

Chapter 8 – Endocrine system



The objectives of this chapter are:

1. Name the endocrine glands.
2. Describe the hypophysis.
3. Describe the thyroid gland.
4. Describe the parathyroid glands.
5. Describe the paraganglionic or chromaffin system.
6. Describe the endocrine function of the thymus, pancreas, and gonads.

1 - Introduction

The endocrine system is an additional messenger system of human body, alongside the nervous system. It includes endocrine glands that release their products named hormones directly into the circulatory system. The hormones are then transported by blood to the distant organs, and the organs which have receptors for the hormone will respond to the binding of hormones on those receptors.

The major endocrine glands are the hypophysis (pituitary gland), pineal gland, thyroid gland, parathyroid glands, and suprarenal glands. Additional organs with important endocrine function are the pancreas, which is part of the digestive system, and the ovaries and testes, which are part of the genital system.

Secretion of hormones is under control of the vegetative nervous system. The organ of the nervous system controlling the endocrine glands is the hypothalamus. It connects the nervous system to the endocrine system via hypophysis. This hypothalamic-pituitary system controls all endocrine functions. Regulation of endocrine system function is organised via feedback loops.

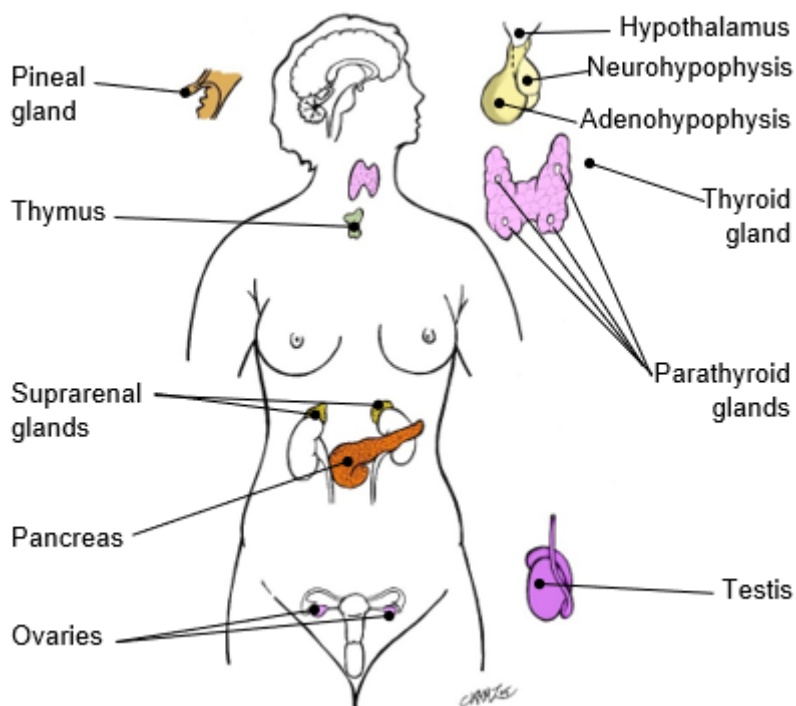


Figure 271: The endocrine glands. Anterior view.

2 - Hypothalamus

The hypothalamus is a small part of the cerebrum that plays a crucial role in endocrine system. It has a shape of a funnel that hangs below the thalamus. It forms the lower part of the lateral wall of the third ventricle. At its bottom there is the pituitary stalk. It is composed of a large number of nuclei.

3 - Hypophysis

The hypophysis or pituitary gland is a pea-sized neuroglandular organ attached to the underside of the hypothalamus by the pituitary stalk (*infundibulum*). It is well protected because it lies in the enclosed part of the sphenoid bone called *sella turcica*, covered by the dural fold. It is positioned just behind the optic chiasma; therefore, tumours of the hypophysis can lead to the loss of vision field.

The hypophysis consists of two parts:

- Adenohypophysis is the larger anterior part arising from the oral ectoderm. It is the glandular part, secreting several hormones that regulate the activity of other endocrine glands and promote protein synthesis (enhance the anabolism).
- Neurohypophysis is much smaller posterior part arising from the neural ectoderm. It is connected to the hypothalamus by the pituitary stalk and presents a collection of axonal projections from the hypothalamus.

The hypophysis is richly supplied with blood. The hypophyseal portal system connects the hypothalamus with the adenohypophysis and enables a quick transport between them.

4 - Pineal gland

The pineal gland or epiphysis is a small gland in a shape of a pine cone that projects posteriorly from the posterior end of the roof of the third ventricle of the brain. The pineal gland is essentially made up of groups of cells called pinealocytes which are supported by glial cells. Melatonin is present in high concentrations in the pineal gland. Plasma levels of melatonin increase in the dark and decrease during the day.

