

Hormones and Endocrine Systems

Chapter 40

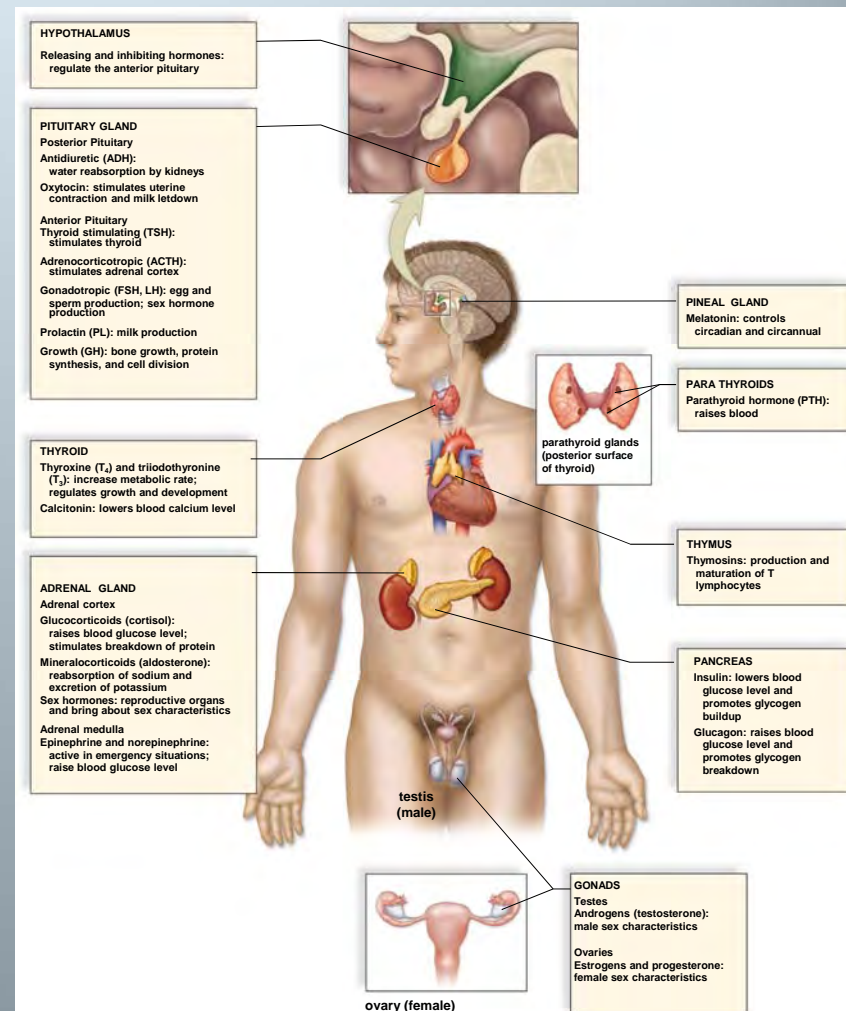
Outline

- Endocrine Glands
 - Pheromones
 - Steroid Hormones
 - Peptide Hormones
- Hypothalamus and Pituitary Gland
- Other Endocrine Glands and Hormones
 - Thyroid
 - Parathyroid
 - Adrenal
 - Pancreas
 - Gonads

Endocrine System

- Compose of **endocrine glands** which secrete **hormones**.
- Works closely with the nervous system
 - Sensory receptors detect changes in environment
 - CNS integrates info and responds by stimulating muscles and glands
- Hormones carried by the bloodstream to target cells throughout the body.
- Only target cells can respond to certain hormones (key and lock).
- Typically uses a **negative feedback mechanism**
- Note: **exocrine glands**= glands that secrete products directly into organ or outside the body. Ex: salivary glands.

- **Hypothalamus:**
Bridge between
Nervous system and
Endocrine system



Picture can be found on page 737 in the
textbook

Hormones are Chemical Signals

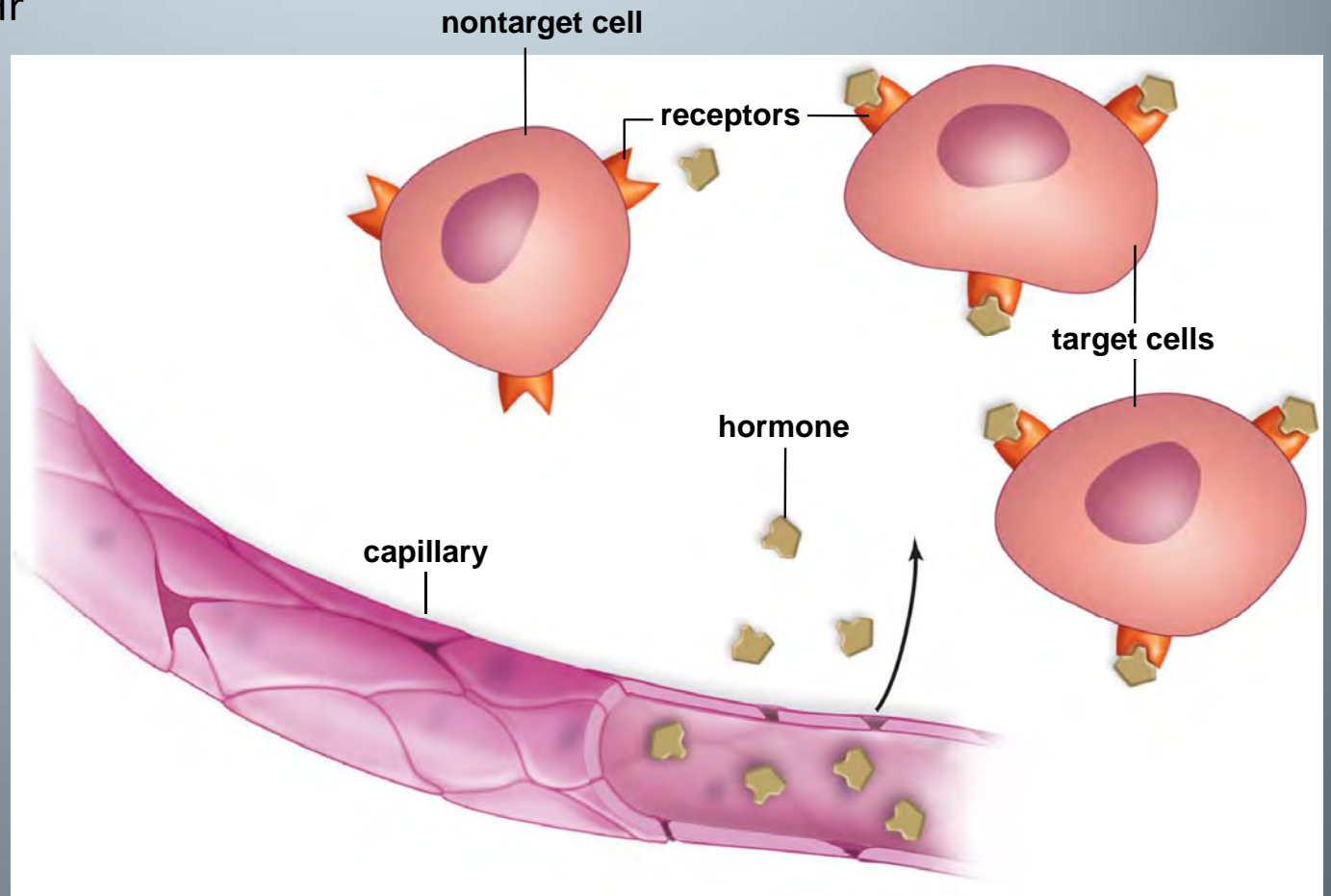
- Means of communication between cells, body parts, and individuals.
- At a distance (e.g., testosterone)
- Neighboring cells – **local hormone** (e.g., prostaglandins)
- **Pheromones**: chemical signals that influence the behavior of other individuals



