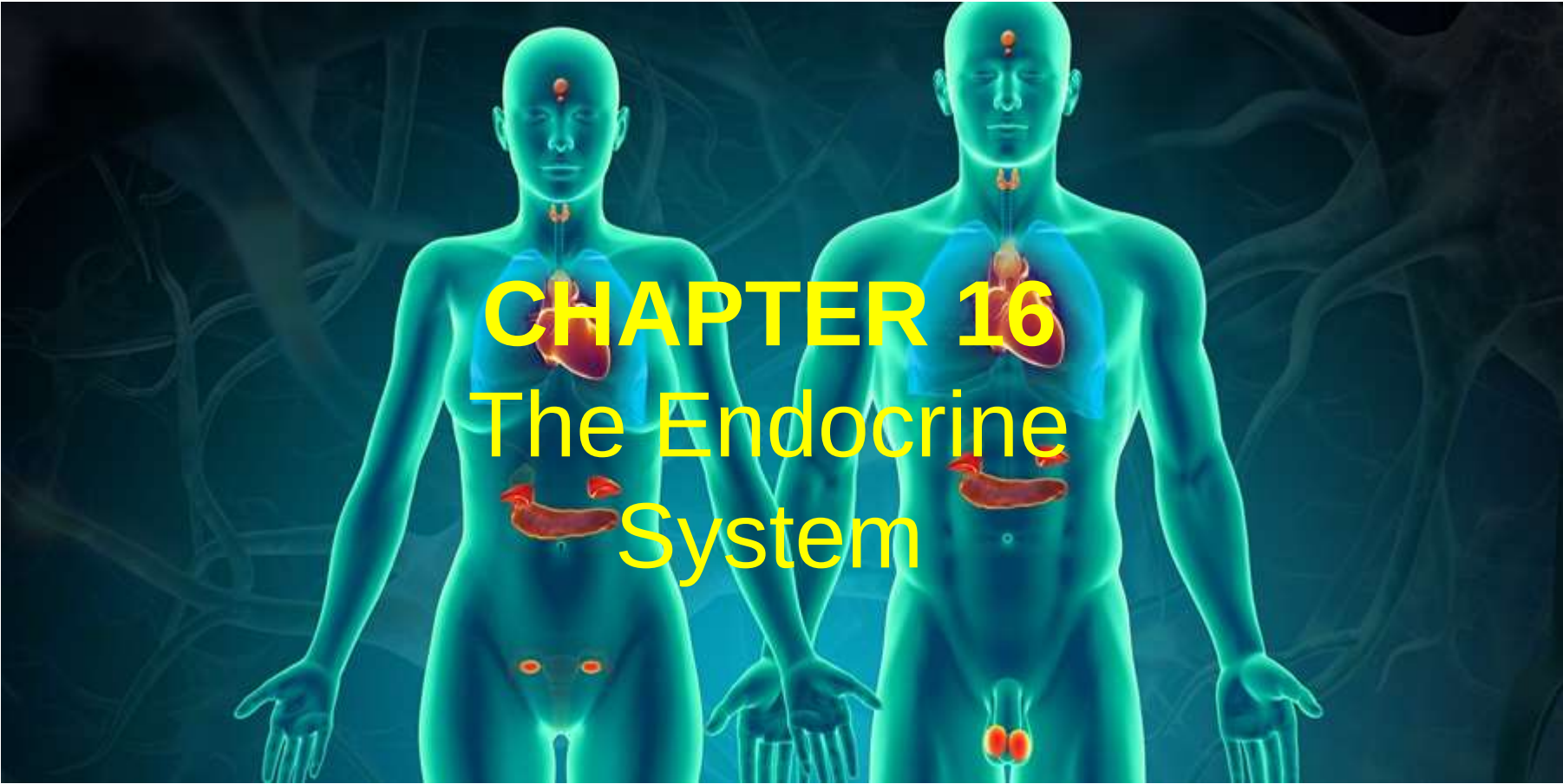




The image features two human figures, one male and one female, rendered in a translucent blue color. They are standing side-by-side against a dark background with faint, glowing blue lines that resemble a network of nerves or blood vessels. The figures are shown from the waist up, with their arms slightly away from their bodies. Overlaid on the figures are various endocrine glands, depicted in red and orange. These include the hypothalamus and pituitary gland in the brain, the thyroid and parathyroid glands in the neck, the thymus in the upper chest, the heart, the lungs, the pancreas, the adrenal glands (situated atop the kidneys), and the gonads (ovaries in the female and testes in the male). The overall aesthetic is scientific and futuristic.

CHAPTER 16

The Endocrine System

Introduction

- Endocrinology
- Hormones

R. Bishay

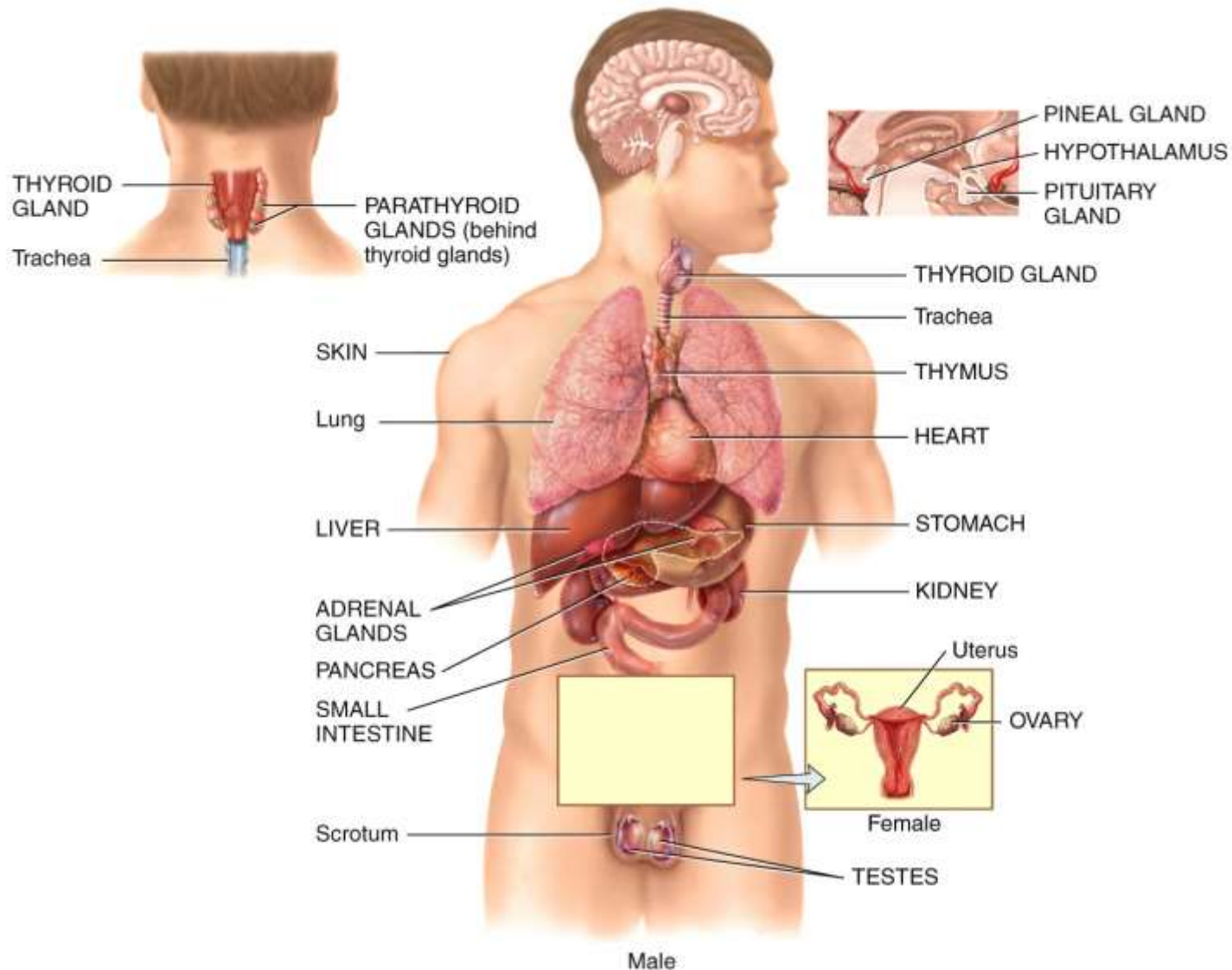
Introduction to Hormonal Regulation, Secretion, and Concentration *Interactions Animation*

- [Introduction to Hormonal Regulation,
Secretion, and Concentration](#)

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Location of Many Endocrine Glands



Hormones

- Target cells
- Receptors

R. Bishay

Mechanisms of Hormone Action

Interactions Animation

- [Mechanisms of Hormone Action](#)

