19

The Endocrine System

Introduction

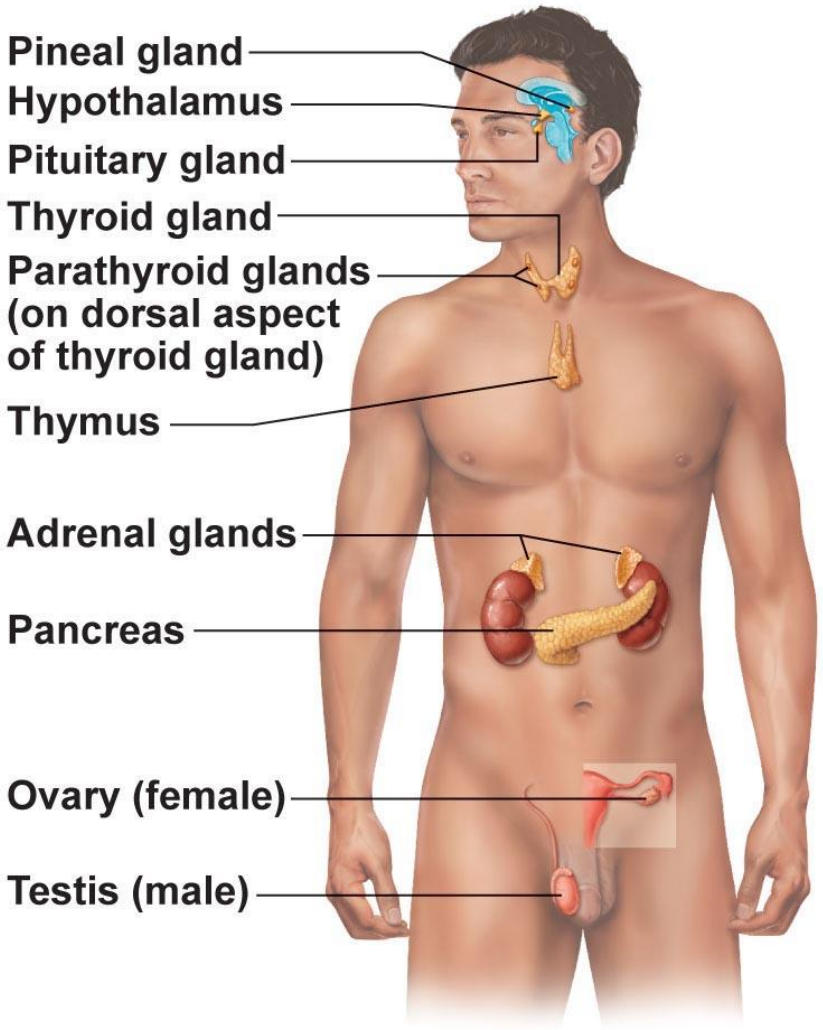
- The nervous system and the endocrine system work together to monitor the body's activities
  - The nervous system: produces short-term, very specific responses
  - The endocrine system: many times it produces long-term, general responses

Introduction

- The endocrine system releases chemicals called **hormones**
  - Hormones leave a gland or gland-like structure
  - The hormone enters into the bloodstream
  - The hormone travels to its target organ or tissue
  - The hormone causes the target organ to respond

An Overview of the Endocrine System

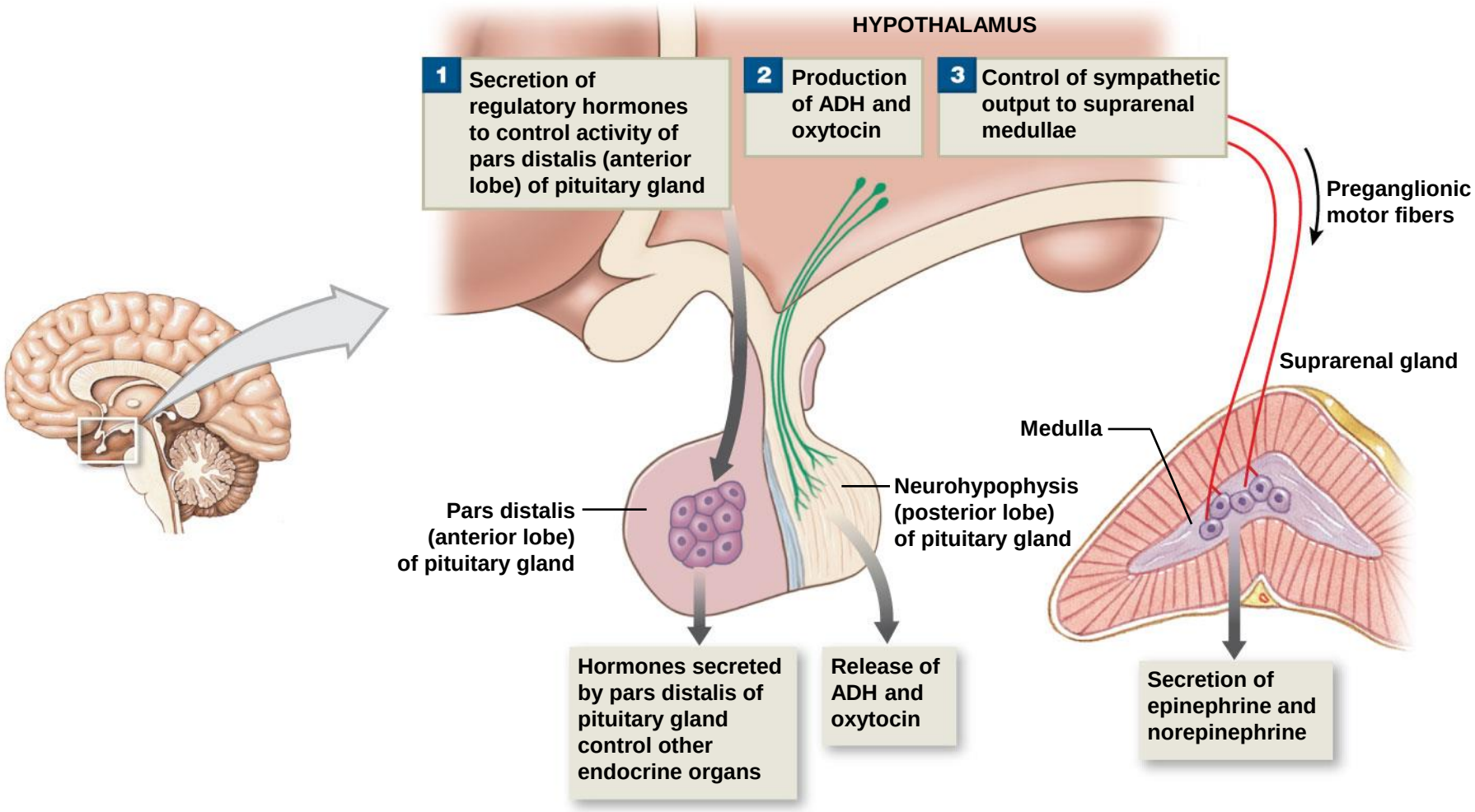
- The main endocrine organs are:
  - **Pituitary gland**
  - **Hypothalamus**
  - **Thyroid gland**
  - **Thymus gland**
  - **Suprarenal glands**
  - **Pineal gland**
  - **Parathyroid glands**
  - **Pancreas**
  - **Reproductive glands**



