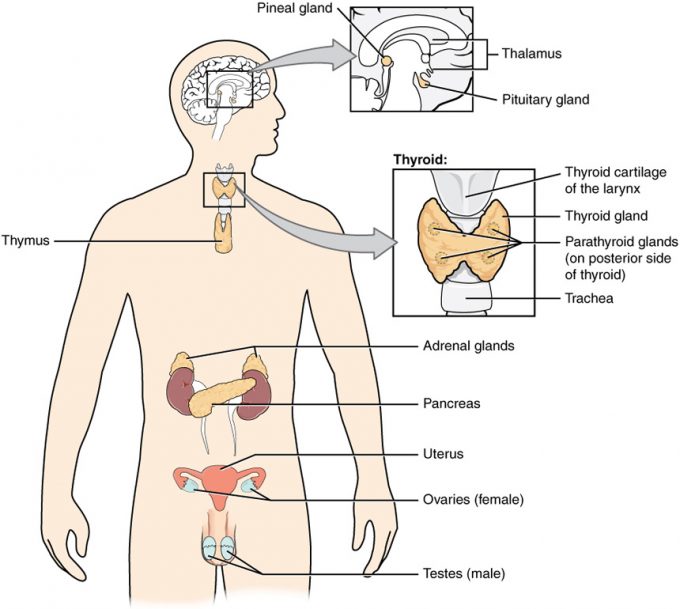
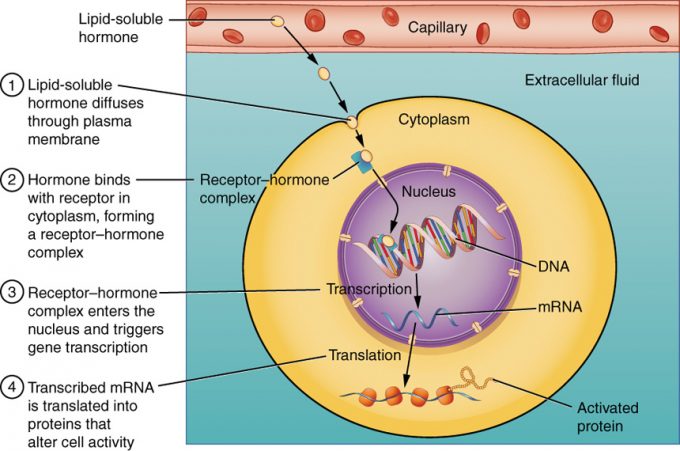
Endocrine System



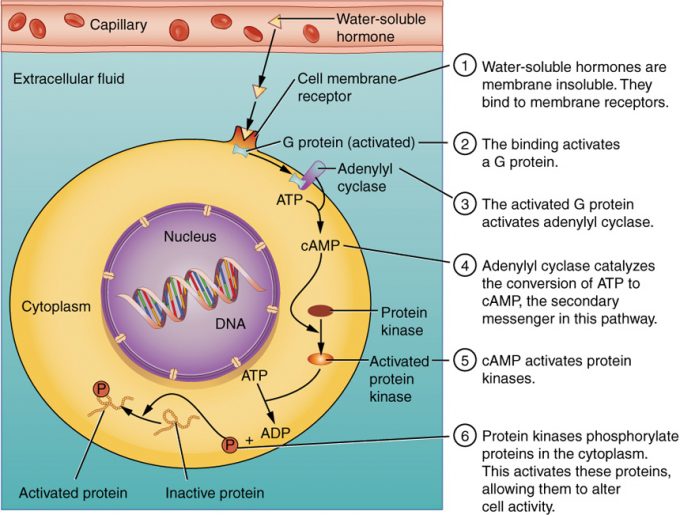
Hormones



Pathways of Hormone Action



**Figure 17.22 – Binding of Lipid-Soluble Hormones:** A steroid hormone directly initiates the production of proteins within a target cell. Steroid hormones easily diffuse through the cell membrane. The hormone binds to its receptor in the cytosol, forming a receptor–hormone complex. The receptor–hormone complex then enters the nucleus and binds to the target gene on the DNA. Transcription of the gene creates a messenger RNA that is translated into the desired protein within the cytoplasm.



