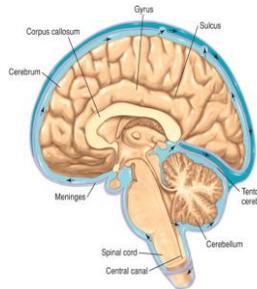


Endocrine Glands: Hypothalamus & Pituitary Glands

- ▶ Hypothalamus (Master Gland)
- ▶ 8 hormones produced in hypothalamus
 - ▶ 6 regulate anterior pituitary
 - ▶ e.g., TRH, GnRH, GHRH
 - ▶ E.g., PIH, Somatostatin (GH TSH)
- ▶ Hypothalamus receives info (direction from higher brain areas)



11-36

The Pituitary Gland: Anterior

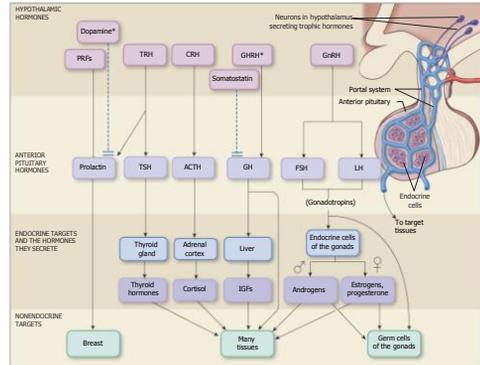
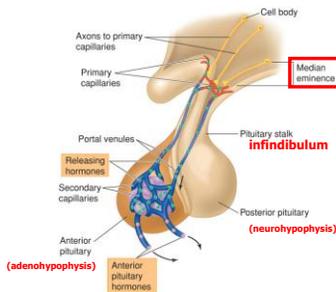


Figure 7-13

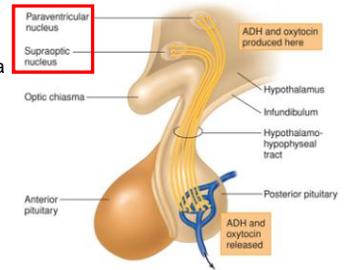
Pituitary Gland (hypophysis)



11-36

Hypothalamic Control of Posterior Pituitary

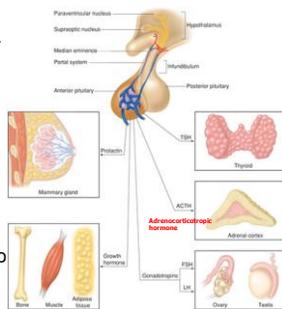
- ▶ Posterior pituitary stores:
 - oxytocin
 - ADH (vasopressin)
- delivered to post. pit. via hypothalamo-hypophyseal tract



11-46

Anterior Pituitary

- ▶ Secretes 6 trophic hormones
- ▶ Trophic = feed
 - ▶ concentration = hypertrophy
 - ▶ Shortened to "tropic" for hormones of Ant. Pit.
- ▶ Ant. Pit. Hormones suffix = "trophin"
- ▶ Hypothalamo-hypophyseal portal system releasing/inhibiting hormones released by hypo



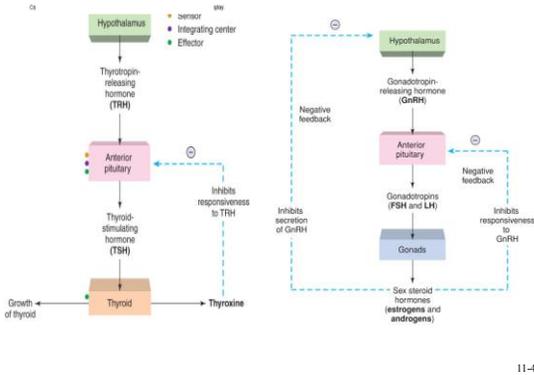
11-39

Anterior Pituitary

- ▶ Growth hormone (GH) (somatotropin) promotes growth, protein synthesis; movement of amino acids into cells
- ▶ Thyroid stimulating hormone (TSH) (thyrotropin) stimulates thyroid to produce and secrete T₄ and T₃
- ▶ Adrenocorticotropic hormone (ACTH) (corticotropin) stimulates adrenal cortex to secrete cortisol, aldosterone
- ▶ Gonadotropic Hormones
 - ▶ Follicle Stimulating Hormone (FSH) Females: follicle maturation; Males: stimulates sperm production
 - ▶ Luteinizing Hormone (LH) Females: stimulates ovulation; Males: stimulates androgen secretion
- ▶ Prolactin (PRL) stimulates milk production by mammary glands

11-40

Feedback Control of Anterior Pituitary



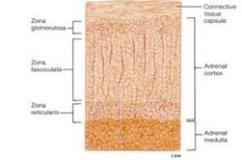
11-43

Adrenal Glands

- Adrenal Medulla synthesizes and secretes **80% Epinephrine and 20% Norepinephrine**
- Controlled by sympathetic division of ANS
 - Recall preganglionic neuron stimulation!



