

Continuing Education Independent Study Series



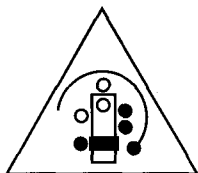
THE ENDOCRINE SYSTEM

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PREFACE

“The Endocrine System” is part of the AST Continuing Education Independent Study Series. The series has been specifically designed for surgical technologists to provide independent study opportunities that are relevant to the field and support the educational goals of the profession and the Association.

Acknowledgments

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INTRODUCTION

Purpose

The purpose of this module is to acquaint the learner with the major endocrine glands, their hormones, and their functions. Upon completing this module, the learner will receive 2 continuing education (CE) credits in category 1G.

Objectives

Upon completing this module, the learner will be able to do the following:

1. Identify the major endocrine glands of the body.
2. Identify the major hormones released by the endocrine system.
3. Explain the effect of hormonal action on the body.
4. Describe symptoms of major hormonal disease processes.

Using the Module

1. Read the information provided, referring to the appropriate figures.
2. Complete the enclosed exam without referring back to the text. The questions are in a multiple-choice format. Select the best answer from the alternatives given.
3. Mail the completed exam to AST, CEIS Series, 7108-C S. Alton Way, Englewood, CO 80112-2106. Please keep a copy of your answers before mailing the exam. You must return the original copy of the answer sheet; this exam may not be copied and distributed to others.
4. Your exam will be graded, and you will be awarded continuing education credit upon achieving a minimum passing score of 70%. If you are an AST member, your credits will be automatically recorded and you do not need to submit the credits with your yearly CE report form.
5. You will be sent the correct answers to the exam. Compare your answers with the correct answers to evaluate your level of knowledge and determine what areas you need to review.

Studying Technical Material

To study technical material, find a quiet place where you can work uninterrupted. Sitting at a desk or work table will be most conducive to studying.

Having a medical dictionary available as you study is very helpful so you can look up any words with which you are unfamiliar. Make notes in the margins of any new definitions so that you can review them.

The ultimate test of how well you learn this material is your ability to relate your knowledge to what is happening in the surgical field. Apply your knowledge to the assessment of the patient's status during surgery.

Additional Resources

Core Curriculum for Surgical Technology. 3rd ed. Association of Surgical Technologists; 1990.

Gray H. *Gray's Anatomy*. New York: Bounty Books, 1978.

Tortora G, Anagnostakos N. *Principles of Anatomy and Physiology*. 7th ed. New York: Harper & Row; 1993.

THE ENDOCRINE SYSTEM

The endocrine system helps to regulate body activities by releasing hormones into the extracellular spaces. These hormones control the internal environment of the body by controlling the chemical composition; by adapting to changes such as trauma, stress, and hemorrhage; by regulating growth; and by contributing to the reproductive process (Figure 1).