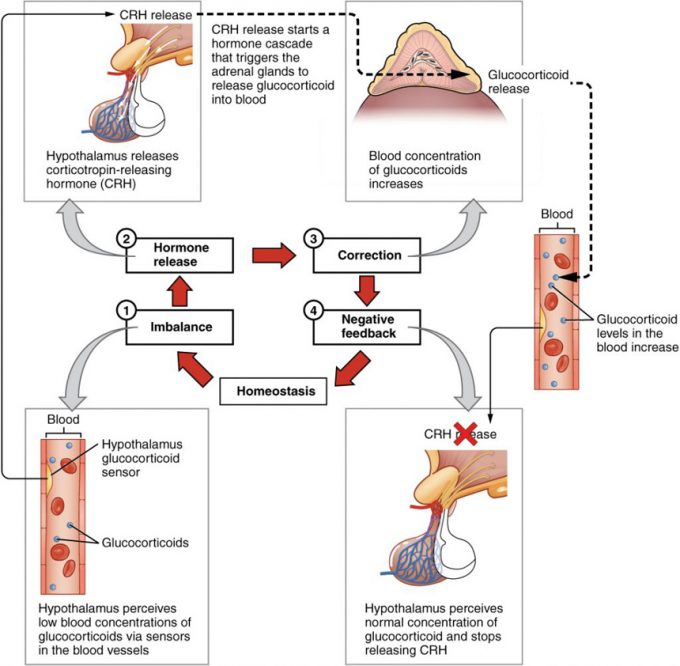
**Figure 17.23 – Binding of Water-Soluble Hormones:** Water-soluble hormones cannot diffuse through the cell membrane. These hormones must bind to a surface cell-membrane receptor. The receptor then initiates a cell-signaling pathway within the cell involving G proteins, adenylyl cyclase, the secondary messenger cyclic AMP (cAMP), and protein kinases. In the final step, these protein kinases phosphorylate proteins in the cytoplasm. This activates proteins in the cell that carry out the changes specified by the hormone.

Target Cell Response

Hormone Interaction

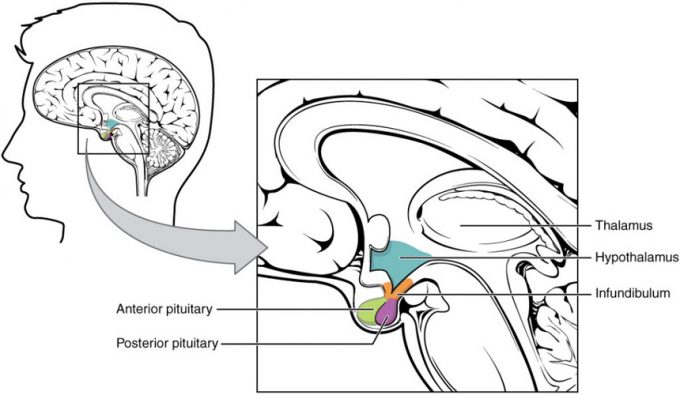
Control of Hormone Release

Homeostasis

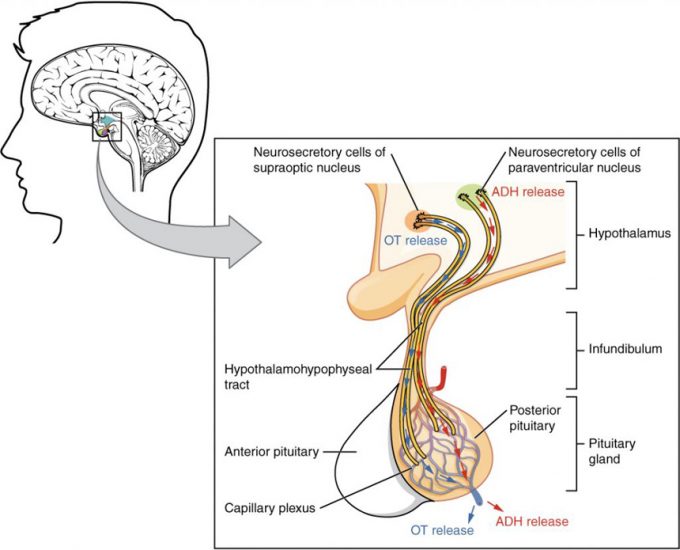


**Figure 17.24 – Negative Feedback Loop:** The release of adrenal glucocorticoids is stimulated by the release of hormones from the hypothalamus and pituitary gland. This signaling is inhibited when glucocorticoid levels become elevated by causing negative signals to the pituitary gland and hypothalamus.

