INTEGRATED SCIENCE

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This space on the edge of each page is your place for drawing, taking notes and making the book your own.

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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. (P. 15)

- **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. (P. 29)

- **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. (P. 36)

- **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. **(P. 44)**

- **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).
- **c.** Relate the sorting of materials that can be observed in streambeds, road cuts, or beaches to the density and particle size of those materials.
- **d.** 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. **(P. 52)**

- **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. (P. 62)

- **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. (P. 75)

- **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. (P. 36)

- **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. (P. 96)

- **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. (P. 116)

- **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. (P. 123)

- **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. (P. 136)

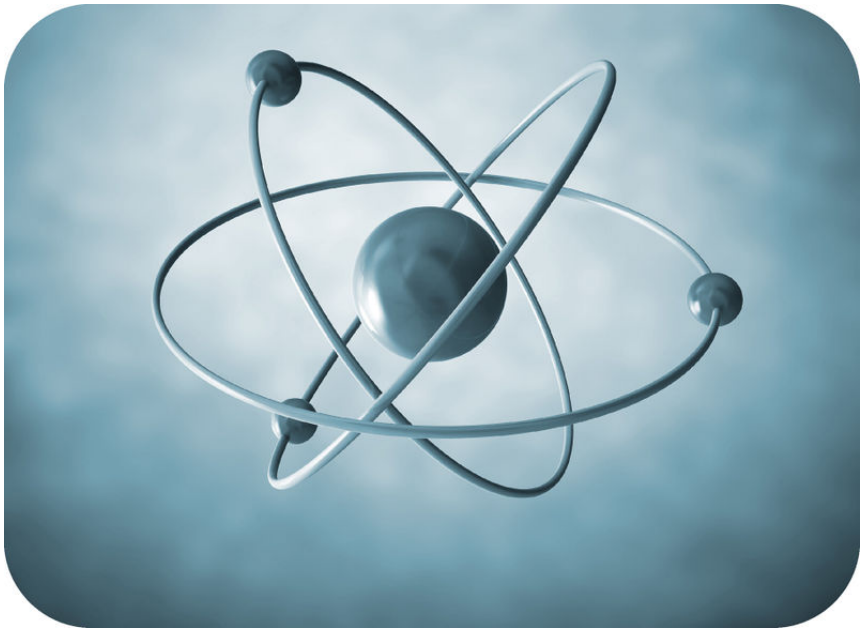
- **a.** Identify types of organisms that are not classified as either plant or animal.
- **b.** Arrange organisms according to kingdom (i.e., plant, animal, monera, fungi, protist).
- **c.** Use a classification key or field guide to identify organisms.
- **d.** Report on changes in classification systems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

ATOMS+MOLECULES

CHAPTER 1

STANDARD 1:
STUDENTS WILL UNDERSTAND THE STRUCTURE OF MATTER.

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



Terms to Know

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

INTRODUCTION:

Have you ever tried to observe or study something that you could not see? Scientists for hundreds of years have been concerned with the smallest particles that make up each and every object in our natural world. Of course, that is the atom. How do scientists study things they can't see? They make models. A scientific model is a tool constructed by the scientist based on all the known experimental evidence about a particular thing such as an atom. The picture above is an artistic look at one model of the atom, showing the electrons in orbit around the central nucleus. As time goes by and more experiments are performed, models evolve and change to account for new understanding. In this chapter, you will begin to learn about how the model of the atom was initially developed and how it has changed over time into what we now have come to accept as the modern model of the atom.

Sizes of Atoms

The graphite in your pencil is composed of the element carbon. 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 physical and chemical properties of the carbon atom. 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. This final particle is called an atom, which is defined as the smallest particle of an element that retains the properties of that element.

Atoms, as you probably know, are extremely small. In fact, the graphite in an ordinary pencil contains about 5 × 1020 atoms of carbon. In other words, that's 500,000,000,000,000,000,000 carbon atoms! This is an almost incomprehensibly large number. The population of the entire Earth is about 7 × 109 people, meaning that there are about 7 × 1010 times as many carbon atoms in your pencil as there are people on the Earth! For this to be true, atoms must be extremely small. Can we see atoms? It's not easy, but a modern instrument called a scanning tunneling microscope allows scientists to visualize the atom, as shown in Figure 1.

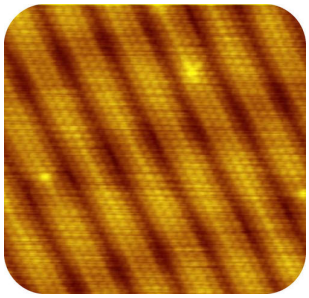


Figure 1. Images of individual gold atoms can be seen on the surface of a smooth sheet of gold metal using scanning tunneling microscopy.