An Overview of the Endocrine System

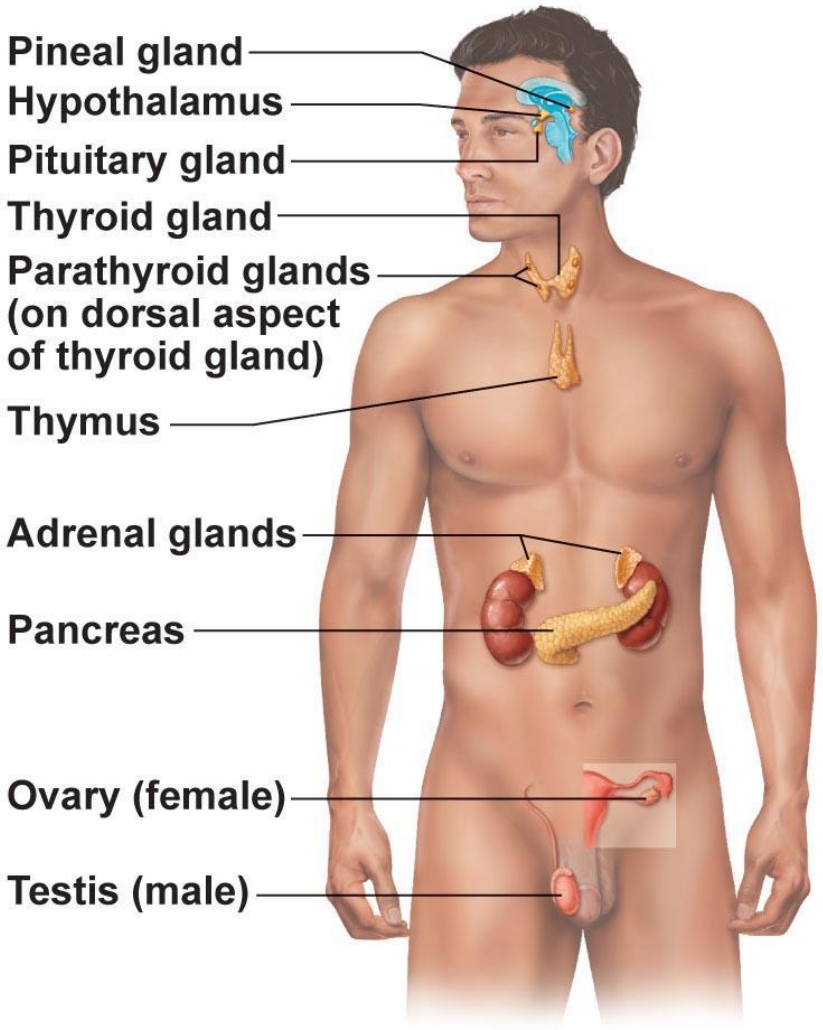
- The Hypothalamus and Endocrine Regulation
  - Hypothalamus functions via three mechanisms
    - **Secretes regulatory hormones**
      - Secretes releasing hormones (RH)
      - Secretes inhibiting hormones (IH)
    - **Acts as an endocrine organ**
      - Releases antidiuretic hormone and oxytocin to the pituitary gland
    - **Contains autonomic nervous system centers**
      - Exerts control over the suprarenal medulla

Figure 19.2 Hypothalamic Control over Endocrine Organs



The Pituitary Gland = the hypophysis

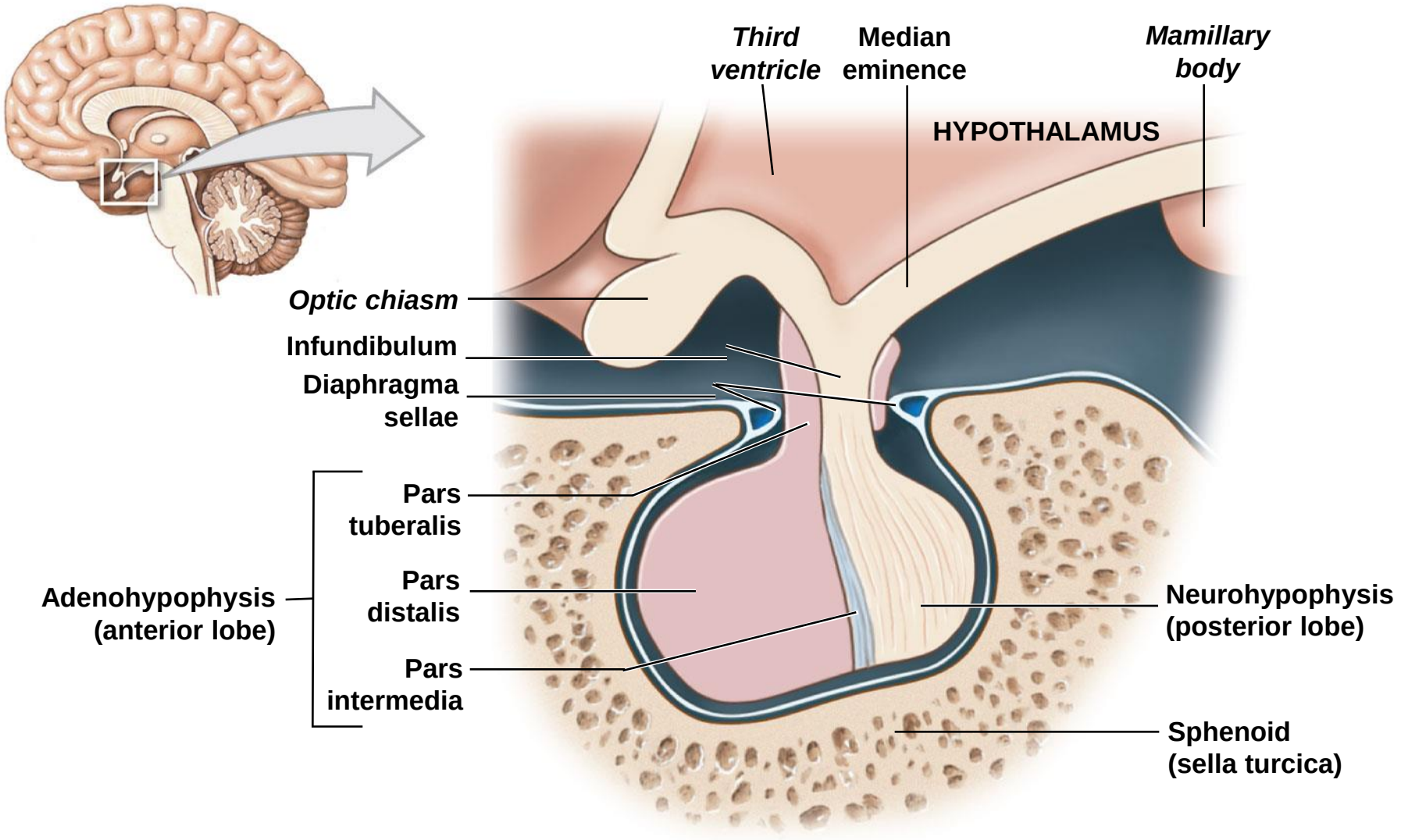
- Attached to the hypothalamus via the **infundibulum**
- Sits in the hypophyseal fossa of the sella turcica
- Consists of two lobes
  - **Adenohypophysis**: anterior lobe releases nine hormones
  - **Neurohypophysis**: posterior lobe releases two hormones



The Pituitary Gland

- The Neurohypophysis
  - Innervated by nerves from the hypothalamus
  - Releases **ADH (antidiuretic hormone)**
    - Causes the kidneys to retain water (prevents dehydration)
    - Constricts peripheral blood vessels (elevates blood pressure)
  - Releases **OT (oxytocin)**
    - Causes uterine contractions
    - Causes mammary glands to release milk from the nipple

Figure 19.3a Gross Anatomy and Histological Organization of the Pituitary Gland and Its Subdivisions



a Relationship of the pituitary gland to the hypothalamus

The Pituitary Gland

- Hormones of the Adenohypophysis
  - **Thyroid-stimulating hormone (TSH)**
  - **Adrenocorticotropic hormone (ACTH)**
  - **Follicle-stimulating hormone (FSH)**
  - **Luteinizing hormone (LH)**
  - **Prolactin (PRL)**
  - **Growth hormone (GH);** also called **somatotropin**
  - **Melanocyte-stimulating hormone (MSH)**

