LESSON 1.3

Homeostasis

Living things maintain a relatively stable internal environment, a process known as homeostasis. For most organisms, any breakdown of homeostasis may have serious or even fatal consequences.

UNIT ENDURING UNDERSTANDING:
The human body is a complex system. The coordinated functions of its many structures support life processes and maintain homeostasis.

C-34 BIG IDEA:
Endocrine glands release hormones that influence the action of target cells. The hypothalamus acts as a master regulator and has direct or indirect influence over many of the other glands.

Chapter 34 EQ:
How does the body use chemical signals to maintain homeostasis?

34.1 GQ: How does the body send and receive chemical signals?

34.2 GQ: What life processes are regulated by hormones?

34.3 GQ: What body structures enable humans to produce offspring?

34.4 GQ: How does a human develop from a single cell to a newborn baby?
Lesson Objectives

- Describe the structure and function of the endocrine system.
- Explain how hormones work.

Lesson Summary

**Hormones and Glands** The endocrine system is made up of endocrine glands that release hormones into the blood.

- **Hormones** are chemicals made in one part of the body that affect cells in other parts of the body. Hormones travel throughout the body in the bloodstream.
  - Hormones bind to **target cells**, which are cells that have specific receptors for a hormone either in the cell membrane or inside the cell.
  - A hormone will not affect a cell that does not have receptors for the hormone.

- Glands are organs that release secretions. The body has two types of glands.
  - **Exocrine glands** release their secretions through ducts either outside the body or into the digestive system.
  - **Endocrine glands** release hormones directly into the bloodstream. Other structures that are not usually considered glands, such as bones, fat tissue, the heart, and the small intestine, also produce and release hormones.

- All cells, except for red blood cells, produce hormonelike substances called **prostaglandins**. Prostaglandins are modified fatty acids that usually affect only nearby cells and tissues. They are sometimes called “local hormones.”

**Hormone Action** There are two types of hormones.

- Steroid hormones are produced from cholesterol. They can cross cell membranes of target cells, bind with their receptors, and enter the nucleus. The hormone-receptor complexes change the expression of genes in the target cell, often resulting in dramatic changes in the cell’s activity.

- Nonsteroid hormones can be proteins, small peptides, or modified amino acids. They cannot cross cell membranes. The receptors for nonsteroid hormones are on the cell membrane. Compounds called secondary messengers carry the messages of nonsteroid hormones inside target cells.
34.2 Glands of the Endocrine System

Lesson Objectives
- Identify the functions of the major endocrine glands.
- Explain how endocrine glands are controlled.

Lesson Summary

**The Human Endocrine Glands** Endocrine glands are scattered throughout the body.

- **The pituitary gland** is a bean-size structure at the base of the brain. Consisting of two parts, the anterior pituitary and the posterior pituitary, it secretes hormones that regulate body functions and control the actions of other endocrine glands.

- The hypothalamus controls the secretions of the pituitary gland and is the link between the central nervous system and the endocrine system. The hypothalamus controls the posterior pituitary through neurosecretory cells. The hypothalamus produces **releasing hormones** that control the secretions of the anterior pituitary.

- An adrenal gland sits on top of each kidney. The adrenal glands make hormones that help the body prepare for and deal with stress. They consist of a cortex and a medulla.
  - The adrenal cortex produces more than two dozen **corticosteroids**, which help maintain homeostasis.
  - The adrenal medulla produces the “fight or flight” hormones **epinephrine** and **norepinephrine**, which help the body respond to stress.

- The pancreas is both an exocrine gland and an endocrine gland. As an exocrine gland, the pancreas releases digestive enzymes.

- Insulin and glucagon, hormones produced by the islets of Langerhans in the pancreas, help keep levels of glucose in the blood stable.

- The thyroid gland wraps around the trachea at the base of the neck. The four parathyroid glands are on the back surface of the thyroid gland. **Thyroxine**, produced by the thyroid gland, regulates metabolism. A hormone from the thyroid gland, **calcitonin**, and one from the parathyroid glands, **parathyroid hormone**, work together to maintain blood calcium levels.

- Reproductive glands, or gonads, make gametes and secrete sex hormones. The female gonads, ovaries, produce eggs. The male gonads, testes, produce sperm.

**Control of the Endocrine System** Feedback mechanisms involving hormones help maintain homeostasis. In feedback inhibition, increasing levels of a substance inhibit the process that produced the substance. Secretions of the hypothalamus and pituitary gland regulate the activity of other endocrine glands in this way.

