# Chapter 19

# The Human Body

## 19.1 Lesson 19.1: Organization of the Human Body

### Lesson Objectives

- Describe the levels of organization of the human body.
- Outline the role of a specialized cell.
- Identify the properties that make body cells and stem cells different from each other.
- List three types of stem cells.
- Identify the four tissue types found in the human body.
- Summarize how tissues and organs relate to each other.
- Name two body systems that work together for a common purpose.

### Introduction

In most multicellular organisms, not all cells are alike. For example, the cells that make up your skin are different from cells that make up your liver, your blood, or your eyes. Yet, all these specialized cells develop from one single fertilized egg which means all of your cells have the same DNA. But liver, blood, and eye cells are very different from each other in form and function. While these cells are specialized for a specific job, there are other cells in the body that remain unspecialized. These cells multiply continuously to replace the millions of different body cells that die and need to be replaced every day.

### Cells

**Cells** are the most basic units of life in your body. Each specialized cell has a specific function in the body. For example, nerve cells transmit electrical messages around the body,

and white blood cells patrol the body and attack invading bacteria. Other cells include specialized cells in the kidney (such as kidney glomerulus parietal cell), brain cells (such as astrocytes), stomach cells (such as parietal cells), and muscle cells (such as red and white skeletal muscle fibers). Cells group together in tissues to carry out a specific function, and different tissues work together to form organs. This grouping of cells and tissues is referred to as levels of organization. Complex multicellular organisms, which include flatworms and humans, have different levels of organization.

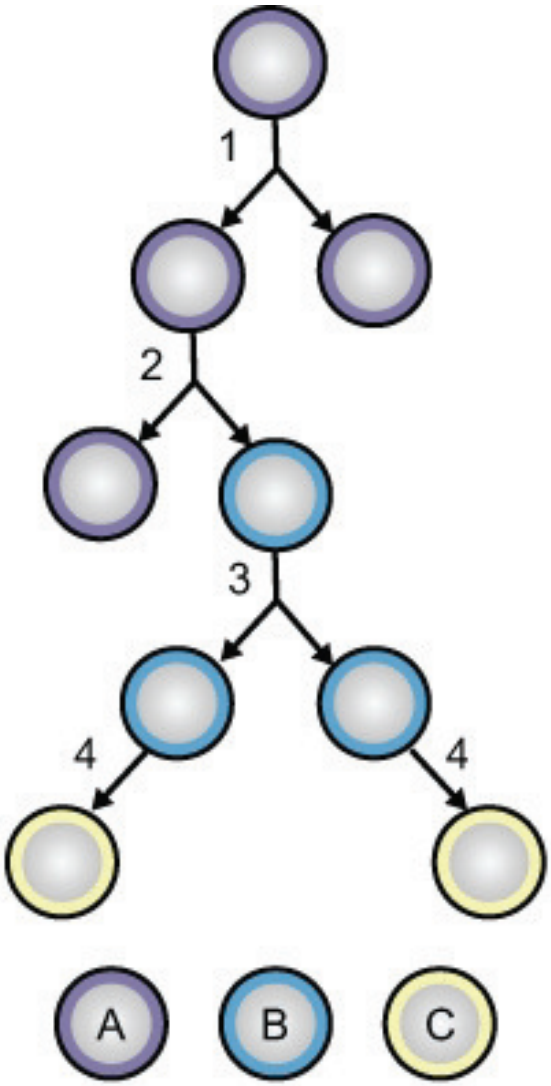
## Differentiation

Every cell in the body originated from a single fertilized egg, which is called a zygote. The zygote divides many times to produce an embryo. These embryonic cells differentiate into many different cell types which in time give rise to all the cells types present in the body of all humans (and other mammals), from a new-born baby to an elderly adult. **Differentiation** is the process by which an unspecialized cell (such as a fertilized egg cell), divides many times to produce specialized cells that work together and make up the body. During differentiation, certain genes are turned on, or become activated, while other genes are switched off, or inactivated. This process is regulated by the cell. A differentiated cell will develop specific structures and perform certain functions.

A cell that is able to differentiate into all cell types within a body is called **totipotent**. They have "total potential" to differentiate into any cell type. In mammals, only the zygote and early embryonic cells are totipotent. A cell that is able to differentiate into many cell types, but not all, is called **pluripotent**. Such cells have "plural potential," (but not "total potential") to differentiate into most but not all cell types.

## Stem Cells

An unspecialized cell that can divide many times and give rise to different, specialized cells is called a **stem cell**, as shown in **Figure** 19.1. Zygotes and embryonic cells are both types of stem cells. The stem cells found in embryos can divide indefinitely, can specialize into any cell type and are called **embryonic stem cells**. Embryonic stem cells are totipotent. Undifferentiated cells that are found within the body and that divide to replace dying cells and damaged tissues are called **adult stem cells**. Adult stem cells can divide indefinitely, and generate all the cell types of the organ from which they originate. They can potentially re-grow the entire organ from just a few cells. A third type of stem cell is found in blood from the umbilical cord of a new-born baby, and the placenta. These "cord blood stem cells" are considered to be adult stem cells because they cannot generate all body cell types, just different types of blood cells. Therefore, adult stem cells and cord blood stem cells are pluripotent.




A–Embryonic stem cells (purple)
B–adult stem cell (blue)
C–differentiated cell (yellow)
1–embryonic stem cell division to make more stem cells
2–totipotent embryonic stem cells can produce pluripotent adult stem cells
3–adult stem cells divide, and eventually differentiate into specialized cells. (4)

Figure 19.1: Division and differentiation of stem cells into specialized cells. (5)

## Stem Cells in Medicine

Stem cells are of great interest to researchers because of their ability to divide indefinitely, and to differentiate into many cell types. Stem cells have many existing or potential therapeutic applications. Such therapies include treatments for cancer, blood disorders, brain or spinal cord injuries, and blindness.