The Pituitary Gland

- Hormones of the Adenohypophysis
  - **Thyroid-stimulating hormone**
    - Causes the thyroid gland to release thyroid hormones (**calcitonin**, **thyroxine**, and **triiodothyronine**)
  - **Adrenocorticotropic hormone**
    - Causes the suprarenal cortex to release **glucocorticoids**

The Pituitary Gland

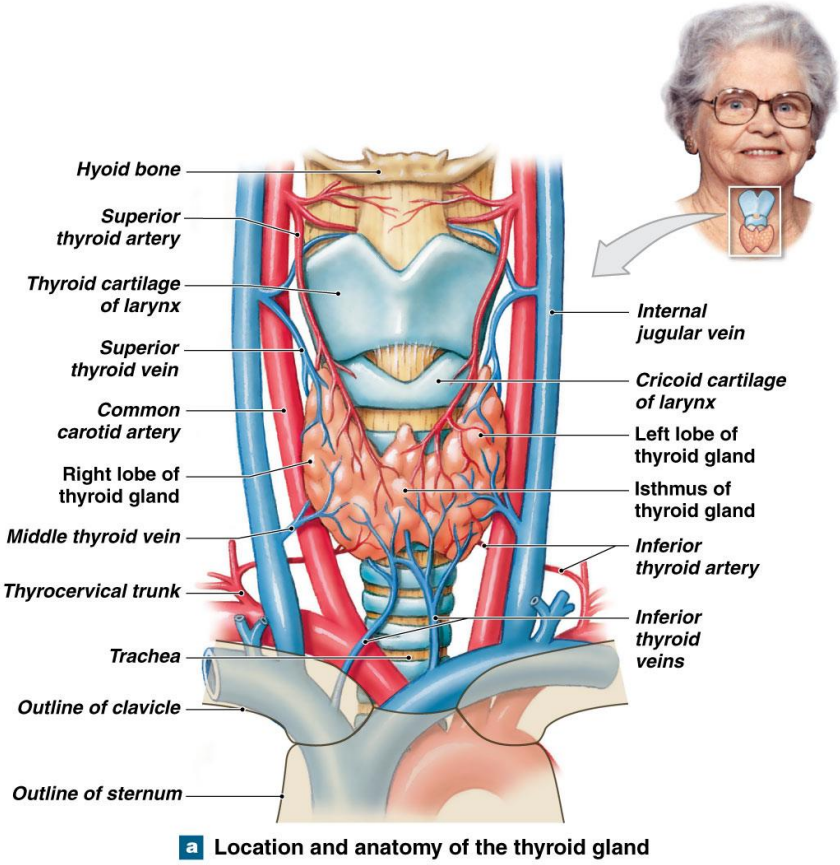
- Hormones of the Adenohypophysis
  - **Follicle-stimulating hormone**
    - Causes the release of estrogen
    - Causes sperm production
  - **Luteinizing hormone**
    - Causes ovulation
    - Causes the release of progestin (**progesterone**)
    - Causes the release of androgens (**testosterone**)
  - FSH and LH are also called gonadotropins

The Pituitary Gland

- Hormones of the Adenohypophysis
  - **Prolactin**
    - Causes the production of milk
  - **Growth hormone** (Also called **somatotropin**)
    - Causes protein synthesis resulting in growth
  - **Melanocyte-stimulating hormone**
    - Causes the production of **melanin**

The Thyroid Gland

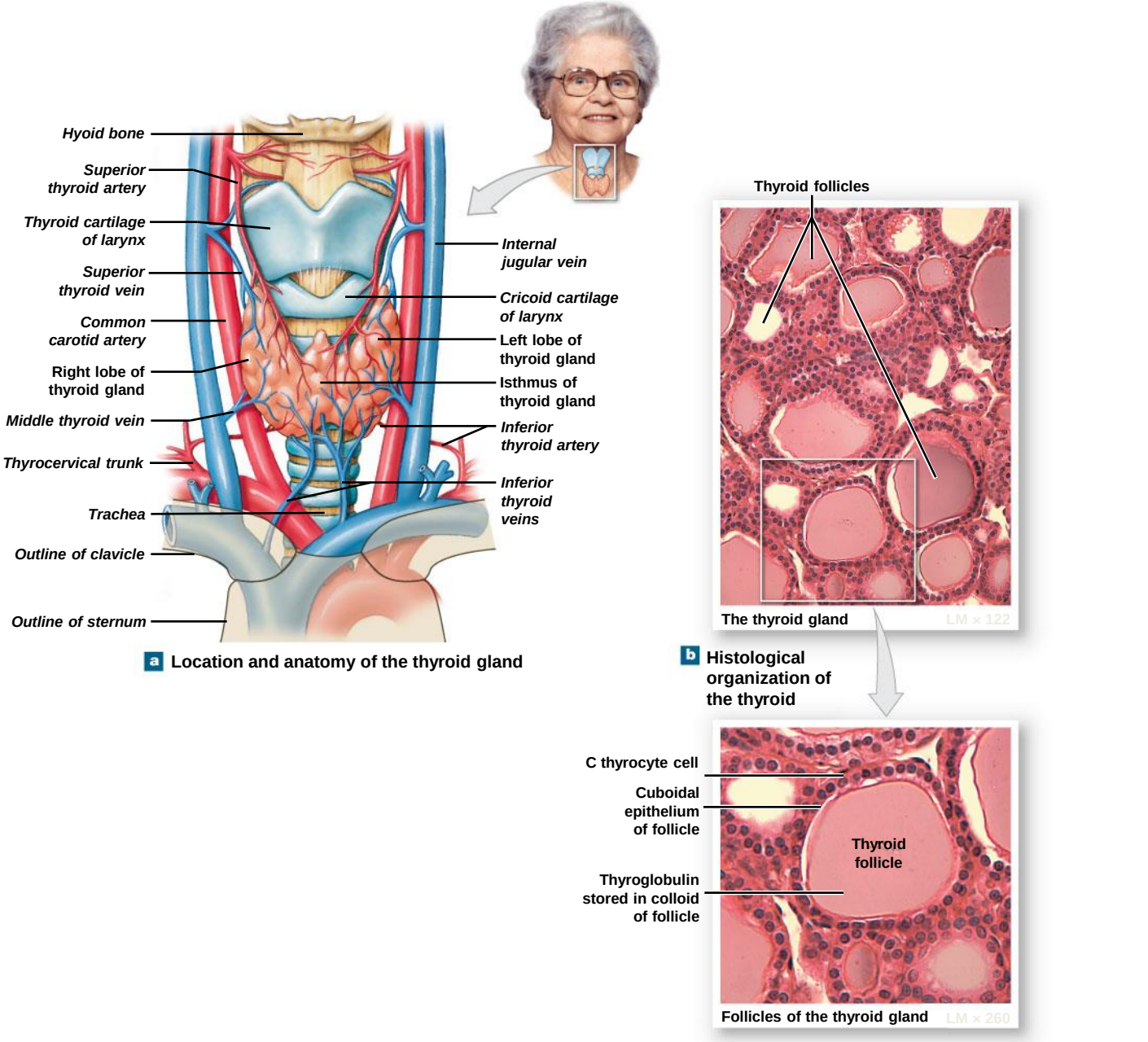
- The thyroid gland is on the anterior surface of the trachea
  - Made of two lobes connected via an **isthmus**
  - Consists of thyroid follicles
  - This is the only gland that stores its hormone products



The Thyroid Gland

- Hormones of the thyroid gland
  - **Calcitonin (CT)**
    - Causes a decrease in blood calcium ion
  - **Thyroxine (T_4)**
    - Causes an increase in metabolism
  - **Triiodothyronine (T_3)**
    - Causes an increase in metabolism

Figure 19.6a–c Anatomy and Histological Organization of the Thyroid Gland



The Parathyroid Glands

- The parathyroid glands are located on the posterior portion of the thyroid gland
- Hormone Production
  - Release **parathyroid hormone (PTH)**
    - Causes an increase in blood calcium ion levels

