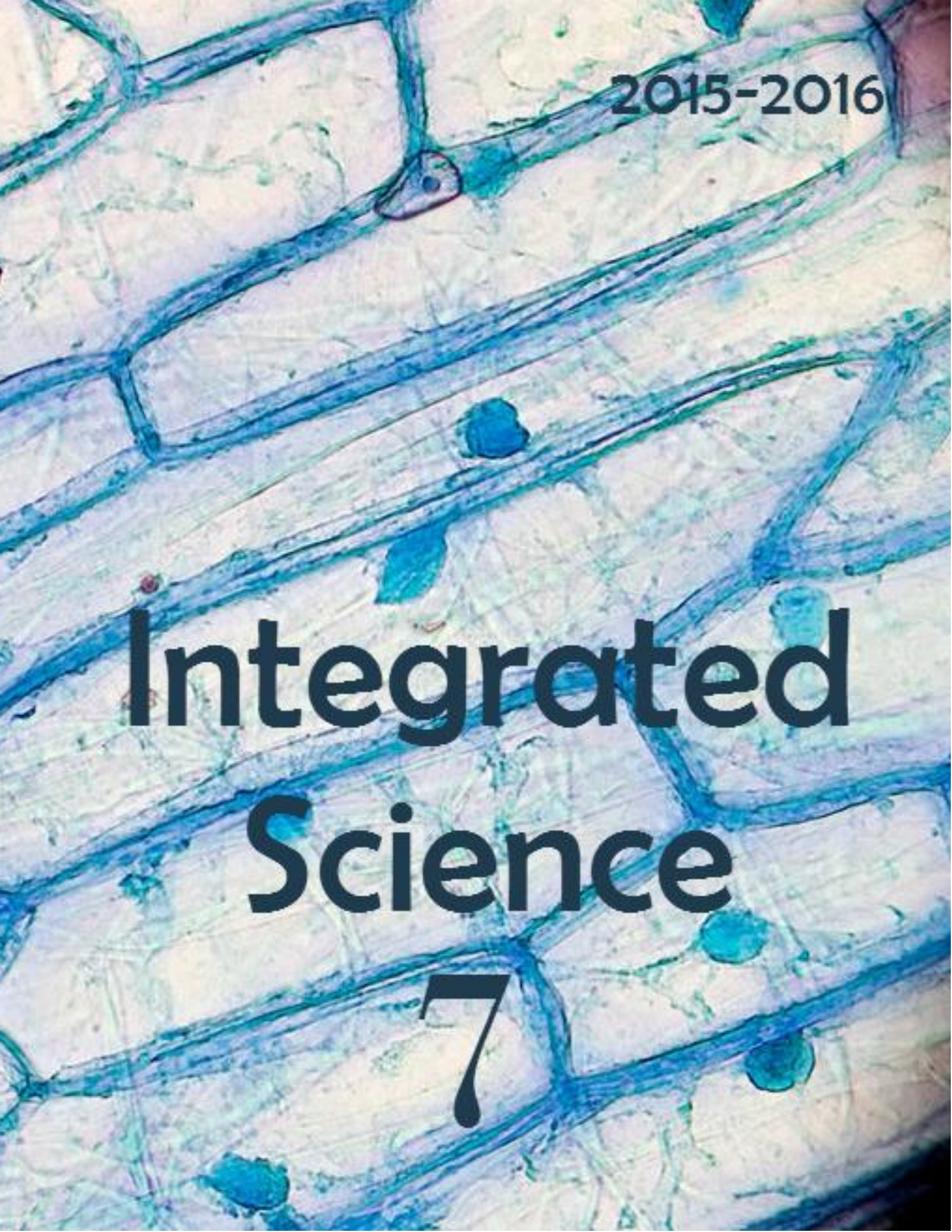
2015-2016
Integrated
Science
7

Credits

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We also thank the amazing Utah science teachers whose collaborative efforts made the book possible. Thank you for your commitment to science education and Utah students!

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Utah science core curriculum alignment

Standard 1: Students will understand the structure of matter.

Objective 1: Describe the structure of matter in terms of atoms and molecules.

a. Recognize that atoms are too small to see.
b. Relate atoms to molecules (e.g., atoms combine to make molecules).
c. Diagram the arrangement of particles in the physical states of matter (i.e., solid, liquid, gas).
d. Describe the limitations of using models to represent atoms (e.g., distance between particles in atoms cannot be represented to scale in models, the motion of electrons cannot be described in most models).
e. Investigate and report how our knowledge of the structure of matter has been developed over time.

Objective 2: Accurately measure the characteristics of matter in different states.

a. Use appropriate instruments to determine mass and volume of solids and liquids and record data.
b. Use observations to predict the relative density of various solids and liquids.
c. Calculate the density of various solids and liquids.
d. Describe the relationship between mass and volume as it relates to density.
e. Design a procedure to measure mass and volume of gases.

Objective 3: Investigate the motion of particles.

a. Identify evidence that particles are in constant motion.
b. Compare the motion of particles at various temperatures by measuring changes in the volume of gases, liquids, or solids.
c. Design and conduct an experiment investigating the diffusion of particles.
d. Formulate and test a hypothesis on the relationship between temperature and motion.
e. Describe the impact of expansion and contraction of solid materials on the design of buildings, highways, and other structures.

Standard 2: Students will understand the relationship between properties of matter and Earth's structure.

Objective 1: Examine the effects of density and particle size on the behavior of materials in mixtures.

a. Compare the density of various objects to the density of known earth materials.
b. Calculate the density of earth materials (e.g., rocks, water, air).
c. Observe and describe the sorting of earth materials in a mixture based on density and particle size (e.g., sorting grains of sand of the same size with different densities, sort materials of different particle size with equal densities).
d. Relate the sorting of materials that can be observed in streambeds, road cuts, or beaches to the density and particle size of those materials.
e. Design and conduct an experiment that provides data on the natural sorting of various earth materials.

Objective 2: Analyze how density affects Earth's structure.

a. Compare the densities of Earth's atmosphere, water, crust, and interior layers.
b. Relate density to the relative positioning of Earth's atmosphere, water, crust, and interior.
c. Model the layering of Earth's atmosphere, water, crust, and interior due to density differences.
d. Distinguish between models of Earth with accurate and inaccurate attributes.

Standard 3: Students will understand that the organs in an organism are made of cells that have structures and perform specific life functions.

Objective 1: Observe and describe cellular structures and functions.

a. Use appropriate instruments to observe, describe, and compare various types of cells (e.g., onion, diatoms).
b. Observe and distinguish the cell wall, cell membrane, nucleus, chloroplast, and cytoplasm of cells.
c. Differentiate between plant and animal cells based on cell wall and cell membrane.
d. Model the cell processes of diffusion and osmosis and relate this motion to the motion of particles.
e. Gather information to report on how the basic functions of organisms are carried out within cells (e.g., extract energy from food, remove waste, produce their own food).

Objective 2: Identify and describe the function and interdependence of various organs and tissues.

a. Order the levels of organization from simple to complex (e.g., cell, tissue, organ, system, organism).
b. Match a particular structure to the appropriate level (e.g., heart to organ, cactus to organism, muscle to tissue).
c. Relate the structure of an organ to its component parts and the larger system of which it is a part.
d. Describe how the needs of organisms at the cellular level for food, air, and waste removal are met by tissues and organs (e.g., lungs provide oxygen to cells, kidneys remove wastes from cells).

Standard 4: Students will understand that offspring inherit traits that make them more or less suitable to survive in the environment.

Objective 1: Compare how sexual and asexual reproduction passes genetic information from parent to offspring.

a. Distinguish between inherited and acquired traits.
b. Contrast the exchange of genetic information in sexual and asexual reproduction (e.g., number of parents, variation of genetic material).
c. Cite examples of organisms that reproduce sexually (e.g., rats, mosquitoes, salmon, sunflowers) and those that reproduce asexually (e.g., hydra, planaria, bacteria, fungi, cuttings from house plants).
d. Compare inherited structural traits of offspring and their parents.

Objective 2: Relate the adaptability of organisms in an environment to their inherited traits and structures.

a. Predict why certain traits (e.g., structure of teeth, body structure, coloration) are more likely to offer an advantage for survival of an organism.
b. Cite examples of traits that provide an advantage for survival in one environment but not other environments.
c. Cite examples of changes in genetic traits due to natural and manmade influences (e.g., mimicry in insects, plant hybridization to develop a specific trait, breeding of dairy cows to produce more milk).
d. Relate the structure of organs to an organism's ability to survive in a specific environment (e.g., hollow bird bones allow them to fly in air, hollow structure of hair insulates animals from hot or cold, dense root structure allows plants to grow in compact soil, fish fins aid fish in moving in water).

Standard 5: Students will understand that structure is used to develop classification systems.

Objective 1: Classify based on observable properties.

a. Categorize nonliving objects based on external structures (e.g., hard, soft).
b. Compare living, once living, and nonliving things.
c. Defend the importance of observation in scientific classification.
d. Demonstrate that there are many ways to classify things.

Objective 2: Use and develop a simple classification system.

a. Using a provided classification scheme, classify things (e.g., shells, leaves, rocks, bones, fossils, weather, clouds, stars, planets).
b. Develop a classification system based on observed structural characteristics.
c. Generalize rules for classification.
d. Relate the importance of classification systems to the development of science knowledge.
e. Recognize that classification is a tool made by science to describe perceived patterns in nature.

Objective 3: Classify organisms using an orderly pattern based upon structure.

a. Identify types of organisms that are not classified as either plant or animal.
b. Arrange organisms according to kingdom (i.e., plant, animal, monera, fungi, protist).
c. Use a classification key or field guide to identify organisms.
d. Report on changes in classification systems as a result of new information or technology.

Why Science?

Many students equate science to learning vocabulary terms, labeling pictures, and memorizing facts. Science by nature is much more inclusive and loosely defined. Have you ever asked yourself questions about your surroundings and wondered how or why they are happening? This is science. Science works best when driven by curiosity and innovation. In order for you to experience science in its fullest sense you must take it beyond the textbook and into your everyday experience, but in order to be meaningful there are certain guidelines that can help us. Science is not constrained to the study of space and microorganisms, but there are cross-cutting concepts threaded throughout all scientific disciplines. These include:

- Patterns; such as the moon phase cycle, rotation, revolution, wavelengths of sound and light.
- Cause and effect: Mechanism and explanation; such as disease-causing microbes, the effects of gravity and velocity on the orbit of celestial objects.
- Scale, proportion, and quantity; such as solar system, universe, galaxy, size of microorganisms.
- Systems and system models; such as solar system, rotation, revolution, constellations.
- Energy and matter: Flows, cycles, and conservation; such as heat transfer, conduction, convection, radiation, sound travels through matter, light does not require a medium.
- Structure and function; such as microorganisms, cell and organelles.
- Stability and change; such as seasons, rotation, revolutions, law of reflection.

When studying any specific scientific discipline you should attempt to keep these cross-cutting concepts in mind in order to gain a better perspective of the world as whole and the nature of science. Included in the concepts are the skills and practices that scientists and engineers utilize. When asking questions about the natural world there are certain skills and practices that can help you be generate better conclusions, explanations and inferences. These practices include:

- Asking questions and defining problems
- Developing and using models
- Planning and carrying out investigations
- Analyzing and interpreting data
- Using mathematics and computational thinking
- Constructing explanations and designing solutions
- Engaging in argument from evidence
- Obtaining, evaluating, and communicating information

While these practices and cross-cutting concepts are crucial to your overall success in science, in order to be most meaningful they do need some context. This is where the study of disciplinary core ideas are most impactful. If you study or any other scientific discipline without the cross-cutting concepts and scientific practices then you limit yourself to fact memorization and miss how these concepts relate to our everyday life and our society as a whole. Studying individual scientific disciplines are the vehicle for understanding cross-cutting concepts and acquiring scientific skills. When individual disciplines are studied within the context of practices and cross-cutting concepts they become more meaningful and more impactful.

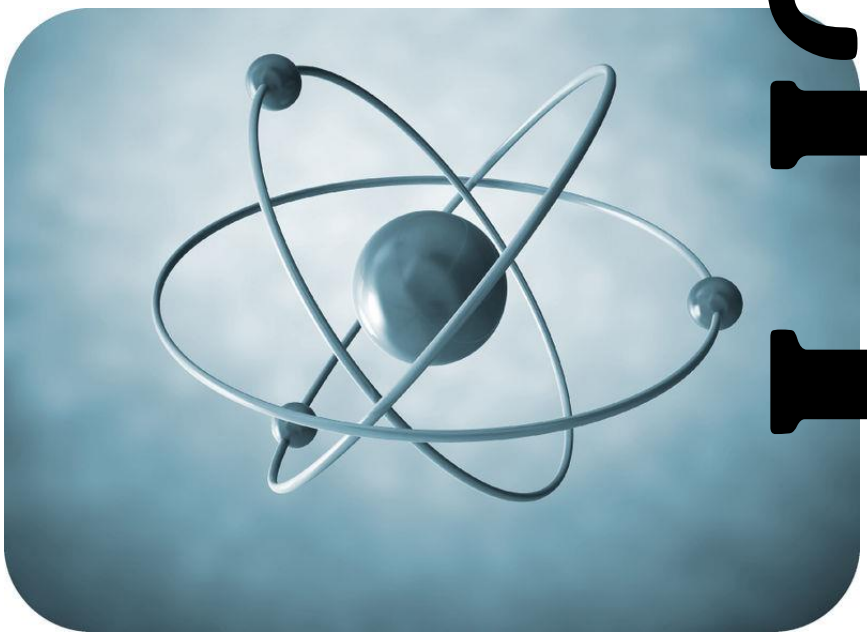
With technology improvements, the ability to solve problems in creative ways increases. There are many examples in the world around us of how the science we learn in sixth grade helps people in general. As astronomers are better able to see elements of the universe, the same technology is used to improve communication such as the internet, cell phones, and multimedia sources. Medical researchers, doctors, and microbiologists work together to find new cures for illnesses. As the knowledge of the transfer of heat energy improves, companies develop different types of clothing to help runners and athletes cool down or stay warm. Tiny speakers have been invented to amplify sound. The skills we learn in science will help all of us, not just scientists, solve everyday problems.

Chapter 1

Structure

STANDARD 1: YOU WILL UNDERSTAND THE STRUCTURE OF MATTER.

OBJECTIVE 1: DESCRIBE THE STRUCTURE OF MATTER IN



Terms to Know

- Atom
- Molecule
- Solid
- Liquid
- Gas
- Model
- Element

TERMS OF ATOMS AND MOLECULES.

What is an atom?

What would we find if we were to break down a material into its most simple parts? For example, if you were to take a piece of pure gold, and cut in half over and over again, you would eventually get to the smallest particle that still retains the properties of gold. What would this particle be called? This tiny piece of material is called an **atom-** the smallest building block of matter. **Atoms** make up every object in the world.

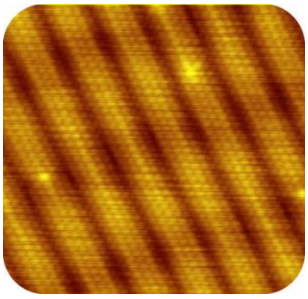


Figure 1. Images of individual gold atoms can be seen on the surface of a smooth sheet of gold metal using scanning tunneling microscopy.

How big are atoms?

The graphite in your pencil is composed of carbon atoms. Imagine taking a small piece of carbon and grinding it until it is a fine dust. Each speck of carbon would still have all of the properties of the pencil lead it came from. Now imagine that you could somehow keep dividing the speck of carbon into smaller and smaller pieces. Eventually, you would reach a point where your carbon sample is as small as it could possibly be. These tiny particles would be carbon atoms.

Why can't you see atoms?

It is because they are very small. They are so small that it is hard for us to even understand just how small they are. A Water molecule is made up of two hydrogen atoms and one oxygen atom. Imagine the amount of water in about 1/2 tablespoon (18 ml). That would not even be enough water to wet your lips if you were thirsty. How many water molecules do you think are in that spoonful of water? A thousand? Maybe ten thousand? Put your calculator away, it won't do you any good. In that small amount of water there are 602,000,000,000,000,000,000,000 ($6.02X10^{23}$)

water molecules. That's 602 billion trillion. Now, let's blow that molecule up until it is the size of a grain of rice. Suppose you have 602 billion trillion rice grains. Imagine you want to use your rice to feed the less fortunate kids in poor countries. How would you get it to them? By train? Ok, how many box cars are you going to need? Five, or ten? Maybe twenty? You had better get on the phone and start finding box cars. If you had 602 billion trillion grains of rice you would need enough box cars to reach to the sun and back to the earth 10,000 times.

How do scientists study something they can't see?

They make **models** - a tool constructed by the scientist based on all the known experimental evidence about a particular thing. Scientists work with **models** because reality is complex and difficult. An atom is an example of a system that is both difficult and complex. There are many parts inside of an atom. It is useful to use a model because it helps us understand what cannot be seen with our own eyes. Models are necessary in science. However, you must always remember that a model is only a representation of the real thing.

Advances in technology, such as the electron microscope in the picture to the left, have led scientists to the discovery of many new things. We can now "see" atoms and other particles that previous Scientists could only imagine

Models are Useful Tools

Models are useful tools for scientists. Models allow scientists to study objects that are nearly impossible to study as a whole and help other scientists to understand these objects. They can analyze and make predictions about them. There are different types of models; some are smaller and simpler representations of the thing being studied. Scientists use models for many things like atoms, the layers of the Earth, and the cell. You will learn about models throughout the school year.

Models Have Limitations

Since models are simpler than real objects or systems, they have limits. A model deals with only a portion of a system. It may not predict the behavior of the real object very

accurately. But the more thought and design that goes into the model and the care with which the scientists construct it the chances that a model will be accurate increase. For example, models of the atom cannot accurately represent the distance between the particles or the motion of the electrons. But the parts of an atom and how they are arranged are easier to show.

How has the model of the atom changed?

It is important to realize that a lot of what we know about the structure of atoms has been developed over a long period of time and many different scientists have made discoveries that helped out. This is often how scientific knowledge develops, with one person building on the ideas of someone else. We are going to look at how our modern understanding of the atom has evolved over time.

Democritus Introduces the Atom

The history of the atom begins around 450 B.C. with a Greek philosopher named Democritus (see Figure 2). Democritus wondered what would happen if you cut a piece of matter, such as an apple, into smaller and smaller pieces. He thought that a point would be reached where matter could not be cut into still smaller pieces. He called these pieces, "atomos." Atomos is a Greek word that means indivisible. This is where the modern term atom comes from.

Figure 2

Democritus was an important philosopher. However, he was less influential than the Greek philosopher Aristotle, who lived about 100 years after Democritus. Aristotle rejected Democritus's idea of atoms. In fact, Aristotle thought the idea of atoms was ridiculous. Unfortunately, Aristotle's ideas were accepted for more than 2000 years. During that time, Democritus's ideas were more or less forgotten.

Figure 3

Dalton Brings Back the Atom

Around 1800, a British chemist named John Dalton revived Democritus's early ideas about the atom. Dalton is pictured in Figure 3. He made a living by teaching and just did research in his spare time. From the results of his

research, he developed one of the most important theories in science.

Dalton's Research

Dalton did many experiments that provided evidence for atoms. For example, he studied the pressure of gases. He concluded that gases must consist of tiny particles in constant motion. Dalton also researched the properties of compounds, substances made of a combination of two or more atoms. He showed that a compound always consists of the same elements in the same ratio. On the other hand, different compounds always consist of different elements or ratios. This can happen, Dalton concluded, only if elements are made of tiny particles that can combine in an endless variety of ways. From his research, Dalton developed a theory of the atom. You can learn more about Dalton and his research by watching the video at this URL: http://www.youtube.com/watch?v=BhWgv0STLZs (9:03).

Dalton's Atomic Theory

The atomic theory Dalton developed consists of three ideas:

- All substances are made of atoms. Atoms are the smallest particles of matter. They cannot be divided into smaller particles. They also cannot be created or destroyed.
- All atoms of the same element are alike and have the same mass. Atoms of different elements are different and have different masses.
- Atoms join together to form compounds. A given compound always consists of the same kinds of atoms in the same ratio.

Dalton's theory was soon widely accepted. Most of it is still accepted today. The only part that is no longer accepted is his idea that atoms are the smallest particles. Scientists now know that atoms are made up of even smaller particles.

Dalton's Atomic Models

Dalton incorrectly thought that atoms are tiny solid particles of matter. He used solid wooden balls to model them. The sketch below (Figure 4) shows how Dalton's model atoms looked. He made holes in the balls so they could be joined together with hooks. In this way, the balls could be used to model compounds. When later scientists discovered subatomic particles (particles

Figure 4. Dalton's model atoms were hard, solid balls. How do they differ from the atomic models earlier in the chapter?

smaller than the atom itself), they realized that Dalton's models were too simple. They didn't show that atoms consist of even smaller particles. Models including these smaller particles were later developed.

Thomson Adds Electrons

The next major advance in the history of the atom was the discovery of electrons. These were the first parts of an atom to be identified. They were discovered in 1897 by a British physicist named J. J. Thomson. You can learn more about Thomson and his discovery online at http://www.aip.org/history/electron/.

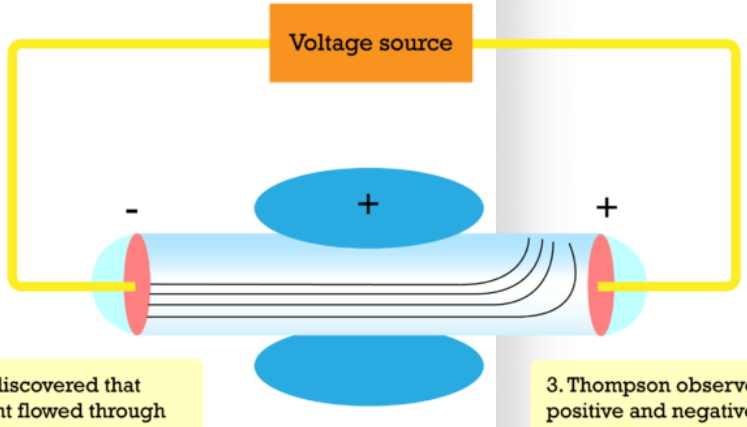
Thomson's Vacuum Tube Experiments

Thomson was interested in electricity. He did experiments in which he passed an electric current through a vacuum tube. Thomson's experiments showed that an electric current consists of flowing, negatively charged particles. Why was this discovery important? Many scientists of Thomson's time thought that electric current consists of rays, like rays of light, and that it is positive rather than negative. Thomson's experiments also showed that the negative particles are all alike and smaller than atoms. Thomson concluded that the negative particles could not be units of matter because all of the negative charges in different substances were alike. Instead, they must be parts of atoms. The negative particles were later named electrons.

Thomson's Plum Pudding Model

Thomson knew that atoms had no overall electric charge. So how could atoms contain negative particles? Thomson reasoned that the rest of the atom must be positive to cancel out

1. When connected to a power source, one end plate becomes negative and one becomes positive.



2. Thompson discovered that electric current flowed through the tube from the negative end plate to the positive end plate. This showed that electric current is negative in charge.

3. Thompson observed that the positive and negative plates along the sides of the tube caused the electric current to bend toward the side with the positive plate. This showed that the charge is carried by particles of matter (rather than by rays).

the negative charge. He said that an atom is like a plum pudding, which has plums scattered through it. That's why Thomson's model of the atom is called the plum pudding model. It shows the atom as a sphere of positive charge (the pudding) with negative electrons (the plums) scattered through it. You may get a better understanding of this model by comparing it to chocolate chip cookie dough with the chocolate chips representing the electrons scattered throughout the atom.

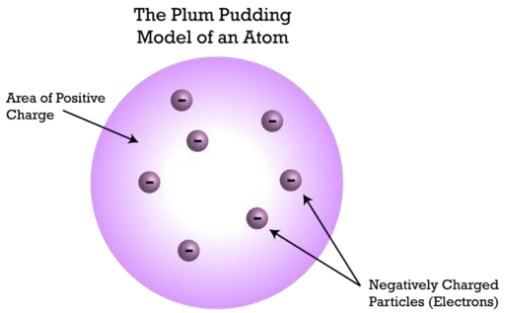


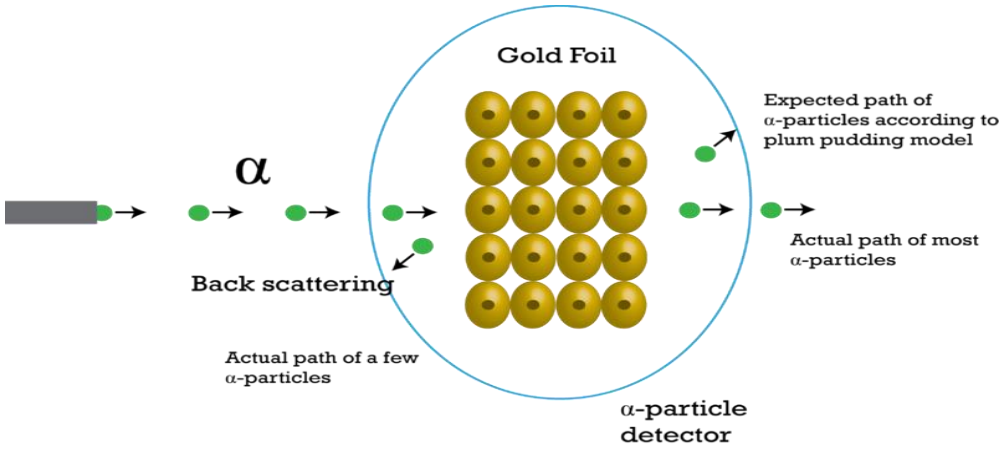
Figure 5.

Rutherford Finds the Nucleus

A physicist from New Zealand named Ernest Rutherford made the next major discovery about atoms. He discovered the nucleus. You can watch a video about Rutherford and his discovery at this URL: http://www.youtube.com/watch?v=wzALbzTdnc8 (3: 28).

Rutherford's Gold Foil Experiments

In 1899, Rutherford discovered that some elements give off positively charged particles. He named them alpha particles. In 1911, he used alpha particles to study atoms. He aimed a beam of alpha particles at a very thin sheet of gold foil. Outside the foil, he placed a screen of material that glowed when alpha particles



struck it.

If Thomson's plum pudding model were correct, the particles should be deflected a little as they passed through the foil. Why? The positive "pudding" part of gold atoms would slightly repel the positive particles causing them to change course. But Rutherford got a surprise. Most of the alpha particles passed straight through the foil as though they were moving through empty space. Even more surprising, a few of the particles bounced back from the foil as though they had struck a wall. Imagine throwing marbles at a chain link fence. Most of the marbles would pass through. A few would be deflected, but still pass through, but the few that hit a link of the fence directly would bounce back. Chain link fences, like atoms, are mostly empty space.

The Nucleus and Its Particles

Based on his results, Rutherford concluded that the positive charge of an atom is concentrated in a small central area. He called this area the nucleus and named the positive particles *protons*. Rutherford also predicted the existence of neutrons in the nucleus

Rutherford's Atomic Model

Rutherford's discoveries meant that Thomson's plum pudding model was incorrect. Positive charge is not spread out everywhere in an atom. It is all concentrated in the tiny nucleus. The rest of the atom is almost entirely empty space,. To understand Rutherford's experiment, imagine throwing marbles at a chain link fence. What would happen? Most would pass straight through, some would be deflected, but still pass through, and a few would bounce back. This is similar to the results Rutherford got in his experiment. Atoms, like a chain link fence are mostly empty space. In Rutherford's model, electrons move around the nucleus in random orbits. He compared them to planets orbiting a star. That's why Rutherford's model is called the planetary model. You can see it in Figure 6.

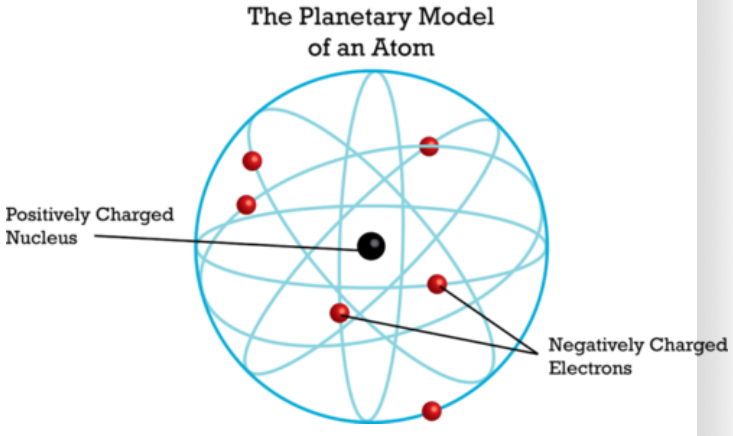


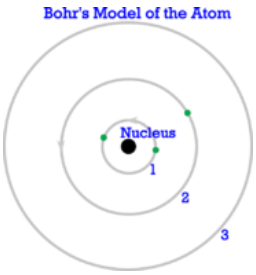
Figure 6. This model shows Rutherford's idea of the atom. How does it compare with Thomson's plum pudding?

Neils Bohr

Rutherford's model of the atom was better than earlier models. But it wasn't perfect. Danish physicist Niels Bohr created a more accurate and useful model. Bohr's model was an important step in the development of modern atomic theory. The video at the URL below is a good introduction to modern atomic theory. It also reviews important concepts from, "Inside the Atom" and "History of the Atom."
http://www.khanacademy.org/video/introduction-to-the-atom?playlist=Chemistry

Bohr's Model of the Atom

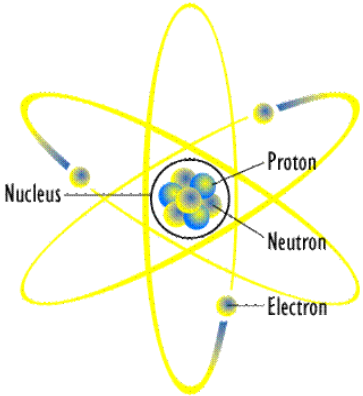
Bohr's research focused on electrons. In 1913, he discovered evidence that the orbits of electrons are located at fixed distances from the nucleus. Remember, Rutherford thought that electrons orbit the nucleus at random.



Energy Levels

Basic to Bohr's model is the idea of energy levels. Energy levels are areas located at fixed distances from the nucleus of the atom. They are the only places where electrons can be found. Energy levels are a little like rungs on a ladder. You can stand on one rung or another but not between the rungs. The same goes for electrons. They can occupy one energy level or another but not the space between energy levels.

The model of an atom above has three energy levels. The level with the least energy is the one closest to the nucleus.



Protons and neutrons are located in the nucleus of the atom. Electrons orbit in energy levels around the nucleus.
http://en.wikipedia.org/wiki/Atomic_nucleus

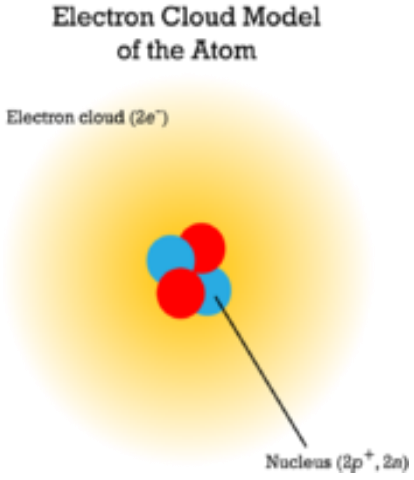
As you go farther from the nucleus, the levels have more and more energy. Electrons can jump from one energy level to another. If an atom absorbs energy, some of its electrons can jump to a higher energy level. If electrons jump to a lower energy level, the atom emits, or gives off, energy. You can see an animation at this happening at the URL below.
http://cas.sdss.org/dr6/en/proj/advanced/spectraltypes/energylevels.asp

Electron Cloud

Imagine the blades on a ceiling fan as they turn around and around. Can you tell exactly where a blade is? Can you predict where it will be? You can, but as soon as the blade is at the position you predict, it has moved and is no longer there. Electrons move around similar to the blades on a fan. The difference is that the pathways electrons travel change. In fact, like the blades on that fan, electrons only have a small chance of being in any particular place. Scientists can only describe where electrons are with mathematical formulas. The areas where electrons are found are called orbitals. Orbitals are like the pathways that planets travel as they orbit the sun with two major differences. First, planets orbit in a flat oval pattern, while electrons orbit in a circular pattern and from every angle around the atom's nucleus. Second, electrons are constantly bouncing from one orbital to another. That would be like Mars and Jupiter suddenly trading places.

Electron Cloud Model

Today, these ideas about electrons are represented by the electron cloud model. The electron cloud is an area around the nucleus where electrons are likely to be.



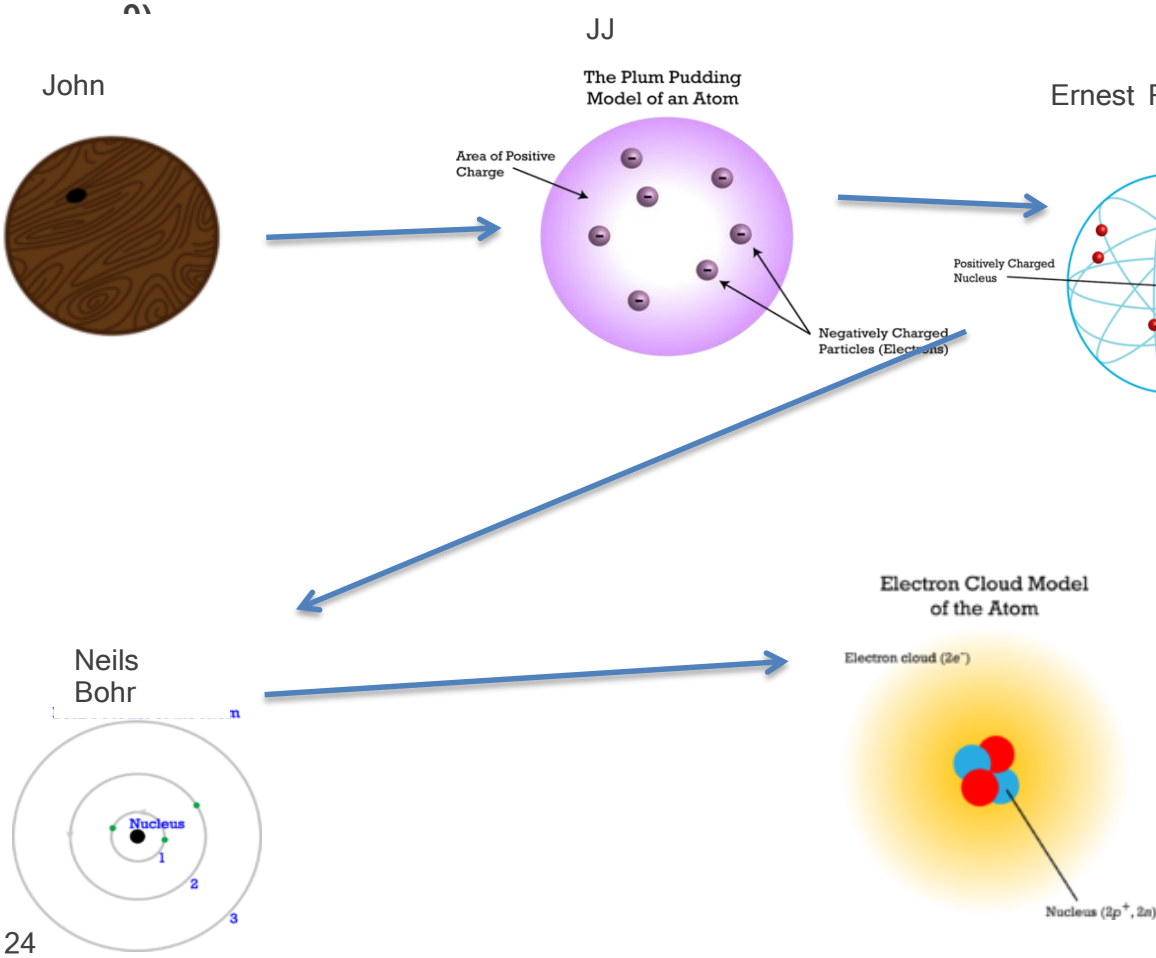
This sketch represents the electron cloud model for helium. What does the electron cloud represent?

Figure 8 shows an electron cloud model for a helium atom.

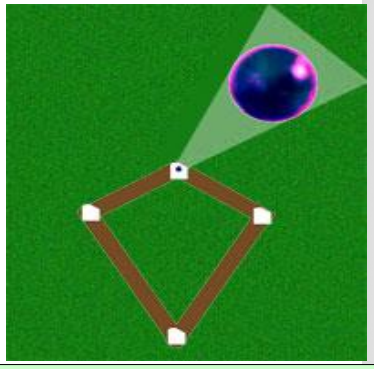
Summary: The Development of the Atomic Theory

Democritus: Theorized that matter is made from small particles that he called atoms.
John Dalton: Developed the 3 parts of the Atomic Theory
J.J. Thompson: Discovered electrons
Ernest Rutherford: Discovered that atoms are mostly empty space
Neils Bohr: Discovered that electrons orbit in energy levels around the nucleus
Werner Heisenberg: Described the location of electrons as "a cloud" around the nucleus.
James Chadwick: Discovered neutrons

HOW DID THE MODEL CHANGE OVER TIME: (Figure 9)

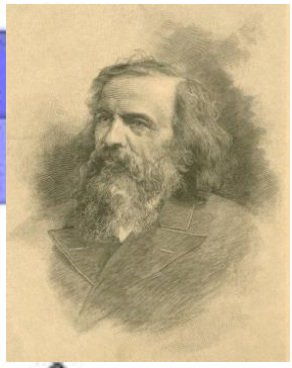


The Scale of Atoms



(Photo from www.usoe.k12.ut.us)

You now know that atoms are incredibly small, but they are also mostly empty space. If the nucleus of an atom was the size of a garden pea, the whole atom would be the size of a football field. If a marble was placed on one of the bases on a baseball diamond representing the nucleus of an atom, the entire atom would be the size of the stadium. Atomic particles are so small that it is hard to comprehend just how small they are. If an electron was blown up to the size of a ping-pong ball, the atom that it belonged to would have to be the size of the entire United States. This fact was discovered with the development of the atomic theory. Since almost all of the mass of an atom is located in the nucleus, not only are the electrons in the outer edges of the atom practically without mass and volume, the atom itself is mostly empty space. Neutrons and protons are so dense that if you had a blob of matter the size of a marble that was the same density as the nucleus of an atom, it would have a mass of about 9,000 kg. That's almost 20,000 pounds.



