CHAPTER V

Tissues, Organs & Homeostasis: For Better or Worse

LEARNING OBJECTIVES

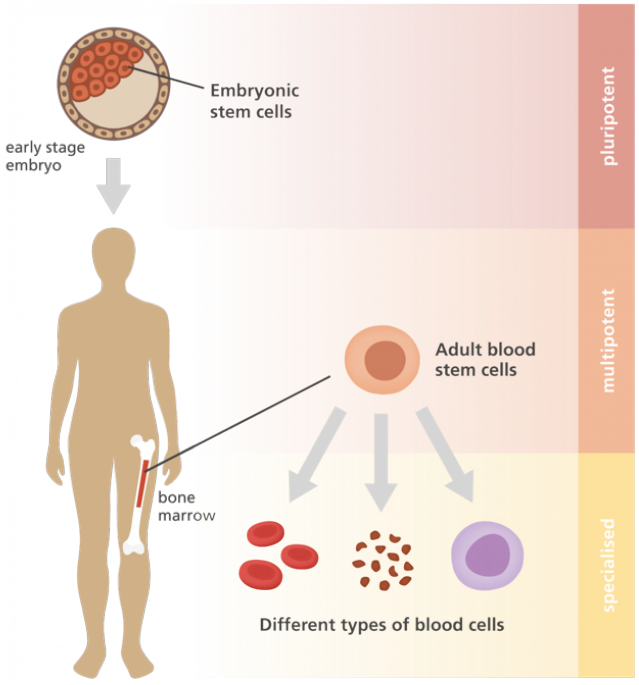
By the end of this class you should be able to:

- Define homeostasis, interstitial fluid, negative and positive feedback.
- Provide examples of negative and positive feedback loops.
- Identify the four major types vertebrate tissues.
- List, describe the various types of epithelial tissue, their location and function(s)
- List, describe the various types of muscular tissue, their location and function(s)
- Identify neurons and explain where nervous tissue is found and describe its function(s).
- List, describe the various types of connective tissue, their location and function(s)
- Identify tissues in an organ such as skin explain its structure and describe its functions.

Introduction

Tissues and organs develop from **stem cells** forming the in the embryo. Embryonic stem cells form soon after fertilization, they are undifferentiated cells that can become any specialized cell type (**pluripotent**). Adults also have stem cells but these are usually only **multipotent**, *i.e.* they only differentiate into a limited variety of cells. Tissues are defined as group of cells and cell products of similar structure and embryonic origin that work together to perform a common function. The study of tissues, their structure, arrangement, is called **histology**. Recall that tissues are groups of similar cells (cells carrying out related functions). These tissues combine to form organs—like the skin or kidney—that have specific, specialized functions within the body. Organs are organized into organ systems to perform functions; examples include the circulatory system, which consists of the heart and blood vessels, and the digestive system, consisting of several organs, including the stomach, intestines, liver, and pancreas. Organ systems come together to create an entire organism. However complex our body may be, its cells belong to one of the four major groups of tissues:

- **Epithelial tissue** lines internal cavities and covers body surfaces
- **Muscle tissue** allows body part movements
- **Nervous tissue** detects and responds to stimuli
- **Connective tissue** provides support and holds the body together

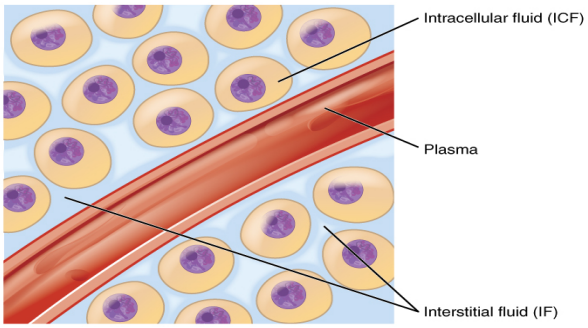


Stem Cells. An illustration showing different types of stem cell in the body (credit: Genome Research Limited CC BY 4.0).

How Do We Keep Our Cells Alive & Healthy?

The Interstitial Fluid

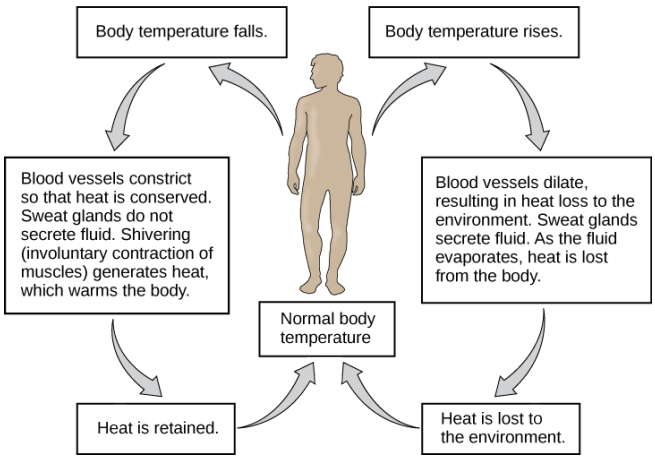
Relative to their weight, animals consist mainly of water. This water is found inside and outside their cells, with many solutes, salts proteins, sugar, gases, … As cells require oxygen and nutrients for survival, they get the substances they need by diffusion from the fluid they bathe in, **the interstitial fluid**, which also serves as a recipient for their wastes.



Cells and the Interstitial Fluid (credit: OpenStax College CC BY 3.0).