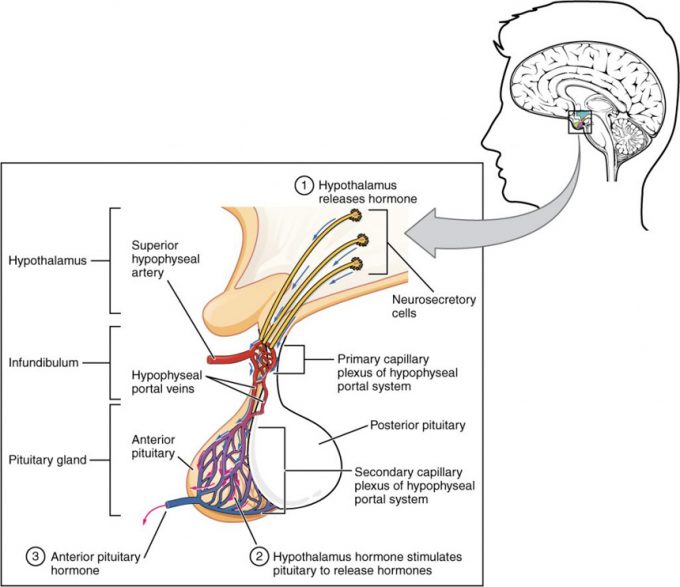
Role of Hypothalamus



**Figure 17.31 – Hypothalamus–Pituitary Complex:** The hypothalamus region lies inferior and anterior to the thalamus. It connects to the pituitary gland by the stalk-like infundibulum. The pituitary gland consists of an anterior and posterior lobe, with each lobe secreting different hormones in response to signals from the hypothalamus.

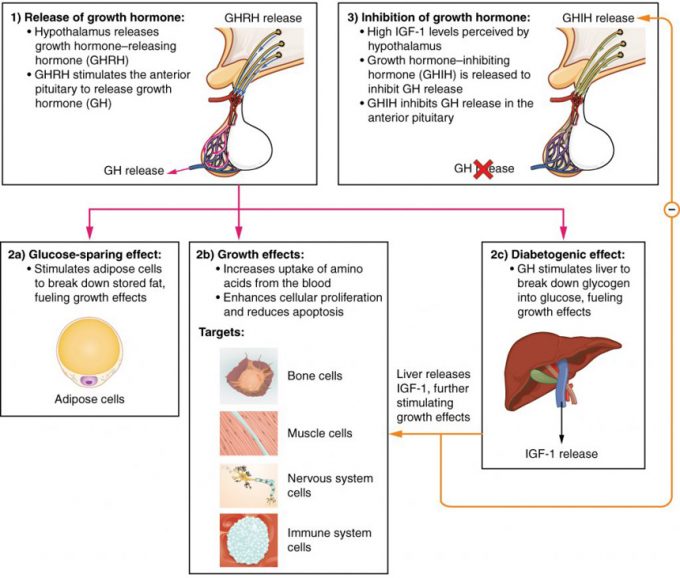


Pituitary Gland



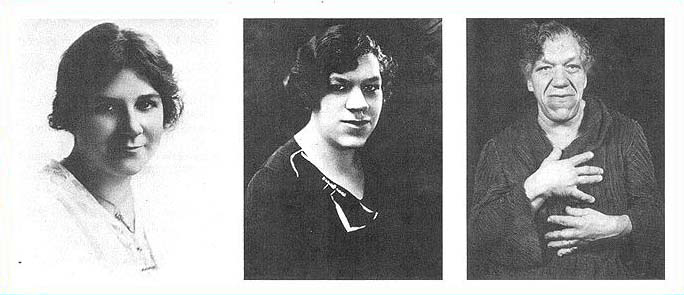
**Figure 17.33 – Anterior Pituitary:** The anterior pituitary manufactures seven hormones. The hypothalamus produces separate hormones that stimulate or inhibit hormone production in the anterior pituitary. Hormones from the hypothalamus reach the anterior pituitary via the hypophyseal portal system.