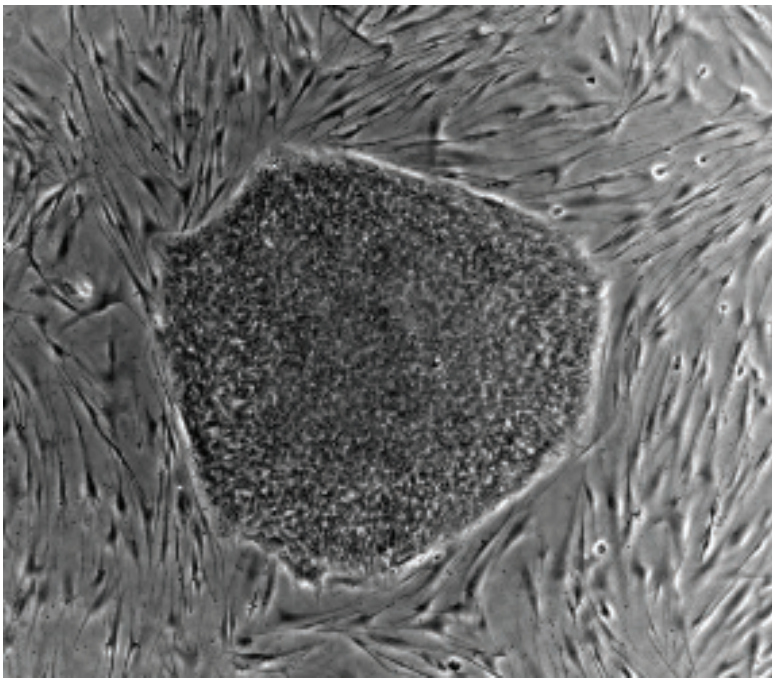


Figure 19.2: Human embryonic stem cell colony, which was grown in a laboratory on a feeder layer of mouse cells. Embryonic stem cells are totipotent. A video of human embryonic stem cell and their uses is available at http://www.sumanasinc.com/webcontent/animations/content/stemcells_scnt.html. An animation of stem cell procedures is available at http://www.pbs.org/newshour/health/stem_cells.swf. (3)

Embryonic stem cells, as shown in **Figure** 19.2, are taken from eggs that were fertilized in the laboratory and donated to research. They may have the greatest potential because they are totipotent, and thus have the most potential medical applications. However, embryonic stem cells harvested from a donated embryo differ from a potential patient's tissue type. Therefore, just as in organ transplantation, there is a risk of a patient's body rejecting transplanted embryonic stem cells. Some individuals and groups have objections to the harvesting of embryonic stem cells, because harvesting the stem cells involves the destruction of the embryo. Some researchers are looking into methods to extract embryonic stem cells without destroying the actual embryo. Other researchers have claimed success in harvesting embryonic stem cells from the embryonic fluid that surrounds a growing fetus.

Adult stem cells, including cord blood stem cells, have already been used to treat diseases

of the blood such as sickle-cell anemia and certain types of cancer. Unlike embryonic stem cells, the use of adult stem cells in research and therapy is not controversial because the production of adult stem cells does not require the destruction of an embryo. Adult stem cells can be isolated from a tissue sample, such as bone marrow, from a person. Scientists have recently discovered more sources of adult stem cells in the body. Adult stem cells have been found in body fat, the inside lining of the nose, and in the brain. Some researchers are investigating ways to revert adult stem cells back to a totipotent stage.

## Tissues

A **tissue** is a group of connected cells that have a similar function within an organism. The simplest living multicellular organisms, sponges, are made of many specialized types of cells that work together for a common goal. Such cell types include digestive cells, tubular pore cells, and epidermal cells. Though the different cell types create a large organized, multicellular structure—the visible sponge—they are not organized into true tissues. If a sponge is broken up by passing it through a sieve, the sponge will reform on the other side.

More complex organisms such as jellyfish, coral, and sea anemones have a tissue level of organization. For example, jellyfish have tissues that have separate protective, digestive, and sensory functions. There are four basic types of tissue in the body of all animals, including the human body. These make up all the organs, structures and other contents of the body. **Figure** 19.3 shows an example of each tissue type.

The four basic types of tissue are:

- **Epithelial tissue** is made up of layers of tightly packed cells that line the surfaces of the body for protection, secretion, and absorption. Examples of epithelial tissue include the skin, the lining of the mouth and nose, and the lining of the digestive system.
- **Muscle tissue** is made up of cells contain contractile filaments that move past each other and change the size of the cell. There are three types of muscle tissue: smooth muscle which is found in the inner linings of organs; skeletal muscle, which is attached to bone and moves the body; and cardiac muscle which is found only in the heart.
- **Nervous tissue** is made up of the nerve cells (neurons) that together form the nervous system, including the brain and spinal cord.
- **Connective tissue** is made up of many different types of cells that are all involved in structure and support of the body. Bone, blood, fat, and cartilage are all connective tissues. Connective tissue can be densely packed together, as bone cells are, or loosely packed, as adipose tissue (fat cells) are.