- Adrenal Cortex
 - No neural innervation!
 - i.e., stimulated by ACTH
 - Releases **Steroid hormones** (corticosteroids = corticoids)



11-48

Adrenal Medulla

- Epi. & Norepi. released in ~ 4:1 ratio
- Innervated by preganglionic Sympathetic fibers
- Activated during "fight or flight" response
- Causes:
 - Increased respiratory rate
 - Increased HR and cardiac output
 - General vasoconstriction which increases venous return
 - Glycogenolysis and lipolysis

11-51

Adrenal Glands

- Adrenal Cortex is controlled by ACTH and secretes:
 - Steroid hormones (corticosteroids)
- 3 functional groups:
 - Mineralcorticoids (regulate Na⁺/K⁺ balance)
 - e.g. **aldosterone** (Na⁺ H₂O retained/ K⁺ excreted) increases blood volume & pressure
 - Glucocorticoids: carb!!!!!!protein/fat metabolism
 - e.g. **Cortisol (hydrocortisone)**:
 - stimulates gluconeogenesis (glucose from non-carbs) - inhibit glucose utilization (raises blood glucose)
 - promotes lipolysis (raises free fatty acids in blood)
 - dampen inflammation & immune response!
 - exogenous glucocorticoids (pills, shots, creams)
 - Sex steroids (weak androgens)

11-49

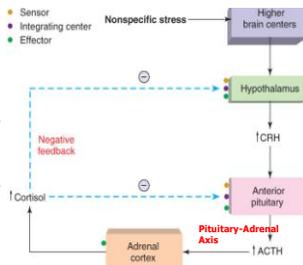
Stress and the Adrenal Gland

Under stress – ACTH increases thus adrenal cortex secretes more glucocorticoids

- Stress induces a non-specific response called **general adaptation syndrome (GAS)**

3 stages in response to stress

- Alarm rx: adrenal glands activated (epi. & cortisol)
- Resistance: readjustment occurs (glycogen used, body uses alternative fuels (pro. & fat breakdown for gluconeogenesis but glucose uptake is inhibited - immune response inhibited)
- Exhaustion



11-52

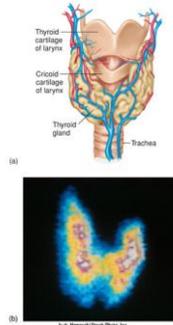
Stress and the Adrenal Gland

- Chronic stress can induce high levels of cortisol that cause a number of negative effects:
 - atrophy of hippocampus (involved in memory)
 - reduced sensitivity of tissues to insulin (insulin resistance)
 - inhibition of vagus nerve activity
 - suppression of growth hormone, thyroid hormone, and gonadotropins
 - Dampened immune response

11-53

Thyroid Gland

- ▶ Located just below the larynx
- ▶ Secretes
- ▶ T₄ (tetraiodothyronine – aka thyroxine)
- ▶ T₃ (triiodothyronine)
 - ▶ set BMR and needed for growth, development
- ▶ Calcitonin: Lowers blood Ca⁺



11-55

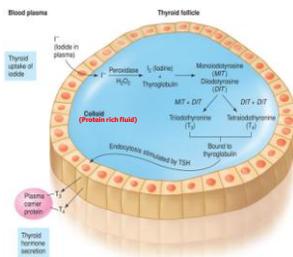
Thyroid Gland

- ▶ Consists of microscopic **thyroid follicles**
 - ▶ Outer layer (**follicle cells**) synthesize T₄
 - ▶ Interior is protein-rich **colloid** fluid
- ▶ Recall Thyroid Hormones:
 - ▶ Protein carriers carried in blood
 - ▶ Stimulate protein synthesis

11-56

Production of Thyroid Hormones

- ▶ Iodide (I⁻) actively transported into colloid
 - ▶ oxidized to iodine (I₂) and attached **thyroglobulin**
- ▶ MIT & DIT then used to **make** T₃ and T₄
- ▶ TSH stimulates hormones to be taken in by follicular cells and removed from thyroglobulin