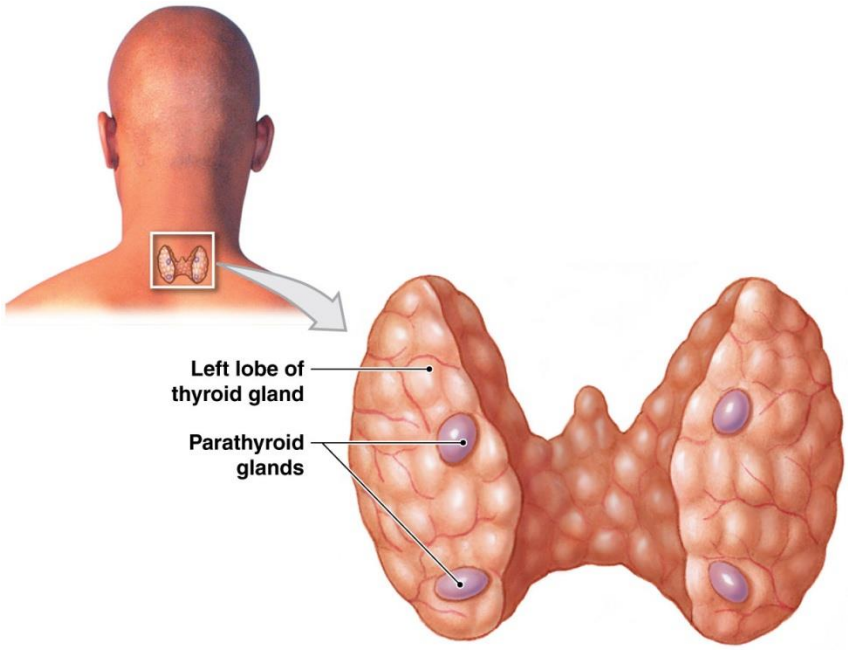
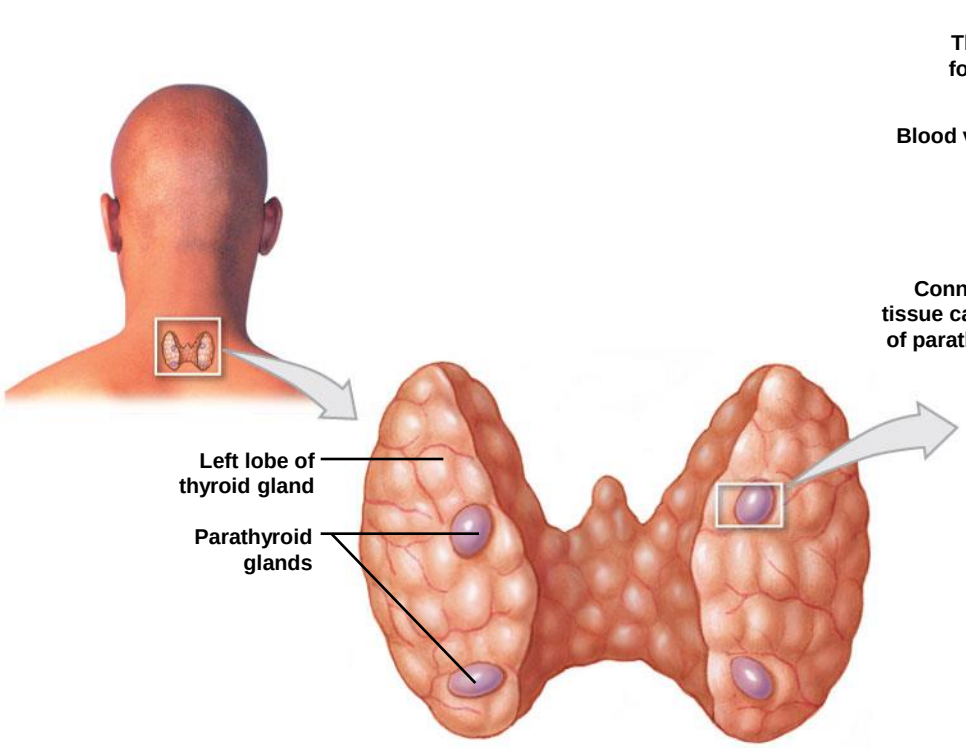
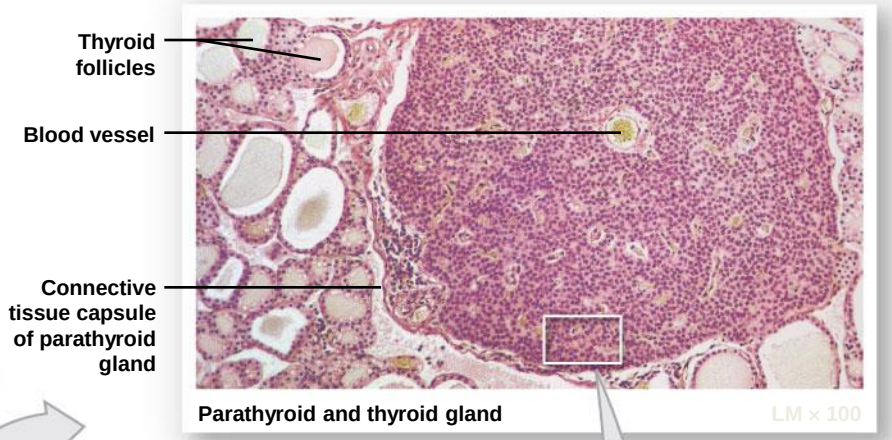


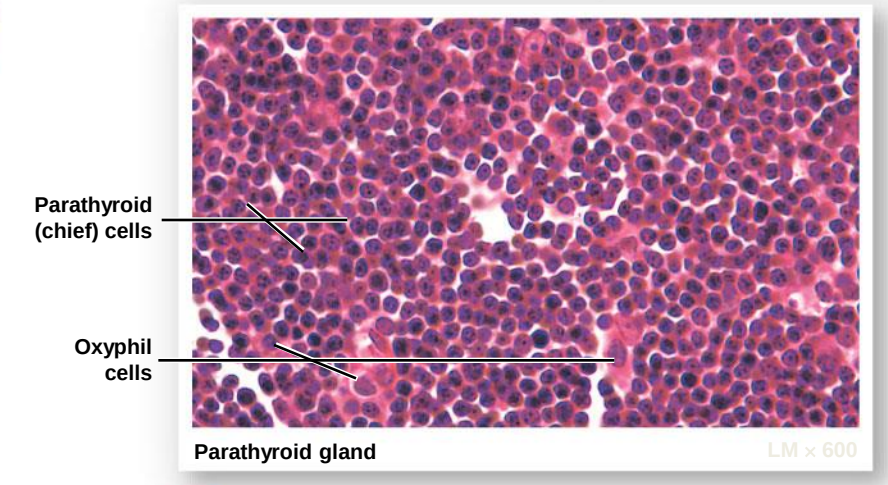
Figure 19.8 Anatomy and Histological Organization of the Parathyroid Glands



a The location and size of the parathyroid glands on the posterior surface of the thyroid lobes



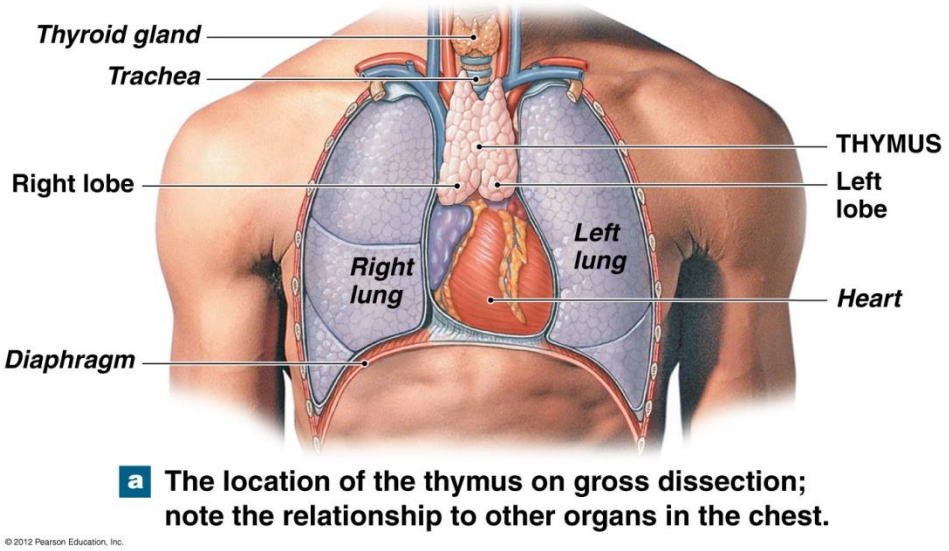
b The histology of the parathyroid and thyroid glands



c A histological section showing parathyroid cells and oxyphil cells of the parathyroid gland