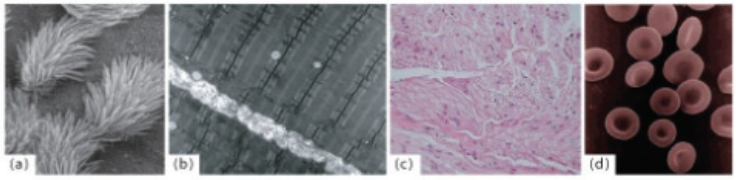



Figure 19.3: (a) Scanning electron micrograph (SEM) image of lung trachea epithelial tissue, (b) Transmission electron micrograph (TEM) image of skeletal muscle tissue, (c) Light microscope image of neurons of nervous tissue, (d) red blood cells, a connective tissue. (9)

## Organs and Organ Systems

Organs are the next level of organization in the body. An **organ** is a structure made of two or more tissues that work together for a common purpose. Skin, the largest organ in the body, is shown in **Figure** 21.41. Organs can be as primitive as the brain of a flatworm (a group of nerve cells), as large as the stem of a sequoia (up to 90 meters in height (300 feet)), or as complex as a human liver. The human body has many different organs, such as the heart, the kidneys, the pancreas, and the skin. Two or all of the tissue types can be found in an organ. Organs inside the body are called internal organs. The internal organs collectively are often called viscera.

The most complex organisms have organ systems. An **organ system** is a group of organs that act together to carry out complex interrelated functions, with each organ focusing on a part of the task. An example of an organ system is the human digestive system in which the mouth and esophagus ingests food, the stomach crushes and liquefies it, the pancreas and gall bladder make and release digestive enzymes, and the intestines absorb nutrients into the blood. An organ can be part of more than one organ system. For example the ovaries produce hormones which make them a part of the endocrine system. The ovaries also make eggs which makes them part of the reproductive system. One of the most important functions of organ systems is to provide cells with oxygen and nutrients and removes toxic waste products such as carbon dioxide. A number of organ systems, including the cardiovascular and respiratory systems, work together to do this.

The different organ systems of the body are shown in **Table** 19.1. Sometimes the cardiovascular system and the lymphatic system are grouped together into one single system called the circulatory system.

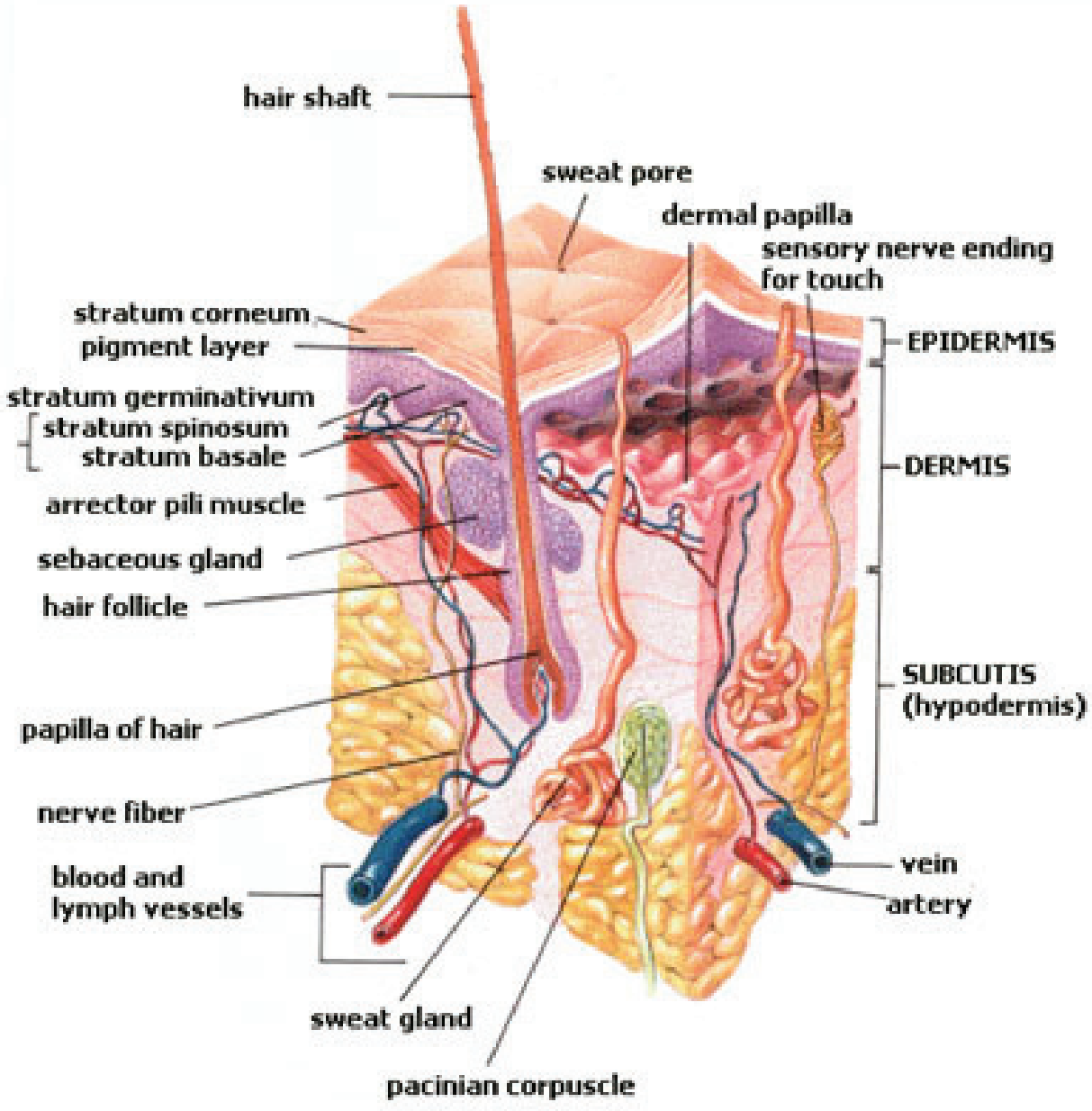



Figure 19.4: Your skin is the largest organ in your body. In this cross section image of skin, the four different tissue types (epithelial, connective, nervous, and muscle tissues) can be seen working together. (10)