Growth Hormone

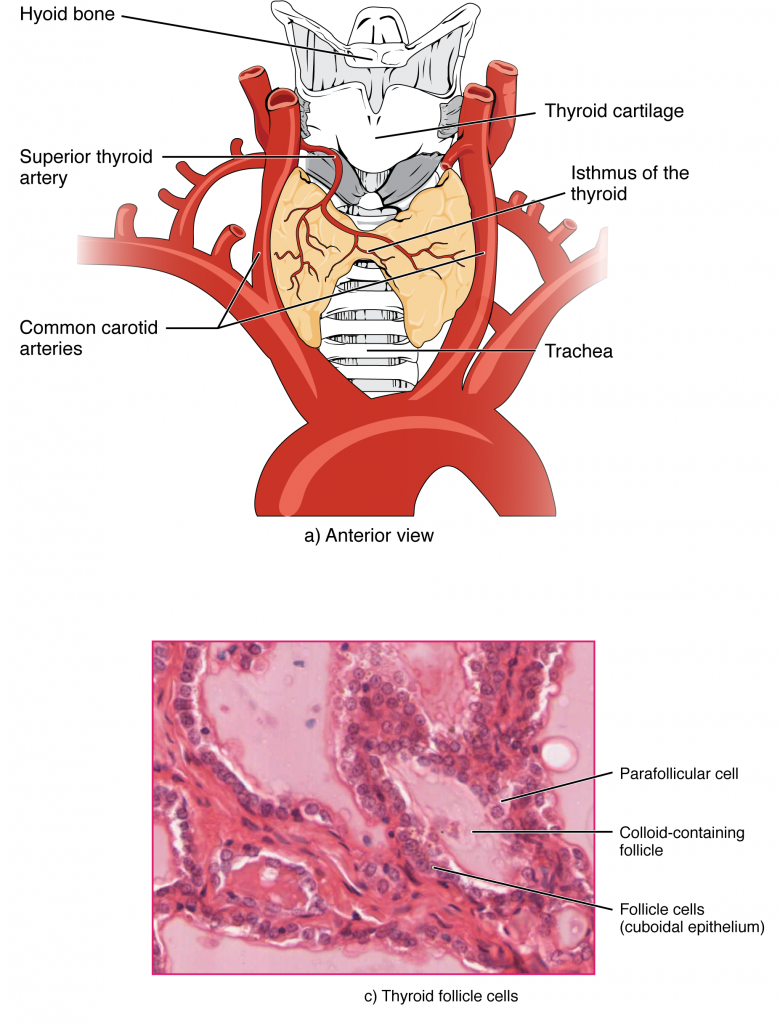


**Figure 17.34 – Hormonal Regulation of Growth:** Growth hormone (GH) directly accelerates the rate of protein synthesis in skeletal muscle and bones. Insulin-like growth factor 1 (IGF-1) is activated by growth hormone and indirectly supports the formation of new proteins in muscle cells and bone.