Dmitri Mendeleev
A Russian chemist and inventor, Dmitri Mendeleev created the first version of the periodic table of elements, and used it to predict the properties of elements yet to be discovered.

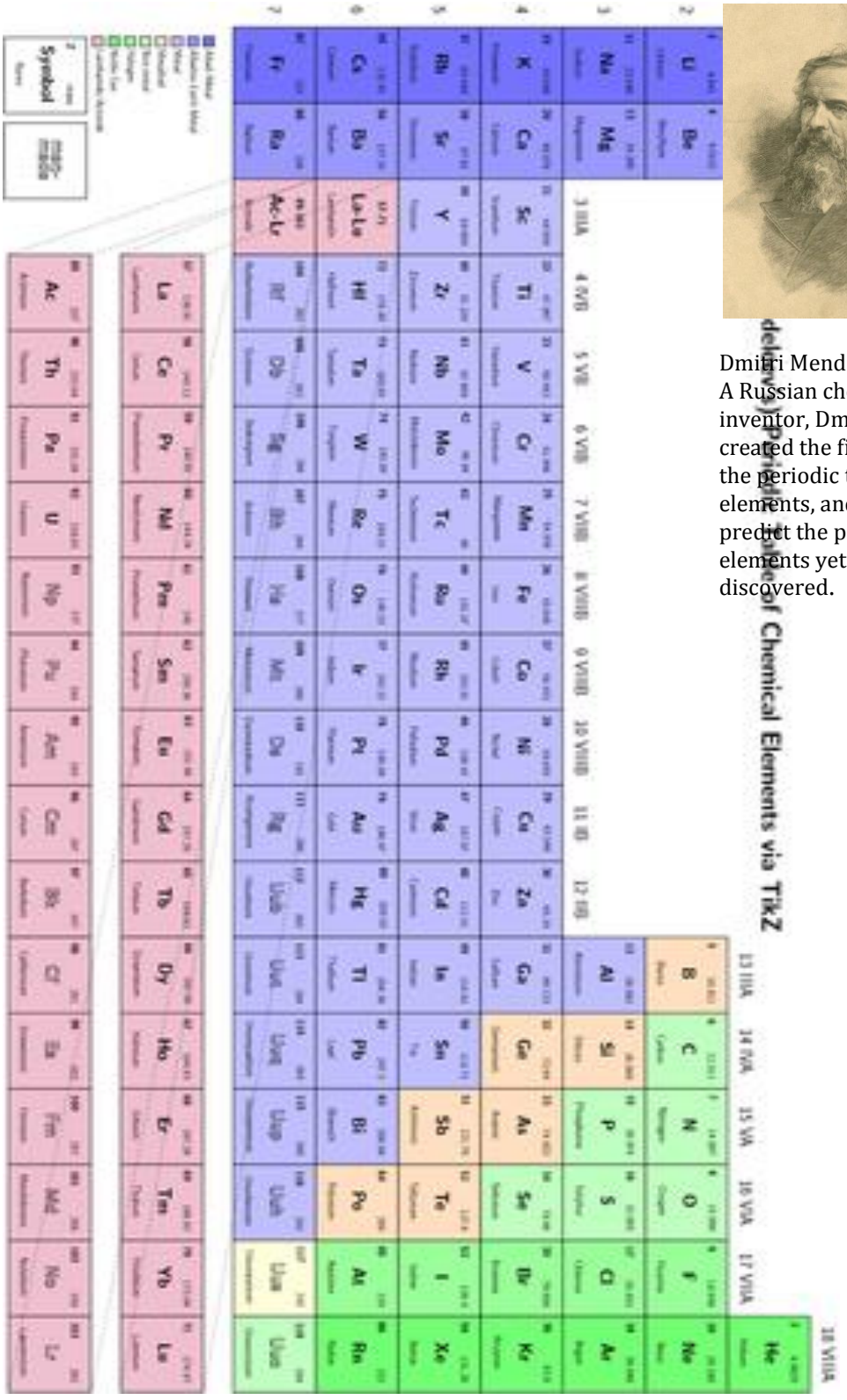
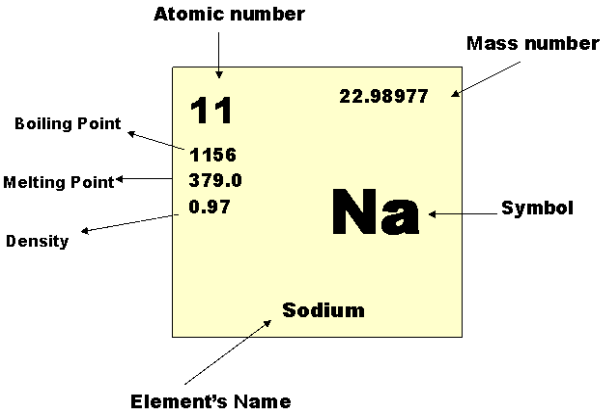


Image by Ivan Griffin,
http://www.texample.net/tikz/examples/periodic-table-of-chemical-elements/

The Periodic Table

There are 92 naturally occurring types of atoms. These types of atoms are called elements. The Periodic Table is a table that gives important information about each element. Chemists, scientists who study how elements combine with each other, use a periodic table as a quick reference guide to information about the elements. There are many different kinds of information given on a table. Some types of periodic tables give more detailed information than others, but all periodic tables give basic information that can be used in Science.



Atomic Symbols

The atomic symbol is the one or two letter abbreviation that is written in large font in each element's box. The symbol for hydrogen, element number one, is H and the symbol for helium is He. It is important to write elements in the right case, with capital and lower-case letters as appropriate. Atomic symbols save time for chemists. They allow them to write in a type of shorthand that explains how elements react without having to write out every word.

Chemical equations show how atoms react to form new substances. When chemists write a chemical equation, they use the symbols of the elements that are being combined. For example: a sodium atom (Na) reacts with a chlorine atom (Cl) to form sodium chloride (NaCl or table salt). The chemical equation for that reaction would be written: Na + Cl → NaCl. The arrow sign indicates that a chemical reaction is taking place.

The Atomic Number

Elements are arranged on the periodic table according to the number of protons that each one has in its nucleus. Two different kinds of atoms might share the same number of electrons or neutrons, but no two kinds of atoms share the same number of protons. In fact, it is the number of protons that determines the difference in each element. The number of protons that an element has is called the atomic number. At first glance you

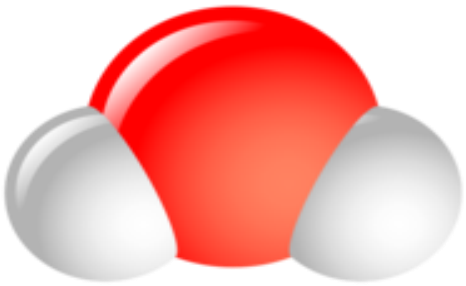
might think that the elements on the table have just been randomly assigned a number. But they are arranged in order according to their number of protons. Hydrogen atoms have only one proton, therefore hydrogen is located in the number 1 spot on the table. All hydrogen atoms have 1 proton and if an atom has a different number then it cannot be hydrogen. If an atom has 2 protons in its nucleus, then it is a helium atom. Three protons make the atom lithium and so on.

Atomic Mass

The other number on the Periodic Table, the larger one, is called the atomic mass or mass number. The atomic mass is the average mass of the atoms of an element. Since electrons have practically no mass, almost the entire mass of an atom comes from its protons and neutrons. To determine how many neutrons an atom typically has, simply subtract the atomic number (number of protons) from the atomic mass. It's that simple. For example: Carbon has an atomic mass of 12 and an atomic number (the number of protons) of 6. The atomic mass (12) minus the number of protons (6) means that the average carbon atom has 6 neutrons.

Atoms Combine to Form Compounds

Most of the elements on the Periodic Table combine with other elements to form compounds. A compound is a substance made of two or more different kinds of atoms bonded together in a definite ratio. Two hydrogen atoms and one oxygen atom combine to form the compound we know as water. Water always has the same ratio of two hydrogen atoms to one oxygen atom and is written as H_2O. A compound can have a similar formula, but it will not be water. An example is the compound that we know of as hydrogen peroxide. Hydrogen peroxide is formed when two hydrogen atoms combine with two oxygen atoms. The formula H_2O_2 may seem very similar to water, but the resulting compounds are very different.



A water molecule has two hydrogen atoms (shown in gray) bonded to one oxygen atom (shown in red).

Some things that contain more than one type of atom are not compounds. In a compound the different kinds of atoms are bonded together and form a new substance. Sometimes things are mixed together and they do not combine into a new substance, but each of the “ingredients” keeps its own identity. When two or more substances combine but do not bond together, a mixture is the result. Examples of mixtures include: lemonade, pizza, and cookie dough. A compound, as stated has a definite ratio, but a mixture does not have a definite composition or “recipe.” In lemonade, for example, you can add more sugar or lemons, but the result is still lemonade. Pizza can have pepperoni or any one of many different items, but it would still be pizza.

The Arrangement of Atoms in Solids, Liquids, and Gases

There are three common states of matter: solid, liquid, and gas. You have learned about the Periodic Table of Elements. You also know a little bit about matter and atoms. All atoms and compounds can occur in all three states of matter. We are familiar with most forms of matter in the state that they are found at common temperatures, or room temperature which is about 72 degrees Fahrenheit. If someone asked you what state of matter gold is, you would say, “solid,” without even thinking about it. If that same person asked you what state oxygen was, you would reply, “gas.” But the state that an element is in at any given time depends on its temperature.

Water is a good example of a compound that you could expect to see in any of the three states. Water that is below 0° Celsius will be a solid. That same water would melt, or change to a liquid if it were heated above 0° Celsius. If you continue to heat the water, it would eventually change to water vapor, a gas. But, water is only one example. Every element on the periodic table, and most compounds, can occur in all three states of matter. Some Periodic Tables show the temperatures at which each element change states.

Movement of Particles

Crystalline solids such as this quartz have a very orderly structure.

The particles that make up matter are in constant random motion. They are always moving. The movement is increased as heat is added to the substance. Heat is energy that makes the particles in matter move faster. The more energy they have the faster they move. The less energy they have (heat is removed), the slower they move. Scientifically speaking, there is no such thing as cold. There is only an absence of heat. When the weather, or some object gets "colder" it is because there is less heat present. The less heat there is, the slower the particles move. At a certain point all energy/heat is gone and the particles stop all motion. This point is known as absolute zero. Absolute zero is -273.15 C°. As particles heat up, they begin to move faster. As this happens, the object expands. This is true for solids, liquids, and gasses. To understand this, imagine that you are spinning a ball on a rubber band in a circle over your head. As you spin the ball over your head the rubber band increases in length. It does this because the faster you spin it, the more energy it has. Matter expands in size as particle motion increases.

Particles in all states of matter are in constant motion. They move fastest in gases and slower in liquids. In solids the movement is even slower and is restricted to vibrating in place. Have you ever been in a class and someone across the room was putting on hand lotion? Could you smell the lotion from where you were, even though you were all the way across the room? There was an area of high concentration of hand lotion particles where the person was applying the lotion. High concentration simply means that there were many lotion particles at that spot. At first, you were in an area of low concentration, or an area where there were few or no particles. Since all particles are in constant motion the air is always mixing and moving. Over time the lotion particles moved randomly throughout the entire room until the concentration was equal in every area. The movement of particles from an area of higher concentration to an area of lower concentration is called

diffusion. If your teacher were to spray perfume into the air at the front of the room, at first you would not be able to smell it. But, the perfume particles would gradually move throughout the room until there was an even concentration of particles in every part of the room.

Characteristics of Solids

Most of the things that you can see around you are solids. The basic characteristics of solids are that they have a definite shape and volume. This understanding will be important when we look at characteristics of the other states of matter, liquids and gasses.
There are two types of solids: crystalline solids and amorphous solids. Amorphous solids are solids that do not have a crystal structure. Examples of amorphous solids are glass, rubber, and wax.
Crystalline solids form crystals as they solidify. The shape and properties of the crystals are determined by what the compound is and other factors such as the amount of heat and pressure applied as the material hardens. The lead in your pencil and a diamond are both made up of carbon atoms. The difference is the amount of heat and pressure applied during the formation of the crystals. Look at common table salt or sodium chloride (NaCl). If you look closely, you will notice that each little grain of salt is in the shape of a cube. The crystal structure of sodium chloride in cubical, or in other words, each salt crystal is shaped like a tiny box. If you were to take a hammer and smash a few cubes into powder and look at the powder under a microscope, the fine grains of powder would still be cubes, only smaller. Examples of crystal solids are salt, sugar, and ice.

When the molecules of a substance are far apart, they can be pushed together. This is called compression. Solids cannot be compressed into smaller spaces. Take a small piece of wood. If you were to place weight on the board until it was crushed you would be amazed at how much weight the board could hold. This characteristic of solids makes it possible to build tall buildings, roads, and other infrastructure. Since the molecules that make up solids are in a crystal structure, they are very close together and strong. The particles in solids are already almost touching and cannot be pushed together any more.

The inability of solids to be compressed is not all good though. Have you ever wondered why construction companies put spaces in sidewalks and roads when they build them? What would happen if the spaces were left out? When solids absorb heat, they expand. When a solid expands and the molecules can't be compressed, it must increase in volume, or take up more space. The spacers are to give the pavement room to expand without buckling the walkway or road. If the spaces were not put between the sections in the sidewalk, the sidewalk would expand and buckle.

The particles in solids are constantly moving, but their movement is limited to vibration against each other. This is considerably different from the particles of matter in the other two states.

Cyber Activity: All Cracked Up

Instructions: Go to the following website and follow the directions given.
http://www.usoe.k12.ut.us/curr/science/core/7thgrd/sciber7/MATTER/HTML/EXPANSON.HTM

Characteristics of Liquids

Liquids, like solids, have a definite volume, but in contrast they do not have a definite shape. Liquids take the shape of whatever container they are in. A 400 ml sample of water in a graduated cylinder would still have a volume of 400 ml if it were poured into a beaker, even though it would take on the shape of the new container.

Like solids, liquids also expand with increases in temperature. Think of a thermometer. As the temperature gets warmer, the

liquid (mercury or alcohol) in the thermometer expands. The temperature markings on the side of the gage are set at the levels that the liquid in the thermometer will be at that given temperature. As the temperature decreases, the liquid contracts and the level in the tube goes down.

Liquids can be compressed only slightly. The particles in a liquid are not arranged in an orderly pattern as they are in a solid, but they are still fairly close together. The particles in a liquid are able to move easily past one another. This property is the reason that liquids flow. The ability of a liquid to flow is called viscosity.

Each bottle contains the same volume of oil. How would you describe the shape of the oil in each bottle?

Liquids have another property that you may have noticed. It is called surface tension. With any liquid there is a certain amount of energy that is required in order to break through the surface. The amount of force required to break the surface of a liquid is called surface tension. Have you ever seen a mosquito or other small insect standing on top of the water? They can do this because they are light enough that they do not break the surface of the water.

Characteristics of Gases

When the atoms or molecules of a substance move so fast that they overcome the bonds that hold them together, the substance becomes a gas. Gases have no definite shape. They take the shape of whatever container they are in. They also have no definite volume. Gases expand and contract to fill whatever space they occupy.

Since the molecules in a gas are far apart, gases are easily compressed. Have you ever put air in the tires of your parent's car or your bicycle? The gas particles in these items are forced closer together than they would normally be. If you were to allow the air in those tires to escape, the air molecules would expand and take up more space. As you put more air in the tires, they get harder. That is because you are putting more air in the tires, but the volume is staying the same.

When you add air to a bicycle tire, you add it only through one tiny opening. But the air immediately spreads out to fill the whole tire.

Air pressure is the measure of the force exerted by a gas in its container. Remember that molecules are in constant motion. The pressure of a gas is actually caused by collisions of the tiny gas particles with the sides of the container.

There are several factors that work together to create the pressure of a gas. Temperature is one factor. As the molecules increase in temperature, the motion of the particles speeds up. This causes more collisions with the sides of the container.

The number of gas particles in a given area is another factor that helps to cause pressure. Simply put, the more air particles there are in a container, the more collisions there are with the sides of the container. That means more pressure.

The third factor that determines gas pressure is the size of the container. If the size of the container is increased and the number of gas particles and the temperature remain the same,
then the pressure will decrease. In other words, there is the same number of particles in a larger area so there are fewer collisions. If the size of the container is decreased the opposite happens. The number of particles is the same and the temperature (speed of particles) is the same, but there is less space in the container for

the molecules to move around. This means that there are more collisions and greater pressure.

These three states of matter are common on Earth. What are some substances that usually exist in each of these states?

Characteristics of Solids, Liquids, & Gases

Solids	Liquids	Gases
Definite shape	Take the shape of the container	Take the shape of the container
Maintain definite volume	Maintain definite volume	Volume changes depending on the container
Cannot be compressed	Difficult to compress	Compressible - very easy to compress
Stay where they are put	Flow/ can be poured	Spread out quickly
Expand slightly when heated	Expand slightly when heated	Expand significantly when heated
Molecule movement is limited to vibrating in place	Molecules move at a medium rate.	Molecules move the fastest

Have you ever had a balloon and you left it in the car? What was the balloon like when you returned? Was it bigger or smaller than you left it? Another characteristic of gases is that they expand noticeably when they are heated and they contract, or get smaller, when they are cooled. If you put the balloon in the car and left it overnight, chances are it was considerably smaller the next day. One of the reasons for this is that as the air temperature gets cooler at night the gas particles in the balloon get closer together and the balloon shrinks.

Measuring the Mass and Volume of Gases

It may seem odd because you can't see them, but even gases are made of matter. When you blow air into a balloon the balloon gets bigger. Why? It is because the air you put into the balloon takes up space. If you put more air into the balloon it takes up more space. Let some air out and the balloon gets smaller. That is because there is less matter in the balloon, so it takes up less space. So air takes up space, but how can we know that it has mass? Atmospheric pressure is the weight of the air in the atmosphere on the earth around us. We are so accustomed to atmospheric pressure that we do not even realize that it is there, but it is.

Have you ever swum to the bottom of the deep end of a swimming pool? What did your ears feel like? Did they hurt? The pain in your ears when you swim into deep water is caused by the pressure of the weight of the water above you. Air creates pressure just like the water in a swimming pool, but since air is so much less dense than water it has far less pressure, but the pressure is still there.

Changes in State

As we stated before, elements and molecules can exist in all three states of matter. The factor that determines the state of matter that a substance will be in is the amount of energy that is present. Temperature is the measure of the amount of heat or energy that is present in a sample of matter.

In order for the temperature of a substance to rise, energy must be added. Eventually, as more and more energy is added the bonds that tie the particles together will break and the solid will turn to a liquid. The temperature at which a solid turns to a liquid is called melting point. Some substances have bonds that are weaker. These substances will have a lower melting point. If the bonds are stronger, the melting point will be at a higher temperature. Ice melts at 0° Celsius. Iron melts at 1535° Celsius. Iron atoms form stronger bonds than water molecules. Therefore, the melting point of iron is higher.

This photo represents solid, liquid, and gaseous water. Where is the gaseous water in the picture?
Figure 12

The gain or loss of energy determines whether a substance is melting or freezing. Energy moves in a manner that is similar to diffusion; from an area of greater energy to an area of less energy. If you place an ice cube in a room that is warmer (has more energy) than the ice cube, energy will flow towards the ice cube and it will melt. If you place water in a freezer that is below freezing, energy will flow from the water to the air around it. When the water has lost enough energy, it will freeze.

As you add more heat or energy to the liquid the particles begin to move faster and faster. Eventually they move so fast that they push away from each other. The faster they move, the further apart they become. The point at which the particles have enough energy to break away from each other is called the boiling point. Like the melting point, all substances have different boiling points.

As heat is added the temperature of a substance rises. But, what happens if heat is removed from a substance? As heat is removed from a substance the temperature of that substance drops (remember that temperature is a measure of the amount of heat present). When the temperature of a gas is lowered far enough that the particles are no longer far apart they come back together and form a liquid. This is called condensation. The temperature at which a substance in a gaseous state condenses and at which that same substance as a liquid turns to a gas are the same. It is whether heat is being added or taken out of the substance that determines which state it will be.

As more heat is removed eventually the particles in the substance will lose enough energy that they form bonds. At this point the

liquid becomes a solid. This temperature is called the freezing point. As with the other changes in state, the point at which different substances freeze varies significantly.

Have you ever looked at dry ice (frozen carbon dioxide) and watched as it seemed to give off smoke. The “smoke” that rises from dry ice is actually the solid changing directly to a gas without passing through the liquid state. This is called sublimation.

How do solids, liquids, and gases differ? Their properties are compared in the Figure below and described below. You can also watch videos about the three states at these URLs:
http://www.youtube.com/watch?v=s-KvoVzukHo (0:52)
http://www.youtube.com/watch?v=NO9OGeHgtBY (1:42)
http://www.youtube.com/watch?v=KCL8zqjXbME (4:53)

Water vapor is an example of a **gas**- matter that has neither a fixed volume nor a fixed shape. Instead, a **gas** takes both the volume and the shape of its container. It spreads out to take up all available space. You can see an example in Figure below.

Online Interactive Activities

- States of Matter Simulation: http://tinyurl.com/UT7th1-1

Think Like a Scientist:

1. In your own words, explain what a model is and how scientists use them.
2. Using an example, explain how small atoms are.
3. List three things that scientists use models for.
4. Explain one way that models are limited in how they present information.
5. In your own words, explain what each of the following scientists did to help develop the atomic theory and our current model of an atom: Tell what they did and what their model was like.
    a) Democritus
    b) Dalton
    c) Thompson
    d) Rutherford
    e) Bohr
6. What is the electron cloud?
7. Explain where protons, neutrons, and electrons are located in an atom.
8. What is a periodic table?
9. Explain the difference between atoms and molecules..
10. Explain the main properties of solids, liquids, and gases.

Terms to Know:

- Matter
- Mass
- Volume
- Density

OBJECTIVE 2: YOU WILL BE ABLE TO ACCURATELY MEASURE THE CHARACTERISTICS OF MATTER IN DIFFERENT STATES

What is matter?

What do you and a tiny speck of dust in outer space have in common? Both you and the speck of dust consist of atoms of different types of matter. **Matter** is anything that has mass and volume. Everything you can see and touch is made of **matte**r. All **matter** is made up of atoms. The only things that aren't matter are forms of energy, such as light and sound. Although forms of energy are not matter, the air and other substances they travel through are.

How do we measure matter?

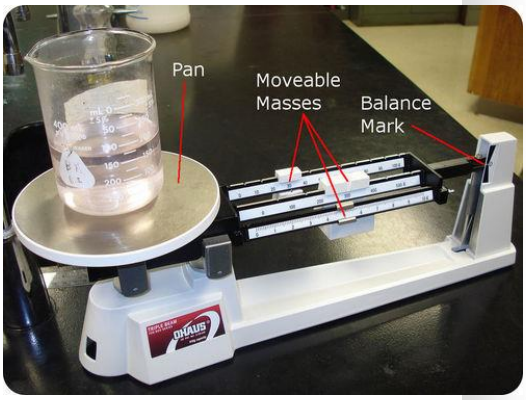
Mass

Mass is the amount of matter in a substance or object. Mass is commonly measured with a balance. A simple mechanical balance is shown below. It allows an object to be compared with other objects of known **mass**. The unit for mass is the kilogram, but for smaller masses grams are often used instead.

This balance shows one way of measuring mass. When both sides of the balance are at the same level, it means that objects in the two pans have the same mass.

Measuring Mass with a Balance

Scientists often measure mass with a balance. A type of balance called a triple beam balance is pictured in Figure below. To use this type of balance, follow these steps:



1. Place the object to be measured on the pan at the left side of the balance.
2. Slide the movable masses to the right until the right end of the arm is level with the balance mark. Start by moving the larger masses and then fine tune the measurement by moving the smaller masses as needed.
3. Read the three scales to determine the values of the masses that were moved to the right. Their combined mass is equal to the mass of the object.

Mass versus Weight

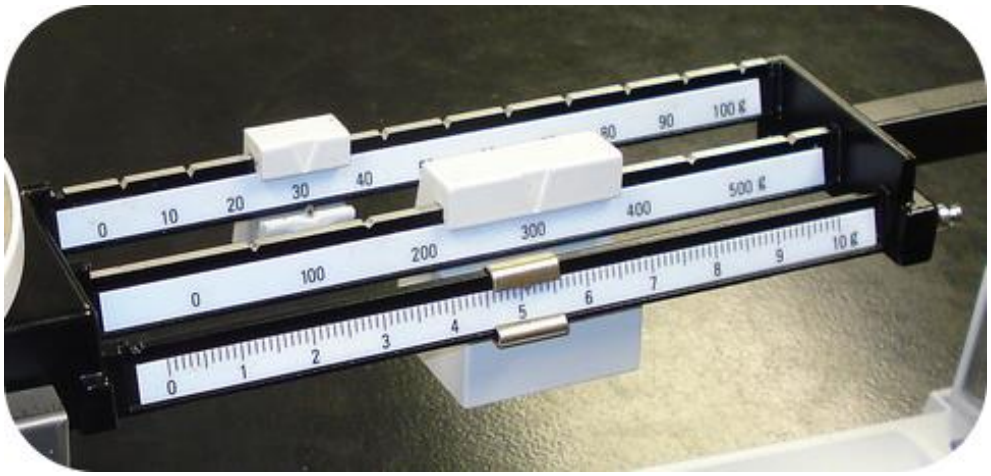
The more matter an object contains, generally the more it weighs. However, weight is not the same thing as mass. Weight is a measure of the force of gravity pulling on an object. It is measured with a scale, like the kitchen scale in Figure below. The scale detects how forcefully objects in the pan are being pulled downward by the force of gravity. Gravity decreases as you move away from the center of the earth. So, gravity pulls less on an object on a mountain than it does at sea level. So the same object weighs less on the mountain even though nothing changed except gravity. The amount of "stuff" in the object stays the same, so its mass doesn't change, even though it weighs less.

This kitchen scale measures weight. How does weight

The Figure below is an enlarged version of the scales of the triple beam balance in Figure above. It allows you to read the scales. The middle scale, which measures the largest movable mass, reads 300 grams. This is followed by the top scale, which reads 30 grams. The bottom scale reads 5.1 grams. Therefore, the mass of the object in the pan is 335.1 grams (300 grams + 30 grams + 5.1 grams).

Q: What is the maximum mass this triple beam balance can measure?

A: The maximum mass it can measure is 610 grams (500 grams + 100 grams + 10 grams).



Q: What is the smallest mass this triple beam balance can measure?

A: The smallest mass it can measure is one-tenth (0.1) of a gram.

To measure very small masses, scientists use electronic balances. This type of balance also makes it easier to make accurate measurements because mass is shown as a digital readout. Digital balances are easier to read since the mass is expressed in numbers.

Find the Mass of a Gas

You might be able to imagine, however, the difficulty for people several hundred years ago to demonstrate that air has mass and volume. Air (and all other gases) are invisible to the eye, have very small masses compared to equal amounts of solids and liquids, and are quite easy to compress (change volume). Without sensitive equipment, it would have been difficult to convince people that gases are matter. The mass of air, under normal room conditions, that occupies a one quart jar is approximately 0.0002 pounds. This small amount of mass would have been difficult to measure in times before balances were designed to accurately measure very small masses. Later, scientists were able to compress gases into such a small volume that the gases turned into liquids, which made it clear that gases are matter.

Air Has Mass Demonstration

Materials Needed: Basketball, triple beam balance, air needle, dish to hold inflated ball

Procedure: Take a deflated basketball and place it onto a triple beam balance with the dish you chose to hold it. Determine the mass of the ball and the dish. Take the ball off of the balance and inflate it to about 10 psi. Place it back onto the balance using the dish to keep it from rolling off. Adjust the weights.

Discussion: Did the mass of the balloon change? Why?

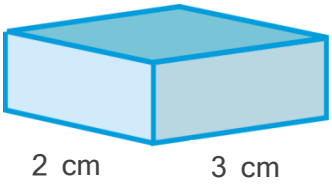
Explanation: The mass of the blown up balloon changed because the air you put into the balloon has mass.

Volume

Volume- The amount of space matter takes up- is measured differently depending on its state (solid, liquid, or gas). For example, the **volume** of liquids is measured with measuring containers. In the kitchen, liquid volume is usually measured with measuring cups or spoons. In the lab, liquid volume is measured with containers such as graduated cylinders. Units in the metric system for liquid volume include liters (L) and milliliters (mL).

The volume of gases depends on the volume of their container. That's because gases expand to fill whatever space is available to them. For example, as you drink water from a bottle, air rushes in to take the place of the water. An "empty" liter bottle actually

holds a liter of air. How could you find the volume of air in an "empty" room?

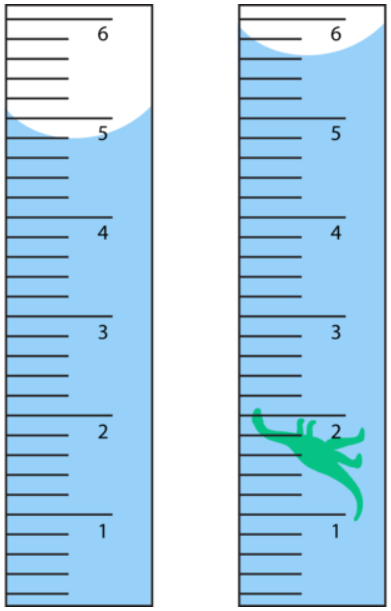


The volume of regularly shaped solids can be calculated from their dimensions. For example, the volume of a rectangular solid is the product of its length, width, and height (l × w × h).

For solids that have irregular shapes, the displacement method is used to measure volume.

You can see how it works in Figure below and in the video below. The SI unit for solid volumes is cubic meters (m^3). However, cubic centimeters (cm^3) are often used for smaller volume measurements.

http://www.youtube.com/watch?v=q9L52maq_vA&feature=related



Displacement Method for Finding Volume

1. Add water to a measuring container such as a graduated cylinder. Record the volume of the water.

2. Place the object in the water in the graduated cylinder. Measure the volume of the water with the object in it.

3. Subtract the first volume from the second volume. The difference represents the volume of the object.

The displacement method is used to find the volume of an irregularly shaped solid object. It measures the amount of water that the object displaces, or moves out of the way. What is the volume of the toy dinosaur in mL?

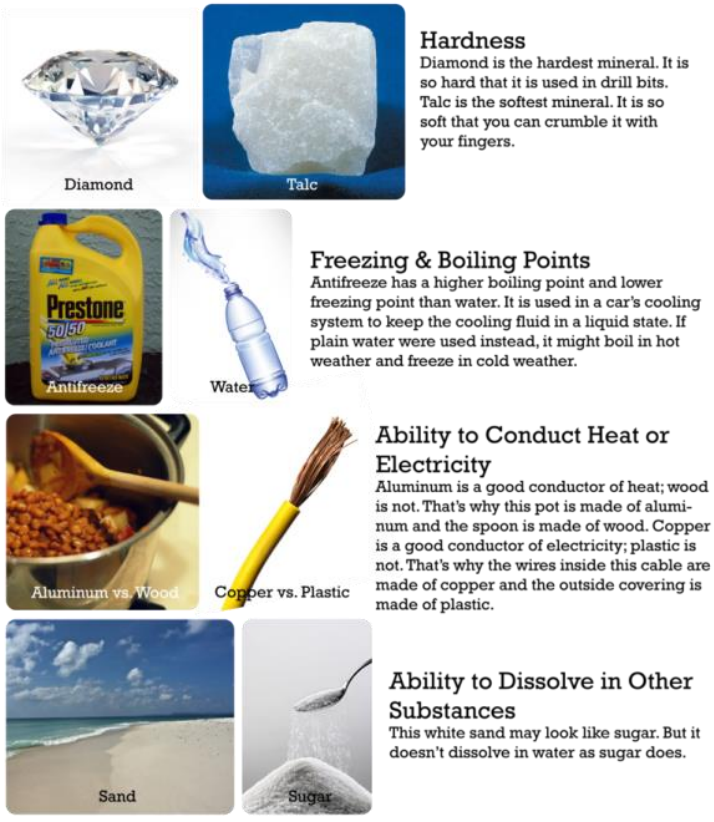
What are "Physical Properties?"

Matter has many properties. Physical properties of matter are properties that can be measured or observed without matter

changing to a different substance. For example, whether a given substance normally exists as a solid, liquid, or gas is a physical property. Consider water. It is a liquid at room temperature, but if it freezes and changes to ice or if it boils and changes to steam, it is still water. Generally, physical properties are things you can see, hear, smell, or feel with your senses.

Examples of Physical Properties

Physical properties include the state of matter and its color and odor. For example, oxygen is a colorless, odorless gas. Chlorine is a greenish gas with a strong, sharp odor. Other physical properties include hardness, freezing and boiling points, the ability to dissolve in other substances, and the ability to conduct heat or electricity. These properties are demonstrated in Figure. Can you think of other physical properties?



What is density, and how do we measure it?

Have you ever looked at an object and then when you picked it up it was heavier than you expected? A Styrofoam ball the size of a baseball would not be very heavy, but a ball of pure lead the size of a baseball would have far greater mass. So what is the difference? The difference is density. Density is the amount of matter in a given volume of a substance. An object where the particles are spread far apart, like a gas, has low density and an object with high density, like the lead ball, has a lot of matter that is closely compacted together.

To better understand density, think about a bowling ball and a volleyball. The bowling ball feels heavy. It is solid all the way through. It contains a lot of tightly packed particles of matter. In contrast, the volleyball feels light. It is full of air. It contains fewer, more widely spaced particles of matter. Both balls have about the same volume, but the bowling ball has a much greater mass. Its matter is denser.

Density plays an important role in nature and the earth would be quite different if density were not a factor. Objects that are more dense sink to the bottom in a mixture and objects that are less dense rise to the top. The reason wood floats on water is because it is less dense than water. Rocks are denser than water, therefore they sink. Objects in nature always layer themselves according to their density.

Density is calculated from the amount of mass in a given volume of matter, using the formula:

$$\text{Density } (D) = \frac{\text{Mass } (M)}{\text{Volume } (V)}$$

So, density=mass divided by volume.

Problem Solving:

Problem: What is the density of a substance that has a mass of 20 g and a volume of 10 mL?
Solution:

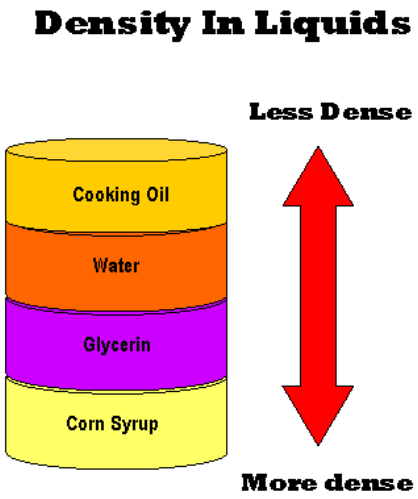
$$D = 20 \text{ g}/10 \text{ mL} = 2.0 \text{ g/mL}$$

You Try It!

Problem: An object has a mass of 180 kg and a volume of 90 m^3. What is its density?

Here is a great video on the density of liquids. http://www.youtube.com/watch?v=B3kodeQnQvU (4:00)

If you were asked if a lead fishing weight floats you would quickly answer no. But the correct answer is that it depends on what you are trying to float it on. Obviously, the lead fishing weight would sink in water, but what about other substances? Liquid mercury has a density of 13.55 and lead has a density of 11.35. Since the density of lead is lower than the density of mercury the lead would float on the mercury.



Sink or Float?	
Substance	**Density**
Water	1.0 g/cm^3
Lead	11.35 g/cm^3
Liquid Mercury	13.55 g/cm^3
Rock	3.7 g/cm^3

If a substance has a lower density than the other substance it will float. If it has a higher density it will sink.

According to the table above:

Will any substances listed float on water?
What will float on mercury?
Will a lead fishing weight float on liquid mercury?
What would happen to the rock if you threw it into the mercury?

Demonstration: Density

Materials needed: beaker, cooking oil, water, corn syrup, glycerin, food coloring

Procedure: Pour about ½ inch of corn syrup into the beaker, put food coloring in a container of water and pour the colored water into the beaker with the corn syrup. Add about ½ inch of glycerin. Add about ½ inch of cooking oil.

Discussion: Did the 4 substances that you put into the beaker mix? Why did they remain separated? What do you think would happen if they were stirred up.

Explanation: The layers remained separate because they have different densities. The corn syrup which is the most dense went to the bottom and the cooking oil, which is the least dense stayed on top. If you were to stir them up after a short time they would separate back into layers.