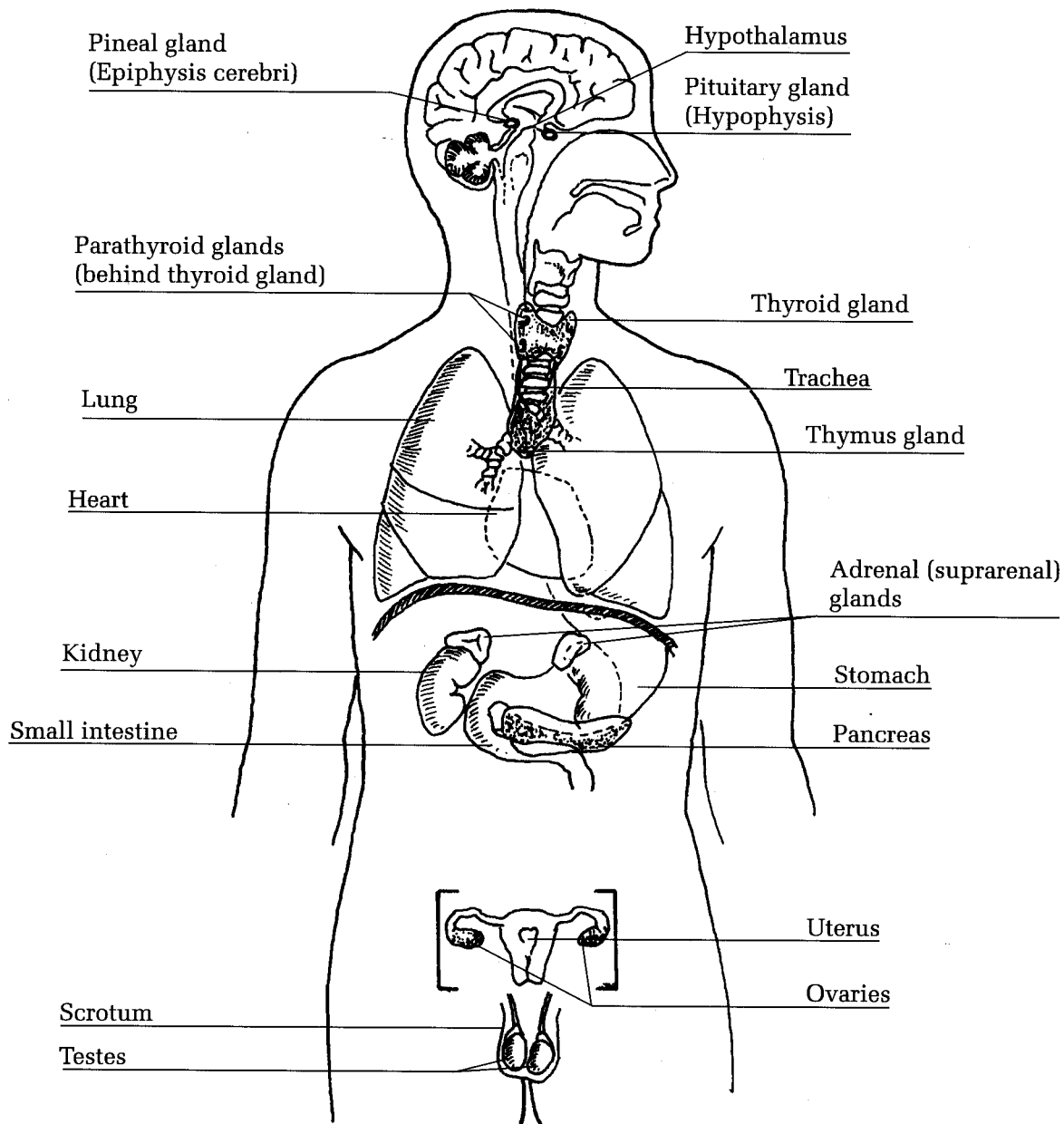


Figure 1.
Location of endocrine glands. (Adapted from Tortora et al.)

Hormones

Hormones are chemicals that regulate metabolic activities of other cells or tissues. Hormones are extremely potent and therefore stimulate activity within target cells and tissue in extremely low concentrations.

Principal Chemical Types

1. Amines: Hormones produced from simple amino acids. Examples: thyroid hormones, epinephrine and norepinephrine, and catecholamines.
2. Proteins and peptides: Water-soluble hormones made from chains of amino acid molecules.
3. Steroids: Lipid-soluble hormones produced from cholesterol. Examples: aldosterone, cortisol, testosterone, estrogens, and progesterone.

Hormonal Action

The amount of hormone released by the endocrine system is equal to the perceived need of the body. An overview of the process through which a hormone is released is as follows:

1. Perceived body need; body out of balance.
2. Hormone released by gland.
3. Hormone carried by blood to a target all within the body.
4. Target cell receptors bind with hormone.
5. Desired effect produced.
6. Effect recognized by original cell in endocrine gland.
7. Endocrine cell stops producing hormone.
8. Homeostasis is achieved; body in balance.

Regulation of Hormonal Secretions

The release of hormones in the body is controlled by three mechanisms.

The first mechanism is the negative feedback system. Within a negative feedback system, the gland responds to the concentration of the substance it controls or to a product of the process it controls. As the concentration of the substance increases, the gland decreases its activity and vice versa.

The second mechanism is the positive feedback system in which the gland is stimulated to produce more hormones by a substance it causes to be produced.

The third mechanism is the nerve impulses provided by the nervous system upon appropriate stimulation.

Pituitary Gland (Hypophysis)

Location and Structure

The pituitary gland is considered the master gland because it regulates many body activities. It lies in the sella turcica of the sphenoid and is attached by a stalk, the infundibulum, to the hypothalamus of the brain.

The pituitary gland is divided into two lobes, anterior and posterior. The anterior lobe constitutes three-fourths of the entire gland. The posterior lobe, although smaller, has neural axons that connect with cell bodies in the hypothalamus of the brain. Between these two lobes is a small avascular area known as the pars intermedia (Figure 2).