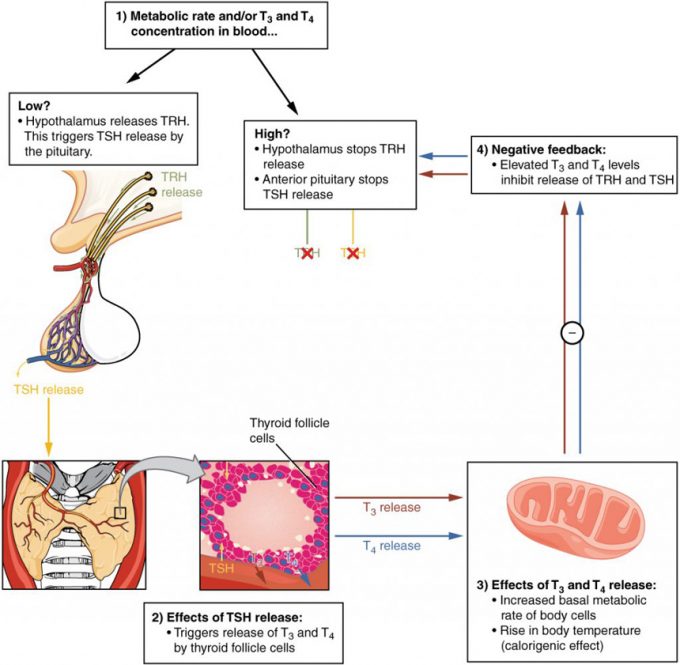




Thyroid Gland



**Figure 17.41 – Thyroid Gland:** The thyroid gland is located in the neck where it wraps around the trachea. (a) Anterior view of the thyroid gland. (b) Posterior view of the thyroid gland. (c) The glandular tissue is composed primarily of thyroid follicles. The larger parafollicular cells often appear within the matrix of follicle cells. LM × 1332. (Micrograph provided by the Regents of University of Michigan Medical School © 2012)



**Figure 17.42 – Classic Negative Feedback Loop:** A classic negative feedback loop controls the regulation of thyroid hormone levels.

Thyroid Hormones

Disorders



Regulation of Blood Calcium

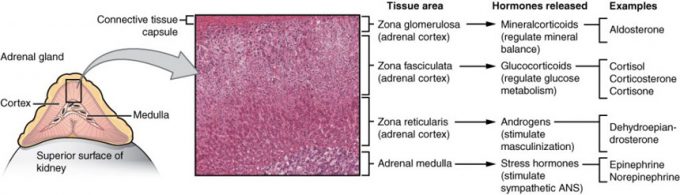


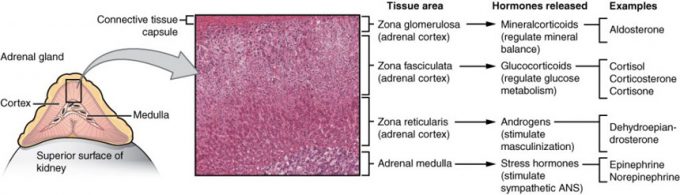
**Figure 17.51 – Parathyroid Glands:** The small parathyroid glands are embedded in the posterior surface of the thyroid gland. LM × 760. (Micrograph provided by the Regents of University of Michigan Medical School © 2012)

This diagram shows the role of parathyroid hormone in maintaining blood calcium homeostasis. When blood calcium concentration drops, chief cells of the parathyroid gland release parathyroid hormone (PTH). PTH affects bone, the kidneys and the intestines. In regards to bone, PTH inhibits osteoblasts and stimulates osteoclasts. This results in compact bone being broken down, as illustrated by an osteoclast burrowing into the surface of a bone. The break down releases calcium ions into a nearby blood vessel. The osteoblasts are inactive in this stage. In regards to the kidneys, PTH stimulates kidney tubule cells to recover waste calcium from the urine. PTH also stimulates kidney tubule cells to release calcitrol. This is illustrated with a cross section of a kidney tubule, showing the cells of the tubule wall. Urine is running to the left of the tubule wall cells while an artery is to the right. The right edge of the tubule wall cells and the left edge of the artery are separated by a small region of interstitial space. The cells are removing calcium from the urine and pumping it into the interstitial fluid, after which the calcium enters the artery. The cells are also pumping calcitrol into the blood vessel. In regards to the intestine, PTH stimulates the intestines to absorb calcium from digesting food. A cross section of an intestinal cell is shown, which is cube-shaped but with finger-like projections on the intestinal lumen side (top). Beneath the intestinal cell is an artery. Calcitrol is leaving the artery and entering the intestinal cell, stimulating it to absorb calcium from food in the intestinal lumen. The effects of PTH on bone, the kidneys and the intestines all cause blood calcium levels to increase. High calcium concentrations in the blood stimulate the parafollicular cells in the thyroid to release calcitonin. Calcitonin reverses the effects of PTH by stimulating osteoblasts and inhibiting osteoclasts in bone tissue. This is illustrated by calcium ions leaving a blood vessel and traveling to osteoblasts on a section of compact bone. The osteoblasts are thickening the compact bone layer while, in this stage, the osteoclasts are inactive.

**Figure 17.52 – Parathyroid Hormone in Maintaining Blood Calcium Homeostasis:** Parathyroid hormone increases blood calcium levels when they drop too low. Conversely, calcitonin, which is released from the thyroid gland, decreases blood calcium levels when they become too high. These two mechanisms constantly maintain blood calcium concentration at homeostasis.