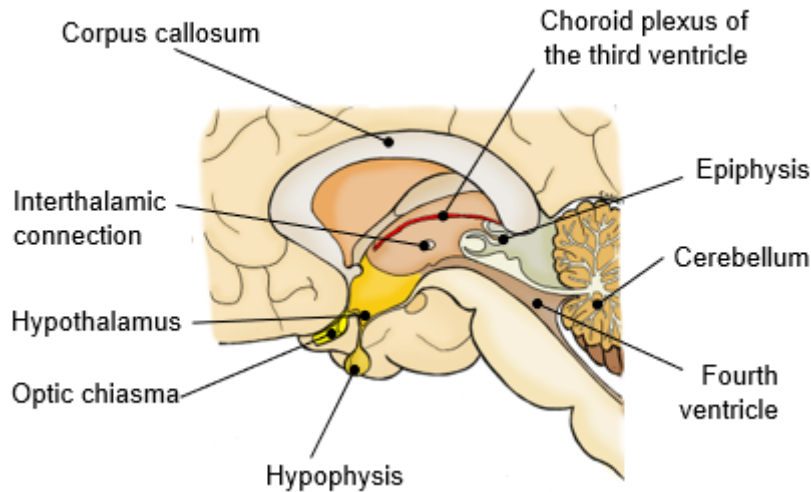


Figure 272: Hypothalamus, hypophysis and epiphysis. Median cross section through the brain.

5 - Thyroid gland

The thyroid gland is a butterfly-shaped red-brown gland that consists of the right and left lobes connected by a narrow isthmus. Sometimes a pyramidal lobe is present projecting upward from the isthmus. The average weight of the gland is 20-25 grams, and each lobe is about 5 cm long and 3 cm wide.

The thyroid gland is located at the anterior part of the neck, below the larynx, in front of and on the sides of the superior part of the trachea. It is surrounded by the pretracheal fascia along with the other neck viscera.

Vascular supply of the thyroid gland is very abundant and is provided by four arteries that originate from the subclavian artery and the external carotid artery. Venous return is also very rich and is provided by numerous veins.

The hormones secreted by thyroid gland are thyroxine and triiodothyronine which enhance the metabolic rate and protein synthesis, and calcitonin which plays a role in calcium homeostasis.

The role of the thyroid gland is fundamental, affecting metabolism and practically all organs. Hyperthyroidism leads to palpitations and rapid weight loss. Hypothyroidism leads to physical and cognitive slowdown. In children, it is also involved in the growth of long bones and in psychomotor and intellectual development.

The imaging of the thyroid gland can be performed by ultrasound which reveals the structure of the gland. For further information, scintigraphy with radiolabelled iodine or technetium can be performed which reveals not only the size and shape of potential lesions, but also their metabolic activity.