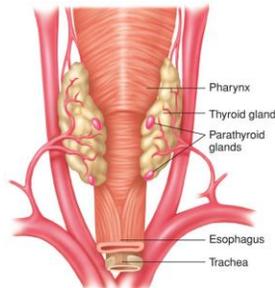


- ▶ Hypothyroidism:
 - ▶ Inadequate T₄ and T₃ levels (**hypothyroid**) or TSH
 - ▶ Low BMR, weight gain, lethargic, cold intolerance
 - ▶ **myxedema** = puffy face, hands, feet
- ▶ Goiter!
- ▶ Hyperthyroidism:
 - ▶ **Grave's disease**
 - ▶ Autoimmune disease where antibodies stimulate thyroid gland to grow and oversecrete
 - ▶ Bulging eyes, weight loss, heat intolerance, irritability, high BMR

11-59

Parathyroid Glands

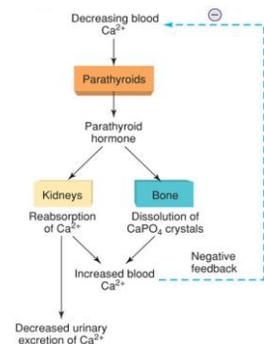
- ▶ 4 glands: posterior lateral lobes of thyroid gland
- ▶ Secrete **Parathyroid hormone (PTH)**
 - ▶ Raises blood Ca²⁺ levels



11-62

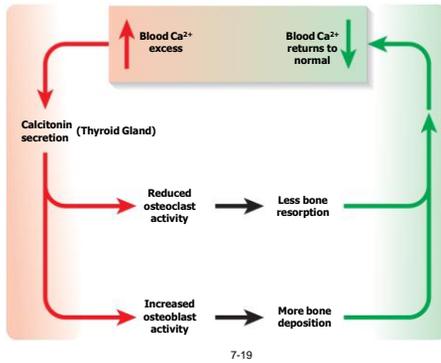
Parathyroid Hormone

- ▶ Stimulated by decreased blood Ca²⁺
- ▶ Acts on bones, kidney, and intestines
 - ▶ Bones; increases osteoclast activity
 - ▶ Kidney: Ca⁺ reabsorption
 - ▶ Intestines: increased Ca⁺ absorption
- ▶ ALL increase blood Ca⁺



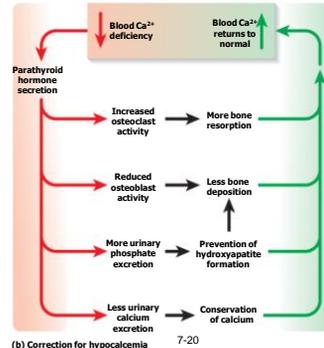
11-63

Correction for Hypercalcemia



7-19

Correction for Hypocalcemia

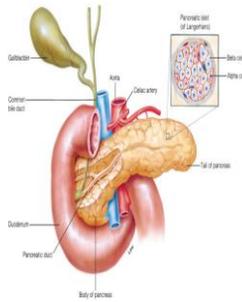


(b) Correction for hypocalcemia 7-20

Figure 7.18b

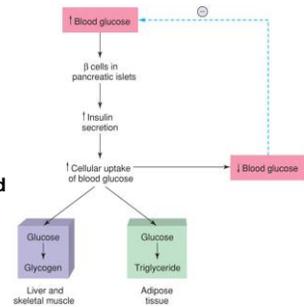
Pancreas

- ▶ Islets of Langerhans
- ▶ Scattered clusters of endocrine cells in pancreas
 - alpha and beta cells
- ▶ Alpha cells secrete hormone **glucagon** in response to low blood glucose
 - ▶ Stimulates **glycogenolysis** and **lipolysis**
 - ▶ Increases blood glucose

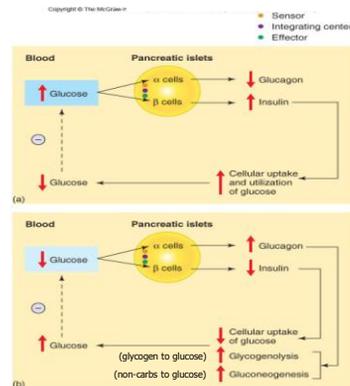
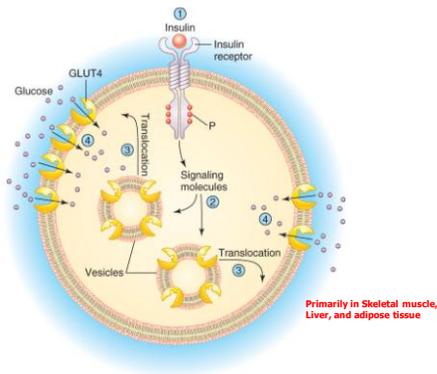