Why do scientists need models?

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.

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 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.

Models Have Limitations

Since models are simpler than real objects or systems, they have limitations. A model deals with only a portion of a system. It may not predict the behavior of the real system very accurately. But the more computing power that goes into the model and the care with which the scientists construct the model can increase the chances that a model will be accurate. For example, models of the atom cannot accurately represent the distance between the particles or the motion of the electrons.

HISTORY OF ATOMIC THEORY

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 "indivisible" pieces atomos. 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.

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. Nonetheless, from his research results, he developed one of the most important theories in science.

Figure 3

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. 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 reasoned, 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 consist 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 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.

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

Figure 4.

Thomson Adds Electrons

The next major advance in the history of the atom was the discovery of electrons. These were the first subatomic particles 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 at this online exhibit: http://www.aip.org/history/electron/.

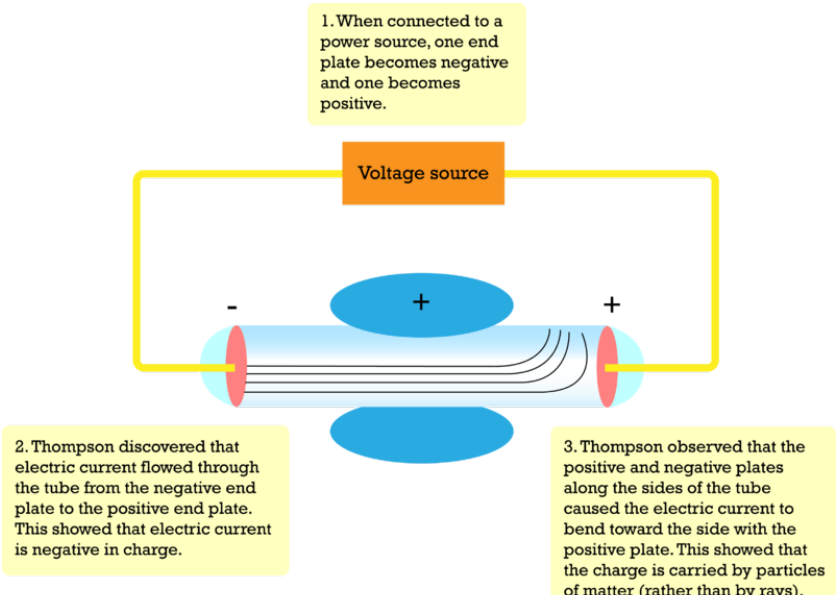


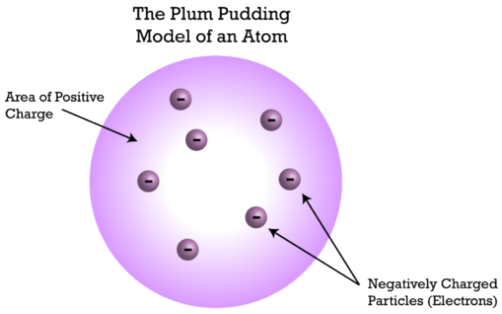
Figure 5.

Thomson's Vacuum Tube Experiments

Thomson was interested in electricity. He did experiments in which he passed an electric current through a vacuum tube. The experiments are described in Figure 5.

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 couldn't be fundamental units of matter because they are all alike. Instead, they must be parts of atoms. The negative particles were later named electrons.

Thomson's Plum Pudding Model



Thomson knew that atoms are neutral in electric charge. So how could atoms contain negative particles? Thomson thought that the rest of the atom must be positive to cancel out 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.

Science Can Be a Blast!!

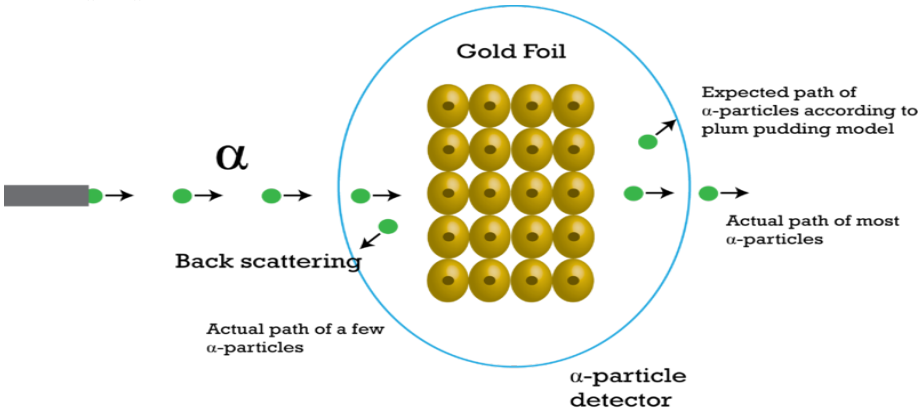
Bohr's idea of energy levels is still useful today. It helps explain how matter behaves. For example, when chemicals in fireworks explode, their atoms absorb energy. Some of their electrons jump to a higher energy level. When the electrons move back to their original energy level, they give off the energy as light. Different chemicals have different arrangements of electrons, so they give off light of different colors. This explains the blue- and purple-colored fireworks below.