Homeostasis

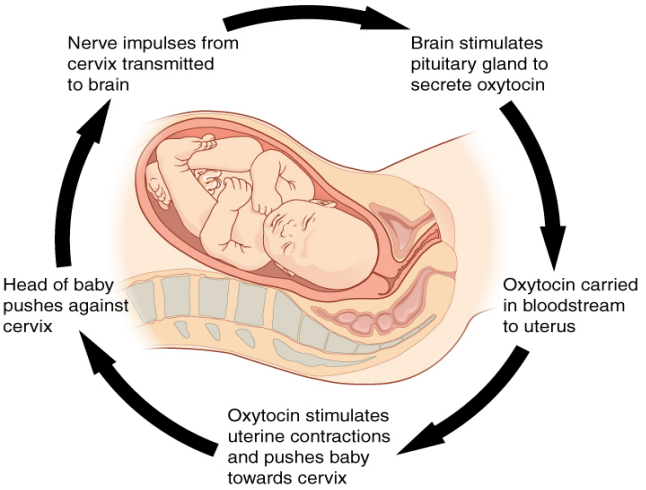
For cells to survives, this interstitial fluid solute concentrations, but also its acidity, pH and temperature, have to remain within narrow ranges, or **set point**, optimum for cell function. This is achieved by the coordinated and regulated functioning of the different organs systems which work and react to maintain a stable environment for the cells. This process is called **homeostasis**. Many diseases are the result of a homeostatic failure. Aging is also a consequence of the increased lack of efficiency in maintaining proper homeostasis. Thus, homeostasis refers to the relatively stable state inside the body of an animal. Our organs and organ systems constantly adjust to internal and external changes in order to maintain this steady state. Examples of internal conditions maintained homeostatically are the level of blood glucose, body temperature, blood calcium level. Sometimes homeostastic control fails to perform properly. This can cause homeostatic imbalance, a condition in which variables in the internal environment are no longer maintained within normal ranges. As a result, cells may not get everything they need, or toxic wastes may accumulate in cells. Eventually, homeostatic imbalance may lead to disease. The term disease can be broadly defined as a condition that is associated with the impairment of normal body functioning.



Negative Feedback. Body temperature is regulated by a negative feedback loop (credit: CNX OpenStax CC BY 4.0).

Negative Feedback

When a change occurs in an animal's environment, an adjustment must be made. The receptor senses the change in the environment, then sends a signal to the control center (in most cases, the brain) which in turn generates a response that is signaled to an effector. The effector is a muscle (that contracts or relaxes) or a gland that secretes. Homeostasis is maintained by **negative feedback** loops. Homeostasis is controlled by the nervous and endocrine system of mammals. The process of negative feedback involves a change that causes a response that reverses the change, as seen with a thermostat connected to a heating system. A decrease in temperature will activate the heating system to reinstate the set temperature. When the temperature reaches the set point, the heating will be turned off. Similarly, in the body, if a level is too high, the body does something to bring it down, and conversely, if a level is too low, the body does something to make it go up. Hence the term negative feedback. A **positive feedback** loop maintains the direction of the stimulus, possibly accelerating it. Positive



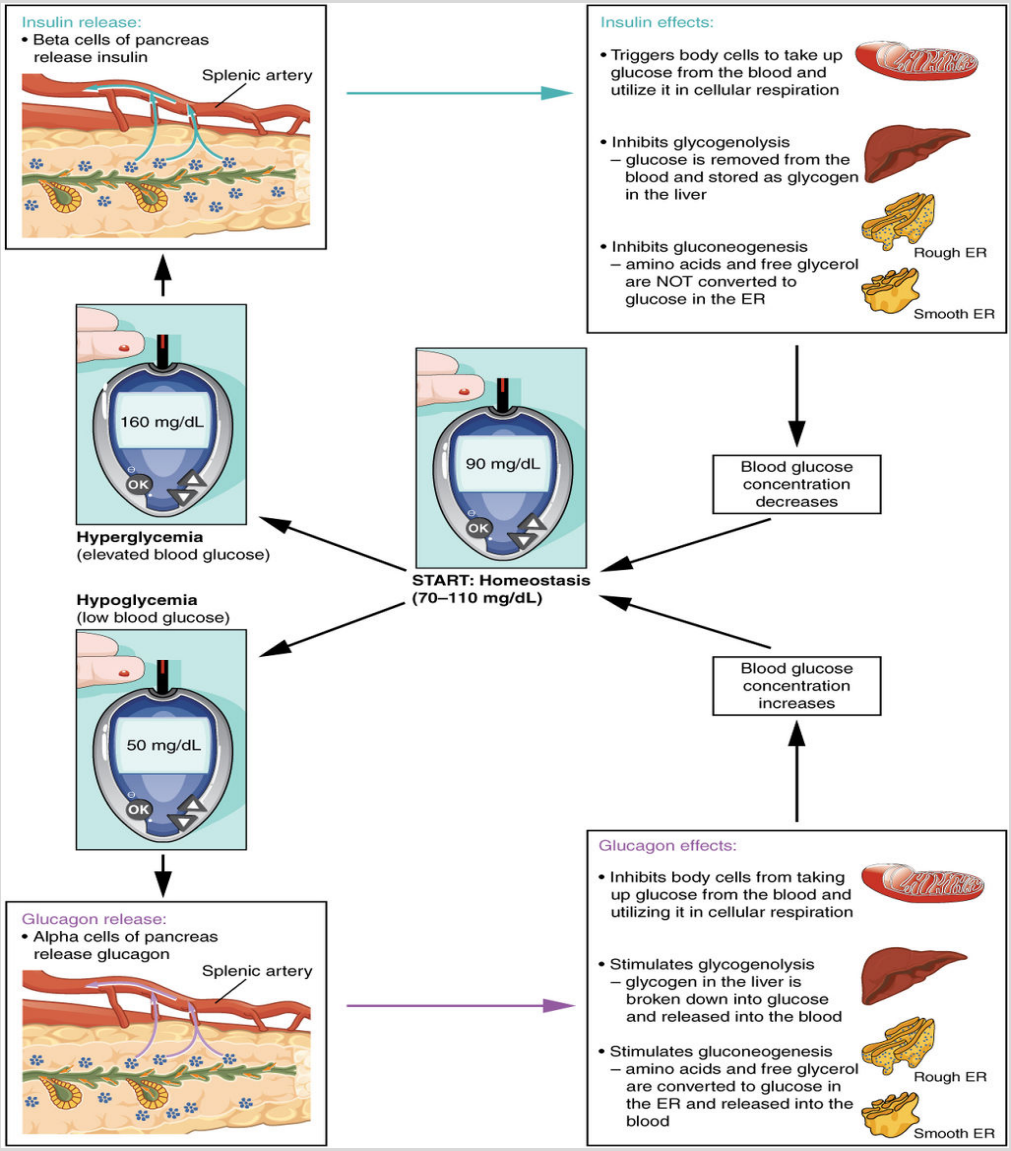
Positive Feedback. Normal childbirth is driven by a positive feedback loop. A positive feedback loop results in a change in the body's status, rather than a return to homeostasis (credit: OpenStax CC BY 4.0).

feedback loops actually push the organism further out of homeostasis, but may be necessary for life to occur. Few examples of positive feedback loops exist in animal bodies, but one is found in the cascade of chemical reactions that result in blood clotting, or coagulation. As one clotting factor is activated, it activates the next factor in sequence until a fibrin clot is achieved. The direction is maintained, not changed, so this is positive feedback. Another example of positive feedback is uterine contractions during childbirth. The hormone oxytocin, made by the endocrine system, stimulates the contraction of the uterus. This produces pain sensed by the nervous system. Instead of lowering the oxytocin and causing the pain to subside, more oxytocin is produced until the contractions are powerful enough to produce childbirth.