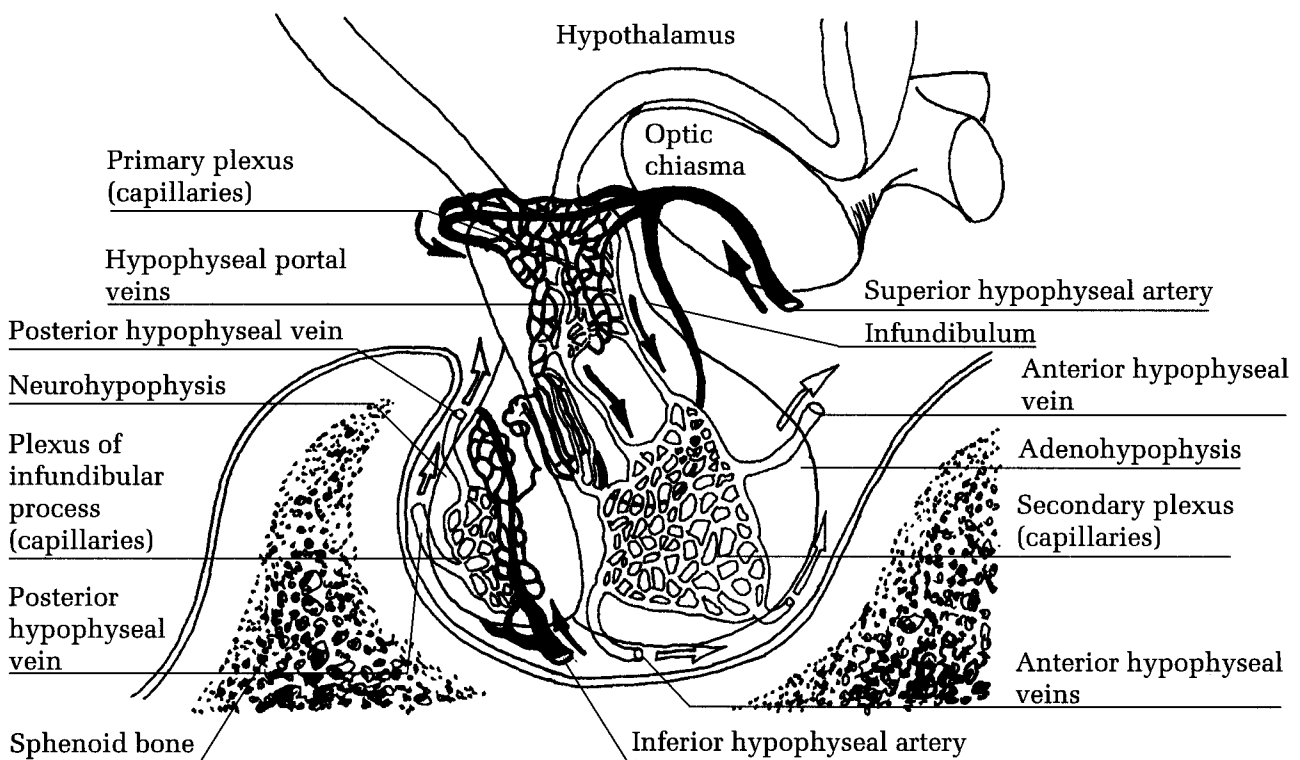


Figure 2.
Structure of the pituitary gland and its blood supply. (Adapted from Tortora et al.)

Hormones Produced

1. Growth hormone (GH) or somatotropin: Acts on skeletal muscles and bones causing them to grow and increase their metabolism. Hyposecretion in childhood causes pituitary dwarfism. Hypersecretion causes gigantism, and hypersecretion during adulthood causes acromegaly. Acromegaly causes bones of the hands, feet, and face to thicken and the surrounding soft tissue to grow.
2. Thyroid-stimulating hormone (TSH), or thyrotropin: Causes the thyroid to produce its hormones. Hypersecretion causes exophthalmic goiter.
3. Adrenocorticotrophic hormone (ACTH), or adrenocorticotropin: Causes the adrenal cortex to manufacture its hormones. Hyposecretion of glucocorticoids results in Addison's disease (lethargy, weight loss, hypoglycemia, and low blood pressure).
4. Follicle-stimulating hormone (FSH): Stimulates production of gametes in ovary and testes and production of estrogen.
5. Luteinizing hormone (LH): Stimulates production of ovum, ovulation, and production of corpus luteum; prepares the uterus for implantation; prepares mammary glands for lactation. In men, stimulates the production of testosterone.
6. Prolactin (PRL): Responsible for milk secretion. In men, it enhances the production of testosterone.
7. Melanocyte-stimulating hormone (MSH): Stimulates the distribution of melanin.
8. Oxytocin (OT): Causes contraction of pregnant uterus and will cause milk ejection.
9. Antidiuretic hormone (ADH) or vasopressin: Causes a decrease in urine production. Will increase blood pressure by constriction of arterioles.

Thyroid

Location and Structure

The thyroid is located below the larynx, a right and left lobe on each side of the trachea, connected by tissue known as the isthmus (Figure 3).

The gland is composed of follicles. Each follicle is composed of two different cells: follicular cells that produce thyroxine and triiodothyronine, and parafollicular cells that produce calcitonin. The thyroid must have iodine in order to synthesize the appropriate hormones.

Hormones Produced

Hyposecretion of thyroid hormones in childhood causes cretinism (dwarfism and mental retardation). In the adult, hyposecretion causes myxedema. Hypersecretion in the adult can cause exophthalmos (protruding eyes) or goiter (Graves' disease).