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 (α). 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 alpha 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 alpha particles. This would cause the alpha particles 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 alpha particles bounced back from the foil as though they had struck a wall. This is called back scattering. It happened only in very small areas at the centers of the gold atoms.

The Nucleus and Its Particles

Based on his results, Rutherford concluded that all the positive charge of an atom is concentrated in a small central area. He called this area the nucleus. Rutherford later discovered that the nucleus contains positively charged particles. He named the positive particles protons. Rutherford also predicted the existence of neutrons in the nucleus. However, he failed to find them. One of his students, a physicist named James Chadwick, went on to discover neutrons in 1932. You learn how at this URL:
http://www.light-science.com/chadwick.html.

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 empty space, except for the electrons moving randomly through it. 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.

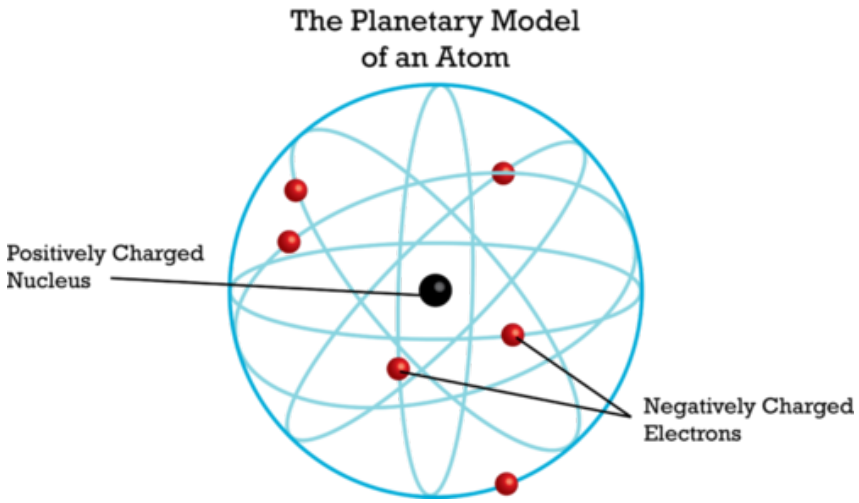


Figure 6. This model shows Rutherford's idea of the atom. How does it compare with Thomson's plum pudding?

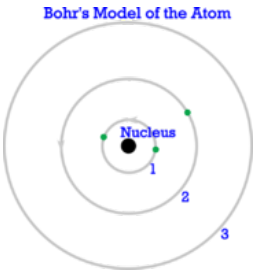
Neils Bohr

Rutherford's model of the atom was better than earlier models. But it wasn't the last word. 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 the previous two lessons, "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. Bohr's model of the atom.



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 in Figure 7 has six energy levels. The level with the least energy is the one closest to the 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

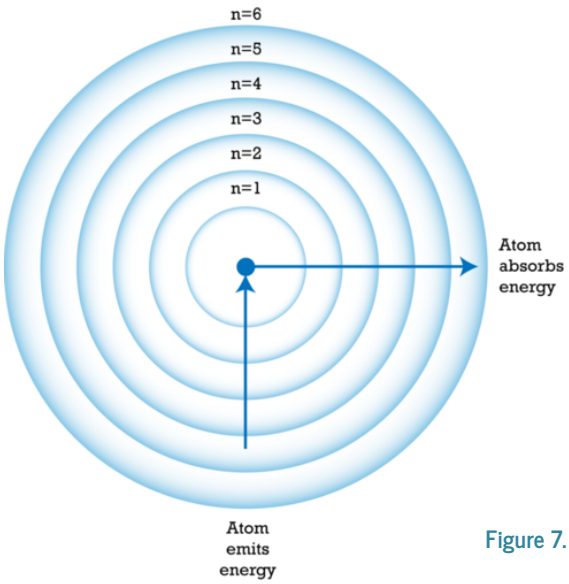


Figure 7.

This model of an atom contains six energy levels (n = 1 to 6). Atoms absorb or emit energy when some of their electrons jump to a different energy level.