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Hormonal Cycles

Interactions Animation

- [Hormonal Cycles](#)

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Clinical Connection

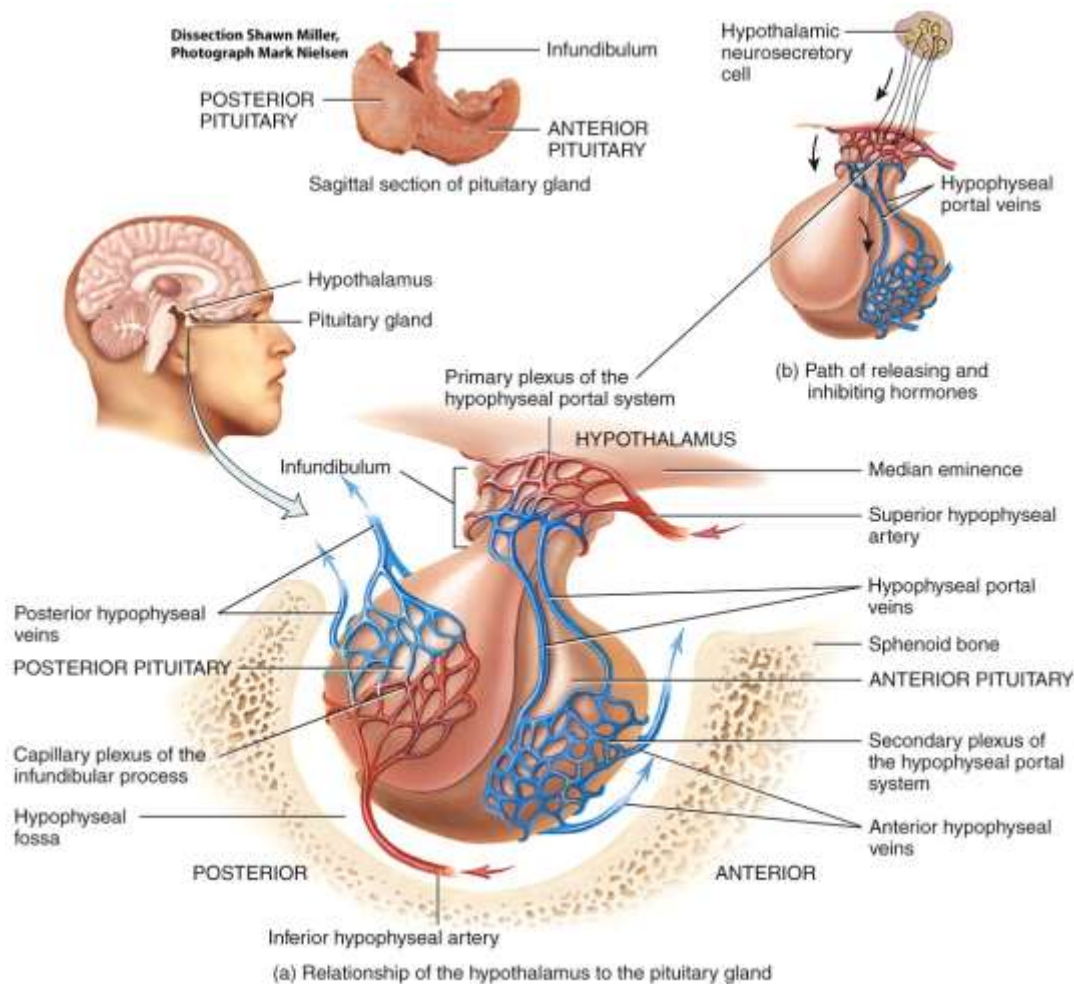
- Blocking hormone receptors

R. Bishay

Hypothalamus and Pituitary Gland

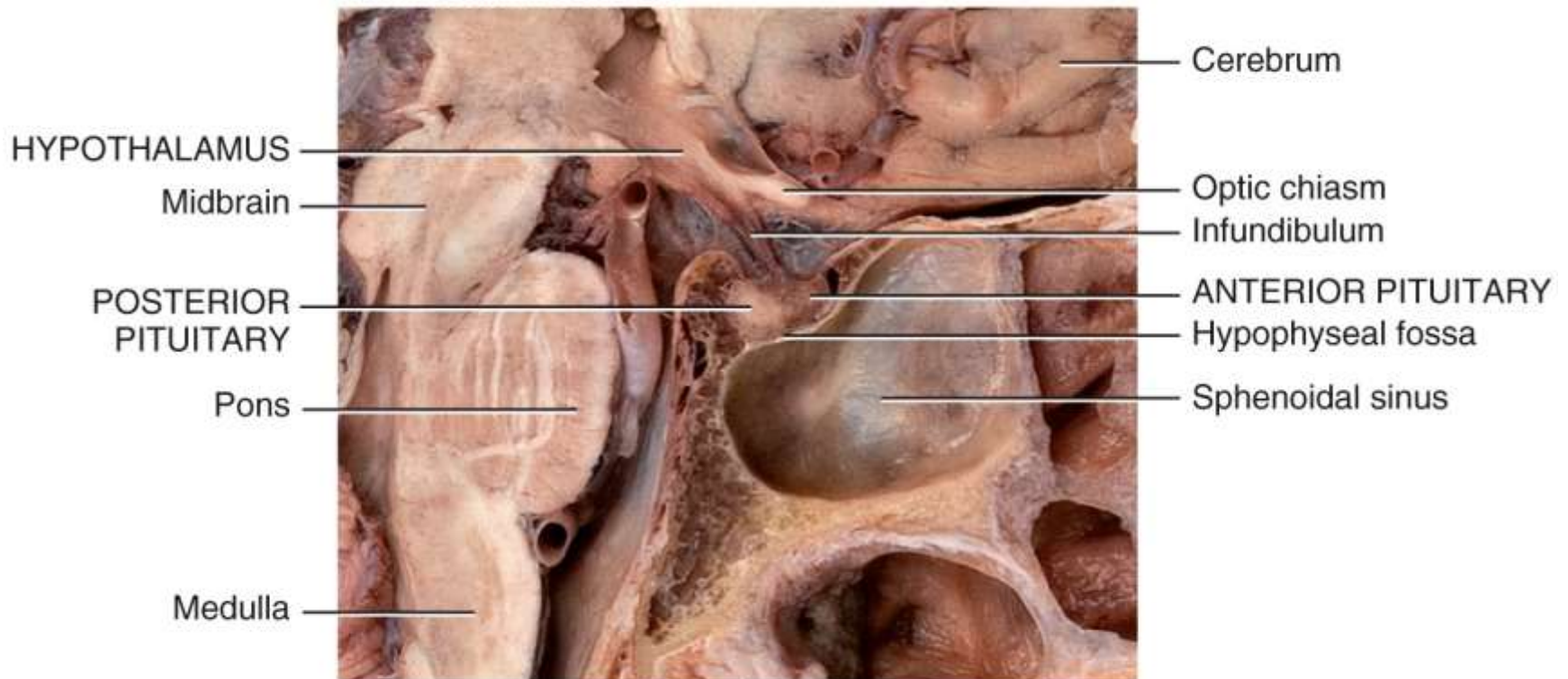
- Hypothalamus
- Infundibulum
- Anterior pituitary cells secrete
 - Human growth hormone (hGH)
 - Thyroid-stimulating hormone (TSH)
 - Follicle-stimulating hormone (FSH)
 - Luteinizing hormone (LH)
 - Prolactin (PRL)
 - Adrenocorticotrophic hormone (ACTH)

Hypothalamus and Pituitary Gland, and Their Blood Supply



Hypothalamus and Pituitary Gland, and Their Blood Supply

Mark Nielsen/Anatbooks Ltd



(c) Sagittal section of hypothalamus and pituitary gland of adult

Posterior Pituitary

The posterior pituitary stores and releases these hormones:

- **Oxytocin (OT):** is a peptide hormone and neuropeptide. It is normally produced in the hypothalamus and released by the posterior pituitary. It plays a role in social bonding, sexual reproduction, childbirth, and the period after childbirth
- **Antidiuretic hormone (ADH), also called vasopressin:** It is normally produced in the hypothalamus and released by the posterior pituitary.
- It helps to control blood pressure by acting on the kidneys and the blood vessels. Its most important role is to conserve the fluid volume of your body by reducing the amount of water passed out in the urine

Clinical Connection

- **Disorders of the endocrine system**
 - **Pituitary dwarfism:** or growth hormone deficiency, is a condition in which the pituitary gland does not make enough growth hormone. This results in a child's slow growth pattern and an unusually small stature (below average height)
 - **Giantism:** is a rare condition that causes abnormal growth **in children**. This change is most notable in terms of height, but girth “measurement around the middle especially a person's waist.” is affected as well. It occurs when your child's pituitary gland makes too much growth hormone, which is also known as somatotropin.
 - **Acromegaly:** is a hormonal disorder that develops when your pituitary gland produces too much growth hormone during adulthood. When this happens, your bones increase in size, including those of your hands, feet and face. Acromegaly usually affects **middle-aged adults**

Pineal Gland and Thymus

- **Melatonin:** The hormone melatonin plays a role in your natural sleep-wake cycle. Natural levels of melatonin in the blood are highest at night
- **Seasonal affective disorder (SAD):** is a type of depression that's related to changes in seasons — SAD begins and ends at about the same times every year. If you're like most people with SAD, your symptoms start in the fall and continue into the winter months, sapping your energy and making you feel moody. Less often, SAD causes depression in the spring or early summer.