Target Cell Concept

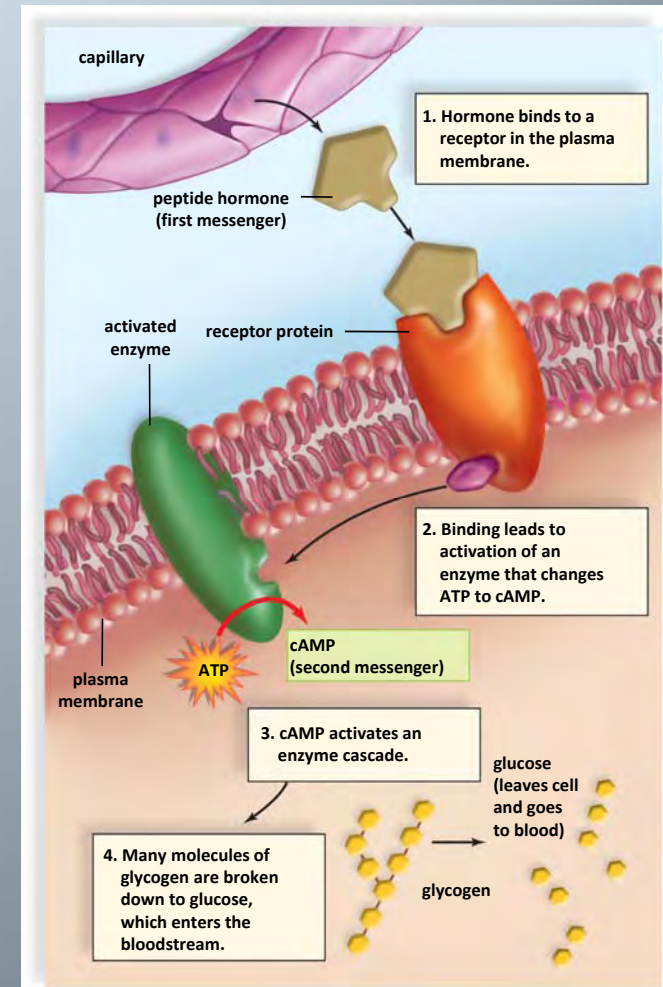
- <http://www.youtube.com/watch?v=HrMi4GikWwQ>

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Peptide Hormones

- **Peptide Hormones:** made of peptides, proteins, glycoproteins, and modified amino acids.
 - Ex: Growth Hormone (secreted by pituitary enhancing cell metabolism leading to a change in the structure of bone)
- Action:
 - 1) peptide hormone (1st messenger) binds to receptor in plasma membrane of target cell.
 - 2) Binding to receptor causes production of 2nd messenger, cAMP (cyclic adenosine monophosphate) which causes an enzyme cascade
 - 3) Many molecules produced, which enter bloodstream.
- Courier and Screen door example.



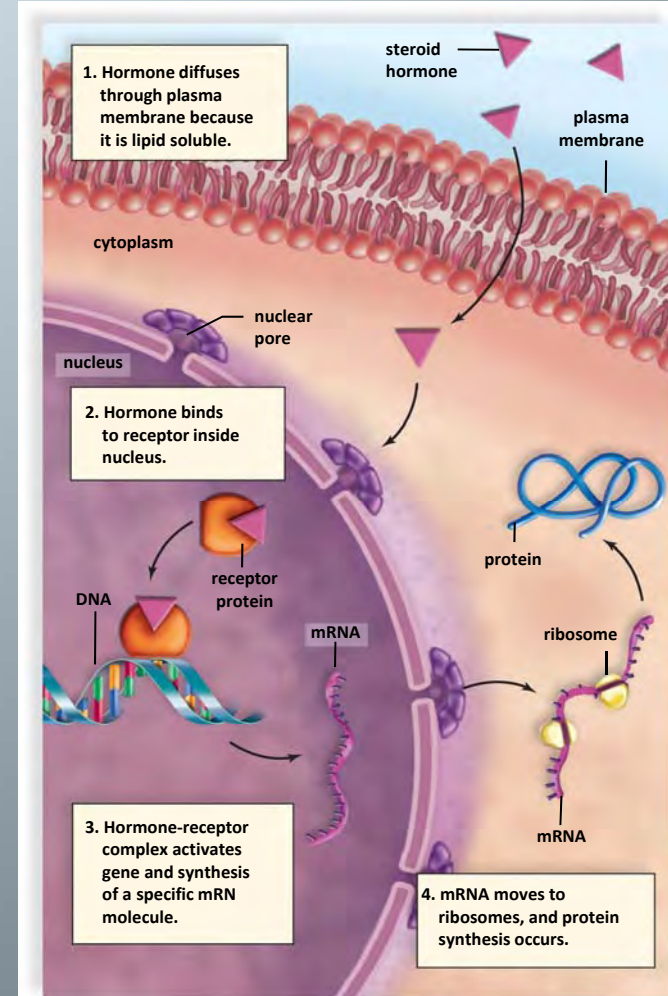
Steroid Hormones

Steroid hormones: produced by adrenal cortex, ovaries, testes

Action:

- Do not bind to plasma membrane receptors, but can enter cell because they are lipids.
- Once inside, steroid hormone binds to a receptor usually in nucleus, sometimes in cytoplasm.
- Hormone receptor complex binds with DNA and activates certain genes.
- Act more slowly than peptides, but action lasts longer.
- Like “a courier that has a pass to enter the factory (the cell). Once inside, he makes contact with the plant manager (DNA), who sees to it that the factory (cell) is ready to produce a product.”

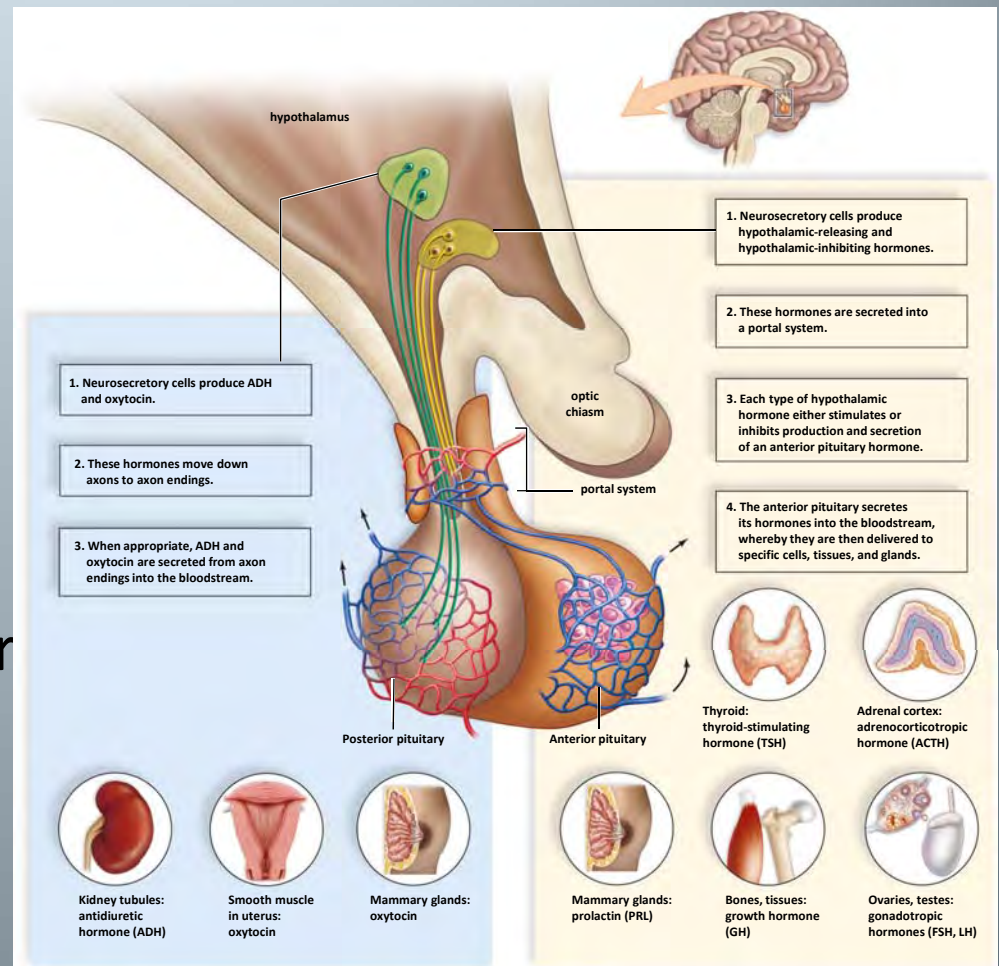
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Hypothalamus and Pituitary Gland