Electron Cloud

In the 1920s, physicists discovered that electrons do not travel in fixed paths. In fact, they found that electrons only have a certain chance of being in any particular place. They could only describe where electrons are with mathematical formulas. That's because electrons have wave-like properties as well as properties of particles of matter. It is the "wave nature" of electrons that lets them exist only at certain distances from the nucleus. The negative electrons are attracted to the positive nucleus. However, because the electrons behave like waves, they bend around the nucleus instead of falling toward it. Electrons exist only where the wave is stable. These are the orbitals. They do not exist where the wave is not stable. These are the places between orbitals.

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

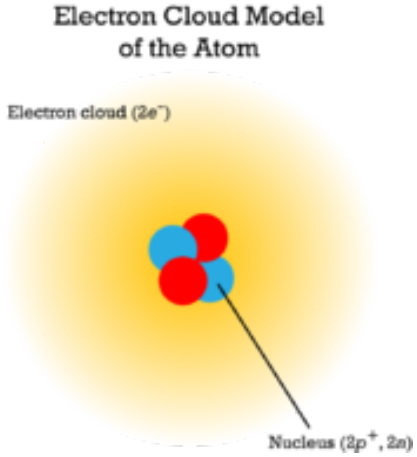


Figure 8.

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

Atoms, Molecules and 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.

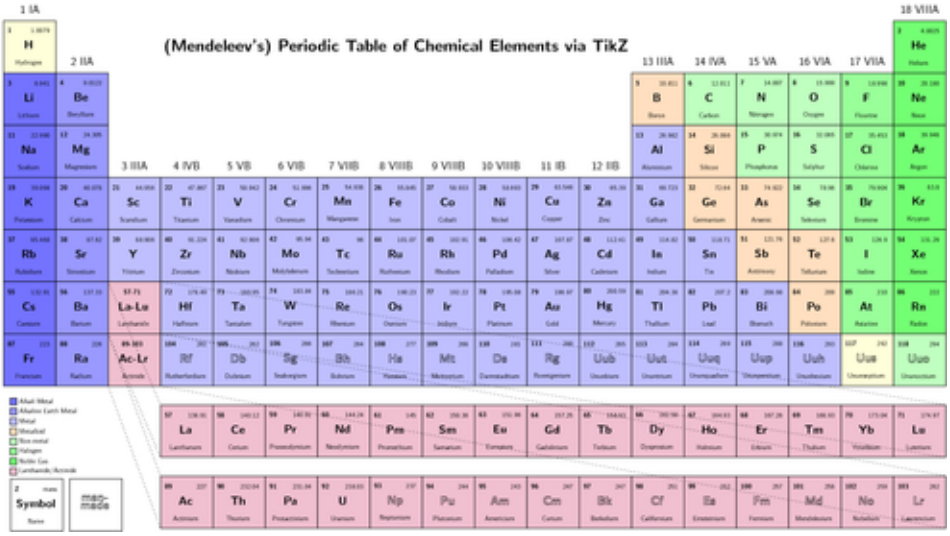
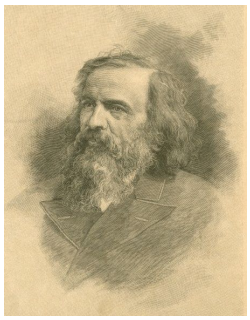


Image by Ivan Griffin,
http://www.texample.net/tikz/examples/periodic-table-of-chemical-elements/



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

Molecules and Compounds

A molecule is the smallest unit of a chemical compound. A compound is a substance made of two or more elements. The elements in a chemical compound are always present in a certain ratio.

Water is probably one of the simplest compounds that you know. A water molecule is made of two hydrogen atoms and one oxygen atom (Figure below). All water molecules have the same ratio: two hydrogen atoms to one oxygen atom.

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

STATES OF MATTER

Introduction

States of matter are the different forms in which matter can exist. Look at Figure below. It represents water in three states: solid (iceberg), liquid (ocean water), and gas (water vapor in the air). In all three states, water is still water. It has the same chemical makeup and the same chemical properties. That's because the state of matter is a physical property.

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

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=N090GeHgtBY (1:42)

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

Solids

Ice is an example of solid matter. A solid is matter that has a fixed volume and a fixed shape. The figure below shows examples of matter that are usually solids under Earth conditions. In the figure, salt and cellulose are examples of crystalline solids. The particles of crystalline solids are arranged in a regular repeating pattern. The steaks and candle wax are examples of amorphous ("shapeless") solids. Their particles have no definite pattern.

The volume and shape of a solid can be changed, but only with outside help. How could you change the volume and shape of each of the solids in the figure without changing the solid in any other way?