Thyroid Gland and Parathyroid Glands

- Thyroid
 - Lateral lobes connected by isthmus
 - Follicular cells produce two hormones:
 - Triiodothyronine (T_3)
 - Thyroxine, also called Tetraiodothyronine (T_4)

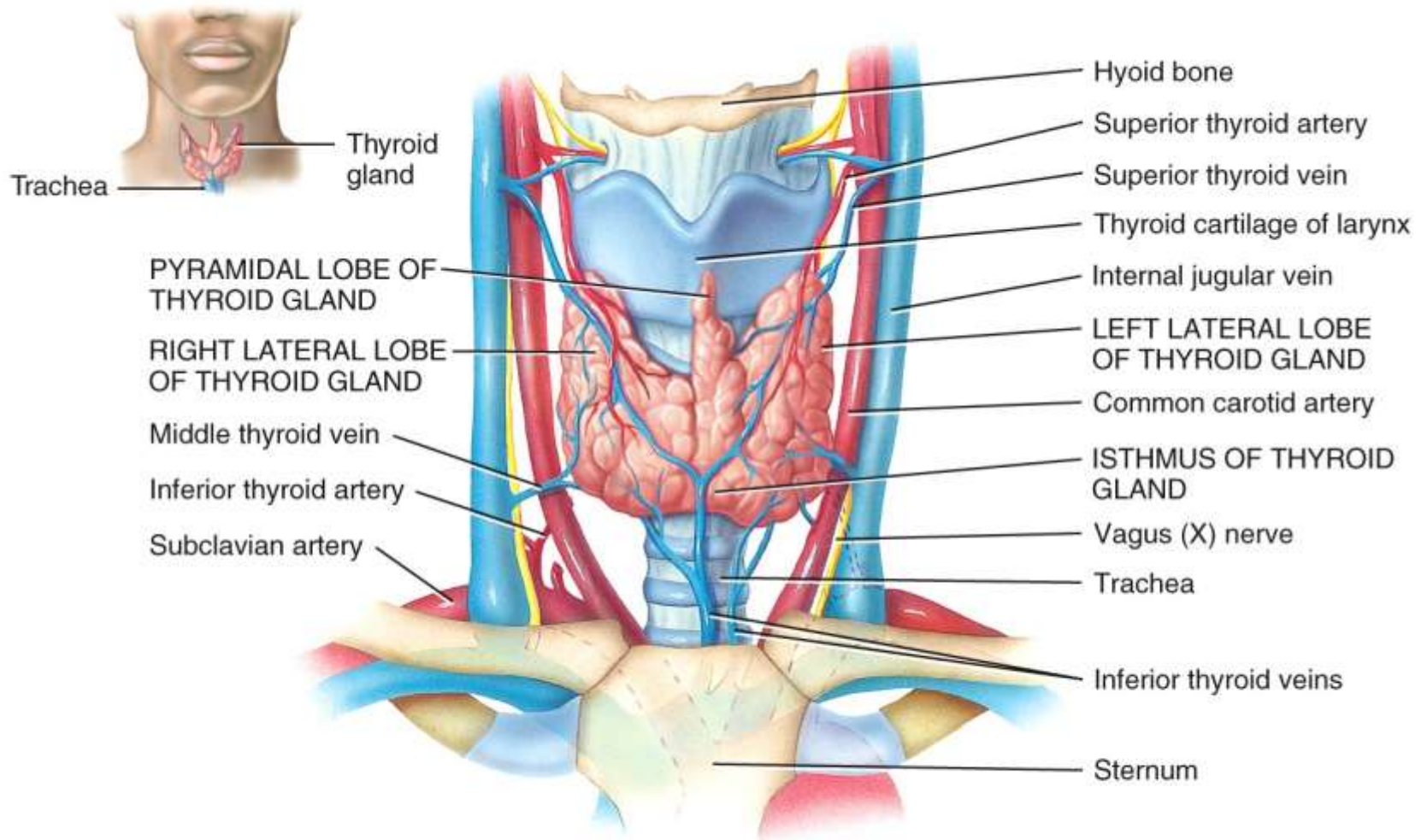
Together, these hormones regulate your body's temperature, metabolism, and heart rate. *Most of the T_3 in your body binds to protein*

 - *Calcitonin: opposing and balancing the action of parathyroid hormone*

Clinical Connection

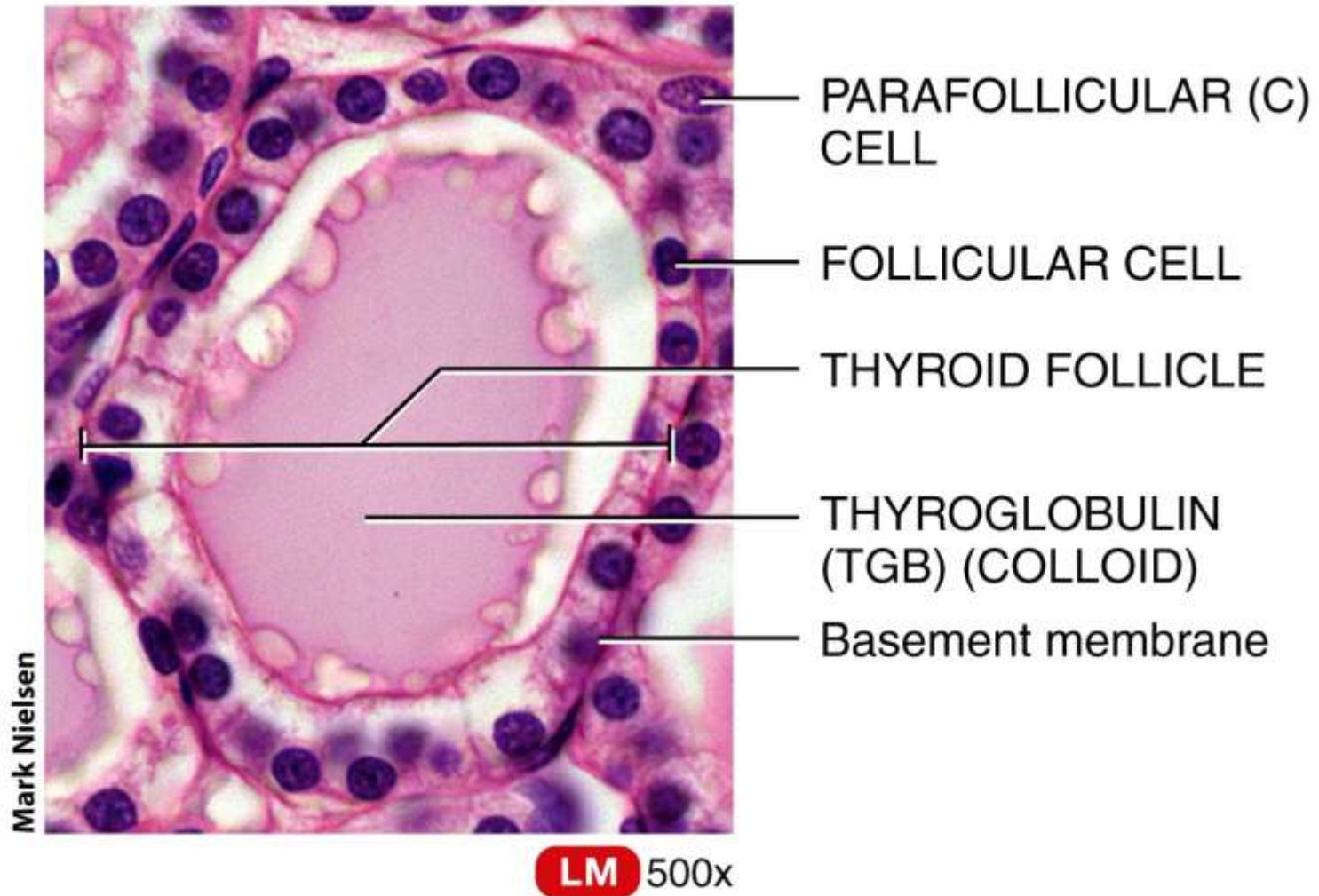
- **Thyroid gland disorders**
 - Congenital hypothyroidism
 - Graves disease – AUTOIMMUNE HYPERTHYROIDISM
 - Exophthalmos
 - Hashimoto's thyroiditis – AUTOIMMUNE HYPOTHYROIDISM
 - Goiter: **enlargement of the gland**, could be associated with hypo, hyper or normal thyroid function.