Online Interactive Activities

Interactive Density Activity: http://tinyurl.com/UT7th1-2

Review Questions for Standard 1 Objective 2

1. In your own words explain what matter is and give three examples of things that are made of matter.
2. Explain what mass is and tell how scientists determine the mass of an object.
3. What metric units are used to report the mass of an object?
4. Distinguish the difference in mass and weight.
5. How is weight affected by gravity?

6. Explain how to use a triple beam balance to determine the mass of an object.
7. Explain how to determine the volume of a regularly shaped solid such as a cube.
8. Explain how to determine the volume of an irregularly shaped object such as a rock.
9. What are physical properties of matter?
10. What two measurements are needed to determine density?
11. Explain how to determine density.
12. What happens when a solid object with a lower density is placed in a liquid with a greater density?
13. Explain how you could determine the mass and volume of a gas.

OBJECTIVE 3: STUDENTS WILL INVESTIGATE THE MOTION OF PARTICLES

Terms to know:
- Temperature
- Diffusion
- Expansion
- Contraction

How does temperature affect particle motion?

Temperature- the amount of heat present in an object-is a concept with which you are probably familiar. It is relatively how hot or cold an object feels. When particles move more quickly they have more energy, **temperature** is higher, and an object feels warmer. When particles lose energy they move more slowly, temperature is lower and an object feels cooler.

Demonstration 1
Diffusion in Liquids

Materials needed: a beaker with warm water, a beaker with cold water, and two different colors of food coloring

Procedure: Ask the class to predict which color of food coloring will diffuse the fastest. Place a drop of food coloring in each of the beakers of water.

Discussion: In which beaker did the food coloring diffuse fastest? Why did this happen?

Explanation: The particles in a liquid move much more slowly than those in a gas. After a few minutes, the food coloring will have diffused throughout the entire beaker. Particles move faster when they are warmer, therefore, the beaker with the warm water diffused faster. What would happen if food coloring was put in a vat the size of your classroom? Of course it would diffuse throughout the vat, but would it move anywhere near as fast as the gas particles moved in the room? It would not. The particles in a liquid move much slower than those in a gas. It would take a long time for the food coloring particles to become evenly distributed throughout the room.

The particles that make up matter are in constant random motion. They are always moving. The movement is increased as heat is added to the substance. Heat is energy that makes the particles in matter move faster. The more energy they have the faster they move. The less energy they have (heat is removed), the slower they move. Scientifically speaking, there is no such thing as cold. There is only an absence of heat. When the weather, or some object gets “colder” it is because there is less heat present. The less heat there is, the slower the particles move. At a certain point all energy/heat is gone and the particles stop all motion. This point is known as absolute zero. Absolute zero is -273.15

C°. As particles heat up, they begin to move faster. As this happens, the object expands. This is true for solids, liquids, and gasses. To understand this, imagine that you are spinning a ball on a rubber band in a circle over your head. As you spin the ball over your head the rubber band increases in length. It does this because the faster you spin it, the more energy it has. Matter expands in size as particle motion increases.

Particles in all states of matter are in constant motion, this is known as molecular motion. They move fastest in gases and slower in liquids. In solids the movement is even slower and is restricted to vibrating in place.

YOU TRY IT

The following link will take you to your own molecular motion experiments!

- http://departments.jordandistrict.org/curriculum/science/secondary/archive/grade7/70103/diffusionindish.doc
- http://departments.jordandistrict.org/curriculum/science/secondary/archive/grade7/70103/make_thermactivity.doc

How do particles move?

Have you ever been in a class and someone across the room was putting on hand lotion? Could you smell the lotion from where you were, even though you were all the way across the room? This happens because of **diffusion-** The movement of particles from an area of higher concentration to an area of lower concentration. There was an area of high concentration of hand lotion particles where the person was applying the lotion. High concentration simply means that there were many lotion particles at that spot. At first, you were in an area of low concentration, or an area where there were few or no particles. Since all particles

Demonstration 2
Diffusion in Gases

Materials needed: cologne or perfume
Procedure: The teacher will spray perfume or cologne at the front of the room. Students will raise their hands as they begin to smell the particles.
Discussion: What happened? Did everyone begin to smell the particles at the same time? Who smelled it first? Why do you think it happened this way?
Explanation: The particles in a vapor or gas move much more quickly than in other states. The particles began at the area of higher concentration, which was where they were sprayed, and moved to the area of lower concentration which was throughout the rest of the room. Under normal conditions, students will raise their hands row by row as the vapor moves away from the teacher.

are in constant motion the air is always mixing and moving. Over time the lotion particles moved randomly throughout the entire room until the concentration was equal in every area. Because the particles moved in this way, we call it **diffusion.** If your teacher were to spray perfume into the air at the front of the room, at first you would not be able to smell it. But, the perfume particles would gradually move throughout the room until there was an even concentration of particles in every part of the room.

How does heat affect the size of an object?

When heat is added or removed, objects can change in size. If heat is added, matter will expand because the particles will move faster and get further apart, making the object larger. For example, in the summer when the weather is warmer, a bridge or railway can heat up and **expand**.

What would happen? If the substance gets larger, its volume increases. However, the mass stays the same. If volume increases, but mass remains constant, what will happen to density?
When heat is removed, an object **contracts (contraction)** - particles in the object will get closer together and the object gets smaller. In the winter, structures will **contract** as the molecules loose heat and move closer together. If a substance contracts, its volume decreases but its mass stays the same. If volume is decreased, but mass remains constant, then what will happen to density?

Expansion and contraction also happens in sidewalks. Have you ever noticed the seam between each slab?

http://bestandworstever.blogspot.com/2012_03_01_archive.html
Having sidewalks built in sections allows them to expand and contract a little bit on hot or cold days without buckling. Buckling occurs when the two slabs expand from being heated and they push against each other. Expansion can cause the sidewalk to crack or even form areas where the concrete plates rise up. This expansion and contraction in nature is so powerful that it causes rocks to break apart and erode.

Having sidewalks built in sections allows them to expand and contract a little bit on hot or cold days. If the whole thing were attached, it would buckle and break. Engineers have to take this fundamental property of matter into account when building everything from bridges to buildings.

Have you ever seen the structures that look like metal teeth on a bridge? Those are called expansion joints. The purpose of these is to allow expansion in the summer.

Online Interactive Activities

- Changes of State: http://tinyurl.com/UT7th1-3

Review Questions for Standard 1 Objective 3

1. Explain what temperature is.
2. What happens to the speed of particles as they increase in heat?
3. In your own words explain what molecular motion is.
4. Explain what happens to particles in diffusion. What causes diffusion?
5. Why do particles in gases and liquids diffuse, but not solids?
6. Why does diffusion happen faster in warmer substances than in colder ones?
7. Explain why matter expands and contracts as they heat up and cool down.
8. Why do builders have to consider expansion and contraction of particles when building structures such as bridges and railroads?

Standard 1 Review

Objective 1

1. Use an example to explain how small atoms are.
2. How do scientists study things they can't see?
3. List three things scientists use models for.
4. Explain the limitations of models.
5. List six scientists who helped develop the atomic theory. Explain what each of them discovered.
6. List and explain in your own words the three parts of Dalton's atomic theory.
7. List the three particles that atoms are made of, give their charge, and where they are located.
8. What did Russian scientist Dmitri Mendeleev do?
9. Explain what atomic symbols, atomic mass, and atomic number are.
10. In your own words explain what a compound is.
11. Explain the basic properties of solids, liquids, and gases.
12. How is the motion of particles different in solids, liquids, and gases?
13. Explain how particles are arranged in solids, liquids, and gases.
14. What happens to the volume of a gas when heat is added or removed?
15. What causes a substance to change states between solid, liquid, and a gas?

Objective 2

1. What is matter? Give three examples of things that are made of matter.
2. In your own words explain what mass is.
3. What do scientists use to measure mass?
4. Explain the difference between mass and weight.
5. In your own words explain how to use a balance.
6. How would you find the mass of a gas?
7. Give two ways to determine the volume of objects and tell when you would use each method.
8. What are physical properties?
9. If an object with a greater density is placed in an object with a lower density, what will happen?
10. Explain density and tell how to find the density of an object.

Objective 3

1. Explain what happens to the motion of particles when heat is added or removed.
2. What would happen if all heat was removed from an object?
3. Using examples, explain what diffusion is and what causes diffusion to happen.
4. Why does matter expand and contract as it heats up or cools down?
5. Explain the motion of particles in solids, liquids, and gases.

6. What happens to the volume of a solid when it is heated? What happens to the volume when heat is removed?
7. Why do builders have to consider expansion and contraction of particles when building structures such as bridges and railroads?

Glossary

Atom The smallest unit of matter that retains the characteristics of the type of element that it is.

Contraction The decrease in the size of an object due to decreased molecular motion from loss of heat

Density The measure of the amount of matter in a given volume of a substance.

Diffusion The movement of particles from an area of high concentration (its source) to an area of low concentration.

Electrons Negatively charged parts of an atom that are located in an electron field orbiting the nucleus of the atom.

Expansion Increase in the size of an object due to increased molecular motion from increased heat

Gas The least dense form of matter. The particles move rapidly and are far apart. A state of matter that has no definite volume and no definite shape.

Gravity The pull of the earth or another celestial body on another object.

Heat The transfer of kinetic energy or motion.

Heat Energy The measure of the amount of heat present in a substance

Liquid The form of matter that tends to flow freely. Particles are in constant motion and are close together, but no bonds are formed. A state of matter that has a definite volume and takes the shape of its container.

Model A larger or smaller representation of an item to be studied.

Mass The amount of matter in an object. Measured in grams.

Matter Anything that has mass and takes up space

Molecular Motion The speeds at which molecules move in solids, liquids or gases

Molecules A combination of atoms in a definite ratio that are chemically combined to form a substance. Water is a molecule made of two hydrogen atoms and one oxygen atom.

Neutrons Particles located in the nucleus of an atom that are made up of an electron and a proton giving them an overall neutral charge.

Nucleus (1) The control center of a cell where the genetic material is located. Or, (2) the center of an atom that is made up of protons and neutrons.

Particle A small piece of something. Term used to represent a small part of matter.

Protons Positively Charged particles located in the nucleus of an atom.

Solid The most dense form of matter. A state of matter with a definite volume and shape in which the atoms or molecules are arranged in an organized manner. Particle motion is limited to vibrating in place.

Temperature The measure of the amount of energy present in an object.

Volume The amount of space that an amount of matter occupies.

Weight The measure of the earth's gravitational attraction on an object

Earth matters

chapter 2

STANDARD 2: STUDENTS WILL UNDERSTAND THE RELATIONSHIP BETWEEN PROPERTIES OF MATTER AND EARTH'S STRUCTURE.

Objective 1: Examine the effects of density and particle size on the behavior of materials in mixtures.

We have discussed density. But, how does density affect us every day? We tend to think of density in terms of materials that we are familiar with. If you throw a rock into a lake the rock will sink to the bottom. Why does the rock sink? The rock sinks to the bottom of the lake because it is denser than the water in the lake. If you throw a block of wood into the lake it will float because wood is less dense than water.

Density does not only affect items that are thrown into water. It does not matter what the substances are that are being compared. The denser substance of the two being compared will always sink to the bottom and the less dense substance will always rise to the top.

Density does not just determine what sinks and floats when comparing solids and liquids, it applies to any substances that can be mixed with each other. Remember the density demonstration in Chapter 1, where a variety of liquids were placed in a beaker together? Even though all of the substances were liquids the denser liquids went to the bottom and the less dense liquids rose to the top.

Solids work the same way. If we were to place several different solids in a box and shake the box back and forth, the materials would separate according to their density just like the liquids did in the demonstration.

Important Review

Density is the amount of matter in a certain amount of a substance. For example: Imagine two objects the size of a baseball. One object is made of lead and the other is made of foam. Even though they are the same size the two objects have a considerably different amount of mass. The lead ball is denser. To determine density simply divide mass by volume (d=m/v). If an item has a mass of 20 grams and a volume of 5 cm^3 the density would be:

density=20g/5cm^3=4g/cm^3.

Holy Cow!

Mercury is a metal that is a liquid at room temperature. It has a density of about 13.5 g/cm^3. Lead is also a metal, but is solid at room temperature. The density of lead is about 11.4 g/cm^3. If you drop a lead fishing weight into water, naturally it will sink. Lead is much more dense than water. But what will happen if you drop the lead weight into a beaker of mercury? Since lead is less dense than mercury, it will float.

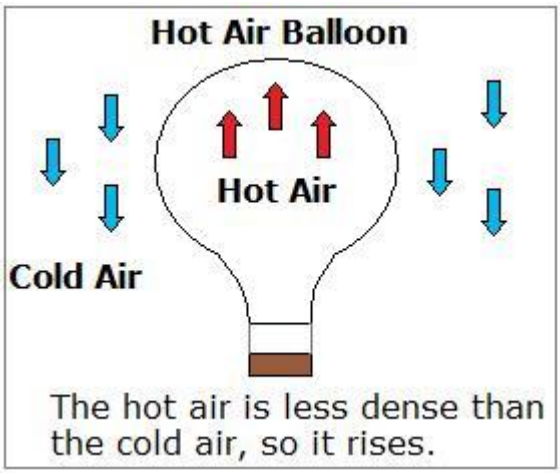
Demonstration

Materials: Lead fishing weights, gravel, wood chips, marbles

Procedure: Pour each of the materials into a clear box and mix them thoroughly. When the materials are well mixed, gently shake the box back and forth. The movement of the box represents the constant shaking of the earth through earthquakes and natural processes.

Discussion: What happened to the materials? Why did they separate? In what order did they separate? Do you think that the same results would happen if you used different materials?

Summary: the materials in the box separated according to density. It does not matter what materials are used, they will always separate according to density.



Archimedes' Principle

The Greek scientist Archimedes made a significant discovery in 212 B.C. The story goes that Archimedes was asked to find out for the King if his goldsmith was cheating him by replacing his gold for the crown with silver, a cheaper metal. Archimedes did not know how to find the volume of an irregularly shaped object such as the crown, even though he knew he could distinguish between substances by their density. While thinking on this puzzle in a bath, Archimedes recognized that when he entered the bath, the water rose. He then realized that he could use a similar process to determine the density of the crown! He then supposedly ran through the streets naked shouting "Eureka," which means: "I found it!" in Latin.

Archimedes then tested the king's crown by taking a genuine gold crown of equal mass and comparing the densities of the two. The king's crown displaced more water than the gold crown of the same mass, meaning that the king's crown had a greater volume and thus had a smaller density than the real gold crown. The king's "gold" crown, therefore, was not made of pure gold. Of course, this tale is disputed today because Archimedes was not precise in all his measurements, which would make it hard to determine accurately the differences between the two crowns.

Archimedes' Principle states that if an object has a greater density than the liquid that it is placed into, it will sink and displace a volume of liquid equal to its own. If it has a smaller density, it will float and displace a mass of liquid equal to its own. If the density is equal, it will not sink or float.

Archimedes' Principle explains why balloons filled with helium float. Balloons, as we learned in the section concerning density and temperature, float because they are less dense than the surrounding air. Helium is less dense than the atmospheric air, so it rises. Archimedes' Principle can also be used to explain why boats float. Boats, including all the air space, within their hulls, are far less dense than water.

Observe the two corks in the picture below. Notice how the dark cork sinks in water and the light cork floats in the water. Which of these corks is densest? What is your evidence?

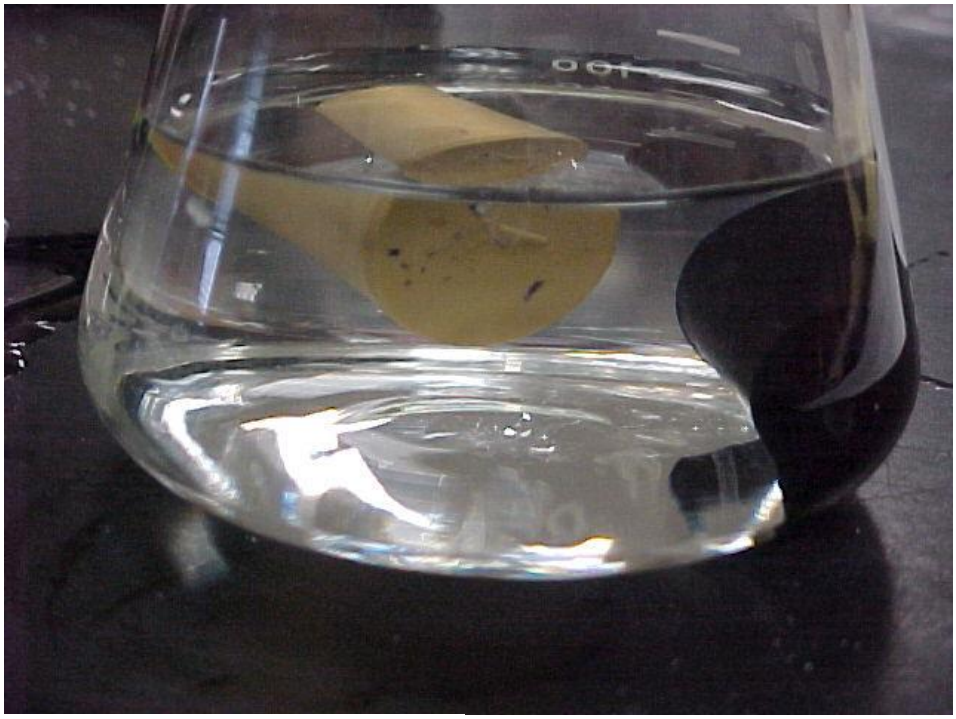


Photo by: Glen Westbroek

Air is a mixture of different substances that exist in a gaseous state. Nitrogen is the most common element found in air. Other substances include Helium, Oxygen, Carbon Dioxide, and water. A mixture is a combination of substances that can be

physically removed. The photograph shows a mixture of candies. Notice how easily this mixture can be separated.

Having learned the formula for Density (D=M/V) it's time to practice. The following are examples of different types of density problems.

Density Problems

Answers should be in g/cm3.

1) If you have a 4 cm^3 sample of rock salt with mass of 10 grams, what is the density?

2) You have a 10 cm^3 sample of water with a mass of 10 grams what is the density?

3) You have an unknown metal with a volume of 4 cm^3 and a mass of 42.0 grams. Compared to the chart above, what is this metal most likely to be?

4) Find the density of an unknown liquid in a beaker. The empty beaker's mass is 165 grams. With the unknown liquid inside the beaker, the total mass is 309 grams. The volume of the unknown liquid is 125mL. Is the liquid pure water? Explain your answer.

http://www.flickr.com/photos/qilin/527129762/

The man in this photo is selling balloons with helium gas. What will happen if he lets go of the filled balloons? They will rise up into the air and float away. Do you know why? It's because helium has less density than air.

Answers:
Here are the solutions to the listed practice problems.

1) 2.5 g/cm^3
2) 1 g/cm^3
3) 10.5 g/cm3 (Silver)
4) 1.152 g/cm^3(Pure water would be 1.0 g/cm^3 – this density is greater than water so it cannot be pure.)

Defining Density

http://www.youtube.com/watch?v=B3kodeQnQvU (4:00)
(Table 1.2)

Element Name and Symbol	Density (g/cm3)
Hydrogen (H)	.00009
Helium (He)	.00018
Aluminum (Al)	2.7
Zinc (Zn)	7.13
Tin (Sn)	7.31
Iron (Fe)	7.87
Nickel (Ni)	8.9
Copper (Cu)	8.96
Silver (Ag)	10.5
Lead (Pb)	11.35
Mercury (Hg)	11.55
Gold (Au)	19.32
Platinum (Pt)	21.45

As can be seen in this table, the densest element is Platinum (Pt) with a density of 21.45 g/cm3. The least dense element is Hydrogen (H) with a density of .00009 g/cm3.

The Sorting of Particles in a Streambed

Have you ever walked along a stream and wondered why some areas are sandy and others are strewn with rocks? Different sizes of matter are called **particles**. **Particles** are small pieces of matter defined by their size. Clay and sand are examples of smaller particles. Boulders and cobbles are particles that we would normally refer to as rocks. What makes sand deposit in some areas and not in others? Why do the rocks all seem to group together? The answer lies in three factors: one, the density of the materials involved, two: the size (it's volume) or total **mass** (the amount of matter in a substance) of the objects, and third: the rate at which water in the stream is flowing.

To understand these questions we need a basic understanding of how water moves in a stream. Heavy, larger objects can only be moved by a stronger current. Smaller and less dense objects can be carried by much weaker currents and are therefore, carried further.

Why is there a pile of cobbles in that stream?

A river meanders causing erosion on one side of its bank. On the other side, sediments are deposited. On this photo of a meander, where is there erosion and where is there deposition?

When the water in a stream is forced through a narrow canyon or passage, or it drops quickly in elevation, the force of the stream increases. As the water leaves the faster flowing area it spreads out into a larger area. The larger area gives the water more room and the current becomes weaker. Larger rocks and debris are deposited at the end of the faster flow because the current is no longer strong enough to carry them. But, the smaller rocks and debris are carried further downstream until eventually, the current is too weak to carry them and they too settle. The term **sorting** is used to describe how particles are distributed in a stream.
Since sand particles are smaller and have less mass they are carried to areas with the weakest current and are deposited there. That is where beaches are formed. Silt and other very fine materials are carried still further. Silt tends to build up at the mouths of rivers where the current deposits it. This silt forms a geologic formation known as a delta.

How particles are moved by flowing water depends on their size. Sediments are carried as Particles. Sand, clay, and silt are sediments that are often carried by water. As the water slows, larger particles drop out of the water.

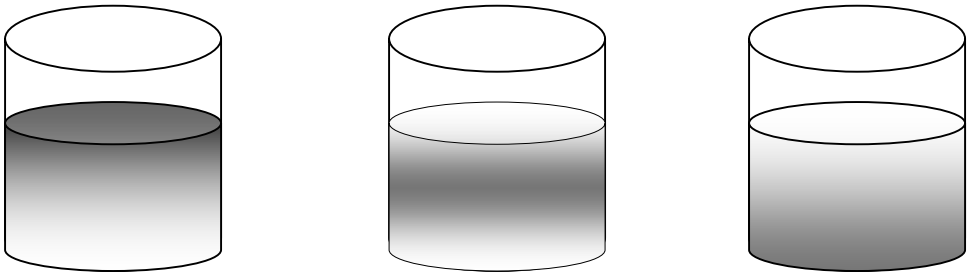
The Connecticut River is brown from the sediment it carries. The river drops the sediment offshore into Long Island Sound

The Natural Sorting of Earth Material

We have discussed the sorting of materials by size and density as it applies to streams and the earth, but particles are sorted by density and size in other settings as well. If you have ever seen a construction crew move earth around to build a home or a road you may have noticed that there are layers in the soil. These layers are the result of the same processes that separate materials in a stream or in the earth's interior.

As materials are deposited, wherever that may be, those materials are sorted by size and density. Of course there are exceptions where the separation has not been complete or some factor has limited sorting, but the concept is present in every part of the earth that we live on.

Sediment Demonstration



Put some sand and sediment into a jar of water, shake it up and watch the materials settle to the bottom. The materials settle because, even though they are light, they are denser than the water. Materials in a stream are similar to this. As the current flows it carries the materials with it, but as it slows the sand, sediment, and other debris settle to the bottom. The finer sediment settles in the weakest current.

Gee Whiz!!!
Density: How Does It Really Work

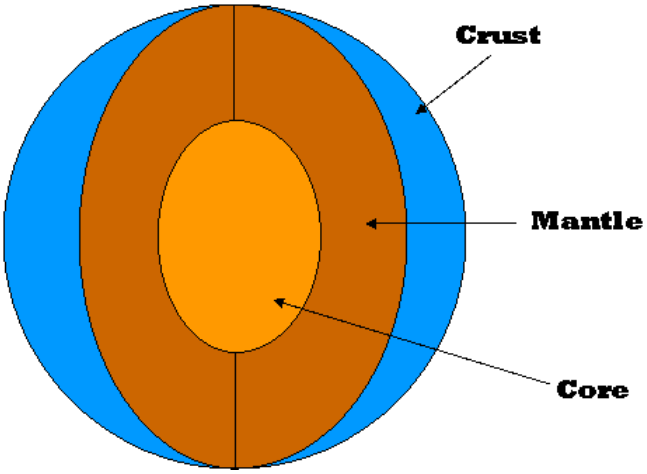
Do the densest substances really go to the bottom? If you place a rock in a jar full of water and place the lid on it the rock will be at the bottom of the jar. But, what happens to the rock when you turn the jar over? Now the rock goes to what is really the top of the jar. Now turn the jar sideways. Where is the rock? Gravity is the driving force on density and always pulls towards the core of the earth. In reality, regardless of how you hold the jar, the rock will always move to where it is the closest to the earth's core because that is the direction that gravity pulls it. This concept is true for rocks in water, air in the atmosphere, mixtures of various solids such as the layers of the earth, and for everything else in nature.

Interactive Online Activities

- Density Activity: http://tinyurl.com/UT7th2-1-a
- Sorting by Particle Size: http://tinyurl.com/UT7th2-1-b
- Sorting by Particle Size: http://tinyurl.com/UT7th2-2-a

OBJECTIVE 2: ANALYZE HOW DENSITY AFFECTS EARTH'S STRUCTURE.

Earth's Structure Is Affected by Density



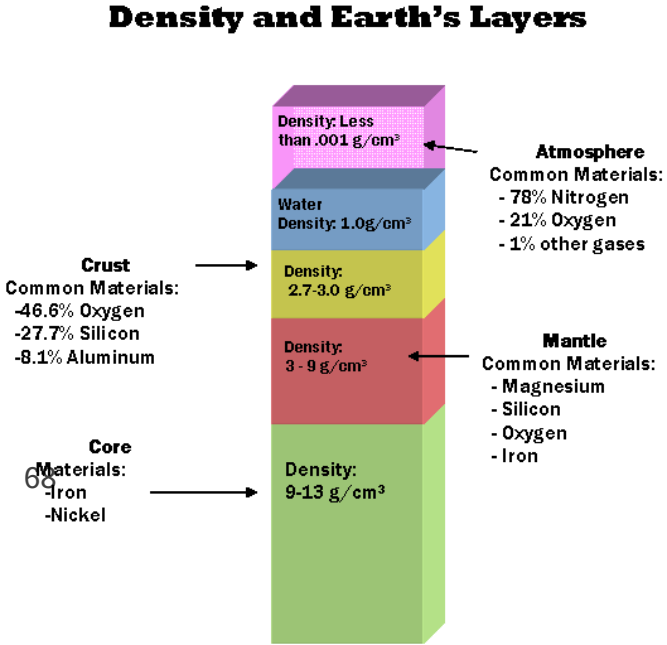
Do you remember our discussion on mixtures? If you do then you remember that a mixture is a combination of different materials that are mixed together but not chemically combined. In some mixtures the different parts mix together and move evenly throughout the container. A salt water solution is a good example of this. As the salt dissolves in the water, the salt molecules diffuse (move around) until the number of salt particles is the same in every part of the solution.
Other mixtures are not like solutions and the particles tend to separate. The particles in mixtures separate according to particle size and the density of the particles in the mixture. When particles separate according to density, the most dense particles will always be on the bottom and the least dense particles will always be on top.

The materials that make up the earth follow all of the principles of density that we have discussed. The most dense materials in the earth tend to be located closest to the center, or **core**, of the earth. The least dense materials are on top of the earth. The air, which is the least dense earth material, is located above the earth.

The Core

The very center part of the earth is called the **core**. Earth's core is divided into the inner core and the outer core.

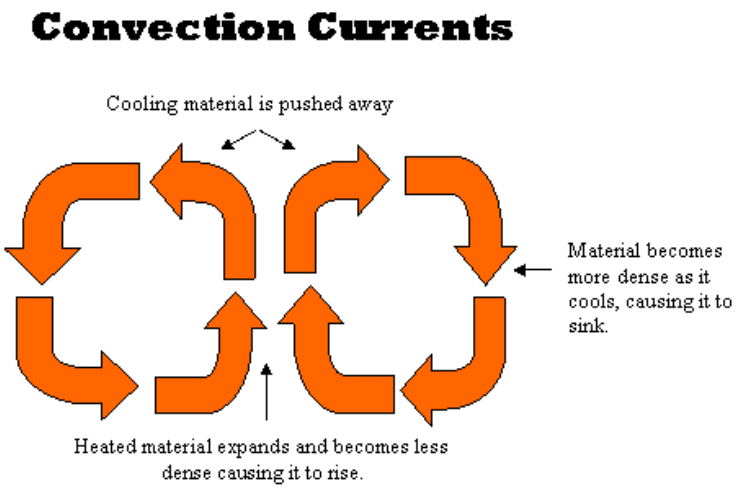
The **inner core** of the earth is a **solid** ball and is made up mostly of iron and nickel. These are very dense materials. The inner core is about 1,230km in diameter.
The **outer core**, like the inner core, is mostly iron and nickel, but the outer core is a liquid and is about 2,200km thick.
Temperature increases as you get closer to the center of the earth. If both the inner and outer core are made of similar materials then why would the inner core be **solid** and the outer core liquid even though the inner core was hotter? In order for a solid to turn to a liquid it must be able to expand. The weight of all of the upper materials on the



inner core is so intense that it cannot overcome the pressure and expand. Therefore, it must remain solid. If the pressure were to ease up, the inner core would expand and liquefy.
The core of the earth is tightly compacted. The **density** of the core ranges between 9 and 13 g/cm³. The core contains about 33% of earth's total mass.

The Mantle

The part of the earth that lies between the core and the surface is the **mantle**. The mantle is about 2,900km thick and is composed of upper and lower parts. About 67% of earth's mass is located in the mantle.
The mantle is located far enough below the crust that no one has been able to go there and study it. Scientists must rely on interpreting data that they have in order to study the mantle. Volcanoes offer some help in studying the mantle. Since magma from volcanoes come from the mantle scientists can use lava flows and magma domes to see what materials are present in the mantle. From these sources we know that magnesium is one of the more common materials found in the mantle.



In a convection current, heat rises because it is less dense than the cooler material around it. As it rises it cools and is pushed out by the hotter material rising below it. Eventually, it cools and sinks. As it sinks it is heated again and is pulled to the center to fill the space left by the rising heated material.

The mantle is divided into the upper and lower mantle. The lower mantle is about 2,550 km thick and is made up of solid rock. Most of earth's mass is located here. The upper mantle is about 250 km thick and is made of rock that flows very slowly. This rock can best be explained as a semi-solid. It is "plasticky," having a consistency like peanut butter. Heat in the lower mantle circulates in convection currents. Scientists believe that, since the earth's tectonic plates sit on top of the lower mantle, they ride these currents. It is these currents that are responsible for the movement in plate tectonics.

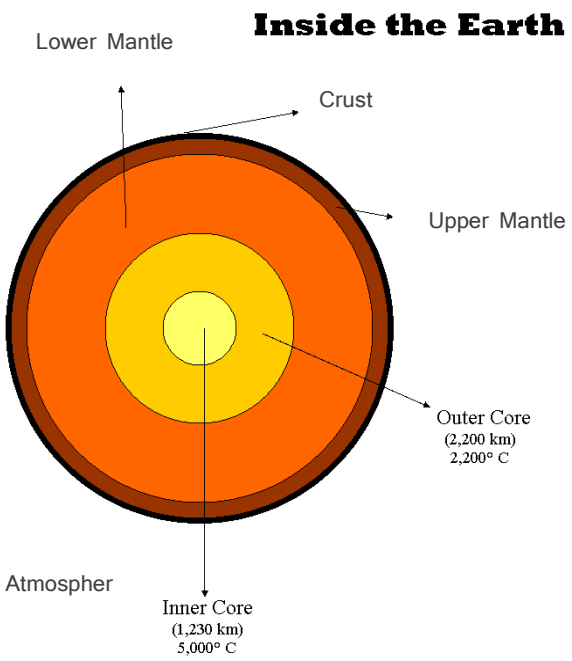
The mantle is a fairly dense region of earth's interior but nowhere near as dense as the core. The density of the mantle ranges between 3 and 9 g/cm³.

The Crust

The upper part of the earth where most life exists is called the **crust**. The **crust** ranges in thickness from about 5 to 100 km. The thickest spots are on land and are called continental crust. The thinner parts of the crust are under the ocean, called oceanic crust.

The crust and the very top layer of the mantle compose a layer called the lithosphere. The top layer of the mantle is included with the lithosphere because it is solid and does not flow like the asthenosphere. The lithosphere contains the tectonic plates.

The most abundant elements in the crust are oxygen, silicon, and aluminum. Many other elements are present as well, but in lower quantities.



The density of earth's crust is between 2.7 and 3.0 g/cm³. Since water has a density of 1.0 g/cm³ it sits on top of the crust and fills in any seams, cracks, and empty areas that may be present.

The Atmosphere

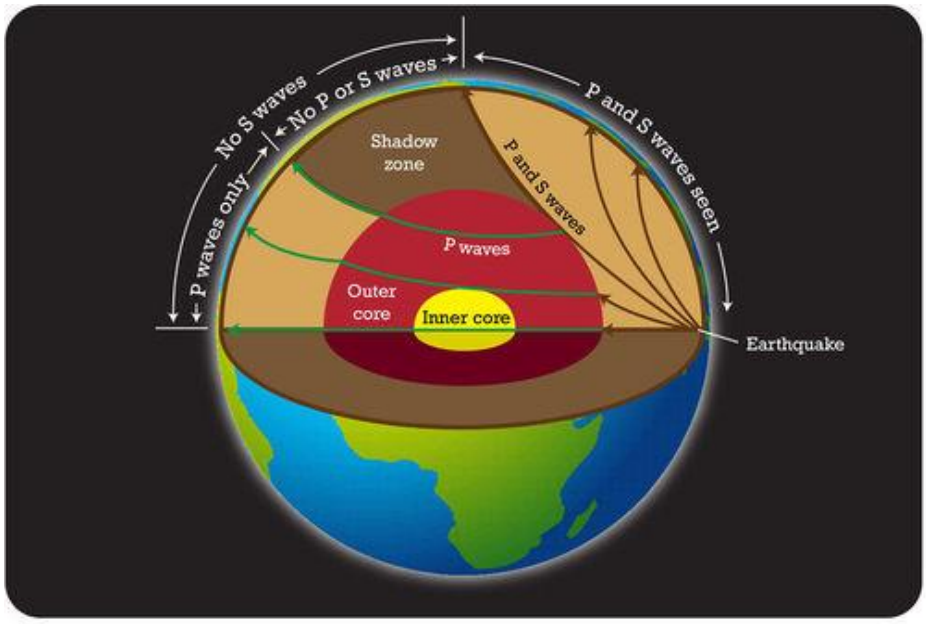
The least dense layer of the earth is the **atmosphere**. The **atmosphere** is the layer of the earth that contains all of the oxygen and other gases in the air around us. It extends several miles above earth's surface. The reason our atmosphere is above the earth is because it is far less dense than each of the other layers. The atmosphere has a density of less than .0013 g/cm³.

Remember, the densest materials in the earth tend to be the closest to the core. Likewise, the least dense materials tend to be located on the surface and above the surface of the earth.

How Do Scientists Know About the Inside of the Earth?

Seismic waves are another way that Scientists can study the earth's interior without actually visiting there. **Seismic waves** are the energy waves that are generated by earthquakes. To understand what these waves are like, fill a tub with water and drop a rock into the water. Watch the waves that spread out from the point that the rock entered the water. When an earthquake occurs, the energy waves move out from the point of the quake in much the same way.

There are two types of seismic waves, S waves and P waves. These waves act differently in solids and liquids. When P waves pass through liquids they slow down. They pick up speed when they reach a solid on the other side of the liquid. The S waves stop completely in liquids. Waves also travel faster in materials that are denser. Scientists look at data that they collect from earthquakes and can determine the composition of earth's interior by how the waves slow down, speed up, and disappear.



The properties of seismic waves allow scientists to understand the composition of Earth's interior

Meteorites

Scientists study meteorites to learn about Earth's interior. Meteorites formed in the early solar system. These objects represent early solar system materials. Some meteorites are made of iron and nickel. They are thought to be very similar to Earth's core. An iron meteorite is the closest thing to a sample of the core that scientists can hold in their hands!

Models of the Earth: Accurate or Inaccurate

Models are representations of a concept or process that help teach about that principle. They can be very effective ways to study the earth and learn about the relationships of various parts of the earth. You can study a map in order to learn more about how countries or landscapes are situated. A globe, which is another type of model, can help you to have a better understanding of how the earth is organized. There are many types of maps and other earth **models** that you can learn from. Models can have drawbacks as well. A flat map cannot correctly show exactly what a round world looks like. Likewise, a round globe can never show the detail that a flat section of a map can show. Basically, models can show one or two

things very well, but in order to really understand, a series of different types of models would be best. It is always important to keep in mind the strengths and weaknesses of each type of model that you are using.
Models are not always accurate. In fact, there have been times when an entire model that had been accepted was thrown out with the discovery of new evidence or the development of new technology. Scientific theories are truly dynamic. That means that they are constantly changing. The theories that we have today will be adjusted, or possibly changed completely as technology adds new information to what we already know.

On Your Own

Task: Find a map of the world and a globe.

Guide: Look carefully at the two models. What differences do you see? What kind of study do you think each would be good for? Find a country that is far North such as Greenland on both models. Do you see a difference in how they country is presented on each model? What differences do you see?

Summary: If you used good models, you probably noticed several strengths and weaknesses of each model. The map gave you better details. It probably listed many cities and rivers that the globe did not show. The Northern (or Southern) Country that you picked out was probably greatly distorted in size on the flat map. It is also hard to see the relationship between two countries on a map when they are on opposite sides of the paper.