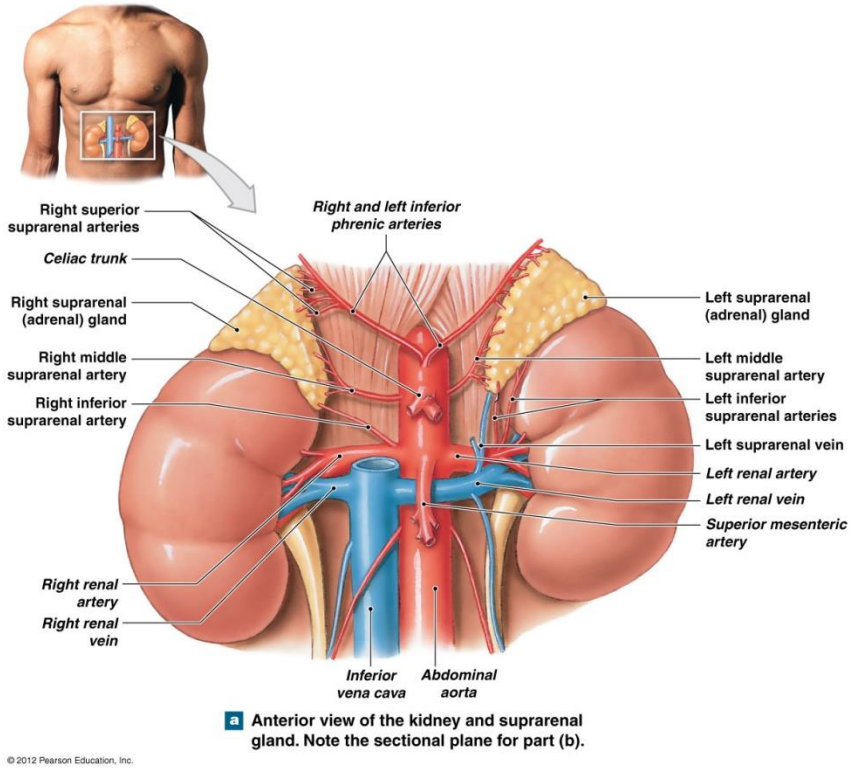
The Thymus Gland

- The thymus gland is posterior to the sternum
- Hormone production
  - Produces **thymosin**
    - Causes lymphocytes to develop into T cells



