SUPERCHARGED SCIENCE

# Unit 19:
# Biology Part 2

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**Appropriate for Grades:**
Grades K-8
**Duration:** 4-30 hours, depending on how many activities you do!

Your body does a tremendous number of things all the time. In these sections, you'll learn about your skeleton, bone joints, muscle tension, blood cells, lungs, ears, eyes, and so much more!

We will go over integumentary, skeletal, and muscular systems by beginning with a general overview of the body. We'll also learn about what should we eat, what happens to food once we swallow it, and how your digestive system works, and why the standard American diet of fries, shakes, and sodas wreaks havoc on our digestive system. Another system we'll cover is the respiratory system, which is responsible for providing your organs with the oxygen it needs and removing the carbon dioxide it doesn't. Speaking of things your body doesn't need, our next topic will be the excretory system, the one responsible for getting rid of *all* waste from the body. We'll talk about how your body allows you to do all the things you do. In order to do those things, your body must stay healthy, and keeping you healthy is the job of the immune system.

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# Materials for Experiments

*Note: These materials are only for the experiments listed in this document (Unit 19 Lesson Plan). If you'd like to do the additional experiments online with the e-Science program, download the online shopping list for Unit 19 at* ***www.ScienceLearningSpace.com***

Sand
1 ½ cups of instant potato flakes
Food coloring
Plain paper
Paper plates
Normal-sized books
Chicken bones
2 jars
Vinegar
Tape measure
Measuring cup
Sugar
Salt
Paper towels
Paper and pen
Permanent marker
Notebook
Protective eyewear
Cornstarch
Iodine
Plate
Two coffee stirrers
Cedarwood furniture oil
Flashlight
Oblong balloon
Two small balloons
One large balloon
Syringe
Tennis Ball
Clay
Straws
Plastic container
Gelatin
Yardstick
Unsweetened Iced Coffee
Lemonade or Lemon Juice
Q-tips
Vanilla Extract
Rubbing Alcohol
30 pennies
12 nickels
6 dimes
4 quarters
Spinning Office Chair
Two Washcloths
Small pan
Candle
Rubber bands
Rubber cement
Milk jug
Milk carton
Aquarium tubing
Masking tape
Cheesecloth
Large bowl
Colander
Regular yogurt (not 'light' or lowfat)
UV Light (black light)
Cups
Water
Food Coloring (any color)
Yellow Food Coloring
Vegetable Oil
Corn Syrup
Apple
Plastic Wrap
Sour milk, expired sour cream or fresh yogurt
Deck of Playing Cards

GloGerm or Germ Juice (refer to website)
1 Gallon plastic bag
2 Similar sized glasses
Measuring spoon
Teaspoon
Plastic cups
1 Cardboard tube
1 Paper towel roll
Scissors or knife
Stopwatch or clock
Paperclip
1 Teaspoon Bromthymol Blue
Sugar water or punch
Soap
Salt water
10 Volunteers
10 Cups
½ Cup boiling water
Fork
Methylene Blue
Mineral Oil
Large clear bowl

# Key Vocabulary

Absorption - Process in which substances are taken up by the blood; after food is broken down into small nutrient molecules, the molecules are absorbed by the blood.

Acne- Pimples caused by blocked oil glands.

Aerobic exercises- Types of exercises that cause the heart to beat faster and allow the muscles to obtain energy to contract by using oxygen.

alveoli – grape-like sacs where gas exchange occurs in the lungs

Anabolic steroids- Hormones that cause the body to build up more protein in its cells.

Anaerobic exercise- Types of exercises that involve short bursts of high-intensity activity; forces the muscles to obtain energy to contract without using oxygen.

Antibody – Chemical that identifies and destroys harmful substances

Artery – Blood vessel that carries blood away from the heart

asthma – chronic disease caused by an inflammation of the bronchioles

Atherosclerosis – Buildup of plaque in the arteries

Atrioventricular Valve – Valve separating each of the heart's atria from the ventricles

Atrium – One of the two chambers at the top of the heart that gets blood from other parts of the body

Autonomic Nervous System – Part of the motor division of the PNS controlling involuntary motions

Axon – Part of the neuron that sends impulses to other cells

Bacteria – Single-celled organisms without a nucleus

Ball and Socket joints- Joint structure in which the ball-shaped surface of one bone fits into the cuplike depression in another bone; examples include the shoulder and hip joints.

Body odor- Smell that is produced by the breakdown of sweat by bacteria that live on the skin.

body system – group of organs and tissues working together towards a common purpose

Bone marrow- Soft connective tissue found inside many bones; site of blood cell formation.

Brain – Complex organ that is the control center of the body

Brain Stem – Part of the brain that controls basic body functions such as breathing, heartbeat, and digestion

bronchi – tube leading from the trachea into the lungs

bronchiole – smaller tubes the bronchi branch into

bronchitis – disease caused by an inflammation of the bronchi

Capillary – Small blood vessel connecting arteries and veins where oxygen transfer takes place

Capillary Bed – Network of capillaries providing oxygen and nutrients to organs

Carbohydrates - Nutrients that include sugars, starches, and fiber; give your body energy; organic compound.

Cardiac muscle- An involuntary and specialized kind of muscle found only in the heart.

Cartilage- Smooth covering found at the end of bones; made of tough collagen protein fibers; creates smooth surfaces for the easy movement of bones against each other.

Cell Body – Part of the neuron that contains the nucleus and organelles

Central Nervous System (CNS) – Part of the nervous system consisting of the brain and spinal cord

Cerebellum – Part of the brain that controls body position, coordination, and balance

Cerebrum – Part of the brain that controls voluntary motion and speech

Chemical digestion - Digestion in which large food molecules are broken down into small nutrient molecules.

Cilia – Small hairs that push mucus and pathogens out of your body

Circulation – The movement of blood around the body

Cochlea – Liquid-filled cavity in the ear

Collagen-

Compact bone- The dense, hard outer layer of a bone.

Connective tissue- Tissue that is made up of different types of cells that are involved in structure and support of the body; includes blood, bone, tendons, ligaments, and cartilage.

Constipation - Having three or less bowel movements each week.

Contraction - Shortening of muscle fibers.

Cornea – Clear protective layer on the outside of the eye

Coronary Circulation – The process of providing oxygen to the heart muscle

Coronary Heart Disease – Atherosclerosis blocking blood flow to the heart

Dairy - Milk products.

Dendrite – Part of the neuron that receives nerve impulses

Dermis- The layer of skin directly under the epidermis; made of a tough connective tissue that contains the protein collagen.

dialysis – artificial kidney function

diaphragm – sheet of muscle that contracts or relaxes to let air into and out of the lungs.

Diastolic Pressure – Measure of the lowest blood pressure

Diet - The sum of the food and drinks consumed by a person. Especially in regard to his or her health.

Digestion - Process of breaking down food into nutrients.

Duodenum - The first part of the small intestine; where most chemical digestion takes place.

Eardrum – Part of the ear that vibrates from sound waves

Elimination - The process in which solid food waste passes out of the body.

Enzymes - A substance—usually a protein—that speeds up chemical reactions in the body.

Epidermis – Outer layer of skin

Epidermis- The outermost layer of the skin; forms the waterproof, protective wrap over the body's surface; made up of many layers of epithelial cells.

epiglottis – flap of connective tissue that covers the trachea when eating to prevent choking

Epithelial tissue- A tissue that is composed of layers of tightly packed cells that line the surfaces of the body; examples of epithelial tissue include the skin, the lining of the mouth and nose, and the lining of the digestive system.

Esophagus - The narrow tube that carries food from the throat to the stomach.

excretion – act of removing waste from the body

excretory system – group of organs that removes waste from the body

exhalation – movement of air out of the body

Extensor - The muscle that contracts to cause a joint to straighten.

external respiration – the process of air entering the body, going to the lungs and exchanging oxygen for carbon dioxide

Fever – Raising of the body temperature above normal

Fixed joints- Joints which do not move. Skull joints, for example.

Flexor- The muscle that contracts to cause a joint to bend.

Food allergy - A condition in which the immune system reacts to harmless substances in food as though they were harmful.

Fruit - A sweet, fleshy part of a plant which can both be eaten and has at least one seed.

Fungi – Simple organisms that can have one or more cells

Genetic – Able to be passed on from parents to offspring

Gliding joints- Joint structure that allows one bone to slide over the other; examples includes the joints in the wrists and ankles.

Grains - Any food made from wheat, rice, oats, cornmeal, barley or another cereal grain is a grain product. Bread, pasta, oatmeal, breakfast cereals, tortillas, and grits are examples of grain products.

Hearing – The ability to detect sound

Heart Attack – The complete blockage of a coronary artery

Hemoglobin – Oxygen-carrying protein

hereditary – able to be passed on from parents to children

Hinge joints- Joint structure in which the ends of bones are shaped in a way that allows motion in two directions only (forward and backward); examples include the knees and elbows.

Homeostasis- The ability of the body to maintain a stable internal environment in the response to external changes.

Hormones - Regulatory molecules used in many bodily processes, including digestion.

Hyperopia – Vision disorder in which light is focused behind the retina

Hypertension – Disease in which a person always has high blood pressure

Hypodermis- Fatty layer of tissue that lies under the dermis, but is not part of the skin. Also called the subcutaneous tissue.

Ileum - The third part of the small intestine; covered with villi; the few remaining nutrients are absorbed in the ileum.

Immune Response – Reaction of the body when a pathogen enters

Infectious – Able to be spread from one person to another

Inflammation – Reaction to infection involving increased blood flow

Ingredients - A specific item that a food contains.

inhalation –movement of air into the body

Insoluble fiber - Large, complex carbohydrate; does not dissolve in water; moves through the large intestine and helps keep food waste moist so it can pass easily out of the body.

Integumentary system- The outer covering of the body; made up of the skin, hair, and nails.

internal respiration – the process of blood taking oxygen to the cells of the body and exchanging it for carbon dioxide

Involuntary muscle- A muscle that a person cannot consciously control; cardiac muscle and smooth muscle are involuntary.

Iris – Colored part of the eye around the pupil

Jejunum - The second part of the small intestine; where most nutrients are absorbed into the blood; lined with tiny "fingers" called villi.

Joints- Point at which two or more bones meet.

Keratin- Tough, waterproof protein that is found in epidermal skin cells, nail, and hair.

kidney – organ that filters urine

kidney stone – crystalized nitrogen-bearing compound that can lead to intense pain

Ligaments- Fibrous tissue that connects bones to other bones; made of tough collagen fibers.

Lipids - Nutrients such as fats that are rich in energy; organic compound.

Lymphocytes – White blood cells involved in the immune response

Lysozymes – Enzymes that kill pathogens

Mechanical digestion - Digestion with the teeth.

Melanin- The brownish pigment that gives skin and hair their color.

Minerals - Chemical elements that are needed for body processes.

Motor Division – Part of the PNS that sends messages from the brain back to the internal organs

Motor Neuron – Neuron that carries messages from the brain and spinal cord to the organs and muscles

Movable joints- Most mobile type of joint; the most common type of joint in the body.

Mucus – Moist sticky substance that traps pathogens

Mucus Membrane – Area of the body not covered by skin

Muscle fibers - Long, thin cells that can contract; also called muscle cells.

Muscle tissue- Tissue that is composed of cells that have filaments that move past each other and change the size of the cell. There are three types of muscle tissue: smooth muscle, skeletal muscle, and cardiac muscle.

Myelin – Fatty layer that allows nerve impulses to move more quickly

Myopia – Vision disorder in which light is focused in front of the retina

MyPlate - Diagram that shows what portions of which food groups you should include in your diet. Updated from MyPyramid.

MyPyramid - Diagram that shows how much you should eat each day of foods from six different food groups.

Negative Feedback Loop- A mechanism of control in the body in which the result of a bodily function acts as a signal to stop.

Nerve – Group of nerve cells

Nerve Impulse – Message sent by the nervous system

Nervous tissue- Composed of nerve cells and related cells.

Neuron – Nerve cell that sends messages throughout the body

Noninfectious – Not able to be spread from one person to another

Nutrients - Chemicals in food that your body needs.

Nutrition Facts - The label on packaged food that shows the nutrients in the food.

Oil glands- Skin organ that secretes an oily substance, called sebum, into the hair follicle.

Organ – A group of tissues working together

Organ – Group of specialized cells working together

Organ- A structure made of two or more tissues that work together.

Organ System – A group of organs working together

Organ System – Group of organs working together

Organ system- A group of organs that work together.

Organelle – Small structure inside a cell

Parasympathetic Division – Division of the autonomic nervous system that controls involuntary motion under normal circumstances

Partly movable joints- Joints which can only move in one direction; for example, elbows.

Pathogen – Something that causes disease

Pathogen – Substance capable of causing infection or disease

Periosteum- Tough, shiny, white membrane that covers all surfaces of bones.

Peripheral Nervous System (PNS) – Part of the nervous system consisting of all the nerve cells outside the CNS

Peristalsis - The wave-like movement of the intestinal muscles used to move food from the esophagus to the anus.

Phagocyte – White blood cell that engulfs and destroys pathogens and debris

Phagocytosis – Process in which phagocytes destroy pathogens and debris

pharynx – tube through which food and air travels; commonly called the throat

Pinna – The outer ear

Pivot joints- Joint structure in which the end on one bone rotates within a ring-type structure which can be made partly of bone and partly of ligament; example includes the joint between the radius and ulna.

Plaque – Material that can build up and block arteries

Plasma – The liquid part of blood

Platelet – Part of the blood that assists in clotting

Protein - Nutrients made up of smaller molecules called amino acids; give your body energy; help control body processes; organic compound.

Protozoa – Single-celled organisms with nuclei

Pulmonary Artery – Artery that takes blood from the heart to the lungs

Pulmonary Circulation – Circulation of blood from the heart to the lungs, and back to the heart

Pulmonary Vein – Vein that takes blood from the lungs back to the heart

Pupil – Small black opening in the eye that lets in light

Red Blood Cell – Disc-shaped cell that carries oxygen

Red marrow-

Reflex Arc – Nerve impulse that only makes it to the spinal cord, and never gets to the brain

Retina – Area at the back of the eye on which light is focused

Sebum- An oily substance secreted by oil glands which breaks down bacteria.

Secretions – Things that come out of the body

Seizure – Period of unconsciousness, possibly including violent muscle movements

Semicircular Canals – Liquid filled part of the ear involved in balance

Semilunar Valve – Valve separating each of the heart's ventricles from the arteries leaving the heart

Sensory Division – Part of the PNS that sends messages from sense organs to the brain

Sensory Neuron – Neuron that sends messages from the organs to the brain and spinal cord

Skeletal muscle- The muscle that is usually attached to the skeleton.

Skeletal system- Body system that is made up of bones, cartilage, and ligaments.

Skeletons- Sturdy scaffolding of bones and cartilage that is found inside vertebrates.

Skin- The largest organ in the body. It covers the body; keeping water out, and helping keep the temperature stable inside.

Skull – Bones that protect the brain

Small intestine - The narrow tube between the stomach and large intestine where most chemical digestion and absorption of nutrients take place.

Smooth muscle- Involuntary muscle found within the walls of organs and structures such as the esophagus, stomach, intestines, and blood vessels.

Soluble fiber - Large, complex carbohydrate; dissolves in water; helps keep sugar and fat at normal levels in the blood.

Somatic Nervous System – Part of the motor division of the PNS controlling voluntary motion

Sphygmomanometer – Tool used to measure blood pressure

Spinal Cord – Tube of neurons that carries messages to and from the brain

Spongy bone- Lighter and less dense than compact bone; found toward the center of the bone.

Sprains- A ligament injury; usually caused by the sudden overstretching of a joint which causes tearing.

Stretching exercises- Exercises which warm-up the muscles.

Stroke – Disease caused by atherosclerosis of the arteries providing blood to the brain

Sweat glands- Gland that opens to the skin surface through skin pores; found all over the body; secretes sweat.

Sympathetic Division – Division of the autonomic  nervous system that controls the “fight or flight” response

Synapse – Place where axons and dendrites meet

Systolic Blood Pressure – Measure of the highest blood pressure

Taste Buds – Clusters of sensory neurons found on the tongue

Tissue – A group of cells working together

Tissue- A group of cells that work together for a common purpose.

Touch – Sense of pain, pressure, and temperature

trachea – tube through which air travels on its way to the lungs

urea – nitrogen-containing compound in the urine

ureter – tube that moves urine from the kidneys to the urethra

urethra – tube through which urine leaves the body

urinary bladder – organ that stores urine before it is released

urinary system – group of organs that remove urine waste from the body

urine – combination of water and liquid wastes in the body

USDA - United States Department of Agriculture.

Vector – Organism that transfers disease

Vegetables - Any vegetable or 100% vegetable juice counts as a member of the Vegetable Group. Vegetables may be raw or cooked; fresh, frozen, canned, or dried/dehydrated; and may be whole, cut-up, or mashed.

Vein – Blood vessel that brings blood back to the heart

Ventricle – One of the two chambers at the bottom of the heart that pumps blood to other parts of the body

Vertebrae – Bones that protect the spinal cord

Virus – Non-living pathogen that takes over cells by injecting genetic material

Vitamins - Substances that the body needs in small amounts to function properly.

Voluntary muscle- A muscle that a person can consciously control; skeletal muscle is voluntary.

Water - One of the essential nutrients needed by the body.

White Blood Cell – Blood cell that protects the body from disease

Yellow marrow- The bone marrow that makes white blood cells.

# Unit Description

Your body does a tremendous number of things all the time. In these sections, you'll learn about your skeleton, bone joints, muscle tension, blood cells, lungs, ears, eyes, and so much more!

Some of the experiments you'll be creating include: a working lung model so you can see how pressure differences affect the lungs and diaphragm; a robotic hand model with real tendons; working eye model which you can adapt for near and far sighted conditions; how to do chemical fingerprinting… and so much more!

We will go over integumentary, skeletal, and muscular systems by beginning with a general overview of the body. We'll also learn about what should we eat, what happens to food once we swallow it, and how your digestive system works, and why the standard American diet of fries, shakes, and sodas wreaks havoc on our digestive system. Another system we'll cover is the respiratory system, which is responsible for providing your organs with the oxygen it needs and removing the carbon dioxide it doesn't. Speaking of things your body doesn't need, our next topic will be the excretory system, the one responsible for getting rid of *all* waste from the body. We'll talk about how your body allows you to do all the things you do. In order to do those things, your body must stay healthy, and keeping you healthy is the job of the immune system.

# Objectives

## Lesson 1: Skin, Bones & Muscles

We will go over integumentary, skeletal, and muscular systems by beginning with a general overview of the body.

The first section describes how the organization of the body helps maintain the normal state called *homeostasis*. The body is made up of millions of cells, which are organized into tissues. Two or more tissues helping perform the same function is called an organ.

The second section deals with our largest organ (our skin) as well as our hair and nails. These three together are called the integumentary system. We'll soon discover the main functions of our skin, hair, and nails, as well as what they are made out of.

Bones are made up of several parts; bone marrow (red and yellow), spongy bone, compact bone, and the periosteum.

Bones give the body its structure—its shape. It holds up the tissue against the pressure of gravity. Bones also protect certain tissues.

The bones work in concert with the muscles to give us the ability to move. Certain parts of certain types of bones make blood cells. Bones store calcium and phosphorus (mostly calcium).

It's always good to have a strong finish—so we end with muscles! How do they do what they do? What are they made of? What would an absurdly muscular man look like? All of these questions and more are answered in this section.

By the end you will have a whole new vocabulary and a whole new—and detailed—way to look at the human body.

# Objectives

## Lesson 2: Digestive System

What should we eat? What happens to food once we swallow it? How long is our digestive system? You'll learn all about food, nutrients, how your digestive system works, and why the standard American diet of fries, shakes, and sodas wreaks havoc on our digestive system.

**Food and Nutrients**

We need to eat and drink to have energy, build and repair our bodies, and maintain homeostasis.

The six things we need to consume are protein (things like fish and certain vegetables), carbohydrates (things like bread), lipids (fat), vitamins (found in high concentrations in fruits and vegetables), minerals (certain molecules our systems need), and water.

**Creating a Healthy Diet**

The new, simpler "My Plate" division of dietary recommendations from the USDA has replaced the old "My Pyramid".

A healthy diet is a *balanced* diet. A diet that includes the right amounts of protein, grains, fruits, vegetables, and dairy.

We will also learn how to check the nutrition facts found on the labels of packaged food and drink. They will tell you the information you need to know to make smart food decisions!

Exercise is just as important as a good diet—we need both. A good goal is 60 minutes of exercise 3 times a week.

**The Digestive System**

Digestion is broken down into four steps: mechanical digestion (with our teeth), chemical digestion (with our enzymes), absorption (when we take the nutrients into our body), elimination (when we get rid of the waste).

Enzymes are chemicals in our body which make chemical reactions go faster; they are catalysts.

The digestive organ—from mouth to anus—is enormous. On average, it's over thirty feet long!

Keeping your digestive system healthy involves several things:

- Eating healthy food; making sure to get all the right nutrients and fiber.
- Taking care of yourself if you contract a food-borne illness.
- Drinking lots of water.

It's important to be aware of any food allergies or intolerances you may have. For example, some people are allergic to peanuts and can die from eating even one! Other people cannot process dairy products like milk and cheese due to intolerance to lactose.

# Objectives

## Lesson 3: Cardiovascular System

Every living thing, from tiny bacteria, to giant oak trees, to you and me, is made of tiny things called cells. When groups of cells work together, they form structures called tissues.

When groups of tissues work together, they form structures called organs. Your brain, lungs, and heart, are all examples of organs.

When groups of organs work together, they make organ systems, which are sometimes just called systems. Your body has many systems, including the cardiovascular system.

In this lesson, you will learn more about the cardiovascular system, and the important things it does to keep you alive. Here are the highlights for this lesson:

- Learn about blood, blood vessels, and the heart
- Learn how the flow of blood throughout the body helps us live
- Learn the process of circulation
- Learn about common diseases of the cardiovascular systems and how to minimize the risk of getting these diseases

# Objectives

## Lesson 4: Respiratory & Excretory Systems

In this section, you will learn about two different body systems: respiratory and excretory systems.

The excretory system removes waste from the body. The respiratory system removes carbon dioxide, which is one form of waste, from the body. Along with carbon dioxide, a major form of waste is urine, which is removed by the urinary system. This is important because removing waste is a crucial function of the body.

Diseases to any of these systems can cause major problems for individuals. At the end of this section, you will know:

- The parts of the respiratory system and what they do
- The path air takes as it goes into and out of the body
- The way pressure affects breathing
- The major parts of the excretory system and the other systems the organs of the excretory system belong to
- Common diseases of the respiratory and excretory systems

# Objectives

## Lesson 5: Controlling the Body

How do you keep your balance while riding a bike? Why do certain things smell and taste so good? How does our brain keep all the parts of our body doing their jobs, while still allowing us to learn and remember new things? The answer to these, and many more, questions, can be answered by learning about the nervous system.

This group of organs is so important because it controls all the other systems in our body. There is just no way we'd be able to survive without it. In this section, we'll talk about the most important organs of the nervous system, how they work, and what happens if they don't work. You will learn:

- The parts of the brain, and what each part does
- The structure and function of nerve cells
- How messages are passed from the body to the brain and back to the body
- How the sense organs allow us to see, hear, touch, smell, taste and keep our balance
- The causes and symptoms of some common diseases of the nervous system

# Objectives

## Lesson 6: Diseases and Defenses

Our body does a pretty remarkable job of keeping us healthy. Every day, we are bombarded by germs, yet we generally stay pretty healthy.

In this section, you will learn about what the body does to prevent germs from making their way into the body, and what happens if the germs do somehow get in. This is important because knowing what makes us sick, and what the body does about it, can help you make choices that will keep you and those around you healthy. If you do get sick, knowing these things will help you get well as soon as possible.

In this section, you will learn:

- The difference between infectious and noninfectious diseases
- How infectious diseases can be prevented
- How your skin protects your body against infection
- The importance of inflammation, fever, mucus, and fever in stopping infections
- What an immune responses is, and how white blood cells are involved in them
- How people develop immunity to disease

# Textbook Reading

## Lesson 1: Skin, Bones & Muscles

### Organization of the Body

Our cells are happiest when they are in their normal or "home" state. This is a state in which the temperature, the concentrations of molecules, and molecules being produced are all at the levels at which they normally function. This "normal" or "home" state is called **homeostasis**.

Our cells—and the tissues and organs they constitute—work hard to maintain **homeostasis**. We can see this in action. When it is cold out and we shiver, that's our body trying to get the temperature up to normal levels. When it's hot out and we sweat, that's our body trying to get the temperature down to normal levels. We see our body trying to maintain homeostasis when we feel hungry, or thirsty. Homeostasis is an important characteristic of living things.