Adrenal Glands

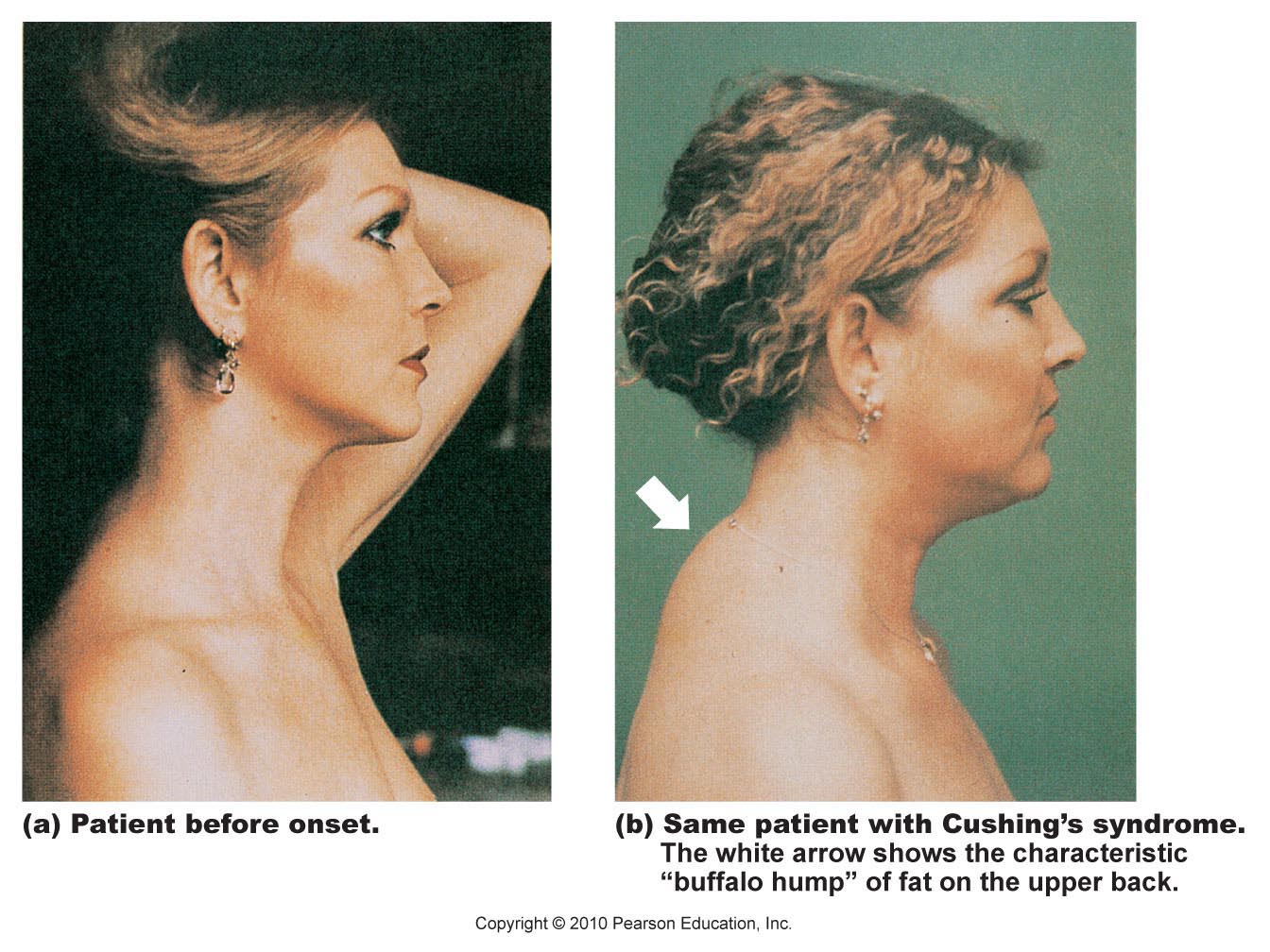




**Figure 17.61 – Adrenal Glands:** Both adrenal glands sit atop the kidneys and are composed of an outer cortex and an inner medulla, all surrounded by a connective tissue capsule. The cortex can be subdivided into additional zones, all of which produce different types of hormones. LM × 204. (Micrograph provided by the Regents of University of Michigan Medical School © 2012)