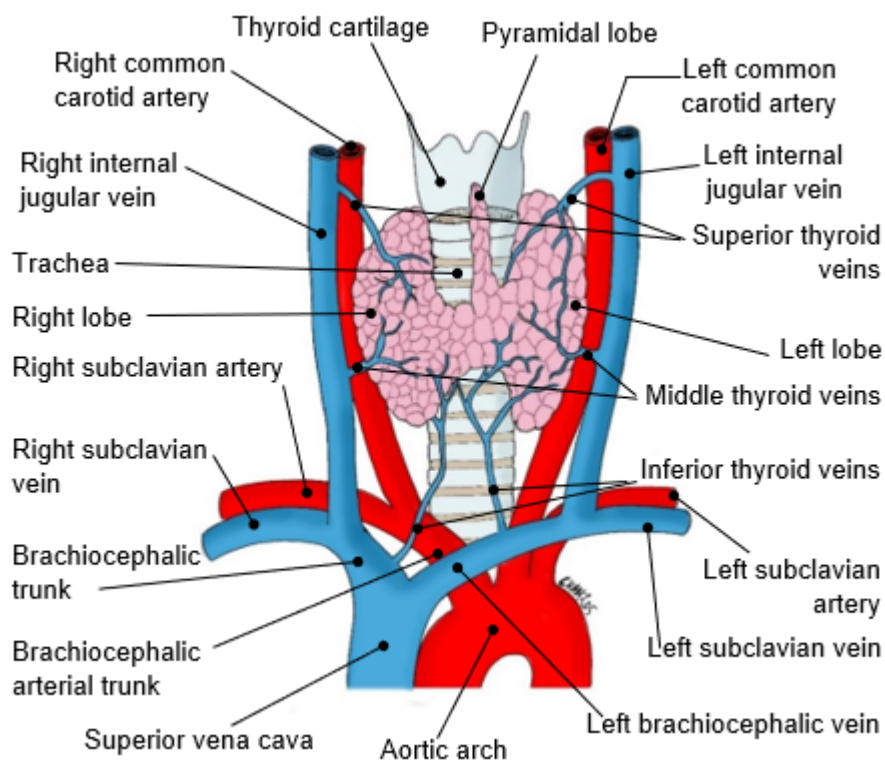


Figure 273: The thyroid gland. Anterior view.



Figure 274: Dissection of the anterior compartment of the neck showing the thyroid gland. Anterior view.

6 - Parathyroid glands

The parathyroid glands are small egg-shaped glands about 6 mm long. They weigh about 30-35 mg each. There are usually four parathyroid glands, located on the posterior surface of the thyroid gland.

They secrete the parathyroid hormone (PTH) which plays a role in calcium homeostasis.

Vascular supply of the parathyroid glands is the same as of the thyroid gland.

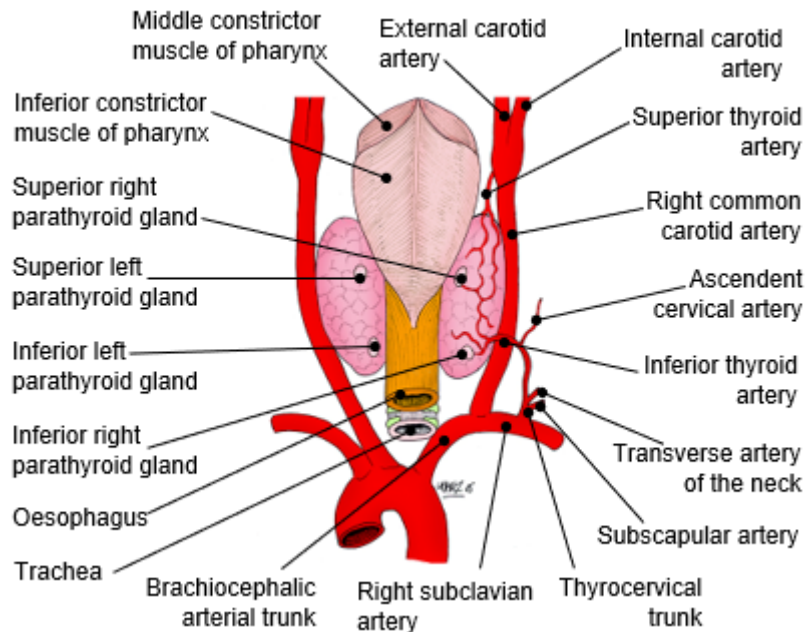


Figure 275: The neck viscera showing the parathyroid glands. Posterior view.

7 - Suprarenal glands

The suprarenal glands are yellowish retroperitoneal organs that lie on the upper poles of the kidneys. They are surrounded by renal fascia and separated from the kidneys by the perirenal fat. Each gland has a yellowish cortex and a dark brown medulla.

The cortex of suprarenal gland secretes three main types of steroid hormones. The mineralocorticoids regulate the electrolyte balance and blood pressure. The glucocorticoids regulate the metabolism and suppress the immune system. The androgens are sex hormones and are produced in small quantities.

The medulla of suprarenal gland secretes the catecholamines epinephrine and norepinephrine. Unlike the cortex, which is regulated by the hypophyseal hormones, the medulla is stimulated by the sympathetic nervous system.

The suprarenal gland has a rich arterial supply up to three arteries arising from the inferior phrenic artery, abdominal aorta, and renal artery.