The Thyroid Gland



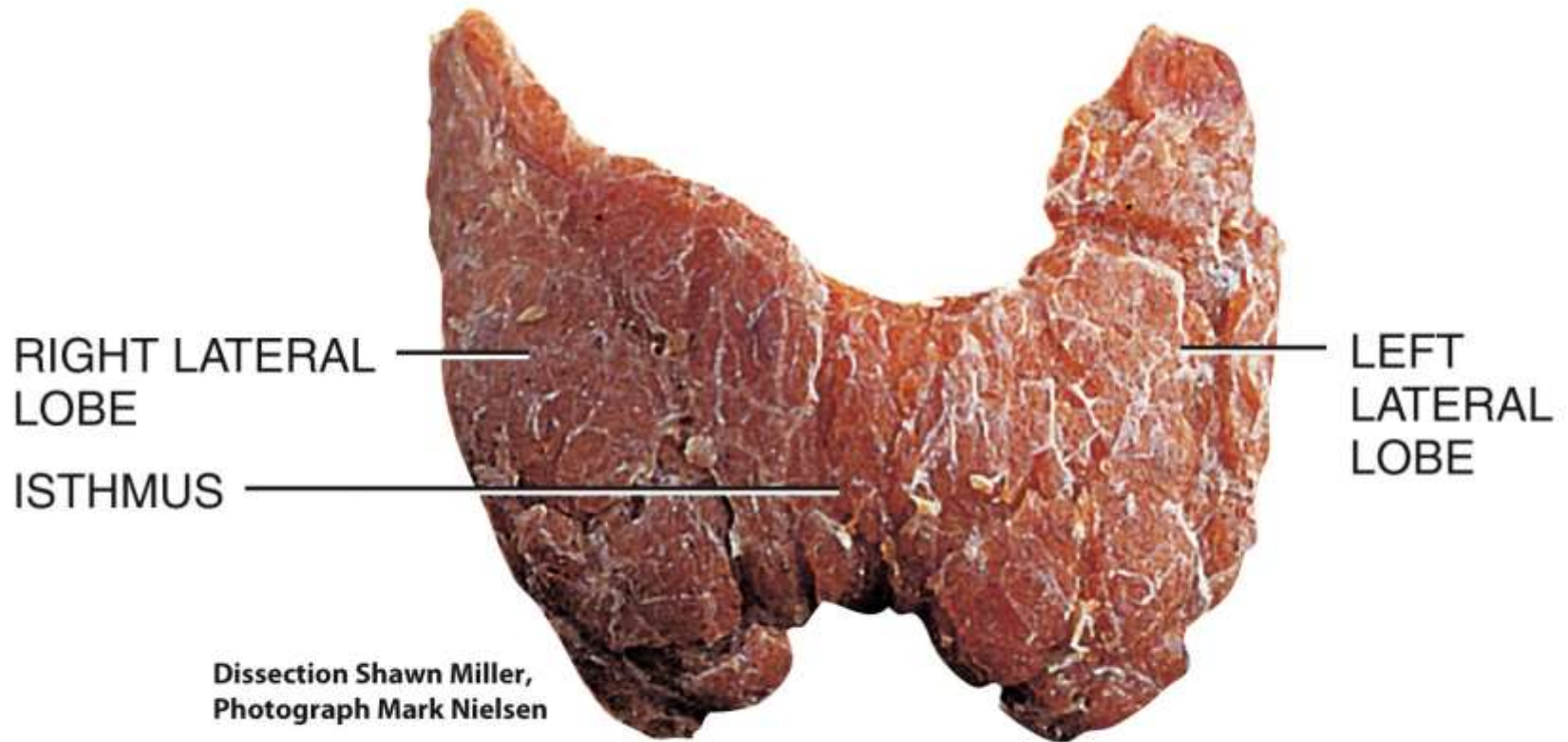
(a) Anterior view of thyroid gland

The Thyroid Gland



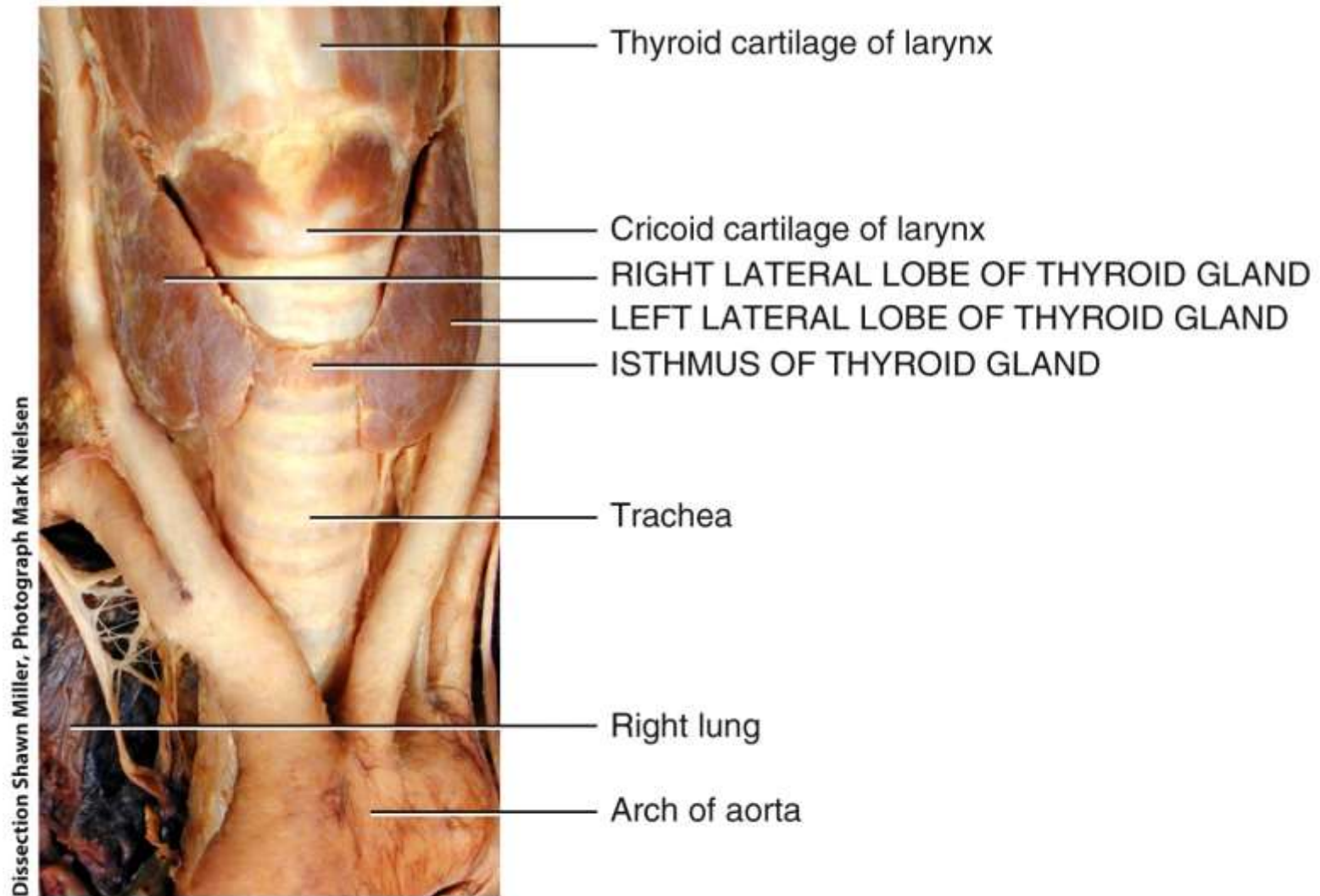
(b) Thyroid follicles

The Thyroid Gland



(c) Anterior view of thyroid gland

The Thyroid Gland



(d) Anterior view

Parathyroid Glands

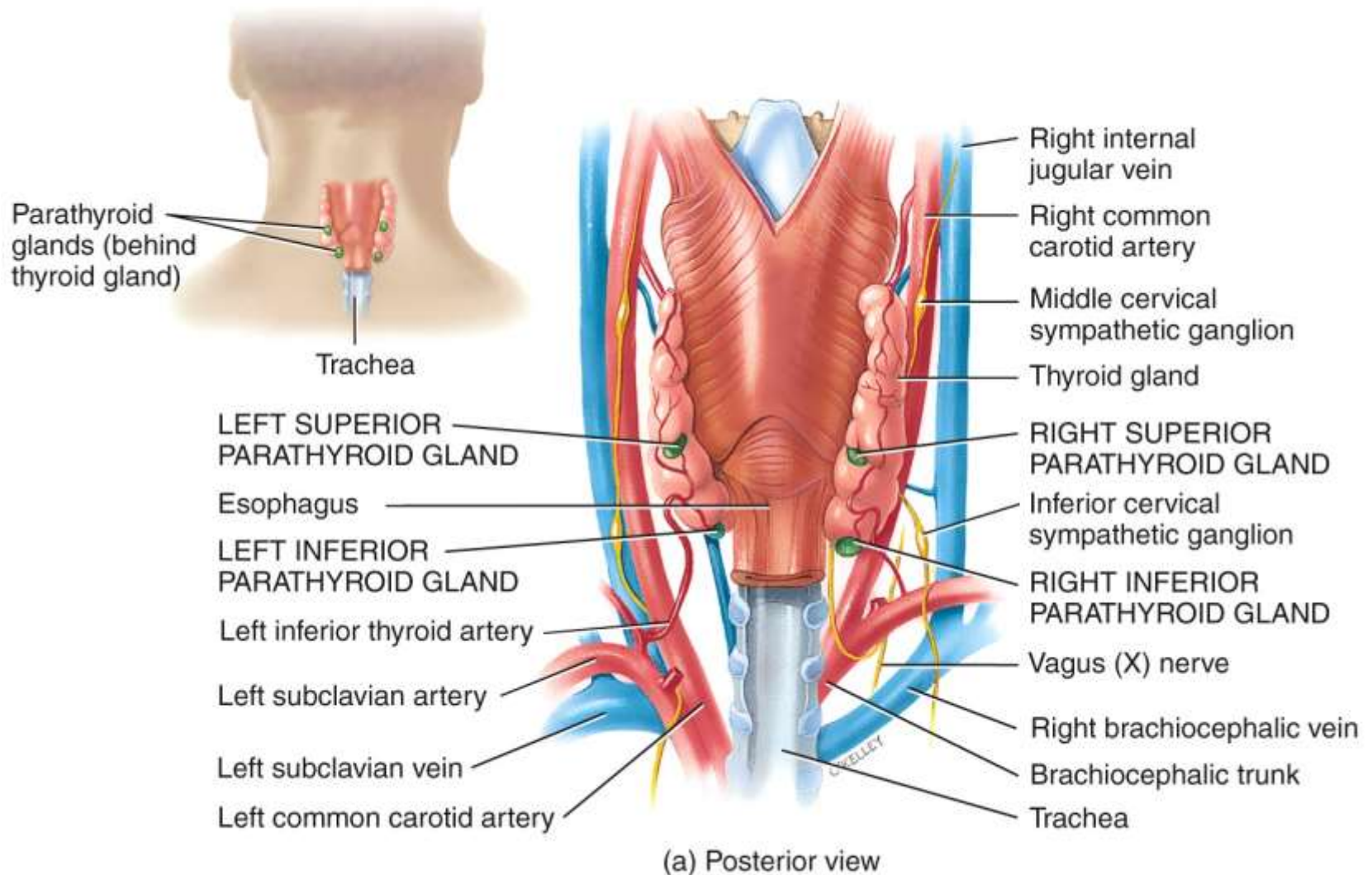
- **Parathyroid**

- **Parathyroid hormone (PTH)** : also called parathormone or parathyrin, is a hormone secreted by the parathyroid glands that regulates the serum calcium through its effects on bone, kidney, and intestine