**If you were in the desert,** your body would be working hard to maintain homeostasis—despite the high temperature and the lack of water.

### Cells, Tissues, and Organs

There are many different types of cells in the body, but all of them work to maintain homeostasis. For example, there are specific muscle cells for muscles, specific heart cells for the heart, specific pancreas cells for the pancreas, and skin cell cells making up the skin. The different cell types differ in how they function. They all work together to make sure the body functions normally.

A **tissue** is composed of specific cells performing the same function. An **organ** is made up of two or more types of tissues working together. Organs which work together form **organ systems**. Organ systems work together to maintain homeostasis.

There are four main types of tissue. Tissues are groups of cells which together form specific functions. These types are: **epithelial tissue**, **nervous tissue, muscle tissue**, and **connective tissue.**

Epithelial tissue is found in tightly packed surface layers; such as the skin, as well as the lining of the digestive system and the lining of the mouth and nose.

Nervous tissue is responsible for relaying information. All together the nervous tissues form the nervous system. The nervous system includes the sensory nerves in the body, nerves in the spinal cord, and the brain.

There are three types of muscle tissue: smooth muscle, skeletal muscle, and cardiac muscle. All three cell types have filaments which change the size.

Bone, cartilage, and tendon tissues are examples of connective tissue. Connective tissue connects one part of the body to another and is involved in structural support.

**Negative feedback loop.** The low blood temperature sends a message to the brain which then sends a message to the adrenal gland, which increases the blood temperature by raising the metabolism. The raised blood temperature then signals to the brain that it's time to stop sending the message to the adrenal gland.

A key way organ systems maintain homeostasis is via a **negative feedback loop**.

A negative feedback loop simply means that the result is a signal to stop. For example, if you haven't eaten for a while your body will sense that your blood sugar is low. The low blood sugar acts as a signal for the body to start releasing sugar into your blood. However, once the blood sugar levels are back to normal—homeostasis has been reestablished—that normalcy acts as a signal for the body to stop releasing sugar into your blood.

Many problems can occur if these negative feedback loops do not function properly. For example, diabetes is a disease which results from the blood sugar negative feedback loop functioning abnormally.

## The Integumentary System

The *big* deal is **skin**—the biggest organ in the body. The skin, along with the **hair** and **nails** make up the **integumentary system**. They help maintain homeostasis by:

- Helping regulate temperature
- Sending sensory information about the environment outside the body to the brain.
- Keeping water and germs out of the body.

- Acts as a barrier to sunlight.

The integumentary systems ability to do these four things helps maintain homeostasis and keep your body healthy!

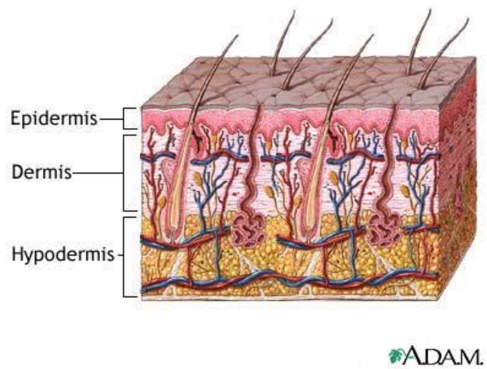



**Figure 1 The Integumentary System.** *The integumentary system, and a cross-section of the skin showing its three layers.*

## Skin

The skin has two layers. The **epidermis** is the waterproof layer of dead skin cells which sits on top of the **dermis**. The **hypodermis** is a fatty layer of tissue underneath the dermis. As you can also see, the hair and sweat pores originate in the hypodermis.

The epidermis contains **keratin** (which makes it waterproof) and **melanin** (a brownish pigment which gives the skin color, and helps protect the lower layers from the sun).

When you are scared, your dermis might be causing **goosebumps** to appear. That is because the dermis contains tiny muscles which pull up on the hair follicles and make them stand up when you're cold or afraid. The dermis is made of the protein **collagen**. Collagen is a tough connective tissue.

Hair follicles also have **oil glands** which secrete water-proofing oil called **sebum** onto the hair. Sebum can also prevent the growth of bacteria underneath the skin. If the oil gland becomes blocked it can develop into pimples called **acne**.

**Figure 2 Acne**. *A woman with acne on her face.*

Lastly, the skin uses **sweat glands** to control temperature. The glands secrete sweat, which evaporates off—taking heat with it.

## Hair and Nails

What are hair and nails made of? Do they have nerves?

Hair and nails are made of keratin. Keratin is a tough, waterproof protein. Hair color comes from melanin—the same pigment that acts as a sun-block in the skin. Luckily, they do not have nerves—otherwise it would be pretty painful to get a hair cut or clip your nails!

Nails act as protective plates on the fingers, while hair serves several purposes. Hair can keep use warm, although it's mostly used this way by other mammals. The melanin protects us from the sun. Hair can even act as filters—filtering the air that comes up our noses.

Keeping your skin, hair, and nails clean is an important part of keeping them healthy. Poor hygiene can lead to offensive **body odor**—a bad smell that comes off your skin, hair, and nails. Good skin hygiene can help fight both body odor and acne.

Sunlight is a double-edged sword. On the one hand, your skin makes vitamin D when exposed to sunlight. On the other, sunlight can damage skin and even lead to skin cancer. It's important to get sunlight, but to do so safely; using a sun block that blocks UV rays.

## The Skeletal System

What makes us so human-shaped? Answer: Our bones! Without them we would be a blob of tissue. Our **skeletal system**—our **bones**, **ligaments**, and **cartilage**—give us our structure.

Maintaining a healthy skeletal system is important. We must make sure we get the right nutrients—especially while we're still growing.

If our bones get broken, it's important to see a health-care professional; if not correctly treated, bones may not heal properly.

Vertebrate (animals with backbones) **skeletons** (the bones) are connected to each other by protein fibers called ligaments. Where two bones meet, there's a layer of cartilage to create a smooth movement-surface.

The main functions of bones are:

- Support: Bones give the body its structure—its shape. It holds up the tissue against the pressure of gravity.
- Protection: The bones protect certain tissues. For example, the skull protects the brain,

and the ribs protect the heart and lungs.
- Movement: The bones work in concert with the muscles to give us the ability to move.
- Making Blood Cells: Certain parts of certain types of bones make blood cells.
- Storage: Bones store calcium and phosphorus (mostly calcium).

## What are bones?

Bones are made up of several parts; bone marrow (red and yellow), spongy bone, compact bone, and the periosteum.

**Bone marrow** makes blood cells. Red blood cells are made in the **red marrow**, while white blood cells are made in the **yellow marrow**. When babies are born they only have red marrow.

**Spongy bone** is a light, spongy type of bone found inside bones.

**Compact bone**, on the other hand, is hard and makes up the outer layer of bones. The compact bone layer is covered by a thin white membrane called the **periosteum**.

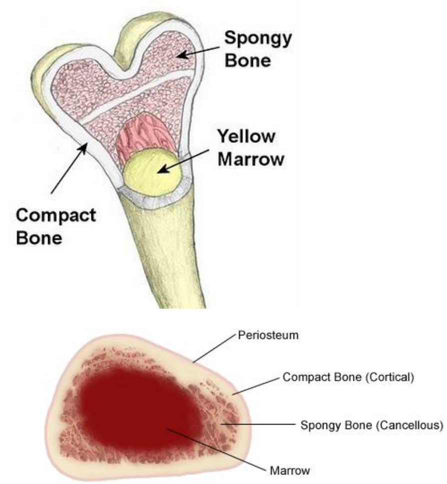



**Figure 4 Cross-sections of human bones.**

## Growth

Bones begin growing very early, and stop growing between the ages of 18-25. At about eight weeks of development, we form a skeleton of cartilage and other connective tissues. As we grow up, the cartilage becomes bone. Normally, we have all of our bones by our early twenties. We still keep some of the cartilage in areas like our nose and ears.

## Movement

Joints are essential in how we move. Bones work as levers and the joints work as the fulcrums—making our movement easier. Some joints are fixed; for example, many in the skull. Some allow only little movement; for example, the vertebrae which make up the backbone. Lastly, there are movable joints; for example, our knees and elbows. These make up the three classes of joints: **fixed joints, partly movable joints, and movable joints**.

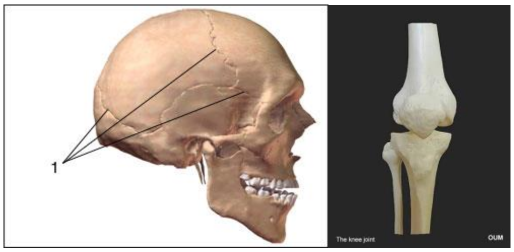



**Figure 5 Examples of fixed and movable joints.** *Skull joints (fixed) and a knee joint (movable).*

There are four types of movable joints:

1. **Ball and Socket joints**: In these joints, one bone fits into the other because one has a ball-shaped ending, and the other has a cup-shaped ending which fits around the ball. These are the most common type of joint. Hips, fingers, and toes are all ball and socket joints.

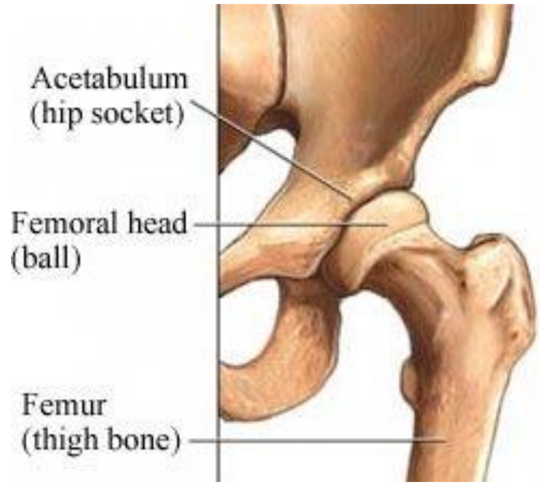



**Figure 6 Example of a ball and socket joint.** *The femoral head of the femur (thigh bone) fits into the hip socket.*

2. **Hinge joints:** The joints that only move two directions. Elbows and knees fall into this category.

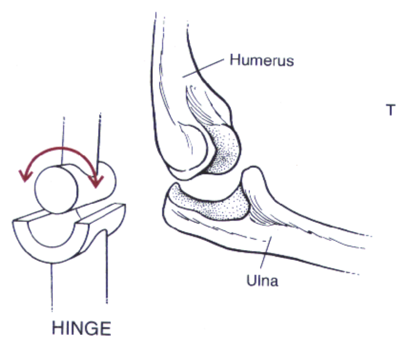



**Figure 7 Example of a hinge joint.** *The elbow joint.*

3. **Pivot joints:** This joints allow the bones to rotate within a ring—for example the palm of your hand.

**Figure 8 Pivot joint.**
*Human palm.*

4. **Gliding joints:** bones are only allowed to glide over one another. For example the joint that allows you to flex your wrist.

## Keeping the skeletal system healthy

The keys to keeping the skeletal system healthy are:

- Eating well.
- Getting exercise.
- Taking care of injuries to the skeletal system.

Eating a good balanced diet is very important for overall health, but making sure to get specific nutrients help ensure a healthy skeletal system throughout your life! Those nutrients are: calcium and vitamin D. 1300mg of Calcium is recommended (one cup of milk has about 300mg of Calcium) and 200IU of vitamin D (31/2 ounces of cooked salmon is about 360IU of vitamin D). Calcium can be found in dairy products as well as broccoli and cabbage. Your skin makes vitamin D when exposed to sunlight. Additionally, fish is rich in vitamin D.

It's important to get out an exercise to maintain a healthy skeletal system. When we exercise we put stress on our bones and stimulate them to stay strong. Exercising also keeps the muscles which work with the bones strong. Just remember to stretch and wear all the appropriate safety gear!

Lastly, if an injury occurs—a bone breaks or a ligament tears, for example—it's important to see a medical professional as soon as possible. Otherwise, the skeletal system may not heal properly.

## The Muscular System

What do our muscles do—and how do they do it? How many types of muscles do we have? How do we take care of them? These are the questions we'll answer in this section.

Our muscular system helps us move, and helps keep us alive. Our muscles are involved in actions we decide to do (kicking a ball, for example) as well as actions we do without thinking about (like digesting food). There are three types of muscles responsible for these actions:

- **Skeletal muscle:** Muscle attached to our bone that allows us to move. Generally, skeletal muscle is voluntary (we choose to use them), however in some cases (when we touch something hot, for example) they move involuntarily.
- **Smooth muscle:** We do not control this muscle. It is found lining our organs. It helps us digest, or our blood vessels contract and dilate.
- **Cardiac muscle:** As you might be able to tell from the name, cardiac muscle is found only in the heart. Cardiac muscle is involuntary—thankfully! Could you imagine how stressful it would be to make your heart beat all the time?

## Bone movers

Muscle cells have the ability to contract. **Muscle fibers** in the muscle cells allow them to contract. Through this **contraction** we move. Muscles work in pairs; the muscle that makes the joint bend, and the muscle that makes the joint straighten out. The bender is called the **flexor** and the straighten-er is called the **extensor**.

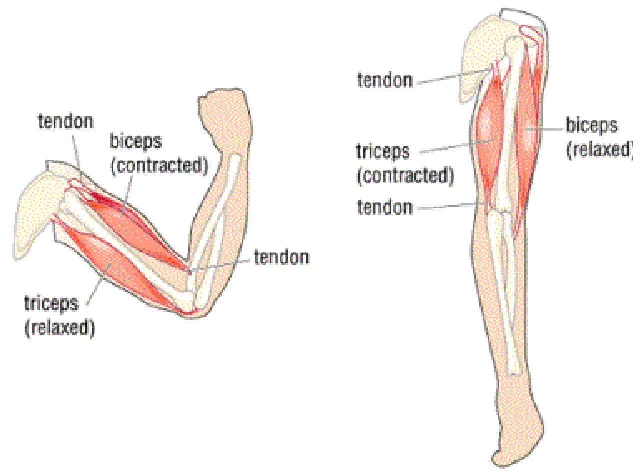



**Figure 10 Extensors and flexors working together.** *In the first image the elbow bends because the biceps contract while the triceps relax. In the second image the knee straightens because the biceps relax and the triceps contract.*

## Nerves: how we control our muscles

Nerves are both how we receive sensory information about our environment, and how we control our muscles. Some signals we control, and others we do not. For example, when we go swimming nerves tell us the temperature of the water regardless if we want to know it, we consciously move our arms and legs to swim, and we unconsciously (without thinking about it) control our hearts.

### Keeping muscles health

Keeping our muscles healthy involves:

- Eating a healthy diet.
- Stretching exercises
- Anaerobic exercises
- Aerobic exercises
- Taking immediate care of muscle injuries

Eating healthily is especially important when we are growing up. Muscles are made from protein, so it's important to make sure that we get enough protein while we are still growing.

Exercising is important to stay healthy overall (to avoid diseases such as type 2 diabetes, for example), and specifically important for keeping our muscles healthy. There are three main types of exercise; **stretching exercises** which make our muscles more flexible, **anaerobic exercise** which build our muscles by making them work against resistance, and **aerobic exercises** which increase our endurance. Touching our toes is an example of a stretching exercise, push-ups are an example of anaerobic exercise, and jogging is an example of aerobic exercise. Doing all three regularly is important in maintaining a healthy muscular system. A good goal is to get sixty minutes of these exercises five days a week.

Taking care of muscle injuries, if they occur, is equally important. **Sprains** occur when the muscle tears. Sprains can be painful and result in swelling. Treatment usually involves a combination of stretching and exercises. The best way to avoid muscle injuries is to stretch well before exercising.

It goes without saying; **anabolic steroids** should never be used to increase muscle mass. The body makes small amounts of anabolic steroids to repair itself. However, using anabolic steroids to increase muscle mass damages the kidneys, liver, reproductive system, and more.

# Lesson 2: Digestive Systems

### Food and Nutrients

Ironically, people often say "to our health" when they drink alcohol; which is bad for our health. In this chapter we will cover food, drink and their effects on our health.

You are what you eat. What you eat gives you the energy to do what you do, the building blocks to build and repair yourself, and to keep all your systems running well (maintain homeostasis). Does that mean that if you eat nothing but beef you will start moo-ing?

No! But it does mean that if your diet is healthy (contains the energy, building blocks, and nutrients you need in the right amounts) then chances are you will be healthy

A **diet** is simply the sum of the food and drink consumed considered in terms of its effect on health. When we say "diet", we sometimes immediately think about losing weight.

However, in this chapter on <u>food and its effects on our bodies</u> we will use the word diet to simply mean the sum of food and drink consumed.

In this chapter we will consider several things:

- Why we drink and eat.
- What we drink and eat.
- What happens to our food and drink after we put it in our mouths.

## The Six Nutrients

**Nutrients** are the molecules our body needs for:

a.) Energy
b.) To build and repair itself
c.) To maintain homeostasis

There are six types of nutrients which the body needs:

**Protein:** Proteins are made up of smaller molecules—called amino acids—which are strung together and then folded into a three-dimensional shape. Proteins are the main build blocks of our tissues, they help fight bacteria and other harmful invading organisms and molecules, they are also involved in many biological processes in the body from cell signaling to carrying oxygen in the blood. They are very important. High concentrations of protein are found in meat as well as nuts and some vegetables. It is important not only to get the right quantities (~34 grams/day) but also all essential amino acids. The best way to ensure a balanced protein diet is to eat both plant and meat high protein sources.

**Carbohydrates:** These are found in things like bread, potatoes, and sugar. They include sugars, starches, and fiber. They provide energy. There are two types of fiber: water-soluble and water-insoluble. Soluble fiber helps maintain blood-sugar levels. Insoluble fiber helps move food-waste through the digestive system.

**Lipids:** Fats. Lipids have many functions in the body, from storing energy to making up the cell-membrane in cells. Lipids also help the blood clot, protect nerves, and control blood pressure. Fat is an important part of the diet, <u>but only in small quantities</u>. Consuming too much fat can result in obesity as well as diseases such as type 2 diabetes.

**Vitamins:** Vitamins help maintain homeostasis by acting as key elements of biochemical functions in the body. A common example of a vitamin is vitamin C—found in oranges.

**Minerals:** Like vitamins, minerals do not provide energy, but play important roles in bodily functions. A common example is fluoride, which (among other functions) helps maintain dental health.

**Water:** Yes, it is a nutrient! Up to 60% of the human body is water. What percent of the brain is water, you ask? 70%! We can only last for a couple days without water. Making sure to get enough water each day is essential—especially when it is warm out and/or you are exercising!

## Summary

Eating and drinking are essential parts of our life. Part of maintaining a healthy lifestyle is making sure to eat and drink the right quantities of the six essential nutrients. Those nutrients are: protein, carbohydrates, lipids, vitamins, minerals, and water.

## Creating a Healthy Diet

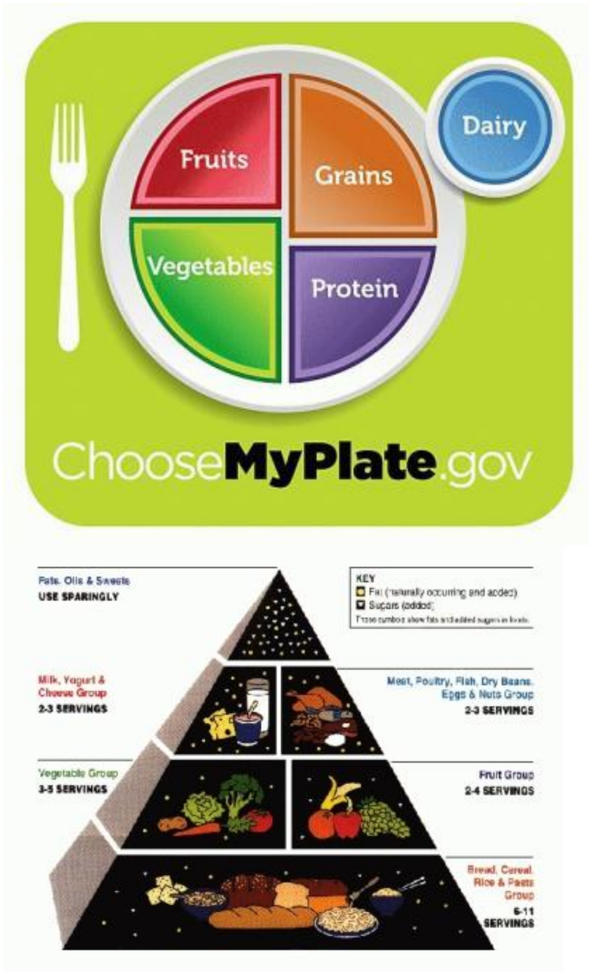



**Figure 12 New and old USDA dietary recommendation schemes.** The simpler MyPlate has recently replaced the long-standing, complicated food pyramid scheme of representing a balanced diet.

We already know what a diet is—the sum of food and drink consumed. Now, what does it mean to have a healthy diet? Does it mean to eat all vegetables? Does it mean to eat only meat? No.

A healthy diet is a balanced diet. This is what **MyPlate** demonstrates. A balanced diet means getting the right amounts of nutrients.

MyPlate guidelines are recommendations from the United States Department of Agriculture (USDA). Since 1958 the USDA has recommended a balanced diet in the form of the food pyramid. However, the pyramid proved to be too complicated for most Americans to efficiently use to create diets. In response, the USDA simplified its recommendations in 2011 into the MyPlate format.

The specific advice of the **USDA** is:

1. **Balance calorie intake.** Enjoy your food, but eat less. Avoid oversized portions.
2. **Eat certain foods**. Make half your plate fruit and vegetables. Make at least half your grains whole grains. Switch to fat-free or low fat (1%) milk.
3. **Eat certain foods in moderation**. Compare sodium in foods like sodium, bread, and frozen meals—and choose the foods with

lower numbers. Drink water instead of sugary drinks.

## Protein

According to the USDA: *All foods made from meat, poultry, seafood, beans and peas, eggs, processed soy products, nuts, and seeds are considered part of the* ***Protein*** *Foods Group.*

The key to choosing the healthy proteins is limiting the fat. On meats the percentage is often listed (for example, 96% lean meat, 4% fat).

## Grains

According to the USDA: *Any food made from wheat, rice, oats, cornmeal, barley or another cereal grain is a grain product. Bread, pasta, oatmeal, breakfast cereals, tortillas, and grits are examples of grain products.*

Grains are divided into 2 subgroups, **whole grains** and **refined grains**. Whole grains contain the entire grain kernel — the bran, germ, and endosperm. For example: whole-wheat flour, bulgur (cracked wheat), oatmeal, whole cornmeal, and brown rice.

Refined grains have been milled, a process that removes the bran and germ. This is done to give grains a finer texture and improve their shelf life, but it also removes dietary fiber, iron, and many B vitamins.

Some examples of refined grain products are white flour, degermed cornmeal, white bread ad white rice.

Most refined grains are enriched. This means certain B vitamins (thiamin, riboflavin, niacin, folic acid) and iron are added back after processing. Fiber is not added back to enriched grains. Check the ingredient list on refined grain products to make sure that the word "enriched" is included in the grain name. Some food products are made from mixtures of whole grains and refined grains."