Islets of Langerhans

- ▶ Beta cells secrete **insulin** in response to high blood glucose
 - Promotes entry of glucose into cells
 - Conversion of glucose into glycogen and fat
- ▶ Both decrease blood glucose



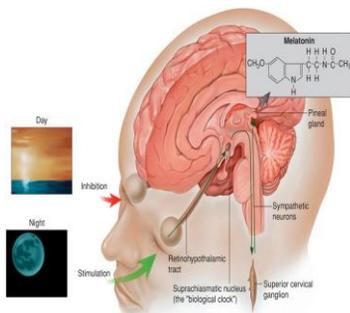
11-67



Diabetes mellitus:
Type 1 insulin-dependent:
 -Beta cells don't secrete insulin
Type 2 non insulin-dependent (more common):
 - tissue loses sensitivity for insulin
 i.e., need more for normal effect

Pineal Gland

- ▶ Located epithalamus
- ▶ Secretes **melatonin** in response to activity of **suprachiasmatic nucleus** of hypothalamus
- ▶ Daylight inhibits SCN reducing sympathetic stimulation of Pineal gland.



11-69

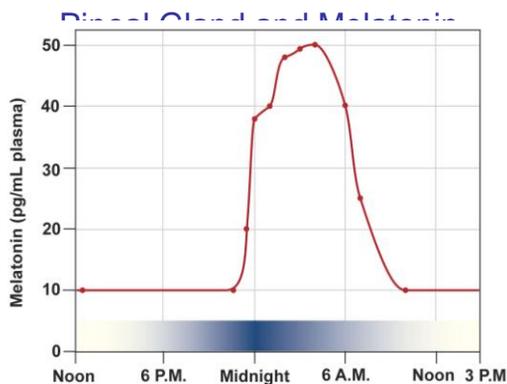


Figure 7-22 (2 of 3)

GI Tract

- ▶ A number of GI organs produce hormones:
 - ▶ Stomach
 - ▶ Small intestine
 - ▶ Act on GI tract itself, gallbladder, and pancreas
 - ▶ Act in concert with ANS to coordinate regions of GI tract and pancreatic juice and bile

Sex and Reproductive Hormones

- ▶ **Gonads (testes and ovaries)** secrete sex steroid hormones:
 - ▶ Androgens (testosterone)
 - seminiferous tubules = spermies
 - leydig cells = testosterone
 - ▶ Estrogens & Progesterone
 - ▶ Estrogens
 - ▶ **Placenta** secretes estrogen, progesterone, hCG, and somatomammotropin

11-72

Autocrine and Paracrine Regulation

- ▶ **Autocrine regulators:** Chemicals produced in a cell and have an effect on same cell
 - ▶ All autocrines control gene expression in target cells
- ▶ **Paracrine regulators** produced by tissue of an organ and act on different cells of the same organ
- ▶ A chemical can function as both
 - ▶ Autocrines and paracrines include:
 - ▶ **Cytokines** (lymphokines, interleukins)
 - stimulate (regulate), proliferation of cells of immune system
 - ▶ **Growth factors** (promote growth and cell division)
 - ▶ **Neurotrophins** (provides trophic support for neurons)

11-74

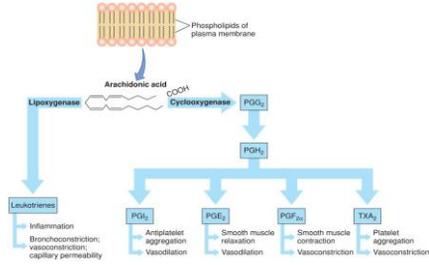
Autocrine Regulators: Prostaglandins (PGs)

- ▶ Produced in almost every organ
- ▶ Belong to **eicosanoid** family -- all derived from **arachidonic acid** of plasma membrane
 - ▶ Hormones or other agents stimulate release of arachidonic acid from membrane
- ▶ PGs have wide variety of functions
 - ▶ Different PGs may exert antagonistic effects in tissues
 - ▶ Some promote smooth muscle contraction and some relaxation
 - ▶ Some promote clotting; some inhibit
 - ▶ Promotes **inflammatory process** of immune system
 - ▶ Plays role in ovulation
 - ▶ Inhibits gastric secretion in digestive system

11-75

Autocrine Regulators: Prostaglandins (PGs)

› **Cyclooxygenase (COX)** needed for PG synthesis



Prostaglandin inhibitors:

non-steroidal anti-inflammatory drugs (NSAIDs) inhibit COX
i.e. drugs inhibit inflammation!!!!!!!!!!!!!!!

11-75