Endocrine Glands

- The *endocrine system* is made of glands & tissues that secrete hormones.

- *Hormones* are chemicals messengers influencing
  a. metabolism of cells
  b. growth and development
  c. reproduction,
  d. homeostasis.
Hormones

Hormones (*chemical messengers*) secreted into the bloodstream and transported by blood to specific cells (*target cells*)

Hormones are classified as

1. proteins (*peptides*)

2. Steroids
Hormone Classification

Steroid Hormones:
- Lipid soluble
- Diffuse through cell membranes
- Endocrine organs
  - Adrenal cortex
  - Ovaries
  - Testes
  - Placenta
Hormone Classification

- Nonsteroid Hormones:
  - Not lipid soluble
  - Received by receptors external to the cell membrane
  - Endocrine organs
    - Thyroid gland
    - Parathyroid gland
    - Adrenal medulla
    - Pituitary gland
    - Pancreas
Hormone Actions

“Lock and Key” approach: describes the interaction between the hormone and its specific receptor.
- Receptors for nonsteroid hormones are located on the cell membrane
- Receptors for steroid hormones are found in the cell’s cytoplasm or in its nucleus
There is a close assoc. b/w the endocrine & nervous systems.

Hormone secretion is usually controlled by either *negative feedback* or antagonistic hormones that oppose each other’s actions.
1. regulates the internal environment through the autonomic system

2. controls the secretions of the pituitary gland.
Hypothalamus & Pituitary Gland

posterior pituitary/ anterior pituitary
Posterior Pituitary

The *posterior pituitary* secretes

- **antidiuretic hormone (ADH)**
- **oxytocin**
Anterior pituitary gland

1. Human growth hormone (hGH) (Somatotropin)
2. Thyroid stimulating hormone (TSH)
3. Follicle-stimulating hormone (FSH)
4. Luteinizing hormone (LH)
5. Interstitial cell stimulating hormone (ICSH)
6. Prolactin (PRL): initiates milk production
7. Adrenocorticotropic hormone (ACTH):
Feedback inhibits release of hormone 1.

Hypothalamus

releasing hormone (hormone 1)

Anterior pituitary

stimulating hormone (hormone 2)

Target gland

target gland hormone (hormone 3)

Feedback inhibits release of hormone 2.
Hypothalamus and the pituitary
Effects of Growth Hormone

GH promotes bone and muscle growth.

*Pituitary dwarfism* results from too little GH during childhood.

*Giants* result from too much GH during childhood.

If growth hormone is overproduced in an adult, it causes *acromegaly*. 
Effect of growth hormone
Acromegaly
Thyroid and Parathyroid Glands

- The thyroid gland
- The four parathyroid glands are embedded in the posterior surface of the thyroid gland.
Thyroid Gland

- The thyroid gland requires iodine to produce *thyroxine* $(T_4)$ which contains four iodine atoms.
- *triiodothyronine* $(T_3)$ which contains three iodine atoms.
- Thyroid hormones increase:
  1. Oxygen use
  2. Cellular metabolism
  3. Growth & development
Effects of Thyroid Hormones

- If *iodine* is lacking in the diet, a *simple goiter* develops.

- Use of iodized salt helps prevent simple goiters.

- *Hypothyroidism* in childhood produces *cretinism*; in adulthood it causes *myxedema*.

- If the thyroid is overactive (Grave’s disease) an *exophthalmic goiter* develops.
Simple goiter
Cretinism
Thyroid Gland

Calcitonin

- which helps lower the blood calcium level when it is too high.
- deposits calcium in the bones
- regulates calcium homeostasis
Parathyroid hormone (PTH) stimulates the activity of osteoclasts, thus releasing calcium from bone, & stimulates the reabsorption of calcium by the kidneys and intestine.
Regulation of blood calcium level

- Thyroid gland secretes calcitonin into blood.
- Bones take up $\text{Ca}^{2+}$ from blood.
- Blood $\text{Ca}^{2+}$ lowers.
- Blood $\text{Ca}^{2+}$ rises.
- Intestines absorb $\text{Ca}^{2+}$ from digestive tract.
- Kidneys reabsorb $\text{Ca}^{2+}$ from kidney tubules.
- Bones release $\text{Ca}^{2+}$ into blood.
- Parathyroid glands release PTH into blood.

When blood $\text{Ca}^{2+}$ rises, calcitonin is secreted, which helps to lower blood calcium. Conversely, when blood $\text{Ca}^{2+}$ is low, parathyroid hormone (PTH) is released, which helps to raise blood calcium.
**Adrenal Glands**

- Cortex: corticosteroids - essential to life.
- Medulla: epinephrine and nor-epinephrine.
Adrenal Glands

- Adrenal glands sit atop the kidneys and have an inner adrenal medulla and an outer adrenal cortex.
- The hypothalamus uses ACTH-releasing hormone to control the anterior pituitary’s secretion of ACTH that stimulates the adrenal cortex.
- The hypothalamus regulates the medulla by direct nerve impulses.
The adrenal medulla secretes *epinephrine* and *norepinephrine*, which bring about responses we associate with emergency situations.

On a long-term basis, the adrenal cortex produces *glucocorticoids* similar to cortisone and *mineralocorticoids* to regulate salt and water balance.