## Vegetables

According to the USDA: *Any* ***vegetable*** *or 100% vegetable juice counts as a member of the Vegetable Group. Vegetables may be raw or cooked; fresh, frozen, canned, or dried/dehydrated; and may be whole, cut-up, or mashed.*

There are five subgroups of vegetables. They are (according to chooseMyPlate.gov):

1. Dark green vegetables (broccoli, lettuce, kale, spinach, etc)
2. Starchy vegetables (corn, green peas, potatoes, etc.)
3. Red & Orange Vegetables (winter squash, tomatoes, peppers, yams, etc)
4. Beans and peas (chickpeas, kidney, lentils, split peas, black beans)
5. Other vegetables (artichokes, asparagus, avocado, celery, beets, cucumbers, onions, zucchini, etc)

## Fruits

According to the USDA: *Any fruit or 100% fruit juice counts as part of the Fruit Group. Fruits may be fresh, canned, frozen, or dried, and may be whole, cut-up, or pureed.*

## Dairy

According to the USDA: *All fluid milk products and many foods made from milk are considered part of this food group. Most dairy choices should be fat-free or low-fat. Foods made from milk that retain their calcium content are part of the group. Foods made from milk that have little to no calcium, such as cream cheese, cream, and butter, are not. Calcium-fortified soymilk (soy beverage) is also part of the Dairy Group.*

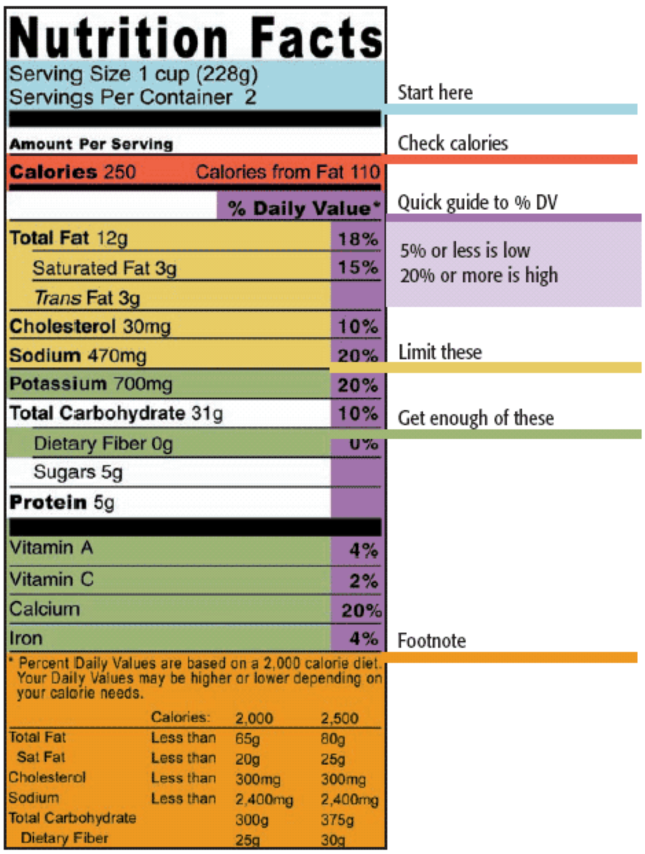
**Selection Tips:** Choose fat-free or low-fat milk, yogurt, and cheese. If you choose milk or yogurt that is not fat-free, or cheese that is not low-fat, the fat in the product counts against your maximum limit for "empty calories" (calories from solid fats and added sugars).

If sweetened milk products are chosen (flavored milk, yogurt, drinkable yogurt, desserts), the added sugars also count against your maximum limit for "empty calories" (calories from solid fats and added sugars).

For those who are lactose intolerant, smaller portions (such as 4 fluid ounces of milk) may be well tolerated. Lactose-free and lower-lactose products are available. These include lactose-reduced or lactose-free milk, yogurt, and cheese, and calcium-fortified soymilk (soy beverage). Also, enzyme preparations can be added to milk to lower the lactose content. Calcium-fortified foods and beverages such as cereals, orange juice, rice milk, or almond milk may provide calcium, but may not provide the other nutrients found in dairy products.

## Check labels

A great way to manage what you consume is to check the **nutrition facts** on the labels. When you read the labels, try to think of how the nutrients fit into MyPlate.




Also important is the **ingredient list**. The ingredients are listed from most used to least used. If you see corn syrup at the top of the ingredients it means that the greatest percentage is the percentage of corn syrup compared with the rest of the ingredients.

## Exercise

Staying healthy means more than just eating healthy—it also means getting regular exercise every week. Sixty minutes of exercise at least three times a week supports healthy eating habits. So, get out there! Throw a ball! Go for a walk! Get some of your friends together and create your own game! Exercise!

Leading a healthy lifestyle means consuming the right quantities of nutrients and getting weekly exercise. The United States Department of Agriculture suggests the recommendations found at chooseMyPlate.gov. Eating healthy also means getting at least three days of exercise in every week.

## The Digestive System

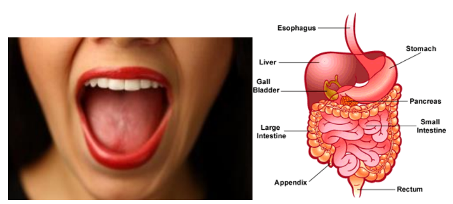



**Figure 15 The digestive system.**

So far, we've talked about the food and drinks we need. What happens to those meals when they enter our mouths?

1. **Digestion.** Digestion involves the breakdown of what we consume into nutrients. The first step is **mechanical digestion**—chewing. After we mechanically break down the food with our teeth, we begin **chemical digestion**. Chemical digestion breaks down what we eat and drink chemically. Chemical digestion is mostly accomplished by proteins called **enzymes**.
2. **Absorption**. After we've broken down the nutrients we need, we absorb them into our body. This step is called absorption.
3. **Elimination**. Lastly, we excrete solid and liquid waste.

## Enzymes

Enzymes make reactions go faster—they are **catalysts**. They are found at every important step of digestion.

Here are some of the key enzymes:

- **Amylase** is found in our saliva (in our mouths). It helps breaks down bread-like things (starches) into smaller sugar molecules.
- **Pepsin** helps us digest protein in our stomachs.
- **Pancreatic lipase** breaks down fats. It is secreted by the pancreas.

## Hormones

What is happening when we *feel* hungry? Or when we *feel* thirsty? What we are feeling is **hormones** signaling our brains that we need food or we need water. Hormones—made by the endocrine system—play a large role in our digestion process. They help maintain homeostasis by stimulating appetite, thirst, as well as many, many other bodily functions.

## Digestive Organs

The digestive system is essentially one long tube. It begins with the mouth and ends with the anus. On average, it is thirty feet long! In between the mouth and anus are many organs which play various roles; esophagus, stomach, small intestine, large intestine, and anus, to name a few.

Food is moved through the tube via muscle contractions. The muscle contractions start in the esophagus and end in the anus; moving in a wave called **peristalsis.** Peristalsis is the name of the movement of the muscle contractions moving the food through the tube.

## Mouth to Stomach

Digestion begins in the **mouth**. In the mouth, the teeth digest food mechanically, and the saliva digests starches chemically. And so begins the journey.

After the mouth, the food travels to the stomach through a narrow tube called the **esophagus**. The esophagus moves the ball of chewed and partially digested food via peristalsis into the stomach.

Once in the **stomach**, the food is further chemically digested. The protein is digested with the enzyme pepsin. Pepsin, along with other chemicals such as hydrochloric acid (HCl) chemically digests the food. Water, salts, and simple sugars are absorbed through the walls of the stomach. The rest of the nutrients are absorbed after exiting the stomach.

## The small intestine

The **small intestine** is about 7m long in adults and is composed of three parts. Even though it's only seven feet long, if it were spread out it would cover a basketball court!

1. **The duodenum.** The duodenum is the first part of the small intestine. In the duodenum the food from the stomach is further digested (chemically). Some of the chemicals are secreted from the duodenum itself, others are secreted from the liver and pancreas.
2. **The jejunum.** Most nutrients are absorbed into the body at this second part of the small intestine. The nutrients are absorbed through tiny blood vessels.
3. **The ileum.** Here nutrients are also absorbed into the blood stream. What is not absorbed in the ileum is passed as waste through the large intestine.

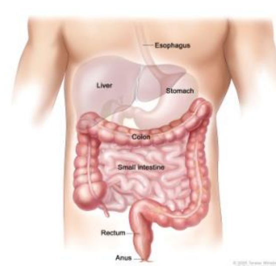



**Figure 16 The intestines.**

## The Large Intestine

The **large intestine** takes the liquid waste from the small intestine, absorbs the excess water, and excretes the solid was through the anus.

The large intestine is home to trillions of helpful bacteria. Although we often think of bacteria as harmful, we want the bacteria in our small intestines. We have a **symbiotic** relationship with the bacteria in our small intestines—we help each other to live. Among other functions, the bacteria in our large intestines produce vitamins $B_{12}$ and K, as well as break down poisons.

## The Liver

**The liver** is essential to digestion, and life. The liver detoxifies the blood, maintains the glucose balance, synthesizes proteins, and produces many chemicals needed for digestion. The liver is essential to life perhaps that is why it is called *the liver*.

## Maintaining a Healthy Digestive System

Keeping your digestive system healthy involves several things:

- Eating healthy food; making sure to get all the right nutrients and fiber.
- Taking care of yourself if you contract a **foodborne illness**.
- Drinking lots of water.

Getting the right nutrients and getting fiber in your diet is extremely important. The nutrients keep your system running well, while fiber helps to move waste through your digestive system. If you do not get enough fiber you may become **constipated**; unable to pass waste.

Foodborne illnesses usually result from food or drink contaminated by harmful bacteria. This often results in diarrhea. To avoid foodborne illness you can:

- Always wash your hands after you go to the bathroom.
- Always wash your hands before you eat.
- Make sure that meats, fish, poultry, and eggs are thoroughly cooked before you eat it.

## Food allergies

Food allergies can be dangerous, even deadly. Common food allergies are: peanut, eggs, fish, milk, and shellfish. If you suspect that you have a food allergy, a medical doctor could be able to check.

**Figure 17 Child suffering from peanut allergy.**

Some peoples' bodies cannot break down certain chemicals. These are called **intolerances**. A common intolerance is lactose intolerance—an inability to break down lactose found in dairy products. Seventy five percent of the world is lactose intolerant.

### Summary

Digestion is the process of food (and drink) being broken down and absorbed. The mouth begins the digestion by breaking down food mechanically and beginning chemical digestions. Protein is digested in the stomach. The small intestine finishes the chemical digestion and absorption of food. The large intestine absorbs excess water from the waste and finally passes it through the anus.

Maintaining a healthy digestive system means maintaining a healthy diet, and taking care of any illnesses, allergies, or intolerances which arise.

## Lesson 3: Cardiovascular System

Every living thing, from tiny bacteria, to giant oak trees, to you and me, is made of tiny things called cells.

When groups of cells work together, they form structures called **tissues**. When groups of tissues work together, they form structures called **organs**.

Your brain, lungs, and heart, are all examples of organs. When groups of organs work together, they make **organ systems**, which are sometimes just called systems. Your body has many systems, including the cardiovascular system. In this section, you will learn more about the cardiovascular system and the important things it does to keep you alive.

## Blood – It's Not Just for Vampires

The whole point of the cardiovascular system is to get blood to all the parts of the body. If there's a whole system just for that, blood must be pretty important. In fact, blood does several important jobs in our body.

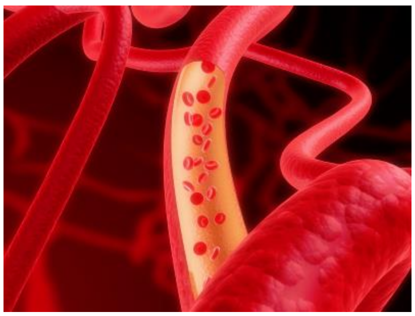


**Figure 18 – Blood has many important jobs in our body.**

First, blood is the body's delivery system. You can think of it as both the postal service (delivering things you want) and the garbage company (taking away the things you don't). It carries things you need, including nutrients, oxygen, and other important chemicals to all the parts of your body. It also takes away waste products, including carbon dioxide, from all the parts of your body. Besides being a delivery system, blood helps keep our bodies warm. By moving warm blood around, our body stays at the right temperature.

## What is Blood, Anyway?

Let's take a closer look at what blood is made of. Blood is made of four things: plasma, platelets, red blood cells, and white blood cells. Let's take a look at each one of these parts individually.

## Plasma

**Plasma** is the liquid part of blood. Plasma is about 90% water, with the other 10% made of dissolved proteins, glucose, ions, hormones, and gases. Blood is mostly plasma, so since plasma is mostly water, blood is mostly water. By itself, plasma is a golden-brown color.

**Figure 19 – Plasma is a golden-yellow color.**

**Red Blood Cells** (or RBC's for short) are disc-shaped cells that carry oxygen. Every cubic milliliter of blood (that's about 1/1,000 the size of a sugar cube) has 4-6 million RBC's. RBC's are the most common cells in blood. Every second, 2-3 million new RBC's are produced. Unlike the other cells in our body, RBC's have no nucleus.

They do however, have a protein called **hemoglobin.** In fact, RBC's are 95% hemoglobin.

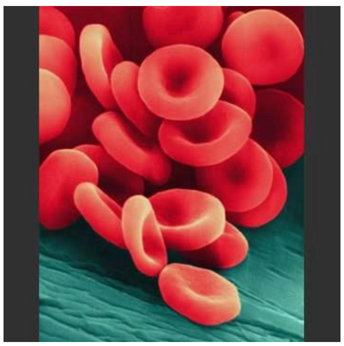


**Figure 20 – Red blood cells are disc shaped cells with no nucleus.**

Hemoglobin is the protein that carries oxygen. It also gives RBC's their red color.

**White Blood Cells** (WBC's) are larger than RBC's, have a nucleus, and do not have hemoglobin. WBC's only make up 1% of blood, but still have a very important job to do. These cells help keep us healthy by seeking out and destroying bacteria, viruses, and **pathogens**, which are substances that can cause infection and disease.

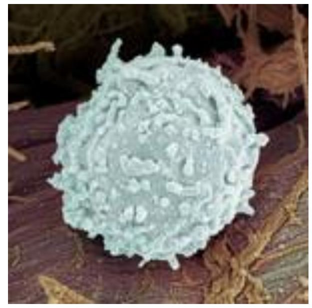


**Figure 21 – White blood cells help keep us healthy by destroying pathogens.**

Some WBC's create **antibodies**. Antibodies destroy pathogens.

The last thing that blood is made of is platelets. **Platelets** are the part of blood that helps with clotting. If you have ever fallen down and scraped your knee, or received a small cut, it was the platelets that helped stopped the bleeding. Platelets can do this important job because they are sticky little pieces of cells.

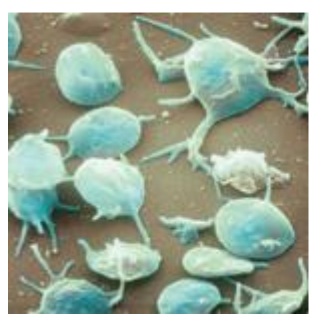


**Figure 22 – Platelets are sticky pieces of cells that help in clotting.**

If blood is traveling through a blood vessel, and the vessel gets cut, the platelets will stick to the cut area. These small particles then release chemicals called clotting factors. The clotting factors form a web of protein, which catches red blood cells leaving the body through the cut. In this way, blood stops leaving the body and bacteria are stopped from entering.

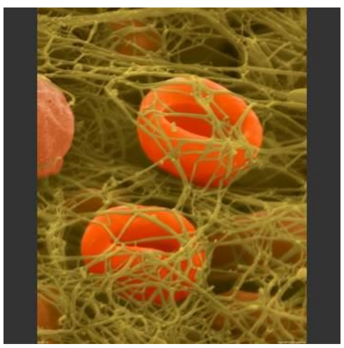


**Figure 23 – A web of protein is created that catches RBC's and stops blood from leaving the body.**

The heart is the most important organ in the cardiovascular system. You may have seen pictures of the heart like the one below before, and you may have heard your heart beat when you were at the doctor's office, but you may never have thought about what the heart was actually made of.

The heart is made of four sections, or chambers. The two chambers at the top of the heart are called the **left atrium** and **right atrium**. The two chambers at the bottom of the heart are called the **left ventricle** and **right ventricle**.

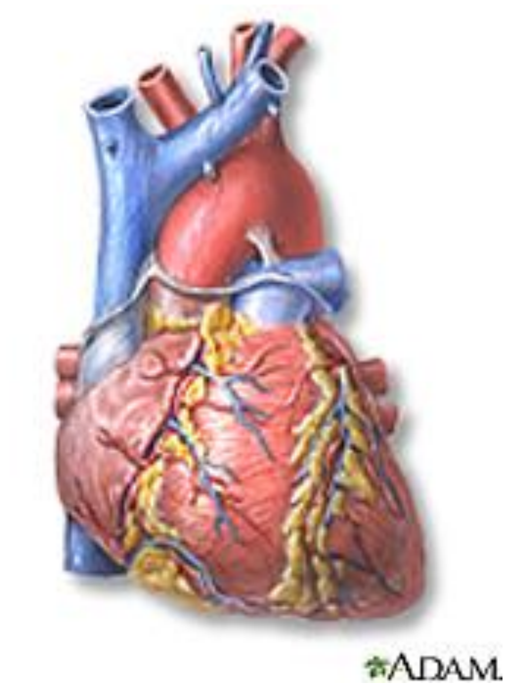



**Figure 24 – The heart Is the most important organ in the cardiovascular system**

The job of the atria (that's the plural of atrium) is to get blood from the other parts of the body. The job of the ventricles is to pump the blood from the heart to other parts of the body. We'll worry about exactly where the atria are getting the blood from and where the ventricles are sending it to a little later. For now, just make sure you understand that atria get blood in and ventricles pump blood out.

Along with the heart, another important part of the cardiovascular system are blood vessels. There are three main types of blood vessels; arteries, veins, and capillaries.

**Arteries** are blood vessels that carry blood away from the heart. Arteries have thick walls. They need these thick walls because there is a lot of pressure on the blood in arteries.

Every time the heart contracts, it creates a force on the walls of the arteries. This force creates pressure. You've probably heard of blood pressure, and had your blood pressure taken during a check-up. Blood pressure is a measure of the pressure on the walls of the arteries caused by your beating heart.

The next types of blood vessels are **veins**. In many ways, veins are the opposite of arteries. While arteries move blood away from the heart, veins bring blood back to the heart. While arteries have thick walls to handle blood under high pressure, the walls of veins are much thinner, because the blood they carry is under a much smaller amount of pressure. Veins contain valves, which stop the blood they are carrying from moving backwards.

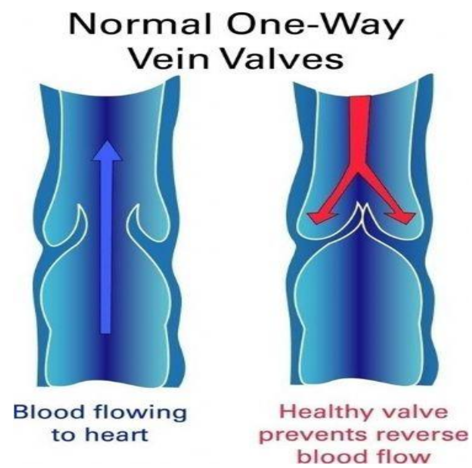



**Figure 26 – As blood flows through the veins back to the heart, valves stop the blood from flowing backwards.**

The last types of blood vessels are **capillaries.** Capillaries connect veins and arteries, and they are tiny. Their walls are only one cell thick, and they are so narrow, blood cells have to go through them single file.

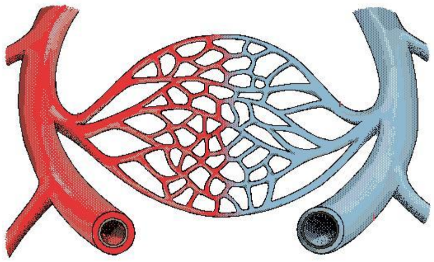


**Figure 27 – Capillaries are the smallest of the blood vessels, and connect arteries and veins.**

In spite of their small size, however, capillaries are the place where one of the most important things in our body happens. Networks of capillaries, called **capillary beds,** are the places where blood gives off oxygen to the parts of the body, and collects waste products like carbon dioxide. One of the major purposes of the cardiovascular system, oxygen transfer, is happening in these tiny vessels. The more active an organ is, the more capillaries it will need to get oxygen and other nutrients from the blood.

### Circulation

Now that we have examined blood, blood vessels, and the heart individually, lets take a look at how everything works together to get the organs of our body the oxygen and nutrients they need, while getting rid of the waste products they don't.

**Circulation** is the movement of blood around the body and is really divided into two "loops," pulmonary and systemic circulation. The diagram below provides an overview of circulation. In the sections below, we will go into much more detail.

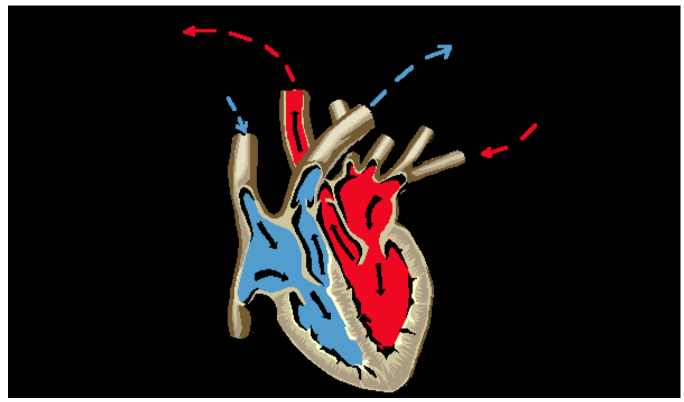


**Figure 28 – The flow of blood into and out of the heart**

### Pulmonary Circulation

Let's start our journey by considering blood that has just returned to the heart from some organ in the body. Since the blood gave oxygen to the organ, it now has very little oxygen in it. Blood that has very little oxygen is called "oxygen-poor," just like someone who has very little money is poor.

As we said earlier, it is atria of the heart that takes in blood. The right atrium is the one that takes in oxygen-poor blood. With a beat, the oxygen-poor blood moves down from the right atrium to the right ventricle, and with another beat, the blood moves from the right ventricle into a blood vessel.

Stop for a moment and see if you can figure out what kind of vessel the blood enters. You are right if you said that it's an artery. We know it's an artery because it is taking blood *away* from the heart. This particular artery is called the **pulmonary artery**.

The pulmonary artery is special because it is the only artery in the body that carries oxygen-poor blood. As we learn more about circulation, let's see if we can figure out why this is.

As you might imagine, it is very important that the blood moves from the right atrium to the right ventricle to the pulmonary artery, and doesn't flow backwards. To make sure this happens, the heart has valves that stop the blood from flowing the wrong way.

The **atrioventricular valves** separate the atria from the ventricles and the **semilunar valves** separate the ventricles from the arteries that leave the heat. The "lub-dub" sound of your heartbeat is actually the closing of these two valves. The lub is caused by the closing of the atrioventricular valve and the dub is caused by the closing of the semilunar valve.

When you exercise, or get frightened, signals are sent to your heart that more blood is going to be needed in certain parts of your body. The blood begins to travel faster, and your heart rate increases.

The blood leaves the heart through the pulmonary artery and enters the lungs. In the lungs, the blood picks up the oxygen it will deliver to the organs of the body. As you might guess, the blood is now called oxygen-rich.

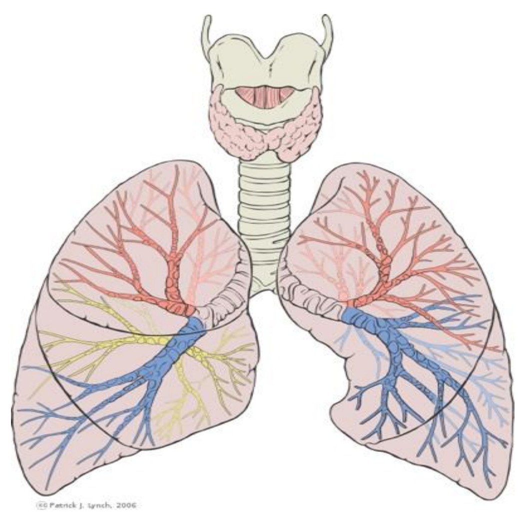


**Figure 29 – Blood gets oxygen in the lungs.**

The oxygen-rich blood leaves the lungs, and returns to the heart in a blood vessel. What type of vessel? You're right if you said it's a vein, because blood always goes back to the heart in veins, and you're also right if you guessed that this vein was called the **pulmonary vein**.

The pulmonary vein is the only vein that carries oxygen-rich blood. Once again, let's save the question about why this is the case for a little later. This process of going from the heart, to the lungs, getting oxygen, and going back to the heart is called **pulmonary circulation**. Have you noticed that we are using the word "pulmonary" a lot? This is because pulmonary refers to the lungs, and, as you can see, the lungs are very important in this part of circulation.

**Systemic Circulation**

The oxygen re-enters the heart and goes into the left atrium. With a beat, the blood goes through the atrioventricular valve in to the left ventricle. With another beat, it goes through the semilunar valve into an artery.

Since this is the first artery to carry oxygen-rich blood from the heart to the other parts of the body, it gets a special name. It is called the **aorta**. Even though it has this special name, it is just like any other artery. It carries blood away from the heart and has thick walls to handle the high pressure on the blood inside of it.