Activity 1. Homeostasis and Negative Feedback

Diabetes mellitus, also commonly known as diabetes, is a group of diseases resulting in higher than normal blood sugar (hyperglycemia)[1] This high blood sugar results in symptoms such as increased thirst, frequent urination, and increased hunger. Left untreated, diabetes can cause many serious complications such as cardiovascular disease, stroke, chronic kidney disease, foot ulcers, and damage to the eyes and acute death.

Study the figure below showing the negative feedback regulation of blood sugar (glucose). Provide and discuss reasons that could explain diabetes.



Homeostatic Regulation of Blood Glucose Levels Blood glucose concentration is tightly maintained between 70 mg/dL and 110 mg/dL. If blood glucose concentration rises above this range, insulin is released, which stimulates body cells to remove glucose from the blood. If blood glucose concentration drops below this range, glucagon is released, which stimulates body cells to release glucose into the blood (credit: CNX OpenStax CC BY 3.0).

How Are Cells and Tissues Studied?

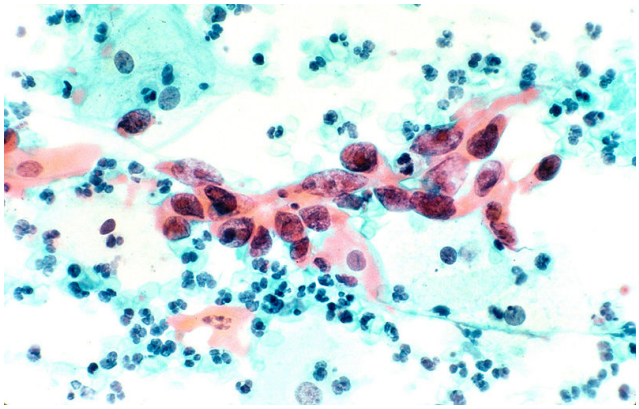
Histology and Preparation of Specimens

Histology is the microscopic study of tissue appearance, organization, and function. The microscopy slides used to produce photomicrographs such as the one you will see through this chapter, and the slides you will be using in this lab, were obtained by following a series of sequential steps. These are necessary for proper **preservation of the cells and tissues structures** and clear **visualization** under a microscope. Although several protocols are routinely used in histology labs they all include the following:

- **Fixation:** the tissue (a biopsy or necropsy) is either placed in a preservative solution and/or quickly frozen at -80°C;
- **Embedding:** the sample is dehydrated and the tissue is immersed in liquid paraffin wax and left to solidify;
- **Sectioning:** the tissue is sliced very thinly (between 2-20 μm) with a special device called a microtome. Longitudinal sections (cut in the length of the tissue) are labeled "l.s." while those done across the tissue are noted as "c.s." for cross sections;
- **Staining:** the sections are affixed to glass slides and put in contact with different dyes that bind to different cellular structures and thus stain them. Common dyes stain in blue and red, according to the acidic or basic nature or organelles.

Staining. Tissue sections on slides are stained using an automated stainer (credit: Ed Uthman CC BY-SA 2.0).

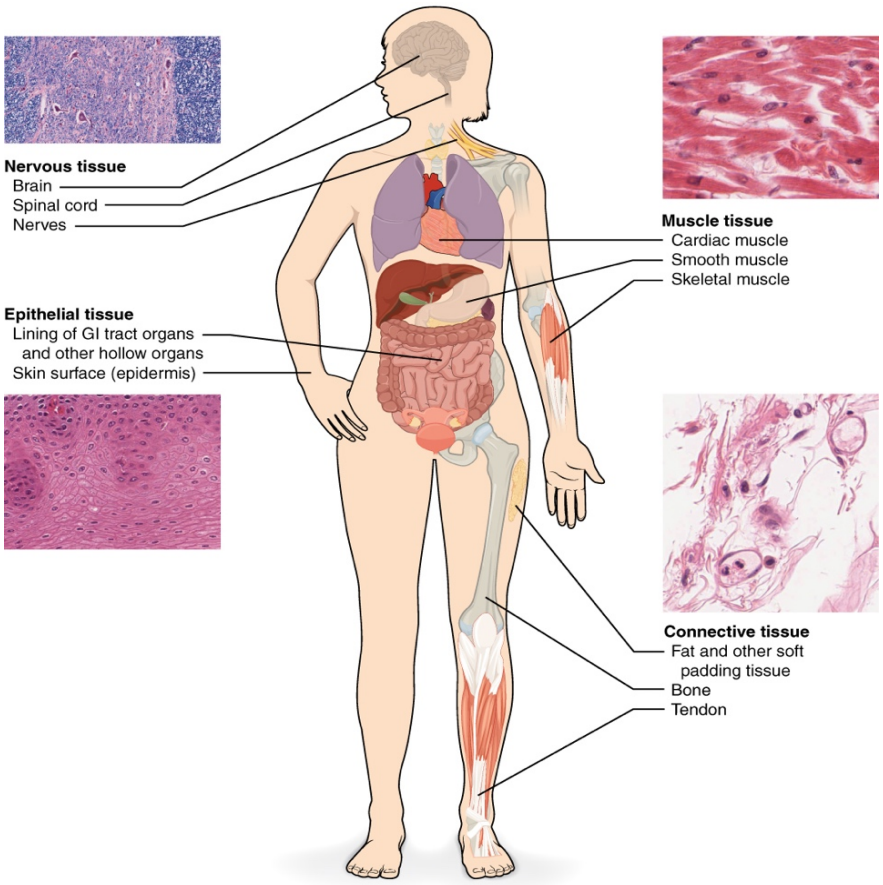
All the steps described above are necessary to obtain slides such as the ones you will be handling. Unless broken, these slides can be kept and used for many years to allow observation of cells and tissues but also abnormalities, damage, diseases, etc… which can be essential to diagnose pathologies. A common example is the one of **Pap (Papanicolaou) smears**. In this test, a doctor takes a small sample of cells from the uterine cervix of a patient and sends it to a medical lab where a cytotechnologist stains the cells and examines them for any changes that could indicate cervical cancer or a microbial infection. Cytotechnologists (*cyto-* = cell) are professionals who study cells through microscopic examinations and other laboratory tests. They are trained to determine which cellular changes are within normal limits or are abnormal. Their focus is not limited to cervical cells; they study cellular specimens that come from all organs. When they notice abnormalities, they consult a pathologist, who is a medical doctor who can make a clinical diagnosis. Cytotechnologists play vital roles in saving people's lives. When abnormalities are discovered early, a patient's treatment can begin sooner, which usually increases the chances of successful treatment.