Salt consists of crystals of sodium and chloride.

The steaks on this grill consist of carbon compounds called proteins.

Wood is about 50 percent cellulose. Cellulose is a carbon compound.

This candle consists mostly of wax, a solid fat-like substance.

Liquids

Ocean water is an example of a liquid. A liquid is matter that has a fixed volume but not a fixed shape. Instead, a liquid takes the shape of its container. If the volume of a liquid is less than the volume of its container, the top surface will be exposed to the air, like the oil in the bottles in Figure below.

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

Gases

Water vapor is an example of a gas. A gas is 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.

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.

REVIEW QUESTIONS FOR STANDARD 1 OBJECTIVE 1

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.
    - Democritus
    - Dalton
    - Thompson
    - Rutherford
    - 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. What did Dmitri Mendeleev do?
10. Explain the difference between molecules and compounds.
11. Explain the main properties of solids, liquids, and gases.

STANDARD 1: STUDENTS WILL UNDERSTAND THE STRUCTURE OF MATTER

Objective 2:
You will be able to accurately measure the characteristics of matter in different states

INTRODUCTION

Here's a riddle for you to ponder: What do you and a tiny speck of dust in outer space have in common? Think you know the answer? Read on to find out.
What is Matter?
Both you and the speck of dust consist of atoms of matter. So does the ground beneath your feet. In fact, everything you can see and touch is made of matter. 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. So what is matter? Matter is defined as anything that has mass and volume.

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 in Figure below. It allows an object to be matched with other objects of known mass. SI units for mass are 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.

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. The SI unit for weight is the newton (N). The common English unit is the pound (lb). With Earth's gravity, a mass of 1 kg has a weight of 9.8 N (2.2 lb).

This kitchen scale measures weight. How does weight differ from mass?

Terms to Know:

- Matter
- Mass
- Volume
- Density
- Solid
- Liquid
- Gas

Problem Solving

Problem: At Earth's gravity, what is the weight in newtons of an object with a mass of 10 kg?

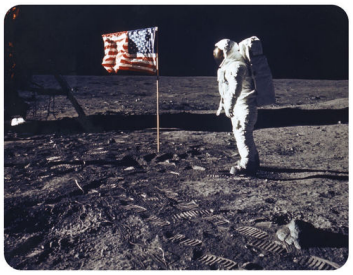
Solution: At Earth's gravity, 1 kg has a weight of 9.8 N. Therefore, 10 kg has a weight of (10 × 9.8 N) = 98 N.

You Try It!

Problem: If you have a mass of 50 kg on Earth, what is your weight in newtons?

An object with more mass is pulled by gravity with greater force, so mass and weight are closely related. However, the weight of an object can change if the force of gravity changes, even while the mass of the object remains constant. Look at the photo of astronaut Edwin E. Aldrin Jr taken by fellow astronaut Neil Armstrong, the first human to walk on the moon, in Figure below. An astronaut weighs less on the moon than he does on Earth because the moon's gravity is weaker than Earth's. The astronaut's mass, on the other hand, does not change. He contains the same amount of matter on the moon as he does on Earth.

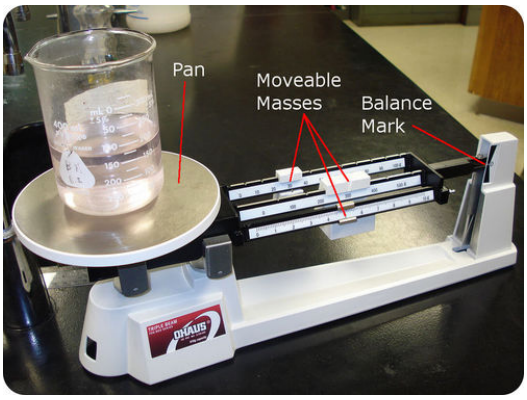
If the astronaut weighed 175 pounds on Earth, he would have weighed only 29 pounds on the moon. If his mass on Earth was 80 kg, what would his mass have been on the moon?