1. Thyroxine (T_4): Regulates metabolism, increases basal metabolic rate, stimulates growth of tissue, and helps to regulate nervous system.
2. Triiodothyronine (T_3): Same effect as T_4 . Contains three atoms of iodine, more potent than thyroxine.
3. Calcitonin (CT): Regulates calcium and phosphate levels by inhibiting the breakdown of bone tissue.

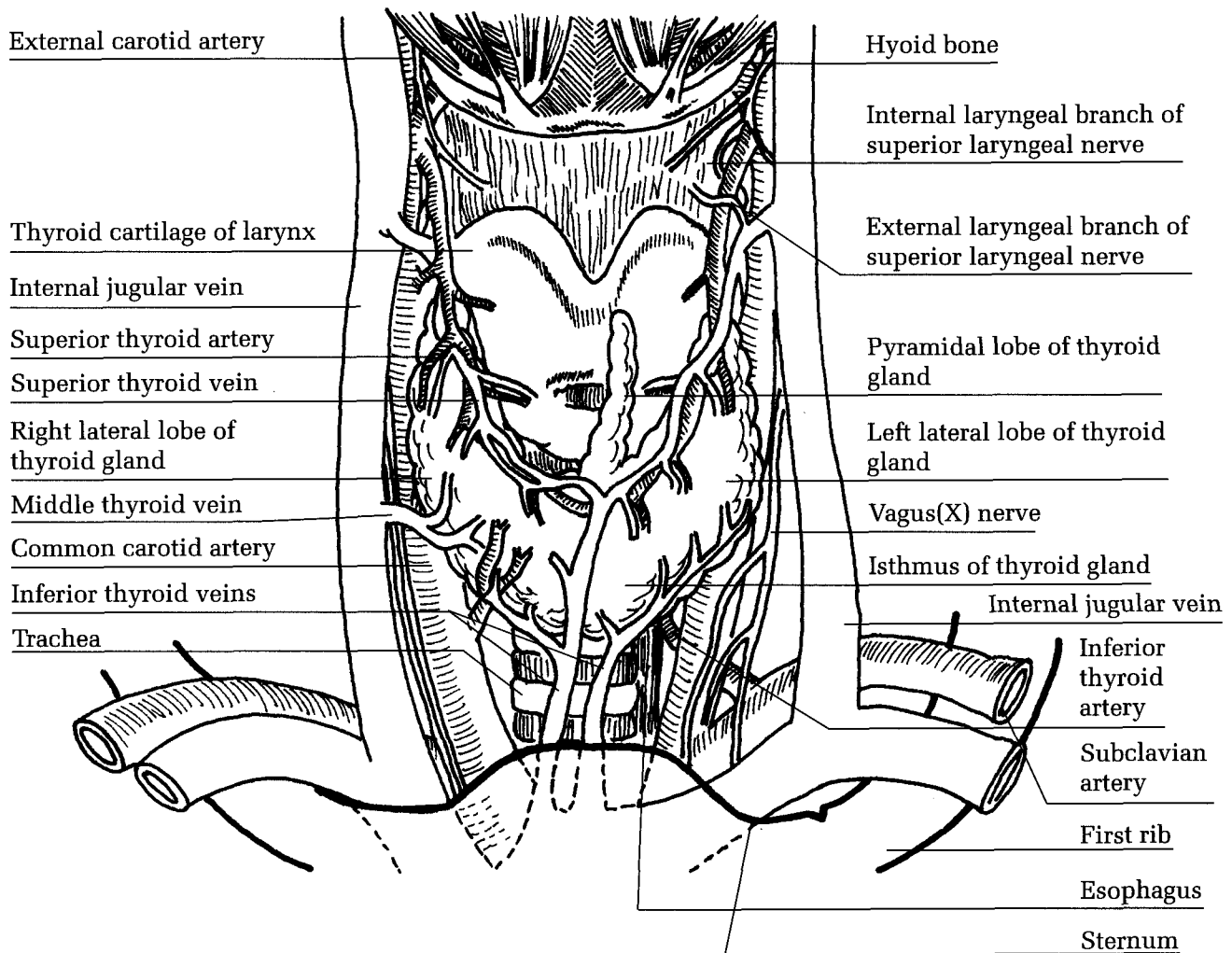


Figure 3.
Location and blood supply of the thyroid gland in anterior view. (Adapted from Tortora et al.)

Parathyroids

Location and Structure

The parathyroids are located on the posterior surface of the thyroid, two pairs on each lobe (Figure 4). They are composed of epithelial cells. The principal cells, or chief cells, are responsible for the production of parathyroid hormone (PTH), the only hormone produced by the parathyroids. The oxyphil cell is believed to produce a reserve capacity of the hormone.