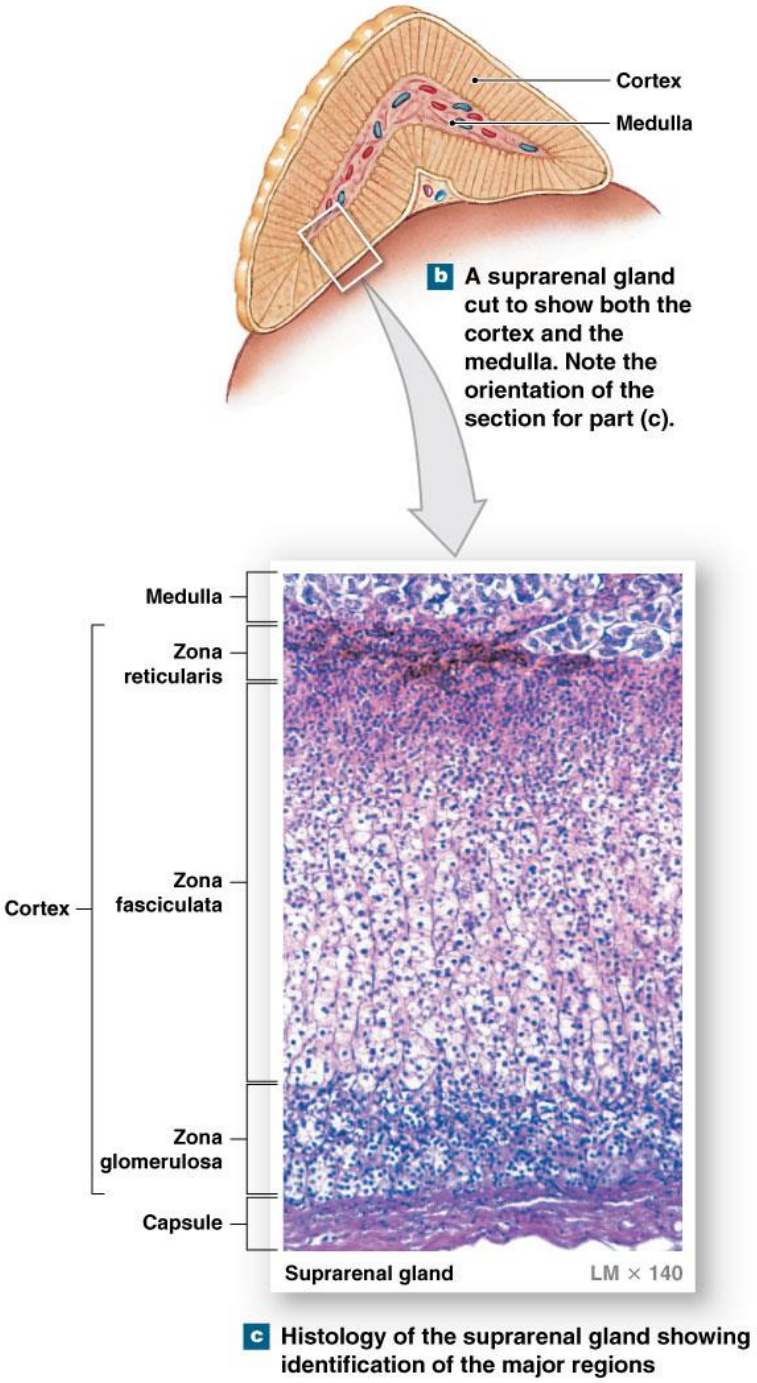
The Suprarenal Glands

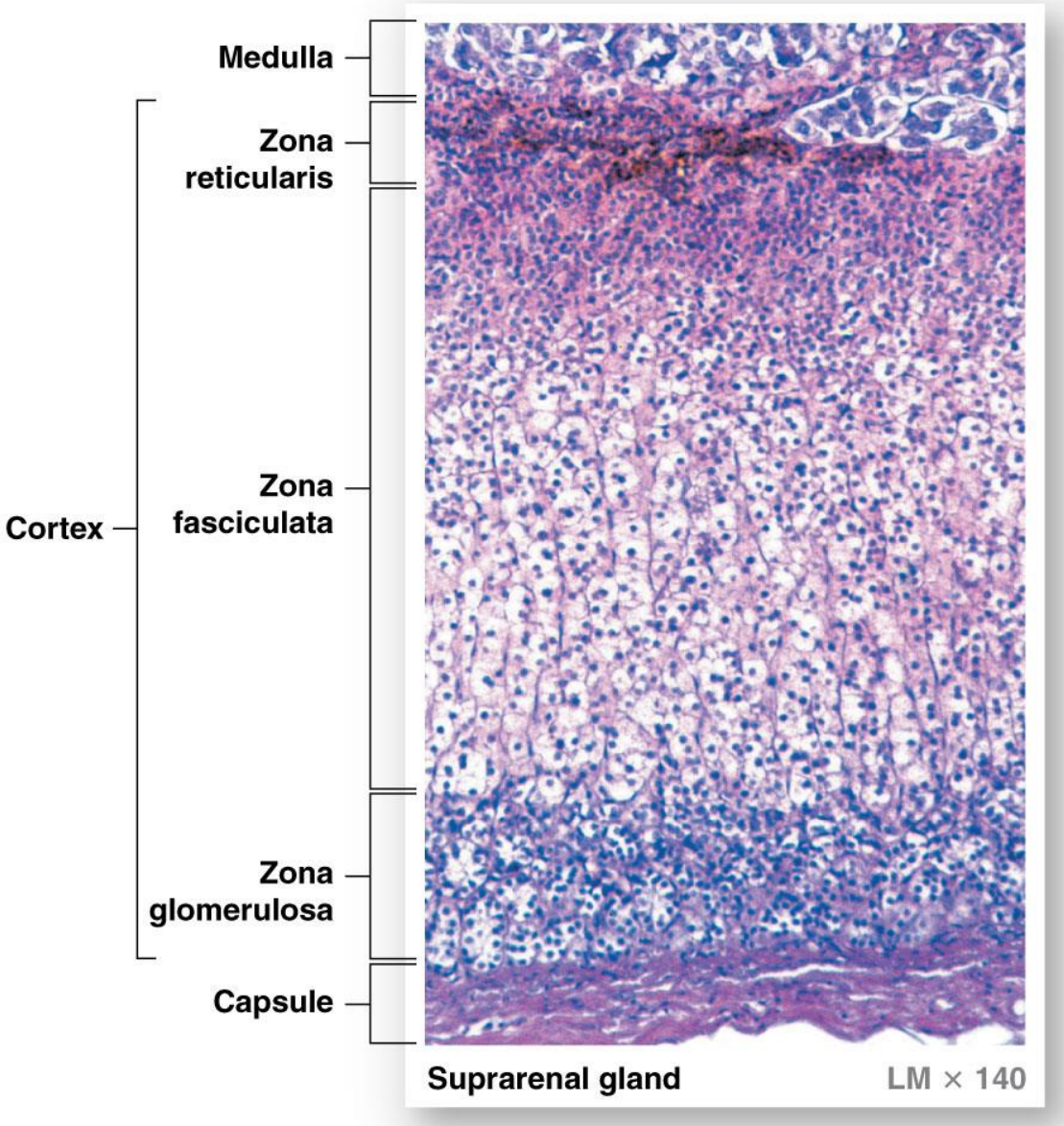
- The suprarenal glands (adrenal glands) are located attached to the superior border of the kidneys



The Suprarenal Glands

- The suprarenal glands are made of two parts
  - **Suprarenal medulla**
  - **Suprarenal cortex**
- The suprarenal cortex is made of three distinct zones
  - **Zona glomerulosa**
  - **Zona fasciculata**
  - **Zona reticularis**





C Histology of the suprarenal gland showing identification of the major regions

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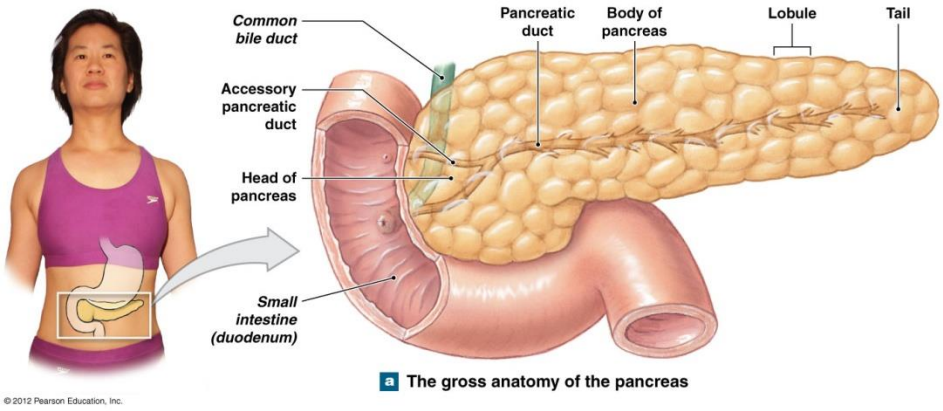
The Suprarenal Glands

- Suprarenal medulla
  - Produces **epinephrine** (adrenaline) and **norepinephrine** (noradrenaline)
  - Cause an increase in cardiac activity, blood pressure and in glycogen breakdown
- Suprarenal cortex
  - **Zona glomerulosa**
    - Produces mineralocorticoids such as **aldosterone**
    - Causes retention of sodium ions and water thereby reducing ion and water loss from the body
  - **Zona fasciculata**
    - Produces glucocorticoids such as **cortisol**, **cortisone**, and **corticosterone**
    - Causes the liver to synthesize glucose and glycogen
  - **Zona reticularis**
    - Produces small amounts of **androgens**

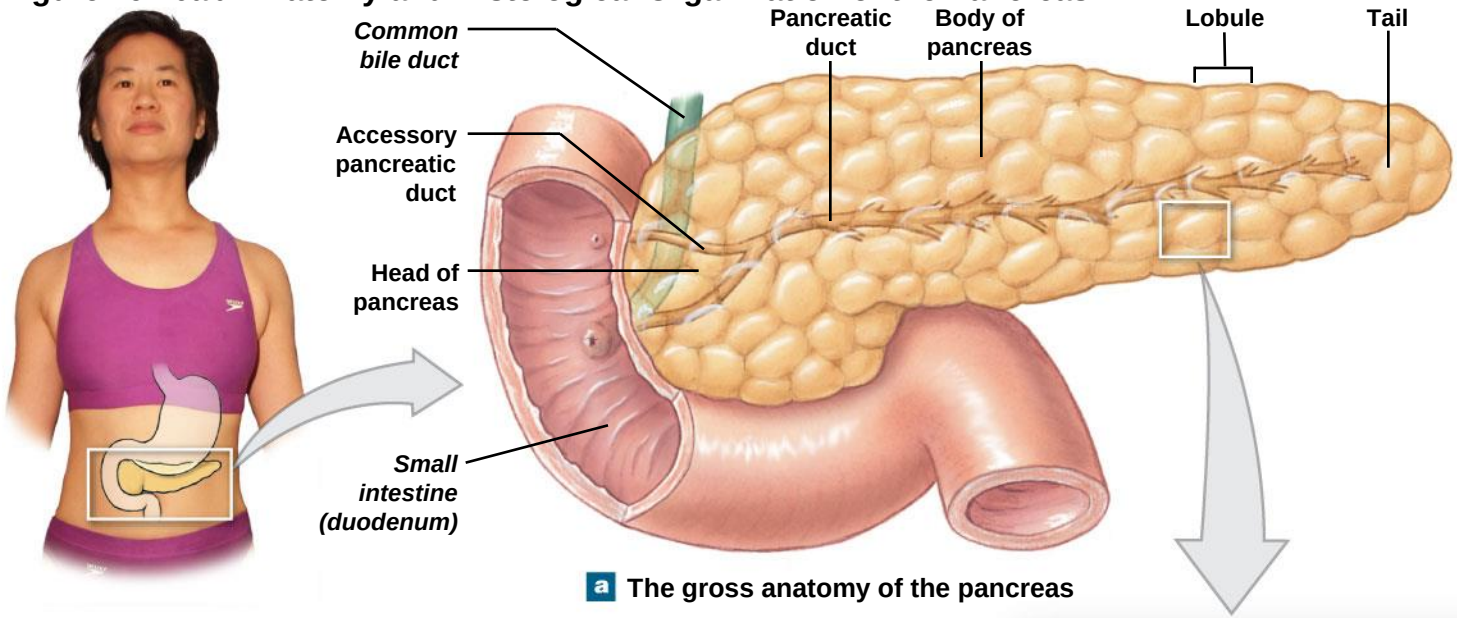
The Pancreas and Other Endocrine Tissues