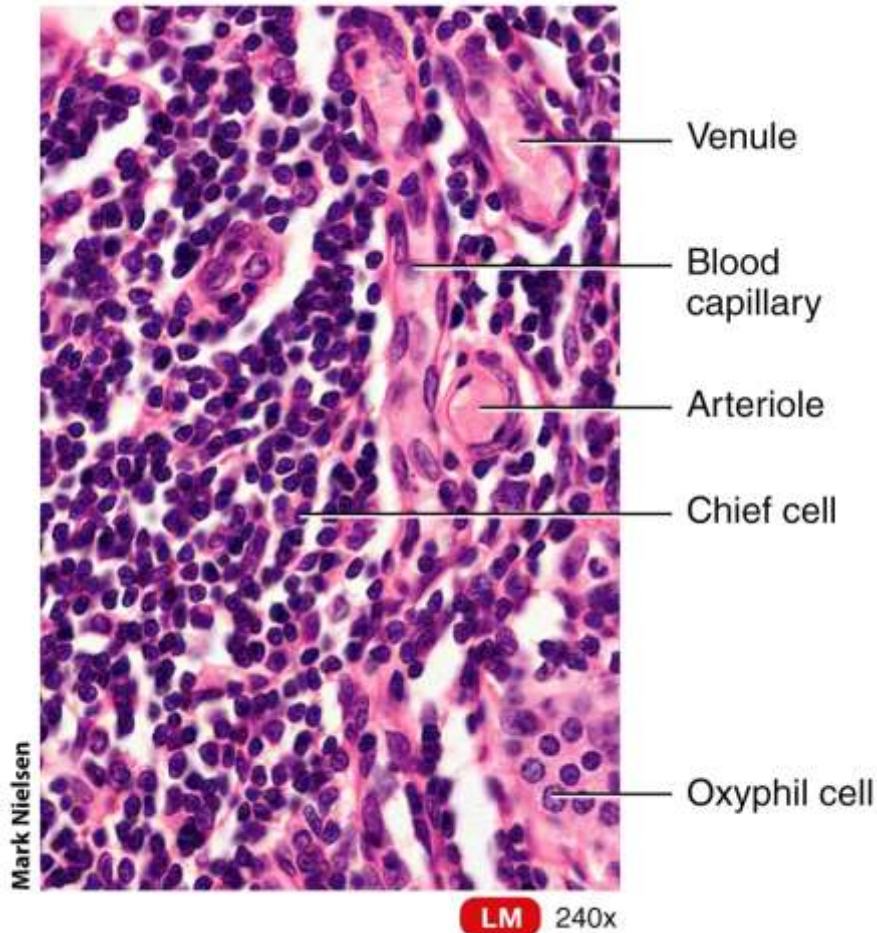
Clinical Connection

- Thyroid gland disorders and parathyroid gland disorders
 - **Hypoparathyroidism:** is the state of decreased secretion or activity of parathyroid hormone (PTH). This leads to decreased blood levels of calcium (hypocalcemia) and increased levels of blood phosphorus (hyper-phosphatemia)
 - **Hyperparathyroidism:** is a condition in which one or more of the parathyroid glands become overactive and secrete too much parathyroid hormone (PTH). This causes the levels of calcium in the blood to rise, a condition known as hypercalcemia.