Table 19.1: **Major Organ Systems of the Human Body**

| Organ System | Function | Organs, Tissues, and Structures Involved |
|---|---|---|
| Cardiovascular | Transporting oxygen, nutrients and other substances to the body cells, and wastes, carbon dioxide, and other substances away from cells; it can also help stabilize body temperature and pH | Heart, blood, blood vessels |
| Lymphatic | Defense against infection and disease, transfer of lymph between tissues and the blood stream | Lymph, lymph nodes, lymph vessels |
| Digestive | Processing of foods and absorption of nutrients, minerals, vitamins, and water | Salivary glands, esophagus, stomach, liver, gallbladder, pancreas, small intestine, large intestine |
| Endocrine | Communication within the body with hormones; directing long-term change over other organ systems to maintain homeostasis | Among many, the pituitary gland, pineal gland, thyroid, parathyroid gland, adrenal glands, testes, and ovaries |
| Integumentary | Protection from injury and fluid loss; physical defense against infection by microorganisms; temperature control | Skin, hair, and nails |
| Muscular | Movement, support, heat production | Skeletal, cardiac, and smooth muscles, tendons |
| Nervous | Collecting, transferring and processing information; directing short-term change over other organ systems in order to maintain homeostasis | Brain, spinal cord, nerves, and sense organs (eyes, ears, tongue, skin, nose) |
| Reproductive | Production of gametes (sex cells) and sex hormones; production of offspring | Fallopian tubes, uterus, vagina, ovaries, mammary glands, testes, vas deferens, seminal vesicles, prostate, and penis |

Table 19.1: (continued)

| Organ System | Function | Organs, Tissues, and Structures Involved |
|---|---|---|
| Respiratory | Delivery of air to sites where gas exchange can occur between the blood and cells (around body) or blood and air (lungs) | Mouth, nose, pharynx, larynx, trachea, bronchi, lungs, and diaphragm |
| Skeletal | Support and protection of soft tissues of body; movement at joints; production of blood cells; mineral storage | Bones, cartilage, ligaments |
| Urinary | Removal of excess water, salts, and waste products from blood and body; control of pH | Kidneys, ureters, urinary bladder, and urethra |
| Immune | Defending against microbial pathogens (disease-causing agents) and other diseases | Leukocytes, tonsils, adenoids, thymus, and spleen |

## Lesson Summary

- Not all cells are alike in a multicellular organism, but all of the cells in a multicellular organism have the same DNA.
- Each specialized cell has a specific function in the body. Specialized cells group together to carry out a specific function.
- Every cell in the body originated from a single zygote. The unspecialized zygote differentiates to produce specialized cells that work together and make up the body.
- A cell that is able to differentiate into all cell types within a body is totipotent. Embryonic stem cells are totipotent.
- A cell that is able to differentiate into many cell types, but not all types, is pluripotent. Adult stem cells and cord blood stem cells are pluripotent.
- A tissue is a group of connected cells that have a similar function within an organism. There are four basic types of tissue in the body of all animals: connective, muscle, nervous, and epithelial.
- An organ is a structure made of two or more different types of tissue that work together for a common purpose.
- An organ system is a group of organs that act together to carry out complex related functions, with each organ focusing on a part of the task.

## Review Questions

1. Give three examples of specialized cells.
2. Contrast specialized cells and stem cells.
3. Name three sources of stem cells.
4. List the four tissue types that are found in the human body, and give an example of each type.
5. These cells form the lining of the trachea. Identify the cells and the type of tissue of which the ciliated cells in **Figure** 19.5 are a part.

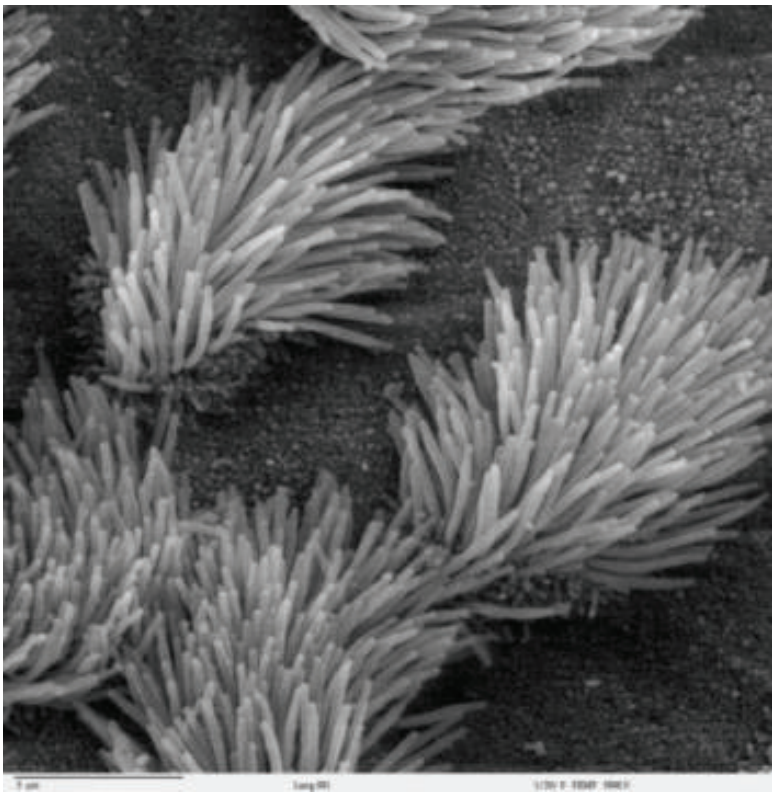


Figure 19.5: (4)

6. Summarize the relationship between tissues and organs.
7. Identify an organ that is part of two body systems.
8. A classmate says that the lymphatic system should not be an organ system in its own right, and is a part of the cardiovascular system. Do you agree or disagree with your classmate? Explain your answer by using your knowledge of organ systems.