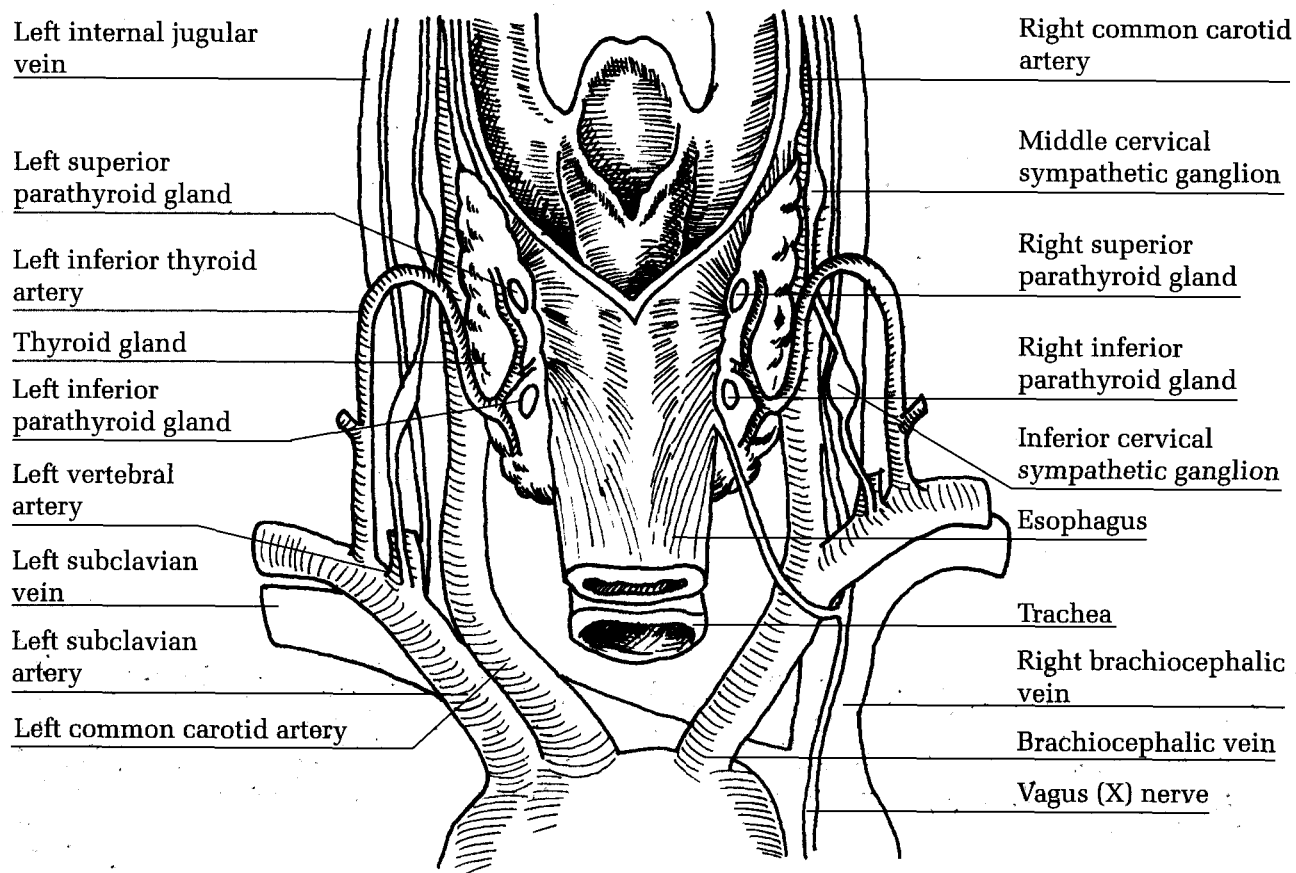


Figure 4.

Location and blood supply of the parathyroid glands in posterior view. (Adapted from Tortora et al.)

Hormone Produced

Parathyroid hormone regulates calcium and phosphate ions. Hyposecretion results in tetany (muscle twitches, spasms, and convulsions). Hypersecretion causes osteitis fibrosa cystica (demineralization of bone tissue).

Adrenals

Location and Structure

One adrenal lies just above each kidney. Each adrenal consists of an outer larger section known as the cortex and an inner section known as the medulla. The entire gland is enclosed in a capsule and is very vascular (Figure 5).