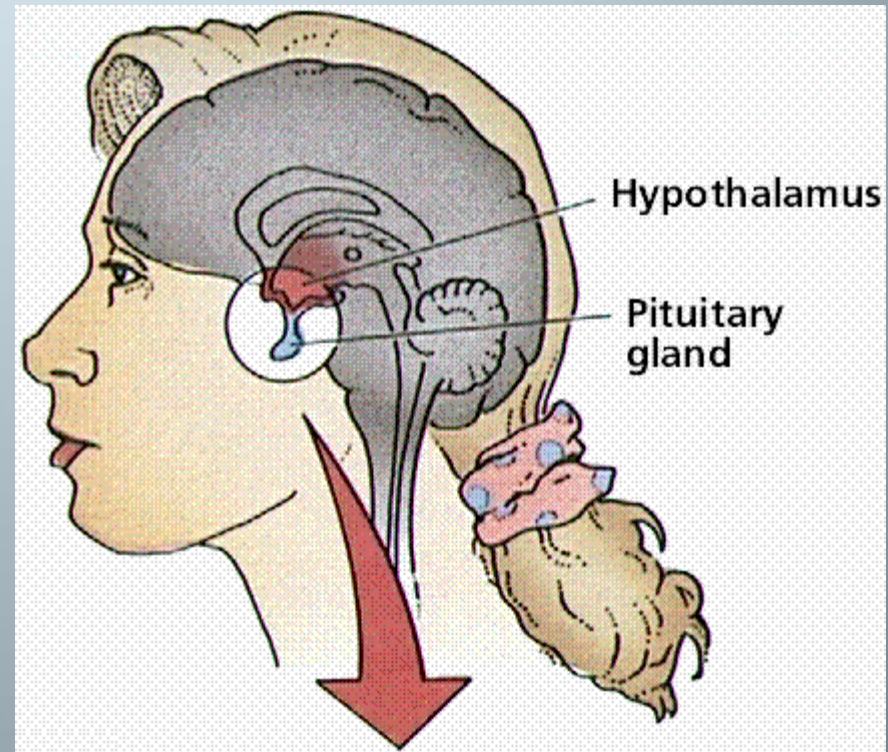
- **Hypothalamus:** regulates internal environment through autonomic system (controls heartbeat, body temp, water balance).
- **Neurosecretory cells:** Neurons in hypothalamus that produce the hormones antidiuretic hormone (ADH) and oxytocin, which pass through axons into posterior pituitary gland.
- **Pituitary Gland:** connected and regulated by hypothalamus

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Posterior Pituitary

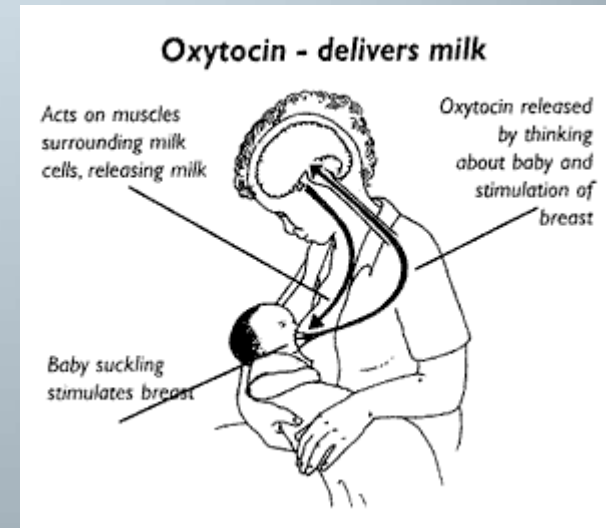
- **Antidiuretic hormone (ADH):** produced by posterior pituitary when cells in the hypothalamus determine that salt concentration in the blood is too high.
 - Reaches kidneys, causes water to be reabsorbed into blood (and not excreted) so blood becomes more dilute.
 - Continues to be produced until blood becomes more dilute, then signal stops.
 - Example of negative feedback mechanism.
 - Release of ADH inhibited by alcohol



Posterior Pituitary

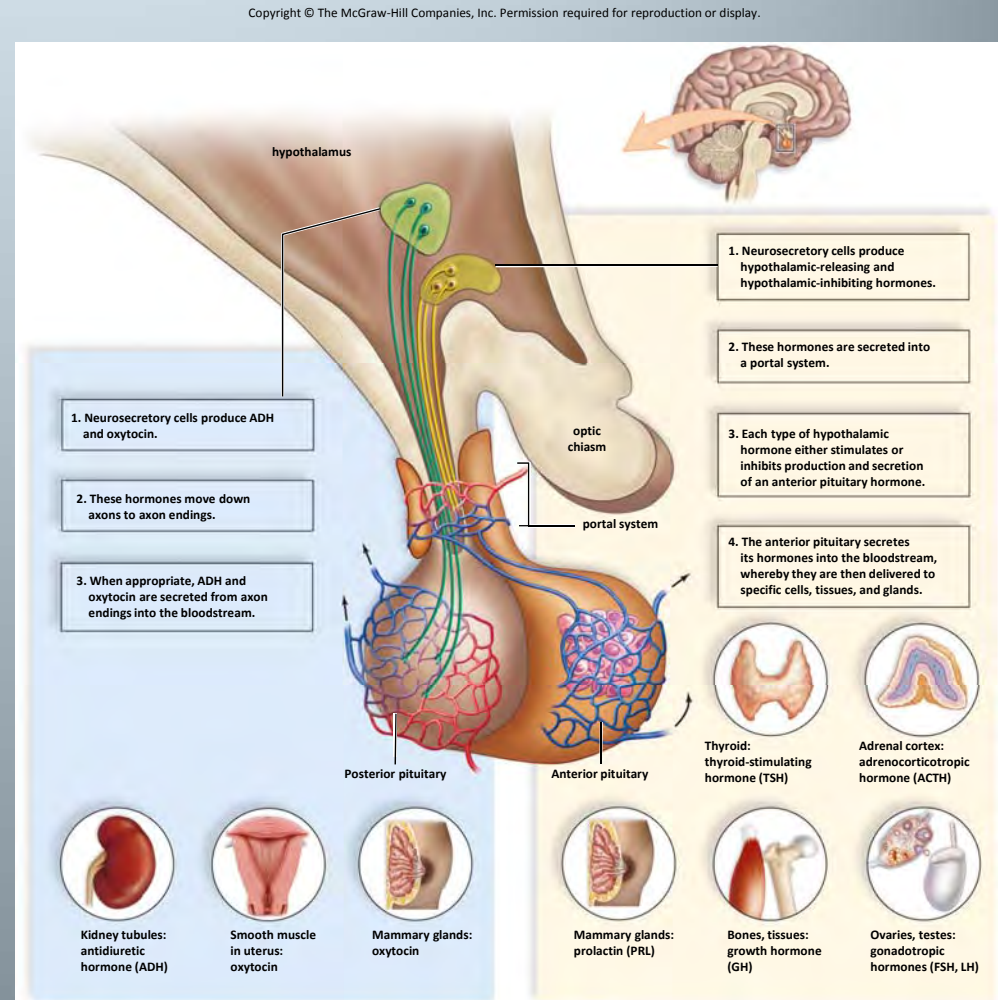
Oxytocin: made in hypothalamus.

- Cause uterine contractions during childbirth, milk letdown during nursing.
- Positive feedback mechanism: the stimulus increases the intensity which increases intensity even more.



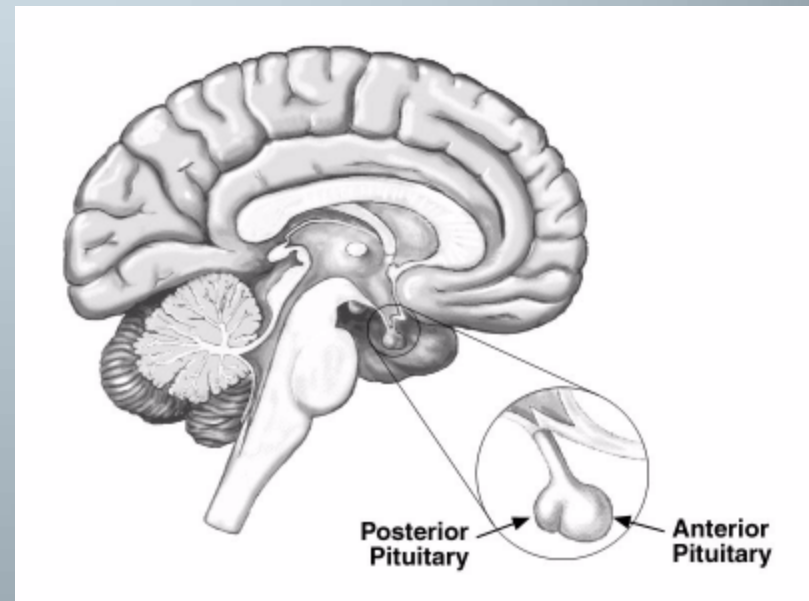
Hypothalamus and Posterior Pituitary Gland

- 1) In Hypothalamus: Neurosecretory cells produce ADH and oxytocin
- 2) Hormones move down axons to axon endings
- 3) When appropriate, ADH and oxytocin are secreted from axon endings into bloodstream



Anterior Pituitary

- Controlled by hypothalamus via hypothalamic-releasing hormones and hypothalamic-inhibiting hormones.
- Portal system lies between hypothalamus and anterior pituitary.