## Further Reading / Supplemental Links

- *Human Anatomy* ©2003 by Fredric H. Martini, Inc. and Michael J.Timmons. Published by Pearson Education, Inc.
- http://web.jjay.cuny.edu/~acarpi/NSC/14-anatomy.htm
- http://en.wikipedia.org

## Vocabulary

**adult stem cells** Undifferentiated cells that are found within the body and that divide to replace dying cells and damaged tissues.

**cell** The most basic unit of life; basic unit of structure and function in living organisms.

**differentiation** The process by which an unspecialized cell (such as a fertilized egg cell), divides many times to produce specialized cells that work together and make up the body.

**embryonic stem cells** Stem cells found in embryos that can divide indefinitely, and specialize into any cell type.

**organ** A structure made of two or more tissues that work together for a common purpose.

**organ system** A group of organs that act together to carry out complex interrelated functions, with each organ focusing on a part of the task.

**pluripotent** A term that describes a cell that is able to differentiate into many cell types, but not all, within a body.

**stem cell** An unspecialized cell that can divide many times and give rise to different, specialized cells is called a stem cell.

**tissue** A group of connected cells that have a similar function within an organism.

**totipotent** A term that describes a cell that is able to differentiate into all cell types within a body.

## Points to Consider

- The smallest unit capable of carrying out life processes in your body is a single cell. Cells organize into tissues, which organize into organs. Groups of organs work together as organ systems. Consider how the last meal you consumed is interacting with each level of organization in your body.
- Think about the advantages and disadvantages of having a body composed of many small cells as opposed to a single large cell.

# 19.2 Lesson 19.2: Homeostasis and Regulation

## Lesson Objectives

- Identify the process by which body systems are kept within certain limits.
- Explain the role of feedback mechanisms in homeostasis.
- Distinguish negative feedback from positive feedback.
- Identify and example of two organ systems working together to maintain homeostasis.
- Summarize the role of the endocrine system in homeostasis.
- Outline the result of a disturbance in homeostasis of a body system.

## Introduction

The human body is made up of trillions of cells that all work together for the maintenance of the entire organism. While cells, tissues, and organs may perform very different functions, all the cells in the body are similar in their metabolic needs. Maintaining a constant internal environment by providing the cells with what they need to survive (oxygen, nutrients, and removal of waste) is necessary for the well-being of individual cells and of the entire body. The many processes by which the body controls its internal environment are collectively called homeostasis. The complementary activity of major body systems maintains homeostasis.

## Homeostasis

**Homeostasis** refers to stability, balance, or equilibrium within a cell or the body. It is an organism's ability to keep a constant internal environment. Homeostasis is an important characteristic of living things. Keeping a stable internal environment requires constant adjustments as conditions change inside and outside the cell. The adjusting of systems within a cell is called homeostatic regulation. Because the internal and external environments of a cell are constantly changing, adjustments must be made continuously to stay at or near the set point (the normal level or range). Homeostasis can be thought of as a dynamic equilibrium rather than a constant, unchanging state.

## Feedback Regulation Loops

The endocrine system plays an important role in homeostasis because hormones regulate the activity of body cells. The release of hormones into the blood is controlled by a stimulus. For example, the stimulus either causes an increase or a decrease in the amount of hormone secreted. Then, the response to a stimulus changes the internal conditions and may itself become a new stimulus. This self-adjusting mechanism is called feedback regulation.

Feedback regulation occurs when the response to a stimulus has an effect of some kind on the original stimulus. The type of response determines what the feedback is called. **Negative feedback** occurs when the response to a stimulus reduces the original stimulus. **Positive feedback** occurs when the response to a stimulus increases the original stimulus.

## Thermoregulation: A Negative Feedback Loop

Negative feedback is the most common feedback loop in biological systems. The system acts to reverse the direction of change. Since this tends to keep things constant, it allows the maintenance of homeostatic balance. For instance, when the concentration of carbon dioxide in the human body increases, the lungs are signaled to increase their activity and exhale more carbon dioxide, (your breathing rate increases). Thermoregulation is another example of negative feedback. When body temperature rises, receptors in the skin and the hypothalamus sense the temperature change. The temperature change (stimulus) triggers a command from the brain. This command, causes a response (the skin makes sweat and blood vessels near the skin surface dilate), which helps decrease body temperature. **Figure** 19.6 shows how the response to a stimulus reduces the original stimulus in another of the body's negative feedback mechanisms.

Positive feedback is less common in biological systems. Positive feedback acts to speed up the direction of change. An example of positive feedback is lactation (milk production). As the baby suckles, nerve messages from the mammary glands cause the hormone prolactin, to be secreted by the pituitary gland. The more the baby suckles, the more prolactin is released, which stimulates further milk production.

Not many feedback mechanisms in the body are based on positive feedback. Positive feedback speeds up the direction of change, which leads to increasing hormone concentration, a state that moves further away from homeostasis.