Pap Smear. These uterine cervix cells, viewed through a light microscope, were obtained from a Pap smear. Normal cells stain in blue. The cells on in pink are infected with human papillomavirus (HPV) (credit: National Cancer Institute, Public Domain).

Activity 2. Histology
Discuss what would happen if either of the steps to prepare specimens for histology (see above) were not properly completed.

The Four Types of Tissues



The Four Major Types of Tissues. An illustration showing the four types of tissues in the human body, from prepared histological slides (credit: OpenStax College CC BY 3.0).

Activity 3. What Type of Tissue Do Your Cheek Cells Belong To?

As you work through the activities and get to know more about each type of tissue, you will have to identify the type of tissue lining your mouth.

3.1 - The first step is to obtain cells from inside your cheeks and prepare them for observation:

a. Put a drop of methylene blue on a slide. Caution: methylene blue will stain clothes and skin.
b. Gently scrape the inside of your cheek with the flat side of a toothpick or cotton swab. Scrape lightly.
c. Stir the end of the toothpick in the stain and throw the toothpick away.
d. Place a coverslip onto the slide.
e. Use the SCANNING objective to focus. You probably will not see the cells at this power.
f. Switch to LOW POWER. Cells should be visible, but they will be small and look like nearly clear purplish blobs. If you are looking at something very dark purple, it is probably not a cell.
g. Once you think you have located a cell, switch to HIGH POWER and focus using the fine adjustment knob. (Remember, do NOT use the coarse adjustment knob at this point.) (credit: Biology Corner CC BY-SA 4.0)

3.2 - Using your own words, note your observations on the appearance (shape, color, nucleus or not, etc…) of the cells.

3.3 - Keep the slide with your stained cheek cells handy so you can compare it to the cells from the different tissues you will study.

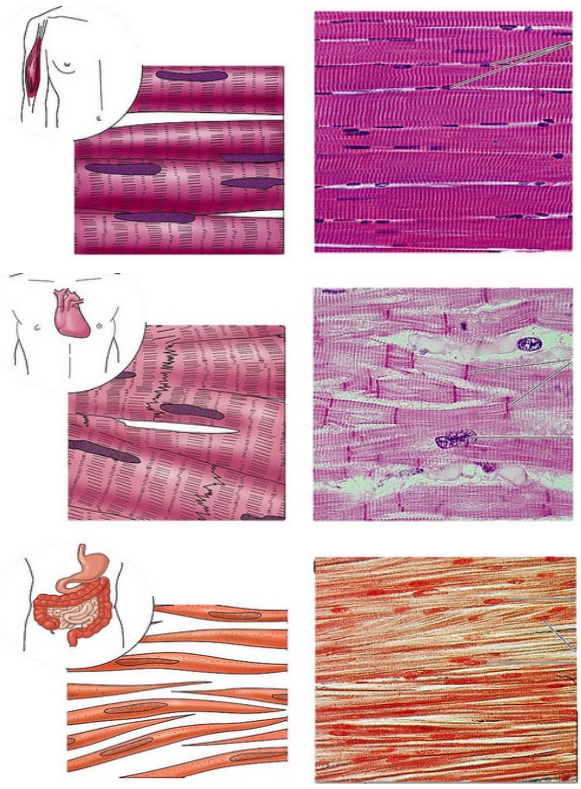
Muscle Tissues Move

Muscle tissues are composed of cells that can contract (shorten) when stimulated. These contractile cells are called **fibers** and their ability to contract comes from interactions between protein (actin and myosin) fibrils (filaments). Muscle tissue moves the body or material through the body. There are three types of muscle tissues and they are distinguished on their structure, location and contraction characteristics:

a) **Skeletal muscle tissue** it is found in muscles (organs), attached to the bones, that move joints, assist in breathing and support the skeleton. Skeletal muscle fibers are the largest cells in the body and can be several centimeters long. Each cell contains several peripherally located nuclei and exhibits **striations** (dark and light bands). Skeletal muscles are said to be **voluntary** as their contraction occurs under conscious control. Skeletal muscle cells cannot divide but can be repaired by generation of myoblasts which fuse with the damaged fiber.

b) **Cardiac muscle tissue** is the muscle tissue that forms the walls of the heart. The cardiac muscle fibers are **branched** and bound to one another by **intercalated discs** which appear as dark bands. Intercalated discs are adhering junctions that prevent cells from being ripped apart during strong contractions and aid in communication between fibers. Striations are present and each cell has a central nucleus. Functionally, cardiac muscle is involuntary as its contraction does not require conscious control. Cardiac muscle has a limited ability to regenerate when damaged

c) **Smooth muscle tissue** is found in the wall of hollow organs other than the heart, *e.g.* stomach, intestines, uterus, bladder or blood vessels. The cells are spindle-shaped (tapered at both ends), **unbranched** with a central nucleus and **no striations**. The contraction of this type of muscle tissue is **involuntary**. Smooth muscle cells have the greatest ability for regeneration and can divide and increase in number.



Muscle Tissue. Skeletal (top), cardiac (middle) and smooth (bottom) muscle tissue. (credit: Modified from Brittany CC BY 2.0).

Activity 4. Muscle Tissue

2.1 - Examine prepared slides of muscle tissues and note their characteristics. Compare your observations with the corresponding figures and, adjusting the magnification and focus, note the elongated cells, their shape and branching, the nuclei, striations and intercalated disks when present.

2.2 - Complete the table below:

Tissue	Control (Voluntary/Involuntary)	Striations (Yes/ No)	Nuclei Position (Central/Peripheral)	Branching (Yes/No)	Intercalated Discs (Yes/No)
Skeletal Muscle					
Cardiac Muscle					
Smooth Muscle					

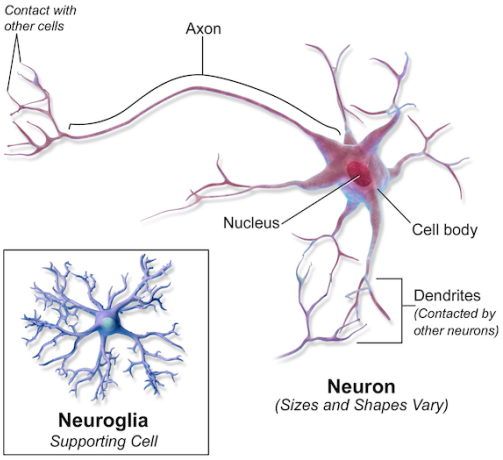
2.3 - Contrast the voluntary and involuntary control of the different muscle tissues with their respective locations and functions. How does it benefit an animal to have different types of muscles?