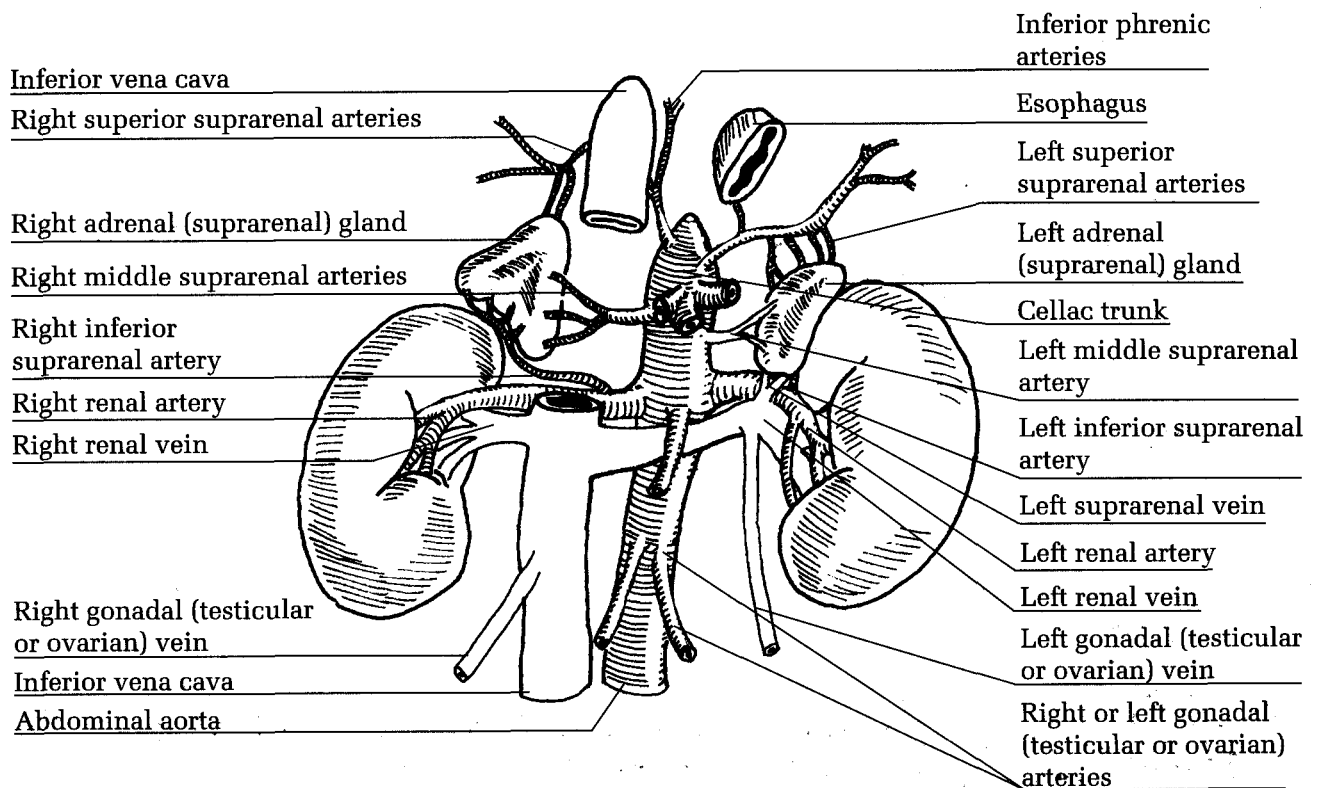


Figure 5.
Location and blood supply of the adrenal glands. (Adapted from Tortora et al.)

The adrenal cortex is divided into three areas, or zones. Each zone is responsible for secreting different hormones. The outermost area is the zona glomerulosa, which is responsible for the production of the mineralocorticoids. The middle area is the zona fasciculata, which secretes glucocorticoid. The innermost area is the zona reticularis, which is responsible for the production of gonadocorticoids, primarily the androgens.

The adrenal medulla is composed of chromaffin cells arranged around large vascular sinuses. The chromaffin cells are directly innervated by cells of the autonomic nervous system. This allows the autonomic nervous system to control the release of the hormones produced in the medulla and ensures a quick response to any stimulus. The hormones produced by the medulla are epinephrine and norepinephrine.

Hormones Produced

1. Mineralocorticoids (aldosterone): Regulates electrolytes and fluid balance mainly through control of sodium and potassium. Hypersecretion of aldosterone causes muscular paralysis and sodium and water retention.

2. Glucocorticoids (cortisol, corticosterone, and cortisone): Controls normal metabolism, fights the effects of stress, and works as an antiinflammatory agent. Hyposecretion causes Addison's disease, while hypersecretion of glucocorticoid causes Cushing's syndrome.
3. Gonadocorticoids (estrogen and androgens): Sex hormones.
4. Epinephrine and norepinephrine: Controls "fight or flight" response; helps to resist effects of stress.

Pancreas

The pancreas is both an endocrine and exocrine gland.

Location and Structure

The pancreas is located posterior to and below the stomach. It is divided into a head, body, and tail.

The endocrine cells are called islets of Langerhans. These islets are composed of three types of cells: alpha cells that secrete glucagon, beta cells that secrete insulin, and delta cells that secrete somatostatin. The islets are also surrounded by acini cells that produce pancreatic juice.