Web link:
http://www.usoe.k12.ut.us/curr/science/core/7thgrd/sciber7/EARTH/HTML/MODEL.HTM

Online Interactive:

- Plate Tectonics: http://tinyurl.com/UT7th2-2-b

Standard 2 Glossary

Atmosphere – The various layers of air that surround Earth. The densest atmospheric layers are closer to Earth, and the least dense layers are farther away from Earth.

Crust – The solid outer layer of Earth where life is found. This is the thinnest layer of Earth.

Density – A comparison of the Mass and Volume of an object. Density is calculated as Mass ÷ Volume. A dense object or liquid tends to sink in a less dense liquid.

Inner Core – The centermost layer of Earth. This solid metal layer is the hottest and most dense layer.

Mantle – A semi-solid layer of Earth that takes up the most volume of Earth. This layer is found directly below Earth's crust.

Mixture – A combination or blend of two or more substances that have not chemically combined. Each substance maintains its own identity.

Model: A diagram, or three dimensional (3-D) representation of an object or process used to teach a concept **or** idea. Models are usually best for one or two ideas and are limited since they do not always show detail or proper scale.

Outer Core – A liquid layer of Earth found near the center. It is between the Mantle and Inner Core - This layer is made of metal.

Particle – A small piece of something, typically used to represent a small part of matter.

Seismic waves: Waves that are generated by earthquakes and used to explain the state of matter and density of earth's interior layers.

Sorting – The process that separates particles based on differences in density and/or particle size. Notice how the material behind this beaver dam is more of mud while in the faster moving stream below there are larger rocks.

Standard 2 Review

Objective 1

1. Explain why a rock sinks when it is thrown into a lake.
2. What is Archimedes' principle and explain how it was discovered.
3. Explain how to determine density.
4. Why would a lead fishing weight float in a beaker of liquid mercury?
5. If you place an assortment of various solid objects in a box and shake it back and forth, how would the objects be sorted?
6. Explain why a hot air balloon rises through the air around it?
7. If you have a 10 cm^3 sample of rock salt with mass of 25 grams, what is the density?
8. You have a 400 cm^3 sample of water with a mass of 400 grams what is the density?
9. You have an unknown metal with a volume of 4 cm^3 and a mass of 46.0 grams. What is the density of the metal? Use the chart in this section to help you.
10. Find the density of an unknown liquid in a beaker. The empty beaker's mass is 150 grams. With the unknown liquid inside the beaker, the total mass is 300 grams. The volume of the unknown liquid is 225mL. Is the liquid pure water? Explain your answer.
11. What three factors determine how particles are sorted in a stream?
12. Where will the largest particles in a stream be deposited?
13. Where will the smallest particles in a stream be deposited?
14. What is the force that causes particles to sort by density?

Objective 2

1. List the main layers of the earth.
2. What is the state of matter for each of the layers of the earth? What is unique about the mantle?
3. Based on what you have learned about expansion and contraction of particles when heated, why do you think the inner and outer core are similar in composition and temperature, but the inner core is solid and the outer core is liquid?
4. List the main materials found in each of earth's layers.
5. Give the average density for each of earth's layers.
6. From what you learned in objective 1, why do you think the layers of the earth are separated by density?
7. Explain how convection currents work.
8. What is the main gas that makes up earth's atmosphere?
9. Explain how scientists use earthquakes and meteorites to learn about the interior of the earth.
10. How are models of the earth helpful to scientists?
11. Based on what you have learned about models, what do you think some of the limitations are for models of the earth?

cells

chapter 3

Terms to know

Cell wall

Central vacuole

Chloroplast

Cytoplasm

Nucleus

Organelle

Cell membrane

mitochondria

Standard 3: Students will understand that the organs in an organism are made of cells that have structures and perform specific life functions

Objective 1: Observe and describe cellular structures and functions

What are the different parts of cells and what does each do?

How Much is a Trillion?

What would you do if you had a $1,000 bill? That's a lot of money. What if you had a stack of $1,000 bills 4 inches high? A stack of $1,000 bills 4 inches high would be about a million dollars. A million dollars is a lot more money. You would be rich. But how much is a trillion? In order to have a trillion dollars, you would need to have a stack of $1,000 bills that was about 63 miles high. So, a trillion is a big number. There are more than 75 trillion cells in the average adult human's body.

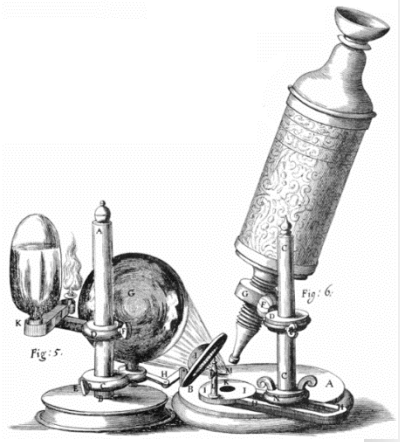
Cells are the basic unit of all living things. Chances are by now you have studied cells in school and you have a basic idea of what they are. Scientists have only known about cells for a short period of time. Cells are tiny. In fact, there are more than 75 trillion cells in the body of an average adult human. Scientists could not study cells until technology had advanced enough that they could look at them. These advances in technology have helped scientists study cells as well as other microscopic things.

Understanding Cells

The first Scientist to see cells was a man named Robert Hooke. About the year 1665 Hooke built his own microscope and began to use it to look at various objects. One of the things that he looked at was shavings from cork. Hooke noticed that the shavings contained little compartments. He noticed these compartments in other living things that he looked at as well. Hooke called the little compartments, cells. The term cells means "little rooms" in Latin.

A few years later, another Scientist named Anton von Leeuwenhoek (Lay' vin hook) built his own microscope. Leeuwenhoek used his microscope to examine other living things such as those found in pond water. Leeuwenhoek noticed that there were living things in the water that looked

like tiny animals that could not be seen without a microscope. He named these tiny animals animalcules, or as some prefer "wee beasties." The animalcules that Leeuwenhoek saw in his microscope are now classified as Protists. You will learn more about Protists later this year. Using his homemade microscope, Leeuwenhoek was also the first person to see bacteria.



The first microscopes were very simple. Robert Hooke made his own microscope by putting two lenses together

As technology progressed, the microscopes that Scientists used became better. Scientists continued to study microscopic life and to learn more about it.

In the 1830s German Scientists Matthias Schleiden (pronounced Shlie' den) and Theodor Schwann (pronounced Shvon) developed the first two parts of what is known as the cell theory. Schleiden and Schwann theorized from their studies that:

- All organisms are made of one or more cells
- Cells are the basic unit of all living things

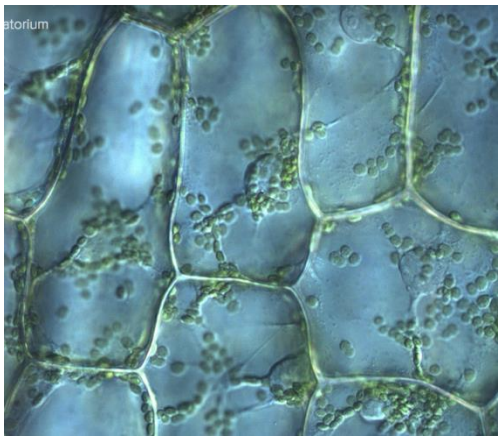
The Cell Theory

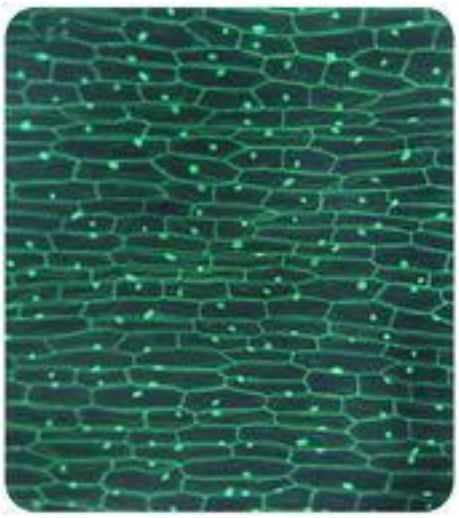
1. All organisms are made of one or more cells.
2. The cell is the basic unit of all living things.
3. All cells come from existing cells.

About 20 years later, in 1858, another German Scientist, Rudolf Virchow (pronounced fer' coe) added to the cell theory by stating:

▪ All cells come from existing cells

Some organisms, like bacteria are one cell, or **unicellular**, but **Multicellular** (made of more than one cell) organisms, like humans, may consist of trillions of cells. On the outside, plant and animals look very different, but if you examine their cells you'll see that they have many similarities.





These pictures show groups of typical **cells.** But As you can see not all cells look alike. Cells can differ in shape and sizes. The different shape usually means the cells have different jobs.

http://upload.wikimedia.org/wikipedia/
http://www.flickr.com/photos/exploratorium/5137916196/commons/3/36/Cheekcells_stained.jpg

Two Types of Microscopes

You will use light microscopes (also called compound microscopes) as you study cells in class. Light microscopes use two lenses working together to

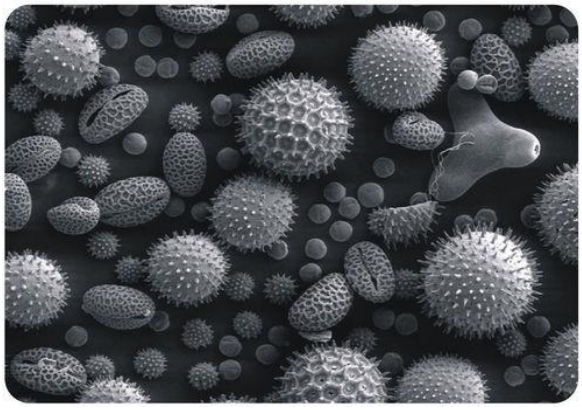
enlarge the specimen you are studying. These are similar to the ones use by early the scientists who discovered cells.

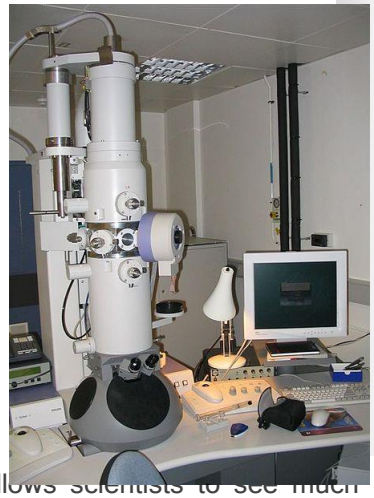
Advances in Technology Improve the Microscope

Many structures in the cell are too small to see with a light microscope. So, what do you do if you want to see the tiny structures inside of cells?

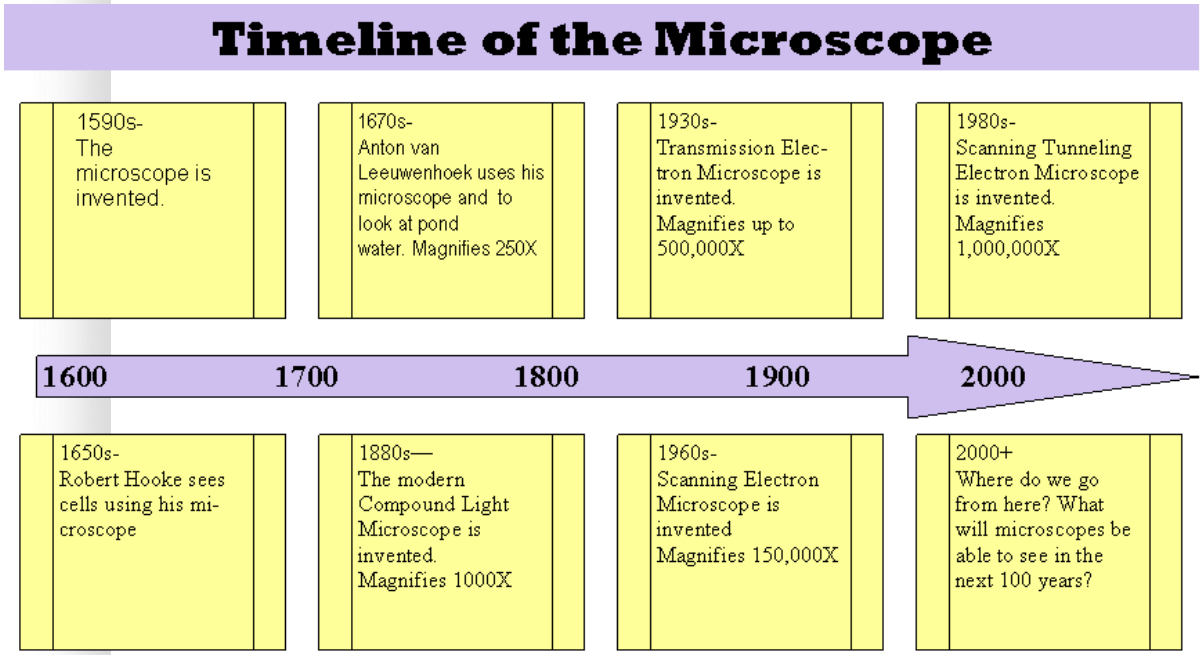
In the 1950s, scientists developed more powerful microscopes. A light microscope, like the one you will use in this class, sends a beam of light through a specimen, or the object you are studying. These can magnify objects anywhere from about 40x to 1000X in some cases. A more powerful microscope, called an electron microscope, passes a beam of electrons through the specimen. Sending electrons through a cell allows us to see its smallest parts, even the parts inside the cell (Figure below). Without electron microscopes, we would not know what the inside of a cell looked like. Some electron microscopes can magnify objects up to 10 million X.

The outline of onion cells (left) is visible under a light microscope like the one on the right. Light microscopes tend to be less expensive and can be carried around, but are not as powerful as electron microscopes.
http://en.wikipedia.org/wiki/File:Hooke-microscope.png





An electron microscope, like the one pictured, allows scientists to see much more detail than a light microscope, as with this sample of pollen. Electron microscopes are extremely powerful, but are also large and very expensive.



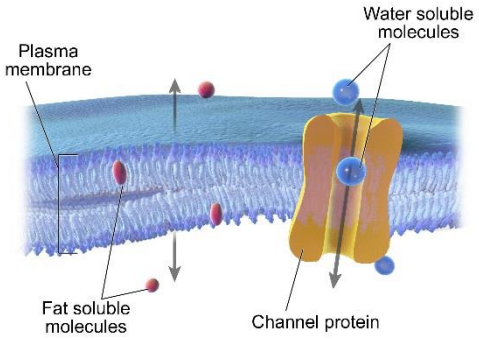
Are cells the smallest structures?

Think about the definition for cells. Cells are defined as the basic unit of all living things. This means that the cell is the smallest unit that can still be considered living. If a cell were broken down further, it would no longer be considered a living thing. But what makes up a cell? Cells are made up of smaller structures called **organelles**. **Organelles** are common to most cells. The word **organelle** means "small organs." Each organelle has its own function, or job, in the cell.

Two groups that cells are often divided into are plant and animal. These cells have many organelles in common, and a few that are different.

Cell Membrane

The function, or job of the **cell membrane**–(a layer surrounding the cytoplasm cell)- is to control what goes in and out of the cell and hold all of the cell's contents together . The cell membrane is **semipermeable** –(some things can cross it and some things cannot).



Diffusion Across the Plasma Membrane

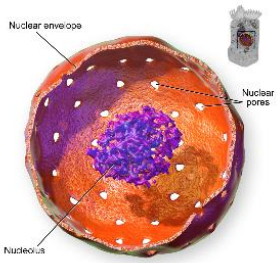
http://upload.wikimedia.org/wikipedia/commons/9/93/Blausen_0213_CellularDiffusion.png

Cytoplasm

Cytoplasm–(the jelly-like substance that fills the cell)- also holds the organelles in place. Everything in the cell - the nucleus and other organelles are found in the **cytoplasm**, like fruit in a Jell-O mold. It also provides a medium for the transport of materials within the cell.

Nucleus

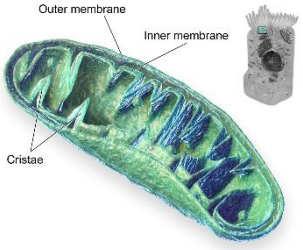
The **nucleus**–(the control center of the cell)- is like the boss. It contains most of the genetic information and controls all the activities of the cell.



Nucleus

Mitochondria

The mitochondria –(the powerhouse of the cell)- provides the energy needed to power the cell by extracting energy from food. It does that by breaking apart food molecules and releasing the energy stored in them. Food is the energy source for ourbodies. Just as wood is burned to use the stored energy to make a fire to heat some water, the food

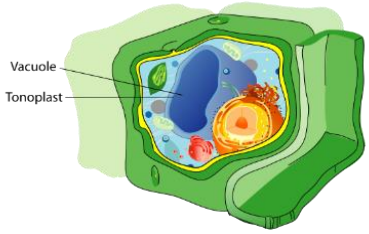


Mitochondria

commons.wikimedia.org

that we eat needs to be broken down in order to release the energy so that our bodies can function. Mitochondria are responsible for doing this.

Vacuole



http://en.wikipedia.org/wiki/File:Plant_cell_structure_svg_vacuole.svg

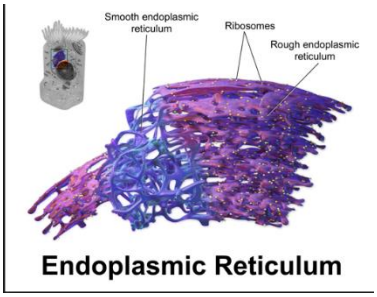
Vacuoles (storage centers) are organelles that can have different functions. Organisms use vacuoles as storage areas. Many plant cells have one large vacuole that can occupy as much as 90% of the cell's volume because they need to store water and other nutrients. Animal cells have several smaller vacuoles.

Ribosomes

Ribosomes– (organelles that make proteins)- connect molecules together into proteins. Proteins are the main product of the cell, which are an essential part of life functions. **Ribosomes** are the smallest organelles in the cell. They can be free floating in the cytoplasm, or attached to the endoplasmic reticulum (see image to the right).

Endoplasmic Reticulum

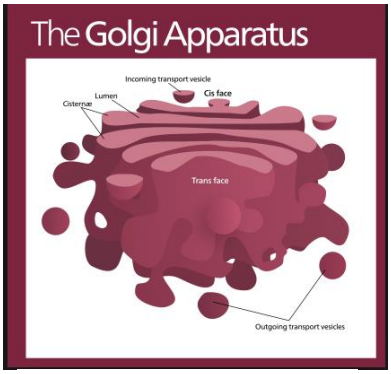
The **endoplasmic reticulum– (**a network that modifies and transport proteins)-has proteins made by ribosomes attached to it. These proteins and other molecules are then modified and moved to areas of the cell where they are needed.



Endoplasmic Reticulum

Golgi Apparatus

The **Golgi apparatus**–(the postal service of the cell)- works like a mail room. It receives the proteins from the

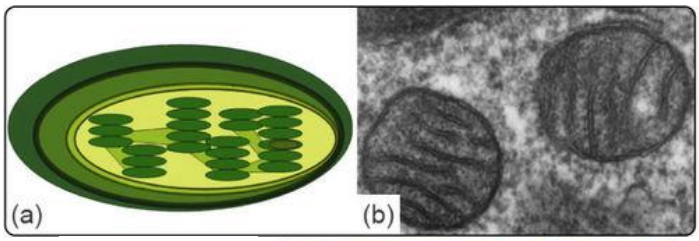


commons.wikimedia.org

rough ER, may make additional modifications, puts "shipping addresses" on the proteins, packages them, and then sends them to the right place in or out of the cell.

Chloroplast

The c**hloroplasts** –(organelles that make food through photosynthesis) are found in plant cells but not in animal cells. These green structures make food for the plant by converting the energy of sunlight into sugar. Because plants have **chloroplasts** to make their own food they do not need to obtain it from other sources.



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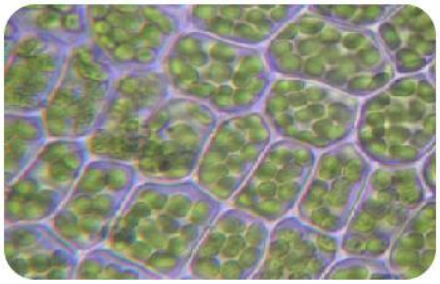
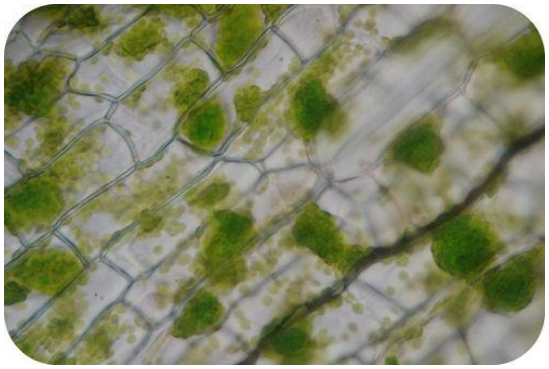


Even though plants and animals are both made of cells, plant cells differ in some ways from animal cells. First, plant cells have a cell membrane and a cell wall that supports and makes the cell somewhat rigid. Plant cells need this cell wall because they do not have a skeleton to offer the strength and support that an animal does, Animal cells do not have a cell wall but only a cell membrane. The cell wall surrounds the cell membrane. A cell wall gives the plant cell strength and protection.

Plant cells have a large central vacuole that holds a mixture of water, nutrients, and wastes. A plant cell's vacuole can make up 90% of the cell's volume. In animal cells, vacuoles are much smaller. It prevents the cell from absorbing too much water and bursting. It also keeps large, damaging molecules out of the cell.

Cell wall

Plant cells need a cell wall (a rigid outer barrier that supports and protects the cell) because they do not have a skeleton to offer the strength and support like an animal does.

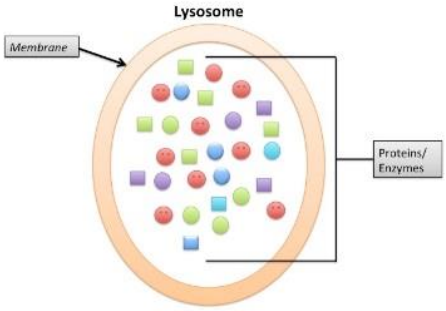


The **cell wall** in plant cells is the outermost layer of the cell.

In this photo of plant cells taken with a light microscope, you can see a cell wall around each cell and green chloroplasts. (The cells of animals do not have chloroplasts and cannot make their own food.)

Lysosome

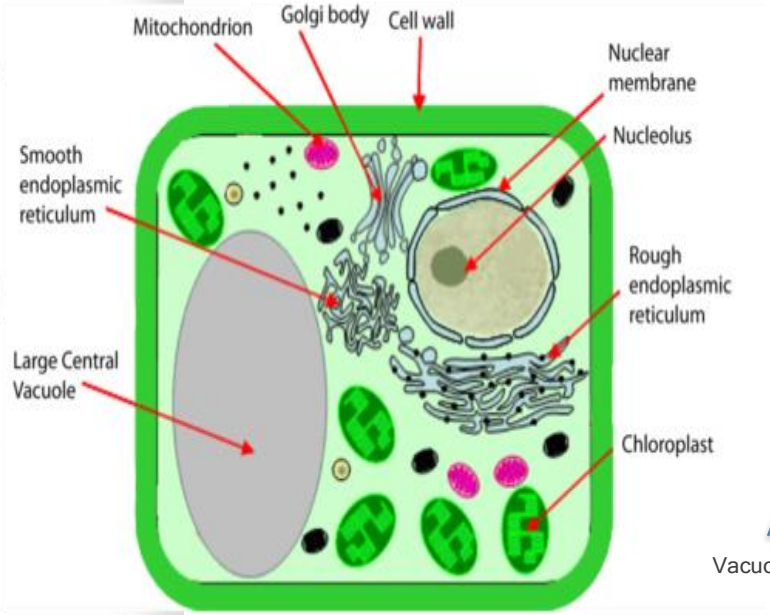
The **lysosomes** (the clean-up crew) are like the garbage trucks that carry waste away from the cell. Inside **lysosomes** are chemicals that break down old molecules and waste products into parts that can be recycled into new ones. They digest invading organisms such as bacteria and also break down cells that are ready to die. Lysosomes are common in animal cells, but rare in plant cells.



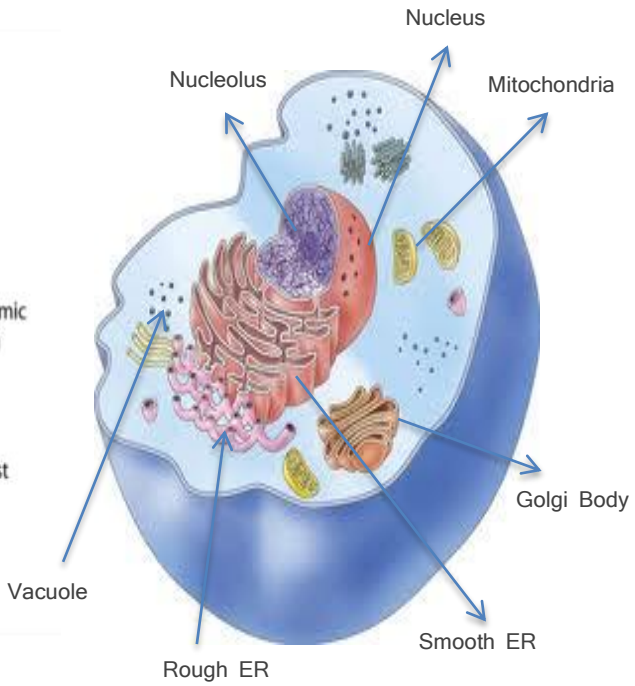
http://commons.wikimedia.org/wiki/File:Lysosome.jpg

How are plant and animal cells different?

PLANT CELL



ANIMAL CELL



Plant and animal cells are very similar to each other but there are a few differences. Plant cells have chloroplasts that help them obtain food. Since animals get their food from other sources, they do not need chloroplasts. Plant cells also have cell walls that surround them and give them support. It is the strength of trillions of cell walls in trees that make them strong enough to grow as tall as they are. Animals have skeletons and do not need cell walls. Plant cells also have large vacuoles, mainly for water storage. When grocery workers spray the produce in the supermarket, the water is absorbed into the vacuoles in the plat cells making them crispy.

Lesson Summary

Each part of a cell has a specific function. The nucleus controls the cell, the cell membrane provides a barrier, the cytoplasm fills the cell and provides for transport of materials in the cell. The Mitochondrion releases the energy stored in food, vacuoles store materials, the endoplasmic reticulum modifies proteins and transports them. The golgi apparatus serves as the postal system, chloroplasts make food for the plant, and the cell wall offers protection and support to the cell.

Plant cells are different from animal cells. For example, plant cells contain chloroplasts, cell walls, and large vacuoles. Animal cells don't have cell walls, chloroplast, or a single large vacuole. They do have lysosomes and smaller vacuoles.

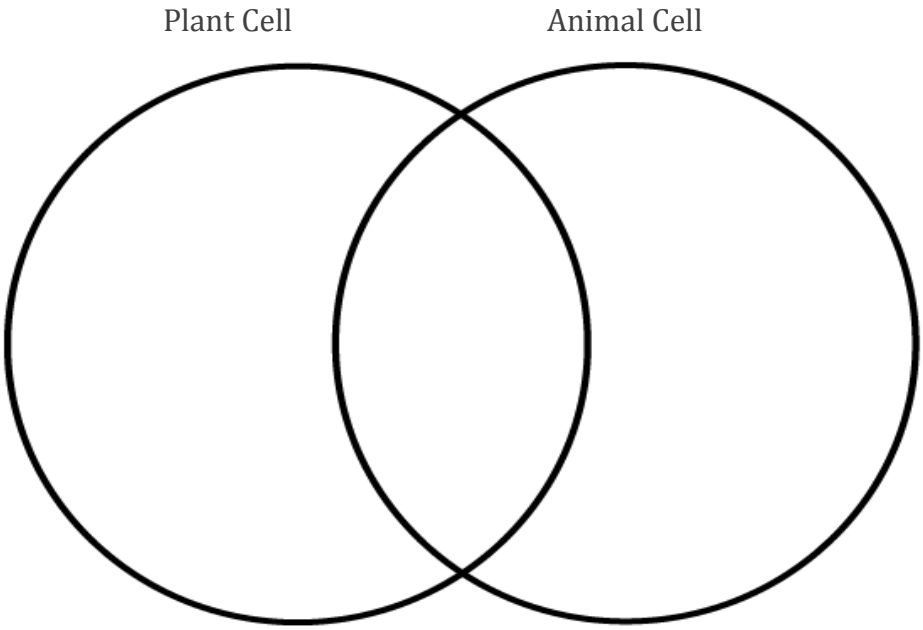
Think like a scientist

1. What are the differences between plant and animal cells?

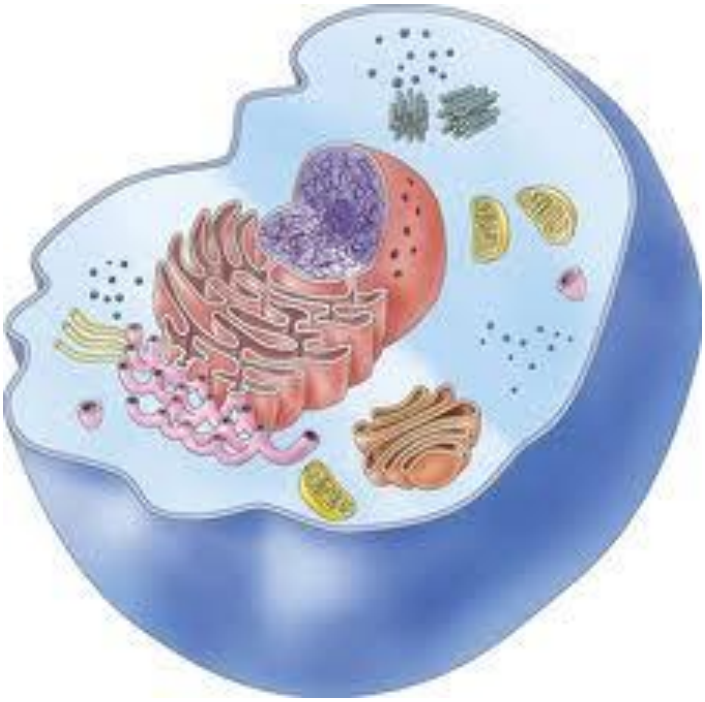
Fill in the table below with the proper characteristics for each cell type.

Organelle	Plant	Animal
Cell Wall		
Cell Membrane		
Cytoplasm		
Nucleus		
Mitochondria		
Vacuoles		
Lysosomes		
Endoplasmic Reticulum		
Golgi Apparatus		
Chloroplast		

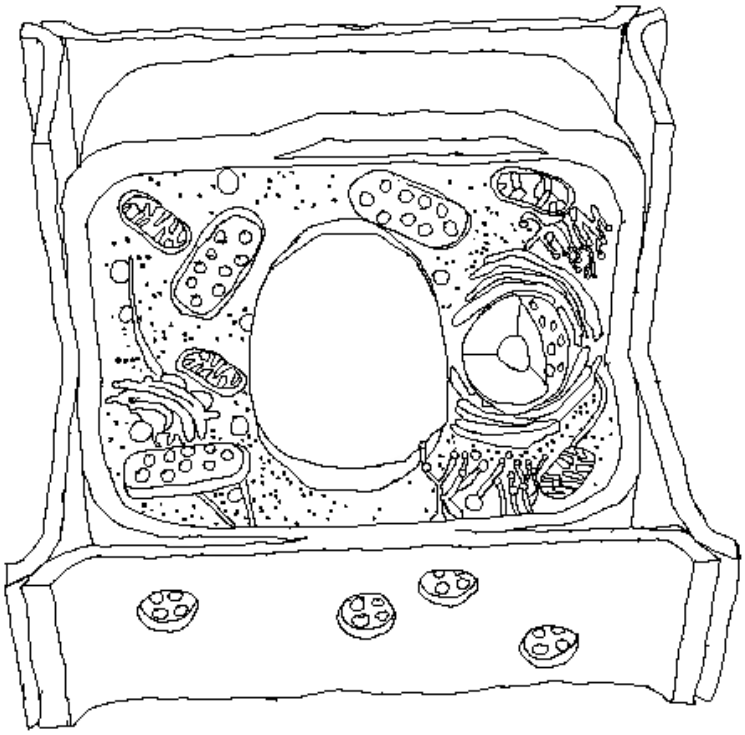
2. Fill out the following Venn diagram comparing and contrasting plant and animal cells.



3. Label the following cell with the correct animal cell parts.
http://monstara.deviantart.com/art/Animal-cell-49149164



4. Label the following cell with the correct plant cell parts.



http://www.deviantart.com/art/Plant-Cell-lineart-139554328

5. What is the cell membrane and what is its role?

6. Why is the mitochondria known as the powerhouse of the cell?

7. Why does photosynthesis not occur in animal cells?

Additional Practice:

Label the Diagram of Plant Cell at
http://www.neok12.com/diagram/Cell-Structures-01.htm

Test your knowledge of the different cell parts by completing the Plant Cell interactive.

Plant vs. Animal Cells at
http://www.neok12.com/quiz/CELSTR08

Do you know the difference between plant and animal cell? Go to the website above and play the Plant vs. Animal Cell game.

Osmosis and Diffusion

How do osmosis and diffusion occur in cells?

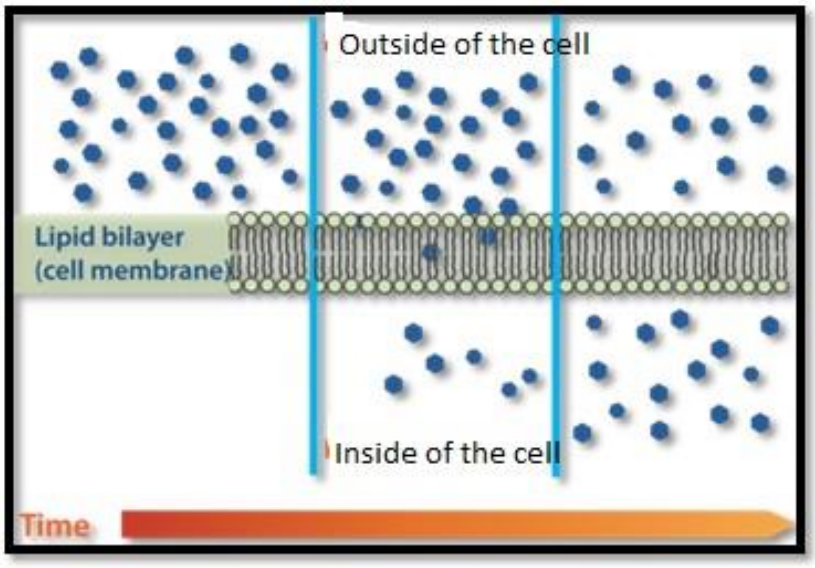
Terms to know:
Diffusion

Osmosis

What happens if you put a few drops of food coloring in water?

Over time, the molecules of color spread out through the rest of the water. When the molecules are evenly spread throughout the space, the water will become an even color. This process of molecules moving from an area where there are lots of molecules to an area where there are fewer molecules is known as diffusion.

Diffusion can occur across a **semipermeable** membrane, such as the cell membrane.. This is a natural process and does not require energy. Molecules will continue to flow in this manner until equilibrium is reached. At equilibrium, particles are moving equally in both directions across the barrier.



Osmosis (the diffusion of water across a semipermeable membrane) is similar to diffusion, except **osmosis** ONLY involves WATER. In the case

of the cell, the semipermeable membrane is the cell membrane. Let's explore three different situations and analyze the flow of water.

Water will move out of the Cell if the environment outside of the cell has a lower concentration of water than the inside of the cell does. If a cell is placed in this type of solution the cell will shrink.

Water will move into a cell if the environment outside of the cell has more water than the inside of the cell does. If a cell is placed in this type of solution, water entering the cell will cause the cell to swell and possibly burst.

Water will move both into and out of the cell in a solution in which the amount of water is equal both inside and out. Water continues to move in both directions, so an equal amount enters and leaves the cell.

Applications of Osmosis

How do marine animals keep their cells from shrinking? How do you keep your blood cells from bursting? Both of these questions have to do with the cell membrane and osmosis. Marine animals live in salt water, there is more salt in the water than in their cells. To prevent losing too much water from their bodies, these animals intake large quantities of salt water and then secrete the excess salt. Red blood cells can be kept from bursting or shriveling if put in a solution that is equal in the amount of water as the blood cells. If the blood cells were put in pure water, water would enter the blood cells, and they would swell and burst.

Saltwater Fish vs. Freshwater Fish?

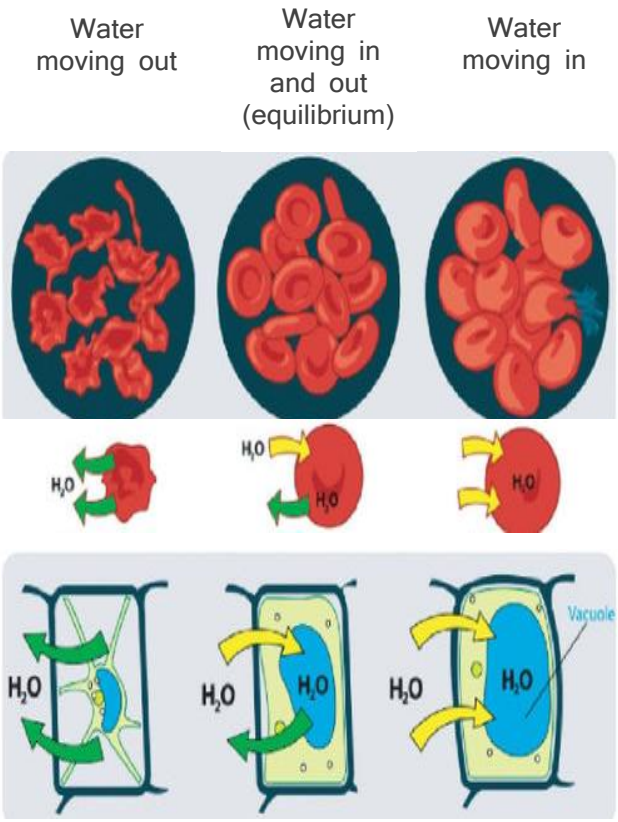
Fish cells, like all cells, have semi-permeable membranes. Eventually, the concentration of "stuff" on either side of them will even out. A fish that lives in salt water will have somewhat salty water inside itself. Put it in the freshwater, and the freshwater will, through osmosis, enter the fish, causing its cells to swell, and the fish will die.