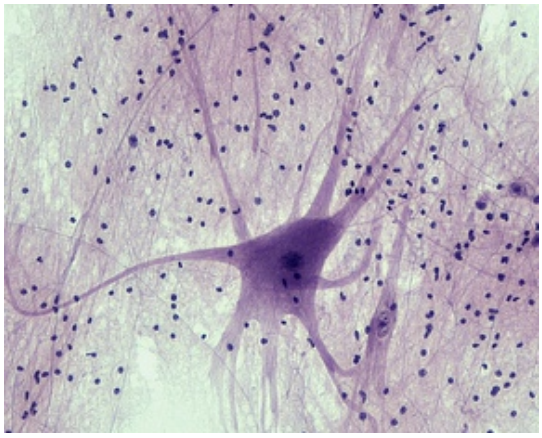
Nervous Tissue Transmits and Communicates

Nervous tissue consists of specialized cells called **neurons** which can receive signals and conduct electrical impulses throughout the body. These neurons are surrounded by other kinds of cells which support their function, the **neuroglia** or **glial cells**. More than half of the nervous tissue volume is neuroglial cells which outnumber neurons at a ratio of 10:1. Unlike neurons, they undergo mitosis and can proliferate. Astrocytes regulate the chemical environment of the nerve cell, and oligodendrocytes insulate the axon so the electrical nerve impulse is transferred more efficiently. Other glial cells that are not shown support the nutritional and waste requirements of the neuron. Some of the glial cells are phagocytic and remove debris or damaged cells from the tissue. A nerve consists of neurons and glial cells.

In Vertebrates, nervous tissue is divided into **central nervous system** (CNS) consisting of the brain and spinal cord, and **peripheral nervous system** (PNS) comprised of all nerve cells and structures outside the CNS. The nervous system is responsible for the control of glands and muscles, and communication among different parts, coordinating the overall functioning of the body.

Neurons are structural and functional units of nerve tissue. They display a distinctive morphology, well suited to their role as conducting cells, with three main parts: a**cell body (**or **soma)** which contains the nucleus and other organelles, and two types of processes, i) one or several **dendrites** that carry impulses toward the cell body and ii) an **axon** that carries impulses away from the cell body. The cell bodies of most neurons are in the CNS. Axons can be very short or very long (more than 1m/1 yard) and myelinated, *i.e.* wrapped in the plasma membrane of Schawnn cells (PNS) or oligodendrocytes (CNS), called **myelin sheath**. Myelin insulates the axon and increases the rate at which the axon conducts its electrical signal. **White matter** contains myelinated axons and a small number of glial cells while **gray matter** contains cell bodies, dendrites and neuroglia.





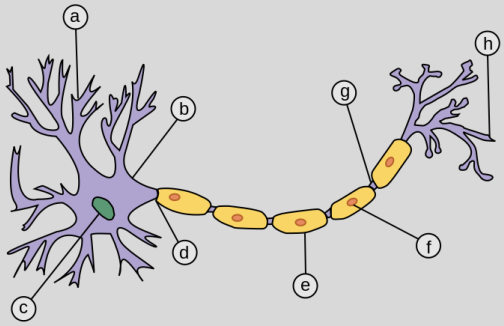
Nervous Tissue. Left: neuroglia and neuron (credit: BruceBlaus CC BY 3.0) Right: Smear of spinal cord at 100x showing a neuron surrounded by neuroglia (credit: Berkshire Community College Bioscience Image Library, Public Domain).

Activity 5. Nervous Tissue

5.1 - Examine stained slides of nervous tissue. Locate a neuron, identify its different parts. Is the neuroglia easy to observe? Why?

5.2 - Label the diagram and state the function of each structure:

a) _____
b) _____
c) _____
d) _____
e) _____
f) _____
g) _____
h) _____



Neuron. (credit: Lokal_Profil CC BY-SA 3.0).

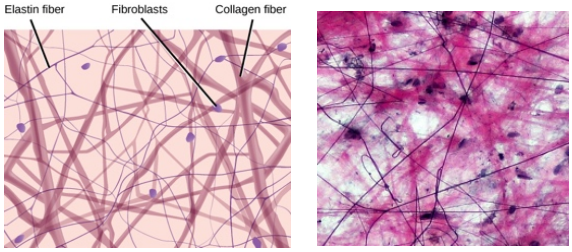
Connective Tissues Connect and Support

Connective tissues are characterized by cells surrounded by a large amount of **matrix**, a non-living substance secreted by the cells themselves (fibroblasts). The extracellular matrix (ECM) contains a mixture of proteoglycans, adhesive glycoproteins and long protein structures (collagen and elastin) called fibers. It can be jelly-like, solid, fibrous or liquid or a combination of these. In addition to joining different parts of the body together, connective tissue structurally and metabolically supports, protects, organizes and insulates other tissues. It can also store energy and transport materials. Connective tissues are the most abundant and widely distributed tissues in animals, their diversity arises from the variations of the ECM composition.

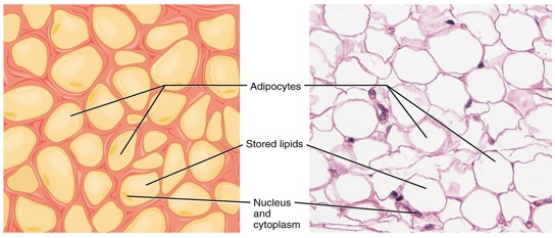
CONNECTIVE TISSUE PROPER	SUPPORTIVE CONNECTIVE TISSUE	FLUID CONNECTIVE TISSUE
Loose Connective Tissue • Areolar • Adipose • Reticular	**Cartilage** • Hyaline • Fibrocartilage • Elastic	**Blood**
Dense Connective Tissue • Regular Elastic • Irregular Elastic	**Bones** • Compact • Cancellous	**Lymph**

Summary of the Various Types of Connective Tissues Found in the Human Body (credit: modified from OpenStax CNX CC BY 4.0)

- **Loose connective tissue** has fibroblasts and fibers dispersed though the matrix. It holds organs and epithelia together while allowing them to expand. Areolar connective tissue is found within and around internal organs, muscles, nerves and attaches the skin to the underlying muscles. It is the most common connective tissue in vertebrates.
  - **Adipose (fat) tissue** is a special type of loose connective tissue. It is the body's main energy storage. Excess sugars and lipids are converted into droplets of fat stored in vacuoles that push the cytoplasm and nucleus of the **adipocytes** (cells of the adipose tissue) against their cytoplasm. Adipose tissue is found under the skin. It provides insulation and padding.