- The pancreas is about 20–25 cm long
  - The large rounded end connects to the duodenum of the small intestine
  - The pointed tail extends toward the spleen
- Functions of the Pancreas
  - Endocrine function
    - Consists of **pancreatic islets**
    - Produces hormones
  - Exocrine function
    - Consists of **acinar cells**
    - Produces digestive enzymes

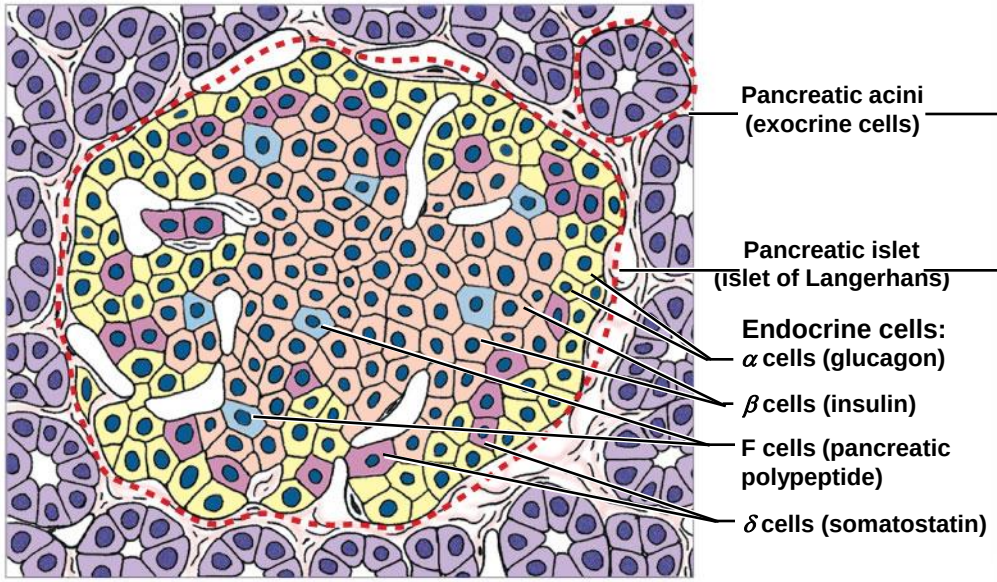


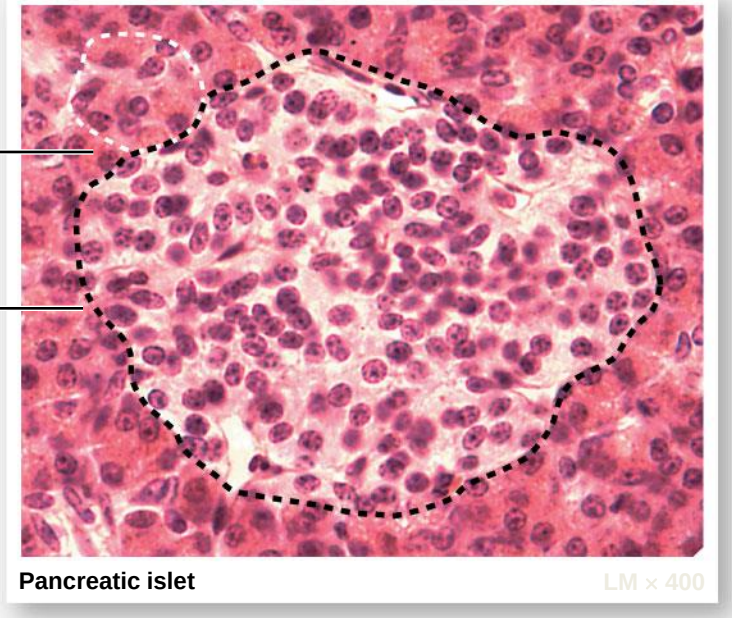
a The gross anatomy of the pancreas

Figure 19.10ab Anatomy and Histological Organization of the Pancreas



a The gross anatomy of the pancreas





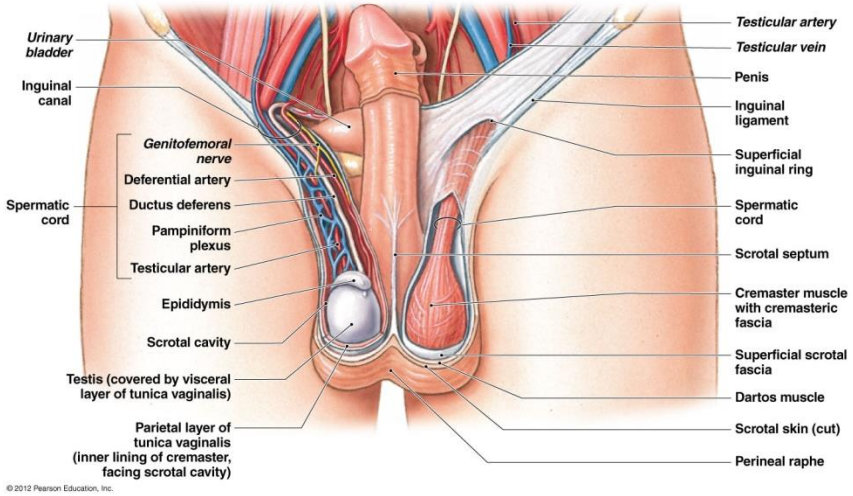
b General histology of the pancreatic islets

The Pancreas and Other Endocrine Tissues

- Hormones of the Pancreas
  - **Glucagon**
    - Produced by alpha cells of the islets
    - This raises blood glucose levels
  - **Insulin**
    - Produced by beta cells of the islets
    - This lowers blood glucose levels
  - **Somatostatin**
    - Produced by the delta cells of the islets
    - This results in inhibiting growth

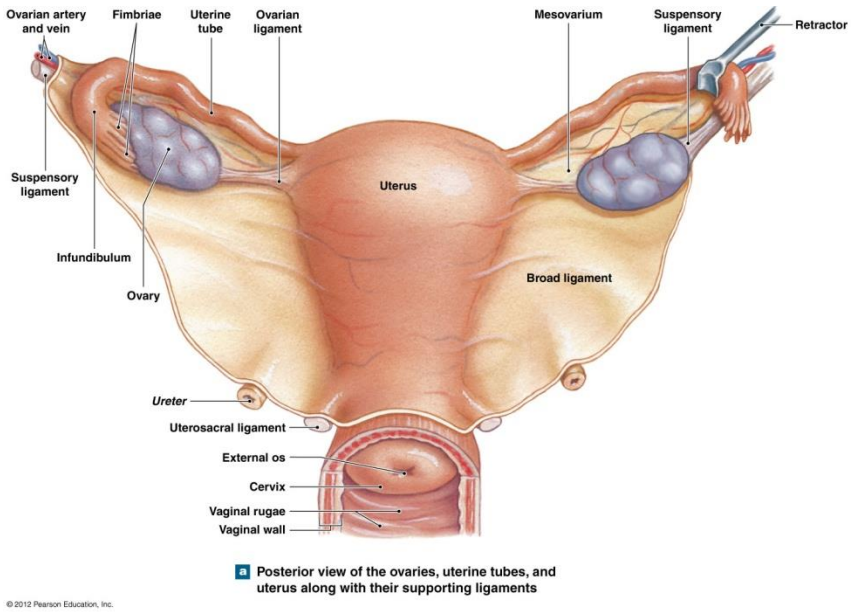
Endocrine Tissues of the Reproductive System

- Testes
  - The interstitial cells release **testosterone**
    - Promotes the production of sperm
  - The sustentacular cells release **inhibin**
    - Depresses the secretion of FSH