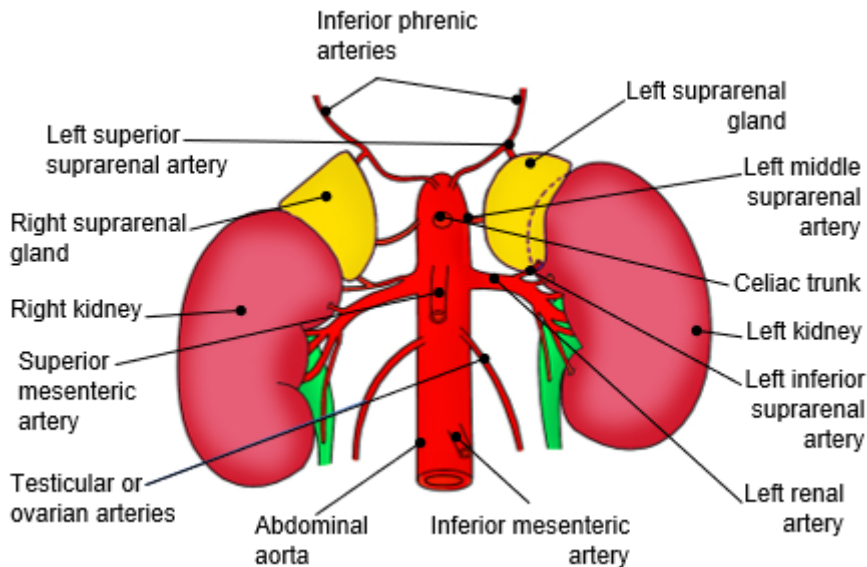


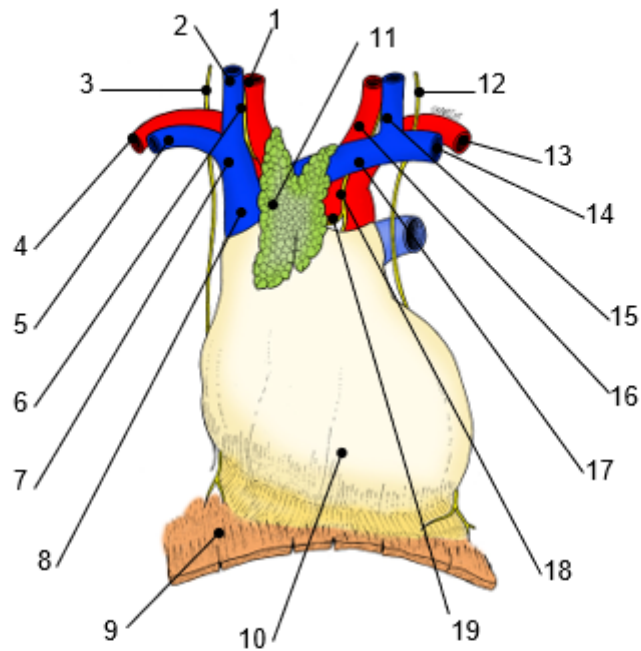
Figure 276: Blood supply of the suprarenal glands. Anterior view.

8 - Organs of other organ systems with endocrine function

8.1 - Thymus

The thymus is a flattened organ located behind the sternum in the superior mediastinum. It can stretch upwards toward the neck or downwards in front of the pericardium. In a new-born, the thymus reaches its largest size in relation to the body size. It continues to grow until puberty, after which it regresses.

The thymus is a specialised primary lymphoid organ in which the T lymphocytes (T cells) mature. It produces several hormones which regulate the T cells maturation.



- | | |
|--------------------------------|------------------------------------|
| 1. Right common carotid artery | 11. Thymus |
| 2. Right internal jugular vein | 12. Left phrenic nerve |
| 3. Right phrenic nerve | 13. Left subclavian artery |
| 4. Right subclavian artery | 14. Left subclavian vein |
| 5. Right subclavian vein | 15. Left internal jugular vein |
| 6. Right vagus nerve | 16. Left common carotid artery |
| 7. Right brachiocephalic vein | 17. Left brachiocephalic vein |
| 8. Superior vena cava | 18. Left vagus nerve |
| 9. Diaphragm | 19. Left recurrent laryngeal nerve |
| 10. Pericardium | |

Figure 277: The thymus. Anterior view.

8.2 - Pancreas

The pancreas is a soft, lobulated organ located on the posterior abdominal wall behind the peritoneum. It is elongated transversely, the head lies within the concavity of the duodenum, and the neck, body, and tail extend to the left. The tail lies in contact with the hilum of the spleen. It is approximately 18 cm long, 3 cm wide and 4 cm high. It weighs about 70 g.

The pancreas is an organ of the digestive system. According to the function, we distinguish between the exocrine and endocrine part of the pancreas. The larger exocrine part of the gland produces the pancreatic juice with digestive enzymes and secretes it into the lumen of the duodenum. The endocrine part of the gland consists of clusters of cells, called the islets of Langerhans, which are scattered between the exocrine acini. The islets are particularly numerous in the tail of the pancreas. The cells of the islets secrete the hormones insulin and glucagon which regulate the blood sugar level.