What will happen to a freshwater fish in the ocean?

A freshwater fish would have the water pulled out of its cells in the ocean causing the cells to shrink resulting in its death.

Practice

1. Examine the image of cells. What is it that prevents the plant cell (bottom right) from bursting like the animal cell (top right)?



Answer:

The plant cell has a cell wall that prevents the cell from swelling to the bursting point. Imagine filling a water balloon inside a cardboard box. The balloon would only be able to expand until it was stopped by the sides of the box.

Summary

Diffusion is the movement of molecules from an area of high concentration to an area of low concentration.

The diffusion of water across a membrane because of a difference in concentration is called osmosis.

Demonstration: Diffusion and Osmosis

Materials Needed: 2 beakers, Carrot, water, salt, string, triple beam balance
Background Knowledge: Diffusion is the movement of particles from an area of higher concentration to an area of lower concentration. Osmosis is the diffusion of particles across a cell membrane.
Procedure:

1. Put enough water in the two beakers to cover the carrot.
2. Add 20g of table salt to one beaker and mark it as salt water.
3. Cut a carrot in half and tie a string snugly around each piece below the cut end.
4. Place the cut end of one carrot in the salt water and the other carrot with cut end down in the fresh water. Let the carrots sit for a day. The next day, take the carrots out of the water and observe the tightness of the strings.

Discussion: What happened to the carrots? Were they different? Did one of them get bigger or smaller? Why were there changes in the carrots?

Summary: The salt in the salt water created a higher concentration of pure water in the carrot so water flowed from the carrot to the beaker. The other beaker had a higher concentration of pure water than the carrot and water flowed from the beaker to the carrot causing it to swell.

Online Interactive Activities

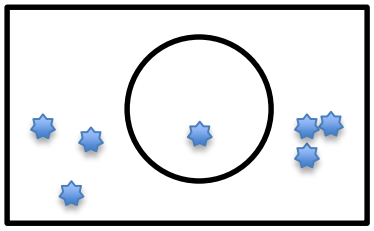
- Cells Alive: http://tinyurl.com/UT7th3-1-a
- Interactive Cell Models: http://tinyurl.com/UT7th3-1-c
- Osmosis/Diffusion Simulation: http://tinyurl.com/UT7th3-1d1
- Osmosis and Diffusion Interactive: http://www.bbc.co.uk/schools/gcsebitesize/science/add_aqa_pre_2011/cells/osmosisact.shtml

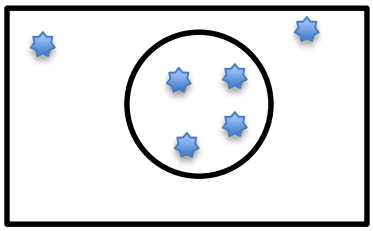
Think Like a Scientist

1. Describe the process of diffusion in cells.

2. How is the process of osmosis different from the process of diffusion?

3. An animal cell is placed in two different types of solutions. Draw arrows showing the movement of water into or out of each cell.





4.

Which Way Will It Go?

Percent Water in Solution	Percent Water in Cell	Will Water Move In or Out of the cell?
30%	50%	
75%	60%	
100%	75%	
65%	75%	

4. Use the resource below to answer the following questions.

http://www.youtube.com/watch?v=7-QJ-UUX0iY
What is osmosis? What drives this process?

Objective 2: Students will be able to identify and describe the function and interdependence of various organs and tissues.

Terms to know
Cell

Tissue

Organ

Organ System

Organism

How are living things organized?

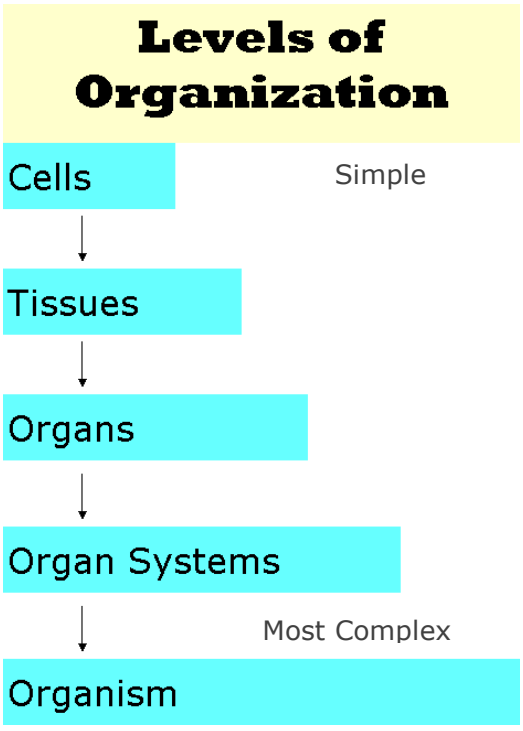
We know that cells are the basic unit of all living things. Some species, like bacteria, are made of only one cell. In other organisms, the cells come together to form tissues, tissues form organs, organs form organ systems, and organ systems combine to form an organism.

Inside the circle are neurons (brain cells). It would take a combination of cells to make up the tissues that make up the brain, which is an organ.

Levels of Organization

The living world can be organized into the following levels:

Cell: Basic unit of all living things.



Tissue: A group of similar cells working together to perform a specific function.

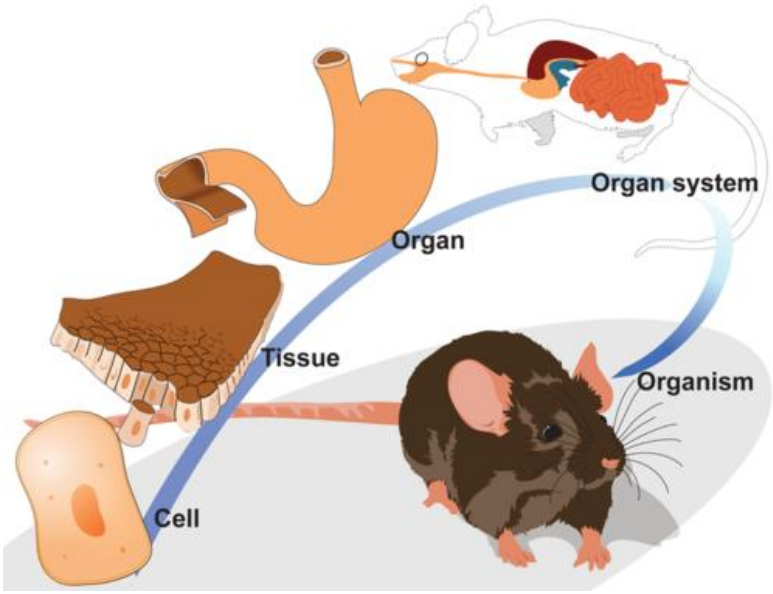
Organ: A structure composed of two or more types of tissues working together to perform a specific function.

Organ system: A group of organs that work together to do a certain job.

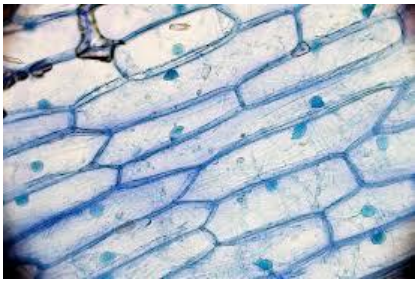
Organism: Individual living thing that may be made up of two or more organ systems.

Examples of these levels of organization are shown in the Figure below.

An individual mouse is made up of several organ systems. The system shown here is the digestive system, which breaks down food into a form that cells can use. One of the organs of the digestive system is the stomach. The stomach, in turn, consists of different types of tissues. Each type of tissue is made up of similar cells working together.



Cells

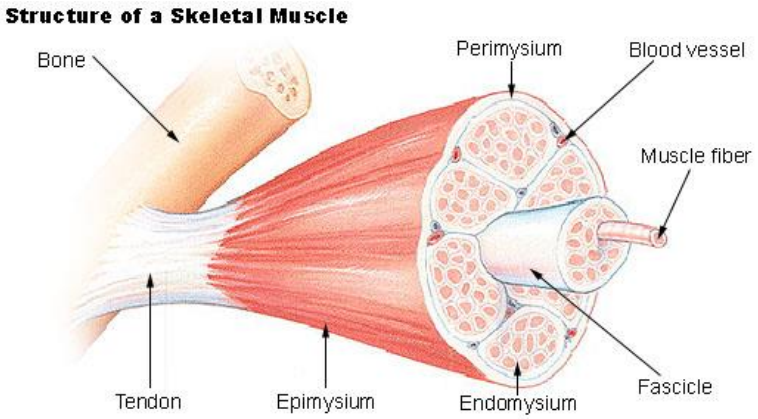


With livings things the whole is the sum of its parts. Every function that takes place in multi-cellular organisms happens on a cellular level. Even though many cells carry on similar functions, not all cells are alike. The cells in each part of your body have their own jobs and work together to perform all of the different activities that are necessary for life. As you have learned, cells are the basic unit of all living things. Similar cells bond together and form tissues, tissues group together to form systems, and these systems all function together to form a living organism.

As you have already learned, cells carry on the basic functions necessary for life. It is in the cells that reactions occur that provide the energy necessary for your body to work. Cells also use and break down nutrients and help your body to get rid of wastes. Cells work together to form tissues.

Tissues

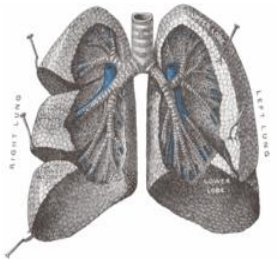
There are several different kinds of tissue in living things. Plants tissues include transport tissue, protective tissue, and ground tissue. As its name suggests, transport tissue transports water and food throughout the plant. Ground tissue is where photosynthesis takes place, and protective tissue forms a covering to protect the plant.



Animals have four types of tissue: nerve, muscle, connective, and protective. Your skin is an example of protective tissue. It shields your body from the elements and helps it to maintain healthy levels of moisture and nutrients. It also performs certain functions that help you to stay warm or cool down. Nerve tissue makes up your brain and nervous system. Nerves carry electrical impulses to the brain that include messages to help your brain what it needs to do to run your body correctly. Muscle tissue performs the necessary movements and helps you to do things. Finally, connective tissue holds your bones and muscles together. Tissues work together to form organs.

Organs

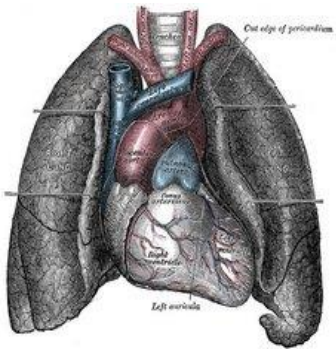
Organs are groups of tissue that carry on a specific job in a living organism. Examples of organs include your heart, lungs, stomach, and kidneys. Plant organs include leaves, roots, and stems. Each of these organs carries on a specific job that is needed for the plant to live.



Your lungs are an example of an organ.

Organ Systems

Several organs work together to form an organ system. It is the job of the heart to pump blood throughout the body, but the circulatory system is also made up of the blood vessels, arteries, and veins that the blood travels through. It is the job of the circulatory system to transport oxygen and nutrients to the cells. The nervous system is made up of the brain, nerve cells, synapses, neurons, and the spinal cord. These structures work together to transport messages and signals throughout the body.



You heart, lungs, and blood vessels make up the circulatory system.

Organism

All of the systems working effectively together form a living organism. In simple single celled organisms all of the necessary functions of life might be carried on by the different organelles in the cell. But as you have seen, multi-cellular organisms are far more complex. Having many cells allows an organism to grow larger and to live longer. Since cells are constantly replaced in multi-cellular organisms, life is able to last much longer. In a single celled organism, when the cell becomes old and stops functioning in a normal way, the organism dies.

An organism is a group of organ systems all working

Matching Structures in a Level of Organization

Object	Level of Organization
1. Nucleus	
2. Tree	
3. Leaf	
4. Heart	
5. Muscle	
6. Blood Vessels, arteries, and Heart	
7. Deer	

Now that you understand that there are several levels of organization, it is time to learn which structures fit into each category. On a sheet of paper, draw a table like the one above and write the proper level of organization (cell, tissue, organ, organ system, or organism) for each of the structures.

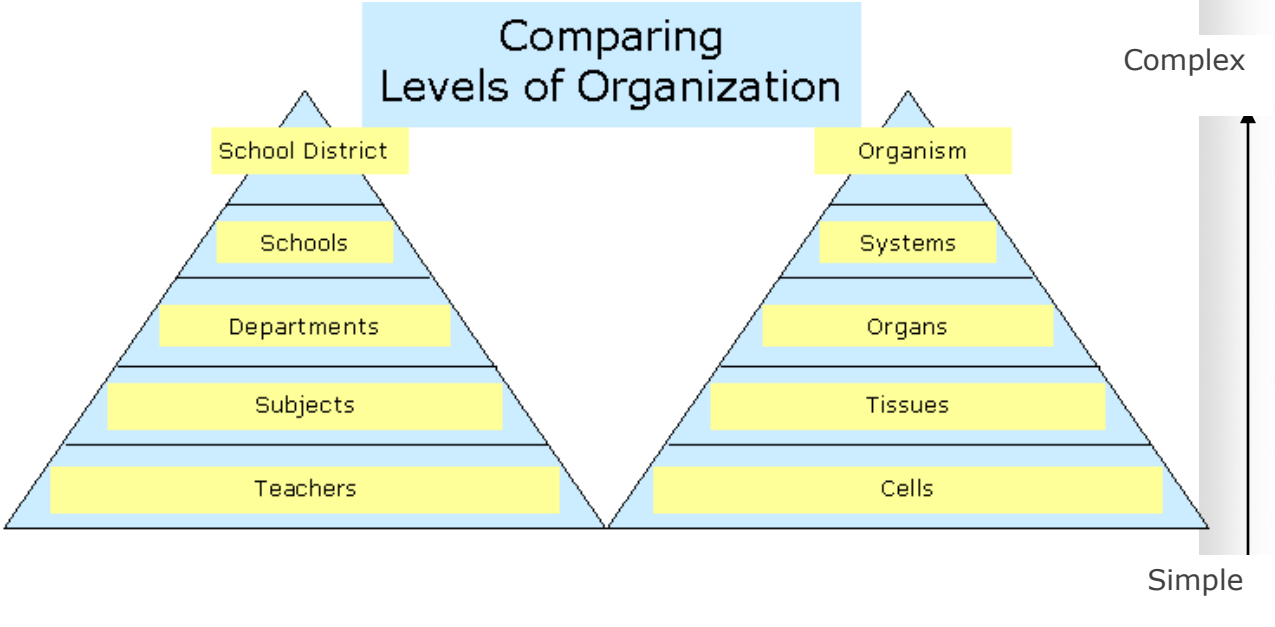
Different Levels Working Together

You have learned that all of the functions necessary to maintain life happen at the cellular level. But, how do the cells get the materials that they need? And what happens to the waste products that are produced as cells carry on their functions?

Everything that cells need to do their work is supplied by the various organs and systems of the organism. Oxygen is taken into the lungs and diffuses from there into the bloodstream. The bloodstream carries oxygen to the cells as they need it for respiration. Likewise, the blood absorbs nutrients as it passes through the digestive system. It then takes these nutrients to each cell. As the blood passes the cells, it leaves nutrients and picks up the waste products, such as carbon dioxide and water, and transports them to be expelled from the body.

The Whole is the Sum of the Parts

Can you imagine a school with only one room? Many years ago they were common, but today schools tend to be far more complex. There are usually many rooms and several different departments. Normally there are a number of teachers who teach various subjects as well as other people with various different jobs. They all work together to make up your school. Several schools may be part of a School District. Living organisms have a similar leveled organization. Just as all of the different people work together to make up a school, the various parts of a living organism work together to carry on all of the important functions of life in that organism.



Brain and nerve cells carry on the functions of memory storage and the transportation of messages throughout the body. When you prick your finger on a pin or touch a hot burner on a stove, your nerves carry the message of what has happened to your brain. Your brain then interprets the information and sends a signal back to your finger that it has been hurt. You then begin to feel pain in your finger. All of this occurs in milliseconds and all of the information is passed from cell to cell.

What about plants?

Most of the examples that have been provided use animals. What about Plants? We know that plants have cells, but what about tissues and organs? You may not think about it, but plants do have tissues and organs. For example, think of a tree. The entire tree would be the organism. Trees have systems for the movement of fluids, etc. Roots and leaves would be examples of organs; these are, of course, made up of tissues (think of the layers of an onion as you peel it apart), these tissues are made up of cells.

Examples of Organs

Your Heart

Think about some of the organs in your body. They do not all look the same because they have different functions. For example, think about the heart. The heart is a muscular organ in the chest. It consists mainly of cardiac muscle tissue and pumps blood through blood vessels by repeated, rhythmic contractions. The heart has four chambers, as shown in

It is important that the heart has the structure that it does to ensure blood keeps pumping through the body. What do you think would happen if the heart had the same structure as a bone?

Answer: It would be unable to pump because bones are rigid.

What would happen if it were made of weak muscle tissue?

Answer: It might be unable to pump the blood completely throughout the body.

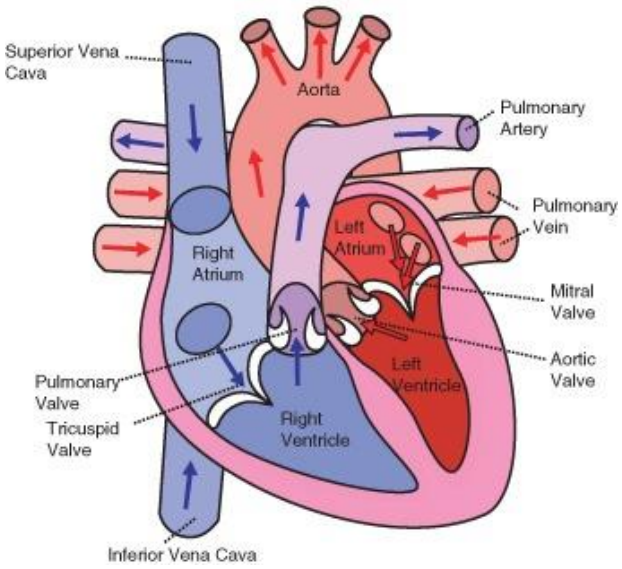
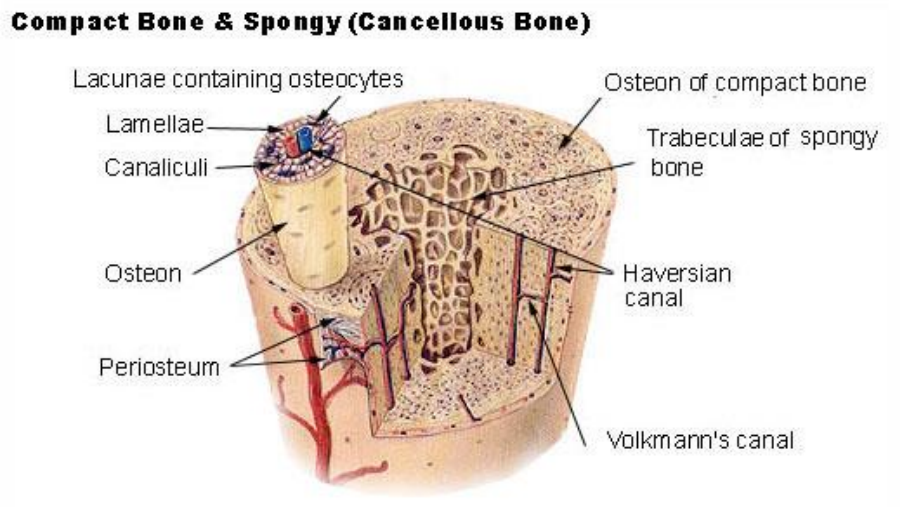


Figure: two upper atria (singular, atrium) and two lower ventricles. Valves between chambers keep blood flowing through the heart in just one direction.

Bones

Each bone ion your body is considered a separate organ. Notice that bone is made up of several different tissues that give it a stiff and rigid structure.

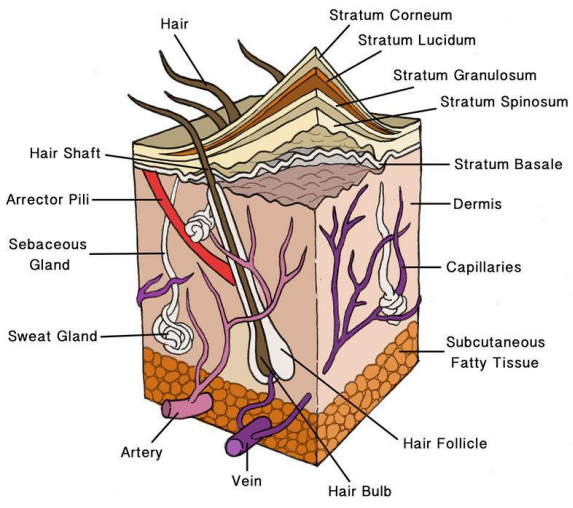
http://upload.wikimedia.org/wikipedia/commons/3/34/Illu_compact_spongy_bone.jpg



Some Examples of Organ Systems

Integumentary System

The skin is the major organ of the **integumentary system**, which also includes the nails and hair. Because these organs are external to the body, you may think of them as little more than "accessories," like clothing or jewelry, but the organs of the integumentary system serve important biological functions. They provide a protective covering for the body and help the body maintain homeostasis. For an overview of the integumentary system, you can watch the animation at this link:http://www.youtube.com/watch?v=IAAt_MfIJ-Y.



The skin has multiple roles in the body. Many of these roles are related to homeostasis. The skin's main functions are preventing water loss from the body and serving as a barrier to the entry of microorganisms. In addition, melanin in the skin blocks UV light and protects deeper layers from its damaging effects.

The skin also helps regulate body temperature. When the body is too warm, sweat is released by the sweat glands and spreads over the skin surface. As the sweat evaporates, it cools the body. Blood vessels in the skin also dilate, or widen, when the body is too warm. This allows more blood to flow through the skin, bringing body heat to the surface, where it radiates into the environment. When the body is too cool, sweat glands stop producing sweat, and blood vessels in the skin constrict, or narrow, thus conserving body heat.

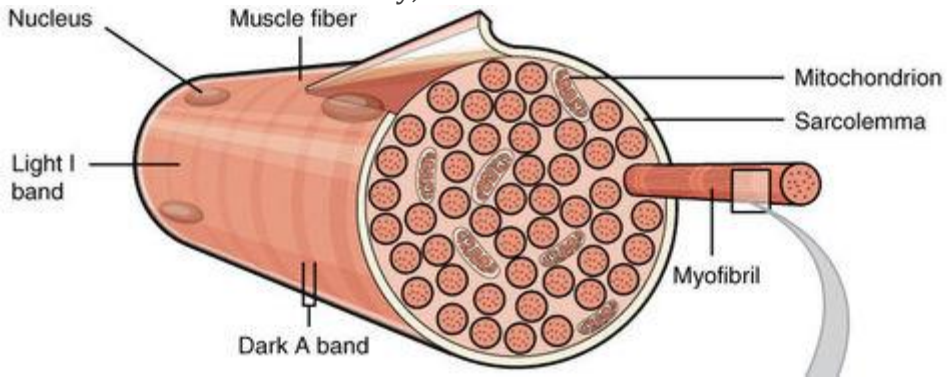
Fingernails and toenails consist of specialized epidermal cells that are filled with keratin. The keratin makes them tough and hard, which is important for the functions they serve. Fingernails prevent injury by forming protective plates over the ends of the fingers. They also enhance sensation by acting as a counterforce to the sensitive fingertips when objects are handled.

Hair helps to insulate and protect the body. Head hair is especially important in preventing heat loss from the body. Eyelashes and eyebrows protect the eyes from water, dirt, and other irritants. Hairs in the nose trap dust particles and microorganisms in the air and prevent them from reaching the lungs. Hair also provides sensory input when objects brush against it or it sways in moving air.

Muscular System

Muscles in the arms and shoulders, which move the body, are easy to see and feel. However, they aren't the only type of muscles. Many muscles are deep inside the body, mostly in the walls of organs. For example, your heart is almost completely muscle. These muscles don't directly move your body, but you couldn't survive without them.

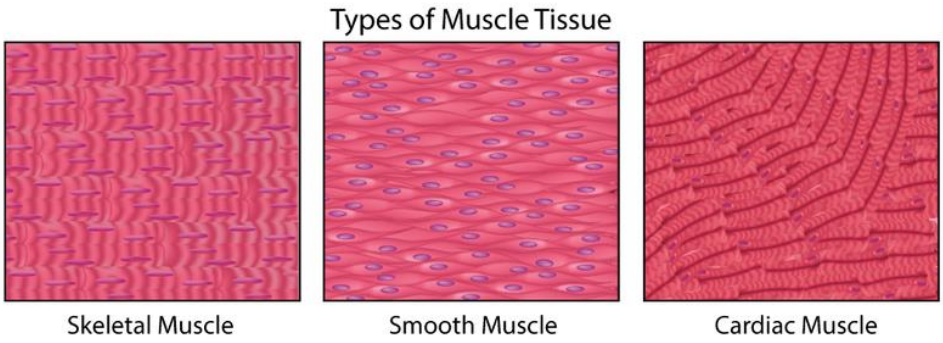
Muscles are the main organs of the muscular system. Muscles are composed primarily of cells called muscle fibers. A muscle fiber is a very long, thin cell, as you can see in **Figure** below. It contains multiple nuclei and many mitochondria, which produce ATP for energy. It also contains many organelles called myofibrils. Myofibrils allow muscles to contract, or shorten. Muscle contractions are responsible for virtually all the movements of the body, both inside and out.



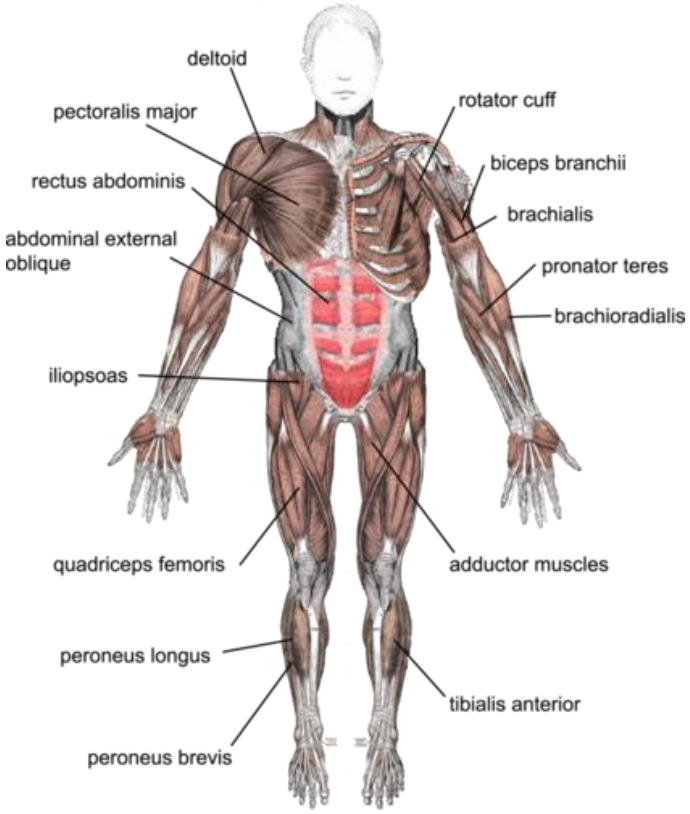
A muscle fiber is a single cell that can contract. Each muscle fiber contains many myofibrils.

Types of Muscle Tissue

There are three different types of muscle tissue in the human body: cardiac, smooth, and skeletal muscle tissues. All three types consist mainly of muscle fibers, but the fibers have different arrangements. You can see how each type of muscle tissue looks in the below.



The human body has more than 600 skeletal muscles. You can see some of them in **Figure** below. A few of the larger muscles are labeled in the figure.



Human Skeletal Muscles. Skeletal muscles enable the body to move.

Nervous System

Michelle was riding her scooter when she hit a hole in the street and started to lose control. She thought she would fall, but, in the blink of an eye, she shifted her weight and kept her balance. Her heart was pounding, but at least she didn't get hurt. How was she able to react so quickly? Michelle can thank her nervous system for that (**Figure** below).

Staying balanced when riding a scooter requires control over the body's muscles. The nervous system controls the muscles and maintains balance.

The **nervous system** , together with the endocrine system , controls all the other **organ systems**. The nervous system sends one type of signal around the body, and the endocrine system sends another type of signal around the body. The endocrine system makes and releases chemical messenger molecules, or hormones, which tell other body parts that a change or a reaction is necessary. So what type of signal does the nervous system send?

Controlling muscles and maintaining balance are just two of the roles of the nervous system. The nervous system also lets you:

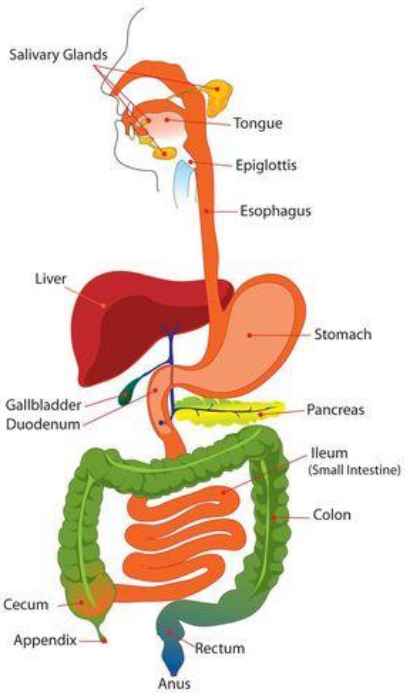
- Sense your surroundings with your eyes and other sense organs.
- Sense the environment inside of your body, including temperature.
- Control your internal body systems and keep them in balance.
- Prepare your body to fight or flee in an emergency.
- Use language, think, learn, and remember.

The nervous system works by sending and receiving electrical signals. The main organs of the nervous system are the brain and the spinal cord. The signals are carried by **nerves** in the body, similar to the wires that carry electricity all over a house. The signals travel from all over the body to the spinal cord and up to the brain, as well as moving in the other direction. For example, when Michelle started to fall off her scooter, her nervous system sensed that she was losing her balance. It responded by sending messages from her brain to muscles in her body. Some muscles tightened while others relaxed. Maybe these actions moved her hips or her arms. The nervous system, working together with the muscular and skeletal systems, allowed Michelle to react to the situation. As a result, Michelle's body became balanced again. The messages released by the nervous system traveled through nerves. Just like the electricity that travels through wires, nerve quickly carry the electrical messages around the body.

Think about how quickly all this happens. It has to be really fast, otherwise Michelle would not have been able to react. What would happen if a car pulled out unexpectedly in front of Michelle? A signal would have to go from her eyes to her brain and then to her muscles. What allows the nervous system to react so fast. It starts with the special cell of the nervous system, the neuron.

Digestive System

The **digestive system** consists of organs that break down food and absorb nutrients such as glucose. Organs of the digestive system are shown in **Figure** below . Most of the organs make up the gastrointestinal tract . The rest of the organs are called **accessory organs** .



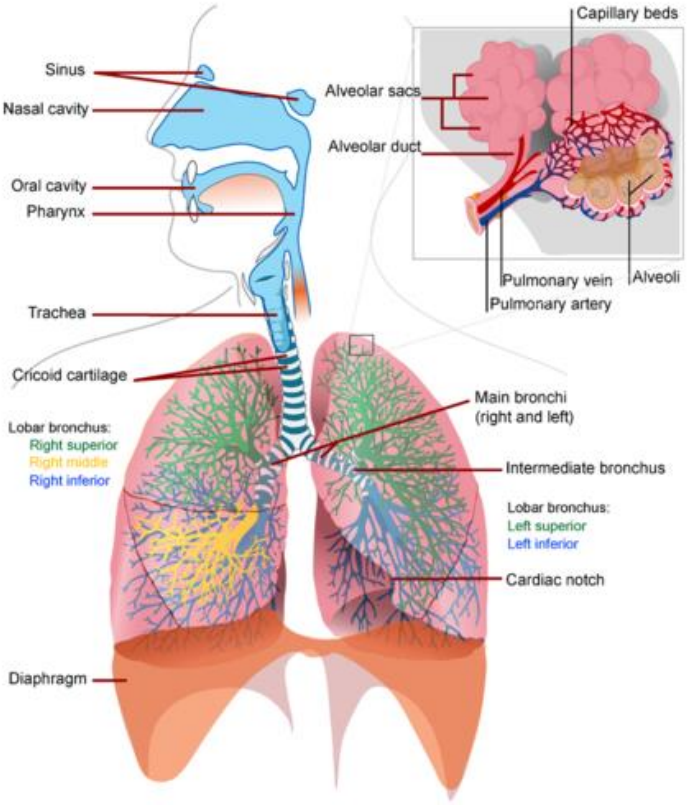
The gastrointestinal (GI) tract is a long tube that connects the mouth with the anus. It is more than 9 meters (30 feet) long in adults and includes the esophagus, stomach, and small and large intestines. Food enters the mouth, passes through the other

organs of the GI tract, and then leaves the body through the anus.

At **The Digestive Process** link below, you can watch an animation that shows what happens to food as it passes through the GI tract. http://www.youtube.com/watch?v=lm3oIX6jjn4 .

Respiratory System

The organs of the respiratory system that bring air into the body are divided among the upperrespiratory tract and lower respiratory tract. These organs are shown in **Figure** below . In addition to the **lungs** , these organs include the pharynx, larynx, trachea and bronchi. Thenasal cavity is also part of the respiratory system.



The organs of the respiratory system move air into and out of the body.

Think like a scientist

How are living things organized? Match a Particular Structure to the Appropriate Level

Letter	Structure	Level
1._____	A group of Muscle cells	a. cell
2._____	Neuron	b. tissue
3._____	Digestive System	c. organ
4._____	Mouse	d. organ system
5._____	Heart	e. organism

Choose the best answer for the following questions

6. The lowest level of organization is the organism.
a. True
b. False

7. A group of the same kind of cells is called _____.
a. an ecosystem.
b. an organism.
c. an organ.
d. a tissue.

8. The basic unit of life is called _____.
a. an organism.
b. an organ.
c. a cell.
d. a tissue.

9. Which of the following is the pattern for the organization of most organisms starting with the simplest?
a. cell, tissue, organ, organ system, organism
b. organ system, organism, organ, tissue, cell
c. tissue, organism, cell, organ system, organ
d. organism, tissue, cell, organ, organ system

10. All organs have different structures. For example, bones are rigid and strong, whereas skin is soft and flexible. Explain how these differences make them suitable for their functions.

11. Choose one organ (either plant or animal) and explain what it does. Then describe what would happen to the organism if that organ stopped functioning properly.

GLOSSARY

Cell: Basic unit of all living things.

Cell Membrane: The semipermeable layer on the outside of the cytoplasm of cells.

Cell Wall: The rigid outer layer of plant cells.

Chloroplast: The organelle which transforms sunlight into food through photosynthesis.

Diffusion: Movement of molecules from an area where there is a higher concentration (larger amount) of the substance to an area where there is a lower concentration (lower amount) of the substance.

Endoplasmic reticulum: Organelle that is the site of lipid synthesis and protein modification.

Equilibrium: State in which the concentrations of the diffusing substance are the same or become equal.

Lysosome: Organelle of the cell that breaks down and recycles old molecules.

Mitochondria: Organelle of the cell in which energy is generated.

Multicellular: Organism made up of more than one cell.

Nucleus: Cell structure that contains the genetic material, DNA.

Organ system: Group of organs that work together to do a certain job.

Organ: Structure composed of one or more types of tissues.

Organelle: Structure within the cell that has a specific role.

Organism: Individual living thing that may be made up of one or more organ systems.

Osmosis: Diffusion of water across a membrane.

Ribosome: Organelle in which proteins are made (protein synthesis).

Semipermeable: Allows some substances to pass through while stopping others.

Tissue: Group of cells of the same kind.

Unicellular: Organism made up of only one single cell.

Vacuoles: A membrane-bound space within the cell used for storage.

Standard 3 Review

Objective 1

1. Explain how Robert Hooke discovered cells.
2. What did Von Leewenhoek discover?
3. List the three parts of the "Cell Theory" and explain each of them in your own words.
4. What are the two types of microscopes and how are they different?
5. What are organelles?
6. Explain the function or job of each of the following organelles:
   a. Cell membrane
   b. Cytoplasm
   c. Nucleus
   d. Mitochondria

e. Vacuole
f. chloroplast
g. cell wall

7. How do plants obtain food?
8. Why do animals not need cell walls or chloroplasts?
9. What is meant by the term semi-permeable membrane?
10. Explain how osmosis works.
11. Explain why salt water fish do not lose water through osmosis.