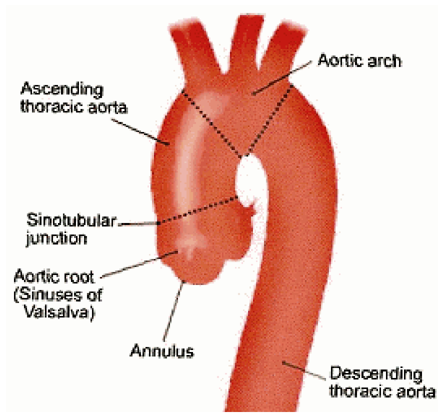



**Figure 30 – The aorta carries blood from the heart to all organs of the body.**

The aorta branches out into smaller and smaller arteries, until eventually the blood reaches the capillary bed of the organ oxygen is being delivered to. The exchange of oxygen from the blood in the capillary bed to the organ takes place, and the blood, which is now oxygen poor, leaves the capillary bed and enters a tiny vein.

The blood travels back to the heart through larger and larger veins. Eventually, the blood gets back to one of the two largest veins in the body, which lead directly back into the right atrium of the heart. Just like the aorta has a special name because it is the first artery out of the heart, these veins, which are the last ones blood goes through before re-entering the heat, have special names. They are called the superior and inferior vena cava. Blood returning from an organ in the top half of the body enters through the superior vena cava, while blood coming from the bottom half uses the inferior vena cava.

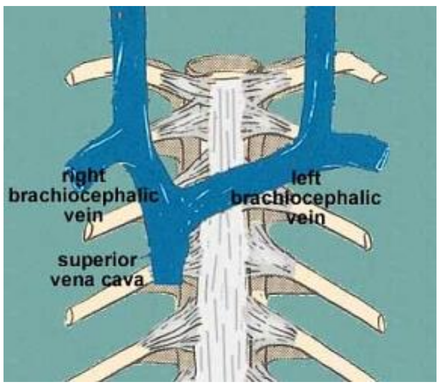
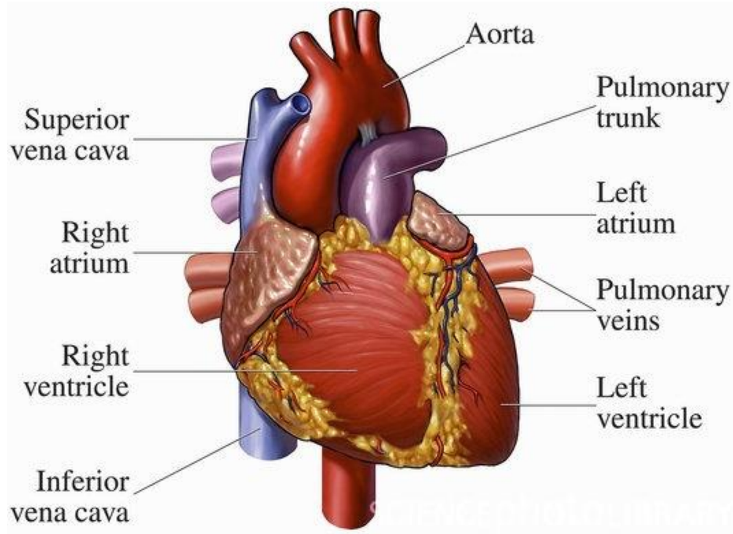



**Figure 31 – The superior vena cava is one of two veins that bring blood back into the heart.**

Once the blood is back in the right atrium, the process begins again.

Now that we have gone through the entire process of both pulmonary and systemic circulation, we can answer the questions about why the pulmonary artery is the only artery to carry oxygen-poor blood, and the pulmonary vein is the only one to carry oxygen rich blood. In systemic circulation, all of the




arteries branch off of the aorta, so they are all carrying oxygen-rich blood to the various parts of the body.

Similarly, all of the veins are carrying oxygen-poor blood back to the heart. It is only during pulmonary circulation that oxygen-poor blood leaves the heart to get oxygen, or oxygen-rich blood comes back to the heart to be pumped out to the body. This is a good reminder of an important point. The heart is not where blood gets oxygen. It is a pump that sends blood where it needs to go. It is just a pump, but a very important one for our survival!

The figure below shows the major parts of the heart. By now, you should be able to describe what goes on in each part.

**Coronary Circulation**

The heart is an organ, and like all organs, it needs oxygen. The process of providing the heart muscle with oxygen is called **coronary circulation.** As we said before, during systemic circulation, blood leaves the aorta and branches out into many smaller arteries. One set of arteries are called the coronary arteries. These arteries take blood to the heart muscle and provide it with the oxygen it needs. This seems strange, because we have learned that arteries always go *away* from the heart. To understand this, it's helpful to think of the heart as two different things – a pump that sends blood everywhere it needs to go and an organ that needs oxygen. Arteries always go away from the pump, but they sometimes provide oxygen to the organ.

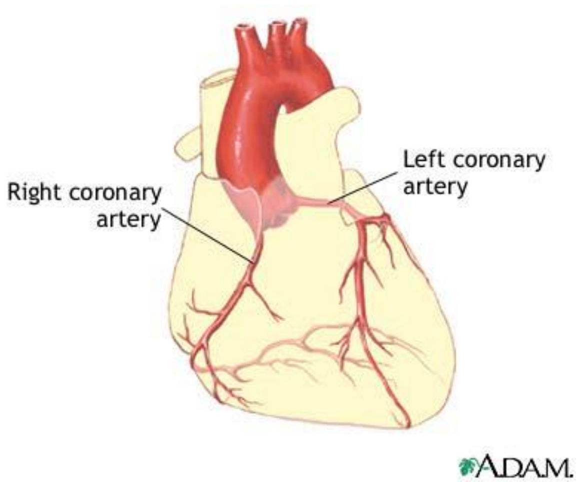



**Figure 33 – The coronary arteries branch off of the aorta and provide oxygen to the heart.**

Once the heart muscle receives the oxygen it needs, the oxygen-poor blood returns to the heart pump in the cardiac vein.

**Diseases of the Cardiovascular System**

The cardiovascular system is essential for life. If one or more parts of the system are not working properly, the result can be serious illness or death. Three common diseases of the cardiovascular system are hypertension, coronary heart disease and stroke.

**Hypertension**

As we learned earlier, blood in arteries is under pressure, and this pressure is referred to as blood pressure. If you have ever had your blood pressure taken, the doctor or nurse probably used a tool called a **sphygmomanometer**, like one of the ones shown below.


**Figure 34 – Although neither of these sphygmomanometers use actual mercury, they both measure blood pressure in the unit millimeters of mercury (mm Hg.)**

Sphygmomanometers measure two things – the highest pressure in the artery, which is called **systolic pressure**, and the lowest pressure, which is called **diastolic pressure**.

Old-fashioned sphygmomanometers measured pressure by making a column of the liquid mercury rise a certain number of millimeters. Most modern sphygmomanometers don't use mercury, but blood pressure is still measured in millimeters of mercury. Millimeters are abbreviated mm and mercury is abbreviated Hg, so millimeters of mercury can be abbreviated mm Hg.

You are considered healthy if your systolic blood pressure is less than 120 mm Hg and your diastolic blood pressure is less than 80 mm Hg. Blood pressure can change for many reasons, but if a person always has high blood pressure, they have **hypertension.** If someone has hypertension, they have a greater risk of getting other cardiovascular diseases. Hypertension can be treated by improving diet, increasing exercise, or with medication.

**Coronary Heart Disease**

One of the most common forms of cardiovascular disease occurs when cell pieces, fatty substances, calcium, and connective tissue, which together are called **plaque**, build up in the arteries and make it harder for blood to flow. This is called **atherosclerosis**. Atherosclerosis is very serious if it blocks blood from getting to the heart muscle. When this happens, it is known as **coronary heart disease**.

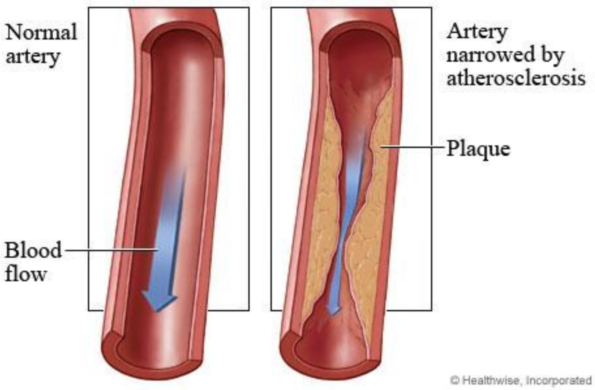



**Figure 35 – A buildup of plaque from atherosclerosis makes it harder for blood to get through the artery.**

If coronary heart disease completely blocks the heart's blood supply, the result is a **heart attack**. Coronary heart disease is the most common cause of death amongst adults in the United States. Ways to prevent to prevent coronary heart disease are very similar to ways to prevent hypertension. Healthy eating and regularly exercising are very important. The best way to prevent heart disease is by not smoking.

### Stroke

A **stroke** is caused by atherosclerosis of the arteries that provide blood to the brain. Sometimes the blockage of the artery is caused by blood clot, a free-floating object, or a bleeding blood vessel. Reducing blood pressure is the best way to avoid a stroke, although not smoking is also helpful.

### Conclusion

The cardiovascular system is crucial for survival. Blood pumped around the body provides organs with oxygen, and helps control body temperature. Pulmonary circulation takes blood to the lungs to get oxygen, and systemic circulation takes this oxygen-rich blood to the various organs of the body. We can keep our cardiovascular systems healthy by eating right, exercising, and not smoking.

# Lesson 4: Respiratory and Excretory Systems

## Introduction to the Respiratory System

Take a deep breath in, and slowly let it out. As you do, think about the breaths you take without thinking about it. The truth is, you probably only think about breathing when you are coughing and having a hard time breathing. Even though breathing is not something we think about regularly, it is absolutely required for the survival of the cells in your body.

As you breathe, oxygen flows into the body and carbon dioxide flows out. This very important exchange of gases is the main function of your body's respiratory system.

## The Parts of the Respiratory System

The respiratory system, like all **body systems**, is a group of organs and tissues all working together for a common purpose, in this case exchanging oxygen for carbon dioxide. Some of the respiratory system's parts are shown below.

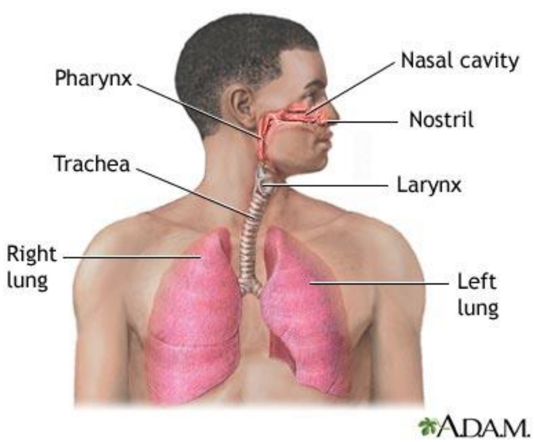



**Figure 36 – The parts of the respiratory system work together to provide oxygen and get rid of carbon dioxide.**

## Diaphragm

One important muscle not shown in the picture above is the **diaphragm.** This sheet of muscle goes along the bottom of the rib cage. The diaphragm contracts to make more space in the chest, allowing air containing oxygen and other gases to come in. It then relaxes, causing there to be less space in the chest and forcing air containing carbon dioxide and other gases out.

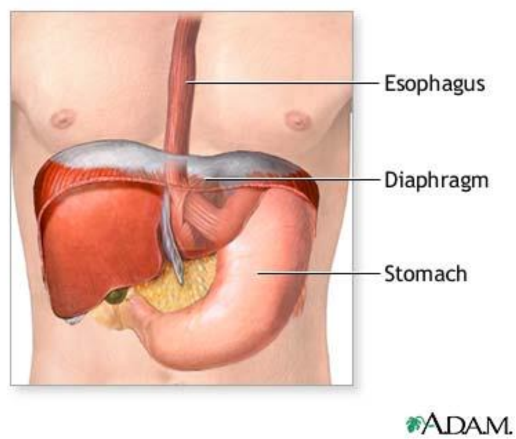



**Figure 37 – The diaphragm goes across the bottom of the rib cage.**

## Nose and Nasal Cavity

The first stop for air entering your body is your nose. In the nose, the air is warmed and moistened. The air also acts as a filter. Hair and mucus in the nose catch particles in the air that could be harmful to you and keep them from going any further into your body and eventually reaching your lungs.

## Pharynx and Trachea

After leaving the nasal cavity, air passes through the **pharynx**, a long tube that carries both food and air. In everyday language, the pharynx would be referred to as the throat. At the end of the pharynx is a flap of tissue called the **epiglottis**.

Have you ever been told not to talk and eat at the same time? Good manners are not the only reason for this. The epiglottis is part of why this is a smart idea too. When you are eating, the epiglottis covers the **trachea**, or windpipe, which is a tube air is supposed to travel down.

With the trachea covered, food can go down the esophagus to the stomach. If food gets into the trachea, it can cause coughing and choking. If you talk or laugh while you eat, you are more likely to have the epiglottis unable to cover the trachea, and therefore more likely to choke.

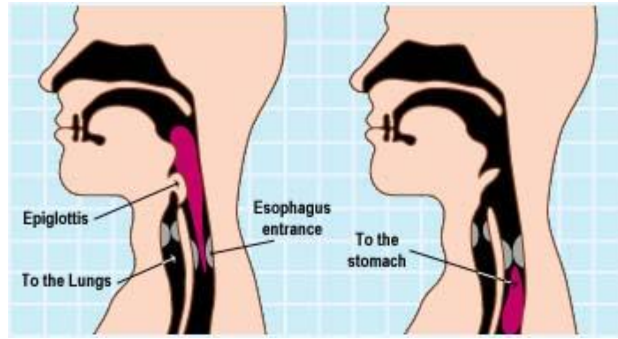



**Figure 38 – When you eat, the epiglottis covers the trachea (the tube on the left) so the food can go down the esophagus (the tube on the right.)**

Air travels down the trachea until it gets to the lungs. You have a left and right lung, so the trachea divides into two tubes, one going into each lung. These tubes are called the left and right **bronchi**. Each bronchus (that's the singular form of bronchi) branches out into smaller tubes called **bronchioles**. Bronchioles lead to **alveoli**. Trace the path or air from trachea, to bronchus, to bronchiole, to alveoli in the figure below.

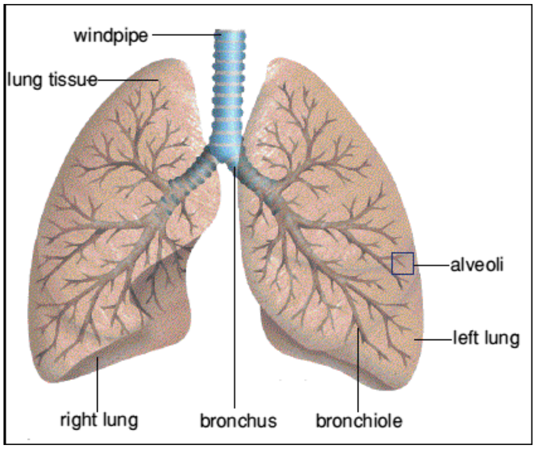



**Figure 39 – Air breathed in eventually leads to the alveoli in the lungs.**

Alveoli are small sacs at the end of bronchioles that look sort of like a bunch of grapes. These sacs are the places where gas exchange takes place.

Gas exchange means that, in the alveoli, oxygen moves into the blood so it can be taken all over the body, and carbon dioxide crosses from the blood back to the alveoli so it can be breathed out.

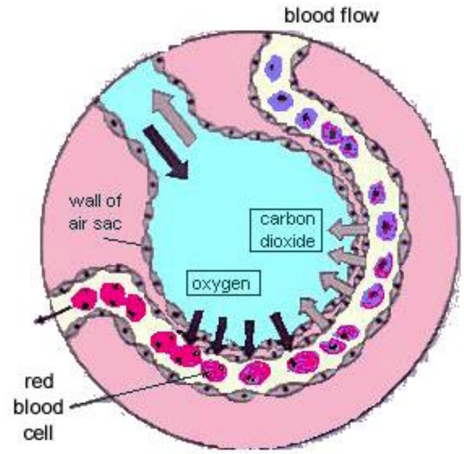



**Figure 40 – In each alveolus (that's the singular form of alveoli) oxygen flows into the blood while carbon dioxide flows out.**

## How We Breathe

We usually breathe without thinking about it, which is a good thing. Imagine if you had to stop and think about it each time you had to breathe. You wouldn't be able to do anything else! If you've ever gone swimming, done yoga, or sung, however, you know that it is possible to control when you breathe.

Earlier, we talked about how the diaphragm is important for breathing in and out, but how does it work exactly? To understand this, you have to understand something about pressure.

Gases or liquids will always flow from areas that have high pressure to low pressure. If you've ever let the air out of a balloon, you've seen this in action. The pressure inside the balloon is much higher than the pressure outside the balloon. So, if the air can, it will flow quickly out of the balloon.

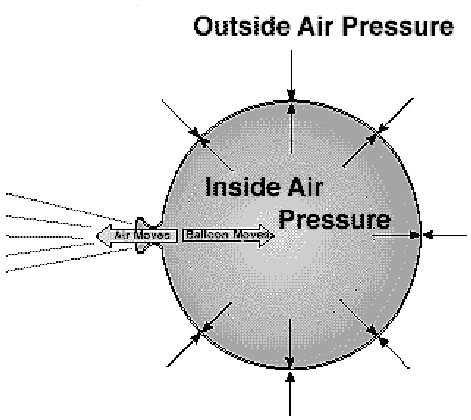



**Figure 41 – The air pressure in a balloon is greater than the air pressure outside a balloon, causing the air to flow out of it.**

A similar thing goes on in the lungs. When you want to breathe out, the diaphragm relaxes and moves up, reducing the size of the chest. The air pressure is higher in the chest than outside, so air goes out. This is called **exhalation.**

Breathing in, or **inhalation**, is the reverse of this. The diaphragm contracts and moves down, making more space in the chest. Now the pressure becomes less inside the chest than outside of it, so air goes in.

## Gas Exchange in the Alveoli

The process of gas exchange – oxygen going into the blood and carbon dioxide leaving the blood to be exhaled – also involves differences in pressure, and is actually very similar to inhalation and exhalation. The amount, or concentration, of oxygen in the air found in alveoli is much greater than it is in the blood that has just come back from the cells of the body. So, oxygen flows from the alveoli to the blood, from high to low concentration. Carbon dioxide is simply the opposite. The concentration is higher in the blood than in the air, so the flow goes from the blood to the alveoli.

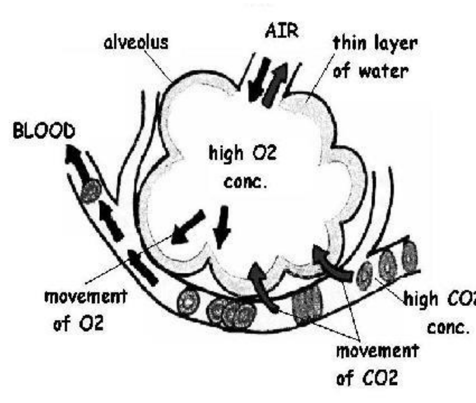



**Figure 42 – The difference in concentrations of carbon dioxide ($CO_2$) and Oxygen ($O_2$)**

**explain the flow of oxygen carbon dioxide in the alveoli**

## Breathing Versus Respiration

Sometimes, people will say "breathing" and "respiration" as though they were the same thing, but they are actually very different. What we have been talking about so far is breathing.

This is the process where air enters the body, goes into the lungs, and exchanges its oxygen for carbon dioxide. This is part of respiration, and is known as **external respiration,** but it only half of full respiration.

Respiration also includes **internal respiration**, where the blood, full of oxygen, goes to the parts of the body that need it. This process can be learned about in a discussion of the circulatory system, another body system.

## Respiratory System Diseases

There are many diseases involving the respiratory system. These diseases, like all diseases, can be acute, which means they last for a short period of time, or chronic, which means they last for a long time. Many things cause respiratory diseases. They can be caused by bacteria, or things in the environment like tobacco smoke. Other respiratory diseases are **hereditary**, which means that parents can pass them on to their children.

## Bronchitis

**Bronchitis** is an extremely common respiratory system disease. In fact, you've probably has bronchitis a few times in your life. This disease occurs when the bronchi become inflamed. Acute bronchitis is usually caused by a virus or bacterium, and can last from several days to a week. People with acute bronchitis usually have a cough that produces mucus. They may also be short of breath or wheeze. Chronic bronchitis lasts at least three months over a two year period. The most common cause of chronic bronchitis is smoking, although it can be caused by pollution or smoke in the air. Bronchitis is treated with antibiotics.

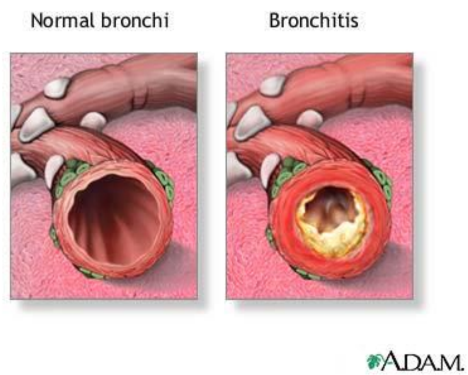



**Figure 43 – In both acute and chronic bronchitis, the bronchi are inflamed.**

## Asthma

You probably know someone who has **asthma**. Perhaps the person with asthma has to be very careful when doing very active things, or avoid certain materials, like pet hair, mold, or dust.

Asthma is a chronic disease caused by an inflammation of the bronchioles. People with asthma can have an asthma attack because of air that is warm, cool, or moist, exercise, stress, diseases like the common cold, or some of the materials in the air mentioned above, like pet hair, mold, or dust.

During an attack, not only do the bronchioles become inflamed, but the muscles in the bronchioles contract, making them even smaller. As if that wasn't enough, mucus lines the lungs, making it even harder to breathe.

People with asthma exercise, play sports, and do most other activities. They just need to make sure they control their asthma, and look out for things that might trigger an attack. Some people with this disease take medicines called bronchodilators to open up the bronchioles.

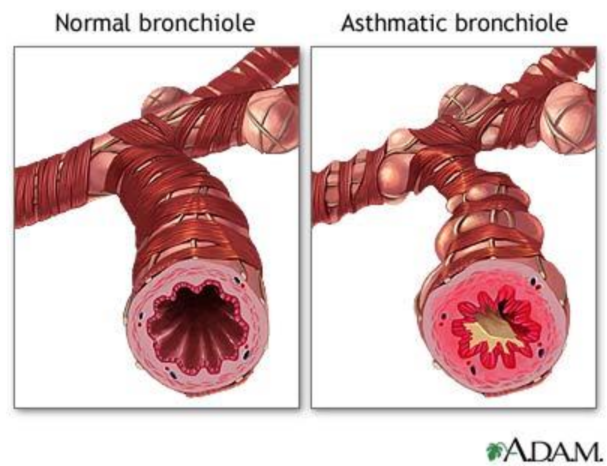



**Figure 44 – During an asthma attack, the bronchioles get inflamed, the muscles in the bronchioles contract, and the lungs line with mucus.**

## Pneumonia

Pneumonia occurs when the alveoli become inflamed and full of fluid. This makes it impossible for gas exchange to happen the way it should. As a result, people with pneumonia have trouble breathing.

This disease is caused by bacteria, viruses, fungi, or parasites, and can be treated differently depending on the cause.

## Introduction to the Excretory System

One of the most important things our body does is to keep the right amount of water and salt inside the body. If the body had too much water, cells would burst. If the body had too little water and too much salt, cells would shrivel up and die.

Either extreme would cause major problems. Keeping the balance of water and salt just right is one job of the **excretory system**. This system is also responsible for removing the waste the body creates through activities such as digestion. Removing waste is also needed for cells to survive. This process of removing wastes is known as **excretion**.

## The Organs of the Excretory System

Earlier is this section, you learned that the lungs are an important organ in the respiratory system. This is true, but the lungs are also an organ of the excretory system. If you think about what the excretory system does, this makes sense.

The excretory system removes waste from the body. Since carbon dioxide is a waste, and the lungs remove this gas, they are a part of both systems.

In fact all the organs of the excretory system are also part of other body systems. The skin removes water and salt, and is a part of the integumentary system as well as the excretory system; the large intestine removes solid waste and is a part of the digestive system as well as the excretory system.

Finally, the kidneys remove urea, salts, and water and is a part of the urinary system as well as the excretory system.