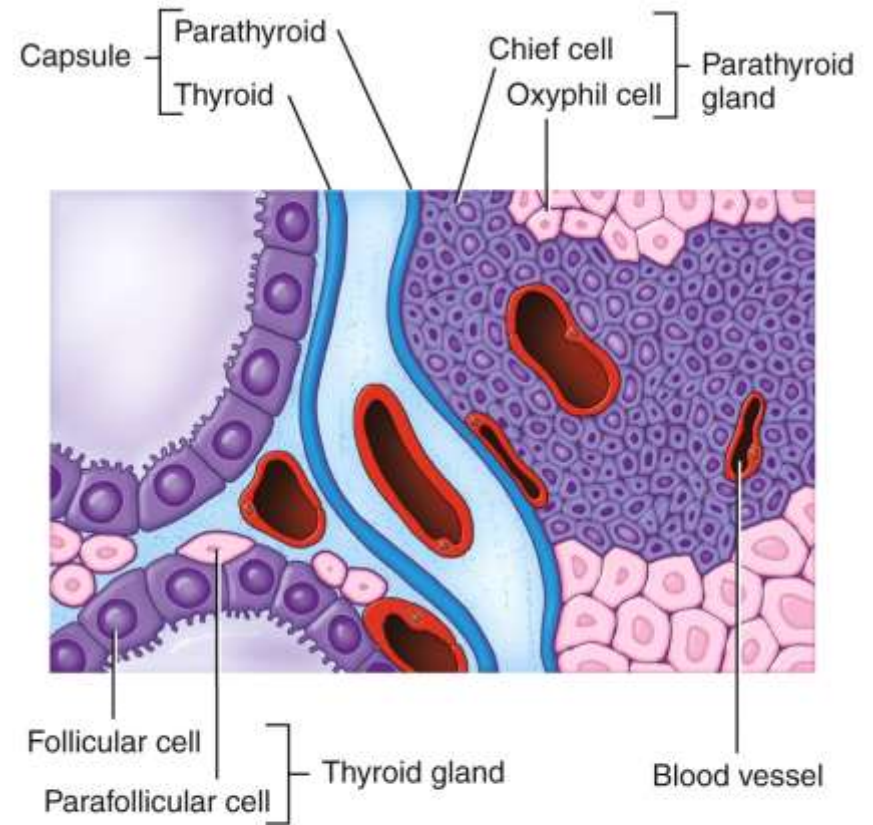
The Parathyroid Glands



The Parathyroid Glands

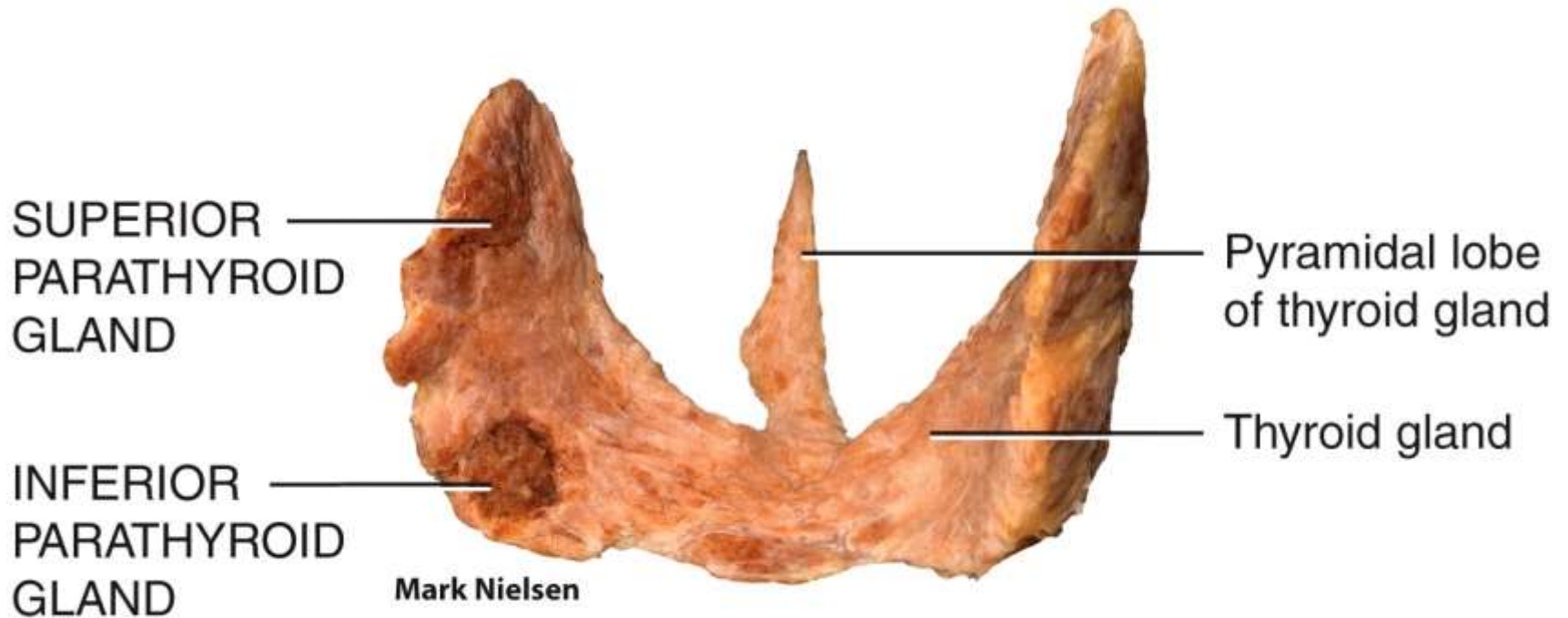


(b) Parathyroid gland



(c) Portion of the thyroid gland (left) and parathyroid gland (right)