Hormones Produced

1. Glucagon (produced by the alpha cells): Causes an increase in the blood glucose.
2. Insulin (produced by the beta cells): Causes a decrease in the blood glucose. Hyposecretion of insulin results in diabetes mellitus, which causes an increase in the blood glucose.
3. Somatostatin (produced by delta cells): Growth-inhibiting hormone; inhibits the production of glucagon and insulin.

Ovaries

Location and Structure

The ovaries are paired, almond-shaped glands that are located in the pelvis adjacent to the uterus. They consist of the following microscopic parts (Figure 6).

1. Germinal epithelium: Layer covering the outer surface of the ovary.
2. Tunica albuginea: Collagenous layer after the germinal epithelium.
3. Stroma: Next layer composed of a cortex and a medulla. The ovarian follicles are found in the cortex.
4. Ovarian follicles: Immature ova (oocytes).
5. Graafian follicles: Fluid-filled follicle containing the oocytes. The graafian follicles secrete estrogen.
6. Corpus luteum (yellow body): Remains of a ruptured graafian follicle (ovulation). The corpus luteum then continues to produce progesterone, estrogen, relaxin, and inhibin.

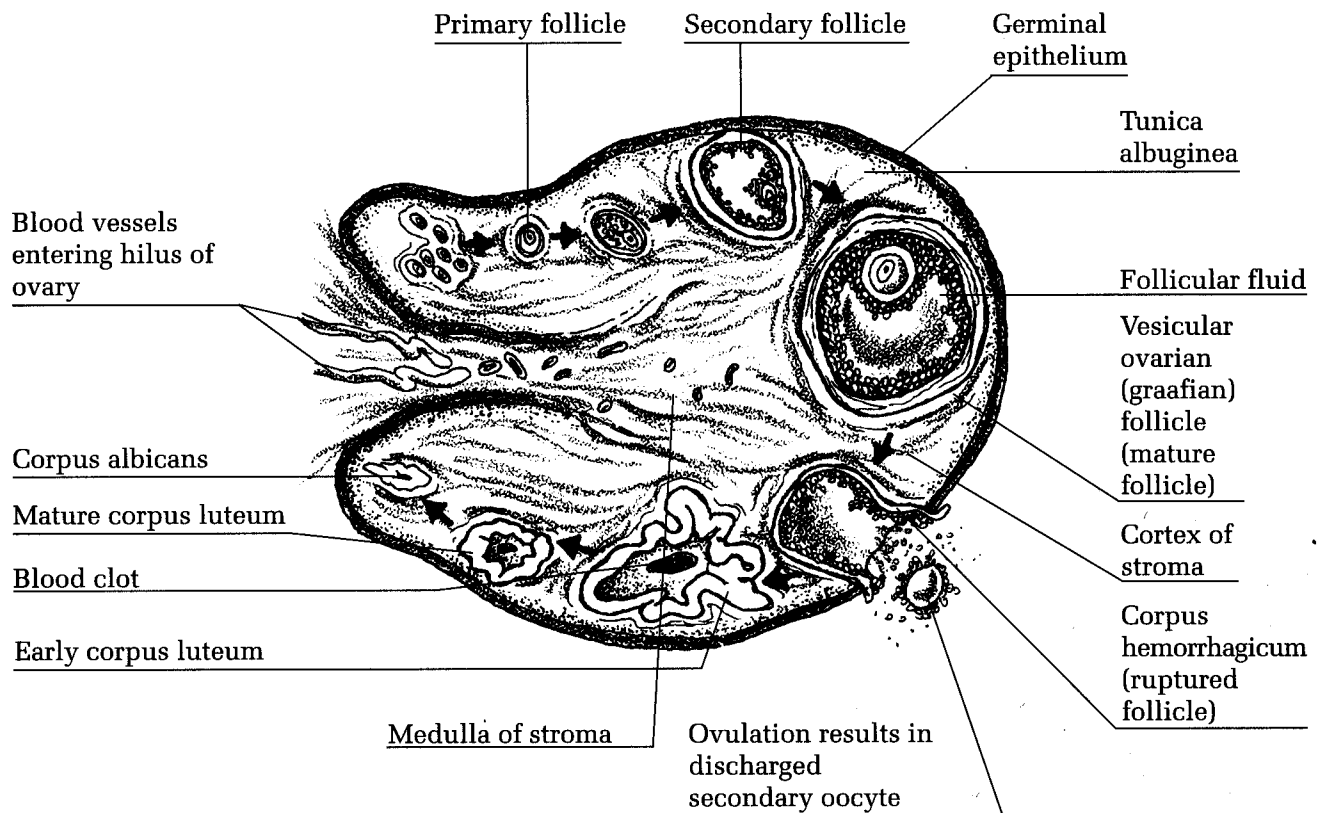


Figure 6.
Histology of the ovary with arrows indicating the sequence of developmental stages that occurs as part of the ovarian cycle. (Adapted from Tortora et al.)