Measuring Mass with a Balance

Mass is the amount of matter in an object. 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:

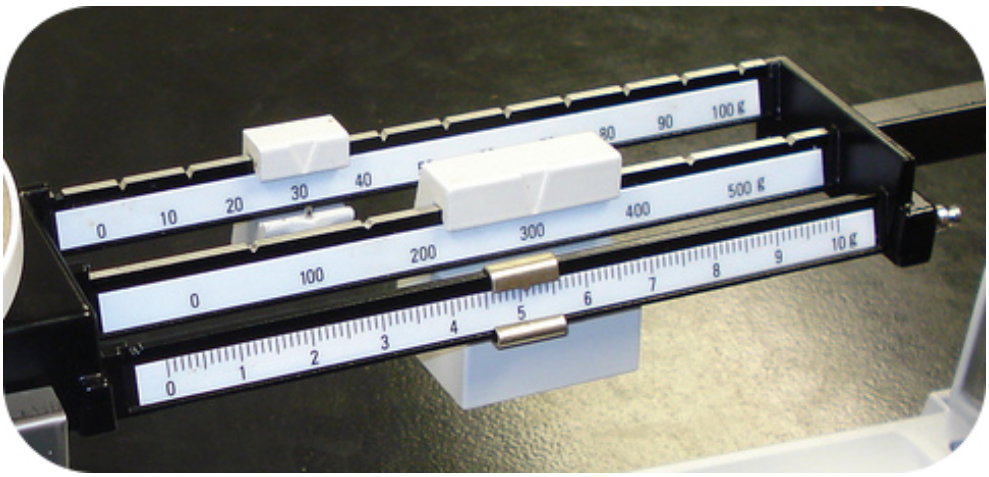
1. Place the object to be measured on the pan at the left side of the balance.
2. Slide the movable masses to the right until the right end of the arm is level with the balance mark. Start by moving the larger masses and then fine tune the measurement by moving the smaller masses as needed.
3. Read the 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.



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.



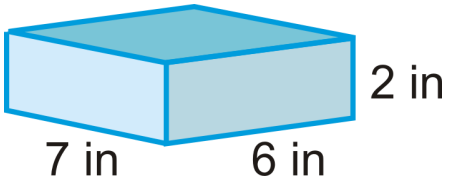
To measure very small masses, scientists use electronic balances, like the one in the Figure below. This type of balance also makes it easier to make accurate measurements because mass is shown as a digital readout. In the picture below, the balance is being used to measure the mass of a yellow powder on a glass dish. The mass of the dish alone would have to be measured first and then subtracted from the mass of the dish and powder together. The difference between the two masses is the mass of the powder alone.

Volume

The amount of space matter takes up is its volume. How the volume of matter is measured depends on its state.

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?

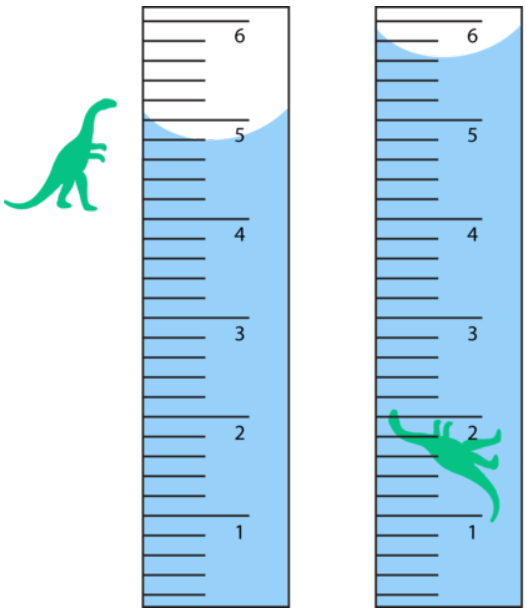


The volume of regularly shaped solids can be calculated from their dimensions. For example, the volume of a rectangular solid is the product of its length, width, and height (l × w × h).

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 (m3). However, cubic centimeters (cm3) 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.

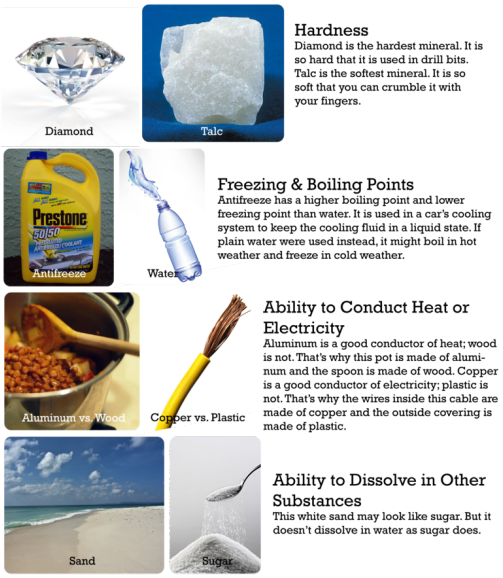
2. Place the object in the water in the graduated cylinder. Measure the volume of the water with the object in it.

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?

PHYSICAL PROPERTIES OF MATTER

Matter has many properties. Some are physical 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?

Density

Density is an important physical property of matter. It reflects how closely packed the particles of matter are. Density is calculated from the amount of mass in a given volume of matter, using the formula:

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

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 m3. What is its density?