The Parathyroid Glands

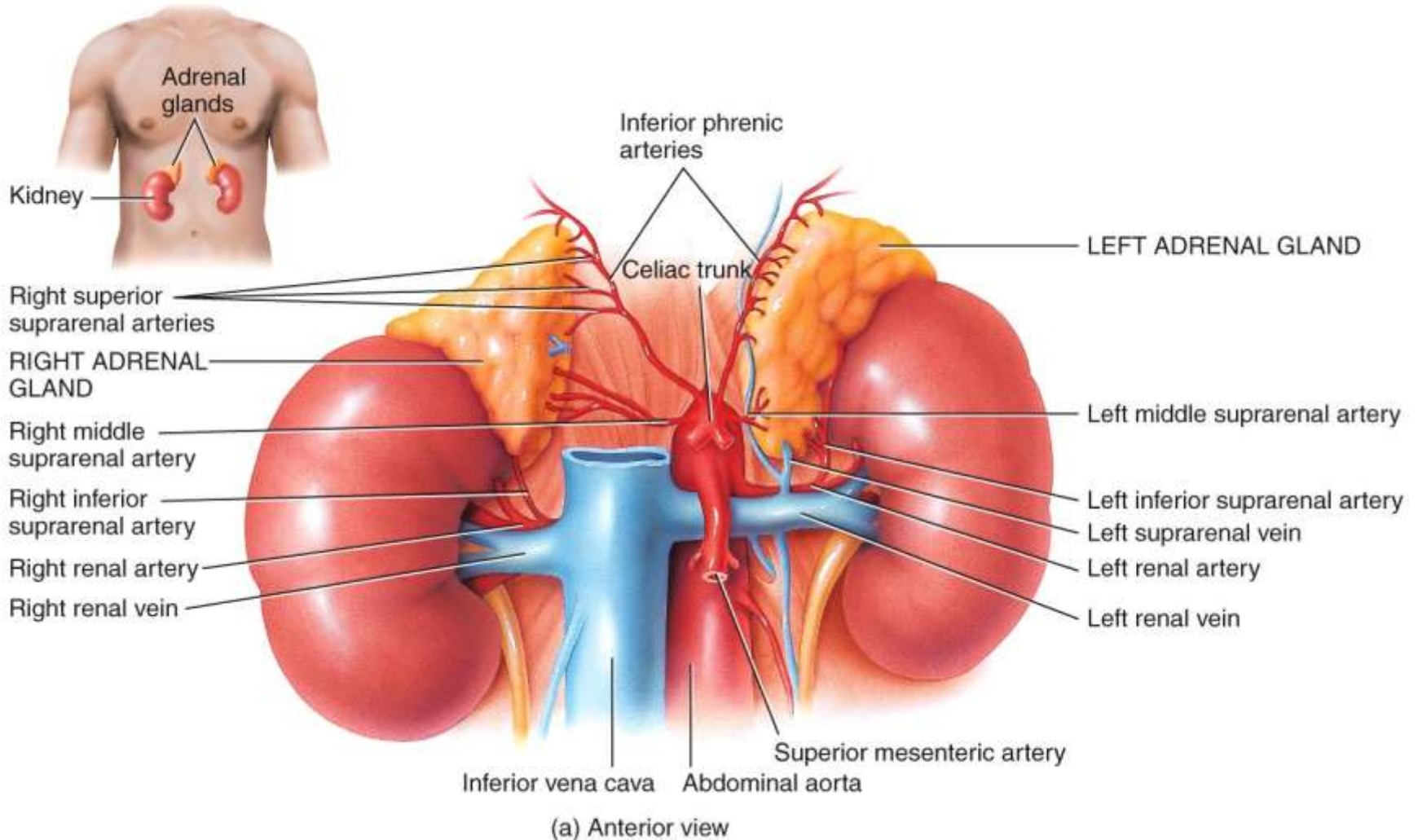


(d) Posterior view of parathyroid glands

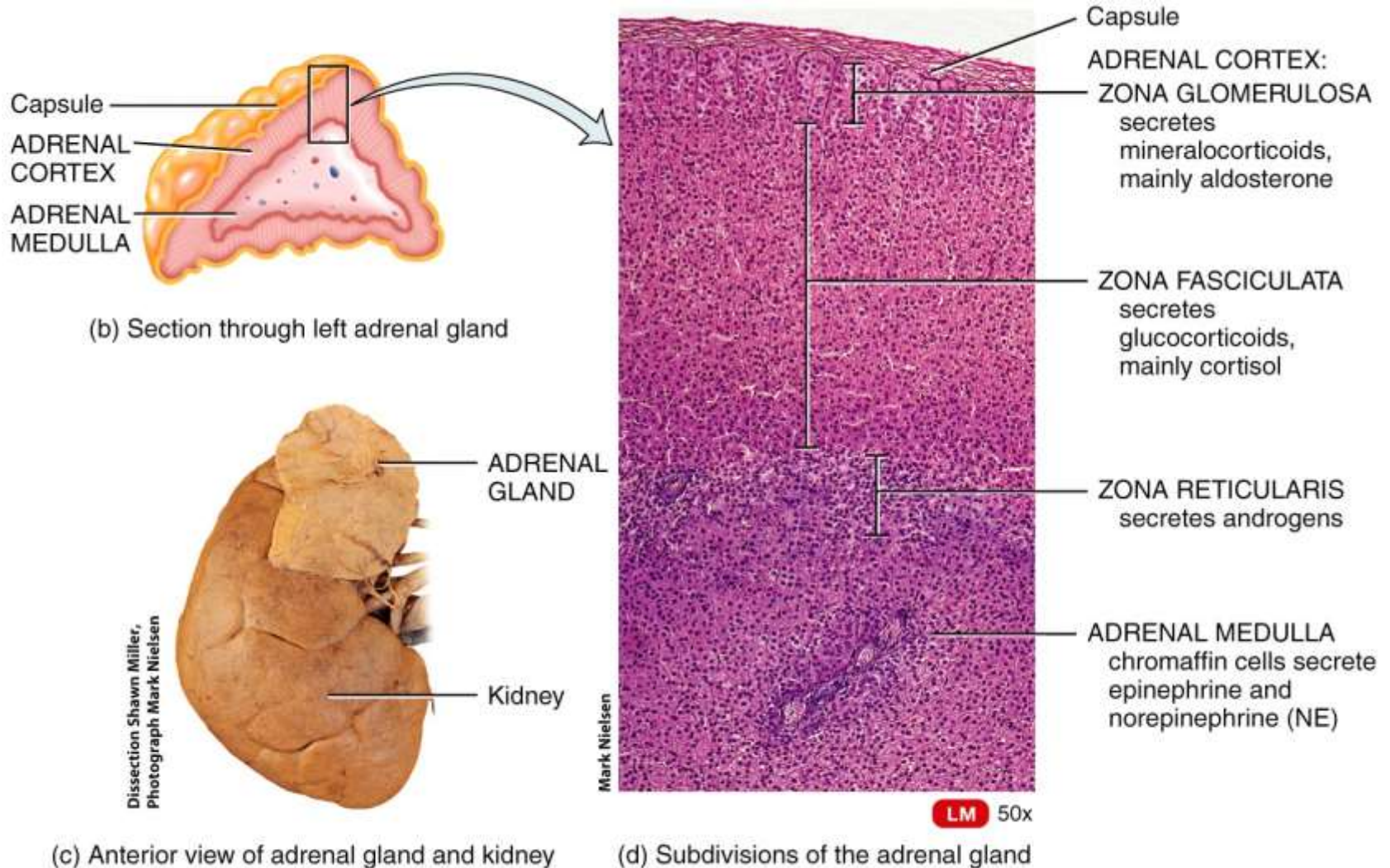
Adrenal Glands

- Lie superior to each kidney
- Adrenal cortex
- Adrenal medulla
 - Inner region of the adrenal gland
 - Produces two hormones:
 - Epinephrine
 - Norepinephrine

The Adrenal (Suprarenal) Glands



The Adrenal (Suprarenal) Glands



Clinical Connection

- **Adrenal gland disorders**

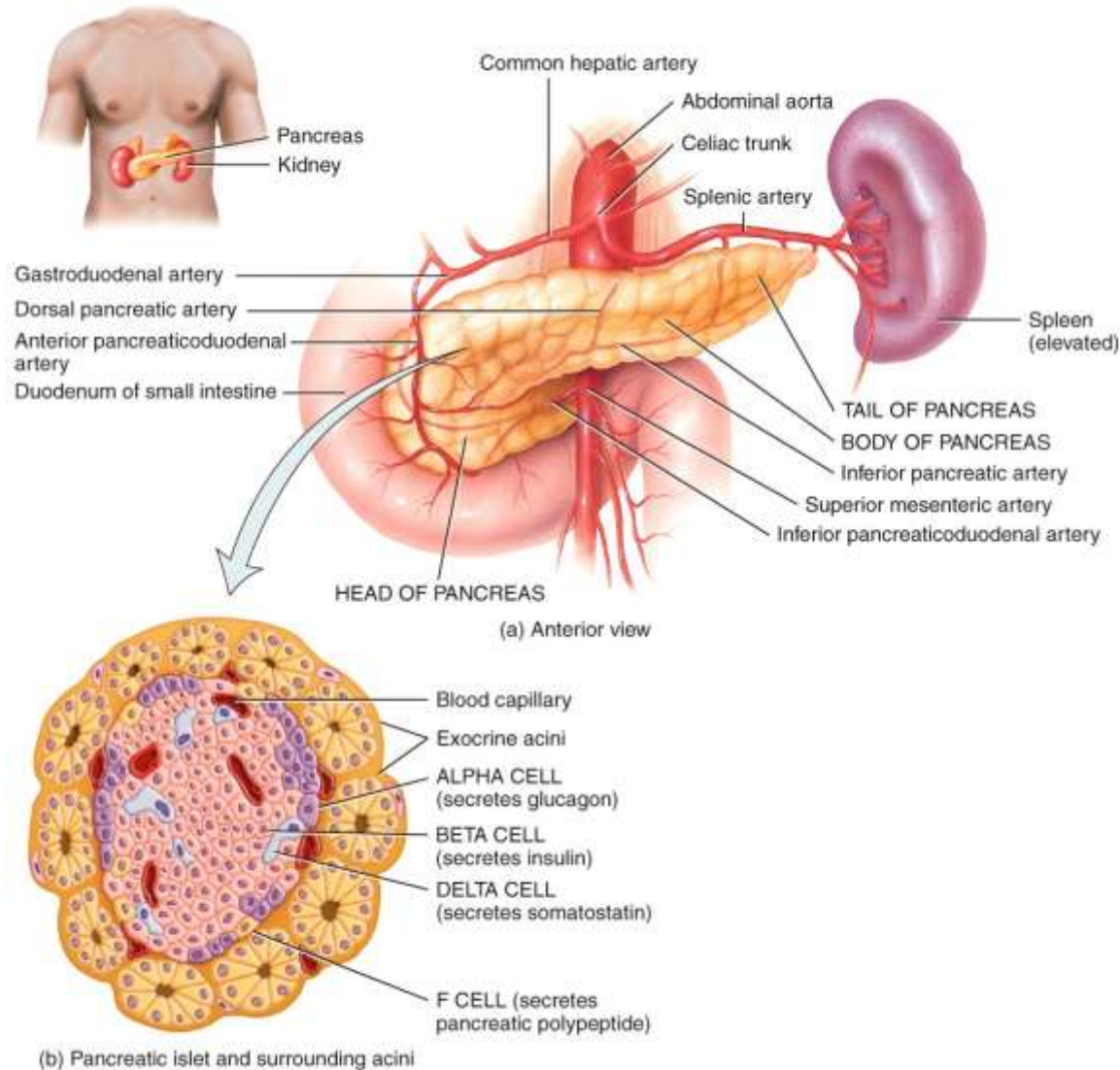
- **Congenital adrenal hyperplasia (CAH):** is a form of adrenal insufficiency in which 21-hydroxylase, the enzyme that produces two important adrenal steroid hormones, cortisol and aldosterone, is deficient. Because cortisol production is impeded, the adrenal gland over-produces androgens (male steroid hormones)
- **Cushing's syndrome:** is a disorder that occurs when your body makes too much of the hormone cortisol over a long period of time. Cortisol is sometimes called the “stress hormone” because it helps your body respond to stress.
- **Addison's disease:** also known as primary adrenal insufficiency and hypocortisolism, is a long-term endocrine disorder in which the adrenal glands do not produce enough steroid hormones. Symptoms generally come on slowly and may include abdominal pain, weakness, and weight loss.
- **Pheochromocytomas:** is a rare tumor of adrenal gland tissue. It results in the release of too much epinephrine and norepinephrine, hormones that control heart rate, metabolism, and blood pressure