Hormones Produced

1. Estrogen and progesterone: Controls development of secondary sex characteristics.
2. Relaxin: Helps in the dilatation of the cervix and increases the motility of sperm after intercourse.

Testes

Location and Structure

The testes are paired, oval-shaped glands found in the scrotum and consisting of the following parts (Figure 7):

1. Tunica vaginalis testis: Serous covering of the testes formed by an outpocketing of the peritoneum.

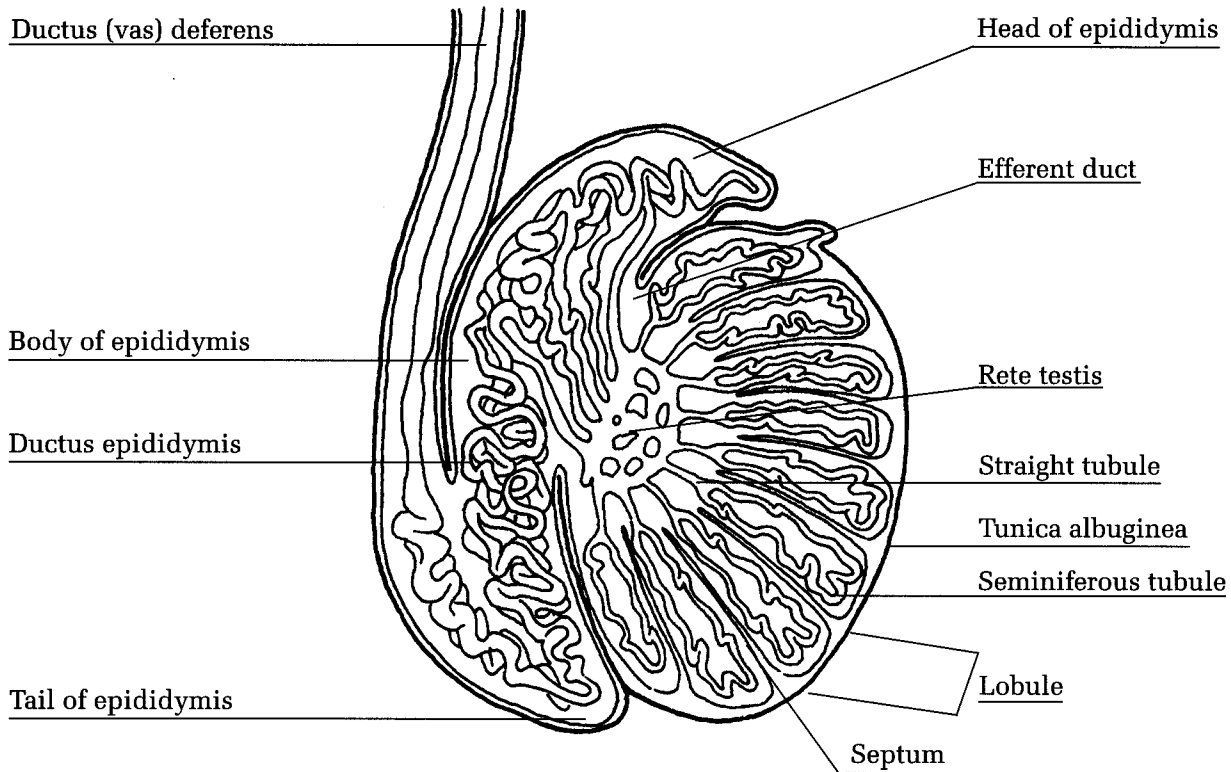


Figure 7.
Anatomy of the testes. (Adapted from Tortora et al.)

2. Tunica albuginea: Next layer of white fibrous tissue that divides the testes into lobules.
3. Seminiferous tubules: Tightly coiled tubules in the lobules that produce sperm. The spermatogenic cells that lie against the basement membrane produce sperm cells that move up toward the lumen of the tubules as they mature.
4. Cells of Leydig: Cluster of cells between the seminiferous tubules that produce testosterone.

Hormones Produced

1. Testosterone: Controls development of secondary sex characteristics.
2. Inhibin: Helps to control the production of sperm.

Pineal Gland

Location and Structure

The pineal gland is found on the roof of the third ventricle of the brain. The gland is formed by masses of neuroglia and secretory cells, pinealocytes, enclosed within a capsule.

Hormones Produced

1. Melatonin: Is produced in darkness and may inhibit gonadotropic hormones.
2. Adrenoglomerulotropin: Stimulates production of aldosterone.

Thymus

Location and Structure

The thymus is located in the upper mediastinum, posterior to the sternum. The thymus gland tissue is present in childhood but is gradually replaced with connective tissue by adulthood.

Hormones Produced

The thymus produces thymosin, thymic humoral factor (THF), thymic factor (TF), and thymopoietin. All these hormones help to provide for maturation of T cells, which play an important role in immunity.