Anterior Pituitary

Certain hormones produced by the anterior pituitary affect other glands.

- **Gonadotropic hormones** stimulate gonads to produce gametes and sex hormones.
- **Adrenocorticotrophic hormone (ACTH)** stimulates adrenal cortex to produce glucocorticoid.
- **Thyroid-stimulating hormone (TSH)** stimulates thyroid to produce thyroxine and triiodothyronine.

Anterior Pituitary

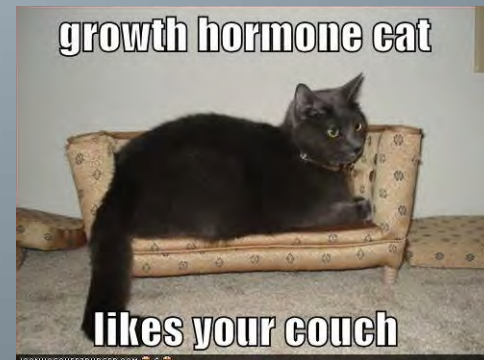
Other hormones produced by the anterior pituitary are under the control of the hypothalamus and do not affect other endocrine glands:

- **Prolactin (PRL)** is produced only after childbirth; causes mammary glands in the breasts to develop and produce milk.
- **Melanocyte-stimulating hormone (MSH)** causes skin color changes in fishes, amphibians, and reptiles having melanophores, specialized skin cells that produce color variations. (This is very low in humans)

Anterior Pituitary

Effects of Growth Hormone

- Hypothalamus stimulates AP to produce; quantity greatest during childhood and adolescence.
- Too little produced causes **pituitary dwarfism**: normal proportions but small stature.
- Too much GH: giant!
- Health problems associated with each: high GH cancels out the effects of insulin, causing diabetes. Low GH causes low blood sugar (hypoglycemia).



Acromegaly

- Growth Hormone overproduced in an adult.
- Long bone can no longer grow, so only feet, hands, and face respond.

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Age 9

Age 16

Age 33

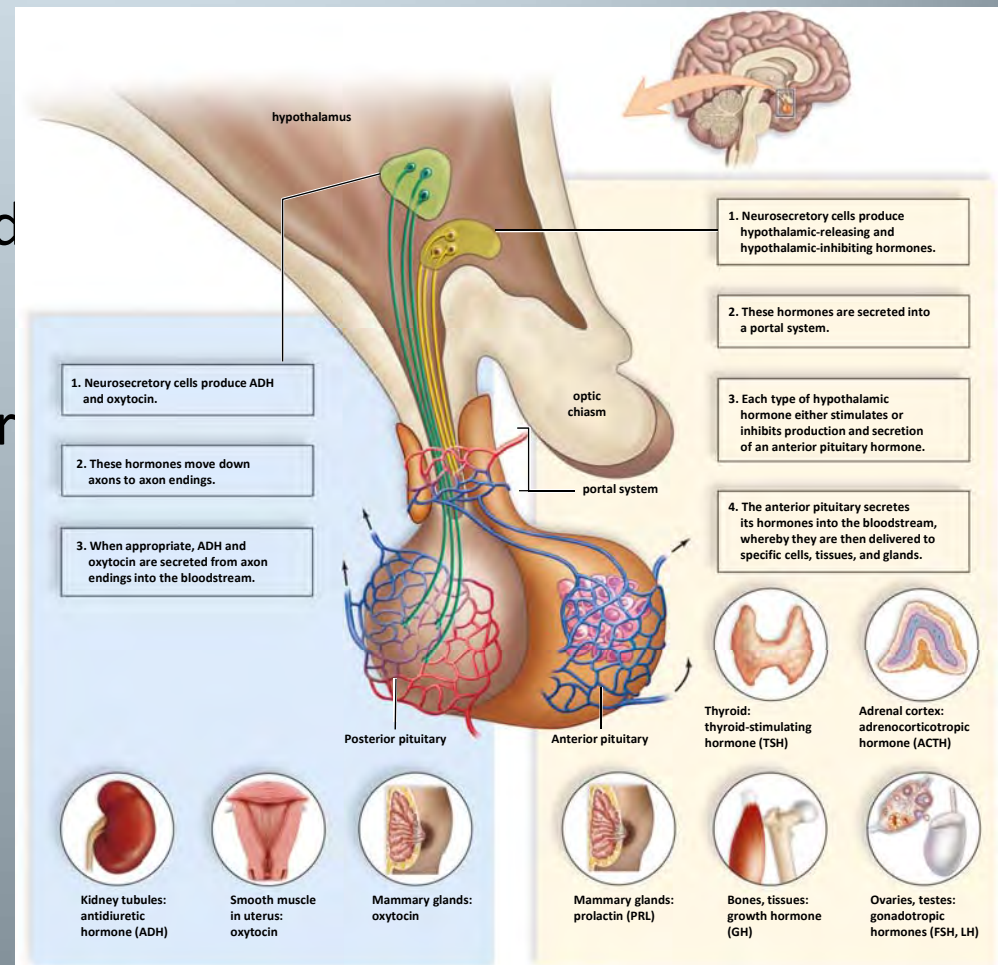
Age 52

From Clinical Pathological Conference, "Acromegaly, Diabetes, Hypermetabolism, Proteinuria and Heart Failure", *American Journal of Medicine*, 20 (1956) 133. Reprinted with permission from Excerpta Medica Inc.

Hypothalamus and Anterior Pituitary Gland

- 1) Neurosecretory cells produce hypothalamic-releasing and hypothalamic-inhibiting hormones.
- 2) These hormones are secreted into a portal system
- 3) Each type of hypothalamic hormone either stimulates or inhibits production and secretion of an anterior pituitary hormone.
- 4) The anterior pituitary secretes its hormones into the bloodstream, whereby they are then delivered to specific cells, tissues, and glands.

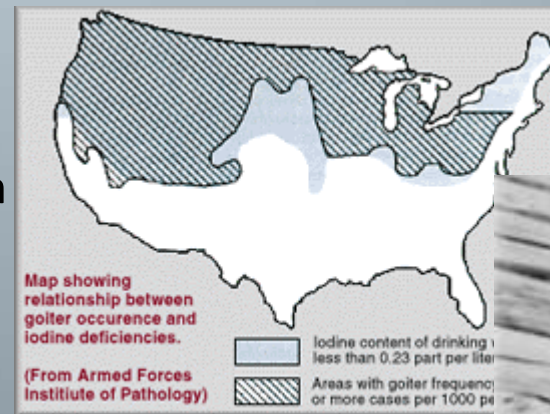
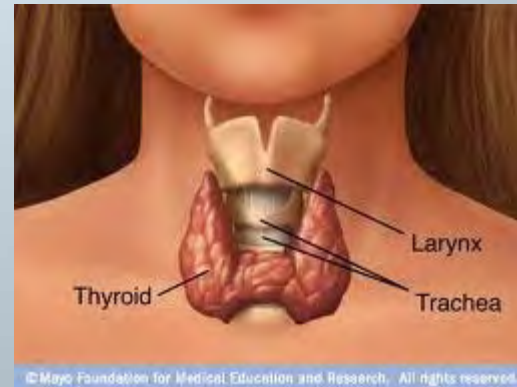
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Thyroid Gland

Thyroid

- Largest endocrine gland, found in neck, attached to trachea.
- Thyroid hormones:
 - triiodothyronine (T3, contains 3 iodine atoms) and thyroxine (T4, 4 iodine atoms)
 - Require iodine to produce
 - Concentration of iodine in thyroid can increase to as much as 25 times that of the blood.
 - Diet low in iodine prevents production of thyroid hormones, causing simple goiter, an enlarged thyroid.
 - Goiters were once common in the US, but the addition of iodine to salt solved the problem.