# System Interactions

Each body system contributes to the homeostasis of other systems and of the entire organism. No system of the body works in isolation and the well-being of the person depends upon the well-being of all the interacting body systems. A disruption within one system generally has consequences for several additional body systems. Most of these organ systems are controlled

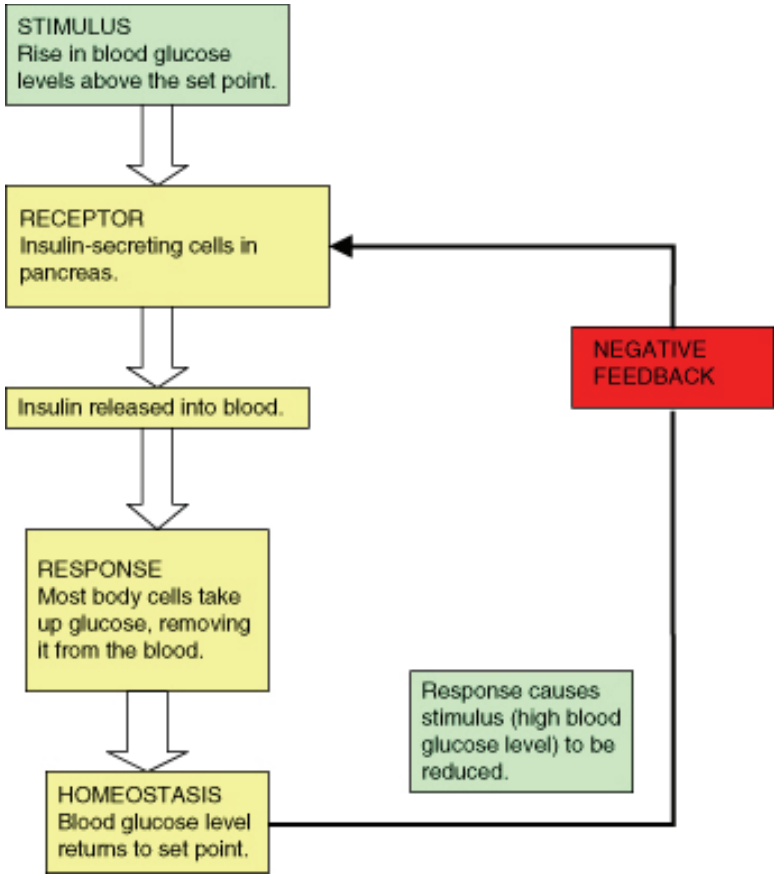



Figure 19.6: Control of blood glucose level is an example of negative feedback. Blood glucose concentration rises after a meal (the stimulus). The hormone insulin is released by the pancreas, and it speeds up the transport of glucose from the blood and into selected tissues (the response). Blood glucose concentrations then decrease, which then decreases the original stimulus. The secretion of insulin into the blood is then decreased. (2)

by hormones secreted from the pituitary gland, a part of the endocrine system. **Table** 19.2 summarizes how various body systems work together to maintain homeostasis.

Main examples of homeostasis in mammals are as follows:

- The regulation of the amounts of water and minerals in the body. This is known as osmoregulation. This happens primarily in the kidneys.
- The removal of metabolic waste. This is known as excretion. This is done by the excretory organs such as the kidneys and lungs.
- The regulation of body temperature. This is mainly done by the skin.
- The regulation of blood glucose level. This is mainly done by the liver and the insulin and glucagon secreted by the pancreas in the body.

Table 19.2: **Types of Homeostatic Regulation in the Body**

| | Homeostatic Processes | Hormones and Other Messengers | Tissues, Organs and Organ Systems Involved |
|---|---|---|---|
| **Osmoregulation (also called excretion)** | Excess water, salts, and urea expelled from body | Antidiuretic hormone (ADH), aldosterone, angiotensin II, carbon dioxide | Kidneys, urinary bladder, ureters, urethra (urinary system), pituitary gland (endocrine system), lungs (respiratory system) |
| **Thermoregulation** | Sweating, shivering, dilation/constriction of blood vessels at skin surface, insulation by adipose tissue, breakdown of adipose tissue to produce heat | Nerve impulses | Skeletal muscle (muscular system), nerves (nervous system), blood vessels (cardiovascular system), skin and adipose tissue (integumentary system), hypothalamus (endocrine system) |

Table 19.2: (continued)

| | Homeostatic Processes | Hormones and Other Messengers | Tissues, Organs and Organ Systems Involved |
|---|---|---|---|
| **Chemical Regulation (including glucoregulation)** | Release of insulin and glucagon into the blood in response to rising and falling blood glucose levels, respectively; increase in breathing rate in response to increases carbon dioxide levels in the blood, and release of carbon dioxide into exhaled air from lungs, secretion of erythropoietin by kidneys to stimulate formation of red blood cells | Insulin, glucagon, cortisol, carbon dioxide, nerve impulses, erythropoietin (EPO) | Pancreas (endocrine system), liver (digestive system); adrenal glands (endocrine system) lungs (respiratory system), brain (nervous system), kidneys (urinary system) |

## Endocrine System

The endocrine system, shown in **Figure** 20.39, includes glands which secrete hormones into the bloodstream. Hormones are chemical messenger molecules that are made by cells in one part of the body and cause changes in cells in another part of the body. The endocrine system regulates the metabolism and development of most body cells and body systems through feedback mechanisms. For example, Thyrotropin-Releasing Hormone (TRH) and Thyroid Stimulating Hormone (TSH) are controlled by a number of negative feedback mechanisms. The endocrine glands also release hormones that affect skin and hair color, appetite, and secondary sex characteristics of males and females.

The endocrine system has a regulatory effect on other organ systems in the human body. In the muscular system, hormones adjust muscle metabolism, energy production, and growth. In the nervous system, hormones affect neural metabolism, regulate fluid and ion concentration and help with reproductive hormones that influence brain development.