REAL LIFE SCIENCE

Today you can measure the mass of the air in a basketball. Measure the mass of the basketball when deflated. Then inflate the ball 10 psi and measure the mass again. The difference in the masses will be the mass of the air in the ball!

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

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:

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

If you were asked if a lead fishing weight floats you would quickly answer no. But the correct answer depends of 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.

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.

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. What happens when an object with a lower density is placed in a container with an object with a higher density?
14. Explain how you could determine the mass and volume of a gas.

STANDARD 1: YOU WILL UNDERSTAND THE STRUCTURE OF MATTER

Objective 3: Students will investigate the motion of particles
Terms to Know: Temperature, Molecular Motion, Heat Energy, Diffusion, Expansion, and Contraction

THE MOVEMENT OF PARTICLES INTRODUCTION

The hot air and sand in Death Valley have a lot of thermal energy, or the kinetic energy of moving particles. But even cold objects have some thermal energy. That's because the particles of all matter are in constant random motion. If cold as well as hot objects have moving particles, what, if anything, does temperature have to do with thermal energy?

Temperature

No doubt you already have a good idea of what temperature is. You might define it as how hot or cold something feels. Temperature is defined as the amount of heat present in an object. When particles move more quickly, temperature is higher and an object feels warmer. When particles move more slowly, temperature is lower and an object feels cooler.

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

Diffusion

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.

Demonstration 1
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.

Demonstration 2
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?

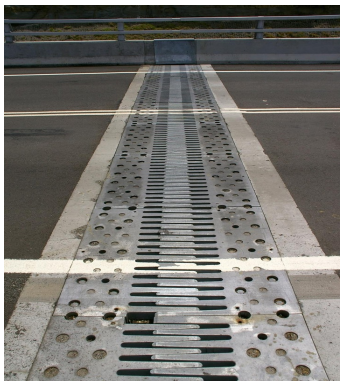
Explanation: The particles in a liquid move much more slowly than those in a gas. After a few minutes, the food coloring will have diffused throughout the entire beaker. Particles move faster when they are warmer, therefore, the beaker with the warm water diffused faster. What would happen if food coloring 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.

Expansion and Contraction:

When heat is added or removed, expansion and contraction can take place. If heat is added, the particles will move further apart and the object will expand. 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, it's volume increases. However, the mass stays the same. If volume increases, but mass remains constant, what will happen to density?

CC BY NC Photo from
http://www.flickr.com/photos/45012438@N00/297149472

When heat is removed, the particles in the object will get closer together and the object will contract, or get 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?



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.

You can also consider expansion and contraction when you think of sidewalks. Have you ever noticed the cracks 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. Why do sidewalks have cracks in them? Why not one long strip of concrete? Why have sidewalks come in sections? The answer: expansion. When a substance heats up it has a tendency to expand. That's because the molecules that make it up have a greater average kinetic energy, or in other words, they're all jostling and bumping into each other.

Think of it like a room full of people. When they're all standing still, they take up less space than when everyone is dancing. Individual parts bumping and pushing cause the whole to expand. 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.

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?

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 OBJECTIVE 1: I CAN UNDERSTAND THE RELATIONSHIP BETWEEN PROPERTIES OF MATTER AND EARTH'S STRUCTURE.

Terms to Know

- Density
- Mixture
- Particle
- Sorting

INTRODUCTION

The components of density are: mass and volume

Which one has more mass, a kilogram of feathers or a kilogram of bricks? Though many people will say that a kilogram of bricks is heavier, they actually have the same mass! However, many people confuse mass and density. This confusion causes them to answer the question incorrectly. A kilogram of feathers clearly takes up more space, but this is because it is less "dense." What is density, and how can it be calculated, and how can it be used?

Density is a physical property. It represents how tightly packed together particles in a substance are. Density is determined by dividing the mass of an object by its volume. Regardless of a sample size, density is always constant. For example, the density of a pure sample of gold is always 19.32 grams per cubic centimeter. This means that whether you have one gram or one kilogram of gold, the density will never vary.

Density, a famous concept that was discovered by Archimedes, can be expressed by a simple equation:

$$Density = \frac{Mass}{Volume}$$

or just

$$D = \frac{m}{v}$$

Keeping this equation in mind, let's move on to a more in-depth discussion of what mass and density mean in the real world.

In the laboratory, density can be used to identify substances. In daily life, density explains everything from why boats float to why air bubbles will try to escape from soda. It even affects your health because bone density is very important.

YouTube video of bubbles rising:
http://www.youtube.com/watch?v=r81Nc7z6v1Y

Based on the equation, it's clear that density can, and does, vary from substance to substance due to differences in the ratio of mass to volume.

