodothyronine (T4).
- Spaces between follicles are filled with connective tissue containing numerous capillaries and lymphatics (**Figs. 21.9–21.11**).

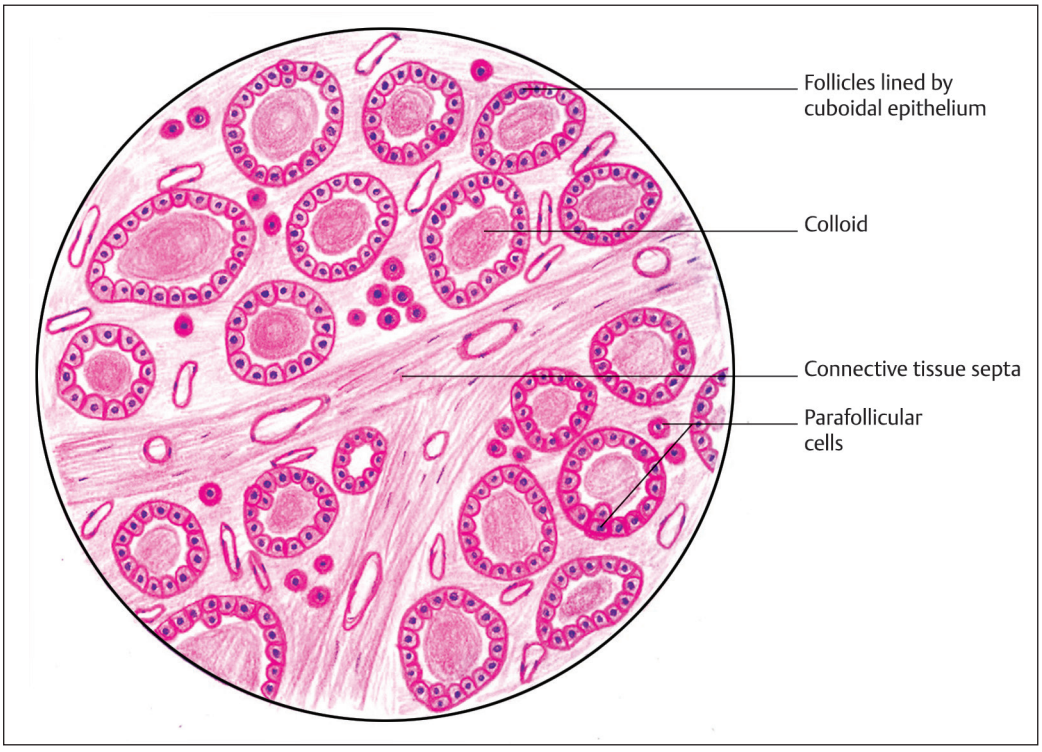


**Fig. 21.9** Diagram of thyroid gland (H&E pencil). H&E, hematoxylin and eosin.

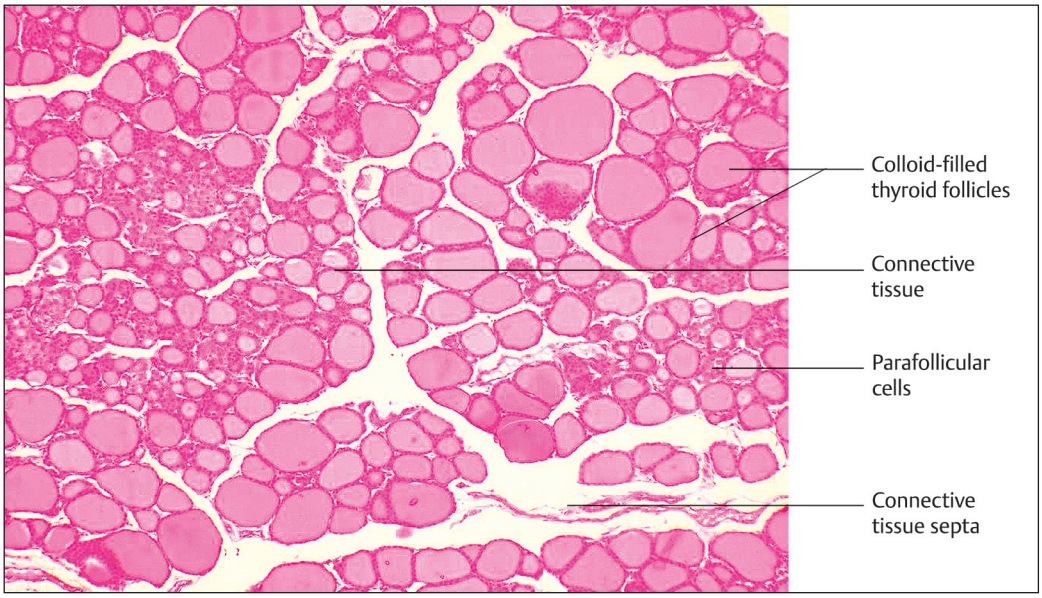


**Fig. 21.10** Section of thyroid gland in low magnification (H&E stain). H&E, hematoxylin and eosin.

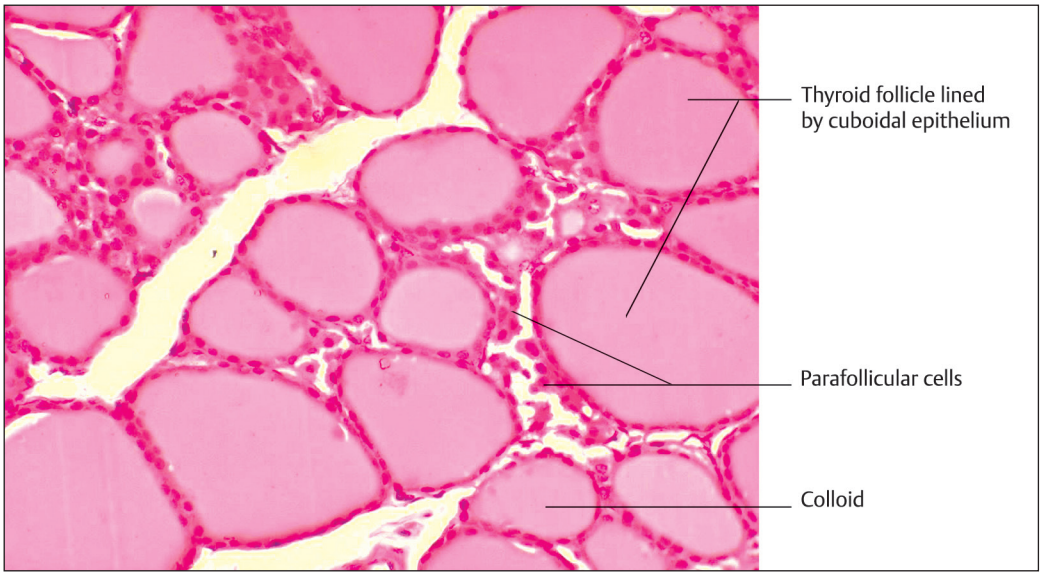


**Fig. 21.11** Section of thyroid gland in high magnification (H&E stain).

### Parafollicular Cells/C Cells

- Thyroid parenchyma also contains C cells that are present either in between follicles or between follicular cell and basement membrane.
- C cells are polyhedral with pale cytoplasm and oval eccentric nucleus.
- C cells are derived from neural crest cells.
- They secrete *calcitonin*.
- Calcitonin lowers blood calcium level by initiating bone resorption.

## Parathyroid Gland

These are two pairs of endocrine glands located on the posterior aspect of the thyroid gland and are separated from the thyroid gland by a capsule.

## Microscopic Structure of Parathyroid Gland

It is covered by a thin layer of connective tissue capsule, and trabeculae arising from the capsule divides the gland into incomplete lobules. The substance of the gland is made up of two types of cells: Chief/Principal cells and Oxyphil cells. They are arranged in clusters/anastomosing cords separated by capillaries/sinusoids.

Chief cells/Principal cells are small polygonal cells with round nuclei and pale-staining eosinophilic cytoplasm. They secrete parathormone or parathyroid hormone which increases blood calcium levels and decreases phosphate levels in the following ways:

- Parathyroid hormone stimulates the osteoclasts to enhance bone resorption, thus mobilizing calcium from the bones.
- Stimulates calcium reabsorption and phosphate excretion in the distal convoluted tubule.
- Kidneys secrete calcitriol under the influence of parathormone, resulting in the absorption of dietary calcium from small intestine to blood stream.

Chief/Principal cells are categorized into three types on the basis of glycogen and lipofuscin content: Light, Dark, and Clear cells.

Oxyphil cells are lesser in number, appear singly or in groups and before puberty, and increase in number as age advances. They are characterized by small nuclei, deep eosinophilic cytoplasm due to the presence of many mitochondria (**Figs. 21.12** and **21.13**).