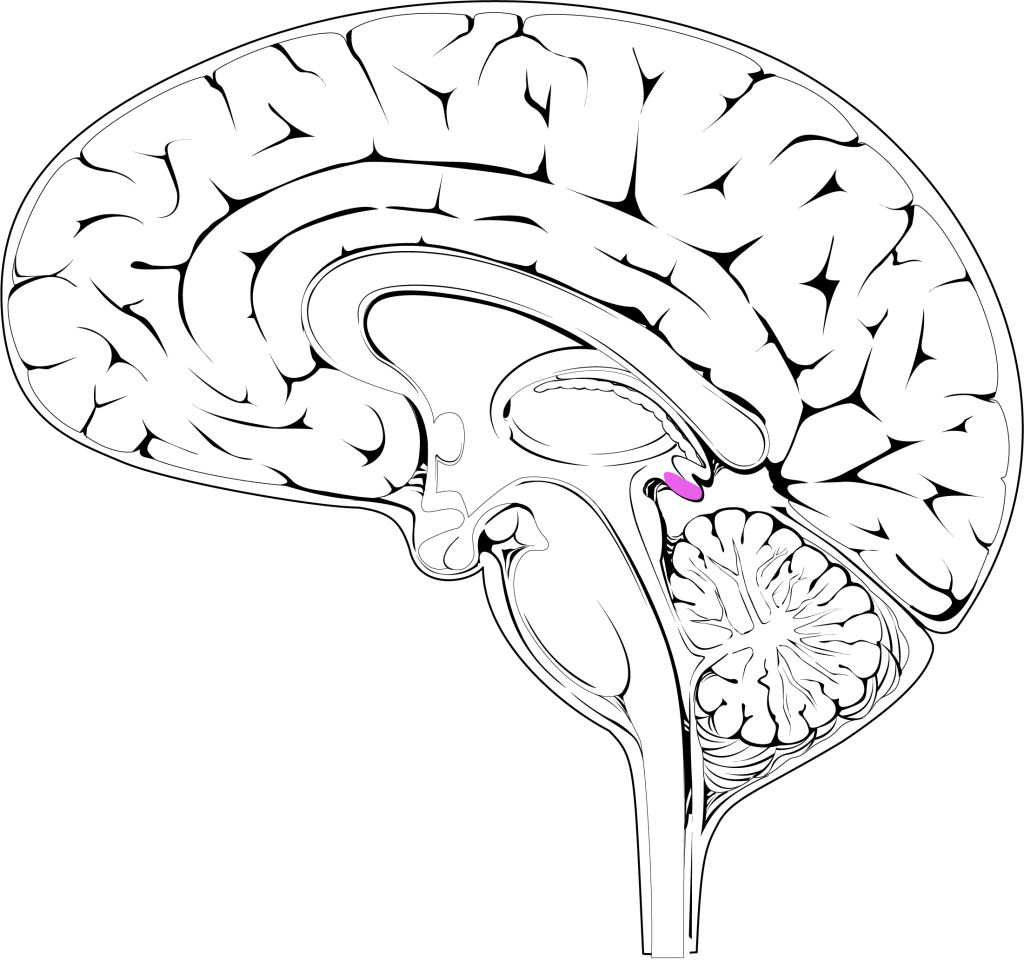
Mineralcorticoids

Glucocorticoids



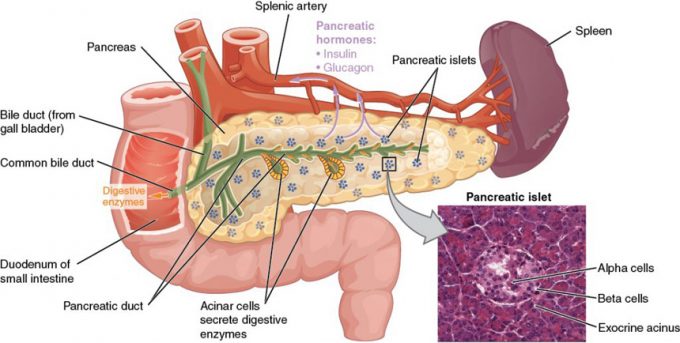
Gonadocorticoids

Pineal Gland

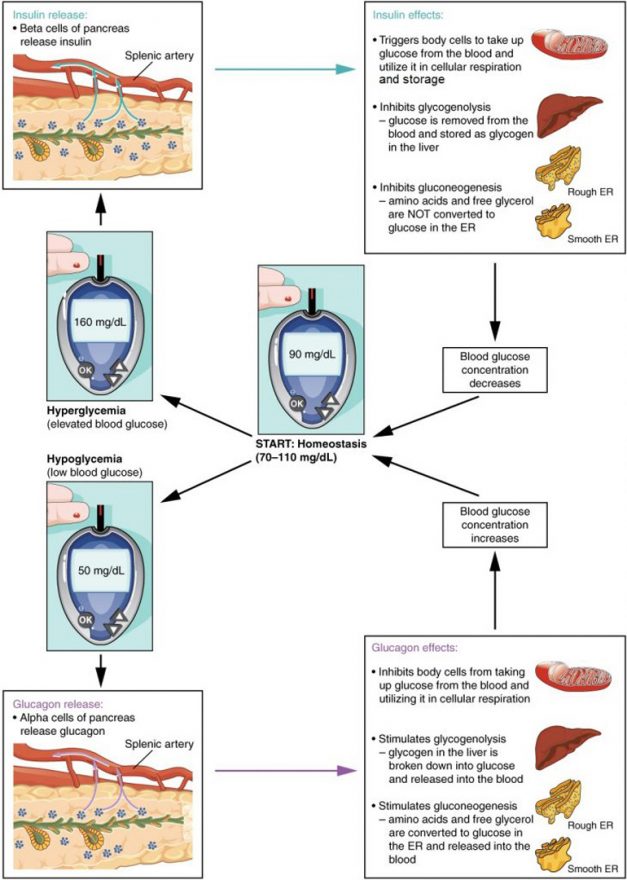


Gonadal and Placental Hormones

Pancreas



**Figure 17.91:** Pancreas endocrine function involves the secretion of insulin (produced by beta cells) and glucagon (produced by alpha cells) within the pancreatic islets. These two hormones regulate the rate of glucose metabolism in the body. The micrograph reveals pancreatic islets. LM × 760. Also shown are the exocrine acinar cells. (Micrograph provided by the Regents of University of Michigan Medical School © 2012)



Diabetes Mellitis

Other Organs

| **Organs with Secondary Endocrine Functions and Their Major Hormones (Table 8)** | | |
| --- | --- | --- |
| **Organ** | **Major hormones** | **Effects** |
| Heart | Atrial natriuretic peptide (ANP) | Reduces blood volume, blood pressure, and Na+ concentration |
| Gastrointestinal tract | Gastrin, secretin, and cholecystokinin | Aid digestion of food and buffering of stomach acids |
| Gastrointestinal tract | Glucose-dependent insulinotropic peptide (GIP) and glucagon-like peptide 1 (GLP-1) | Stimulate beta cells of the pancreas to release insulin |
| Kidneys | Renin | Stimulates release of aldosterone |
| Kidneys | Calcitriol | Aids in the absorption of Ca2+ |
| Kidneys | Erythropoietin | Triggers the formation of red blood cells in the bone marrow |
| Skeleton | FGF23 | Inhibits production of calcitriol and increases phosphate excretion |
| Skeleton | Osteocalcin | Increases insulin production |
| Adipose tissue | Leptin | Promotes satiety signals in the brain |
| Adipose tissue | Adiponectin | Reduces insulin resistance |
| Skin | Cholecalciferol | Modified to form vitamin D |
| Thymus (and other organs) | Thymosins | Among other things, aids in the development of T lymphocytes of the immune system |
| Liver | Insulin-like growth factor-1 | Stimulates bodily growth |
| Liver | Angiotensinogen | Raises blood pressure |
| Liver | Thrombopoetin | Causes increase in platelets |
| Liver | Hepcidin | Blocks release of iron into body fluids |



Endocrine Disrupting Chemicals