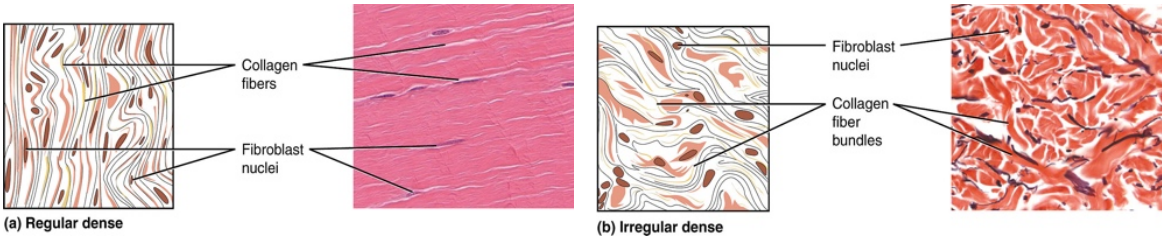


Loose Connective Tissue. Diagram (left; credit: CNX OpenStax CC BY 4.0) and photomicrograph (right; credit: Berkshire Community College Bioscience Image Library Public Domain).



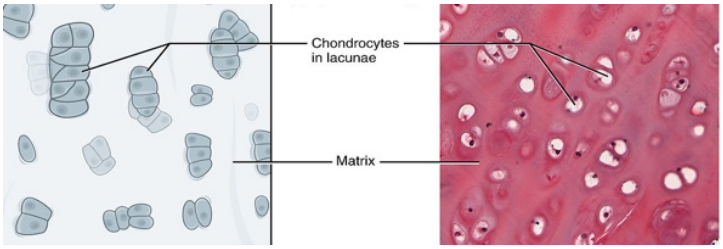
Adipose Tissue. Diagram and photomicrograph (credit: OpenStax College CC BY 3.0)

- **Dense connective tissue** contains many tightly packed fibers of collagen. Regular dense fibrous connective tissue connects bones to bones (ligaments) and muscles to bones (tendons) while sustaining mechanical stress and remaining flexible. Irregular dense connective tissue makes up skin layers and supports visceral muscles and form capsules around organs that do not expand such as kidneys.



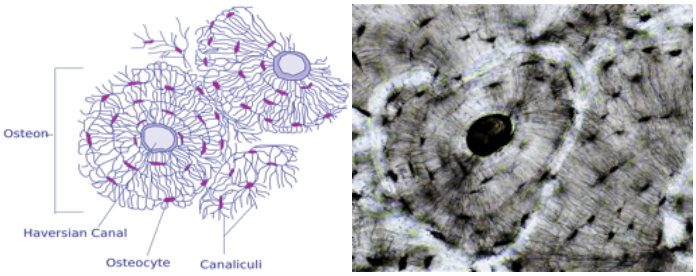
Dense Connective Tissues. Diagrams and photomicrographs (credit: OpenStax College CC BY 3.0)

- **Cartilage** has a matrix of collagen fibers and rubbery glycoproteins making it glassy white and flexible. The scattered cells, the **chondrocytes** are located in lacunae. Some vertebrates, the chondrichthyes (sharks, rays), have a skeleton made of cartilage. In human embryos, the skeleton is first formed of cartilage then bone replaces most of it. In adults, cartilage is found in the outer ear, the nose, and throat, it also covers the end of long bones and forms the intervertebral discs. Cartilage serves as a cushioning shock absorber, and a supportive framework. Unlike other connective tissues, cartilage does not repair itself as chondrocytes do not divide.



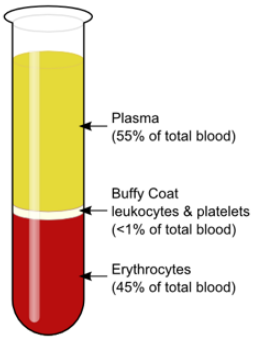
Cartilage. (credit: Modified from OpenStax College CC BY 3.0).

- **Bone (or osseous) tissue,** is found in bones. It is the hardest and most rigid connective tissue as the matrix formed by the osteocytes (bone cells), contains calcium carbonate. **Osteocytes** are found in **lacunae**, tiny spaces within the matrix arranged in concentric rings. Canaliculi (tiny canals) allows diffusion of molecules to and from osteocytes. Bones interact with muscles to move the body and they also support and protect softer organs.

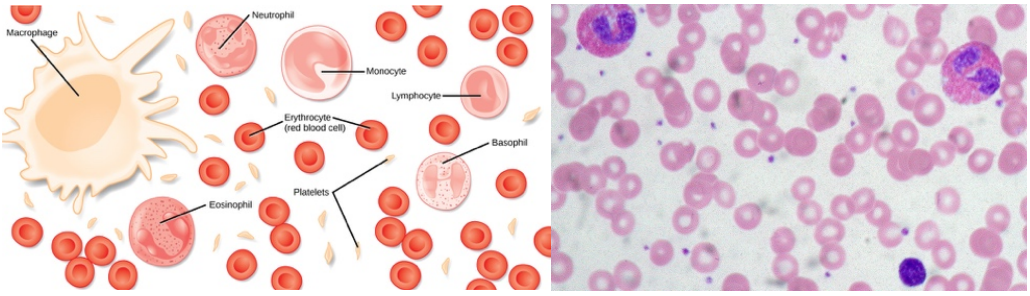


Compact Bone. Diagram (left; credit: BDB CC BY-SA 2.5) and photomicrograph (right; credit: Berkshire Community College Bioscience Image Library Public Domain).