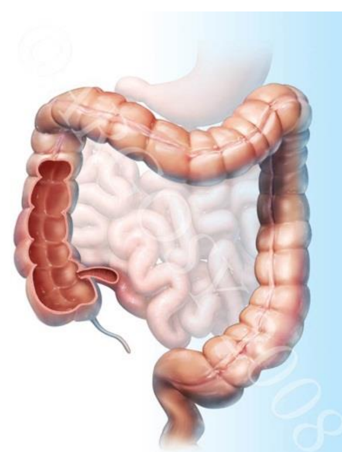


**Figure 45 – The large intestine is a part of both the digestive and excretory system.**

## The Urinary System

Sometimes people think of the **urinary system** and the excretory system as the same thing. This is not true. In fact, the urinary system is just a part of the excretory system. This system consists of the organs that make, store, and get rid of urine.

## Urine and the Kidneys

**Urine** is a waste product made mostly water, with dissolved salts and molecules containing nitrogen mixed in. One of the nitrogen-containing molecules is **urea,** which is formed when foods containing protein, such as meat, poultry, and certain vegetables are eaten. Urine is usually a pale yellow color, but can be colorless to dark yellow, depending the amount of water it contains. The **kidneys** are about the size of your fist and are found below your ribcage, as shown in the figure above. The human body has two kidneys. The job of the kidneys is to clean and filter the blood and form urine. To do this, each kidney contains millions of tubes called **nephrons**. If the body needs more water, water is removed from nephrons and returns to the blood.

**Figure 46 – The kidney filters blood in the body.**

## Other Organs in the Urinary System

Urine leaves the kidneys and flows into the **ureters.** These tubes carry the urine from the kidney to the urinary bladder. The **urinary bladder** is hollow, muscular, and elastic-walled. It looks sort of like a balloon, and fills up with urine. Once full, urine leaves the body through the **urethra.**

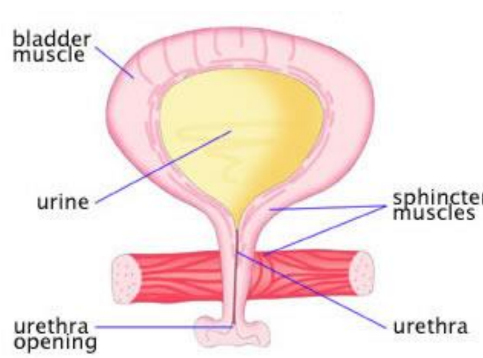



Figure 66 – Urine is collected in the bladder and leaves the body through the urethra.

## Diseases of the Excretory System

Three common diseases of the excretory system are kidney stones, kidney failure, and urinary tract infections. **Kidney stones** are crystallized minerals created by waste in the kidneys. Although the stones form in the kidneys, they can be found anywhere in the urinary system. Depending on how large the stones are, they can cause no pain at all or cause a great amount of pain. Sometimes stones need to be removed in surgery.

**Figure 47 – Kidney stones form in the kidneys, and can cause great pain.**

Kidney failure occurs when the kidneys stop filtering blood. This can happen because of an injury to the kidneys, the loss of a lot of blood, or by some drugs and poisons. If the kidneys are not seriously damaged, they may be able to recover and continue to function. However, in the event of very serious kidney failure, a person may need to have kidney **dialysis**. Dialysis is a process in which a machine, called a dialysis machine, artificially filters the blood, as the kidney normally would.

A final disease of the excretory system is urinary tract infections (UTI.) UTI occur when bacteria get into the bladder or kidney and multiply. The most common type of UTI is a bladder infection. It is more common for women to get UTI's than men, and they are often treated with antibiotics.

**Figure 48 – A kidney dialysis machine performs the job of the kidney in the event of kidney failure.**

## Conclusion

The respiratory and excretory systems are both necessary for life. The respiratory system takes in oxygen-containing air and releases carbon dioxide-containing air. Additionally, it provides much-needed oxygen to the organs of the body. The excretory system removes wastes from the body by working together with other organ systems. Diseases to either of these systems can cause major problems.

# Lesson 5: Controlling the Body

Your body is made of **organs**, like your heart, lungs or stomach. These organs work together to allow you to breathe, eat, move, and do just about everything else you need to do. Organs working together are called **organ systems.** Although all organ systems are important, and necessary for us to survive, the most important system might be the nervous system, the system that controls all the others. This system not only controls all the systems of your body but also allows you to learn and use language, senses conditions inside and outside your body and prepares you to fight or flee if you are in a dangerous situation.

## Nerves and Nerve Impulses

Imagine you walk into your home one night and it's pitch black. You quickly flick on a light switch and the room is immediately lit up. You may have never thought about it, but it's kind of amazing that this happens. Even though it may be a long distance from the light switch to the actual light, the light comes on.

Fortunately, messages in your nervous system also travel at the speed of electricity. The nervous system is made of bundles of nerve cells called **nerves**. Nerve cells called **neurons** send messages, called **nerve impulses,** throughout the body. Since these messages are electrical impulses, they travel very quickly. Neurons are also covered with a fatty covering called **myelin** which insulates the neuron, like the plastic on the outside of a wire, allowing the nerve impulse to travel even faster.

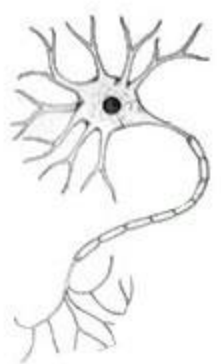


**Figure 49: Neurons send nerve impulses throughout the body at the speed of electricity.**

Look at the shape of the neuron. These cells are the perfect shape for their job of sending messages all over the body. The small extensions on the end of the cell are called **dendrites** and get nerve impulses from other cells. The longer extension at the other end of the cell is called an **axon** and sends nerve impulses to other cells. The central part of the cell, between the dendrites and axon, is called the **cell body**. This part of the cell contains the nucleus and all the **organelles**, which are small structures inside the cell. The place where the axon of a nerve cell meets the dendrites of another nerve cell or another type of cell is called a **synapse.**

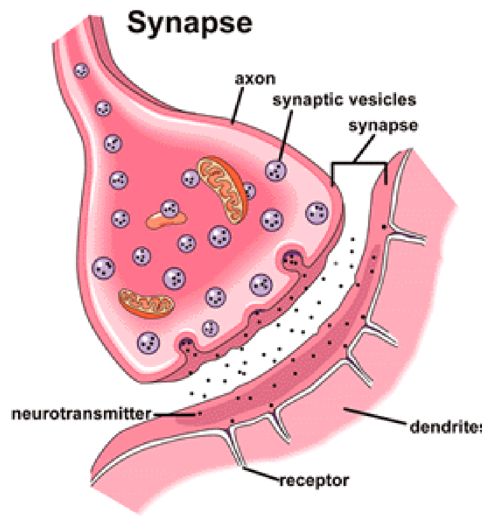



**Figure 50 – A synapse is found where the dendrite and axon of two neurons meet.**

Neurons can be classified, or put into groups, based on their job in the body. **Sensory neurons** carry messages from the organs to the brain and spinal cord. **Motor neurons** carry messages from the brain and spinal cord to organs, glands, and muscles.

## The Central Nervous System

The Central Nervous System (CNS) is the part of the nervous system including the brain and spinal cord. Both of these organs are protected by bones. The brain is protected by the **skull** and the spine is protected by bones called **vertebrae**.

With 100 billion neurons each connected to thousands of other neurons, the **brain** is the control center of the body and one of its most complex organs. Like a plane's pilot or a ship's captain, the brain tells the other part of the nervous system what to do.

Since the nervous system controls the other systems, and the brain controls the nervous system, the brain is in charge of nearly everything in our body, from memory, to speech, to seeing and hearing, to our overall ability to learn.

Think about all the way your brain is working as you read this sentence. Your see the words, read them, think about what they mean, and try to remember them as much as you can. It's all controlled by the brain!

The brain is made of three parts – the cerebrum, the cerebellum, and the brainstem. The **cerebrum** is the largest part and controls the things we are aware of, such as speaking and solving problems. It also controls voluntary motions, meaning the motions we think about doing, such as walking, waving, or typing.

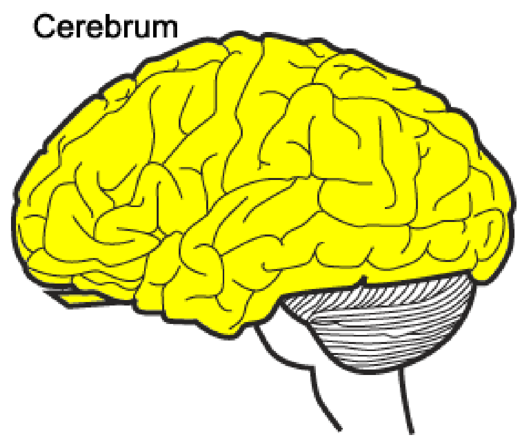



**Figure 51 – The cerebrum is the largest part of the brain.**

The cerebrum is divided into two halves called hemispheres. The left hemisphere controls the right part of the body, and vice versa. Each hemisphere has four parts, called lobes. These lobes are the frontal, parietal, occipital, and temporal lobe. Each lobe has different things it is responsible for. For example, the frontal lobe controls speech, thinking, and touch, while the temporal lobe controls hearing and smell.

Under the cerebrum lies the **cerebellum.** This part of the brain controls balance, coordination, and body position. All of the cerebellum's jobs are on display if you are riding a bike.

The smallest part of the brain is the **brain stem**. It is also located under the cerebrum, but in front of the cerebellum. The brain stem is concerned with basic functions of the body that we don't even have to think about doing. These activities include such important activities as digestion, heartbeats, and even breathing.

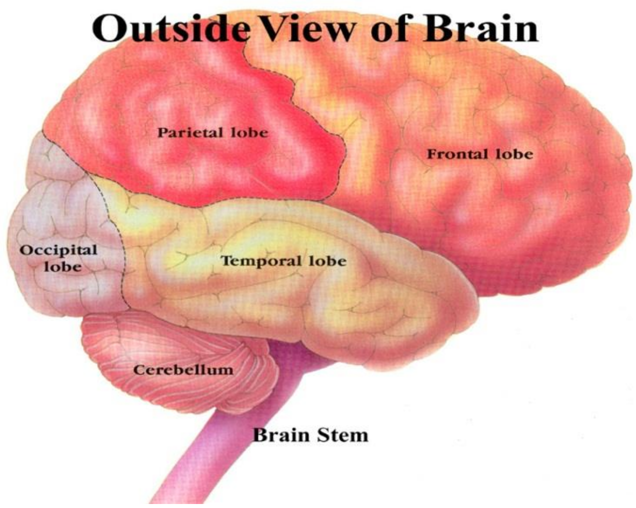



**Figure 52 – The cerebellum and brainstem lie under the cerebrum, which is divided into four lobes.**

The other organ of the CNS is the **spinal cord.** The spinal cord is a long, tube-shaped bundle of neurons. Running from the brainstem to the lower back, the spinal cord is like the highway of the nervous system. Messages get sent from the parts of the body to the brain, providing the brain with critical information about the inside and outside surroundings. The brain sends back messages telling the parts of the body what to do based on the information it was given. All this information is sent in the form of nerve impulses up and down the spinal cord.

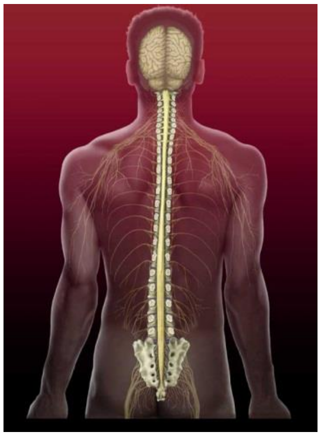


**Figure 53 – The spinal cord runs from the brainstem to the lower back.**

## Peripheral Nervous System

The nervous system is not just made of your brain and spinal cord. From your arms and hands, down to your feet and legs, up to your scalp and face, and even to the organs inside you, all your body parts have nerves traveling to and from them, so that messages can get to the CNS. This network of nerve cells outside the CNS is called the **peripheral nervous system** (PNS.) The nerves of the PNS are connected, either directly or indirectly, to the spinal cord.

Within the PNS is two divisions, the sensory division and the motor division. The **sensory division** carries messages from the sense organs and internal organs to the CNS. Human senses include sight, smell, taste, touch, smell, and balance.

Other animals have senses we don't have. Sharks can sense a mild electric current and birds can sense magnetism, allowing them to find their way like a hiker with a compass.

Every sense we have has a sense organ associated with it. For example, our eyes are associated with sight. The optic nerve travels from the eye to the brain, sending messages.

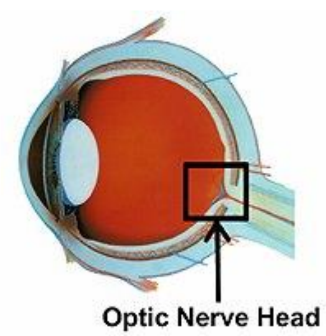



**Figure 54 – The optic nerve sends messages from the eye to the brain.**

Imagine you get home and smell something delicious. You think you know the smell, but just to be sure, you peek into the oven and see chocolate chip cookies baking. It is tempting to say that your nose and eyes "told" you about the cookies, but this is not actually correct. Although your nose detects chemicals coming from the cookies, and your eyes detect light that bounce off the cookies, all these sense organs can do is send a message about what they sensed. The brain then has the job of interpreting these messages, trying to make sense of them. Each sense organ is associated with a certain region of the brain that interprets its messages.

The **motor division** of the PNS carries messages from the CNS to the internal organs and muscles. The motor division is further divided into two parts called the somatic nervous system and autonomic nervous system. The **somatic nervous system** is in charge of voluntary movements, or movements over which you have control. If you play soccer, your eyes send a message to your brain each time you see the ball coming. Your somatic nervous system is then responsible for kicking the ball. Your brain sends a message to your leg instructing it to kick the ball.

**Figure 55 – Seeing and kicking a soccer ball requires the sensory division and the somatic nervous system, within motor division of the PNS.**

The **autonomic nervous system** is in charge of involuntary motions, or motions over which you have more control. These include such essential actions as breathing, digestion, and even the circulation of blood. Under normal circumstances, the **parasympathetic division** of the autonomic nervous system handles all of the necessary involuntary motions. However, in and emergency, the **sympathetic division** takes over, controlling what is known as the "fight or flight" response to dangerous or frightening situations.

As you can see, the nervous system does many things and has many parts. Consider the chart below, which lists the divisions of the system. Each part of the system plays a unique and important role in allowing the other body systems to function.

## Eyes and Vision

Try to think of an activity you do, while you are awake, that does involve sight. If you are not visually impaired, this is probably hard to do. Human beings, more than many other animals, rely of their sense of sight to survive. Sight is our single most important sense. For this reason, human sight is very highly developed.

As humans, we can see objects that are both close up and far away. We can also tell that they are close ore far apart because we can see in three dimensions. We are able to see in three dimensions because we have two eyes, both facing the same direction, a few inches apart. So, we see things with both our eyes, but from slightly different angles. The closer an object is to you, the more different the angle from each eye is. Your brain can use this information to see how far apart objects are.

Along with being able to see in three dimensions, humans have the ability to see in color. We can do this because the eye contains special cells called rods and cones.

Rods allow us to see in dim light, while cones allow us to see light of different colors.

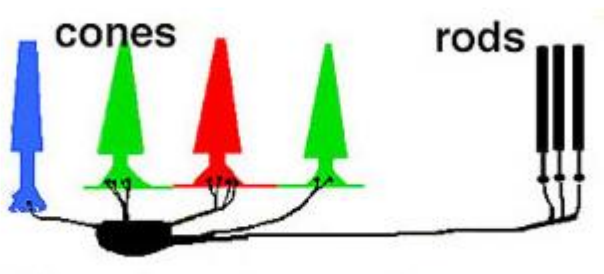



**Figure 56: Rods allow us to see in dim light while cones allow us to see in color.**

## The Structure of the Eye

The eye is a complex structure that detects and focuses light. Light first enters the eye through the **cornea**, a clear protective layer on the outside of the eye. The **pupil,** a black opening in the eye, lets light in. In dark rooms, the pupil will become larger, or dilate, in order to let in more light. If the room suddenly becomes bright, the pupil will become smaller. The pupil is surrounded by the brown, blue, grey, or green **iris.**

After passing through the pupil, light goes to the **lens** which, like a hand lens, is a clear curved structure that helps focus light on the **retina**, in the back of the eye. The retina is where the rods and cones are found.

## Vision Problems

Do you or someone you know where glasses or contact lenses. Glasses and contacts are used to correct vision problems. The two most common eye problems are myopia and hyperopia, and each is fixed a different way.

**Myopia** is sometimes called nearsightedness. About one third of people have this problem. Myopia happens when the eye is too long. With eye too long, images seen are focused a little bit in front of the retina, instead of on the retina as they would be in a normal eye.

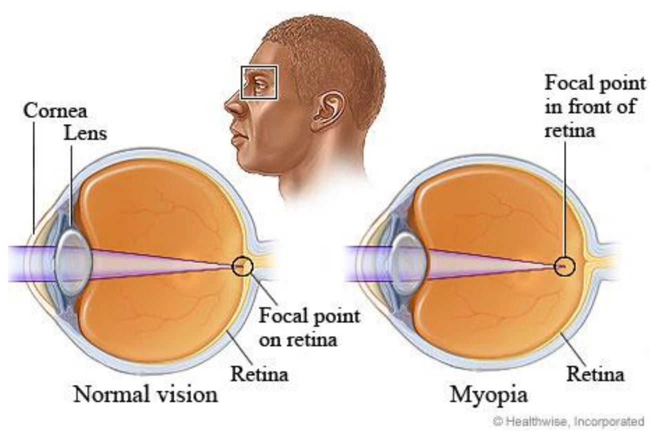



**Figure 57 – If a person has myopia, light focuses in front of the retina.**

People with myopia can see nearby objects clearly. Objects that are far away, however, look blurry. This can be corrected with a concave lens on glasses or contacts. “Concave” means that the lens curves inward, like the inside of a bowl. The concave lens helps focus light on the retina instead of in front of it, correcting the problem.

**Hyperopia,** which is also called farsightedness, affects about one fourth of people, is pretty much the opposite of myopia. In this disorder, the eye is too short, so images become focused behind the retina**.** As a result, people with hyperopia can see things clearly when they are far away, but not when they are close up.

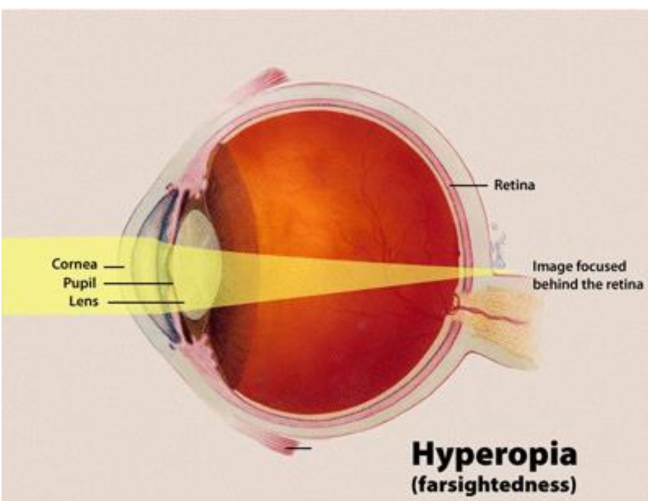



**Figure 58 – When the eye is too short, hyperopia occurs, and images are focused behind the retina.**

To correct hyperopia, a convex lens, which is a lens that curves out, like the outside of a bowl, is used in glasses or contacts.

Some people suffer from both myopia and hyperopia. How can this be? It doesn’t seem possible that the eye could be too long *and* too short.

The answer lies in the lens of your eye. You can think of the lens like a trampoline. As you jump up and down on the trampoline, it moves closer or further from the ground. The lens does a similar thing when you look at things closer together or further away. This makes the overall shape of the eye change slightly.

As your trampoline gets older, the springs may begin to wear down, and it may become harder for the trampoline to move. The same thing happens with the lens in your eyes.

As a result, many older people develop hyperopia. If these people already had myopia, they will need a lens that has both a concave and convex part. Bifocals are glasses that have these two parts.

These glasses were invented by Benjamin Franklin over 200 years ago, and are still used today.

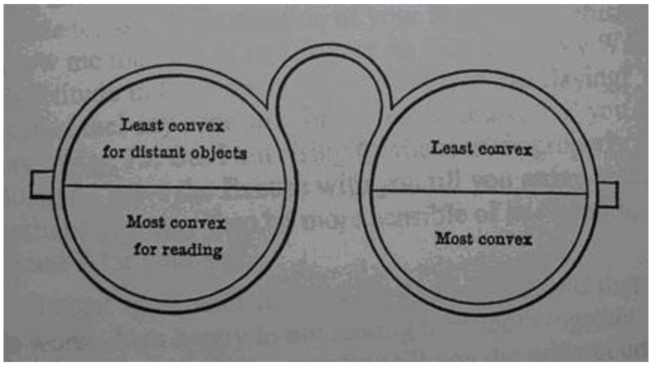



**Figure 59 – Although modern bifocals look more stylish than these Benjamin Franklin-style glasses, they still use the same basic idea.**

Today, some people with vision problems choose to have surgery called LASIK. In this surgery, a laser changes the shape of the cornea correcting the vision problem. As a result, the person usually no longer needs to wear glasses or contacts.

## Hearing and Balance

It may seem like walking across a balance beam and listening to your favorite song are very different activities, but they both depend on your ears. Ears are the sense organs that control **hearing**, which is the ability to detect sound. Ears also sense the position of the body and help maintain balance when you walk a balance beam or ride a bike.

Imagine a pebble being dropped into a lake. Waves of water go off in all directions. A similar thing happens when a car driving down the street honks its own. Waves go off from the car in all direction. The difference is that these are not waves of water, but instead are sound waves, which travel through the air. If you are nearby, some of those sound waves make it to your ear.

The **pinna**, or outer ear, which is the part of your ear that you can see, gathers up some of the sound waves, sends them down the ear canal, and eventually they strike the **eardrum**. The eardrum is a thin membrane that vibrates like a drum when the waves hit it. The vibrations pass three tiny bones, called the hammer, anvil, and stirrup, as well as a membrane called the oval window, causing them all to vibrate.


**Figure 60 – Many parts of the ear work together to make hearing possible.**

From the oval window, the vibrations go to the **cochlea**, liquid-filled space lined with hairs. The vibrations make waves in the cochlea's liquid, just like waves in a pond, causing the hairs to move. The movement of the hairs sends a nerve impulse through the auditory nerve to the brain. The brain interprets the message and "tells" you what you have heard.

Along with hearing, the ears play a major role in balance. Inside the ears are **semicircular canals** which are lined with hairs and full of liquid. When the body moves in one direction, the liquid in the semicircular canals also moves. This causes the hairs inside to move, which sends a message to your brain, which gives instructions for the body's muscles to contract or relax. This keeps you balanced.

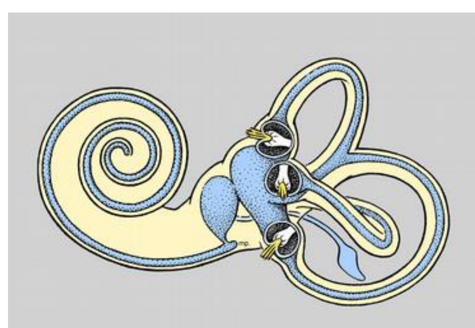


**Figure 61 – The semicircular canals help with balance**

## Touch

If you've ever accidently touched a hot stove, prickly cactus plant, or a block of ice, you know how strong the sense of touch can be. **Touch** is the sense of pain, pressure, or temperature. All of our skin contains sensory neurons. When you touch something, messages go from the sensory neurons to the brain, which interprets what you've touched.

Although all of the skin, as well as many internal organs, have sensory neurons allowing them to experience touch, certain areas of the body, including the palms of the hands, soles of the feet, lips, and tongue, have more sensory neurons than other parts of the body. This makes them more sensitive to touch.

As we've learned, messages travel from sense organs, like the skin, to the brain very quickly. There are times, however, when something we touch is so dangerous that our body does not even want to take the time to send the message to the brain. For example, if you touch a hot stove, the message that you are touching something hot will only go to your spinal cord, instead of making it all the way to your brain. This is called a **reflex arc.**

**Figure 62 – A reflex arc causes the spinal cord to send a message pulling your hand away from a hot stove.**

You often hear people say they did something, "without thinking." The truth, however, is that our brain is usually very much involved in the things we do. A reflex arc is one of the rare times when the brain is truly not involved. Other responses may come later. You may scream in pain, say "ouch" or cry after touching the hot stove. All these involve your brain and therefore happen *after* the reflex arc action of removing your hands. It is only the initial movement, to prevent damage to the tissue of the skin, that is brain-free.