Objective 2

1. Why are cells considered the basic unit of all living things?
2. Explain each of the levels of organization.
3. Explain how the needs of organ systems are met by cells.
4. Explain how organ systems work in plants.
5. Explain the functions of each of the following organ systems:
   a. Integumentary
   b. Muscular
   c. Nervous
   d. Digestive
   e. Excretory
   f. Respiratory
   g. Skeletal

genetics

chapter 4

Terms to Know

- DNA
- Genetics
- Offspring
- Chromosomes
- Sexual reproduction
- Asexual reproduction
- Reproduce
- Inherited trait
- Acquired trait
- Traits
- Recessive
- Dominant
- Homozygous
- Heterozygous

STANDARD 4

Students will understand that offspring inherit traits that make them more or less suitable to survive in the environment.

http://www.flickr.com/photos/benhelps/31920820/

OBJECTIVE 1: STUDENTS WILL BE ABLE TO DISTINGUISH BETWEEN INHERITED AND ACQUIRED TRAITS

WHAT IS GENETICS?

The above puppies are offspring from the same parents. The term offspring refers to the new individuals created from parents. Why don't the puppies look identical to each other? Do you think they are identical to their parents? Or do you think they have some traits from their mother and some from their father?

Just as you don't look exactly like your parents, neither do these puppies. Has anyone ever told you, “You have your father’s eyes”? Or, “You have red hair like your grandmother; it must have skipped a generation.” This

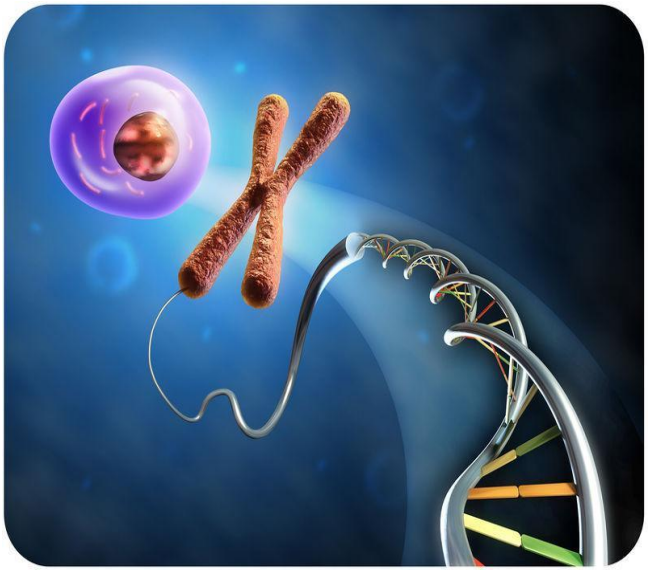
idea that traits skip a generation is false. Traits are passed from parent to offspring. Even though it may not show in one generation, the gene is still present even though it is not expressed (seen). You don't look identical to your parents or to your grandparents. But many of their traits are passed down to you and chances are you can identify a few traits that you got from each of your parents and grandparents.. Genetics is the study of inheritance. The field of genetics seeks to explain how traits are passed on from one generation to the next.

HEREDITY: PASSING ON TRAITS

Have you ever wondered why some people throw a baseball or softball with their left hand when most others use their right hand? Why do some people write with their left and others their right? The answer to these questions is heredity. **Heredity** is the passing of traits and characteristics from parents to their offspring. **Genetics** is the study of how traits are passed from parents to their offspring.

Over the past few decades, the field of genetics has grown into one of the most interesting and popular areas of Science. Research is currently underway that will make great advances in medicine, agriculture, and many other branches of Science. Why do you think people are so fascinated with genetics and heredity?

DNA, Genes, Chromosomes



In order for Scientists to understand genetics they first had to come to understand what caused the traits that were expressed in an organism. The information for all of the traits that you have is located on structures called chromosomes. Chromosomes are located in the nucleus of every cell in your body. Humans

have 23 pairs of chromosomes, which gives us a total of 46. Think of it like shoes. If you have 23 pairs of shoes you have 46 shoes.

You have probably heard the phrase, “it’s in your genes.” Genes are tiny sections of chromosomes that contain codes for the traits that we carry. A single chromosome can contain thousands of genes, making it responsible for controlling how thousands of traits appear in an individual. There are more than 90,000 genes that determine the traits of the human body.

What are We Made Of?

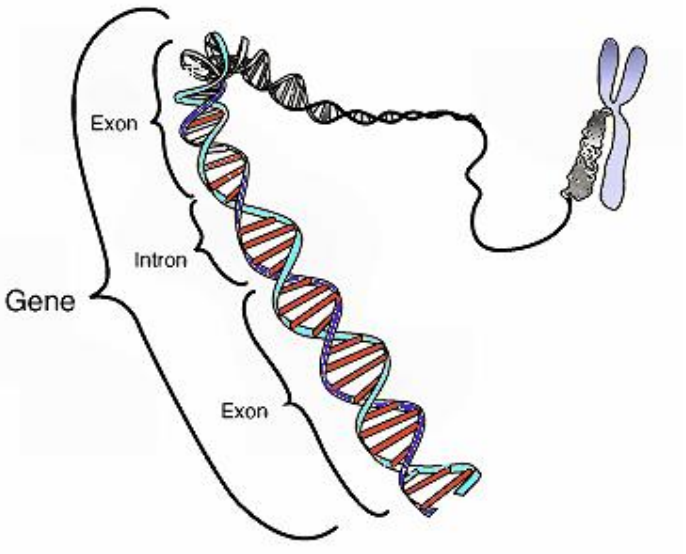
Adenine, Cytosine, Guanine, and Thymine combine in different orders to form DNA and genes.

↓

Thousands of genes combine to form Chromosomes

↓

There are 23 pairs of chromosomes in the human body.



Genes are made up of a substance called deoxyribonucleic acid, or DNA. All living things have DNA. DNA is the basic unit of all genetic material. It can be called the basic “ingredient” of life. DNA has a shape called a double helix and looks like a twisted ladder. DNA is made up of four different substances called bases: adenine, cytosine, guanine, and thymine. The DNA of all living things is made up of these same four substances. The biggest difference among species is the order in which the substances combine to form genes. All living things share a certain number of DNA sequences. Organisms that have more DNA sequences in common are more closely related genetically. Mammals share DNA sequences with all living things, but they share more with each other than they do with things like birds or

trees. Differences in DNA sequences account for the differences among the various species of living things. Humans have more than 70 trillion possible genetic combinations.

What Is DNA?

DNA is the material that makes up our chromosomes-strands of DNA found in our cells- and stores our genetic information. When you build a house, you need a blueprint, a set of instructions that tells you how to build. The DNA is like the blueprint for living organisms. The genetic information is a set of instructions that tell your cells what to do. DNA is an abbreviation for deoxyribonucleic acid.

MENDEL'S EXPERIMENTS

What does the word "inherit" mean? To inherit is to receive something from someone who came before you. You may have inherited something of value from a grandparent or another family member. A trait is a characteristic that describes an organism. You can inherit objects, but you can also inherit traits. This means your DNA determines it. If you inherit a trait from your parents, you can be inheriting their eye color, hair color, or even the shape of your nose and ears! A specific haircut or a scar also describes a trait you might have, but this is acquired or received during your lifetime and not passed on to future offspring through the DNA code.

Figure 1
Gregor Mendel

In the late 1850s, an Austrian monk named Gregor Mendel (Figure 1) performed the first genetics experiments. To study genetics, Mendel chose to work with pea plants because they have easily identifiable traits (Figure 2). For example, pea plants are either tall or short, which are easily identifiable traits. Pea plants grow quickly, so he could complete many experiments in a short period of time.

Mendel also used pea plants because they can either self-pollinate or be cross-pollinated by hand, by moving pollen from one flower to another. These crosses produce offspring. Since Mendel could move pollen between plants, he could carefully observe the offspring of crosses between pea plants with different traits.

Seed		Flower	Pod		Stem	
Form	Cotyledon	Color	Form	Color	Place	Size
						
Grey & Round	Yellow	White	Full	Green	Axial pods	Tall
						
White & Wrinkled	Green	Violet	Constricted	Yellow	Terminal pods	Short
1	2	3	4	5	6	7

Figure 2: Traits of pea plants.

Mendel studied the inheritance patterns for many different traits in peas, including round seeds versus wrinkled seeds, white flowers versus purple flowers, and tall plants versus short plants. He proposed that each pea plant inherited two genes for each trait, one from each parent plant. There were two possibilities for each hereditary trait, such as short or tall. One gene is dominant, the trait that is always visible over the other. Dominant traits are represented by a capital letter. For example, purple is a dominant trait and is represented by P. The **recessive gene,** a trait that can be hidden or masked, seems to disappear and only the effects of the dominant gene are noticeable. Recessive traits are represented by a lower case letter. For example, white is a recessive trait and is represented by p. The letter used is the first letter of the dominant

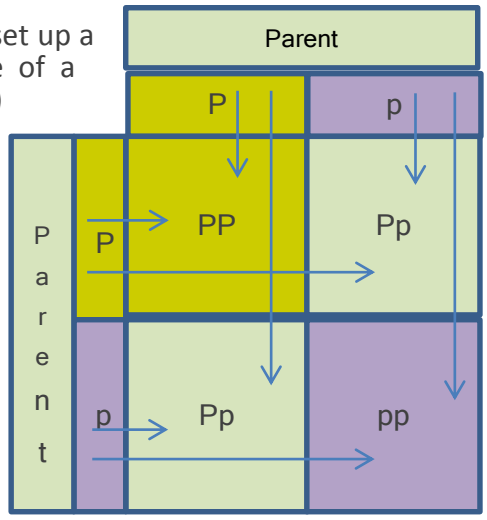
trait. The letter P is used for flower color in pea plants because purple is the dominant color for flowers.

When both genes for a trait are dominant (ex. PP) it is called homozygous dominant. The prefix *homo* means "the same." When the genes inherited from the parents are different, one dominant and one recessive (ex. Pp), it is called heterozygous. The prefix *hetero* means "different." When you have two recessive factors together (ex. pp) it is called homozygous recessive.

PUNNETT SQUARES

If this is confusing, don't worry. A Punnett Square is a special tool used to predict the offspring from a cross, or mating between two parents.

On the right is an example of how to set up a Punnett square. The Punnett Square of a cross between two purple flowers (Bb)



The possible offspring are represented by the letters in the boxes with one factor coming from each parent.

Results:

Top left box: BB, or Purple flowers
Top right box: Bb, or Purple flowers
Lower left box: Bb, or Purple flowers
Lower right box: bb, or White flowers
Only one of the plants out of the four, or 25% of the plants, has white flowers (bb). The other 75% have purple flowers (BB, Bb) because the color purple is the dominant trait in pea plants.

How To Make A Punnett Square

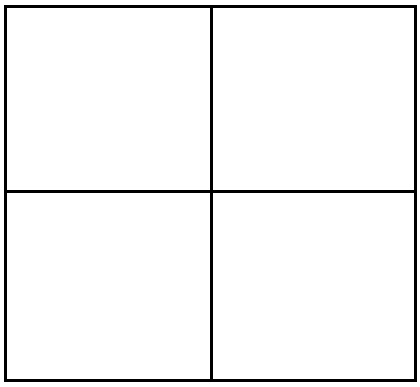
To create a Punnett Square, perform the following steps:

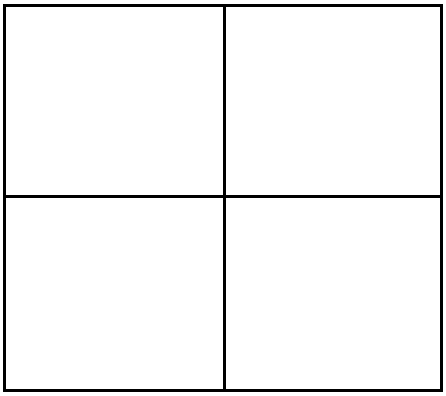
1. Take the factors from the first parent and place them at the top of the square (B and b)
2. Take the factors from the second parent and line them up on the left side of the square (B and b).
3. Pull the factors from the top into the boxes below.
4. Pull the factors from the side into the boxes to the right.

Practice Filling In A Punnett Square Below:

Trait - Seed Color
Y = Yellow
y = green

Trait - Plant Height
T = Tall
t = Short





Practice more Punnett squares here:
http://www.zerobio.com/drag_gr11/mono.htm
http://www2.edc.org/weblabs/WebLabDirectory1.html

ACQUIRED AND INHERITED TRAITS

There is an argument about what causes people to be like they are that is older than the study of genetics. The argument is over the influence of a person's genetics versus the influence of the environment that the person grows up in. Which one is the strongest in determining what a person will be like? Traits that are received through heredity are called inherited traits and those that are that are developed during a person's lifetime are called acquired traits.

Why is Lebron James such a great basketball player? What makes the same people win the same events year after year? As you might suppose, genetics plays a major role in the things that a person is able to do. A world class sprinter would normally have an inherited muscle structure that provides the ability to run fast. A marathon champion would probably have a genetic make-up that helped provide the ability to run at a quick pace for a long time. Traits that are passed on through heredity are called **inherited traits**. Many professional athletes inherited genetics that made it possible for them to be as good as they are at their sport, but they only inherited natural ability and must still develop those skills in order to be good.

Heredity can only give a person an edge, it does not mean that they will be great or that someone without those fantastic genes cannot succeed. Naturally, the ability to be a super athlete is not the only inherited trait. There are millions of traits in humans that are passed on from parents to their offspring. Your looks, your size, and many of your attitudes and the ways that you do things were inherited from your parents.

Many traits that we have are developed or chosen. **Acquired** traits are traits that are developed through environmental conditions, practice, choices, or possibly accident. The language you speak, your culture, and your interests are acquired traits. If you had been born in France to French parents, you would have learned to speak French instead of English. If you had been born in Japan, you would have developed Japanese language and cultural traits. The fact that traits can be acquired means that many people are able to do many things that do not come easily to them. They simply need to work harder to develop those traits.

Do you think that playing the piano is an inherited trait or an acquired one?

http://www.flickr.com/photos/seriousbri/4148739768/

You Try It

Write if the trait listed below is inherited or acquired.

Trait	Acquired or Inherited?
Hair color	
Doing well in Math	
Throwing a ball with your right hand	
Your height	
You like to dance	
You prefer snowboarding	
You wear a size 8 shoe	
You tan easily	
You speak 2 languages	

The environment that an organism lives in can have a big impact on how inherited traits are developed or expressed. Even though people in countries that have food shortages have the genetics to be taller, those genes rarely are expressed to their full potential because of a lack of good nutrition. Many other inherited traits have similar environmental challenges as well. If you have blonde hair and all of the genes you carry are for blonde hair, what will your children be like if you dye your hair brown? Will they have blonde hair or brown hair? What if a person is in a car accident and as a result of the accident they lose an arm? Will that person's children be born without an arm? Dying hair and losing a limb in an accident are examples of acquired traits. Acquired traits are not passed on genetically. The only traits that these people will pass on to their children will be the ones that they inherited from their parents. So, since Lebron James and Payton Manning are such great athletes does that mean that their children will be just as great? The answer to this is, maybe. Both of these men have genetics that made it possible for them to accomplish the things that they did and they will pass some of those genetics on to any children that they have. But, it was only after many hours of hard work that they were able to take advantage of their skills and do those great things. To sum it all up: some traits are inherited (nature) and some traits are acquired (environment). In most cases it is a combination of both that determine what a person is and what they are good at.

DO ALL LIVING THINGS HAVE 2 PARENTS?

http://www.fotopedia.com/items/flickr-3957496474

No, some plants and animals can be produced from just one parent. Reproduction from only one parent usually happens only in very simple organisms or in plants. But, under certain situations some more complex animals can reproduce from only one parent. A reptile such as the Komodo dragon on the left, is one example. Amphibians such as frogs can reproduce by themselves when there are problems in their environment that are threatening their population.

http://en.avaaz.org/874/whats-80000-years-old-turns-yellow-and-quakes

What's 80,000 years old, turns yellow and quakes?

This isn't just any grove of trees: it's Pando, one of the heaviest and oldest organisms on our planet:

Pando, Latin for "I spread", has been alive for 80,000 years and weighs 6m kilograms.
How does an entire colony of trees count as a single organism? Well, quaking aspen are unique in that they're clonal. Trees shoot up from one common root system. This means that thousands of individual trees that live and die can share a single root system that lives underground. And Pando has an incredibly old root system.

To give a bit of perspective: by the time recorded human history began, Pando's ancient roots had already been in the earth for the better part of 75,000 years.

Asexual reproduction is the process of creating offspring from just one individual. Quaking aspen trees can grow from the roots of adult plants. Sexual reproduction is when two parents, such as cows, cats, and dogs create a new organism.

REPRODUCTION

Animals and other organisms cannot live forever. They must reproduce if their species is to survive. But what does it mean to reproduce? **Reproduction** is the ability to pass genetics on and make the next

generation, and it is one of the basic characteristics of life. Two methods of reproduction are:

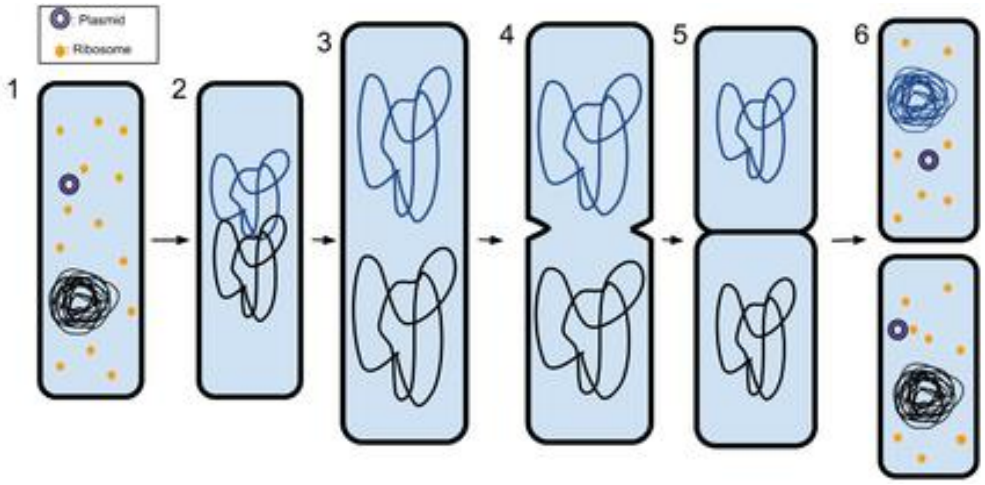
Asexual reproduction: the process of forming a new individual from a single parent. The offspring have no genetic variation and are 100% identical to the parent.

Sexual reproduction: the process of forming a new individual from two parents. The offspring have new combinations of their parents' genes. They receive 50% of their genetics form each parent. Because of the thousands of different genes, the number of combinations is limitless.

There are advantages and disadvantages to each method. But the result is always the same: a new life begins.

Asexual Reproduction

Having one parent is most common in plants. These organisms can reproduce asexually, meaning the offspring have a single parent and share the same genetic material as the parent. Bacteria, being a, single-celled organism, reproduces asexually.
The advantage of asexual reproduction is that it can be very quick and does not require the two parents. The disadvantage of asexual reproduction is that organisms do not receive a mix of traits from two parents. An offspring resulting from asexual reproduction has genetic information from one parent. In fact, the offspring is genetically an exact copy of the parent's genetic information. This can cause problems for the individual. For example, if the parent has a gene that causes a particular disease, the offspring will also have the gene that causes that disease. Likewise, the new individual will have all of the good traits that the parent had.



This diagram shows reproduction in bacteria, called binary fission. Bi means "2" and fission means to split. So basically, binary fission simply means to split in two.

Sexual Reproduction

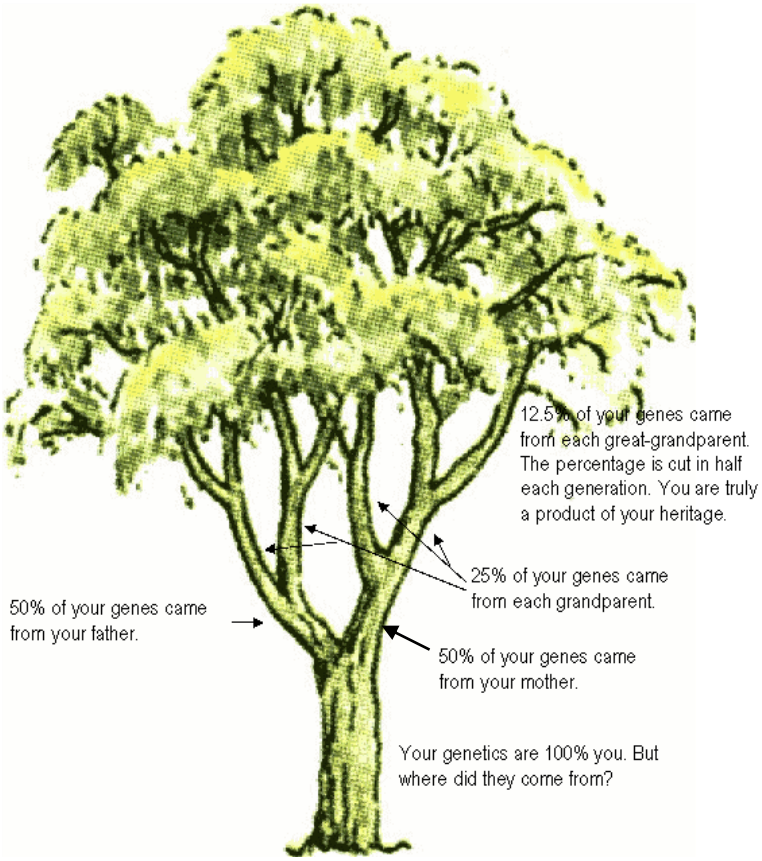
During sexual reproduction, two parents are involved. Sexual reproduction combines the genetic information from both parents. It is a slower, more complex process that creates more genetic diversity. Organisms produced sexually may or may not inherit a disease gene because they receive a mix of their parents' genes.

Family Portrait: Mother, Daughter, Father, and Son. Children resemble their parents, but they are never identical to them. Do you know why this is the case?

Your Personal Genetic History

Has anyone ever told you that you have your mother's eyes or your grandfather's hair color? They probably have said something similar. Why? All of your genes have been passed down from one generation to the next. The diagram on the left explains this. Half of your genes came from each parent. Each of your parents received their genes from their parents. This process goes back from generation to generation. The same genes that all came together to make you, have appeared in the past in your ancestors throughout your family tree.

You and Your Family Tree



The following chart lists some organisms that reproduce asexually and sexually:

Asexual Reproduction	Sexual Reproduction
Hydra	Rats
planaria	Mosquitoes
bacteria	Salmon
Fungi	Sunflowers
cuttings from house plants	Humans

Which Traits Are Inherited By Offspring?

Offspring receive inherited traits from their parents. In asexual reproduction, the new organism is an exact copy of the parent, so all the traits are the same. In sexual reproduction, the new organism receives a combination of traits from both parents. This is why kittens from the same litter can look different.

http://www.flickr.com/photos/ncfc/2096277438/

INHERITED TRAITS IN HUMANS

Characteristics that are encoded in DNA are called genetic traits. Different types of human traits are inherited in different ways. Some human traits have simple inheritance patterns like the traits that Gregor Mendel studied in pea plants. Other human traits have more complex inheritance patterns.

TRACING GENETIC TRAITS

There are many different types of genetic disorders. Some of these disorders such as having extra fingers or toes are not very serious and individuals who carry the disorder can live a normal life. But others such as Down's Syndrome or Sickle Cell Anemia can cause serious problems or can even be life threatening. A **pedigree chart** is a graph that shows the pattern of a genetic trait in a family. Genetic counselors can use pedigrees to trace the presence of genetic problems in families so that they can counsel prospective parents on the possibility of those traits being present in their children. Each row in a pedigree represents a new generation.

You can watch a video explaining how pedigrees are used and what they reveal at this link:
http://www.youtube.com/watch?v=HbIHjsn5cHo.

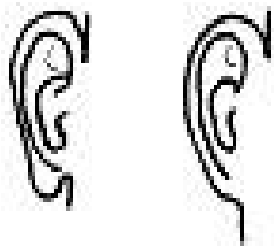
In the pictures below the Widow's peak and hitchhiker's thumb are dominant traits controlled by a single gene.

What number can you see? (go to the online text to see the colors)

Red-green colorblindness is a common inherited trait in humans. About 1 in 10 men have some form of color blindness, however, very few women are color blind. Why?

This is a common test to determine color blindness. The number five in the middle is green and blue and the surround area is multiple colors of red, orange and yellow.

Some Examples of Structural Human Traits



Attached earlobes or free-hanging earlobes

Human earlobes may be free or attached. You inherited the particular shape of your earlobes from your parents. Inherited traits are influenced by genes, which are passed on to offspring and future generations. Your summer tan is not passed on to your offspring. Natural selection only operates on

traits like earlobe shape that have a genetic basis, not on traits like a summer tan that are acquired.

Online Interactive Activities

- Lab with fly physical traits guided to see multiple generations
- http://tinyurl.com/UT7th4-1-d

Terms to know

- Adaptability
- Environment

OBJECTIVE 2: STUDENT WILL BE ABLE TO RELATE ADAPTABILITY OF AN ORGANISM IN AN ENVIRONMENT TO THEIR INHERITED TRAITS AND STRUCTURES.

How are inheritance and adaptability related?
Does this frog look a little scary? It looks that way on purpose. This frog is a poisonous dart frog. They live in Central and South America. Why do you think the frog is so brightly colored? Why do you think the frog is poisonous? Why does the frog only live in warmer climates? There are also many different types of poisonous dart frogs. Some are red, some blue, and some yellow. So why is there such a great diversity of poisonous dart frogs?

Scientists who study heredity are concerned with these types of questions, but they ask them about all of the species on the planet. Why are there millions of different types of species? Why are some small, some large, some furry, and some covered in feathers? The environment- the habitat that an organism lives in-can influence the traits that are expressed by an organism.

NATURAL SELECTION

Do you ever wonder why some birds are big like ostriches and some birds are small like robins? Or why a lion has a mane while a leopard has spots? In the 19th century, an English natural scientist named Charles Darwin (on the right) was also fascinated by the diversity of living things on earth.

He set out to answer the following questions:

- Why are organisms different?
- Why are organisms similar?
- Why are there so many different types of organisms?

While searching to answer his questions, he discovered the principles of **natural selection**. This principle is one of the most important ideas in life science. In everyday English, natural selection means "survival of the fittest". Simply stated, an individual in a species that has genetics that are best suited to survive changes in the environment are the ones that live and reproduce. This increases the presence of those genes in the species until it eventually becomes a characteristic of that species.

Imagine a terrible drought that lasts for years. Many animals and plants would die from a lack of water. Some would live and pass on their genetics to future generations. New individuals that acquired these genes would be more resistant to drought.

Voyage of the HMS Beagle

In 1859, Charles Darwin published his book, On the Origin of Species by Means of Natural Selection. His book describes the observations and evidence that he collected over 20 years of research, beginning with a five-year voyage around the world on a British research ship, the HMS Beagle.

Charles Darwin’s famous five year voyage was aboard the HMS Beagle from 1831-1836. During the voyage Darwin made observations about plants and animals around the world.

HOW DO TRAITS INFLUENCE SURVIVAL?

The Galápagos Islands

The Galápagos are a group of 16 volcanic islands near the equator, about 600 miles from the west coast of South America. The islands are famous for their many species found nowhere else.
Darwin spent months on foot exploring the islands. The specimens he collected from the Galápagos greatly influenced his ideas of how a species can change over time

On the Galapagos, Darwin observed that the same kind of animal differed from one island to another. For example, the iguanas (large lizards) differed between islands (Figure below). The members of one iguana species spent most of their time in the ocean, swimming and diving underwater for seaweed, while those of another iguana species lived on land and ate cactus. Darwin wondered why there were two species of iguana on the same set of islands that were so different from one another. What do you think?

Land Iguana

Marine Iguana

The Galápagos iguanas are among the signature animals of the Galápagos Islands. Here both a land iguana and a marine iguana are shown.

Giant Tortoises

Charles Darwin observed giant tortoises on the Galápagos Islands (Figure below). These tortoises were so large that two people could ride on them. Darwin noticed that different tortoise species lived on islands with different environments. He realized that the tortoises had traits that allowed them to live in their particular environments. For example, tortoises that ate plants near the ground had rounded shells and shorter necks. Tortoises on islands with tall shrubs had longer necks and shells that bent upwards, allowing them to stretch their necks (Figure below). Darwin began to hypothesize that the traits of an organism helped it to survive in different environments.

The name “Galápagos” means “giant tortoise.” When Darwin arrived on the Galápagos Islands, he was amazed by the size and variety of shapes of

these animals. The giant tortoise is a unique animal found only in the Galápagos Islands. There are only about 200 tortoises remaining on these islands. This tortoise above is able to reach leaves high in shrubs with its long neck and curved shell.

Darwin's Finches

The most studied animals on the Galápagos are finches, a type of bird (Figure below). When Darwin first observed finches on the islands, he did not even realize they were all finches. But when he studied them further, he realized they were related to each other. Each island had its own distinct species of finch. The birds on different islands had many similarities, but their beaks differed in size and shape.

Finches from Galapagos Archipelago

The birds came from the same finch ancestor. They evolved as they adapted to different food resources on different islands. The first bird uses its large beak to crack open and eat large seeds. Bird #3 is able to pull small seeds out of small spaces.

In his diary, Darwin pointed out how each animal is well-suited for its particular environment. The shapes of the finch beaks on each island were well-matched with the seeds available on that island, but not the seeds on other islands. For example, a larger and stronger beak was needed to break open large seeds on one island and a small beak was needed to eat the small seeds on a different island.

Terms to know

- Camouflage

HOW DOES THE ENVIRONMENT INFLUENCE TRAITS?

Camouflage

Both predators and prey have adaptations that evolved through natural selection. Predator adaptations help them capture prey. Prey adaptations help them avoid predators. A common adaptation in both predator and

prey is camouflage, the ability of an organism to blend in with its environment because of its inherited traits. Several examples are shown in Figure below. Camouflage in prey helps them hide from predators. Camouflage in predators helps them sneak up on prey.

Camouflage in Predator and Prey Species. Can you see the crab in the photo on the left? It is camouflaged with algae. The praying mantis in the middle photo looks just like the dead leaves in the background. Can you tell where one zebra ends and another one begins? This may confuse a predator and give the zebras a chance to run away.

SCIENCE IN ACTION

Antifreeze Fish

Studying Antarctic toothfish and the special proteins in their bodies that help them thrive in subfreezing waters

Cassandra Brooks is a marine scientist and science writer based in California. She's studied Antarctic marine resources since 2004 at Moss Landing Marine Laboratories (MLML) and with the Antarctic Marine Living Resources (AMLR) Program.

Cassandra Brooks first began studying Antarctic toothfish in 2004 as part of her master's thesis at Moss Landing Marine Laboratories. Antarctic

toothfish are large, deep-sea predatory fish found only in the ice-laden waters surrounding Antarctica. Biologists who were fascinated with their ability to live in these freezing waters were the first to study these fish. It turns out that Antarctic toothfish have special proteins in their bodies that act like anti-freeze to keep their blood from freezing, thus enabling the fish to live in the icy waters off Antarctica.

Commercial fishermen took notice of the Antarctic toothfish only in the last ten years when populations of its sister species, the Patagonian toothfish, became depleted. Patagonian toothfish are found in the northern waters of the Southern Ocean, off the tip of South America and around sub-Antarctic islands. Both species of toothfish are more commonly known by their market name “Chilean Sea Bass,” though they bear no relation to sea bass. The depletions of Patagonian toothfish were likely caused by the large illegal pirate fishery, which has been estimated at up to 70 percent of the total harvest of this species.

As the subantarctic waters where the Patagonian toothfish lives were overharvested, vessels moved further south, into the remote and pristine waters of the Ross Sea, Antarctica, in search of the Antarctic toothfish. The commercial catch of Antarctic toothfish has increased steadily over the last ten years, even though very little is known about the basic biology of this fish. Cassandra’s work focuses on life history and population structure of this species. Her goal is to provide information on their age, growth, and spatial distribution to the toothfish’s managing body (CCAMLR) in order to facilitate sustainable management of this large Antarctic species.

http://icestories.exploratorium.edu/dispatches/antarctic-projects/antifreeze-fish/

Antarctic toothfish have evolved remarkable traits that allow them to survive in sub-freezing waters. One of these traits is a slow heartbeat—a beat only once every six seconds. The main secret of these unique fish, though—who have a natural lifespan of 40 years and can weigh in at over 200 pounds when full-grown—lies in a special protein that acts like antifreeze. By making this unique antifreeze glycoprotein, the Antarctic toothfish are able to keep their blood from freezing. It's a remarkable evolutionary solution to surviving in the frigid waters of the Antarctic.

One of the most amazing things about these Antarctic antifreeze fish is their corollary in the Arctic, where waters reach similar subfreezing temperatures. There, fish carry a similar but different antifreeze protein—evolutionarily distinct from that of the Antarctic toothfish. What this means is that fish at both ends of the planet evolved similar antifreeze survival strategies through completely different methods.

HOW HAVE HUMANS IMPACTED EVOLUTIONARY TRENDS?

Natural Selection and Adaptation

The theory of evolution by natural selection means that the inherited traits of a population change over time through a process called natural selection. Inherited traits are features that are passed from one generation to the next. For example, your eye color is an inherited trait (you inherited it from your parents). Inherited traits are different from acquired traits, or traits that organisms develop over a lifetime, such as strong muscles from working out.

Terms to know

- Natural Influences
- Manmade Influences
- Hybridization
- (Not defined)
- Mimicry

Natural Selection and Influences

Natural Influences explain how organisms in a population develop traits that allow them to survive and reproduce. These traits will most likely be passed on to their offspring. Take the giant tortoises on the Galápagos as an example. If a short-necked tortoise lives on an island with fruit located at a high level, will the short-necked tortoise survive? No, it will not, because it will not be able to reach the food it needs to survive. If all of the short-necked tortoises die, and the long-necked tortoises survive, then over time only the long-necked trait will be passed down to offspring. All of the tortoises with long necks will be "naturally selected" to survive.

Every plant and animal depends on its traits to survive. Survival may include getting food, building homes, and attracting mates. Traits that allow a plant, animal, or bacteria to survive and reproduce in its environments are called adaptations.

Natural selection occurs when:

1. There is some variation in the inherited traits of organisms within a species.
2. Some of these traits will give individuals an advantage over others in surviving and reproducing.
3. These individuals will be likely to have more offspring.

Imagine how in winter, dark fur makes a rabbit easy for foxes to spot and catch in the snow. Natural selection suggests that white fur is a beneficial trait that improves the chance that a rabbit will survive, reproduce and pass the trait of white fur on to its offspring (Figure left). Over time, dark fur rabbits will become uncommon. Rabbits will adapt to have white fur.

In winter, the fur of Arctic hares turns white. The camouflage may make it more difficult for fox and other predators to locate hares against the white snow.

OTHER FACTORS THAT ARE NATURAL INFLUENCES

Reproductive Isolation

There are two main ways that speciation happens naturally. Both processes create new species by isolating populations of the same species from each other. Organisms can be geographically isolated or isolated by a behavior. Over a long period of time, usually thousands of years, each of the isolated populations evolves in a different direction.

Geographic Isolation

Allopatric speciation happens when groups from the same species are geographically isolated for long periods. Imagine all the ways that plants or animals could be isolated from each other:

- A mountain range
- A canyon
- Rivers, streams, or an ocean
- A desert

Example:
When the Grand Canyon in Arizona formed, two populations of one squirrel species were separated by the giant canyon, shown in the figures below. After thousands of years of isolation from each other, the squirrel populations on the northern wall of the canyon looked and behaved differently from those on the southern wall. North rim squirrels have white tails and black bellies. Squirrels on the south rim have white bellies and dark tails. They cannot mate with each other, so they are different species.

Figure 8. Abert squirrel on the southern rim of the Grand Canyon.

Figure 7. Kaibab squirrel found on northern rim of the Grand Canyon.

https://share.ehs.uen.org/node/20578

Sympatric speciation

Sympatric speciation happens when groups from the same species stop mating because of something other than physical separation, such as behavior. The separation may be caused

by different mating seasons, for example.

Some scientists suspect that two groups of orcas (killer whales) live in the same part of the Pacific Ocean part of the year, but do not mate. The two groups hunt different prey species, eat different foods, sing different songs, and have different social interactions.

WHY SO MANY SPECIES?

There are millions of species of living things on the planet. But why are there so many? As environments change over time, organisms must constantly adapt to those environments. Diversity of species increases the chance that at least some organisms adapt and survive any major changes in the environment. For example, if a natural disaster kills all of the large organisms on the planet, then the small organisms will continue to survive.

SELECTIVE BREEDING

With an understanding that some traits are more desirable than others, researchers have been studying ways to increase the presence of desirable traits in the populations of different organisms as well as decrease the presence of bad traits. One method that has been developed is selective breeding. In **selective breeding**, two organisms with desirable traits are crossed to produce offspring with those same traits. By continually crossing for the same good traits, scientists are able to improve the genetic make-up of a species. Purebred animals are the result of selective breeding.

Dairy cows like this Holstein are carefully bred for traits that will give them better strength and produce more milk.

One of the areas where selective breeding gives the most benefit is in farming and ranching. By selecting the best stock for reproduction, the farmer can improve the quality of his plants or animals. Suppose a corn farmer harvested his crop and half of the corn had huge, beautiful kernels while the other half had tiny scrawny kernels. Which corn should he save for seed next year? The

answer would be the corn with the bigger kernels. By using this corn, the farmer would increase the presence of the “big kernel genes” and improve his crop.