- **Blood** is considered a connective tissue which consists of several types of cells - red blood cells (**erythrocytes**), white blood cells (**leukocytes**) and platelets (**thrombocytes**) - all originating from stem cells in the bone marrow, in a liquid matrix, the **plasma**. Plasma represents about 55% of the blood volume and consists mostly of water with dissolved proteins, gases, nutrients and salts. Blood transports material throughout the body, helps regulate the pH, temperature and water content of cells, it also protects against blood loss via clotting (platelets) and is involved in fighting against pathogens and diseases (white blood cells and antibodies). Erythrocytes circulate for about 120 days before being removed and disposed of in the liver at the rate of 3 million red blood cells each second.



Separated Blood. Centrifugated (separated) blood (credit: KnuteKnudsen at English Wikipedia CC BY 3.0).



Blood. Diagram (left; credit: CNX OpenStax CC BY 4.0) and right: photomicrograph (right; credit: Ed Uthman CC BY 2.0) of a blood smear. Basophils, eosinophils, lymphocytes, macrophages, monocytes and neutrophils are all leukocytes (white blood cells).

Activity 6. Connective Tissues

6.1 - For each connective tissue you learned about, correlate its structure and location with its function.

6.2 - As you examine prepared slides of connective tissues, sketch, in the corresponding box, the tissues listed below. Label your drawings indicating the relevant structures and cells using the appropriate terms (lacunae, matrix, fiber, adipocyte, chondrocyte, etc…)

Cartilage

Loose Connective Tissue

Compact Bone

Dense Regular Connective Tissue

Blood (smear)

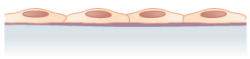
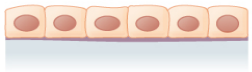
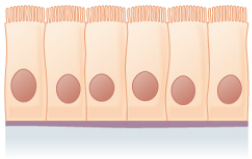
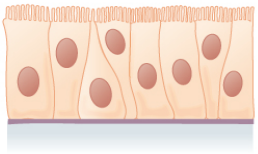
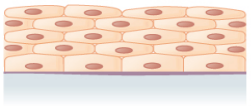
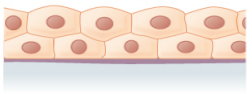
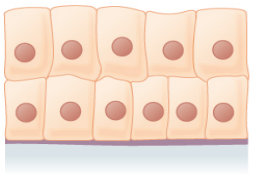
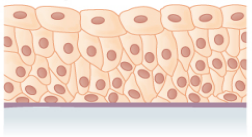
Adipose Tissue

Epithelial Tissue Lines, Protects and Filters

Epithelium (plural, epithelia) consists of a sheet of cells that lines the body's surface and cavities. One side of the layer is exposed to the environment or body fluids and the other side rests against a non-cellular **basement membrane.** The basement membrane is made from cell secretions and allows adhesion of the epithelial tissue to another tissue. Epithelia are **avascular**, *i.e.* no blood vessels run through them and the epithelial cells obtain their nutrients by diffusion from vessels in nearby tissues. Main functions of epithelia are physical protection, control of permeability (diffusion), secretion and absorption. Some epithelia can have **cilia** to move **mucus** or **microvilli** to increase the surface area for absorption. **Goblet cells** are specialized epithelial cells that secrete mucus on the apical surface (opposite to the basement membrane) of the tissue. **Glands** are organs made from epithelial tissue for their secretory portion. Epithelial cells are constantly renewed. We shed about 1.5 pounds of skin cells each year and the lining of our intestine is replaced every 5 days or so. With such a high rate of cell division in epithelia, DNA replication mistakes are likely and such errors can lead to cancerous cells. An epithelial cell cancer is called a **carcinoma**. About 95% of skin cancers and most breast and lung cancers are carcinomas.
Epithelia are classified according to:

i) Number of cell layers; **simple** is used to described one layer while epithelia with more than one layer are called **stratified**. **Pseudostratified** epithelia appear to be layered but are not as all the cells extend from the basement membrane to the surface of the tissue.
ii) Shape of their cells in the outermost layer. **Squamous** epithelial cells, are thin, flat and tile-like; **cuboidal** cells are square cube-like cells and **columnar** epithelia have cells which height is greater than their width.
iii) Presence or absence of cilia.

Transitional epithelium is a stratified epithelium in which the cells change appearance, from cuboidal to squamous, when the tissue is stretched.

Cells	Location	Function
Simple squamous epithelium 	Air sacs of lungs and the lining of the heart, blood vessels, and lymphatic vessels	Allows materials to pass through by diffusion and filtration, and secretes lubricating substance
Simple cuboidal epithelium 	In ducts and secretory portions of small glands and in kidney tubules	Secretes and absorbs
Simple columnar epithelium 	Ciliated tissues are in bronchi, uterine tubes, and uterus; smooth (nonciliated tissues) are in the digestive tract, bladder	Absorbs; it also secretes mucous and enzymes
Pseudostratified columnar epithelium 	Ciliated tissue lines the trachea and much of the upper respiratory tract	Secretes mucus; ciliated tissue moves mucus
Stratified squamous epithelium 	Lines the esophagus, mouth, and vagina	Protects against abrasion
Stratified cuboidal epithelium 	Sweat glands, salivary glands, and the mammary glands	Protective tissue
Stratified columnar epithelium 	The male urethra and the ducts of some glands	Secretes and protects
Transitional epithelium 	Lines the bladder, uretha, and the ureters	Allows the urinary organs to expand and stretch

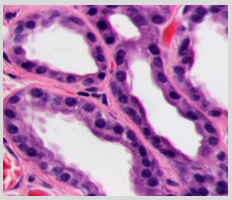
Epithelial Tissue. Types of epithelia, their location and functions. (credit: OpenStax College CC BY 3.0).

Activity 7. Epithelial Tissue

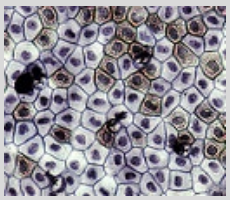
7.1 - Examine prepared slides of epithelium. Compare your observations with the corresponding figures. Can you see the basement membrane easily?

7.2 - Identify and label the epithelia shown below:

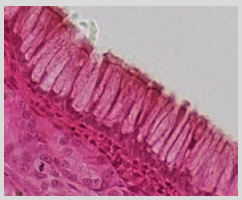
A
Mammalian Gut 400x
(credit: Berkshire Community College Bioscience Image Library, Public Domain).



B
Human Kidney 400x
(credit: Patho CC BY-SA 3.0).



C
Frog Epithelium 200x
(credit: Berkshire Community College Bioscience Image Library, Public Domain).