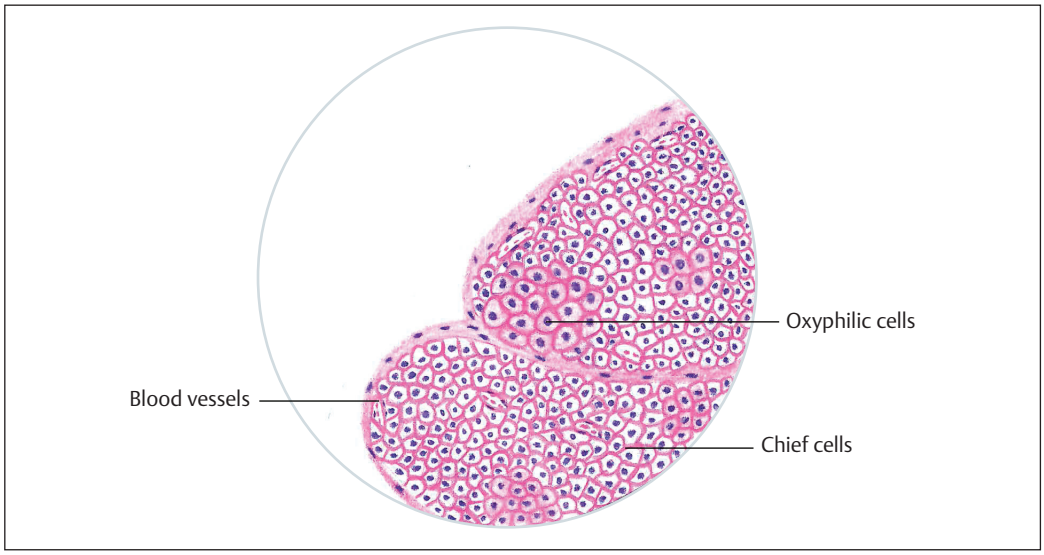


**Fig. 21.12** Diagram of parathyroid gland (H&E Stain). H&E, haematoxylin and eosin.

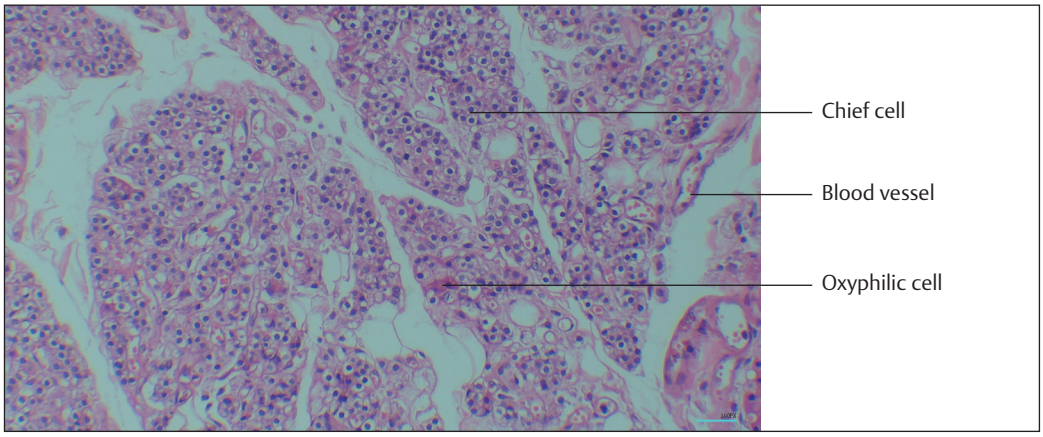


**Fig. 21.13** Section of parathyroid gland (H&E Stain). H&E, haematoxylin and eosin.

# Pineal Gland/Epiphysis Cerebri

- It is a small, conical, glandular organ present between two superior colliculi of midbrain.

## Microscopic Structure of Pineal Gland

- Pineal gland is covered by pia mater forming its capsule.
- Capsule sends septa dividing the gland into many lobules.
- Parenchyma of the gland is made up of two types of cells: Pinealocytes constituting 95% of population and astroglial cells 5%.
- Pinealocytes are arranged in cords separated by connective tissue. They have elongated, tortuous cytoplasmic processes, terminal end of which shows a swelling ending in relation to blood vessel. These swellings store melatonin and serotonin.
- Characteristic feature of pineal gland is the presence of corpora amylacea or brain sand. These are polyhedral epithelioid cells with large irregular nuclei containing calcified concretions made up of calcium and magnesium phosphate. They show lamellate appearance in H&E stain. They increase in number as age advances and can be visualized in radiographs.
- Interstitial/Astroglial cells are small cells with dark elongated nuclei and long cytoplasmic processes containing microfilaments that support pinealocytes and blood vessels (**Fig. 21.14**).