<u>Taste and Smell</u>

Neurons found in your nose detect chemicals in the air. These neurons send messages to your brain, and the brain determines what you are smelling. The nose is able to detect thousands of different odors.

The foods you eat also contain chemicals, and these chemicals are sensed by sensory neurons on your tongue. These neurons are organized into groups called **taste buds**.

There are five types of taste buds on the tongue, and each one senses a different type of taste. You have taste buds for sweet, salty, sour, bitter, and umami (a meaty taste) each in a different spot on the tongue. Just like with the other sense organs, when the tongue's sensory neurons get information, they pass it on to the brain. The brain is then able to determine what you are tasting.

Notice that we spoke about five different tastes, as opposed to thousands of odors, and nearly limitless textures, sights, and sounds. Taste is our weakest sense.

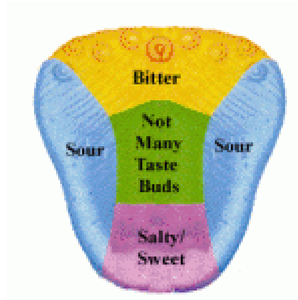



**Figure 63 – Taste buds are found in clusters on the tongue.**

You may have noticed that in general, kids are not as into foods with strong flavors as adults. Much of the reason for this has to do with taste buds.

In babies, taste buds just are found not just on the tongue but all over the mouth. As you get older, taste buds become a little weaker, and are only found on the tongue. As your taste buds change, so do your likes and dislikes in food.

With less sensitive taste buds, you may be interested in trying something more adventurous that you would have eaten as a young child.

## Keeping the Nervous System Healthy

Think about all the things the nervous system does. It not only controls the senses, but also controls feeling, thinking, moving, and just about everything else we do. It should not be a surprise, then, that health problems involving the nervous system can have a big impact in the whole body.

Encephalitis and Meningitis both affect the CNS. Encephalitis can cause swelling of the brain as the body tries to fight off a virus. The problem is that the brain has no room to swell or expand, and pushes against the skull. This can cause brain injury or death. In meningitis, the membranes that cover the brain and spinal cord become infected. If the infection is caused by a virus, it usually will clear up on its own. If it is caused by bacteria, it is much more serious and should be dealt with immediately using an antibiotic.

One additional disease of the CNS that affects young people is Reye's Syndrome. This rare but serious disease occurs when young people take aspirin to treat a viral infection. Reye's Syndrome causes swelling of the brain, which can be fatal. Many cold medicines contain aspirin, so it is important to read labels carefully if you have a viral infection.

**Figure 64 – Illustrations like this one remind parents not to treat viral infections with aspirin, because of the possibility of Reye's Syndrome.**

Other nervous system diseases include cerebral palsy and epilepsy. Cerebral palsy occurs when the developing brain is injured around the time of birth. In mild cases, people with cerebral palsy may just have weak muscles. In more serious cases, they may have trouble walking or talking.

Epilepsy is a disease in which people may have a **seizure**. Seizures are periods of time when people lose consciousness, and sometimes include violent muscle movement. Epilepsy happens due to unusual electrical activity in the brain.

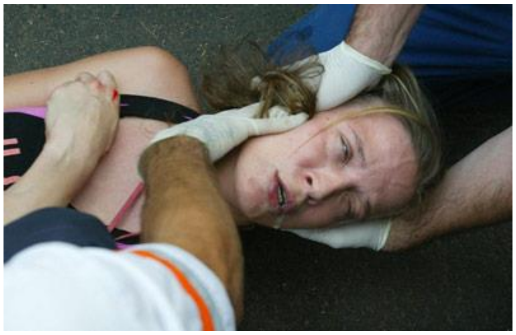


**Figure 65: A person having a seizure is not able to control their body.**

Although it is not possible to prevent all diseases of the nervous system, there are steps you can take to minimize your risk.

Eeating a variety of healthy foods and exercising regularly. Of course, if your exercise includes biking or some other activity that could lead to a head injury, be sure to wear a helmet so you don't damage your nervous system while you are trying to keep it in good condition.

Just the act of using your brain can help make sure that it stays healthy. Doing crossword puzzles, reading, and playing musical instruments have all been shown to help keep your brain active and healthy.

# Lesson 6: Diseases and Defenses

## Infectious Diseases

*Wash your hands! Cover your mouth when you cough! Toss your tissues after you've used them!*

Do these sound familiar to you? If you've heard these pieces of advice, consider yourself lucky. The person who was telling you to do these things was trying to keep you, and those around you, healthy.

By doing simple things like covering your cough and washing your hands, you can help keep yourself from getting or spreading diseases that are **infectious**, or able to be spread from one person to another. Taking these preventative measures is important, but if you do get sick, your body has ways of fighting off diseases as well.

## What Causes Infectious Diseases?

You may have heard that diseases are caused by germs. That's true, but "germ" is not a scientific term. The word **pathogen** is the scientific way of saying "germ," and infectious diseases are caused by pathogens. The reason why infectious diseases can spread from one person to another is because pathogens can spread from one person to another.

One group of pathogens are **bacteria**. Bacteria are one-celled living things with no nucleus. Although most bacteria are harmless, and some are even helpful, some do cause disease. The most common disease caused by bacteria is tuberculosis, which is often abbreviated TB. TB is a disease of the lungs that is very serious. Bacteria also cause strep throat, some types of pneumonia, and many food borne diseases.

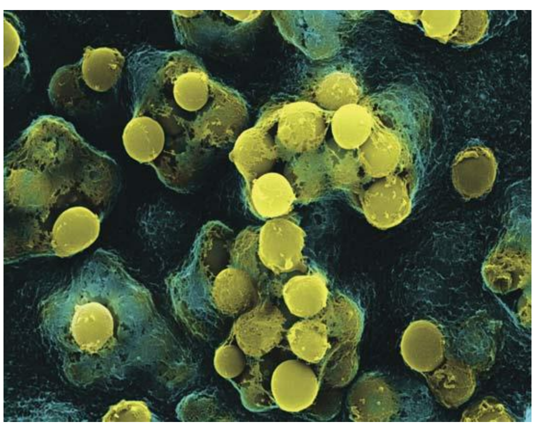


**Figure 66 – These bacteria cause strep throat.**

Bacteria can be treated with medications called antibiotics. If you are ever given an antibiotic to treat a disease caused by bacteria, it is important to take all the medication, even if you start feeling better. If you don't do this, the strongest bacteria may survive and come back to make you sick later.

Infectious diseases can also be caused by **fungi**. Fungi are simple living things made of one or more cells. Like bacteria, many fungi are perfectly harmless. In fact, mushrooms and yeast are both fungi. However, some fungi cause diseases including ringworm and athlete's foot.

**Figure 67 – The fungus *Epidermophyton floccosum* causes athlete's foot.**

These two disease are not very serious, and can be treated with anti-fungal medication. Fungi can cause some serious diseases as well, including a lung disease called histoplasmosis.

A third group of pathogens are **protozoa**. Protozoa have a single cell, like bacteria, but they have a nucleus.

One serious disease caused by protozoa is malaria. More than a million people die from this infectious disease each year. Mosquitoes transfer the protozoan that causes malaria from one person to another when they bite them.

Some protozoa also cause diarrhea. Although diarrhea may just seem like an inconvenience to us, in some poor countries people die of the dehydration caused by diarrhea.

**Figure 68 – The protozoan *Giardia lamblia* causes intestinal diseases, which may lead to diarrhea.**

A final group of pathogens are **viruses**. Viruses are different than the other pathogens we have described because they are not alive. Viruses inject DNA, the genetic material into cells. This allows the viruses to take over the cells and multiply. Viruses are responsible for many common infectious diseases, including colds and the flu.

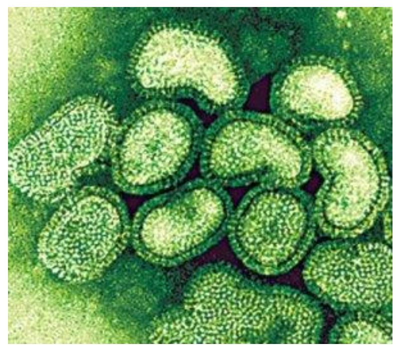


**Figure 69 – Viruses like H1N1, the virus responsible for "swine" flu, inject DNA into cells to take them over.**

Unfortunately, viruses do not respond to antibiotics. Medicines called antiviral drugs can treat diseases caused by viruses, but often times the best thing for a person with a cold or the flu to do is drink plenty of fluids and get lots of rest.

## How Are Pathogens Spread?

Different pathogens are spread in different ways. *Giardia lamblia*, the protozoan shown in the picture above which causes diarrhea, is spread in water.

Some pathogens, including the fungus that causes athlete's foot, or the bacterium that causes the skin disease impetigo, are spread when they get onto objects or surfaces.

If someone with athlete's foot walks on the floor of a public shower, and then you walk on that same floor, the disease can be spread to you. Similarly sharing a towel or piece of clothing with someone who has impetigo can spread this disease to you.

A common way for pathogens to be spread is in the air. This is the method for spreading many pathogens that causes diseases of the throat and lungs. When a person sneezes or coughs, tiny droplets are released into the air.

Each of these drops contains pathogens, such as the pathogens for the cold and flu. If you breathe in these pathogens, you can get the disease.

Another method for spreading pathogens is through the use of a **vector**. Vectors are organisms that carry the disease from one person (or other animal) to another. Vectors are usually insects, and include ticks and mosquitoes. When the insect bites a person with the disease, it picks up the pathogen. Usually, the pathogen does not make the vector sick. However, when the vector bites another person, they transfer the disease to them.

**Figure 70 – A mosquito can act as a vector when it bites a person with a disease.**

As you read above, malaria is one disease transferred by a vector. Ticks act as a vector for Lyme disease. Mosquitoes can also be vectors for West Nile Virus, a disease that has spread rapidly in the United States over the last dozen years.

## Avoid the Spread of Infectious Diseases

The single most effective way of not getting an infectious disease is to wash your hands often. This includes washing your hands after using the restroom, after handling raw meat, after being around someone who is sick, and before preparing or eating food. Soap helps make your hands an undesirable place for pathogens to live, which is, of course, exactly the way you want it.

You can also use a hand sanitizer with alcohol. Alcohol kills many bacteria.

To prevent getting a disease caused by vectors, the best strategy is, of course, to avoid vectors. If you're going somewhere where you know ticks or mosquitoes are likely to be found, it's a good idea to wear long sleeves and long pants. There are also some insect repellants that can be used to keep vectors away.

**Figure 71 – These "gaiters" cover the lower leg and provide some protection against vectors.**

As hard as you might try to prevent it, at some point your will likely get an infectious disease. When this happens, try to avoid being around others so you don't infect them. Also, be sure to cover your cough and continue to wash your hands frequently to keep from spreading your pathogens to others.

## Noninfectious Diseases

Not all diseases can be spread from one person to another. Diseases that are not able to be passed from person to person are called **noninfectious diseases.** Some noninfectious diseases are caused by pathogens, but the pathogens are not able to spread from person to person.

Often times, noninfectious diseases are caused by a combination of genetics and lifestyle choices. This means that a characteristic can be inherited, or passed on from parents to children.

Your eye and hair color are both genetic traits. It is also possible to inherit the tendency to have high blood pressure, a noninfectious disease.

Inheriting this characteristic, however, does not mean you will definitely have high blood pressure. If you eat healthy foods and exercise regularly, you will be less likely to have high blood pressure, regardless of your genetics. It is not possible to change your genetics, but you can control your lifestyle choices.

## Your Body's First Line of Defense

Up to this point, we've been talking about a lot of things you can do to prevent disease. Eating healthy, exercising, avoiding cigarette smoking, washing your hands, and avoiding vectors are all great choices you can make. To go along with these lifestyle choices, your body has some built in defenses against disease that happen without you even having to think about it.

Have you ever seen pictures of old castles? You probably noticed the moat around the castle, designed to keep invaders away. Believe it or not, your body has its own version of a moat, keeping invading pathogens away. Your "moat" is your skin! Your skin is your largest organ, and is a physical barrier between your insides and the outside world. The outer layer of skin, called the **epidermis**, is tough and waterproof. This makes it hard for pathogens to get in.

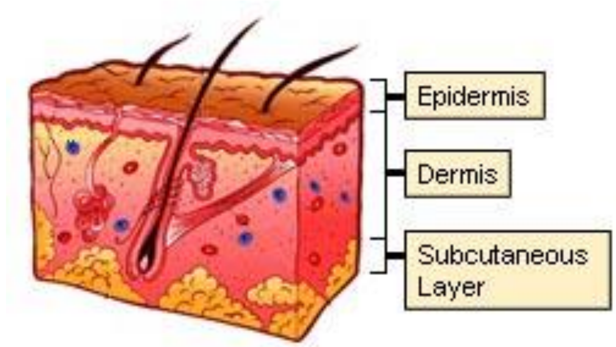



**Figure 72 – The epidermis is thick and keeps out many pathogens.**

Some parts of your body, including your mouth and nose, are not covered by skin. These areas, called **mucus membranes,** are not tough like skin, making them possible places for pathogens to enter.

Fortunately, mucus membranes have some defenses against pathogens. **Mucus** is one defense. It is a moist, sticky substance, and many pathogens get stuck in it before they can do any damage.

Many mucus membranes also have cilia. **Cilia** are small hairs that sweep your mucus and any pathogens they may have trapped toward openings in your body, like your nose and mouth. When you clear your throat or blow your nose, the mucus and pathogens leave your body.

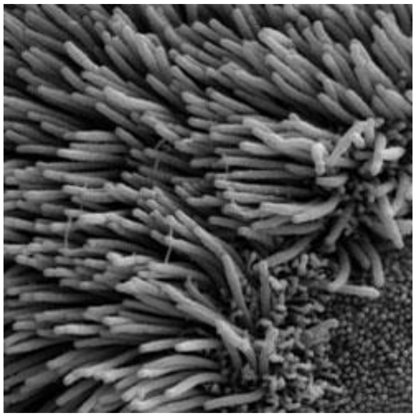


**Figure 73 – Under high magnification, you can see that the cilia of the nose look sort of like a brush, sweeping away mucus and pathogens.**

Things that come out of your body are called body **secretions,** and many of these secretions can also help protect you from disease. Mucus, sweat, tears, and saliva all have chemicals called **lysozymes.** Lysozymes are enzymes that kill pathogens. The stomach secretes a strong acid called hydrochloric acid, which kills most pathogens in food and water. Finally, very few pathogens can grow in urine because it is acidic.

## The Second Line of Defense

As good as the skin is at protecting against infection, sometimes pathogens do manage to get past it. One common way for pathogens to enter is through cuts and scrapes. When the skin has been cut, pathogens have an easy point of entry.

If pathogens get through the skin, and cause an infection, they will face the body's second line of defense. For example, there might be an inflammation in the area of the infection. An **inflammation** happens when chemicals are released causing the blood vessels in the area to get larger, or dilate. The area around the infection becomes red, warm, and painful, while blood flow to the area increases.

**Figure 74 – Although they can be painful, inflammations help the skin to heal.**

The increased blood flow allows white blood cells (WBC) to come to the infected area. There are several types of WBC's and all are very important in fighting off infections and disease. The WBC's involved in an inflammation are called **phagocytes**. Phagocytes literally means "eating cells" and eating is exactly what these cells do. The phagocyte engulfs the pathogens and destroy them in a process called **phagocytosis.** Phagocytosis can also be used for "eating" debris in the cell.

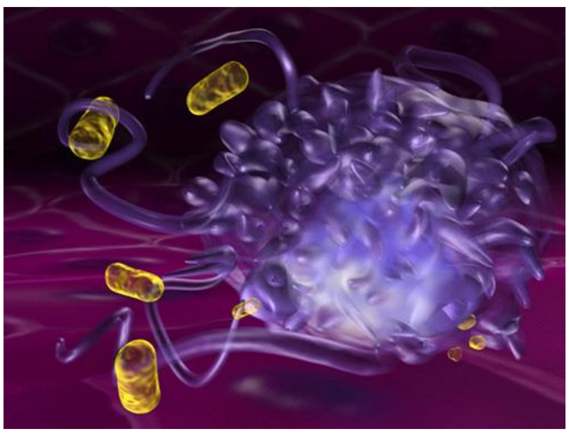


**Figure 75 – Phagocytosis can be used to engulf and destroy pathogens or debris.**

WBC's also produce chemicals that cause a **fever.** As you probably know and have experienced, a fever occurs when the body temperature gets above its normal temperature of 98.6 degrees F (37 degrees C). Although fevers are no fun for you, they are even worse for many pathogens. Most bacteria and viruses that infect people reproduce most rapidly at normal body temperature. With the higher temperature caused by the fever, the pathogens cannot multiply as quickly.

## The Immune System

If a pathogen makes it through both the skin and the second line defenses, the body begins an **immune response**. An immune response is a reaction to pathogens involving WBC's called **lymphocytes**.

Lymphocytes are so important to the immune system that this system is sometimes called the lymphatic system. In addition to lymphocytes, the lymph organs – red bone marrow, the thymus gland, the spleen, and tonsils – are very important in this system. The pictures below illustrate and describe these organs.

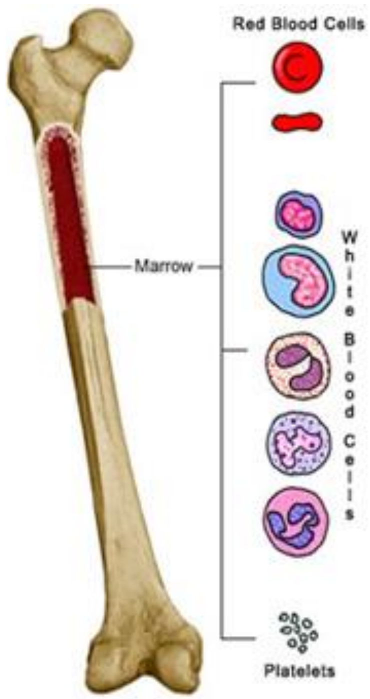



**Figure 76 – Red bone marrow is found in many bones. It produces lymphocytes, as well as other blood cells.**

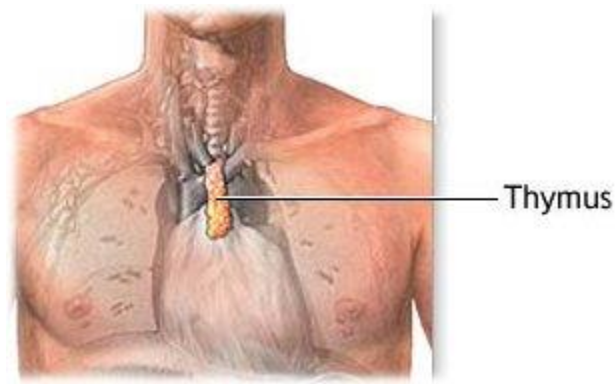



**Figure 77 – The thymus gland is found behind the breastbone and stores lymphocytes until they mature.**

# Activities and Experiments

## Lesson 1: Skin, Bones & Muscles

**Experiment:** *Does drinking soda weaken your bones?*

According to the data in the table below, does drinking soda weaken your bones?

| | **Bones fractured** | **Bones not fractured** |
|---|---|---|
| Soda drinkers | 38 | 69 |
| Non soda drinkers | 5 | 52 |

Answer: *What percent of the soda-drinkers had fractured bones? What percent of non-soda-drinkers had fractured bones? 38+69= 107. That means out of 107, 38 had fractured bones which mean 36% (38 divided by 107). 5+52 = 57. That means that out of 57 only 5 or 9% had fractures. That makes a strong case for the effect of soda, but it's not a cause. In order to know if drinking soda causes weak bones, further research would have to be done.*

**Experiment:** *Make your own brain*

Materials:

- 2 cups of sand
- 1 ½ cups of instant potato flakes
- 2 ½ cups of warm water
- A couple drops of red food coloring
- A 1 gallon plastic bag.

Make the brain:

Mix together in the plastic bag. When fully mixed together you'll have something that's the approximate weight, shape, and size of a human brain. Watch out for zombies!

**Experiment:** *Test bone design*

In this experiment you'll test how strong hollow bones are compared with solid bones.

Materials:

- Plain paper
- Paper plates
- Normal-sized books

Build your bones

1. Roll three pieces of paper into cylinders; so that they're hollow in the middle.
2. Place them on their ends.
3. Place the paper plates on top of them.
4. Stack books on top of the plate. See how many books it takes until the plate collapses.
5. Roll three more pieces of paper tightly into rolls—so that they are not hollow.
6. Place them on their ends.
7. Place a paper plate on top of them.
8. Stack books on top of the plate. See how many books it takes until the plate collapses.

*What happened?* The hollow paper "bones" supported more weight. This is one of the reasons our bones are hollow! Additionally, since our bones are hollow, they take less energy to move.

**Experiment:** *Bones in vinegar; the power of calcium*

Materials:

- Chicken bones
- 2 Jars
- Water
- Vinegar

What to do:

1. Fill one jar with water.
2. Fill the other jar with vinegar.
3. Place one chicken bone in each jar.
4. Wait a day.
5. Take the bones out and compare. What do you notice?

*What happened?* The bone in vinegar became more flexible and breakable. This is because the acid in the vinegar dissolved some of the calcium on the bone. The calcium in our bones contribute it it's hardness.

**Experiment:** *Compare size and strength*

Materials:

- Tape measure
- Paper
- Milk jug

Measure:

1. Find some friends.
2. Measure your biceps. Write down the measurements in the table below.
3. With the same arm use your biceps to lift the jug of milk as many times as you can (without hurting yourself!).
4. Write down how many times you can lift the jug in the table.

| Name | Bicep Size | Number of Times Jug Lifted |
|---|---|---|
| | | |
| | | |
| | | |
| | | |

*What next?* Graph it. On the Y axis of the graph mark the bicep sizes, on the X mark the number of times the jug was lifted. What does the graph tell you about the relationship between size and strength?

# Activities and Experiments

## Lesson 2: Digestive System

**Experiment:** *Magic Spit*

Materials:

- Protective eyewear
- Cornstarch
- Plate
- Iodine (can be purchased at drug stores)
- Water
- Two similar sized glasses. Label them "A" and "B".
- Measuring spoon
- Teaspoon
- Two coffee stirrers
- Notebook

What to do:

1. Put a teaspoon of cornstarch on a plate.
2. Put a couple drops of iodine on the cornstarch. Note the color.
3. Generate at least 2 millimeters of spit in glass A. (Tip: think of lemons helps generate spit).
4. Pour 2 millimeters of water in glass B.
5. Put 1/10 teaspoon in both glasses.
6. Mix glass A with the first coffee stirrer.
7. Mix glass B with the second coffee stirrer.
8. Add two drops of iodine to each.
9. Mix and place in a warm place (i.e. direct sunlight) for twenty minutes.
10. Observe changes.

*What happened?* When the iodine touched the cornstarch on the plate it turned blue-black. This is because it is a starch indicator (it always turns this color in the presence of starch).

Glass A is much lighter than glass B. Why? This is because the enzyme Amylase in saliva digests starch. The iodine reacted with the starch in glass B, but there was no starch in glass A with which the iodine could react.

**Experiment:** *All in Good Taste?*

Find out your sensitivity to sweet and salty tastes. This is best done with a partner.