Pancreas

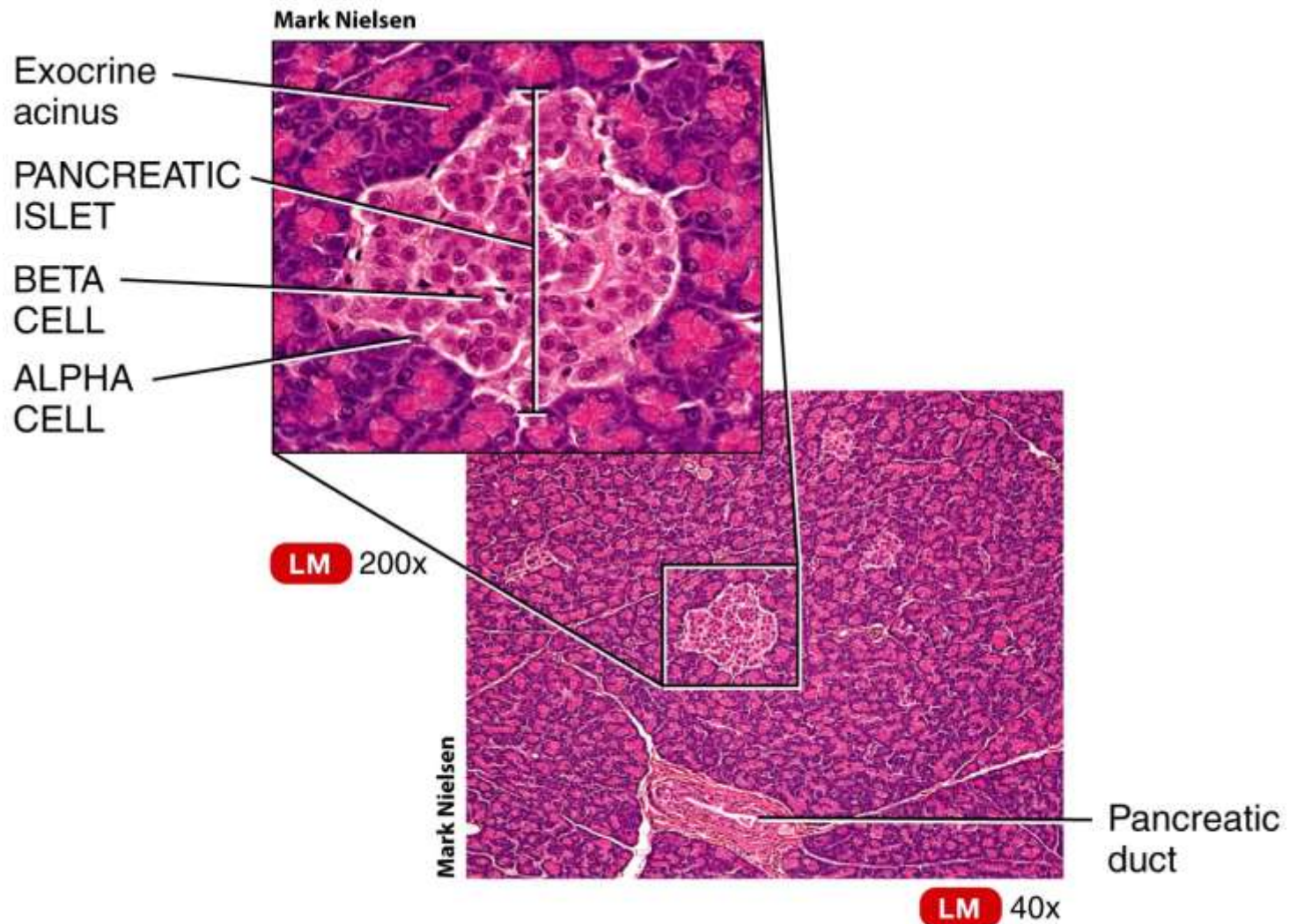
- **Islets of Langerhans**

- **Alpha cells or α -cells:** They make up to 20% of the human islet cells synthesizing and secreting the peptide hormone glucagon, which elevates the glucose levels in the blood.
- **Beta cells:** they constitute the predominant type of cell. The beta cells make and release insulin, a hormone that controls the level of glucose (sugar) in the blood.
- **Delta cells, δ -cells or D cells :** are somatostatin-producing cells. They can be found in the stomach, intestine and the pancreatic islets, it serves to block the secretion of both insulin and glucagon from adjacent cells. Insulin, glucagon, and somatostatin act in concert to control the flow of nutrients into and out of the circulation.
- **F cells, Pancreatic polypeptide cells (PP cells):** or formerly as gamma cells, or F cells, are cells which produce pancreatic polypeptides in the pancreatic islets (Islets of Langerhans) of the pancreas. They are very few in number and are polygonal in shape

The Pancreas



The Pancreas

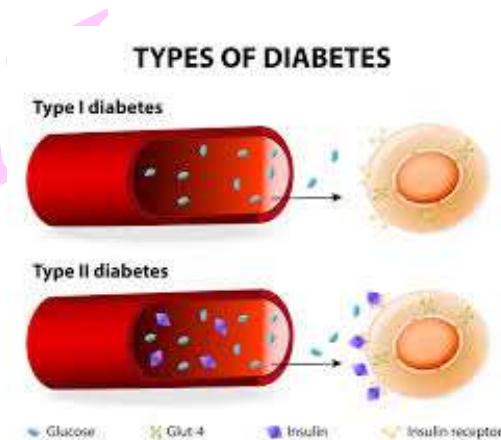


(c) Pancreatic islet and surrounding acini

Clinical Connection

- **Diabetes mellitus**

- **Type 1 diabetes (insulin-dependent diabetes):** once known as juvenile diabetes or is a chronic condition in which the pancreas produces little or no insulin. Insulin is a hormone needed to allow sugar (glucose) to enter cells to produce energy.
- **Type 2 diabetes (non-insulin-dependent diabetes):** is an inherited metabolic disorder characterized by hyperglycemia with resistance to ketosis. The onset is usually after age 40 years.
- Temporary insulin therapy may be needed during inter-current illness, surgery or pregnancy.



Other Endocrine Tissues

- **Gastrointestinal tract**

- **Gastrin:** is a peptide hormone that stimulates secretion of gastric acid (HCl) by the parietal cells of the stomach and aids in gastric motility. It is released by G cells in the pyloric antrum of the stomach, duodenum, and the pancreas
- **Glucose-dependent insulintropic peptide (GIP):** is a hormone produced by the small intestine in response to eating food. Its main action is to encourage the release of insulin into the bloodstream to control blood sugar levels.
- **Secretin:** is a hormone that regulates water homeostasis throughout the body and influences the environment of the duodenum by regulating secretions in the stomach, pancreas, and liver. It is a peptide hormone produced in the S cells of the duodenum, which are located in the intestinal glands.
- **Cholecystikin (CCK):** move the bile-sac (gallbladder), is a peptide hormone of the gastrointestinal system responsible for stimulating the digestion of fat and protein.

Clinical Connection

- *Stress, hormones, and disease*
 - Gastritis
 - Ulcerative colitis
 - Irritable bowel syndrome (IBS)
 - Hypertension
 - Asthma
 - Rheumatoid arthritis (RA)
 - Migraine headaches
 - Anxiety
 - Depression

Other Endocrine Tissues

- **Kidneys**

- **Renin:** primary function is therefore to eventually cause an increase in blood pressure, leading to restoration of perfusion pressure in the kidneys. Renin is secreted from juxtaglomerular kidney cells, which sense changes in renal perfusion pressure, via stretch receptors in the vascular walls.
- **Erythropoietin (EPO):** also known as erythropoetin, haematopoietin, or haemopoietin, is a glycoprotein cytokine secreted mainly by the kidney in response to cellular hypoxia; it stimulates red blood cell production (erythropoiesis) in the bone marrow.
- **Calcitriol:** is the active form of vitamin D, normally made in the kidney

Other Endocrine Tissues

- **LIVER**
- In the last 10 years, many new endocrine functions of the liver have been discovered.
- Advances in the classical endocrine functions include delineation of mechanisms of liver production of endocrine hormones [including **25-hydroxyvitamin D**, insulin-like growth factor 1 (IGF-1), and **angiotensinogen**], hepatic metabolism of hormones (including thyroid hormones, glucagon-like peptide-1, and steroid hormones), and actions of specific binding proteins to glucocorticoids, sex steroids, and thyroid hormones.

Other Endocrine Tissues

- **Heart**

- **Atrial natriuretic peptide (ANP):** is a cardiac hormone which gene and receptors are widely present in the body. Its main function is to lower blood pressure and to control electrolyte homeostasis i.e. reduction in expanded extracellular fluid (ECF) volume by increasing renal sodium excretion

Other Endocrine Tissues

- lung produces mediators such as serotonin, **calcitonin gene-related peptide**, endothelin-1, **leptin**, and keratinocyte growth factor, which regulate vascular tone, alveolar homeostasis, and immune modulation.
- And capillary blood vessels in the lung are one of the major sites of **ACE** expression and **angiotensin II** production in the human body

Other Endocrine Tissues

- **Adipose tissue**

- **Leptin:** a hormone released from the fat cells located in adipose tissues, sends signals to the hypothalamus in the brain. This particular hormone helps regulate and alter long-term food intake and energy expenditure, not just from one meal to the next.
- In recent years, leptin supplements have become quite popular. They claim to decrease appetite and make it easier for you to lose weight.