## Functions of Pineal Gland

- It acts as a biological clock producing circadian rhythm. Release of melatonin is stimulated by darkness and inhibited by daylight. These fluctuations in melatonin levels induces variations in the activities of hypothalamus, pituitary, ovaries, and testes
- Pinealocytes synthesize melatonin in response to sympathetic stimulation.

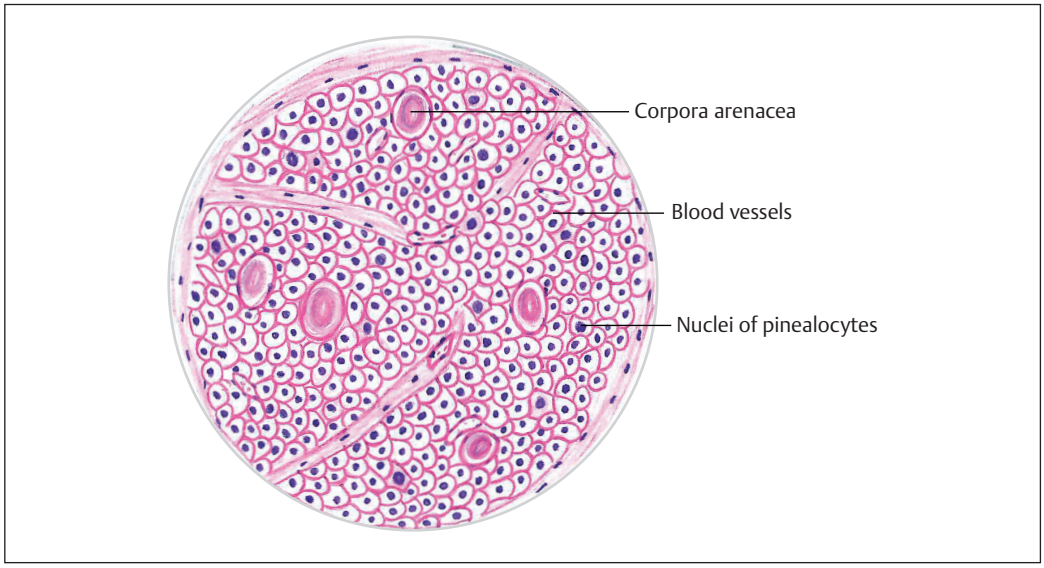


**Fig. 21.14** Diagram of pineal gland (H&E Stain). H&E, haematoxylin and eosin.

## Applied Aspects

- Pituitary adenoma:
  - Pituitary adenomas are benign tumors.
  - Acidophil adenoma causes excessive production of growth hormone, resulting in *gigantism* before puberty and *acromegaly* in adults.
  - Basophil adenoma causes excessive production of ACTH, leading to *Cushing's syndrome*.
- Diabetes insipidus:
  - Lesion of posterior pituitary results in decreased secretion of ADH, causing diabetes insipidus.
- Hyperadrenalism:
  - It results in increased production of glucocorticoids, causing *Cushing's syndrome*.
  - Increased production of mineralocorticoids results in *Conn's syndrome*.
- Hypoadrenalism:
  - It results in decreased production of mineralocorticoid, leading to *Addison's disease*.
- Pheochromocytoma:
  - These are tumors of adrenal medulla, resulting in increased secretion of catecholamine.
- Hyperthyroidism/Thyrotoxicosis:
  - It is caused by excessive secretion of thyroid hormone.
- Hypothyroidism:
  - It is caused by inadequate secretion of thyroid hormone, resulting in *cretinism* in childhood and *myxedema* in adults.
- Osteitis fibrosa: Tumors of the parathyroid gland (hypersecretion of parathyroid hormone) result in osteitis fibrosa making the bone soft due to decalcification resulting in hypercalcemia and stone formation in kidney.
- Tetany:
  - It is caused by hyposecretion of parathyroid hormone.
  - It is characterized by carpopedal spasm and convulsions due to hypocalcemia and increased neuromuscular excitability.

## Questions

1. How does the pituitary gland develop?
2. Name the different parts of pituitary gland.
3. Name the hormones produced by the anterior pituitary.
4. Name the hormones related to posterior pituitary.
5. What are Herring bodies?
6. What are pituicytes?
7. What is hypothalamo-hypophyseal system?
8. What do you understand by development of suprarenal gland?
9. Name the layers of cortex and the hormones secreted by them.
10. What is chromaffin reaction?
11. Name the hormones of adrenal medulla.
12. What are the epithelial changes related to the activity of thyroid follicle?
13. What are colloids?
14. What are parafollicular cells and what do they secrete?