- Actions of the hypothalamus and posterior pituitary gland regulate water balance. The hypothalamus signals the posterior pituitary gland to increase (in the case of dehydration) or decrease (in the case of overhydration) its release of anti-diuretic hormone (ADH). In response to ADH levels the kidneys produce less or more urine.

- The hypothalamus and anterior pituitary regulate metabolism and body temperature by controlling the amount of thyroxine produced by the thyroid gland.
34.3 The Reproductive System

Lesson Objectives
- Describe the effects the sex hormones have on development.
- Name and discuss the structures of the male reproductive system.
- Name and discuss the structures of the female reproductive system.
- Describe some of the most common sexually transmitted diseases.

Lesson Summary

Sexual Development  Hormones released by the ovaries and testes cause sexual development during puberty, a period of rapid growth and sexual maturation that usually starts between the ages of 9 and 15. At the end of puberty, the male and female reproductive organs are fully developed and become fully functional.

The Male Reproductive System  The main role of the male reproductive system is to make and deliver sperm.
- The testes are the main organs of the male system. Two testes are held in an external sac called the scrotum. The testes make sperm in tiny tubes called seminiferous tubules. The sperm mature and are stored in an epididymis. A tube called a vas deferens carries sperm from each testis to the urethra within the penis.
- Along the way, secretions of several glands form a nutrient-rich fluid called seminal fluid. The combination of sperm and seminal fluids is called semen. Semen leaves the body through the urethra. Contractions eject semen from the penis in a process called ejaculation.
- A mature sperm cell consists of a head that contains the nucleus, a midpiece that is packed with mitochondria, and a flagellum that propels the sperm.

The Female Reproductive System  The main roles of the female reproductive system are to make eggs and prepare the female body to nourish an embryo.
- The ovary is the main organ of the female system. Each ovary has thousands of follicles, which are clusters of cells that surround an egg. A mature egg moves through the Fallopian tube to the uterus, which is connected to the outside of the body by the vagina.
- Beginning in puberty, the female body goes through a menstrual cycle, a series of events that prepares the body to care for a fertilized egg. The menstrual cycle has four phases:
  - Follicular phase: An egg matures in its follicle.
  - Ovulation: The mature egg is released from the ovary.
  - Luteal phase: The follicle develops into a structure called the corpus luteum.
  - Menstruation: The lining of the uterus falls away and leaves the body through the vagina if the egg is not fertilized.

Sexually Transmitted Diseases  A disease spread during sexual contact is called a sexually transmitted disease (STD). Bacteria and viruses can cause STDs. Chlamydia, syphilis, gonorrhea, and AIDS are STDs.
34.4 Fertilization and Development

Lesson Objectives

- Describe fertilization and the early stages of development.
- Identify the major events of later stages of development.

Lesson Summary

**Fertilization and Early Development**  Fertilization is the joining of a sperm and an egg. Following fertilization, a series of events called development begins.

- A fertilized egg is called a **zygote**. The zygote divides and undergoes repeated rounds of mitosis and develops into a hollow ball of cells called a **blastocyst**.
- About a week after fertilization, the blastocyst attaches to the wall of the uterus in the process of **implantation**. At the same time, cells of the blastocyst start to specialize through differentiation. Some cells migrate to form two cell layers—the ectoderm and the endoderm.
- A third layer of cells is produced by a process called **gastrulation**, in which cells from the ectoderm migrate to form the mesoderm. The three layers eventually develop into the different organs of the embryo.
- During **neurulation**, the notochord and the neural tube form. The neural tube eventually develops into the brain and spinal cord.
- As the embryo develops, membranes for protection and nourishment also form. Part of one membrane combines with the uterine lining to form the **placenta**. Mother and embryo/fetus exchange gases, food, and waste products across the placenta. The umbilical cord connects the embryo/fetus to the placenta.
- After eight weeks of development, the embryo is called a **fetus**. By the end of three months, most organs are fully formed.

**Later Development**  Another six months of development occurs before birth.

- During months 4–6, the fetus’s tissues become specialized and organs such as the heart begin to function.
- During months 7–9, the fetus’s organ systems mature as the fetus grows in size and mass. The lungs and the central nervous system complete their development.
- Childbirth occurs about nine months after fertilization, when hormones cause contractions in the mother’s uterus. The contractions first push the baby out through the vagina. Then, more contractions expel the placenta and amniotic sac from the uterus. Shortly after birth, the mother’s breast tissue begins to produce milk that contains everything the baby needs for the first months of life.
- The placenta is a barrier to many harmful agents, but some are able to pass through it, such as viruses that cause AIDS and German measles. Alcohol, drugs, and smoking also have negative effects on embryos and fetuses. Prenatal care and advancements in medical technology have lowered the infant mortality rate.