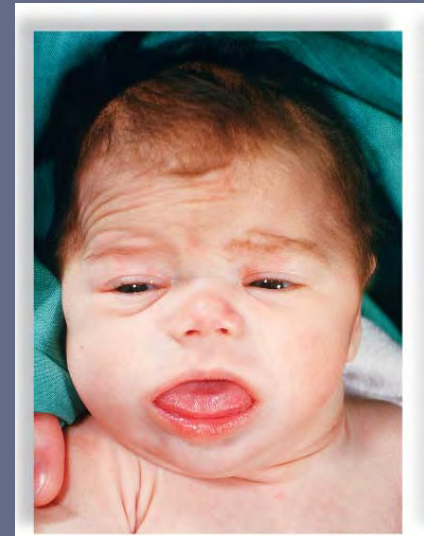


Thyroid Gland

Thyroid hormones increase metabolic rate; no target organ, stimulate all cells of body to metabolize faster.

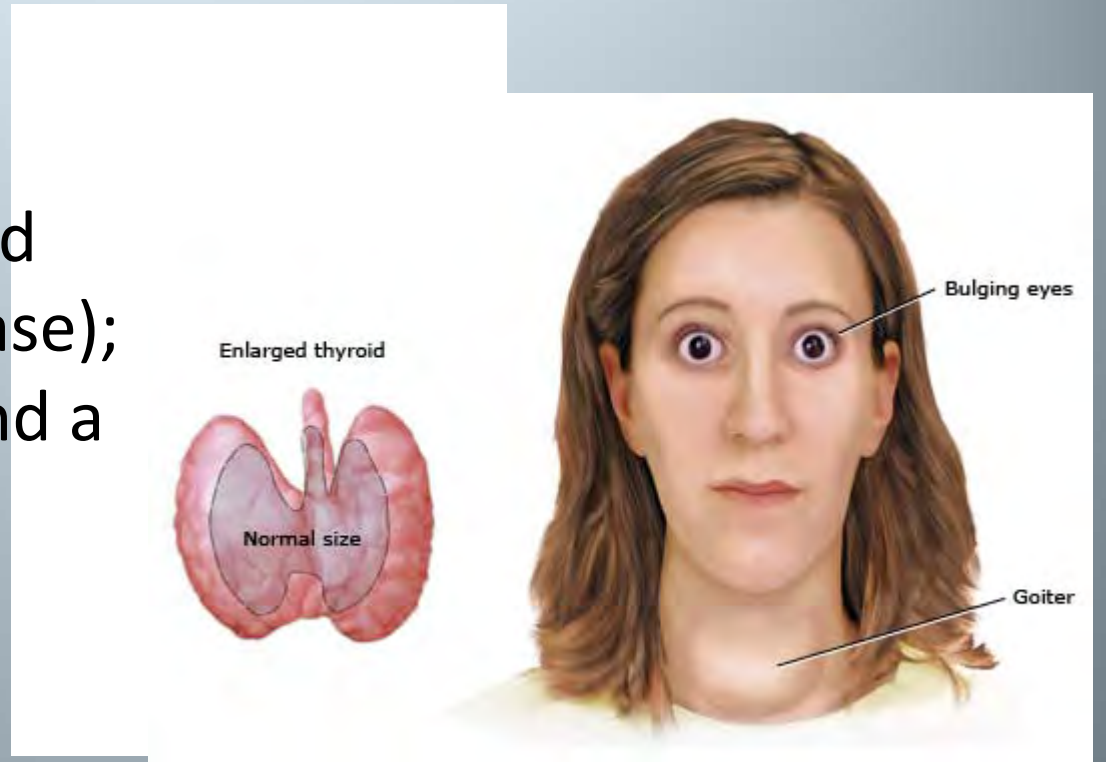
Congenital hypothyroidism: thyroid fails to develop properly, undersecretion of thyroid hormone. Causes mental retardation if not treated within first two months. Individuals are short and stocky.

Myxedema: hypothyroidism in adults. Causes lethargy, weight gain, loss of hair, slower pulse rate, lowered body temp, thick/puffy skin.



Thyroid Gland

Hyperthyroidism:
oversecretion of thyroid hormone (Graves disease); thyroid is overactive and an exophthalmic goiter forms. Eyes protrude. Hyperactive, nervous, irritable.

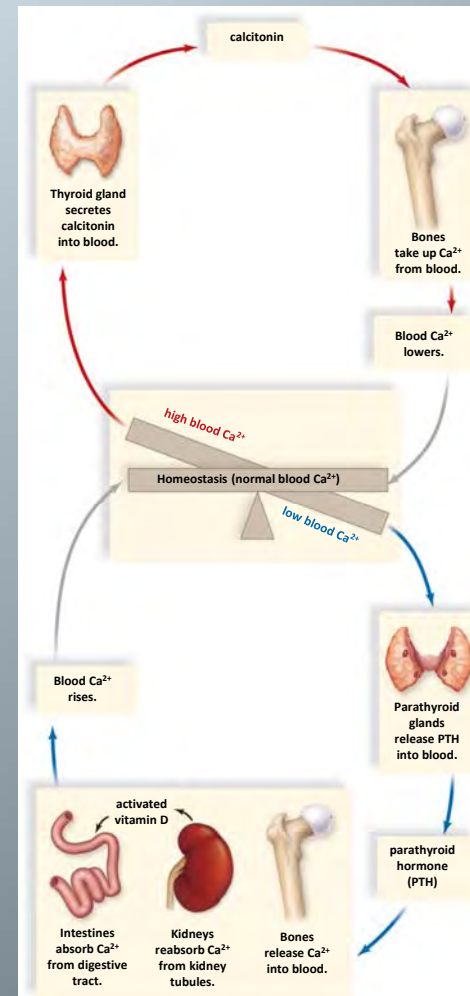


Thyroid Gland

Calcitonin: hormone secreted by the thyroid gland when blood calcium level rises; causes calcium to be deposited in bones by temporarily reducing the number of osteoclasts.

- When blood-calcium is low, **parathyroid hormone (PTH)** is released by the **parathyroid glands** to promote activity of osteoclasts and release calcium from the bones.
- Hyperparathyroidism causes the blood calcium to be too high and thus cause soft, fragile bones.
- Parathyroid glands also activates vitamin D, which stimulates the absorption of calcium from the intestine.
- Calcitonin and PTH are **Antagonistic hormones** since their actions are opposite and work together to regulate blood calcium levels.

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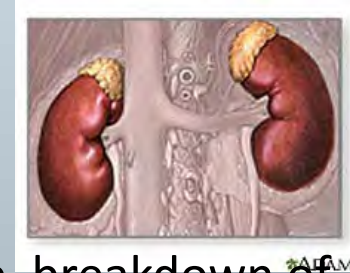


Adrenal Glands

Paired – One sits atop each kidney; each consists of outer **adrenal cortex** and inner **adrenal medulla**.

Adrenal medulla produces:

- **Epinephrine** (adrenaline)
- **Norepinephrine** (noradrenaline)
- Short-term response to stress (flight or fight); accelerate breakdown of glucose to form ATP, trigger mobilization of glycogen reserves in skeletal muscle, increase cardiac rate.



Adrenal cortex produces:

- **Mineralocorticoids**
- **Glucocorticoids**
- Long-term response to stress; increases in blood pressure and volume and increase in blood glucose level.

Hypothalamus controls activity of both portions; initiates nerve impulses through brain stem, spinal cord, sympathetic nerve fibers to adrenal medulla, which secretes hormones.

- Hypothalamus secretes ACTH-releasing hormone, which controls anterior pituitary's secretion of ACTH, which stimulates adrenal cortex to secrete glucocorticoids.