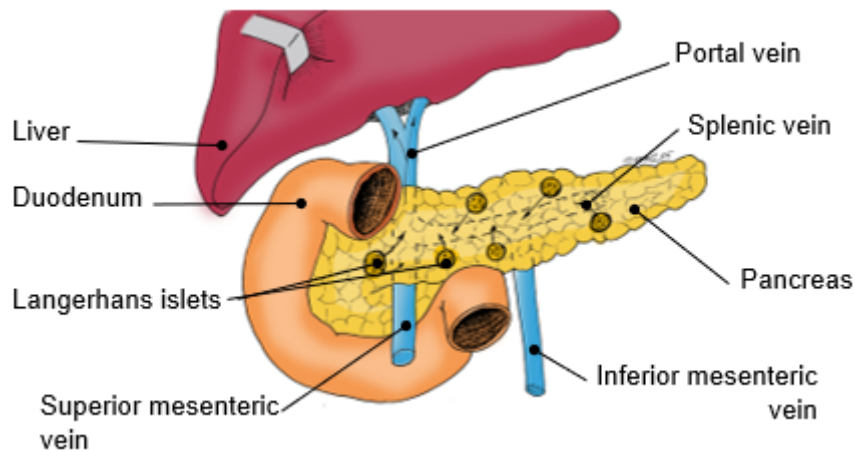


Figure 278: The pancreas. Anterior view.

8.3 - Testis

The **testis** is a paired egg-shaped organ located in the scrotum. It is part of the male genital system.

The greater part of the gland is made up of seminiferous tubules where spermatogenesis occurs and leads to the production of sperm. The endocrine part of the testis consists of groups of rounded interstitial cells (Leydig cells) embedded in the loose connective tissue between the seminiferous tubules. The Leydig cells produce sex hormones called androgens, primarily the testosterone.

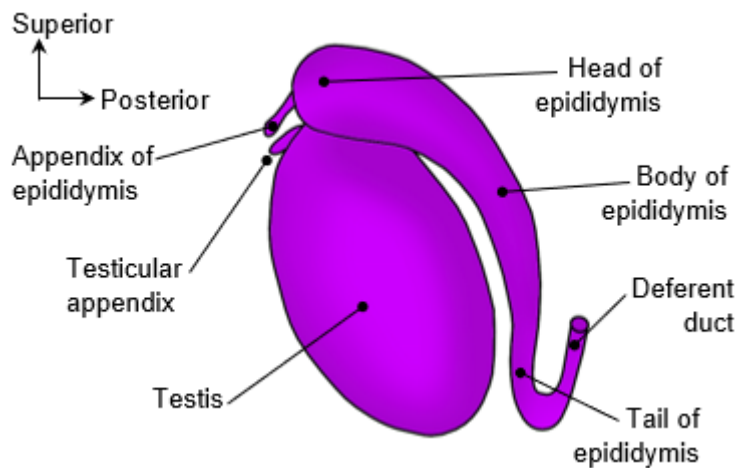


Figure 279: Lateral view of the testis.

8.4 - Ovary

The ovary is a paired egg-shaped organ located in the pelvic cavity. It is part of the female genital system.

The ovary consists of an outer cortex and an inner medulla. Embedded in the connective tissue of the cortex are ovarian follicles in various stages of development. Inside each follicle lies the ovum. The follicular cells produce and secrete sex hormones, primarily the oestrogen and progesterone.

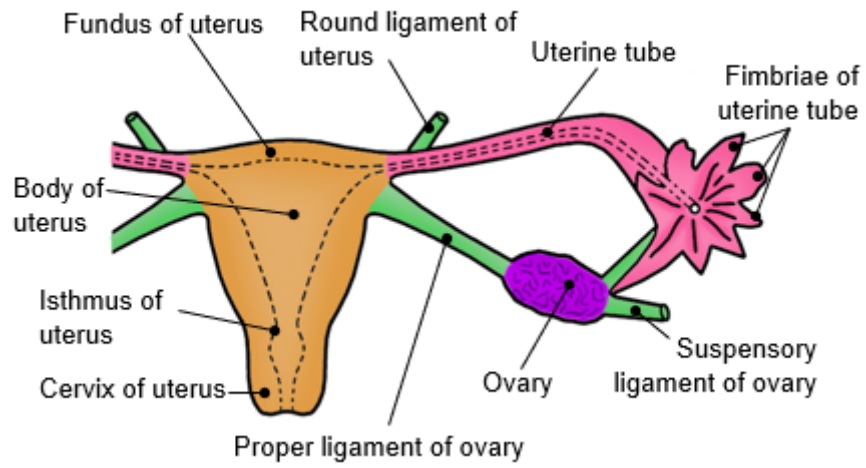


Figure 280: The anterior view of the ovary.