D
Mammalian Trachea 200x
(credit: Berkshire Community College Bioscience Image Library, Public Domain).

E
Human Esophagus 400x
(credit: Samir@enwiki, CC BY-SA 3.0).

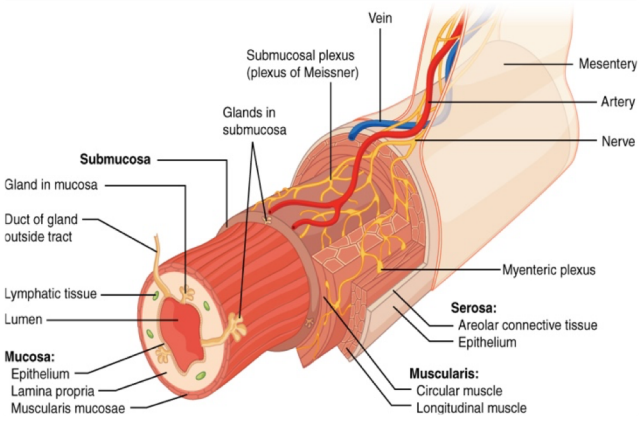
Organs

Organs such as muscles, the skin, kidneys or the heart, are typically made of the four types of tissue, not just one type of tissue. They make up organ systems which work together to sustain the body. With different tissues combined in specific ways, each organ can perform incomparable functions and has unique properties and characteristics. For example, the intestine can move food along its length (smooth muscle and nervous tissues), can breakdown food chemically by secreting enzymes and mucus (epithelial tissue) and absorbs nutrients that pass in blood and lymph vessels (in its loose fibrous connective tissue).

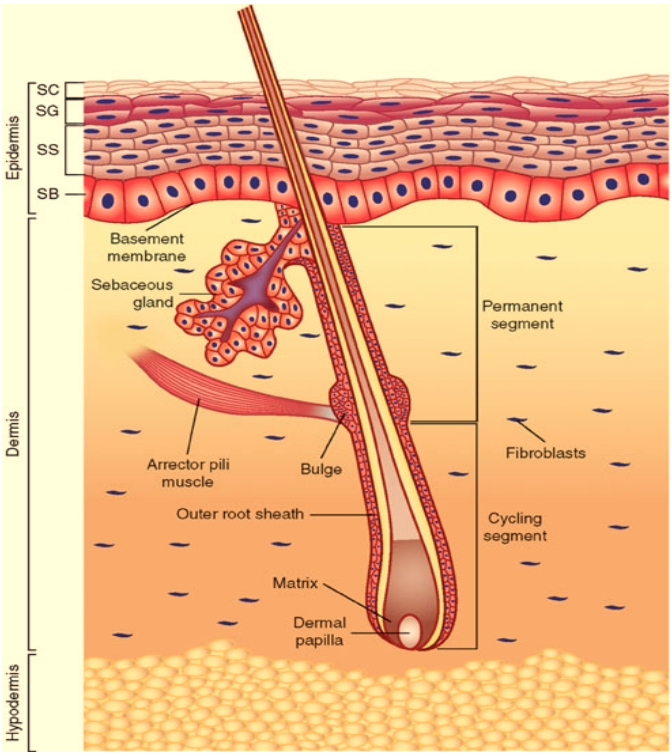
Similarly, the skin, our largest organ functions to sense external conditions which are relayed to the brain, it also serves as a barrier to keep out pathogens, conserves water, contributes to the formation of vitamin D and controls temperature. The skin belongs to the **integumentary system** which also includes the nails, hairs, feathers, scales and hooves. The skin is comprised of:

- the **epidermis** of epithelial tissue and,
- the **dermis** containing dense connective tissue, nerve cells and blood vessels.
- the **subcutaneous layer** or **hypodermis**, beneath the skin (not considered part of the skin) has loose connective tissue and patches of adipose tissue, it contributes to insulation and padding.

Epidermal cells divide less frequently with age and glandular secretions that keep the skin and hair silky and soft decrease. Thus, the thickness and elasticity of the skin decreases, wrinkles appear and/or the coat and hair appear duller and thinner in older individuals



Layers of the Alimentary Canal. The wall of the alimentary canal has four basic tissue layers: the mucosa, submucosa, muscularis, and serosa. (Credit: Goran tek-en CC BY-SA 3.0).



Anatomy of the skin. Skin is composed of three layers, starting with the outermost layer: the epidermis, dermis, and hypodermis. Epidermis is a stratified squamous epithelium that is divided into four layers, starting with the outermost layer: stratum corneum (SC), stratum granulosum (SG), stratum spinosum (SS), and stratum basale (SB). Outer root sheath of the hair follicle is contiguous with the basal epidermal layer. Stem cell niches include the basal epidermal layer, base of sebaceous gland, hair follicle bulge, dermal papillae, and dermis. (Credit: Wong, D.J. and Chang, H.Y. Skin tissue engineering (March 31, 2009), StemBook, ed. The Stem Cell Research Community, StemBook, doi/10.3824/stembook.1.44.1, http://www.stembook.org. CC BY 3.0).

Activity 8. Organs – The Skin
6.1 - Study prepared slides of skin cross sections. Identify the epidermis and dermis. What sort of epithelium makes the outer most layer of the epidermis?
6.2 - Correlate the different skin layers and tissues with the different functions of the skin.

Activity 3. Conclusions (What Type of Tissue Do Your Cheek Cells Belong To?)
3.4 - What are your conclusions as to the type of tissue inside your mouth?
3.5 - How do the shape of the cells and the type tissue they belong to fit their function inside your mouth

Review Questions

1. What is homeostasis?
2. Define the set point and normal range for physiological measures.
3. What happens when homeostasis is not accomplished?
4. How is a condition such as diabetes a good example of the failure of a set point in humans?
5. Compare and contrast negative and positive feedback loops.
6. Explain how negative feedback controls body temperature.
7. Give two examples of physiological processes that are controlled by positive feedback loops.
8. During breastfeeding, the stimulus of the baby sucking on the nipple increases the amount of milk produced by the mother. The more sucking, the more milk is usually produced. Is this an example of negative or positive feedback? Explain your answer.
9. Identify the four types of tissue in the body, and describe the major functions of each tissue.
10. What are examples of cells that can readily divide and cells that can divide only under rare circumstances?
11. Why does skeletal muscle look striated?
12. Which morphological adaptations of neurons make them suitable for the transmission of nerve impulse?
13. Why are bone and blood both classified as connective tissues?

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