Adrenal Hormones

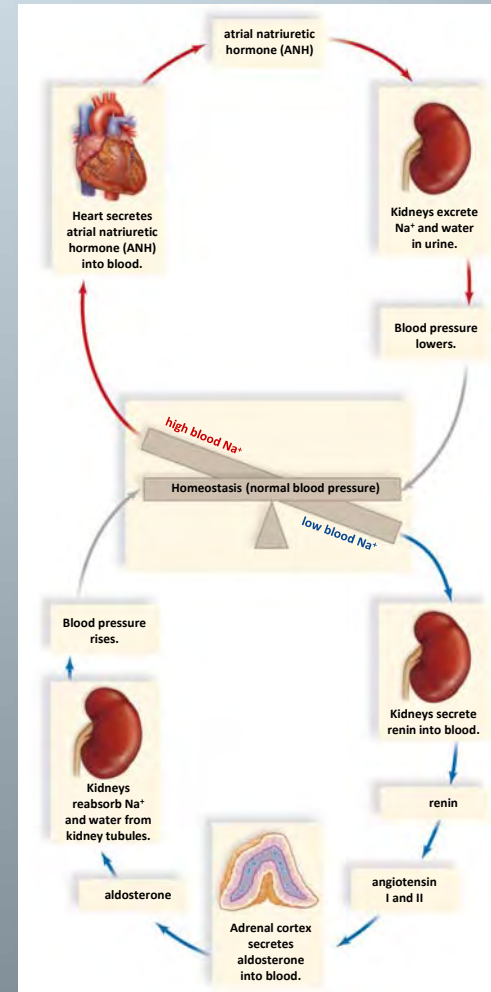
- Glucocorticoids
 - Cortisol; raises blood glucose.
 - Also counteracts inflammatory response; very high levels can suppress the body's defense system.



Adrenal Hormones

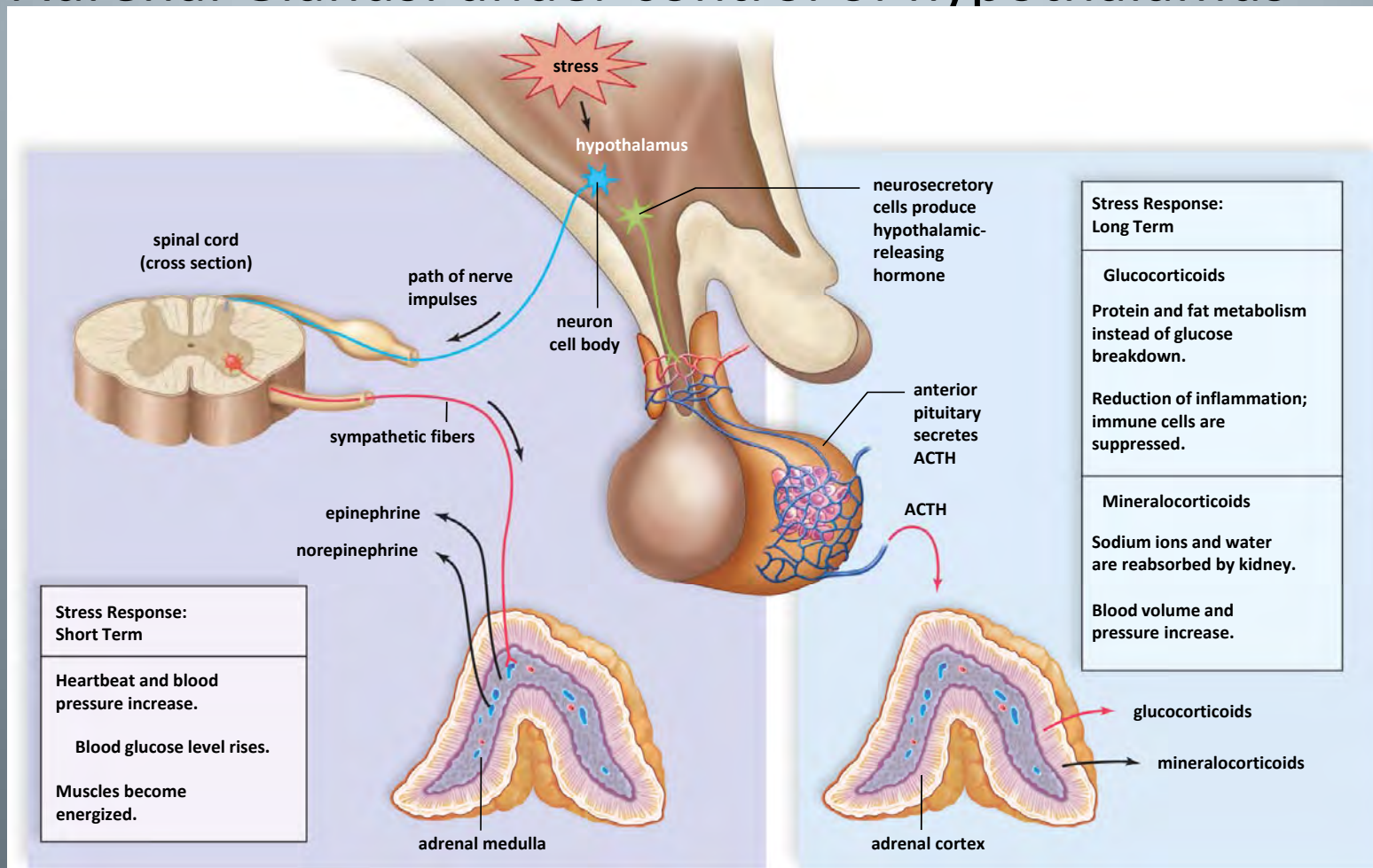
- Mineralocorticoids
 - Aldosterone
 - Promotes two renal functions
 - Absorption of sodium, and
 - Excretion of potassium
 - Renin-angiotensin-aldosterone system
 - Raises blood pressure
 - Angiotensin II constricts arterioles
 - Aldosterone causes kidneys to reabsorb sodium (causing water retention)
 - Atrial natriuretic hormone (ANH) is antagonistic to aldosterone

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Other Endocrine Glands and Hormones

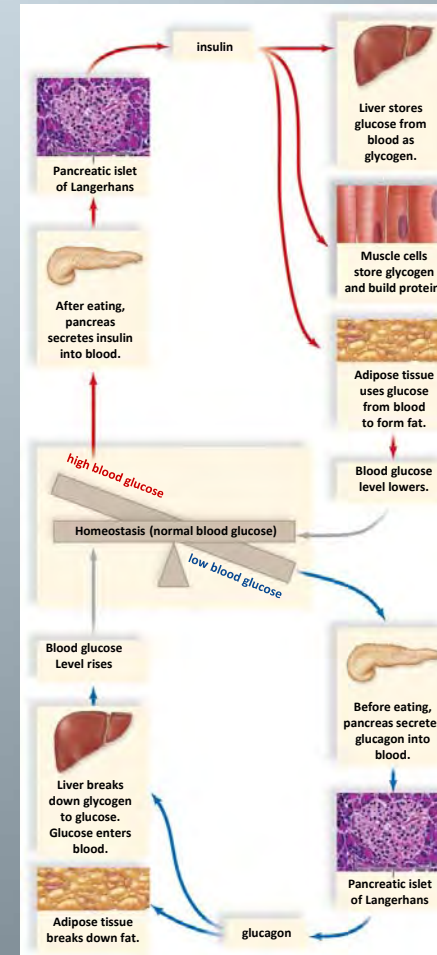
- Adrenal Glands: under control of hypothalamus



Other Endocrine Glands and Hormones

Pancreas

- Made up of exocrine and endocrine tissue
 - Endocrine Portion of the Pancreas:
 - Consists of pancreatic islets
 - Produce and secrete
 - **Insulin**
 - » Secreted during high blood glucose level
 - » Stimulates uptake of glucose by cells
 - **Glucagon**
 - » Secreted during low blood glucose level
 - » Stimulates liver to break down glycogen
 - Exocrine Portion of the Pancreas:
 - Secretes digestive enzymes and buffers into small intestine



Pancreas

Blood glucose high:

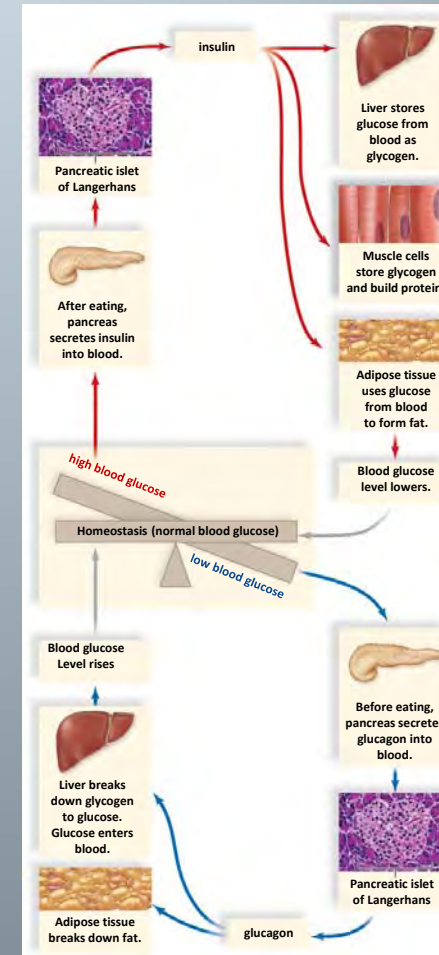
1) Pancreas secretes insulin into blood (from pancreatic islet).

a) Insulin causes liver to store glucose from blood as glycogen

b) Muscle cells store glycogen and build protein

c) Adipose tissue uses glucose from blood to form fat

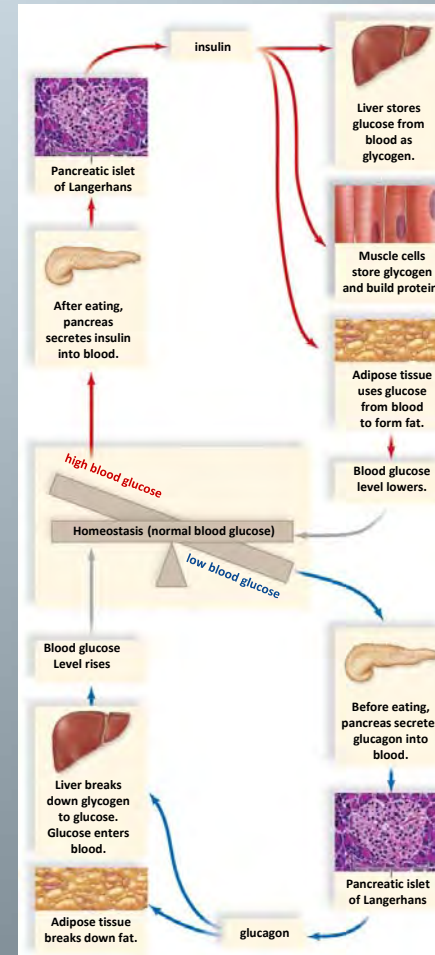
2) Blood glucose lowers



Pancreas

Blood glucose low:

- 1) Pancreas secretes glucagon into blood (from pancreatic islet)**
 - a) Adipose tissue breaks down fat**
 - b) Liver breaks down glycogen to glucose, glucose enters blood.**
- 2) Blood glucose level rises**



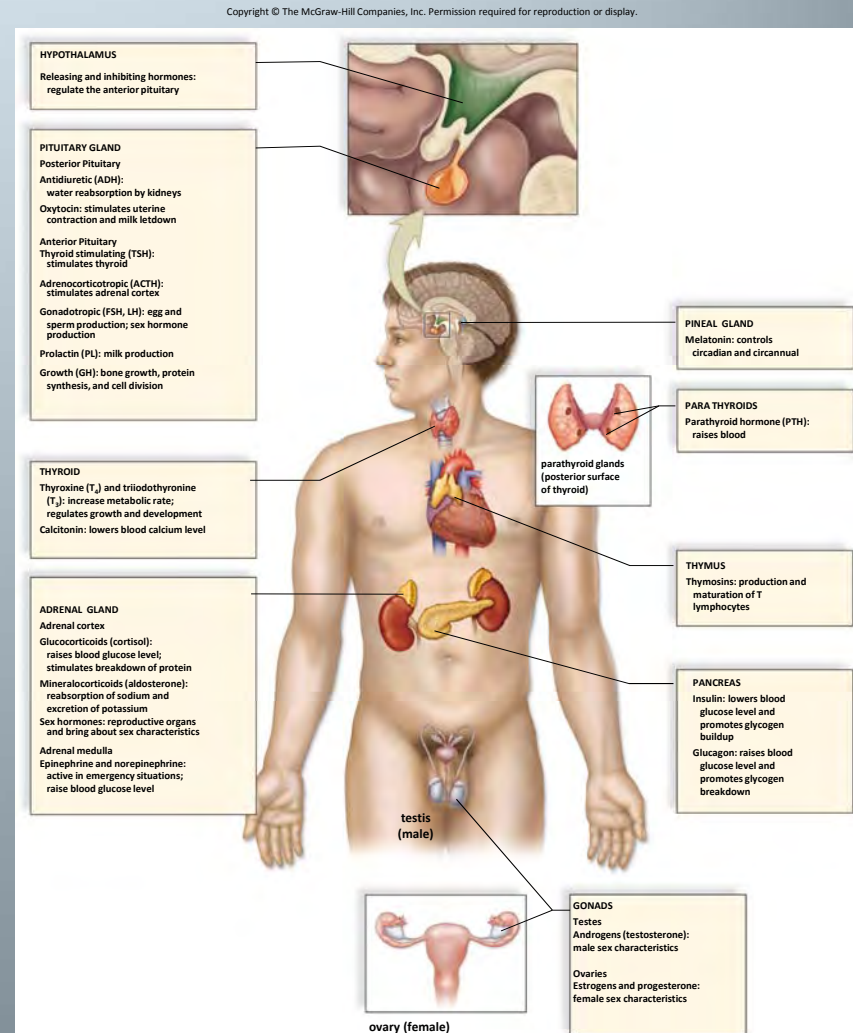
Diabetes Mellitus

- Liver and most body cells are unable to take up glucose properly.
- Person becomes hungry as cells starve
- Blood glucose levels rise and glucose is excreted in urine.
- Diabetes 1: pancreas is not producing insulin.
- Diabetes 2: adipose tissues produce a substance that impairs insulin receptor function; blood insulin level is low and cells do not have enough insulin receptors
 - Insulin resistance
 - Results in too much glucose in blood