02/2009 HA Standard Transmitting Abilities

Select Linear	24677 Dtrs. 8733 Herds	-2 -1 0 1 2	
6	STATURE		0.79T
8	DAIRY FORM		2.08O
6	STRENGTH		0.92S
7	BODY DEPTH		1.26D
7	RUMP WIDTH		2.1W
6	RUMP ANGLE		-0.2H
7	LEGS SIDE VIEW		1.04S
7	LEGS REAR VIEW		0.81S
5	FOOT ANGLE		-0.56L
6	FEET & LEGS SCORE		0.28H
7	FORE ATTACH-MENT		1.5S
8	REAR UDDER HEIGHT		2.13H
7	REAR UDDER WIDTH		1.06W
7	UDDER CLEFT		0.84S
6	UDDER DEPTH		0.81S
5	FRONT TEAT PLACE		-0.07W
5	FRONT TEAT LENGTH		-0.58S

A trait chart similar to this on is used to show the stronger and weaker traits that an animal has. This helps farmers decide which animal to breed in order to produce the best stock.

For many years dairy farmers have practiced selective breeding to increase milk production in their cows. This practice has been limited in the past since the farmer can only use the cows that he has. He cannot change their genetics so the only control that dairy farmers have had is over which bulls

to use for reproduction. Only bulls from the best milk producing cows are used.

In recent years, advances have been made in choosing only the best cows to reproduce. If a farmer has a high producing cow and one that does not produce much milk, the good producer can be given a drug that causes her to release several eggs from her ovaries. The eggs can then be harvested, fertilized, and implanted in a low producing cow. This way, even the lower milk producers can give birth to genetically superior calves.

Selective breeding is also used to increase the desirable characteristics of other animals. Purebred dogs are a good example. Breeders identify the desirable traits of a species and cross breed in order to increase the presence of those desirable traits within the species. Dogs can be selectively bred as watch dogs, hunting dogs, good swimmers, intelligence, and many other traits. Horses can be bred to increase desirable traits such as strength and speed. Even fruits and vegetables are bred selectively to increase size, flavor, and production.

GENETIC ENGINEERING AND CLONING

By developing ways to control genetics, Scientists are able to create living organisms with traits that are more desirable. Each year farmers spend millions of dollars on insecticides that only have a limited effect on pests and can cause harm to the streams and soil. But, what if we could create a crop that had its own built in insecticide? **Genetic Engineering** is a research field that tries to find ways to change the genetics of living organisms so that the organisms have more desirable traits.

Disease and insects have always been one of the biggest problems facing crop farmers. While studying genetics, Scientists realized that some plants seemed to be less affected by insects. Geneticists have been able to identify the genes that made a few organisms less susceptible to disease and pests. Using selective breeding for these traits, plants that are immune to disease and insects have been developed. This technology has led to less crop damage, increased farm production, and less environmental impact. This allows farmers to produce more food on less land. Crops have also been engineered that produce better tasting food with a longer shelf life.

Farming is not the only field that benefits from genetic engineering. Advances in medical research have improved life for people with certain diseases. Diabetes is a disease that limits the body's ability to create or use an important substance called insulin. Insulin is important because it helps to remove sugar from the bloodstream and put it in cells where it can be used by the mitochondria to produce energy. Until a few years ago insulin was extracted from non-human sources. It worked, but was not a perfect solution to the problem. In recent years scientists have found ways to engineer (create) human insulin using bacteria. The human gene that produces insulin is inserted into bacteria. The bacteria then produce human insulin as they reproduce. Then insulin is then harvested from the bacteria and used in patients so that diabetics can have a more normal life.

Dolly, a sheep, was the first mammal to be cloned.

Several years ago, researchers shocked the world when they announced that a sheep had been cloned. A clone is an exact genetic duplicate of a living organism. Even though the cloned sheep had problems and did not live a full life, the experiment proved that the cloning of living things was possible. What are the potential uses for clones? Is cloning the right thing to do?

You have learned about selective breeding. Farmers and ranchers use selective breeding to improve the genetic quality of their animals and crops. But, they are still at the mercy of genetic chance. Just because a cow is a great milk producer does not mean that all of her calves will be as productive as she is. Through continued selective breeding the overall genetics of the farm will improve, but that may take many years and cost a lot of money. What if a dairy farmer had a way to make a copy of all of his good cows? Cloning has the potential to improve food production while reducing costs and stress on the environment. Simply stated, if a farmer can produce a certain amount of milk with 150 cows and through herd improvement he is able to produce the same amount with only 100 cows, he will save money on feed. The lower number of cows will create less

environmental stress. At this time, cloning is very expensive and not efficient. The cloned animals tend to have bad immune systems and get many types of disease more easily, but with advances in technology, the future looks bright for cloning in farm animals.

Cloning farm animals is not very controversial. But, what if someone had a pet that they really loved and that pet died? Would it be right for them to clone that pet so that they had an exact copy of it? Many people fear that if cloning is perfected that scientists in a country that we have no control over will try to clone people. Would it be nice if you could clone yourself and your clone was your slave? You could send your clone to school, make them do your chores, and attend all of the activities that you do not want to go to, right? Well, not exactly.

Cloning people presents some serious ethical problems. Many people feel that it would be wrong to clone humans and that there are no real advantages to it. A human clone would still be human and would have to be treated as such. So, you'll have to do your own chores.

What Cloning Is, and What Cloning Is Not

Cloning is the creation of an exact genetic copy of an organism through artificial methods. A clone must grow and develop from the beginning stages of life inside the mother's womb. Scientists cannot and probably will never be able to send an organism through a machine and have the copy walk out the other side like you see in some movies. The clone would have to grow, develop, and learn just as any other living thing does. Knowledge would be different for the clone and its parent and the expression of the clone's genetics would be subject to the environment in which it was raised.

As more research is done and technology improves, Scientists will continue to learn more about the genetics of living things and find new ways to improve life on earth. We will find better ways to do things and our theories and ideas about how we look at living organisms will continue to change.

Therapeutic Cloning: A New Hope

A very promising form of cloning is called **therapeutic cloning**. Therapeutic cloning is the cloning of body organs to replace those that are worn out or damaged. Hundreds of thousands of people die each year that could be saved if they had access to organ transplants. The list of people who are waiting to receive a transplant is far greater than the number of organs that are available for transplant. At this time, in order for one person to receive an organ, another person must die. Therapeutic cloning could change that. Scientists are currently looking for ways that a certain kind of cell, called a stem cell, could be harvested from the sick person and a new organ, genetically identical to their damaged one, could be cloned for a transplant. When scientists are able to do this, they will extend hundreds of thousands of lives each year.

Artificial Selection (Man Made Influences)

Artificial selection occurs when humans select which plants or animals to breed to pass specific traits on to the next generation. For example, a farmer may choose to breed only cows that produce the best milk and not breed cows that produce less milk . Humans have also artificially bred dogs to create new breeds (Figure below).

Humans selected the genetic information of parent dogs to create these different breeds. Both dog breeds are descended from the same wolves, and their genes are almost identical. Yet there is at least one difference between their genes that determine size.

ADAPTING TO CHANGES

SOME TRAITS OFFER A BETTER ADVANTAGE FOR SURVIVAL

It makes sense that animals do not want to be eaten by other animals, but have you ever thought about plants? Do plants protect themselves as well? Have you ever wondered why a flower that is as attractive as a rose could have something as obnoxious as thorns? Why do some plants emit terrible odors or have bad flavors (no, this is not talking about tomatoes)? Plants and animals, as well as other living things, have developed defense and survival traits that protect them from predators and help them to obtain food. Traits that help an organism survive in its environment are called **adaptations**. Thorns, poisons, and bad smells protect plants and keep them from being eaten by animals. These are adaptations that help them survive.

Thorns on a rose stem help protect the plant from being eaten

Of course animals are able to protect themselves as well. Anyone who has spent time in a rural area understands that a skunk is not to be played with. Predators that are sprayed by a skunk can be left temporarily blinded and without companionship for a considerably longer time.

Not all defense and survival mechanisms are as noticeable as the odor of a skunk. A snowshoe hare changes the color of its fur in the winter. A chameleon, a kind of lizard, can alter its color depending on its surroundings. Color changing is an adaptation that helps these animals blend into their surroundings and hide from predators.

Spots on a deer fawn help it to hide from predators.

Young animals are especially vulnerable to being eaten when they are young and unable to run away. Deer

fawns and elk calves are born with spotted fur. The spots on their fur help them to hide in shrubs when they are young. The spots look like sun spots in the brush and predators often fail to notice the hiding animals. The stripes on a tiger help it to hide as well. This helps them to avoid predators when they are young, but also to hide from their prey when they are older and able to hunt for their own food.

Just about every animal that you can think of has a special adaptation that allows it to fulfill its specific job in the habitat in which it lives. Many animals and plants have several adaptations that work together to help them survive. Most predators, like mountain lions and wolves, have long canine teeth that interlock. These teeth are adapted to gripping and ripping flesh. Long sharp claws help animals and birds catch their prey. Fish have developed fins that help them to swim and move in the water and birds have wings and feathers that enable them to fly. Birds also have hollow bones. This adaptation serves two purposes. The first advantage of hollow bones is that it makes the bird lighter so that it has less weight. Birds also have a way to allow air to flow through their bones as they fly. This system acts as a cooling system to keep the bird from getting too hot on long flights.

Smaller animal such as insects and spiders also have adaptations that help them survive. Spiders have front leg-like structures called pedipalps that help them hold their prey. They also have fang-like appendages that they use to inject venom into their prey.

SOME TRAITS OFFER AN ADVANTAGE IN ONE ENVIRONMENT, BUT NOT IN OTHERS

Most animals are very well adapted for living in the environment in which they are found. But, what would happen if you took that animal out of its environment and placed it in a different one? Would it be able to survive? In order to survive in a different environment, the animal would have to make certain adaptations in order to

A polar bear is very well adapted to live in the arctic, but how well would it do in a dense dark forest?

maintain life. It may have to change what it eats and the way it obtains food, or it might need to find different ways to hide from predators.

Some animals that do very well in their own environment would find it very difficult to survive in a different one. Polar bears are very well adapted for living in the arctic. Their white fur hides them so they are able to approach their prey without scaring it away. A black bear is a very closely related cousin to the polar bear, but its darker fur makes the shadows in the forests where it lives a perfect place. What would happen if these two cousins were to trade habitats? Could you imagine how difficult it would be for a black bear to forage for berries or sneak up on its prey at the Arctic? What kind of trouble would a polar bear with its white fur have trying to ambush prey in a dark forest? Chances are that neither of these two species would survive the change.

Speed is another factor that provides protection in one environment but not in another. Cheetahs are very fast and can run at speeds above 60 miles per hour for short distances. This trait is very practical on an open prairie, but would not be the most desirable trait in rough or densely vegetated terrain. When animals are placed in an environment where they cannot take full advantage of their strong traits, they must either adapt to the new area, or die.

Mimicry

Mimicry is the similarity between species, which protects one or both. This might include warning coloration (like a fly that is colored like a bee), or coloration of a harmful organism, or a bitter tasting organism so others will not eat or bother them. On its back, the Eastern Tiger Swallowtail caterpillar has coloring that look like big eyes to scare away predators.

This is a fly that has mimicked a bee to avoid being eaten by predators.

This Walking Stick has changed over time to mimic pieces of wood or branches from a tree to disguise itself from predators.

These insects have changed over time to mimic a bee.

Terms to know

- Adaptability
- Structure

ARE YOU BUILT TO SURVIVE?

Structural Adaptations

http://www.flickr.com/photos/irishwildcat/3270598289

All organisms have adaptations - traits or characteristics - that help them to survive and reproduce in a particular habitat.

Structural adaptations are physical features of an organism, such as shape, color, size. Not every physical trait of an organism, or every use of a trait by an organism, is an adaptation, however.

For the aquatic mammal, the buoyant effect of water tends to offset the effect of gravity. As a result, the whale requires less structural support than the elephant, despite its massive size.
An adaptation is any kind of inherited trait that improves the chances of survival and reproduction for an organism. These adaptations can occur over long periods of time. Adaptations are indeed changes, and change is a characteristic of evolution.

A comparison of the skeletal structure of an elephant and blue whale.

The environment is the selecting force that chooses the best and most useful inherited characteristics. There are many types of adaptations. Structural adaptations are adaptations that involve the body of the organism.

The wings of birds, for example, are structural adaptations for flight. The bones in birds are also hollow, which makes them lighter and better adapted for flight. Physical adaptations involve the metabolism of organisms.

http://commons.wikimedia.org/wiki/File:Red_Kite_(Milvus_milvus)_-_geograph.org.uk_-_1444337.jpg

Other adaptations are behavioral and some provide protection like camouflage (chameleon) and warning coloration (poisonous frogs).

An internal skeleton is one that is inside the body of the animal. It is made of bone and cartilage, and its function is to protect the soft organs, tissues, and other parts of the vertebrate organisms. It gives something for muscles to attach to and pull against. The internal skeleton also stores mineral reserves and provides a site for blood cell formation.

An external skeleton is an outer covering on an invertebrate such as a spider, sea anemone, clam or lobster; very few vertebrates have an exoskeleton except the turtle. Some exoskeletons are made of chitin, calcium or silica. They have two advantages. They can protect the

http://adaptations-of-organisms.wikispaces.com/2.+Structural+adaptations

organism against their environment and danger, and they protect their wearer from drying out.

Adapted: http://fa-stock.deviantart.com/art/Platypus-4967-124198585

Egg-laying occurs in animals of all kinds including mammals (just a few - the duck-billed platypus and the spiny anteaters), birds, reptiles, amphibians, and fish. An advantage to egg-laying is that the female does not have to continue to give the embryo nutrients and energy. Once the egg is laid, it has all the nutrients it needs until hatching. Eggs can be buried or protected until the animal hatches. In general, organisms can lay more eggs than carry live young.

Live birth is when a mother gives birth to her baby or babies alive. She carries them inside her body until they are fully developed. An animal that carries her babies can protect them from predators. She can also maintain a constant temperature to keep them alive and healthy.

Structures Adapt to Help Survival

All living things have adaptations that increase their chances for survival. Living in a desert area such as Utah, many of the plants that are native to this area have structural adaptations that help them to survive. Have you ever tried to dig a weed out of the ground? Chances are it was not an easy task. Desert plants grow roots that are either very deep in the ground or extremely dense. Sometimes there is more root material under ground than there is plant material above the ground. These extensive root systems allow the plant to obtain as much water as possible from the soil.

The leaves on many desert plants are another example of an adaptation to a dry environment. Some leaves have a tough leathery coating that helps them to conserve water. Other leaves are so different that many people do not even realize they are leaves. The spines on a cactus are one example. Cactus spines are leaves that are modified to conserve water where it is very scarce.

Many plants and animals develop defense mechanisms. These defense mechanisms increase their chances of surviving in their environment.

Adaptation	Purpose
Predators have sharp teeth	Catching and eating prey
Birds have hollow bones	Fly faster and further
Some animals have hollow fur	Better insulation in cold climates
Sharks have a skeleton made from cartilage	Allows faster swimming and better agility
Some plants have thorns	Defense from animals
Animals may look like a more dangerous animal (mimicry)	Predators may think it is the dangerous animal and stay away
Some plants taste bad	Defense from animals

Many structures that are useful in one environment can be used somewhere else if a change takes place. Size and speed are advantages that would help an organism regardless of where it lives. Whatever of the type of adaptation an organism has, all adaptations have one thing in common; they give the organism a better chance to survive in its environment.

GLOSSARY

acquired trait: Trait that organisms develops over a lifetime.

adaptation: Trait that enhances an organism's ability to survive and reproduce in its environment

homozygous: two of the same factors of a trait (BB)

heterozygous: two different factors of a trait (Bb)

dominant: the expressed trait or the visible trait

recessive: the trait that is masked

adaptability: the ability of an organism to change to better survive in its environment

inherited trait: Feature passed from one generation to the next.

reproduction: the ability to make the next generation

asexual reproduction: Process of forming a new individual from a single parent.

sexual reproduction: Process of forming a new individual from two parents.

genetics: the study of inheritance

DNA : the material that makes up our genetic material

chromosomes: organized structures that contain DNA

inherit: is to receive something from someone who came before you

trait: is a genetically determined characteristic

camouflage: the ability of an organism to blend in with its environment because of its inherited traits

man-made influences: the process where humans select which plants or animals to breed to pass specific traits on to the next generation

natural influences: how organisms in a population develop traits that allow them to survive and reproduce

mimicry: is the similarity between species, which protects one or both

offspring: new organisms produced by one or more organisms

structure: physical features of an organism, such as shape, color, size

environment: the habitat in which an organism lives

Standard 4 Review

Objective 1

1. Explain the difference between Heredity and Genetics.
2. In your own words define the terms offspring and parents as they relate to heredity.
3. Explain the relationship between DNA, genes, and chromosomes.
4. How many chromosomes do humans have?
5. Where do we inherit our genes from?
6. Explain the shape of DNA.
7. Explain what Gregor Mendel did.
8. Explain how Mendel did his research.
9. What were Mendel's discoveries?
10. Explain how dominant and recessive traits work.
11. Tell what a Punnett Square is and how to use it.
12. Explain the difference between inherited and acquired traits. Give examples of each.
13. What is the role of environment in the development of traits?
14. Explain the difference between sexual and asexual reproduction.
15. Explain what a pedigree chart is and how it is used.

Objective 2

1. Explain in your own words the meaning of the term, "natural selection."
2. What was significant about the different species of similar organisms on the Galapagos Islands?
3. What are adaptations and how do they help organisms survive?
4. What adaptations do you think plants have that help them survive?

5. Give three examples of adaptations that are not listed in the textbook and tell how each one helps that organism to survive.
6. How does natural selection occur?
7. Explain the benefits of selective breeding.
8. What is genetic engineering?
9. Explain how therapeutic cloning could be a great benefit to the future of medicine.
10. Explain how animals and plants adapt and how this give them advantages in their environment.
11. How can a trait that provides an advantage in one environment be a disadvantage in a different one?
12. How does speciation occur?
13. What is geographic isolation?
14. Explain how mimicry helps an organism to survive.
15. What are structural adaptations?

Classification systems

chapter 5

Terms to Know

- Growth
- Development
- Observation
- Reproduction
- Cellular respiration
- Classification
- Living
- Nonliving

STANDARD 5: STUDENTS WILL UNDERSTAND THAT STRUCTURE IS USED TO DEVELOP CLASSIFICATION SYSTEMS.

OBJECTIVE 1: CLASSIFY BASED ON OBSERVABLE PROPERTIES

Humans like to organize and classify things. We divide sports teams into professional and nonprofessional. Then we divide them into leagues and divisions. We identify automobiles by the company that made them and then we further identify them as cars, trucks, or vans. Almost everything you can imagine has been divided into categories and groups based on its characteristics or some other identifiable property. Living things are no exception.

Classification refers to the organizing of living things into categories based on similar traits. There are millions of living **organisms** that have been identified by Scientists. An **organism** is any living thing. This is an enormous number and far too many for anyone to be able to study all at once. In order to study these living things and to learn more about them systems of **classification** have been developed. **Classification** systems serve two purposes. First of all, since the number of living things is far too vast for anyone to study alone, organisms are divided into groups according to their characteristics. Organisms are also are given scientific names that identify them with similar living things.

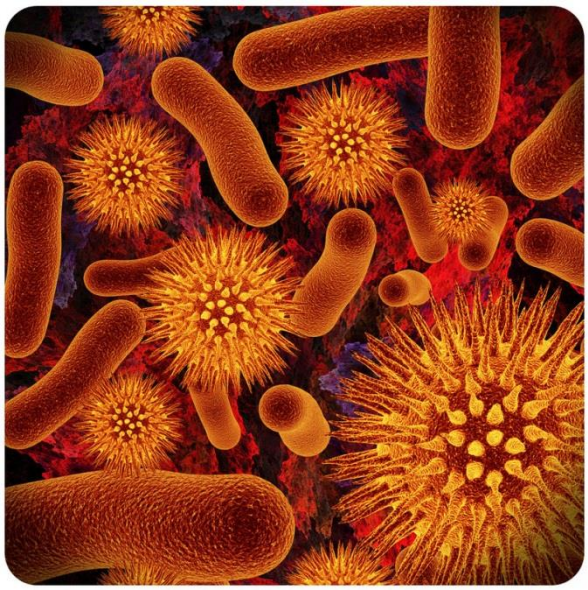
The study of how things are related and classified is called **Taxonomy**. A taxonomist is a person who studies the classification of living organisms. Many people have created different classification systems. We will look at two of them.

CLASSIFICATION SYSTEMS

Living Versus Non-living

How do we tell the difference between a living thing and a non-living thing? Think about your own body. How do you know that you are alive? Your heart beats. You breathe in air. Do all living things need to do be like you in order to be "alive"?

The Image on the right shows bacteria. Do these bacteria look like they could be alive? They do not have hands or feet or a heart or a brain, but they are actually more similar to you than you may think. Scientists found that all living things share certain characteristics. In this chapter, we will discover how to precisely define living things.



Nonliving Objects Based on External Structures

In order to classify anything, observations need to be made. Let's start by thinking about some non-living things.

Candice and Trevor have gotten a job working at the mall for the holiday season. They are both going to be working in the wrapping station. During the holidays, the mall offers free gift wrapping. People can come through and have their gifts wrapped. If they want to make a donation they can and that money is used to help needy families.

Candice and Trevor both show up on their first day for training. Mrs. Scott, the manager of the wrapping station shows them both where they will be working.

"First, we need to show you some great techniques for wrapping presents," Mrs. Scott explains. "There are some ways that are more effective and useful than others."

Candice and Trevor both take a seat in front of a bunch of different items. There is a round bottle of perfume, a shoe box, a soccer ball and a magician's hat with a round bottom and a point at the top.

"What kinds of shapes to do you see here?" Mrs. Scott asked the two.

Before seeing Candice and Trevor's answers, think about this question yourself. Based on the descriptions, how would you classify these objects? Make a few notes in your margin.

As Trevor and Candice tell Mrs. Scott what types of figures are present on the table, let's do our own inventory.

1. The round bottle of perfume is a cylinder.
2. The shoe box is a rectangular prism.
3. The soccer ball is a sphere.
4. The magician's hat is in the shape of a cone.

How did you do? Go back and check the answers that you wrote at the beginning of the lesson. If you got them all correct, good work. If not, then make a note of which ones you mixed up to help yourself next time.

What Are Observations?

An **observation** is any information that is gathered with the senses. Our senses include vision, hearing, touch, smell, and taste. We see with our eyes, hear with our ears, touch with our hands, smell with our nose, and taste with our tongue. We can also extend our senses and our ability to make observations by using tools such as rulers, scales, balances, microscopes, telescopes, and thermometers.

Q: How do these tools extend human senses and our ability to make observations?

A: Rulers can help us identify exact sizes. Scales measure weight and mass. Microscopes and telescopes extend the sense of vision. They allow us to observe objects that are too small (microscopes) or too distant (telescopes) for the unaided eye to see. Thermometers extend the sense of touch. Using our sense of touch, we can only feel how warm or cold something is relative to our own temperature or the temperature of something else. Thermometers allow us to measure precisely how warm or cold something is.

A scientist observed this orange-colored scum on a pond in her neighborhood. She wondered what the scum is and why it was there. She decided to do an investigation to find answers to her questions. Scientific investigations often result when observations like this raise questions.

Besides raising questions for investigation, observations play another role in scientific investigations. They help scientists gather evidence.

Some of these pennies are shiny and copper colored. That's how pennies look when they are new. The older pennies are dull and brown

Characteristics of Life

How do you define a living thing? What do mushrooms, daisies, cats, and bacteria have in common? All of these are living things, or organisms. It might seem hard to think of similarities among such different organisms, but they actually have many things in common. Living things are similar to each other because all living things evolved from the same common ancestor that lived billions of years ago. See http://vimeo.com/15407847 for a powerful introduction to life.

Discussion *– What is life? What is the one thing that makes living things different from non-living things?*

Life cannot be defined by one characteristic; rather organism must have a combination of characteristics. Not all scientists agree on a single list of characteristics. Here is one example:

All living organisms have:

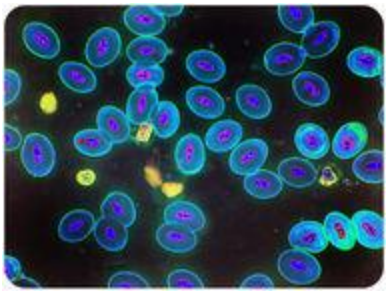
5. Cells – Organisms made of one or more cells.
6. DNA – All living things have DNA
7. Metabolism – Organisms need to get and use energy, and get rid of wastes in order to carry out life processes.
8. Response – respond and adapt to their environment .
9. Growth/Devlopment – organisms grow and develop.
10. Reproduce – organisms make more of the same species.

In order to be alive, *organisms must have all of the characteristics of life*. For example, consider a car. It has fuel cells, but not biological cells. Cars use energy and get rid of wastes. Cars can respond to the environment (when you press the brake or gas pedals, they change speed). Cars do not grow or reproduce. Therefore, cars are not classified as an organism.

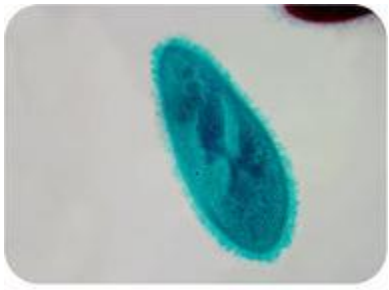
Living Things Are Made of Cells

If you zoom in very close on a leaf of a plant, or on the skin on your hand, or a drop of blood, you will find cells (Figure below). Cells are the smallest unit of living things. Most cells are so small that they are usually visible only

through a microscope. Some organisms, like bacteria, plankton that live in the ocean, or the paramecium shown in the Figure below are made of just one cell. Other organisms have millions of cells. On the other hand, eggs are some of the biggest cells around. A chicken egg is just one huge cell.



Reptilian blood cell showing the characteristic nucleus. A few smaller white blood cells are visible. This image has been magnified 1000 times its real size.



This paramecium is a single-celled organism.

All cells share at least some structures. Although the cells of different organisms are built differently, they all function much the same way. Every cell must get energy from food, be able to grow and reproduce, and respond to its environment.

Living Things Have DNA

All living organisms have DNA. As you learned in chapter 4, DNA is the code of life. It is the sequence of the proteins that form DNA that give each species its individual characteristics. DNA also provides for the differences between individuals of the same species.

Living Things Use Energy

Respiration
Animals Using Energy

$$C_6H_{12}O_6 + 6O_2 \rightarrow \text{energy} + 6H_2O + 6CO_2$$

Animals burn glucose (sugar) for all of their energy needs.

Why do you eat every day? It's simple, to get energy. The work you do each day, from walking to writing and thinking, is fueled

by energy. But you are not the only one. In order to grow and reproduce, all living things need energy. But where does this energy come from?

Why do you breathe? To turn your food into energy your cells can use. Cellular respiration is a chemical reaction that cells use to convert food to ATP energy, which is the chemical that powers everything most cells do. This process requires oxygen and produces carbon dioxide.

The source of energy differs for each type of living thing. In your body, the source of energy is the food you eat. Here is how animals, plants and fungi obtain their energy:

- All animals must eat plants or other animals in order to obtain energy and building materials.
- Plants don't eat. Instead, they use energy from the sun to make their "food" through the process of photosynthesis.
- Mushrooms and other fungi obtain energy from other organisms. That's why you often see fungi growing on a fallen tree; the rotting tree is their source of energy (Figure right).

Bracket fungi and lichens on a rotting log in Cranberry Glades Park near Marlinton, West Virginia. Fungi obtain energy from breaking down dead organisms, such as

Since plants harvest energy from the sun and other organisms get their energy from plants, nearly all the energy of living things initially comes from the sun.

Living Things Respond to their Environment

All living things are able to react to something important or interesting in their external environment. For example, living things respond to changes in light, heat, sound, and chemical and mechanical contact. Organisms have means for receiving information, such as eyes, ears, and taste buds.

When you are cold, what does your body do to keep warm? You shiver to warm up your body.

When you are too warm, you sweat to release heat. When any living thing gets thrown off balance, its body or cells help them return to normal. In other words, living things have the ability to keep a stable internal environment. Maintaining a balance inside the body or cells of organisms is known as homeostasis. Like us, many animals have evolved behaviors that control their internal temperature. A lizard may stretch out on a sunny rock to increase its internal temperature, and a bird may fluff its feathers to stay warm (keep from losing energy).

Living Things Grow and Develop

All organisms begin as a single cell. Some organisms, like bacteria and protists, remain unicellular throughout their lives. Other organisms such as plants and animals grow bigger in size by adding more cells.

Many organisms also develop through their life. Development is a change or reorganization of body structures rather than just a gain in body size. Sometimes, development results in a drastically different body like when a caterpillar metamorphoses into a butterfly. Other developmental changes are more subtle, like changes from an infant to a child or from a child to an adult.

Living Things Reproduce

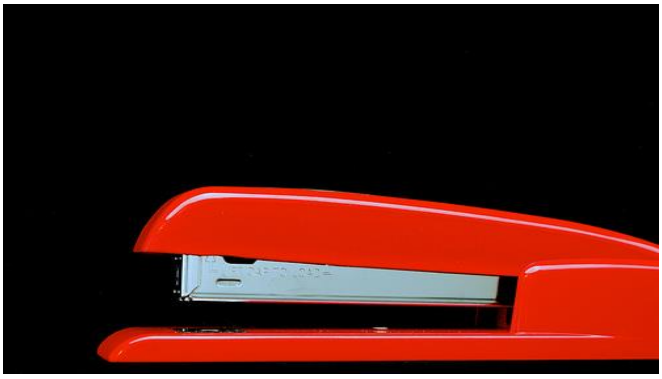
Like all living things, cats reproduce themselves and make a new generation of cats. When animals and plants reproduce they make tiny undeveloped versions of themselves called embryos, **wh**ich grow up and develop into adults. A kitten has not developed into an adult cat.

All living things reproduce to make the next generation. Without reproducing individuals, a species will go extinct. As a result, there are no species that do not reproduce.

Applying the Characteristics: Living, Non-living, and Once-living

Living things have all the characteristics of life. Dead things were once living and had all the characteristics at one time, but no longer carry out the processes of life. However, they may still have some of the structures of life. For example think of a fossil fish. It was alive, then it died, but you can still see the structures preserved in the fossil. Contrast that with a stapler in your classroom. It never had all the characteristics of life, but is not dead, so it is classified as non-living.

Is this stapler is living or non-living?



http://www.flickr.com/photos/jdhancock

Online Interactive Activity

- http://tinyurl.com/UT7th5-1

LESSON SUMMARY

- All living things grow and develop, reproduce, respond to their environment.
- All organisms are made of cells.
- All living things need energy and resources to survive.

Review Questions

Recall
Define the word organism.
What are five characteristics of living things?

Apply Concepts
What are a few ways organisms can get the energy they require?
What is a cell?

Think Critically
Think about fire. Can fire be considered a living thing? Why or why not?

Points to Consider
Do you expect that the same chemicals can be in non-living and living things?

Terms to Know

- Archaea
- bacteria
- binomial-nomenclature
- classify
- domain
- Eukarya
- genus
- species
- taxonomy

OBJECTIVE 2: USE AND DEVELOP A SIMPLE CLASSIFICATION SYSTEM

Lesson Objectives

- Explain what makes up a scientific name.
- Explain what defines a species.
- List the information scientists use to classify organisms.
- List the three domains of life and the chief characteristics of each.

Check Your Understanding

- What are the basic characteristics of life?

Classification

Classification is useful for many objects including living, once living, and non-living things. Classification is the sorting of things into orderly groups based on similar characteristics and structures. The science of classifying organisms, including living, dead, and extinct, is called taxonomy. Scientists that classify these things are called taxonomists.

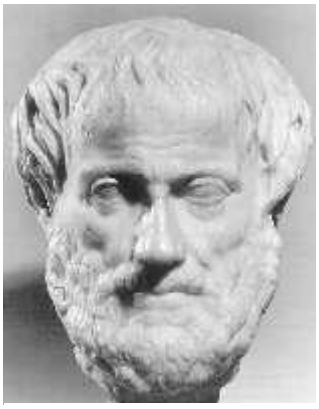
Classifying Organisms

When you see an organism that you have never seen before, you probably put it into a group without even thinking. If it is green and leafy, you probably call it a plant. If it is long and slithers, you probably call it as a snake. How do you make these decisions? You look at the physical features of the organism and think about what it has in common with other organisms.

Scientists do the same thing when they **classify**, or put in categories, living things. Scientists classify organisms not only by their physical features, but also by how closely related they are. Lions and tigers look like each other more than they look like bears. It turns out that the two cats are actually more closely related to each other than to bears. How an organism looks and how it is related to other organisms determines how it is classified.

Aristotle

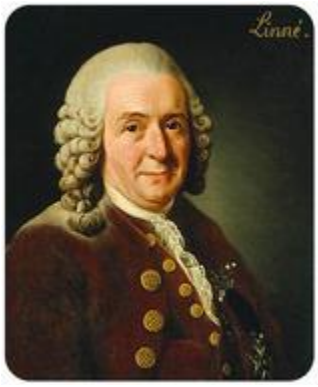
One of the first people to attempt to classify living things was a Greek philosopher by the name of Aristotle (384-322 B.C.). Aristotle's classification system was very basic. Under his system all living things were classed as either plants or animals.



Aristotle
384 -322 B.C.

Plants were classified as being trees, shrubs, or herbs. Animals were divided into groups according to whether they lived in water, on land, or could fly.

As you might have already guessed, there are problems with this system. First of all, many animals live both in water and on land. Amphibians and some reptiles are examples of animals that live both on land and in water. Another problem was that not all animals that fly are closely related. Under Aristotle's system bats, birds, and flying insects were grouped together. It is easy to understand that there is only a very basic relationship between these animals. Aristotle's system was probably acceptable for his time period, but with the coming of new technology and scientific understanding, a new system was needed.



For additional information go to: http://www.ucmp.berkeley.edu/history/linnaeus.html

Carolus Linnaeus (1707-1778)

Carl von Linné was a Swedish botanist. A botanist is a scientist who studies plants. Linné was aware of the problems with the way things were classified and decided that he would create a new way of grouping living things. Linné decided to classify things as either plants or animals, the same way things had been done for hundreds of years. The reason for this was the fact that very little was known about microscopic life in this time period. Microscopes were very basic and scientists were only beginning to study the unseen world that high powered magnification opened up.

Linné created a system that he called binomial nomenclature. Binomial nomenclature is the process of assigning a two word name to all living things. Linné spent much of his life naming every living thing he could find. When he ran out of things to name he was so obsessed with his system of giving everything a two word Latin name that he changed his own name to Carolus Linnaeus, the Latin version of his Swedish name.

SCIENTIFIC NAMES

The purpose for using Latin names for living things might seem hard to understand at first, but there is a reason for everything done by scientists. Organisms all have common names and some have several. In addition to having several common names, these names are usually different in each

language, and there are hundreds of languages. In your history and geography classes you have learned to divide the world up into countries and cultures. But, science has no cultural boundaries and does not change as you go from one country to another. Scientists must be able to communicate with each other without language barriers and without the confusion of having to learn dozens of names for the same organism. Latin has traditionally been the language of science. Because of this it was chosen as the language for scientific naming. Today scientists communicate with each other in various languages, but Latin survives as the language for naming. Linné gave a two word name to everything he could identify. That tradition continues in Science today. All living things are given two names: one to tell the genus of the organism, and one that identifies its species. No two different species ever share the same name. A species is a group of genetically similar organisms that are able to reproduce and create fertile offspring.

Common Names for
Felis concolor

Cougar, wild cat, puma, mountain lion, catamount, cat, lion, panther

The most common name for a cougar changes depending on which part of the country you are in. A common name can even refer to a completely different animal in different areas.

The scientific name for an organism is composed of a genus and a species name. A genus may be made up of several different species of closely related organisms. For example: the genus Canis includes several different kinds of dogs including coyotes (Canis latrans), wolves (Canis lupus), and house pets (Canis familiaris). The genus Felis includes cougars (Felis concolor), bobcats (Felis rufus), lynxs (Felis lynx), and house cats (Felis domesticus). The fact that two organisms share a genus name, such as these, means that they are closely related. Since the species name is often a descriptive term, two organisms may share the same species name and not be related at all. For

Understanding Terms From Latin

Latin is the language of Science. It may seem hard to understand at first, but once you learn how the terms are created you will understand them much better.

Binomial nomenclature: two-name naming system
- Bi-two
- Nomial-name
- Nomen-naming
- Clature-system

Photosynthesis: sugar is created using sunlight
- Photo-light
- Synthesis-to create

Biology: the study of living things
- Bio-life
- -ology-the study of

example: you now know that a cougar has the scientific name Felis concolor. Another organism has the scientific name Abies concolor. Concolor is a Latin term that means "lightly colored." The fact that these two organisms share the name concolor means absolutely nothing. In fact, Felis concolor is a cougar and Abies concolor is a type of fir tree.

Writing Scientific Names

You may have noticed that the names that have been listed are written differently from the rest of the text. There are rules that have been developed for correctly writing a scientific name. These rules are to identify a scientific name and to set it apart from rest of the writing.
There are three rules that should be followed when writing scientific names.

- The genus name begins with a capital letter (Felis).
- The species begins with a lowercase letter (concolor).
- The entire name should be underlined when hand written or italicized when type written. (Felis concolor)

Scientific Name Facts

1. Come from Latin
2. First name is the genus, second name is the species
3. Every species has its own name. No two different species have the same name.
4. Organisms with the same genus name are closely related.