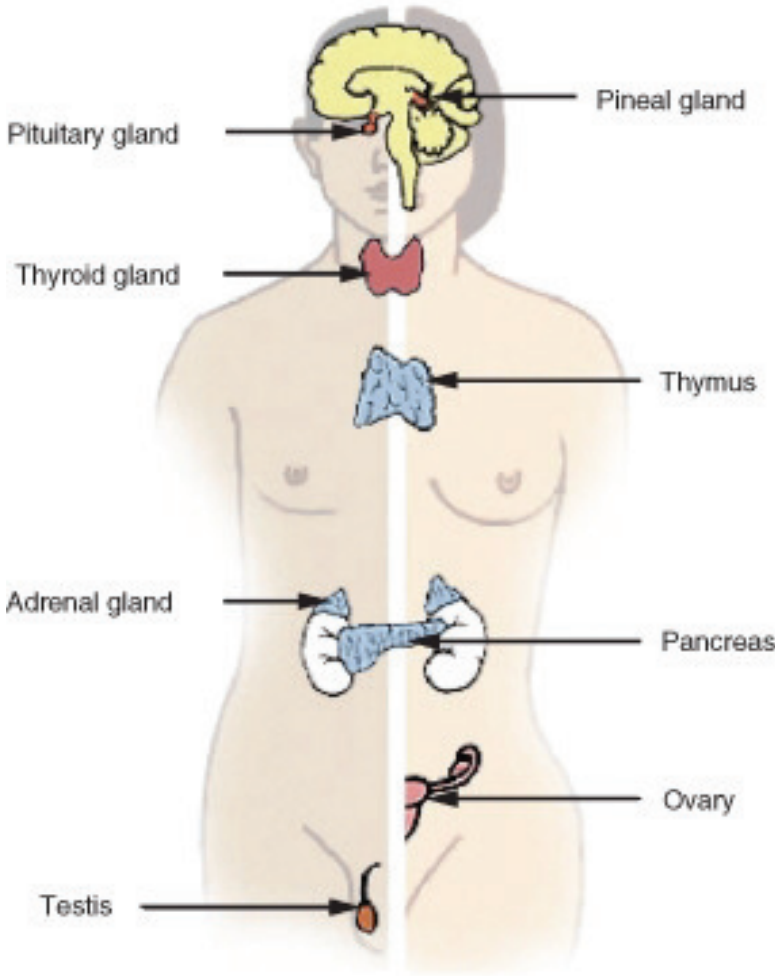



Figure 19.7: The endocrine system controls almost every other body system through feedback mechanisms. Most of the mechanisms of the endocrine system are negative feedback. (6)

### Urinary System

Toxic wastes build up in the blood as proteins and nucleic acids are broken down and used by the body. The urinary system rids the body of these wastes. The urinary system is also directly involved in maintaining proper blood volume. The kidneys also play an important role in maintaining the correct salt and water content of the body. External changes, such as a warm weather, that lead to excess fluid loss trigger feedback mechanisms that act to maintain the body's fluid content by inhibiting fluid loss. The kidneys also produce a hormone called erythropoietin, also known as EPO, which stimulates red blood cell production.

### Reproductive System

The reproductive system does little for the homeostasis of the organism. The reproductive system relates instead to the maintenance of the species. However, sex hormones do have an effect on other body systems, and an imbalance in sex hormones can lead to various disorders. For example, a woman whose ovaries are removed early in life is at higher risk of developing osteoporosis, a disorder in which bones are thin and break easily. The hormone estrogen, produced by the ovaries, is important for bone growth. Therefore, a woman who does not produce estrogen will have impaired bone development.

## Disruption of Homeostasis

Many homeostatic mechanisms keep the internal environment within certain limits (or set points). When the cells in your body do not work correctly, homeostatic balance is disrupted. Homeostatic imbalance may lead to a state of disease. Disease and cellular malfunction can be caused in two basic ways: by deficiency (cells not getting all they need) or toxicity (cells being poisoned by things they do not need). When homeostasis is interrupted, your body can correct or worsen the problem, based on certain influences. In addition to inherited (genetic) influences, there are external influences that are based on lifestyle choices and environmental exposure. These factors together influence the body's ability to maintain homeostatic balance. The endocrine system of a person with diabetes has difficulty maintaining the correct blood glucose level. A diabetic needs to check their blood glucose levels many times during the day, as shown in **Figure** 19.8, and monitor daily sugar intake.

### Internal Influences: Heredity

**Genetics**: Genes are sometimes turned off or on due to external factors which we have some control over. Other times, little can be done to prevent the development of certain genetic diseases and disorders. In such cases, medicines can help a person's body regain homeostasis. An example is the metabolic disorder Type 1 diabetes, which is a disorder where the pancreas is no longer producing adequate amounts of insulin to respond to changes in a person's blood

Figure 19.8: A person with diabetes has to monitor their blood glucose carefully. This glucose meter analyses only a small drop of blood. For an animation of diabetes **Diabetes Cause and Effect,** see (http://video.google.com/videoplay?docid=6553371894741533041&ei=Q4k6SoTVJIGEqAOK0fj_Aw&q=diabetes&hl=en&client=safari). (1)

glucose level. Insulin replacement therapy, in conjunction with carbohydrate counting and careful monitoring of blood glucose concentration, is a way to bring the body's handling of glucose back into balance. Cancer can be genetically inherited or be due to a mutation caused by exposure to toxin such as radiation or harmful drugs. A person may also inherit a predisposition to develop a disease such as heart disease. Such diseases can be delayed or prevented if the person eats nutritious food, has regular physical activity, and does not smoke.