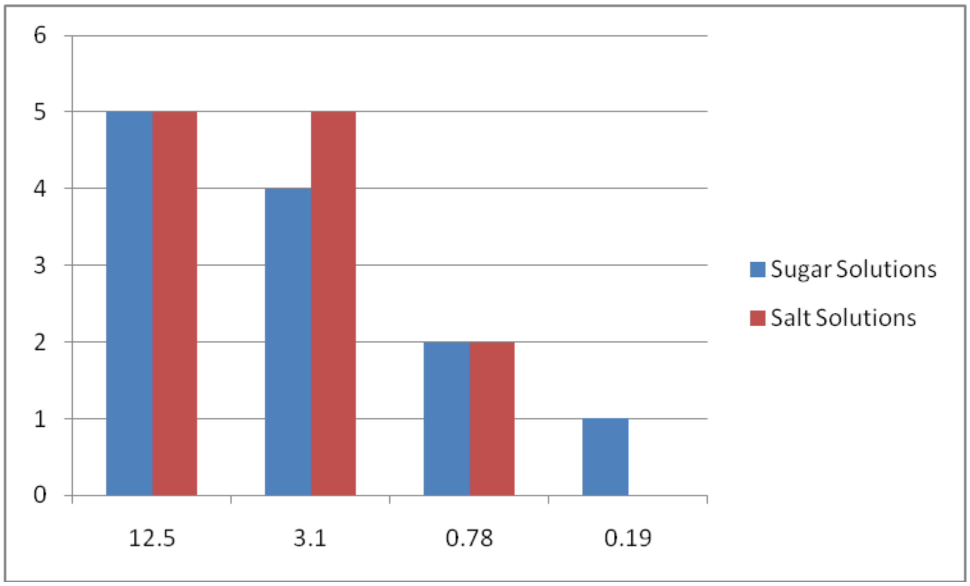
Materials:

- Measuring cup
- Plastic cups
- Water
- Sugar
- Salt
- Paper towels
- Paper and pen
- Permanent marker
- Notebook

What to do:

1. Create sugar and salt solutions.
    a. Mix 1: Mix 1 2/3 cups of water with ¼ sugar. Label the solution "12.5% Sugar".
    b. Mix 2: Make mix 1  take ½ cup of it and then add 1 ½ cup water. Label this solution "3.1% sugar".
    c. Mix 3: Take ½ cup of mix 2 and add it to 1 ½ cups of water. Label this solution "0.78% Sugar".
    d. Mix 4: Mix ½ cup of Mix 3 with 1 ½ cups of water. Label this solution "0.19% Sugar".
    e. Make the same solutions with salt.
2. Have your partner pour a little of one of the solutions onto a paper towel and put it on your tongue. Tell her or him with you can taste the solution, and whether it is salty or sweet. Between each taste rinse out your mouth.
3. Do the same for your partner.
4. If you can, test three more people.

5. Make a graph. In the Y axis use the number of people; from zero to however many people participated. In the x axis write the percentages of the solutions. For example, if you had five participants it could look something like this:



# Activities and Experiments

## Lesson 3: Cardiovascular System

**Experiment:** *A Very Simple Stethoscope*

Materials:

- 1 cardboard tube
- 1 paper towel roll

The first stethoscope was simply a wooden tube. In this activity, you will make your own simple stethoscope.

1. Place a cardboard tube from a paper towel roll over the heart. Try to hear the "lub-dub" sound.
2. Experiment with various exercises to change the heart rate you hear in your stethoscope.

**Experiment:** *The Best Workout*

Materials:

- Pen
- Paper
- Stopwatch or clock

1. Make a hypothesis about what exercise will get your heart beating the fastest: running in place, jumping jacks, hopping on one foot, or stepping onto and off of a chair.
2. Measure your pulse for 30 seconds and multiply by 2, to get resting pulse in beats per minute.
3. Run in place for two minutes
4. Measure your pulse immediately after running, again for 30 seconds, multiplying by two.
5. Rest for several minutes
6. Repeat steps 2-5 for jumping jacks, hopping, and chair steps
7. Make a bar graph showing the increase in pulse for each exercise

8. Evaluate the accuracy of your hypothesis. Are you surprised?

**Experiment:** *The Heart – A Special Muscle*

1. Make a fist with your hand. This is about the size of your heart.
2. Begin to slightly open and close your hand, as though your "heart" is beating.
3. Measure how long it takes before your hand hurts
4. Your heart beats 24 hours a day. But it only hurts when a person is having a heart attack. How can this be?

*Answer:* Your muscles need oxygen. When a muscle like your hand does not get enough oxygen, it still makes the motion, but it uses a different method of getting energy that produces lactic acid, which causes the pain. The heart is constantly supplied with oxygen from coronary circulation. So, lactic acid is never needed.

**Experiment:** *A Tennis Ball Heart*

Materials:

- 1 tennis ball
- Water
- Scissors or knife

1. Carefully cut a hole in the tennis ball
2. Fill the ball with water
3. Squeeze the ball, then release it. What do you observe?
4. How is the ball similar to our heart, as it pumps blood? What does your hand's squeeze represent?

**Experiment:** *Observing Your Capillaries*

Materials:

- Cedarwood furniture oil
- Flashlight

1. Soak your finger in cedarwood furniture oil.
2. Shine a strong flashlight on your finger

3. Your finger becomes so clean, you can see the small capillaries where oxygen transfer is happening.

**Experiment:** *Modeling Blood Pressure*

Materials:

- Oblong balloon
- Syringe

1. Fill an oblong balloon with water
2. Cover the tip of a syringe with the open end of the balloon
3. Using the syringe, remove and replace water to simulate the expansion and contraction of blood vessels
4. Which situation represents systolic blood pressure?  How about diastolic?

**Experiment:** *Clogged Arteries*

Materials:

- Plastic container
- 2/3 cup water
- 2 straws
- Bean sized lump of clay
- Paperclip

1. Fill a plastic container 2/3 full of water.
2. Insert a clean straw about halfway down the container's length measured from the bottom of the vessel to its top.
3. Blow into the straw with a steady air stream that produces about a continual stream of bubbles. Describe the blowing effort needed to produce this steady, but non-violent stream of bubbles.
4. Completely pack the end of a second straw with a bean-sized lump of clay.
5. Unbend a paperclip and use it to poke a small hole through the clay plug.
6. Insert this straw to the same depth as in step 2. Again, blow a steady air stream into the straw. How does the effort compare to when the

passageway was larger? Does the appearance of the bubble stream change? How?

7. What does the clay represent?

# Activities and Experiments

## Lesson 4: Respiratory & Excretory Systems

**Experiment:** *Oxygen All Around*

We breathe in the air that is around us. In order for respiration to work, there must be oxygen in this air. But can we prove that there actually is oxygen in the air around us? This experiment will do exactly that.

Materials:

- Small amount of water
- Pan
- Candle

1. Place a small amount of water in the bottom of a pan. The bottom of the pan should be covered.
2. Light a candle and carefully place it in the water on the bottom of the pan.
3. Cover the lit candle with the glass and observe what happens.

*What's happening:* Fire needs fuel, heat, and oxygen. The candle was getting oxygen from the air around it – the same air we breathe. When the candle had no more oxygen, the flame went out.

**Experiment:** *How Long Can You Hold Your Breath?*

Although you normally breathe without thinking about it, you can, of course, hold your breath. Your brain will not allow you to hold your breath longer than is safe.

Materials:

- Plastic bag
- Pen
- Paper

1. Hold your breath, with your nose plugged, and count how long you can do it
2. Record your time.
3. Breathe into a plastic bag for one minute.
4. Hold your breath again and count how long you can do it now.

*What's happening:* You should have found that you could hold your breath less time after breathing into the bag. As you breathed into the bag, there was more carbon dioxide in the bag, meaning there was less oxygen going into your body with each breath. With less oxygen, you can hold your breath for less time.

**Experiment:** *A Diaphragm's Duty*

When you breathe in, the diaphragm muscle contacts, making more space in the chest, which allows air to come in. When you breathe out, the opposite happens. In this activity, you will create a model diaphragm to demonstrate this important job.

Materials:

- 2 pieces of straw (2 inches)
- Scissors
- Small balloon
- Large balloon
- Rubber bands
- Rubber cement or glue

1. Take a piece of straw about 5 cm (2 inches) long and cut a small triangle in the center. The cut-out should only be on one side of the triangle.

2. Place a small balloon over each end of the straw and secure it with a small rubber band.

3. Blow into the triangle cut-out to make sure that air will go into each balloon.
4. Bend the straw in the middle of the hole.
5. Take a second piece of straw and cut a V-shape on the end. Fit the

V-shape of the second straw into the triangle hole of the bent straw.
6. Cement the two straws together, and allow plenty of time to dry.
7. Cut a hole in the bottom of a clear plastic cup, the size of the bottom of a straw.

8. Push the open end of the straw into the bottom of the cup, going through the hole. Cement the straw into the hole.
9. Cut the neck off of a large balloon.

10. Carefully stretch the cut balloon over the top opening of the cup. Do not crack the cup. Secure the edges with a large rubber band.

11. Squeeze the bottom balloon gently and observe what happens to the small balloons.

*What's happening:* The large balloon represents the diaphragm. When you squeeze it, air is forced out, slightly inflating the small balloons. This is a model of an exhale. How could you model an inhale?

**Experiment:** *What's in an Exhale?*

When you breathe out, you breathe out many things. Carbon dioxide, the waste product of respiration, is the most important. "See" the carbon dioxide in this activity.

Materials:

- 1 teaspoon Bromthymol Blue
- 1 cup
- Straw

1. Place about a teaspoon of Bromthymol Blue (BTB) in a cup

2. Place the straw in the solution and exhale (blow) into the straw.

3. Observe what happens to the blue liquid.

*What's Happening:* With enough blowing, the solution becomes green (or even yellow if you really blow.) BTB is an indicator that becomes yellow when the pH is lowered. The presence of carbon dioxide in your breathe lowers the pH slightly, changing the color.

**Experiment:** *How Much Air is in There?*
Lung capacity is the amount of air in the lungs. When people have respiratory diseases, their lung capacity is often decreased. What's your lung capacity? Let's find out!

Materials:

- Milk jug
- Masking tape
- Water
- 1 cup measuring cup
- Aquarium tubing

1. Place a strip of masking tape down the side of a milk jug from the top to the bottom.

2. Fill the jug all the way up with water using a 1 cup measuring cup. Make a mark on the tape after each cup you pour in.

3. Dump out about half the water, and record exactly how many cups of water are left in the jug.

4. Place one end of a piece of aquarium tubing inside the mouth of the jug.

5. Take a normal breath and exhale through the tubing. Mark how high the water goes.

6. Subtract the water amount after your breathe with the water height before, to see how much air was in your breath.
7. Repeat steps 5 and 6, but breathe out as much air as you possibly can.

*What's happening:* The air you breathed out displaced, or moved the water, allowing you to see how much air you exhaled.

**Experiment:** *The Pressure's On*

Materials:

- Milk carton
- Tape
- Water

You are able to breathe because of differences in the pressure in your body as compared to the pressure outside your body. But what happens when the pressure changes? Conduct this experiment to see.

1. Punch three pencil-sized holes in a ½ liter carton of milk.
2. Tape over the holes with one long piece of tape, so they are completely covered
3. Add water to the milk carton, so it is completely full
4. Quickly rip the tape off the carton and make observations.

*What's happening:* You should have noticed that the lowest hole had the most water flowing out of it. This is where pressure was the greatest. Similarly, air pressure at low elevations (such as sea level) is greater than at high elevations (such as when you are flying in an airplane.) Some people have a harder time breathing at high elevations, and if you get high enough artificial pressure must be added.

**Experiment:** *The Job of a Kidney*

Materials:

- Sand
- Water
- Yellow food coloring
- Cheesecloth
- Large bowl

The job of the kidney is to filter liquid waste. In this activity, you will model the action of the kidney by filtering sandy water.

1. Mix sand, water, and yellow food coloring.
2. Place a piece of cheesecloth over a large bowl.
3. Slowly pour the sandy water over the cheesecloth and into the bowl.
4. Make observations about the liquid that goes into the bowl.

*What's happening:* The cheesecloth, just like the kidney, serves as a filter. Sand is kept out while the water gets through. This is important in maintaining the body's salt balance.

**Experiment:** *A Model Colon*

The colon, also called the large intestine, is an important part of both the digestive and excretory systems, which removes solid waste. This model colon will demonstrate the creation of solid waste.

Materials:

- Cheesecloth
- Colander
- Regular yogurt
- Bowl

1. Place a piece of cheesecloth into a colander.
2. Add regular yogurt (not light) into the colander.
3. Place the colander with the yogurt in it into a bowl and place it into the refrigerator for several days
4. After several days, make observations about both what's in the bowl and what's left in the colander.

*What's happening*: The colon filters out liquids from the digested material (that's modeled by what's in the bowl) and leaves us with solid waste (modeled by what's in the colander.)

# Activities and Experiments

## Lesson 5: Controlling the Body

**Experiment:** *Measuring Reflexes*

Usually our brain sends messages to the muscles of our body, causing them to expand or contract. This makes our body move the way we need it too. Sometimes, such as when something unexpected happens, our body doesn't take the time to send the message all the way to the brain. Instead, the message goes as far as your spinal cord, and the spinal cord gives the muscles the messages they need. This is called a reflex. How good are your reflexes?

Materials:

- Yardstick
- Partner

1. Have a partner hold a yardstick in front of you.
2. Put your fingers around the bottom of the yardstick, but don't touch it.
3. Without warning you, have your partner let go of the yardstick.
4. Try to stop the falling yardstick by squeezing it with your fingers as soon as you notice it falling.
5. When you stop it, record how high up on the yardstick you are (in inches or centimeters.) The smaller the number, the quicker your reflex.

*What's Happening:* Stopping the ruler is a reflex. Your brain was not involved. Other reflexes include removing your hand from a hot or painful object.

**Experiment:** *Message Received*

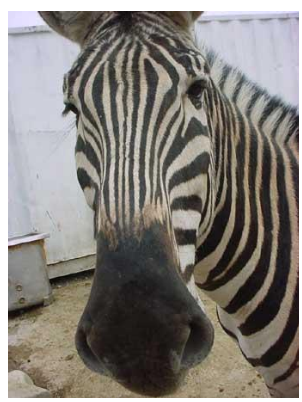
Your brain sends messages to your muscles, as well as to all the other organs in your body. Sometimes, you have no control over these messages, such as when the brain controls breathing, digestion, or blood circulation. Other times, such as when you are exercising or just walking around, you make a decision to move a part of your body, and the brain relays the message. This works well… sometimes a little too well. See for yourself.

1. Stand in a doorway.
2. Clench your hands into fists and press your hands against either side of the doorway as hard as you can. Try to hold this position for about one minute.
3. Step forward, out of the doorway, and relax your hands.

*What's Happening:* Most people will find that their hands rise, at least a little bit. The "trick" is that your arm muscles have been getting the message to tense up for a minute. Even though the brain is no longer giving this message once you relax your arms, your muscles still make the motion, simply based on the "memory" of the message.

**Experiment:** *Jumping Finger*

One of the reasons human vision is so good is that we can see in three dimensions (no 3D glasses required.) This possible because we have eyes on the same side of our face, a certain distance apart. (Look at how the eyes of a cow and zebra are on different sides of the face.) A simple activity can show you how our eye location makes 3-D vision possible.



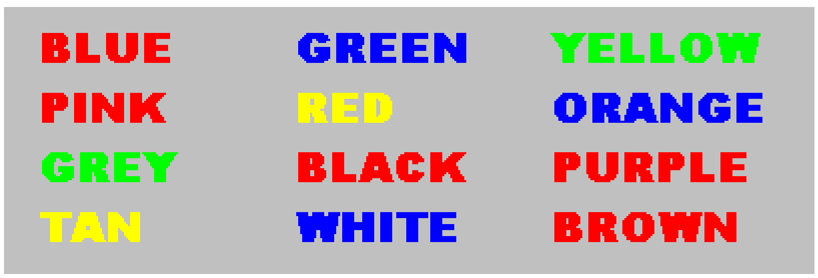
1. Hold your finger out a full arms length in front of you.
2. Close your eyes, one at a time, and look at your finger. You will notice that it seems to change location a little.
3. Now bring your finger very close to your eyes, and again close your eyes, one at a time.
4. Observe the difference of having your finger close up versus far away.

*What's Happening:* When your finger is far away, your eyes perceive it in more or less the same place. This happens because the angle between your left eye and your finger is not that different that the angle between your finger and right eye. As your finger gets closer, the difference becomes more significant. Your brain constantly uses this information to allow you to detect depth, the key to seeing in three dimensions.

**Experiment:** *Can You Believe Your Eyes?*

Our brain is a remarkable organ that receives information from sense organs, processes the information, and then sends out a message in response. But what happens when the brain gets conflicting information? That's what this experiment is all about.

1. Take a look at the chart. Say the COLOR of the word. Don't read the word.




*What's Happening:* It's harder than it looks, isn't it? The problem is that our brain is getting a mixed message. The color of the word is one message, but the word itself if another. Your brain can overcome this and say the right color, but it requires more work simply looking at the sky and saying it's blue.

**Experiment:** *Selective Listening*

Have you ever been accused of having "selecting listening?" This term refers to the idea that when your mom or dad tells you to clean your room, you somehow can't hear them, but when they ask if you want ice cream, your ears work great. Is this a real, scientific thing? It turns out that there actually is something going on your brain that makes your hearing selective. Check it out!

1. Go to a noisy place where you'll be surrounded by people. (A fast food restaurant around lunchtime will work well.)

2. Hold a pen slightly above the table and drop it. Observe any reactions from other people.
3. Wait a minute or two so you aren't too obvious, then drop another object, like a set of keys. Again, look for reactions.
4. Drop a few more things, and, for the last thing, drop several coins.

*What's Happening:* You probably got much more of a reaction from the dropped coins than from the other objects. The reason. People care about money… not so much about pens and keys. Our brain filters out the sounds we don't find important. This is a good thing, because we are bombarded with sounds every day. The problem is that since your brain decides what's important, you don't get to completely control. So, if you decide you are going to watch TV while doing schoolwork, this probably won't work, unless you choose a TV show you don't find interesting (and if that was the case, why would you watch it in the first place.) Some people do find it helpful to listen to quiet music while working, and are able to tune this out enough to focus on the work.

**Experiment:** *Go For a Spin*

Your ears do more than just help you hear. They are also very important for your balance. Inside your ear are liquid-filled tubes called semicircular canals. As your body moves, the liquid in the semicircular canals moves too. But what about when you stop? Let's find out.

Materials:

- Office chair
- Adult

1. Sit on an office chair that spins.
2. Have an adult spin you quickly on the chair. Hold on to the handles and be careful!
3. Have the adult suddenly stop the chair, and observe how you feel.

*What's Happening:* Did you feel as though you were still moving? Part of you was. Although your body stopped, the fluid in your semicircular canals kept on going for a little while. As long as the fluid kept move, your brain was giving the message that you were moving, and it felt that way.

**Experiment:** *Can You Feel It?*

Every bit of your skin has sensory neurons. These neurons sense pain, pressure, and temperature, and send the message to your brain. This is the sense of touch. Not all parts of your body have the same amount of neurons, and the more neurons a certain body part has, the more sensitive it will be to touch. In this experiment, you'll use indirect evidence to figure out if you have more neurons in your palm or lower back.

Materials:

- 2 washcloths
- Water
- Partner

1. Prepare two washcloths – one with cool water and one with slightly warm water. The two washcloths should not be dramatically different in temperature, but there should be *some* difference.
2. Have a partner place a washcloth on your palm 20 times. He or she should not tell you which washcloth it is, and should not do it in any kind of pattern. Your job is to tell if it is the cool or warm washcloth that is being touched to your palm.
3. Have your partner record how many times you answered correctly.
4. Repeat steps two and three placing the washcloth on your lower back.

*What's Happening:* Your palm has more sensory neurons than your lower back, so you should have had an easier time identifying cool versus warm on this part of your body. This means your palm is also more sensitive to pressure and pain. Now that you have compared the palm and lower back, why not compare some other parts of your body?

**Experiment:** *The Nose Knows (Or Does It?)*

Our sense of smell is controlled by sensory neurons in the nose. When a smell is detected, a message is sent to the brain. What the brain does with the information in some cases may surprise you.

Materials:

- Vanilla extract
- Rubbing alcohol

1. Smell some vanilla extract. Continue to smell it until you no longer sense the smell.
2. Place some rubbing alcohol under your nose. Observe the smell.

What's Happening: The human body has a remarkable ability to get used to odors we smell all the time. If the brain keeps getting the same message from the nose, it will eventually learn to ignore it. This is important if you are an animal that could be someone's prey. If you're a rabbit, for example, you'll get used to the normal smells around you and be able to sense if a predator is coming. For humans, who don't use our smell for survival, this ability to block out smells isn't all that helpful, and can actually be a problem. Someone with bad body odor will get used to it, and won't realize they need a shower!

**Experiment:** *Taste Bud Map*

On your tongue are thousands of sensory neurons. These neurons are organized into groups called taste buds. When you eat something, the taste buds send a message to your brain. Your brain interprets the message, and "tells" you what you are eating. Certain areas of the tongue have higher concentrations of certain types of taste buds. In this experiment, you will have a chance to see where they are.

Materials:

- 3 cups
- Sugar water or punch
- Salt water
- Unsweetened iced coffee
- Q tips

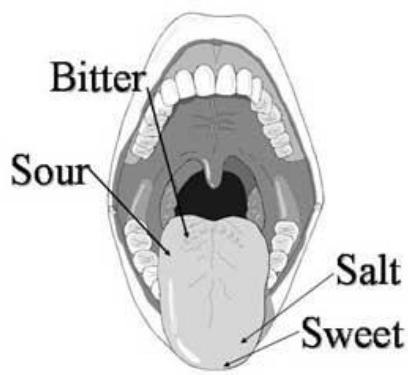
1. Prepare a "sweet," "salty," "sour," and "bitter" cup. In the "sweet" cup, place sugar water or punch. In the "salty" cup place salt water.

In the "sour" cup, place lemon juice or lemonade. In the "bitter" cup, place unsweetened iced coffee.

2. Dip a q-tip into the sweet cup. Place a drop of the sweet liquid on the tip of your tongue. Dip it in again, and place it on the side of your tongue towards the front. Place another drop on the side towards the back, and a final drop in the back. Record where you tasted the sweetness most strongly.
3. With a different q-tip, repeat step two for the other cups.

*What's Happening:* Look at the diagram below, which shows where the concentration of taste buds for each of these tastes are. How closely do your results match the diagram? If your results seem a little off, don't worry. You actually have taste buds for all kinds of tastes everywhere. The map just shows where they are the strongest.




Taste Buds of the Human Tongue

# Activities and Experiments

## Lesson 6: Diseases and Defenses

**Experiment:** *How Clean is Clean?*

The single best way to prevent the spread of infectious disease is to wash your hands. But how much do you need to wash them to actually get rid of all the disease causing pathogens you are carrying? Using a model to represent pathogen-filled hands, you can find out.

Materials:

- GloGerm, Germ Juice or Glitter Bug

1. Copy a chart like the one below:

| 0 | 5 | 10 | 15 | 20 |
|---|---|---|---|---|
| ++++ | | | | |

2. Cover your hands with a pathogen simulator, such as GloGerm, Germ Juice, or Glitter Bug. Cover both your palms and the backs of your hands, and try to get it on the skin under your fingernails.
3. Look at your hands under a UV light. You will see that the "germs" are clearly visible. This is time 0, meaning that you have not washed your hands at all. You will call this level of dirtiness "++++," or the dirtiest. This level of dirtiness has already been filled in on the data table.
4. Wash your hands for five seconds. Again look at your hands under the UV light. Rate their dirtiness as either ++++, +++, ++, +, or –, where ++++ represents as dirty as they were at the start, and – represents totally clean.
5. Wash your hands for an additional 5 seconds, and record their cleanliness after 10, 15, and 20 seconds total.

*What's Happening:* The Centers for Disease Control (CDC) recommends washing your hands with warm, soapy water for 10-15 seconds. This assumes that you scrub vigorously, and that your hands are not abnormally dirty.

**Experiment:** *Don't Forget the Soap*

Materials:

- Vegetable oil
- Water
- Soap

1. Put a spoonful of vegetable oil on your hands
2. Try to wash it off in only cold water, without soap.
3. Repeat with only warm water and with water and soap.

*What's Happening:* Plain water, especially plain cold water, is not as effective at getting the oil off your hands as warm water and soap. This model used vegetable oil, but we have natural oils that build up in our skin. To clean them, and to get rid of pathogens, soap is needed!

**Experiment:** *Don't Sneeze On Me!*

Materials:

- 10 volunteers
- 10 cups
- Water
- Food coloring

When we sneeze, we release a huge number of pathogens into the air. If we don't cover our mouth, these pathogens are more likely to infect another person, making them sick. The person we infected can now spread the disease to others. In this way, pathogens can spread very quickly. You'll need about 10 volunteers for this activity. (You can be one of the 10.) Prior to the activity, prepare 10 cups, by filling them up with water and adding food coloring to one of them. Number the cups 1-10. You can make the colored cup whatever number you want.

1. Explain to your volunteers that we are going to imagine they work together in an office, and have frequent appointments with each other. Have everyone fill out a chart like the one below. To fill the chart out, the volunteers need to make an "appointment" with each other at a certain time. For example, if Jessica and Raul are two of your volunteers, they might agree to have an "appointment" at 9:00. Jessica would write "Raul" under 9:00, and Raul would write "Jessica" under 9:00. You should not meet with the same person twice.

| Time | Appointment With |
|---|---|
| 9:00 | |
| 10:00 | |
| 11:00 | |

2. Assign everyone a number. The oldest volunteer is number 1, and the youngest is number 10, with everyone else somewhere in between based on their ages.
3. Give the volunteers their water cup, based on their number and tell them to go to their 9:00 appointment.
4. During the appointment, we will imagine that each individual sneezed once. We'll model this by exchanging a little bit of water. In the example above, for instance, Raul would spill some water into Jessica's cup, and Jessica would spill some into Raul's.
5. Repeat the procedure for the 10:00 and 11:00 appointments.
6. Once the appointments are over, announce that anyone who has colored water (even just a little coloring) is now sick. Ask who is sick and record the number.