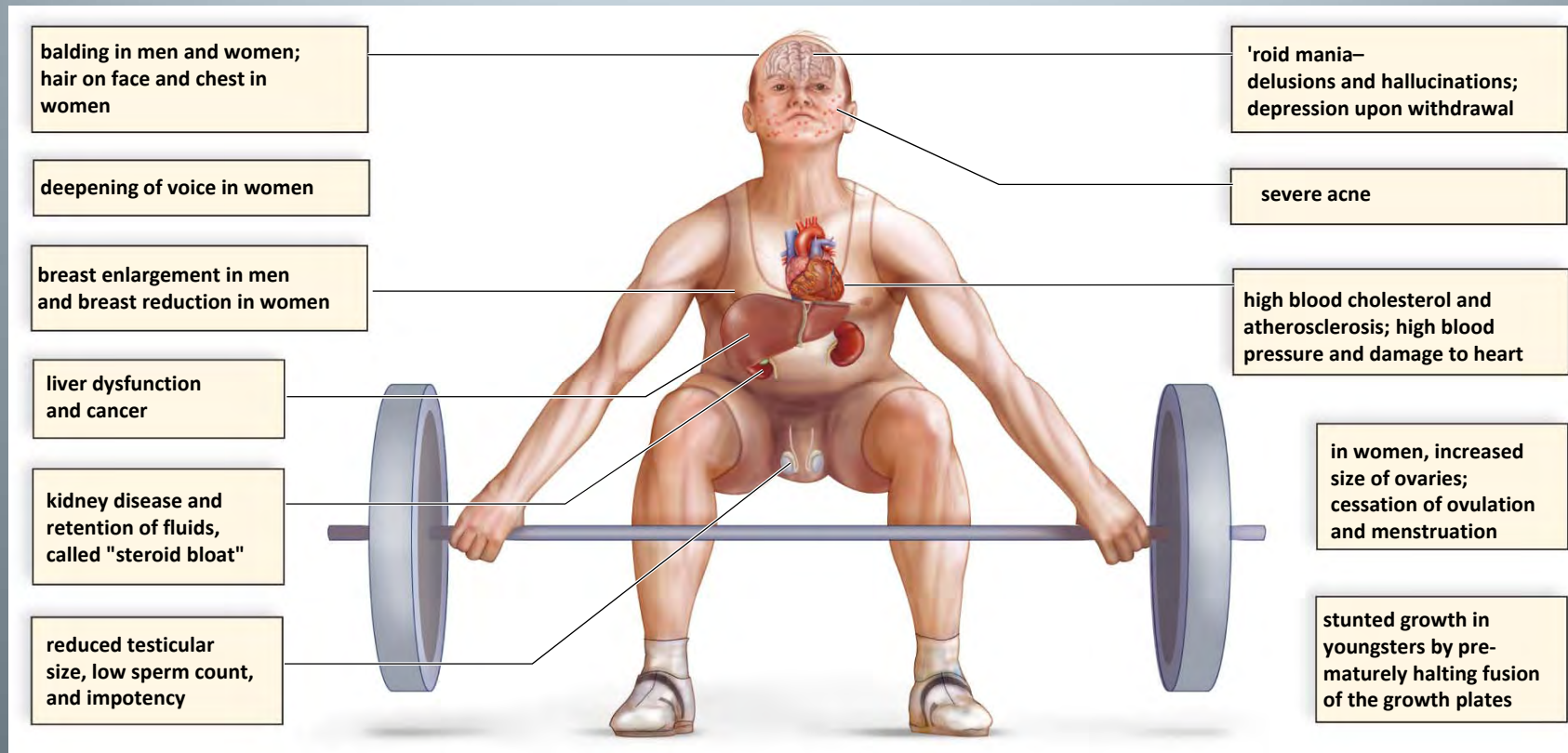
Testes and Ovaries

- Testes: located in scrotum; produce androgens such as testosterone; produce secondary sex characteristics
- Ovaries: located in pelvic cavity; produce estrogens and progesterone (female sex hormones); produce secondary sex characteristics
- Anterior pituitary releases the gonadotropic hormones, follicle-stimulating hormone (FSH), and luteinizing hormone (LH) which control secretions of testes and ovaries in a 3-tier system.



Effects of Anabolic Steroid Use

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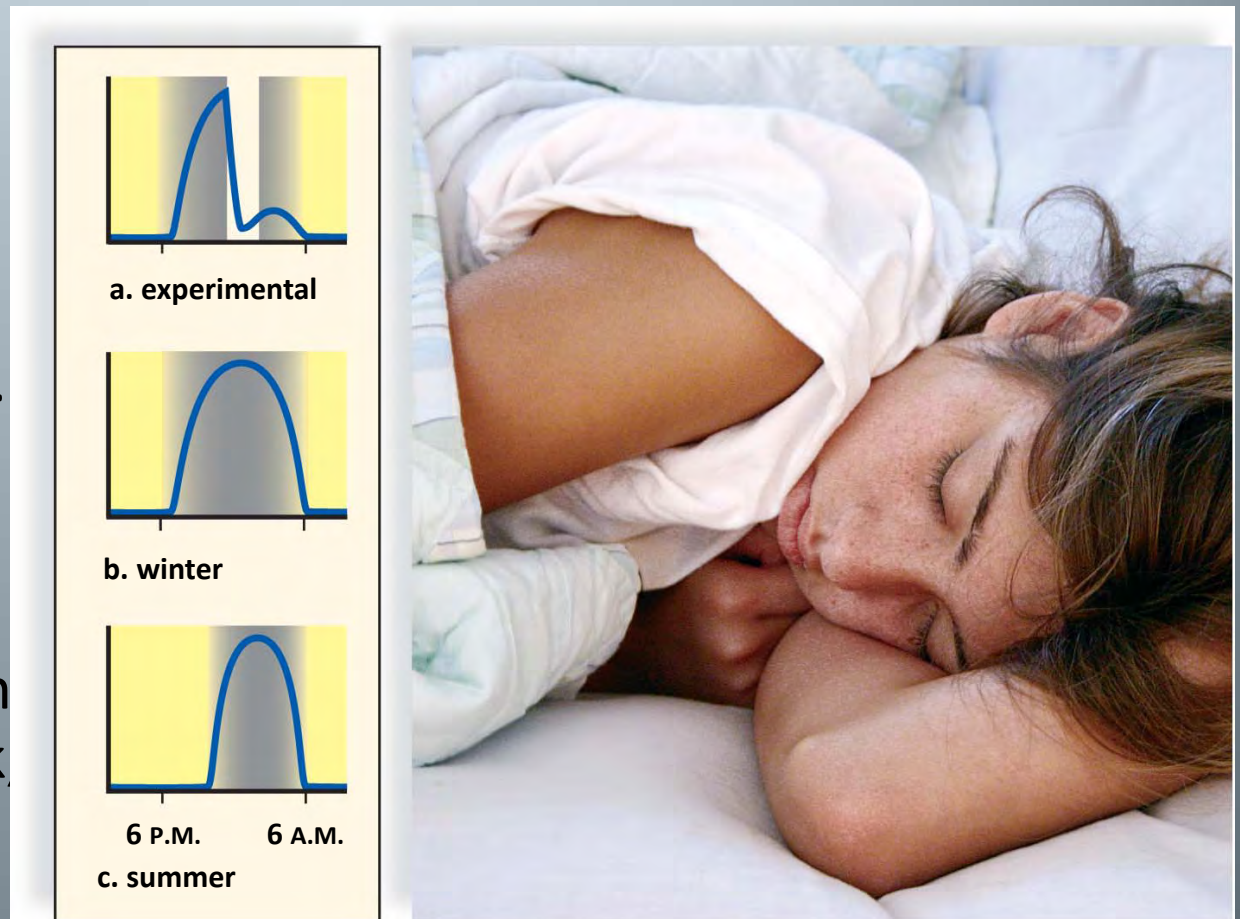


Pineal Gland

Located in brain

- Produces the hormone **melatonin**, primarily at night
 - Regulates sleep-wake cycle; circadian rhythms.
 - Sleepy at night, when melatonin levels are low
 - Effects on sleep and activity: shift work, jet lag

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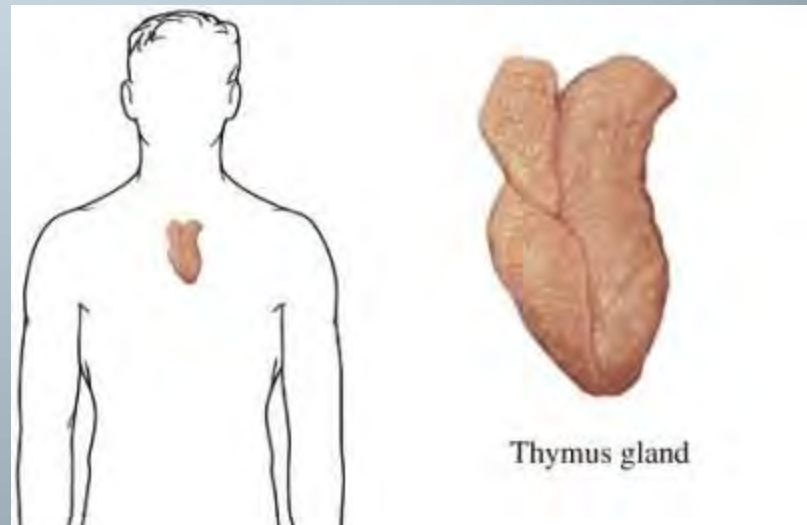
Pineal Gland

- Seasonal Effects - Biorhythms
 - Trigger seasonal changes
 - shedding in mammals
 - migration in birds
 - Hibernation



Thymus Gland

- Lobular gland beneath sternum.
- Lymphocytes pass through and are transformed into T lymphocytes
- Secretes hormones called **thymosins** which aid in differentiation of T lymphocytes backed inside the lobules.



Other Hormones

- **Leptin:** peptide hormone secreted by adipose tissue throughout the body. Works in feedback control of appetite. Binds to neurons in the CNS that control appetite; causes feelings of satiation and suppressed appetite.
- **Erythropoietin (EPO):** peptide hormone produced by kidneys. Released in response to low oxygen levels in kidney tissues. Stimulates production of red blood cells.
- **Local Hormones:** produced by cells, act on neighboring cells. Examples: growth factors, cytokines, prostaglandins.
- **Prostaglandins** are potent chemical signals produced within cells from a fatty acid. Cause muscles to contract in uterus (menstrual pain).



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