The adrenal cortex also secretes both male and female sex hormones in both sexes.
Adrenal glands

Stress response: Short Term
- Heartbeat and blood pressure increase.
- Blood glucose level rises.
- Muscles become energized.

Stress response: Long Term

Glucocorticoids
- Protein and fat metabolism instead of glucose breakdown.
- Reduction of inflammation; immune cells are suppressed.

Mineralocorticoids
- Sodium ions and water are reabsorbed by kidney.
- Blood volume and pressure increase.
Glucocorticoids

- *Cortisol* promotes breakdown of muscle proteins to amino acids; the liver then breaks the amino acids into glucose.
- Cortisol also promotes metabolism of fatty acids rather than carbohydrates, which spares glucose.
- Both actions raise the blood glucose level.
- High levels of blood glucocorticoids can suppress immune system function.
Mineralocorticoids

- *Aldosterone* causes the kidneys to reabsorb sodium ions (Na\(^+\)) and excrete potassium ions (K\(^+\)).

- When blood sodium levels and blood pressure are low, the kidneys secrete renin; the effect of the renin-angiotensin-aldosterone system is to raise blood pressure.
Regulation of BP and Fluid volume

Heart secretes atrial natriuretic hormone (ANH) into blood.

Kidneys excrete Na⁺ and water in urine.

High blood Na⁺

Homeostasis, normal blood pressure

Low blood Na⁺

Kidneys reabsorb Na⁺ and water from kidney tubules.

Kidneys secrete renin into blood.

Aldosterone

Adrenal cortex secretes aldosterone into blood.

Angiotensin I and II

Renin
Malfunction of the Adrenal Cortex

- *Addison disease* develops when the adrenal cortex hyposecretes hormones.

- A bronzing of the skin follows low levels of cortisol, and mild infection can lead to death; aldosterone is also hyposecreted, and dehydration can result.
Addison disease
Malfunction of the Adrenal Cortex

- *Cushing syndrome* develops when the adrenal cortex hypersecretes cortisol.

- The trunk and face become round; too much aldosterone results in fluid retention.
Cushing syndrome
The pancreas is between the kidneys and the duodenum and provides digestive juices and endocrine functions.

Pancreatic islets secrete insulin, which lowers the blood glucose level, and glucagon, which has the opposite effect, together regulating the glucose level in the blood.
Regulation of blood glucose level

- Pancreas secretes insulin into blood.
- Insulin
  - Liver stores glucose from blood as glycogen.
  - Muscle cells store glycogen and build protein.
  - Adipose tissue uses glucose from blood to form fat.
- High blood glucose
  - Homeostasis normal blood glucose
- Low blood glucose
  - Liver breaks down glycogen to glucose. Glucose enters blood.
  - Adipose tissue breaks down fat.
  - Pancreas secretes glucagon into blood.
- In between eating
  - Glucagon
Diabetes Mellitus

- The most common illness due to hormonal imbalance is *diabetes mellitus*.

- Diabetes is due to the failure of the pancreas to produce insulin or the inability of the body cells to take it up.

- *Causing Hyperglycemia*
Diabetes Mellitus

- *Type I diabetes mellitus* occurs when the pancreas does not produce insulin.

- *Type II diabetes mellitus* where the pancreas produces insulin but the body cells do not respond.
Testes and Ovaries

Testes, hormone *testosterone*. Ovaries produce *estrogens* and *progesterone*.

- Secretions from the gonads are controlled by the anterior pituitary hormones.
- These sex hormones maintain the sex organs and secondary sex characteristics.
The effects of anabolic steroid use

- Balding in men and women; hair on face and chest in women
- Deepening of voice in women
- Severe acne
- Breast enlargement in men and breast reduction in women
- Kidney disease and retention of fluids, called "steroid bloat"
- Reduced testicular size, low sperm count, and impotency
- Liver dysfunction and cancer
- In women, increased size of ovaries; cessation of ovulation and menstruation
- Stunted growth in youngsters by prematurely halting fusion of the growth plates
- 'roid mania—delusions and hallucinations; depression upon withdrawal
- High blood cholesterol and atherosclerosis; high blood pressure and damage to heart
Thymus Gland

- The thymus under the sternum produces *thymosins* that stimulate T lymphocyte production and maturation.

- The thymus decreases in size with age and becomes fatty.
The pineal gland in the brain produces melatonin which is involved in circadian rhythms and the timing of development of the reproductive organs.
The Endocrine Glands

- Kidneys (erythropoietin)
  - regulates red blood cell production
Hormones from Other Tissues

Leptin

- Adipose tissue produces leptin that acts on the hypothalamus where it signals satiety—that the individual feels “full” and has had enough to eat.
Prostaglandins

- Prostaglandins are a fatty acid.

- They cause uterine muscle contraction and are involved in the pain of menstrual cramps
A chemical signal is any substance that affects cell metabolism or behavior of the individual. Chemical signals can be used between body parts, between cells, and between individual organisms (pheromones). Underarm secretions may be slightly attractive and may be involved in synchronizing the menstrual cycles of women who live together.
The Action of Hormones

- **Steroid hormones** enter the nucleus and combine with a receptor protein, and the hormone-receptor complex attaches to DNA and activates certain genes.

- **Peptide hormones** are usually received by a hormone receptor protein located in the plasma membrane.
Student Quiz

http://www.zerobio.com/drag oa/endo.htm