## External Influences: Lifestyle

**Nutrition**: If your diet lacks certain vitamins or minerals your cells will function poorly, and you may be at risk to develop a disease. For example, a menstruating woman with inadequate dietary intake of iron will become anemic. Hemoglobin, the molecule that enables red blood cells to transport oxygen, requires iron. Therefore, the blood of an anemic woman will have reduced oxygen-carrying capacity. In mild cases symptoms may be vague (e.g. fatigue), but if the anemia is severe the body will try to compensate by increasing cardiac output, leading to weakness, irregular heartbeats and in serious cases, heart failure.

**Physical Activity**: Physical activity is essential for proper functioning of our cells and bodies. Adequate rest and regular physical activity are examples of activities that influence homeostasis. Lack of sleep is related to a number of health problems such as irregular

heartbeat, fatigue, anxiety, and headaches. Being overweight and obesity, two conditions that are related to poor nutrition and lack of physical activity greatly affect many organ systems and their homeostatic mechanisms. Being overweight or obese increases a person's risk of developing heart disease, Type 2 diabetes, and certain forms of cancer. Staying fit by regularly taking part in aerobic activities such as walking, shown in **Figure** 19.9, has been shown to help prevent many of these diseases.

Figure 19.9: Adding physical activity to your routine can be as simple as walking for a total of 60 minutes a day, five times a week. (7)

**Mental Health**: Your physical health and mental health are inseparable. Our emotions cause chemical changes in our bodies that have various effects on our thoughts and feelings. Negative stress (also called distress) can negatively affect mental health. Regular physical activity has been shown to improve mental and physical wellbeing, and helps people to cope with distress. Among other things, regular physical activity increases the ability of the cardiovascular system to deliver oxygen to body cells, including the brain cells. Medications that may help balance the amount of certain mood-altering chemicals within the brain are often prescribed to people who have mental and mood disorders. This is an example of medical help in stabilizing a disruption in homeostasis.

## Environmental Exposure

Any substance that interferes with cellular function and causes cellular malfunction is a cellular toxin. There are many different sources of toxins, for example, natural or synthetic drugs, plants, and animal bites. Air pollution, another form of environmental exposure to toxins is shown in **Figure** 19.10. A commonly seen example of an exposure to cellular toxins is by a drug overdose. When a person takes too much of a drug that affects the central

nervous system, basic life functions such as breathing and heartbeat are disrupted. Such disruptions can results in coma, brain damage, and even death.

Figure 19.10: Air pollution can cause environmental exposure to cellular toxins such as mercury. (8)

The six factors described above have their effects at the cellular level. A deficiency or lack of beneficial pathways, whether caused by an internal or external influence, will almost always result in a harmful change in homeostasis. Too much toxicity also causes homeostatic imbalance, resulting in cellular malfunction. By removing negative health influences and providing adequate positive health influences, your body is better able to self-regulate and self-repair, which maintains homeostasis.

## Lesson Summary

- Homeostasis is an organism's ability to maintain a stable internal environment. Homeostasis is an important characteristic of living things. Keeping a stable internal environment requires constant adjustments as conditions change inside and outside the cell.
- Feedback regulation mechanisms are important to homeostasis. Feedback regulation occurs when the response to a stimulus has an effect of some kind on the original stimulus. The type of response (increase or decrease in the stimulus) determines what the feedback is called.
- Negative feedback occurs when the response to a stimulus reduces the original stimulus. Positive feedback occurs when the response to a stimulus increases the original stimulus.
- No system of the body works in isolation, and the well-being of a person depends upon the well-being of all the interacting body systems. A disruption within one system generally has consequences for several additional body systems.

- The homeostatic balance of most organs and organ systems is controlled by hormones secreted from the pituitary gland, a part of the endocrine system.
- When the cells in your body do not work correctly, homeostatic balance is disrupted. Homeostatic imbalance may lead to a state of disease. Type 2 diabetes is a disease in which homeostasis of the blood glucose level is disturbed, leading to an imbalance that affect many other body systems, including the cardiovascular system.

## Review Questions

1. Outline the importance of homeostasis to an organism.
2. How do feedback mechanisms help maintain homeostasis?
3. What is the difference between negative and positive feedback?
4. Identify and give an example of two organ systems working together to maintain homeostasis.
5. Summarize the role of the endocrine system in homeostasis.
6. Name two diseases that can result from an imbalance in body homeostasis.
7. Why is positive feedback not an effective way of controlling hormone levels?

## Further Reading / Supplemental Links

- Ostrom, K.M., Department of Nutritional Sciences, University of Connecticut, Storrs.
- A review of the hormone prolactin during lactation.Prog Food Nutr Sci. 1990; 14(1):1-43.
- Anatomy and Physiology © 2002 by Elaine N. Marieb. Published by Benjamin Cummings.
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- http://www.health.gov/dietaryguidelines/
- http://en.wikipedia.org

## Vocabulary

**homeostasis** Stability, balance, or equilibrium within the cell or a body; an organism's ability to keep a constant internal environment.

**negative feedback** Occurs when the response to a stimulus reduces the original stimulus.

**positive feedback** Occurs when the response to a stimulus increases the original stimulus.

## Points to Consider

- Negative feedback is most common feedback loop in biological systems. The system acts to reverse the direction of change. Positive feedback is less common in biological systems. The system acts to speed up the direction of change. Consider how your social interactions with teachers, parents and other students may be classified as either positive or negative feedback.
- When homeostasis is interrupted, your body can correct or worsen the problem, based on certain influences. In addition to genetic influences, there are external influences that are based on lifestyle choices and environmental exposures. Describe how your lifestyle may positively or negatively affect your body's ability to maintain homeostasis

## Image Sources

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