*What's Happening:* At the start of the activity, only one person was sick (had colored water.) Now, it is likely that most people are. Diseases spread quickly, especially when people do not make good decisions about their health and the health of others. The sick person should really have stayed home from work. If he or she had, no one else would have become sick. If they did come in, they should have at least made an effort to cover their mouths when sneezing.

**Experiment:** *Make Model Mucus*

Your mouth and nose are not covered by skin. They are referred to as mucus membranes. The mucus they contain is important in defending against pathogens.

Materials:

- ½ cup boiling water
- 2 teaspoons gelatin
- Fork
- 1 quarter cup corn syrup

1. Fill half a cup with boiling water.
2. Add three teaspoons of gelatin to the boiling water.
3. Let it soften before stirring with a fork.
4. Add a quarter of a cup of corn syrup.
5. Stir the mixture again with your fork and look at the long strands of gunk that have formed.
6. As the mixture cools slowly add more water, small amounts at a time.

*What's Happening:* Mucus is made mostly of sugars and protein. This is exactly what you used to make your model of mucus, although they were *different* sugars and proteins. The long, fine strings you could see inside your model when you moved it around are protein strands. These protein strands make mucus sticky and capable of stretching. Pathogens get caught in this sticky material.

**Experiment:** *Can I Eat That?*

One of the ways that disease can be spread is through contaminated food. In the U.S., we have many systems in place to reduce the chances of getting sick from food. Restaurants must follow strict guidelines for handling food. We have refrigerators and freezers to slow down the growth of bacteria. Perishable foods have expiration dates. Let's take a closer look at how important those expiration dates are.

Materials:

- 4 cups
- Water
- Sour milk, expired sour cream or fresh yogurt
- Methylene blue
- Mineral oil
- Large clear bowl

1. Label four cups as “control,” “milk,” “yogurt,” and “sour cream”

2. Fill the control cup with water.

3. Fill each of the other cups half full with sour milk, expired sour cream, or fresh yogurt.

4. Add 20 drops of methylene blue to each cup.

5. Add 2 drops of mineral oil to each cup.

6. Place the cups in a large clear bowl filled with warm water.

7. Record the time it takes for the color to fade.

*What’s Happening*: Methylene blue is a dye used to detect bacteria. The bacteria use up oxygen, and the dye turns colorless in the absence of oxygen. So, the faster the color fades when the dye is added to a substance, the less oxygen there is, and the more bacteria the substance has. (There are some bacteria that don’t need oxygen, so this test wouldn’t work for them.) You may have noticed that there are bacteria present in the yogurt although it’s fresh. These bacteria are helpful to you. They improve your ability to digest food.

**Experiment:** *The Skin You're In*

Your skin is your first line of defense against pathogens. Everyday, many germs come your way, but most of them are blocked by your skin. This simple model can show how.

Materials:

- Apple
- Plastic wrap
- Food coloring

1. Cut an apple in half.
2. Cover one half in plastic wrap; leave the other uncovered.
3. Add several drops of food coloring to each apple, and make observations.

*What's Happening:* The plastic wrap represents the skin, and the food coloring represents a pathogen. Without skin, pathogens could easily enter the body. The thick skin keeps most pathogens out.

**Experiment:** *Take All Your Medicine!*

If you have ever been prescribed an antibiotic, your doctor probably reminded you to take all the medication prescribed, even if you started to feel better. Why is this so important?

Materials:

- 30 pennies
- 12 nickels
- 6 dimes
- 4 quarters
- Deck of cards

1. For this experiment, assume the following:
    a. Coins represent bacteria. The higher the monetary value of the coin, the more resistant it is. (The harder it is to kill.)
    b. If you have more than 35 bacteria, you will feel sick.

   c. A deck of cards represents an antibiotic. Each card is one dose of medicine.
2. Place 52 coins on a table in the following amounts: 30 pennies, 12 nickels, 6 dimes, and 4 quarters.
3. Shuffle a deck of cards.
4. Pull the top card. This one card is one dose of antibiotic, and will kill one bacterium. Follow these rules to determine which bacterium dies.
   a. Any card numbered 2-7 kills a penny.
   b. Eights, 9, 10's, and Jacks kill nickels
   c. Queens and Kings kill dimes
   d. Aces kill quarters.
   e. If there are no coins in the correct denomination to be killed (for example, you get a jack but all the nickels are already dead,) the card can kill a penny instead.
5. "Dead" bacteria can be taken off the table.
6. The person in this simulation decides to ignore their doctors advice to take all 52 doses, and stop when they feel better. So, when you have 35 coins left on the table, stop.
7. The bacteria reproduce, and their offspring are just like them. So, for every penny still on the table, add another penny. Add another nickel for every nickel, etc. Count how many of each type of coin you have (there will be 70 total), and add it to the data table. Then, figure our the percent of each coin type by dividing the number present by 70. Add this to your data table.

Sample Data Table:

| Coin Type | Number to Start | Percent at Start | Number after Reproduction | Percent After Reproduction |
|---|---|---|---|---|
| Penny | 30 | | | |
| Nickel | 12 | | | |
| Dime | 6 | | | |
| Quarter | 4 | | | |

*What's happening:* Typically, the percent of the highly resistant bacteria (dimes and quarters) will increase while the less resistant ones decrease in percentage. This is exactly what happens in real life if you don't take all the antibiotic. The bacteria that are hardest to kill stay and reproduce. This makes it harder to cure the disease caused by the bacteria. If you had gone through all the cards to begin with, you would have killed all the bacteria for sure. Now one deck won't do it. To avoid needing more medication, or stronger medication, later on, the best thing to do is take all the antibiotic the first time around.

# Exercises

## Skin, Bones & Muscles Exercises

1. What is homeostasis?
2. What is an example of the body maintaining homeostasis?
3. Cells make up tissues, at least how many tissues make up an organ?
4. What are the four main types of tissues?
5. Describe how a negative feedback works and give an example.
6. What is the biggest organ in the body?
7. The skin, hair, and nails make up which system?
8. What are three ways the integumentary system helps maintain homeostasis?
9. What are the two layers of skin? What is the fatty layer underneath the skin called?
10. What role does melanin play in the skin?
11. What causes acne?
12. What three components make up the skeletal system?
13. What are the main functions of bones?
14. What is the difference between red bone marrow and yellow bone marrow?
15. What are the three classes of joints?
16. What are the four types of movable joints?
17. What are two key nutrients bones need?
18. What’s the difference between skeletal muscle, smooth muscle, and cardiac muscle?
19. Muscles work in pairs, what do we call the one that bends the joint? What do we call the one that straightens the joint?
20. What is the difference between stretching exercises, aerobic exercises, and anaerobic exercises?

# Exercises

## Digestive System Exercises

1. What is a diet?
2. Why does our body need nutrients?
3. What are the six essential nutrients? Describe them in your own words.
4. What model of a proper diet do we currently use; *MyPlate* or *MyPyramid*?
5. What are the three general pieces of advice the USDA gives in regards to maintaining a healthy diet?
6. Does the protein food group, according to the USDA, include only meat?
7. Is 30% lean meat the type of meat you should buy often? Why or why not?
8. What is the difference between "enriched" grains and "non- enriched" grains?
9. Do "enriched" refined grains contain fiber?
10. Who should avoid dairy products?
11. If you eat a healthy, balanced diet, is it necessary to get weekly exercise? If so, how much?
12. What is the difference between mechanical digestion and chemical digestion?
13. What are the two steps after digestion?
14. Name two key enzymes used for digestion.
15. What is peristalsis?
16. Is protein chemically digested in the mouth? If not there, where?
17. What are the three parts of the small intestine? What are their functions?
18. What is the main function of the large intestine?

# Exercises

## Cardiovascular System Exercises

1. What is the overall purpose of the cardiovascular system?
2. How could body temperature be affected if someone has poor circulation?
3. What are the four parts of blood?
4. Sickle-cell anemia is a disease in which RBC's cannot carry hemoglobin properly. What could happen to a person who has sickle-cell anemia?
5. What protein give's RBC's their red color?
6. What would happen to a person with too few WBC's?
7. Hemophilia is a disease in which platelets do not work properly. What could happen to someone who has hemophilia?
8. Why do arteries have thick walls?
9. Why do veins have valves?
10. Name the four chambers of the heart.
11. Where does the pulmonary artery start? Where does it lead?
12. What is the difference between oxygen-rich and oxygen poor blood?
13. What happens to blood in the lungs?
14. What is the name of the only vein that carries oxygen poor blood?
15. Which chamber of the heart does blood enter after leaving the pulmonary vein?
16. In which blood vessel does oxygen transfer happen?
17. Where do the superior and inferior vena cava lead?
18. Which organ gets blood from the coronary artery?
19. What is the difference between systolic and diastolic blood pressure?
20. How can hypertension be treated?
21. When can atherosclerosis cause a heart attack?
22. What happens if blood vessels leading to the brain are blocked?
23. What are three benefits of not smoking related to the cardiovascular system

# Exercises

## Respiratory & Excretory Systems Exercises

1. What is the job of the respiratory system?
2. What happens to air in the nasal cavity?
3. What does the diaphragm do when you inhale?
4. Why is it important for the epiglottis to cover the trachea when you are eating?
5. What happens in the alveoli?
6. When pressure is different, in what direction do fluids flow?
7. How does your body use differences in pressure when you exhale?
8. What is the difference between breathing and respiration?
9. What is internal respiration?
10. What disease results from an inflammation on the bronchi?
11. What types of things can cause an asthma attack?
12. What types of things cause pneumonia?
13. Why are the lungs part of both the respiratory and excretory system?
14. Besides the excretory system, what system are the kidneys a part of?
15. What do the kidneys do?
16. What is urine?
17. After traveling down the ureters, where does urine go?
18. How do kidney stones develop?
19. What is the purpose of a kidney dialysis machine?
20. What are the most common types of UTI?

# Exercises

## Controlling the Body Exercises

1. How does the nervous system relate to the other organ systems?
2. What is a synapse?
3. What organs are in the central nervous system?
4. What are the three parts of the brain?
5. If the left side of the cerebrum is injured, will the right or left side of the body most likely be affected? Why?
6. What do the vertebrae do?
7. What is the function of myelin?
8. What is the difference between the somatic and autonomic nervous sytem?
9. When is the sympathetic nervous system used?
10. How is a reflex different from a typical message to the brain?
11. What is the purpose of cones in the eyes?
12. What is the path of light coming into the cornea?
13. What happens to images if a person has myopia?
14. What two things are ears responsible for?
15. If the hairs in the ears semicircular canals move, what message is sent to the brain?
16. What are some parts of the body that have many touch receptors?
17. Where are taste buds found?
18. What causes Reye’s Syndrome?
19. What occurs during a seizure?
20. What are some things you can do to “exercise” your brain?

# Exercises

## Diseases and Defenses Exercises

1. What is the difference between an infectious and noninfectious disease?
2. What are four types of pathogens?
3. How are viruses different than other pathogens?
4. Can a noninfectious disease be caused by a pathogen?
5. How do vectors spread disease?
6. What is the single best way to avoid getting an infectious disease?
7. How can you avoid coming into contact with vectors when you are out in nature?
8. What is the body's first line of defense?
9. How do body excretions keep you from getting sick?
10. How does mucus stop pathogens?
11. What role does cilia play in the nose?
12. What comes out of your body when you cough or clear your throat?
13. When does your body send out signals for an inflammation?
14. How are inflammations helpful?
15. How are fevers helpful?
16. What types of white blood cells are involved in inflammations?
17. When would your body produce an immune response?
18. Where are lymphocytes produced?
19. What is the function of the thymus gland?
20. What do killer t-cells do?

# Answers to Exercises

## Answers to Skin, Bones & Muscles Exercises

1. What is homeostasis? The ability of the body to maintain a stable internal environment in the response to external changes.
2. What is an example of the body maintaining homeostasis? Many examples to choose from. One might be when we sweat to keep our body temperature down, or when we shiver to keep the temperature up. Another example is how we regulate the amount of sugar in our blood. All of the examples should show how the body uses a negative feedback loop to maintain homeostasis. We sweat just until we are cooled down, we shiver until we are warmed up, and we put sugar in our system just until we have enough.
3. Cells make up tissues, at least how many tissues make up an organ? Two or more tissues working together to serve the same function constitute an organ.
4. What are the four main types of tissues? Epithelial tissue, muscular tissue, nervous tissue, and connective tissue.
5. Describe how a negative feedback works and give an example. A mechanism of control in the body in which the result of a bodily function acts as a signal to stop. Plus one example (like the control of blood sugar, or blood temperature).
6. What is the biggest organ in the body? The skin.
7. The skin, hair, and nails make up which system? The integumentary system.
8. What are three ways the integumentary system helps maintain homeostasis? 1.) Helping regulate temperature, 2.) Sending sensory information about the environment outside the body to the brain 3.) Keeping water and germs out of the body 4.) Acts as a barrier to sunlight.
9. What are the two layers of skin? What is the fatty layer underneath the skin called? The two layers are the epidermis and the dermis. The fatty layer beneath is the hypodermis or subcutaneous tissue.
10. What role does melanin play in the skin? It pigments the skin, and helps protect the lower layers from harmful UV rays.
11. What causes acne? Clogging of the oil glands.

12. What three components make up the skeletal system? Bones, ligaments, and cartilage.
13. What are the main functions of bones? Support: Bones give the body its structure—its shape. It holds up the tissue against the pressure of gravity. protection: The bones protect certain tissues. For example, the skull protects the brain, and the ribs protect the heart and lungs. Movement: The bones work in concert with the muscles to give us the ability to move. Making Blood Cells: Certain parts of certain types of bones make blood cells. Storage: Bones store calcium and phosphorus (mostly calcium).
14. What is the difference between red bone marrow and yellow bone marrow? Red bone marrow makes red blood cells while yellow bone marrow makes white blood cells.
15. What are the three classes of joints? Fixed, partly-movable, and movable.
16. What are the four types of movable joints? Ball and socket joints, hinge joints, pivot joints, and gliding joints.
17. What are two key nutrients bones need? Calcium and vitamin D.
18. What's the difference between skeletal muscle, smooth muscle, and cardiac muscle? Skeletal muscle is attached to our bones and allow us to move. We do not control smooth muscle. Cardiac muscle is only found in the heart.
19. Muscles work in pairs, what do we call the one that bends the joint? What do we call the one that straightens the joint? The muscle that bends the joint is called the flexor, and the one that straightens the joint is called the extensor.
20. What is the difference between stretching exercises, aerobic exercises, and anaerobic exercises? Stretching exercises warm-up our muscles and make them more flexible, anaerobic exercise build our muscles by making them work against resistance, and aerobic exercises increase our endurance.

# Answers to Exercises

## Answers to Digestive System Exercises

1. What is a diet? The sum of the food and drink consumed considered in terms of its effect on health
2. Why does our body need nutrients? Because it needs energy, it needs to grow/repair itself, and it needs to maintain the systems that maintain homeostasis.
3. What are the six essential nutrients? Describe them in your own words. Protein, carbohydrates, lipids, vitamins, minerals, water.
4. What model of a proper diet do we currently use; MyPlate or MyPyramid? MyPlate.
5. What are the three general pieces of advice the USDA gives in regards to maintaining a healthy diet? Balance calories intake, eat certain [nutrient rich] foods, eat fatty and sugary foods in moderation.
6. Does the protein food group, according to the USDA, include only meat? No it also includes vegetables, fish, eggs, and poultry.
7. Is 30% lean meat the type of meat you should buy often? Why or why not? No, because it has far too much fat. You should look for 94% lean meat.
8. What is the difference between "enriched" grains and "non- enriched" grains? Enriched grains contain vitamins and minerals we need that are lost in the refining process.
9. Do "enriched" refined grains contain fiber? No, fiber is not added back to enriched refined grains.
10. Who should avoid dairy products? People who cannot digest lactose—people who are lactose intolerant.
11. If you eat a healthy, balanced diet, is it necessary to get weekly exercise? If so, how much? Yes, exercise is always necessary. 60 minutes of exercise three days a week is a good level of activity.
12. What is the difference between mechanical digestion and chemical digestion? Mechanical digestion is accomplished with the teeth, which chemical digestion breaks food down into the nutrients via chemicals and enzymes (catalysts).
13. What are the two steps after digestion? Absorption and elimination.

14. Name two key enzymes used for digestion. Amylase, pepsin, or pancreatic lipase.
15. What is peristalsis? Peristalsis is the wave-like movement of the digestive system used to move food from the mouth to anus.
16. Is protein chemically digested in the mouth? If not there, where? No, protein is digested by pepsin in the stomach.
17. What are the three parts of the small intestine? What are their functions? The duodenum, the jejunum, and the ileum. The duodenum is the first part of the small intestine. In the duodenum the food from the stomach is further digested (chemically). Some of the chemicals are secreted from the duodenum itself, others are secreted from the liver and pancreas.The jejunum; Most nutrients are absorbed into the body at this second part of the small intestine. The nutrients are absorbed through tiny blood vessels. The ileum Here nutrients are also absorbed into the blood stream. What is not absorbed in the ileum is passed as waste through the large intestine.
18. What is the main function of the large intestine? Eliminate solid waste from the body.

# Answers to Exercises

## Answers to Cardiovascular System Exercises

1. What is the overall purpose of the cardiovascular system? to move blood to the various parts of the body
2. How could body temperature be affected if someone has poor circulation? the body would not be able to heat up or cool down to the ideal temperature
3. What are the four parts of blood? plasma, platelets, RBC's, WBC's
4. Sickle-cell anemia is a disease in which RBC's cannot carry hemoglobin properly. What could happen to a person who has sickle-cell anemia? Oxygen would not get to the organs of the body.
5. What protein give's RBC's their red color? hemoglobin
6. What would happen to a person with too few WBC's? they would have a weak immune system and could more easily get diseases
7. Hemophilia is a disease in which platelets do not work properly. What could happen to someone who has hemophilia? their blood would not clot when they got minor cuts and scrapes
8. Why do arteries have thick walls? because the blood in them is under high pressure
9. Why do veins have valves? to keep the blood from flowing backwards
10. Name the four chambers of the heart. right atrium, left atrium, right ventricle, left ventricle
11. Where does the pulmonary artery start? Where does it lead? it starts at the heart and leads to the lungs
12. What is the difference between oxygen-rich and oxygen poor blood? oxygen-rich blood has oxygen and oxygen-poor blood has very little
13. What happens to blood in the lungs? it gets oxygen
14. What is the name of the only vein that carries oxygen poor blood? pulmonary vein
15. Which chamber of the heart does blood enter after leaving the pulmonary vein? left atrium
16. In which blood vessel does oxygen transfer happen? capillaries
17. Where do the superior and inferior vena cava lead? the right atrium of the heart
18. Which organ gets blood from the coronary artery? heart

19. What is the difference between systolic and diastolic blood pressure? systolic is the highest blood pressure; diastolic is the lowest
20. How can hypertension be treated? improved diet, increased exercise, or medication
21. When can atherosclerosis cause a heart attack? when a coronary artery becomes completely blocked
22. What happens if blood vessels leading to the brain are blocked? a stroke
23. What are three benefits of not smoking related to the cardiovascular system decreased risk of hypertension, coronary heart disease, and stroke

# Answers to Exercises

## Answers to Respiratory & Excretory Systems Exercises

1. What is the job of the respiratory system? to provide the body with oxygen and remove carbon dioxide
2. What happens to air in the nasal cavity? air is warmed and moistened
3. What does the diaphragm do when you inhale? contracts to make more room in the chest
4. Why is it important for the epiglottis to cover the trachea when you are eating? this prevents food from going down the trachea
5. What happens in the alveoli? oxygen travels from the alveoli to the blood and carbon dioxide travels from the blood to the alveoli
6. When pressure is different, in what direction do fluids flow? from high to low pressure
7. How does your body use differences in pressure when you exhale? the pressure inside the body increases, becoming greater than the pressure outside, causing air to flow out
8. What is the difference between breathing and respiration? breathing is the act of air coming in and out of the body; respiration includes all gas transfer
9. What is internal respiration? the transfer of oxygen from the blood to the various parts of the body
10. What disease results from an inflammation on the bronchi? bronchitis
11. What types of things can cause an asthma attack? change of temperature, physical activity, poor air quality
12. What types of things cause pneumonia? bacteria, viruses, fungi, and parasites
13. Why are the lungs part of both the respiratory and excretory system? they are involved gas exchange as well as removing a waste product (carbon dioxide)
14. Besides the excretory system, what system are the kidneys a part of? urinary
15. What do the kidneys do? filter urine

16. What is urine? a mixture of water and nitrogen-containing compounds, including urea
17. After traveling down the ureters, where does urine go? to the bladder
18. How do kidney stones develop? nitrogen-containing compounds crystallize in the urinary system
19. What is the purpose of a kidney dialysis machine? to act as the kidneys by filtering blood, if the kidneys have shut down
20. What are the most common types of UTI? bladder infections

# Answers to Exercises

## Answers to Controlling the Body Exercises

1. How does the nervous system relate to the other organ systems? The nervous system controls the other systems
2. What is a synapse? The place where the axon of one neuron meets the dendrite of another
3. What organs are in the central nervous system? The brain and spinal cord
4. What are the three parts of the brain? Cerebrum, cerebellum, and brain stem
5. If the left side of the cerebrum is injured, will the right or left side of the body most likely be affected? Why? The right, because each hemisphere of the cerebrum controls the opposite side of the body
6. What do the vertebrae do? Protect the spinal cord
7. What is the function of myelin? Allow messages to move quickly along nerve cells
8. What is the difference between the somatic and autonomic nervous sytem? The somatic system controls voluntary system, while the autonomic system controls involuntary motion
9. When is the sympathetic nervous system used? In emergencies
10. How is a reflex different from a typical message to the brain? Reflexes bypass the brain, and are controlled by the spinal cord
11. What is the purpose of cones in the eyes? To see in color
12. What is the path of light coming into the cornea? After passing the cornea, the light goes through the pupil, then the lens, and is focused on the retina
13. What happens to images if a person has myopia? The image focuses in front of the retina instead of on it
14. What two things are ears responsible for? Hearing and body position (balance)
15. If the hairs in the ears semicircular canals move, what message is sent to the brain? That the body is moving
16. What are some parts of the body that have many touch receptors? Palms, soles of feet, lips, tongue
17. Where are taste buds found? On the tongue

18. What causes Reye's Syndrome? Giving aspirin to young children with viral infections
19. What occurs during a seizure? A person becomes unconscious and may have violent jerking motions
20. What are some things you can do to "exercise" your brain? Read, learn, and do activities like crossword puzzles

# Answers to Exercises

## Answers to Diseases and Defenses Exercises

1. What is the difference between an infectious and noninfectious disease? Infectious disease can be spread, but noninfectious disease cannot

2. What are four types of pathogens? Bacteria, viruses, protozoa, and fungi

3. How are viruses different than other pathogens? They are not alive

4. Can a noninfectious disease be caused by a pathogen? Yes

5. How do vectors spread disease? They bite someone with the pathogen, keep the pathogen with them, then spread that pathogen to the next person they bite

6. What is the single best way to avoid getting an infectious disease? Washing your hands

7. How can you avoid coming into contact with vectors when you are out in nature? Wear long sleeves and long pants

8. What is the body's first line of defense? The thick outer layer of the skin called the epidermis

9. How do body excretions keep you from getting sick? Many body excretions contain pathogen-killing chemicals

10. How does mucus stop pathogens? Pathogens get stuck in the sticky mucus

11. What role does cilia play in the nose? Cilia sweeps up pathogens and moves them out of the body

12. What comes out of your body when you cough or clear your throat? Mucus and pathogens

13. When does your body send out signals for an inflammation? When pathogens have entered the body through the skin

14. How are inflammations helpful? They bring white blood cells to the site of the infection

15. How are fevers helpful? They raise your body temperature, making it harder for many pathogens to reproduce quickly

16. What types of white blood cells are involved in inflammations? Phagocytes

17. When would your body produce an immune response? When both the first and second lines of defense have failed

18. Where are lymphocytes produced? In red bone marrow

19. What is the function of the thymus gland? To store lymphocytes until they are mature

20. What do killer t-cells do? Attack and destroy specific pathogens