Endocrine Tissues of the Reproductive System

- Ovaries
  - Oocytes maturate due to **FSH**
  - Follicular cells produce **estradiol**
  - Mature eggs are ovulated due to **LH**
  - After ovulation, the follicle becomes a **corpus luteum**
  - Corpus luteum releases **progesterone**
    - prepares the body for pregnancy
  - Corpus luteum releases **relaxin**
    - prepares the body for pregnancy



The Pineal Gland

- The Pineal Gland
  - synthesize the hormone **melatonin**
  - Melatonin
    - Production rate rises at night and declines during the day

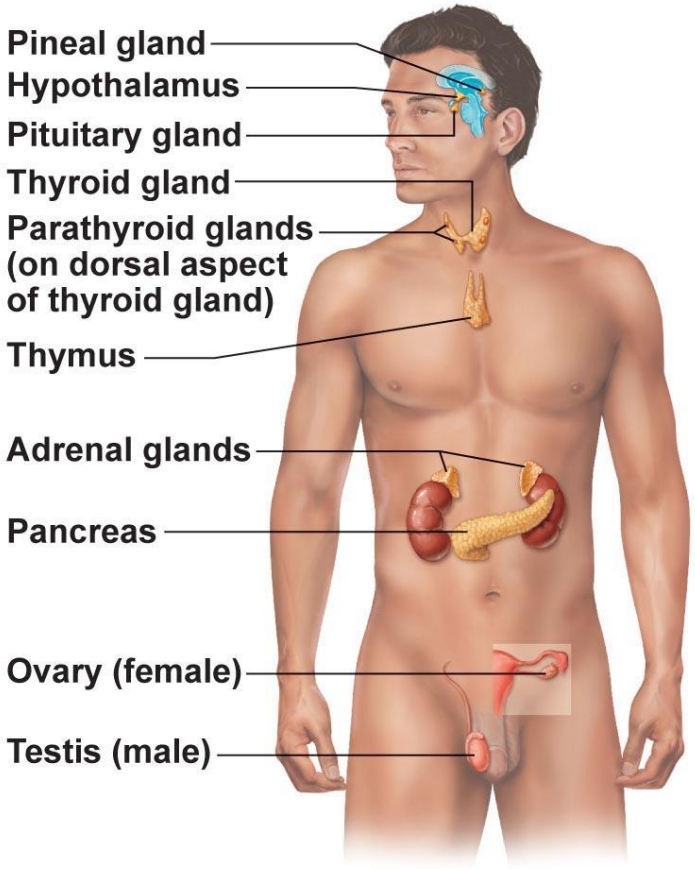
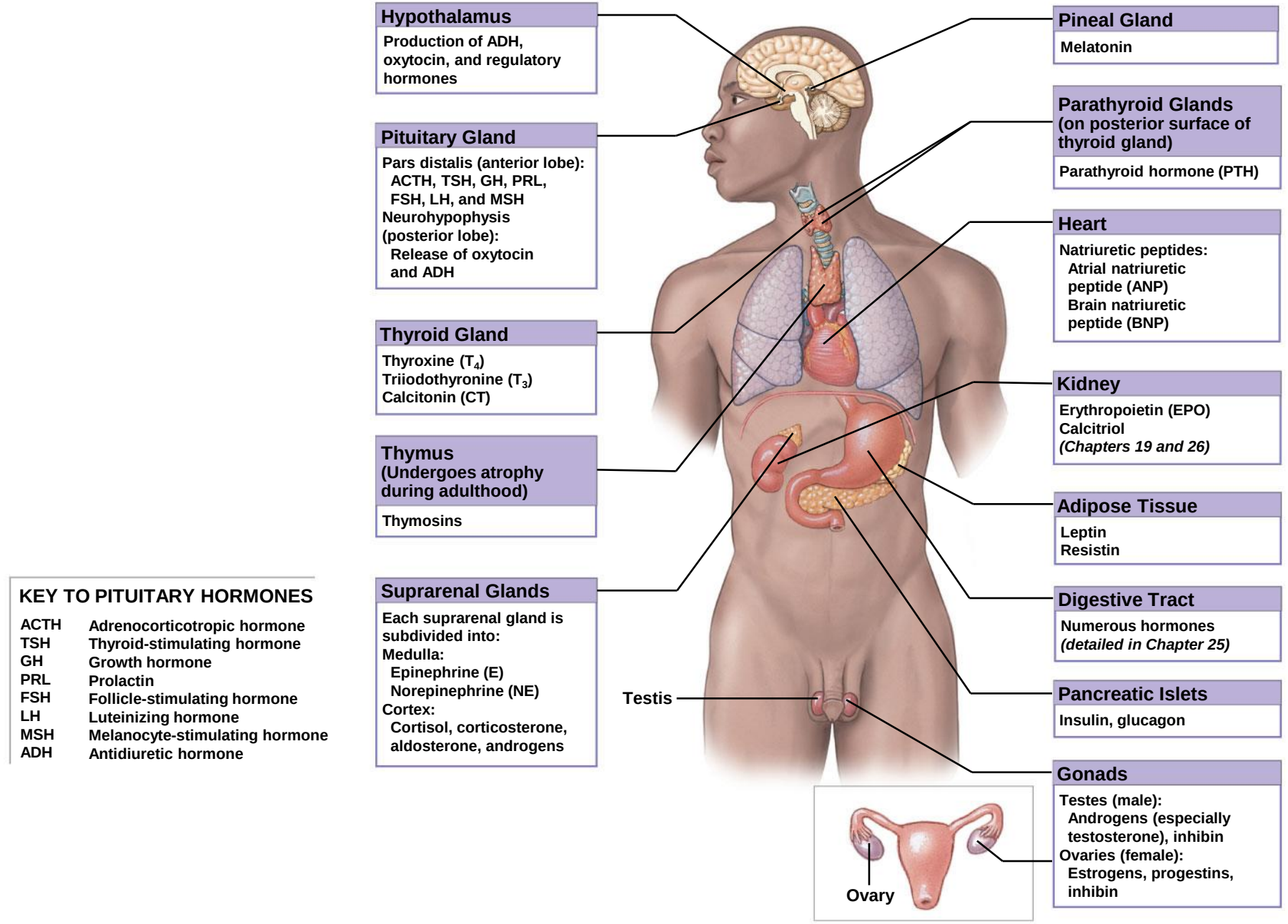


Figure 19.1 The Endocrine System



KEY TO PITUITARY HORMONES

ACTH	Adrenocorticotropic hormone
TSH	Thyroid-stimulating hormone
GH	Growth hormone
PRL	Prolactin
FSH	Follicle-stimulating hormone
LH	Luteinizing hormone
MSH	Melanocyte-stimulating hormone
ADH	Antidiuretic hormone

(a) *Acromegaly* results from the over-production of growth hormone after the epiphyseal plates have fused. Bone shapes change and cartilaginous areas of the skeleton enlarge. Note the broad facial features and the enlarged lower jaw.

(b) *Cretinism* results from thyroid hormone insufficiency in infancy.

(c) An enlarged thyroid gland, or *goiter,* is usually associated with thyroid hyposecretion due to nutritional iodine insufficiency.

Clinical note: Endocrine abnormalities

(d) *Addison's disease* is caused by hyposecretion of corticosteroids, especially glucocorticoids. Pigment changes result from stimulation of melanocytes by ACTH, which is structurally similar to MSH.

(e) *Cushing's disease* is caused by hypersecretion of glucocorticoids. Lipid reserves are mobilized, and adipose tissue accumulates in the cheeks and at the base of the neck.

Hormones and Aging

- Exhibits relatively few changes with advancing age
  - The changes in reproductive hormone levels at puberty
  - The decline in the concentration of reproductive hormones at menopause in women

Summary of the Endocrine System

- Summary
  - The nervous system controls the release of some hormones
  - The pituitary gland releases hormones of which some control the action of other glands
  - The hypothalamus controls the release of some pituitary hormones
  - There are other tissues of the body that act like glands but are not typically called glands

Figure 19.4 Pituitary Hormones and Their Targets