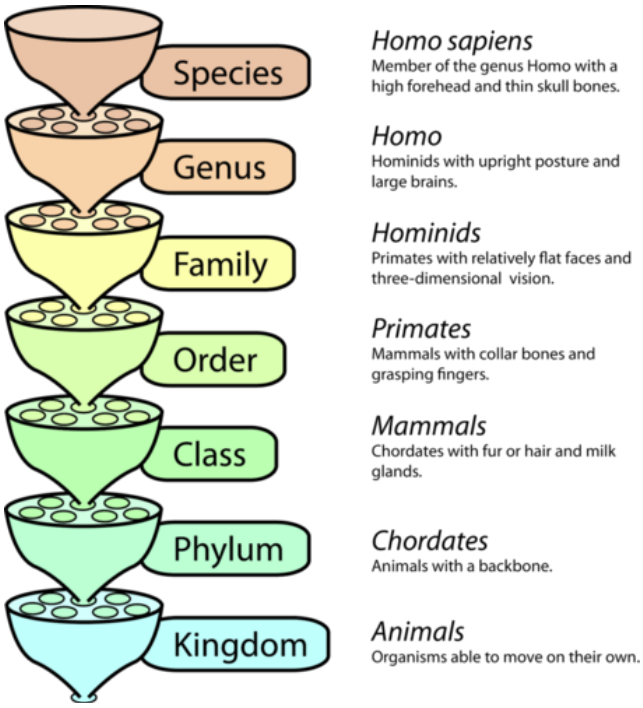
The genus name of an organism that has already been mentioned in a text may be abbreviated as long as it does not cause confusion. For example: in a text that talks about Abies concolor, the name is written out completely the first time it is mentioned. After that, whenever A. concolor is written, the genus is abbreviated.

Another example: The leaves below are from two different species of trees in the genus Acer. The Japanese maple, Acer palmatum, and the sugar maple, Acer saccharum, are both in the same genus and they look similar (Figures below). Notice that the genus is capitalized and the species is not, and that the whole scientific name is in italics when typed, or underlined when handwritten. The names may seem strange because they are written in Latin.

Maple leaves. Their scientific names are Acer saccarum (sugar maple, left) and Acer palmatum (Japanese maple, right)

One of the characteristics of the maple genus is winged seeds

Modern Classification



The main categories that biologists use are listed here from the most specific to the least specific category.
See http://www.pbs.org/wgbh/nova/orchid/classifying.html for further information.

Linnaeus developed a system with 5 taxonomic levels and only 2 kingdoms. As we have discovered new organisms, taxonomists have added additional levels and kingdoms. Some scientists recognize 7 or 8 taxonomic levels and between 5 and 8 kingdoms. The system Linnaeus developed works well centuries later because we can change and add to it as new technologies, like microscopes, allow for additional discoveries and knowledge.

These diagrams illustrate the classification categories for organisms, one has the broadest category (Kingdom) at the bottom, and the most specific category (Species) at the top; the other shows the number of species from greatest (Domain) to least (Species) listed from top to bottom.

The Classification Rap can be heard at: http://www.youtube.com/watch?v=6jAGOibTMuU

Difficulty Naming Species

Even today new organisms are discovered that need to be classified. The system developed by Linnaeus is still used and helps scientists classify new species. Even though naming species is straightforward, deciding if two organisms are the same species can sometimes be difficult. Linnaeus defined each species by the distinctive physical characteristics shared by these organisms. But two members of the same species may look quite different. For example, people from different parts of the world sometimes look very different, but we are all the same species.

These children are all members of the same species, Homo sapiens.

DOMAINS OF LIFE

Let's explore the least specific category of classification, called a domain.
All of life can be divided into 3 domains, which tell you the type of cell inside of an organism:

1. Bacteria: Single-celled organisms that do not contain a nucleus

2. Archaea: Single-celled organisms that do not contain a nucleus; have a different cell wall from bacteria

3. Eukarya: Organisms with cells that contain a nucleus.

Three Domain System

Archaea Domain

Archaebacteria Kingdom

Bacteria Domain

Eubacteria Kingdom

Eukarya Domain

Protista Kingdom
Fungi Kingdom

Archaea and Bacteria

Archaea and Bacteria seem very similar, but they also have significant differences.

Similarities:

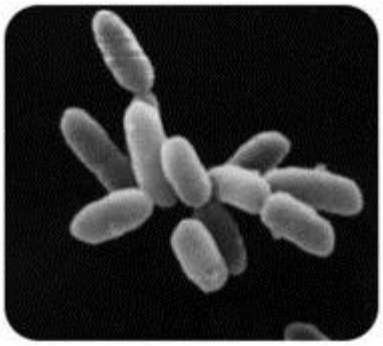
- Do not have a nucleus
- Small cells
- One-celled
- Can reproduce by dividing in two

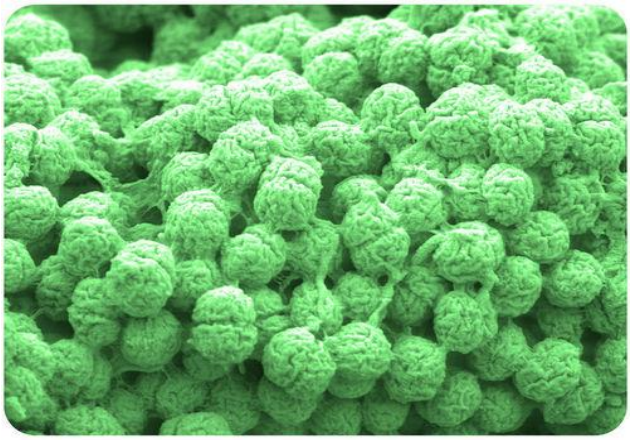
Differences:

- Cell walls made of different material
- Archaea often live in extreme environments like hot springs, geysers, and salt flats while bacteria can live almost everywhere.

The Group D Streptococcus organism is in the domain Bacteria, one of the three domains of life.

The Halobacterium is in the domain Archaea, one of the three domains of life.





This microscopic alga is a protist in the domain Eukarya.

Eukarya

All of the cells in the domain Eukarya keep their genetic material, or DNA, inside the nucleus. The domain Eukarya is made up of four kingdoms:

1. Plantae: Plants, such as trees and grasses, survive by capturing energy from the sun, a process called photosynthesis.

2. Fungi: Fungi, such as mushrooms and molds, survive by "eating" other organisms or the remains of other organisms.

3. Animalia: Animals survive by eating other organisms or the remains of other organisms. Animals range from tiny ants to the largest dinosaurs (reptiles) and whales (mammals), including all sizes in between.

The Western Gray Squirrel is in the domain Eukarya, one

4. Protista: Protists are not all descended from a single common ancestor in the way that plants, animals, and fungi are. Protists are all the eukaryotic organisms that do not fit into one of the other three kingdoms. They include many kinds of microscopic one-celled organisms, such as algae and plankton, but also giant seaweeds that can grow to be 200 feet long (an alga protist is shown in Figure below).

Three Domains of Life			
	Archaea	**Bacteria**	**Eukarya**
Multicelluar	No	No	Yes
Cell Wall	Yes, without peptidoglycan	Yes, with peptidoglycan	Varies. Plants and fungi have a cell wall; animals do not.
Nucleus (DNA inside a membrane)	No	No	Yes
Organelles inside a membrane	No	No	Yes

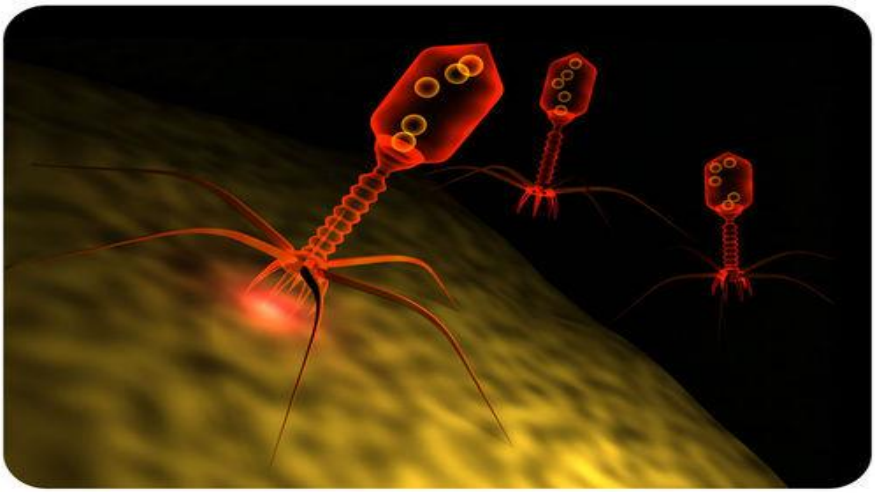
Plants, animals, fungi, and protists might seem very different, but remember that if you look through a microscope, you will find similar cells

with a membrane-bound nucleus in all of them. The main characteristics of the three domains of life are summarized in Table below.

Viruses

We have all heard of viruses. The flu and many other diseases are caused by viruses. But what is a virus? Based on the material presented in this chapter, do you think viruses are living?

The answer is actually "no." A virus is essentially DNA or RNA surrounded by a coat of protein (Figure below). It is not a cell and does not maintain homeostasis. Viruses also cannot reproduce on their own—they need to infect a host cell to reproduce. Viruses do, however, change over time, or evolve. So a virus is very different from any of the organisms that fall into the three domains of life.



These "moon lander" shaped viruses

More information on viruses, and whether or not they are alive, is available from http://www.scientificamerican.com/article.cfm?id=are-viruses-alive-2004 and http://www.youtube.com/watch?v=ctpjjOkUtEU.

EXAMPLES OF CLASSIFICATION

Many scientists currently classify organisms into 6 kingdoms. These are Archaebacteria (ancient cells from extreme environments), Eubacteria (all other bacteria), Protista (protists), Plantae (plants), Fungi, and Animalia (animals.)

After classifying organisms into kingdoms we continue to classify them into smaller groupings.

CLASSIFICATION OF PLANTS

Groups of Plants

1. Nonvascular plants evolved first. They are distinct from the algae because they keep the embryo inside of the reproductive structure after fertilization. These plants do not have vascular tissue to transport nutrients, water, and food.
2. Seedless vascular plants evolved to have vascular tissue after the nonvascular plants but do not have seeds.
3. Gymnosperms evolved to have seeds but do not have flowers.
4. Flowering plants, or angiosperms, evolved to have vascular tissue, seeds, and flowers.

The plant kingdom contains a diversity of organisms.

Plants are formally divided into 12 divisions and these are gathered into four groups (Figure on left). These four groups are based on the evolutionary history of significant features in plants:

SOME OF THE ORDERS OF MAMMALS

Animals are classified into about 35 phyla. One of these, Chordata, includes vertebrate animals with backbones. They are further divided into 7 classes: 3 kinds of fish as well as amphibians, reptiles, birds, and mammals.

One animal class, the mammals, can be characterized a number of ways into orders according to their anatomy, the habitats where they live, or their feeding habits. Most mammals belong to the placental group. There are about 20 orders including:

1. Lagomorphs, such as hares and rabbits.
2. Rodents, including rats, mice and other small, gnawing mammals.
3. Carnivores, such as cats, dogs, bears and other meat eaters (Figure below).
4. Insectivores, including moles and shrews (Figure below).
5. Bats and primates.
6. Ungulates, including hoofed animals such deer, sheep, goats, pigs, buffalo and elephants, as well as marine mammals, such as whales and manatees (Figure below).

A caracal, hunting in the Serengeti.

One of the subgroups of placental mammals is the insectivores, including moles and shrews.

Why do you think these groups of animals are placed together? Can you think of some examples of tooth type that are adapted for a mammal's

diet? Or types of limbs that are adapted for living in different types of habitats?

The ungulates (hoofed animals), like the giraffe here, is one of the orders belonging to the placental mammals.

Mammals can also be grouped according to the adaptations they form to live in a certain habitat. For example, terrestrial mammals with leaping kinds of movement, as in some marsupials and in lagomorphs, typically live in open habitats. Other terrestrial mammals are adapted for running, such as dogs or horses.

Still others, such as elephants, hippopotamuses, and rhinoceroses, move slowly.

Interactive Activities

- Animal Classification: http://tinyurl.com/UT7th5
- Classification Games: http://tinyurl.com/UT7th5-b
- Classifying Arthropods (Spiders and Insects) http://tinyurl.com/UT7th5-a
- Classifying Animals: http://tinyurl.com/UT7th5-c

LESSON SUMMARY

- Scientists have defined several major categories for classifying organisms: domain, kingdom, phylum, class, order, family, genus, and species.
- The scientific name of an organism consists of its genus and species.
- Scientists classify organisms according to their evolutionary histories and how related they are to one another - by looking at their physical features, the fossil record, and DNA sequences.
- All life can be classified into three domains: Bacteria, Archaea, and Eukarya.
- Resources

Two good reviews of the history of the taxonomic levels can currently be found here:

- http://en.wikipedia.org/wiki/Biological_classification
- and here:
- http://en.wikipedia.org/wiki/Kingdom_%28biology%29

A good lab for developing a classification system and writing a classification key can be purchased from Flinn Scientific:
http://www.flinnsci.com/store/Scripts/prodView.asp?idproduct=19185

REVIEW QUESTIONS

Recall

1. Who designed modern classification and invented the two-part species name?
2. Define a species.
3. What kingdoms make up the domain Eukarya?
4. What is the name for the scientific study of naming and classifying organisms?
5. How are organisms given a scientific name?

Apply Concepts

6. In what domain are humans?

7. Quercus rubra is the scientific name for the red oak tree. What is the red oak's genus?
8. In what domain are mushrooms?
9. What information do scientists use to classify organisms?

Think Critically

10. Is it possible for organisms in two different classes to be in the same genus?
11. If molecular data suggests that two organisms have very similar DNA, what does that say about their evolutionary relatedness?
12. Can two different species ever share the same scientific name?
13. If two organisms are in the same genus, would you expect them to look much alike?

Points to Consider

14. This Section introduced the diversity of life on Earth. Do you think it is possible for cells from different organisms to be similar even though the organisms look different?

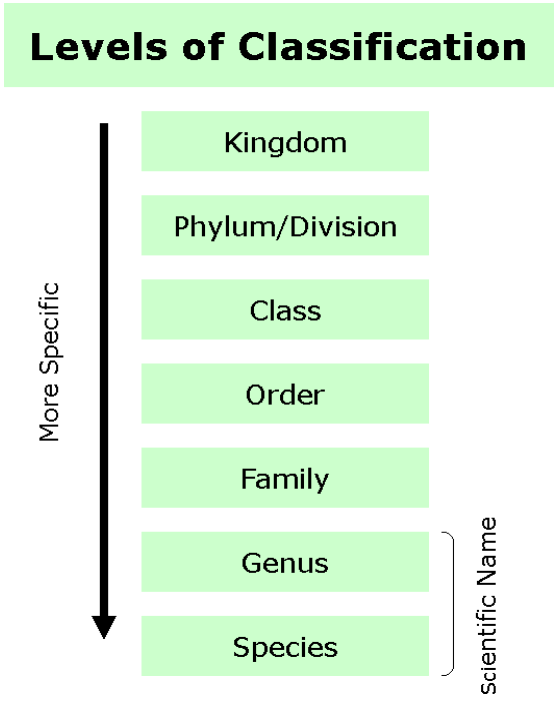
15. Do you think human cells are different from bacterial cells?

16. Do you think it is possible for a single cell to be a living organism?

OBJECTIVE 3: CLASSIFY ORGANISMS USING AN ORDERLY PATTERN BASED UPON STRUCTURE

Taxonomic systems are based on similar characteristics. These systems attempt to model the natural order, thus helping research by classifying different organisms.

A SYSTEM FOR CLASSIFICATION



You may have heard the term animal kingdom used to refer to animals. In order to help understand living things and to organize them, all organisms have been assigned to a kingdom (a kingdom is the largest level of classification) based on observable characteristics, physical structures, and genetic information.

There are six kingdoms that taxonomists have created. They are animals, plants, fungi, protists, archaebacteria, and eubacteria. We will look at the characteristics for each of these kingdoms later.

- Plantae - Plants. Typically multicellular, sessile organisms. Their cells have walls composed of cellulose. They are autotrophs, and photosynthesize (with exceptions).
- Animalia- Animals. Typically multicellilar, motile organisms. They lack rigid cell walls and are heterotrophic (with exceptions).
- Protista - (A contested group of around 40 phyla of eukaryotic organisms) Typically simple, eukaryotic unicellular microorganisms or multicellular microorganisms without specialized tissues.

- Fungi - Include yeast and molds. Typically eukaryotic, multicellular organisms. Like plants, they are sessile, but unlike plants they lack chloroplasts and are heterotrophic (with exceptions).
- Bacteria - Ubiquitous, single-celled prokaryotes a few microns in size, with varying morphology.
- Archaea - Relatively small group of single-celled prokaryotes more closely related to the eukaryotes then to the bacteria.

How are these organisms different from each other?

Organisms are placed in a kingdom with organisms that have similar structure and characteristics. Each kingdom is broken down into several different levels of classification. Kingdoms are divided into phlyla (phylum is singular) or divisions, phyla are divided into classes which are split into orders. Finally, orders are split into families which are divided into genera (genus is singular), and species. Each lower level makes up the level above it just like the schools in your area make up a school district or several sports teams make up a region or division. Families make up orders, orders make up classes, and so on. The genus and species of an organism are the terms that are used when a scientific name is assigned.

Rules for Classification

The three main factors that determine how an organism is classified are observation, its physical structures or characteristics, and its genetic code, or DNA.

Thousands of years ago when Aristotle classified everything as either a plant or animal and split them up according to characteristics, it was based totally on observation. Scientists today still use observable characteristics as a starting point in classifying living things. Many organisms can easily be grouped based solely on their physical appearance or characteristics of their behavior. For instance: if two animals both look like dogs, they might be grouped together to begin with. But, sometimes there are differences that are not easily identified.

Sharks and dolphins are very similar at first glance. They both have fins, they live in similar environments, and their general body shape is very similar. But, when these two species are investigated more closely, huge differences become clear. Dolphins are mammals. That means they feed their young with milk and they have hair or fir on at least part of their body. Neither of these characteristics applies to sharks. Sharks have a skeleton that is made of cartilage. They also have gills which allow them to breathe in the water. Even though these two animals may appear similar, upon further observation, it is clear that they are not very closely related.

Looking at Levels of Organization

Organism	Cougar	Coyote	House Cat	White Fir Tree
Kingdom	Animalia	Animalia	Animalia	Plantae
Phylum/ Division	Chordata	Chordata	Chordata	Tracheophyta
Class	Mammalia	Mammalia	Mammalia	Gymnosperma
Order	Carnivora	Carnivora	Carnivora	Coniferae
Family	Felidae	Canidae	Felidae	Pinaceae
Genus	Felis	Canis	Felis	Abies
Species	concolor	latrans	domesticus	concolor

Which two organisms on the chart are the most closely related? The species name for a white fir tree and a cougar being the same means absolutely nothing. A species name is often a descriptive term for the organism. Concolor means "lightly colored." The cougar and the house cat share 6 of seven levels. This makes them "genetic cousins." The more levels of classification that two organisms share, the more closely they are related.

Identifying Living Organisms

Scientists use a series of paired statements to help classify things to species based on differing characteristics. These are called classification keys, taxonomic keys, and sometimes dichotomous keys; three different names for the same thing. Here is what one looks like and how it is used.

USING A CLASSIFICATION KEY AND A FIELD GUIDE

Imagine that you are walking along a trail in a forest and you discover a tree that you have never seen before. You wonder what type of tree it is. How can you learn what species the tree is?

Classification Key of Evergreen Trees in Utah

1.	a.	Leaves scaly-like; cones are small, blue and berry-like.....go to 2
	b.	Leaves needle-like; cones are large and brown.....go to 3
2.	a.	Leaves rough; berry-like cones are about 1 inch in diameter; trunk is forked.....Utah Juniper
	b.	Leaves smooth; berry-like cones less than 1 in.; trunk has central stem .....Rocky Mtn. Juniper
3.	a.	Needles are in bundles of two or more; cone scales are woody.....go to 4
	b.	Needles are not in bundles, they are single; cone scales are papery.....go to 5
4.	a.	Needles are about 2 inches long and twisted; cones are 1.5 inches long; trunk grows straight and tall.....Lodge pole Pine
	b.	Needles less than 2 inches long; cones 1-3 inches with large edible seeds, trunk is short and bushy.....Piñon Pine
5.	a.	Needles are flat and blunt; not sharp to touch.....go to 6
	b.	Needles are square; stiff and sharp to touch.....Blue Spruce
6.	a.	Needles point outward from twig; cone scales have fork-like tongue attached.....Douglas Fir
	b.	Needles bend upward from twig.....White Fir

Taxonomists have developed tools that the average person can use to easily identify all types of living things. Field guides can be very useful. They offer good descriptions of where you might find a certain organism and usually have good pictures or sketches of leaves or other identifying characteristics. But even with detailed descriptions or photographs it can still be hard to be certain what you are trying to identify, especially if there are several similar species in the area. To solve this problem taxonomists have created another tool called a dichotomous key.

A dichotomous key, or **classification key**, is a list of descriptive statements. Each step has two options that, according to the organism's characteristics,

guide you to another set of options. The series of either/or choices continues until the key ultimately helps you identify the organism. The key above identifies some of the evergreen trees common in Utah.

How the Key Works

1. Go to start
2. Use choices given to arrive at the lowest possible level
3. Organism is identified as much as possible

If the description at each level does not appear accurate then back up to some earlier step and start over, questioning each decision more carefully. Finally, a verification step is important by comparing the specimen with any further details available including description, photographs and other reference. The habitat and location where the sample was collected is useful for plants. If the description and other information satisfactorily confer, then a correct identification is possible.

Below are pictures of 10 Illinois fish. See if you can identify them using this simple key.

1. a) Whiskerlike barbels present on head (catfishes)—Go to 2
   b) No whiskerlike barbels present on head—Go to 3

2. a) Caudal fin forked—channel catfish
   b) Caudal fin rounded—tadpole madtom

3. a) Mouth facing downward (suckers)—Go to 4
   b) Mouth not facing downward—Go to 5

4. a) Front edge of dorsal fin at least 4 times longer than back edge—quillback
   b) Front edge of dorsal fin less than 4 times longer than back edge—black redhorse

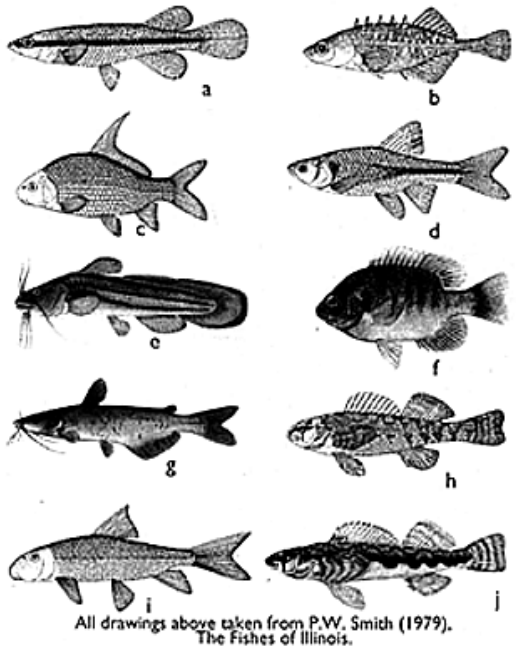
5. a) Body elongate, more than twice as long as tall—Go to 6
   b) Body not elongate, but slab-sided. Not more than twice as long as tall—bluegill

6. a) First five rays of dorsal fin spikelike—brook stickelback
   b) First five rays of dorsal fin not spikelike—Go to 7

7. a) Two dorsal fins. (darters)—Go to 8
   b) Only one dorsal fin—Go to 9

8. a) Bold irregular black stripe on side, like a series of connected blotches—blackside darter
   b) No bold black markings on side. Markings are narrow vertical bars—orangethroat darter

9. a) Caudal fin forked—spotfin shiner
   b) Caudal fin rounded—blackspotted topminnow



All drawings above taken from P.W. Smith (1979). The Fishes of Illinois.

http://bioscholars2.wikispaces.com/classification

To learn how to classify Utah species of fish, see this link: http://utahfish.usu.edu/downloads/HookedonClassification.pdf

Limitations of a Dichotomous Key

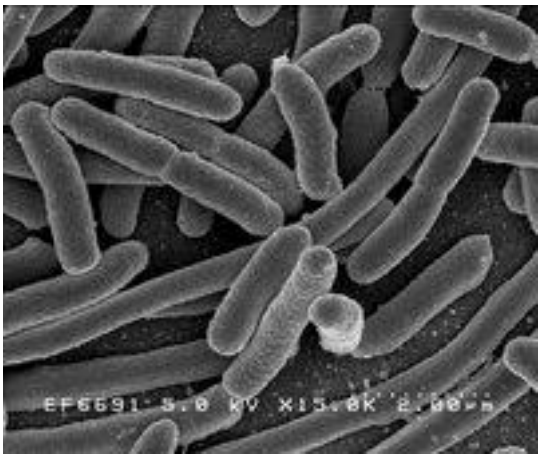
If the organism is not included in this key - it would never be found and this volume remains a work in progress. While dichotomous keys have proved useful, they often offer dilemmas due to individual differences, so with any dichotomous key it helps to have two or three examples to improve sorting. Keys are useful but tend to become increasingly cumbersome as the lower levels are reached especially at genus level and below.

Bacteria

Chances are that when you hear the term bacteria you think of disease and infection. Bacteria can cause both of these, but most bacteria are either harmless or helpful. There are more species of bacteria than all the other species of living things put together, literally millions. But, of all the different species of bacteria only about 200 are harmful.

Bacteria are microscopic. It was not until the 1800s that microbiologists discovered them. Until then people had no real idea about how disease and infection were caused.

Up until just a few years ago bacteria were classified in one kingdom called Monera, but many scientists now divide them into two different kingdoms. Both kingdoms are made up of one celled organisms. They live in soil, on other organisms, and in places where no other living thing could possibly live.



Bacteria like E. coli can cause serious disease in animals. Make sure that all ground meat such as hamburger is thoroughly cooked.

There are three basic shapes of bacteria: spiral, rod, and spherical. Spiral bacteria are called spirilla. They look similar to a cork screw. Spirilla bacteria move with the use of a whip like tail at each end called flagella. Rod-shaped bacteria are called bacilli. Botulism, a type of food poisoning is caused by a rod shaped bacteria. Spherical bacteria are called cocci. Cocci bacteria grow single, in pairs, or in groups. Streptococcus is a spherical bacterium that grows in a chain. You may have heard of strep-throat. This is caused by a streptococcus bacterium. Likewise, staph infection is cause by a staphylococcus bacterium. Staphylococcus bacteria grow in clumps.

Bacteria reproduce through a process called binary fission. Binary fission literally means “splitting in half.” The DNA is copied and split into two rings. Then the bacterium divides with each half receiving a copy of the DNA. Since binary fission is a type of asexual reproduction the DNA of the parent cell and the offspring are identical.

Not all bacteria are bad. There are many types that are good. In fact, life on earth could not exist without bacteria. Our lives are affected everyday by good bacteria. The fact that they are so small makes this hard to realize.

Nitrogen is one of the most important nutrients necessary for plants to live. It also makes up about 78% of the gas in earth’s atmosphere. But plants cannot use nitrogen gas as a nutrient. It must be converted to a different form. Bacteria take nitrogen out of the air and convert it to ammonia. Plants can use the nitrogen in ammonia. This process is called nitrogen fixation. Without bacteria to “fix” the nitrogen in the soil, plants could not exist as they are.

What would happen if dead things did not decompose and their nutrients remained with the dead organism? Can you imagine what the world would be like if everything that had ever died was still on the earth? Our world has a somewhat limited supply of all of the nutrients that are available for living things to use. In most cases there is no shortage of these nutrients. Nutrients that are used by one organism are recycled and later used by others. Bacteria play an important role in recycling nutrients. While an organism is alive, its immune system keeps bacteria that live inside them from reproducing too much and becoming a problem. When the organism dies its immune system can no longer limit the numbers of bacteria and they begin to reproduce quickly. These bacteria are responsible for breaking down the dead body and returning all of the nutrients to the ecosystem. This action of bacteria breaking down the bodies of dead animals fertilizes the soil which enables plants to grow better. The plants are then eaten by animals and the nutrient cycle continues on and on.
Bacteria also provide us with much of the food we eat and medicine that doctors use to help treat diseases. Yogurt is a popular food that is made from bacteria and milk. Cheese is another example of a common food that needs bacteria to be produced.

In recent years medical researchers have begun to use bacteria to treat medical disorders. Diabetes is a disorder that prevents the human body from producing insulin, a substance that helps take sugar out of the bloodstream. For many years insulin was extracted from animals. This process was difficult and expensive. Researchers have now learned how to use bacteria to produce human insulin for diabetics. This process makes higher quality insulin at a cost that is better for the millions of people who need it.

Archaebacteria

The prefix “archae” means ancient. Archaebacteria are considered the oldest form of life on earth. There are three types of archaebacteria: heat loving, salt loving, and methane making. Each of the three lives in an extremely harsh environment. Archaebacteria have been discovered in hot water vents deep in the ocean, in water so salty that few other things can survive, and in swamps. Usually all of these places are void of living things, but these bacteria have managed to survive for millions of years.

Eubacteria

The bacteria that are most common in normal environments are eubacteria. Some Eubacteria are decomposers that get their food by breaking down the bodies of dead things.
Another species of eubacteria are decomposers. Cyanobacteria are bacteria that produce their own food by photosynthesis, the same way that plants do.

Protists

Another type of living organism is classed in the kingdom protista. Protists can either be animal-like or plant-like. Have you ever heard someone say “you can go there, but don’t drink the water?” The reason that you should not drink the water in some places is because of members of the kingdom protista. These mostly one-celled microorganisms live in ponds, sewage systems, and other environments that we would consider to be contaminated.

Dinoflagellates are from the kingdom Protista

There are three different ways that the various kinds of protists can get food. Many protists are parasites. They live off of other organisms and can affect the health of their host if they are not treated. Other protists can be producers. These make their food by photosynthesis and put oxygen in the ecosystem. The remaining protists obtain their nutrients by eating other microscopic things such as bacteria and smaller protists. There are about 100,000 species classed as protists.

Fungi

In the 1920s a man by the name of Alexander Fleming was working in his lab on a bacteria experiment. Fleming, perhaps being a bit frustrated at his lack of progress, left his lab late one night. In his rush to leave, he accidentally left a window open. The next day, Fleming returned to the lab and began to clean things up. Petri dishes are small round plates that lab researchers use to culture (grow) bacteria. Fleming picked up a stack of Petri dishes and, as he was about to throw them away, he noticed that there was a spot on the top

dish that had a small ring bacteria around it that had died. Fleming also noticed that at the center of the ring of dead bacteria was a tiny dark spec. Immediately he inferred that something about the spec must have been responsible for killing the bacteria.

Alexander Fleming carefully removed the spec and began to do tests on it. Through his tests he learned that the spec was a tiny flake of mold called penicillium that grows on citrus fruit. Researchers developed ways to extract penicillin from the mold and created the world's first medicine to treat infections.

Because of this accidental discovery, the age of anti-biotics was born. Doctors could now treat infections rather than merely clean the wound and hope for the best.

Fungi make up one of the most fascinating kingdoms. Fungi vary greatly from one species to the other, and include individual species that range from the mushrooms that you may like on your pizza, to the athlete's foot that your friend has on his toes, to anti-biotic medicines such as Penicillin that help rid your body of infections.

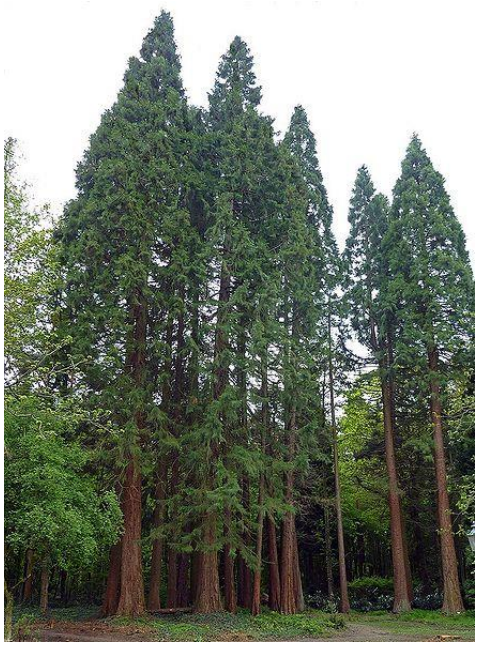
Mushrooms are typical members of the Kingdom Fungi

There are many ways that the various species of fungi obtain food. All however are heterotrophs, which means that they cannot make their own food. Since fungi do not move around they must live close to their food source. Many fungi are decomposers. They live on their food and secrete a substance that helps them to digest the host. Once the food is dissolved it is simply absorbed into the fungus. Many fungi are decomposers and help bacteria break down the bodies of dead and decaying organisms. There are approximately 100,000 species of fungi.

Plants

There are many types of plants. Have you ever seen the giant redwood or sequoia trees in California? Plants range from these trees that can grow 300' high to small matte like plants that cover the ground. So what makes them all plants? Plants are sessile (they stay in one place) organisms that carry on photosynthesis. Plants are multicellular and their cells are supported by cell walls. The cumulative strength of the trillions of cell walls in a tree is what gives them enough structure to stand up under their tremendous weight.

Plants play an important role in the world in which we live. You have already learned that photosynthesis puts oxygen into our atmosphere. Other living things such as animals use this oxygen to sustain their lives. Plants also are considered producers. This means that the nutrients that they create by photosynthesis are the foundation of the food chain for life on land. Without plants life on earth as we know it could not exist.



The giant sequoia trees in California grow tall because of the support of the cell walls in

Plants reproduce sexually, but many are also able to reproduce asexually. Most plants have male and female genders just as animals do. Each provides genetic information that enables the plant to reproduce. Since the offspring are created from two parents with different genetics, their genetic composition is a combination of the two parents. Some plants are both male and female and are able to reproduce on their own. Since they provide both of the sets of chromosome, this is a type of sexual reproduction.

Plants that reproduce asexually are genetic copies of the parent plant. Have you ever looked at the mountains in the autumn and noticed that as the aspen trees begin to change colors, they do not all change at the same rate or at the same time? Sometimes there will be a large stand of trees that are all one color and a smaller stand in the middle that is another color or at another stage of fall coloration. An entire group of aspen trees can grow from the same root system. A new tree simply shoots up from the roots. When you see the different colored stands of trees, usually the ones that are the same color are from the same root system. Since they grow up from a common root system, they are the same genetically. That is why an entire group changes color at the same time. Taxonomists have identified more than 260,000 species of plants.

Animals

More than likely when you think of animals the picture that comes into your mind is of a mammal of some kind. But most animals are far different from that typical image. For example, insects are animals and there are

more species of insects than all other animals put together. The animal kingdom is by far the largest of the six kingdoms with more than 800,000 species.

Animals are all multicellular with no cell walls and most of them are able to move around. Since many animals can move they are able to get food more easily. These animals obtain nutrients by eating living things such as plants and other animals. Animals that eat only plants are called herbivores (herb or plant eaters) while those that eat other animals are called carnivores (carne- means meat). Other animals live on a diet of both plants and animals. These are referred to as omnivores (omni- means all).

Some animals however are sessile. Corals and sponges are simple animals that remain in one place as they gather nutrients and carry on the processes of life. These animals live in the water and filter nutrients from the water as it flows around them.

Dogs are an example of a mammal: they have fur and produce milk to feed

Even though spiders are not cute and furry, they are still animals.

Online Interactive Activity

- Animal Classification: http://tinyurl.com/UT7th5-3

GLOSSARY

Classification – putting things into groups by common characteristics

Taxonomy – the science of classifying and naming of living things

Domain – a grouping of similar kingdoms

Kingdom – a grouping of similar phyla (plural of phylum)

Phylum – a grouping of similar classes

Class – a grouping of similar orders

Order – a grouping of similar families

Family – a grouping of similar genera (plural of genus)

Genus – a grouping of similar species

Species – a group of individuals that can interbreed with one another and produce fertile offspring; a species does not interbreed with other groups

Scientific name – a two-word name for an organism that includes the genus and species names

Binomial nomenclature – a universal system for naming organisms with 2 word names

Standard 5 Review

Objective 1

1. Why do scientists classify living things?
2. What is Taxonomy?
3. In your own words, explain what an observation is in science.
4. List and explain each of the six characteristics of living organisms.
5. What is cellular respiration?
6. What is homeostasis?

7. Do you think that fire is living, or not? Explain your answer using the six characteristics of life.

Objective 2

1. Give two examples of how living things are classified.
2. Explain how Aristotle classified living things.
3. Who was Carl von Linne and what did he do?
4. Why do scientists use scientific names to classify things?
5. Explain three rules for writing scientific names.
6. Explain four facts about scientific names.
7. Explain the two parts of a scientific name.
8. What happens to classification systems as technology provides new information or as new species are discovered?
9. Briefly explain the three domains of life.
10. Do you think viruses should be considered living things? Explain your answer using the characteristics of life that we discussed.
11. How does plant classification differ from the classification of animals?
12. List and briefly explain six orders of mammals.

Objective 3

1. Name the six kingdoms of living things.
2. What are the three main factors for classifying living things?
3. Name the seven levels of organization from most general to the most specific.
4. What is a classification or dichotomous key?
5. Explain how to use a classification key.
6. Explain the basic characteristics of each of the six kingdoms of life.