WHAT ARE MASS AND VOLUME?

Mass

The mass of a 1kg cube is always 1kg whether it is on the top of a mountain, the bottom of the sea, or on the moon. There may be variations in the measurement of mass based on what scientific scale is used (e.g. a digital scale should be more accurate than a triple-beam balance.)

Volume

Volume describes the amount space an object takes up. The volume of a rectangular shaped object can be found by length * height * width. For and irregular shaped object you use water displacement.

Density: A Further Investigation

Units

The unit most widely used to express density is g/cm3 or g/mL. Grams per centimeter cubed are equivalent to grams per milliliter (g/cm3 = g/mL). To solve for density, simply follow the equation D = m/v. For example, if you had a metal cube with mass 7.0g and volume 5.0cm3, the density would be D = 7g/5cm3 = 1.4 g/cm3.

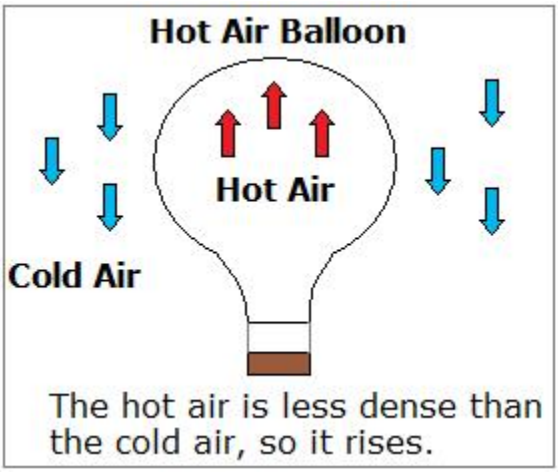
Notice how the density of various elements on the Periodic Table are represented in Table 1.2

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.

(Table 1.3)

Common Earth Materials	Density (g/cm3)
Air	.0013
Coal	1.4
Basalt	2.8
Granite	2.6
Limestone	2.3
Rock Salt	2.5
Sandstone	2.2
Water	1.0



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?

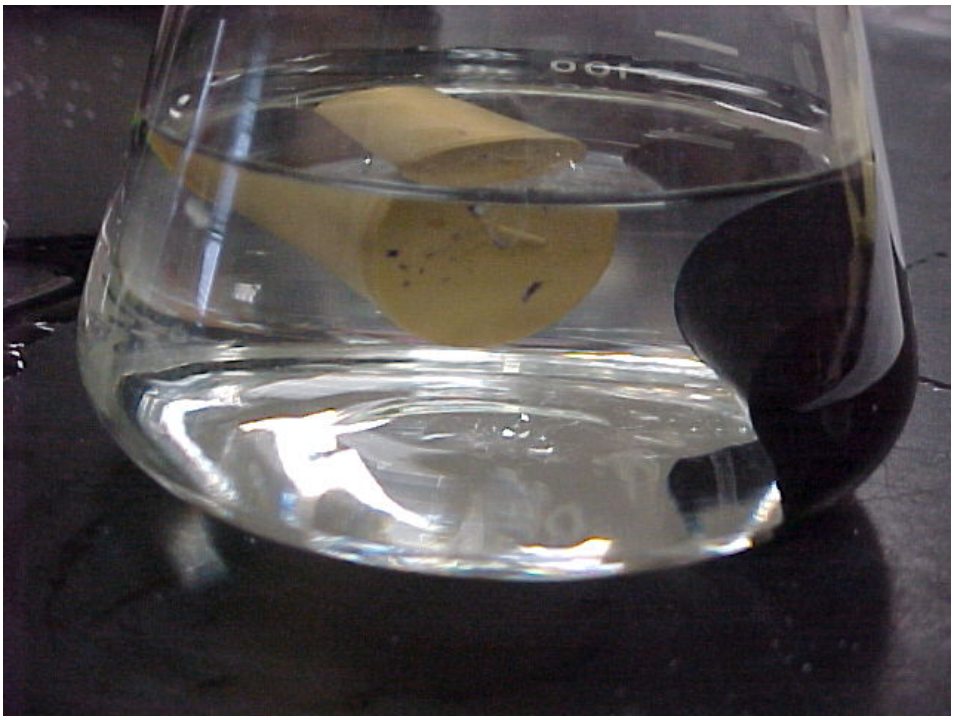


Photo by: Glen Westbroek

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.

Photo by: Glen Westbroek

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 cm3 sample of rock salt with mass of 10 grams, what is the density?
2) You have a 10 cm3 sample of water with a mass of 10 grams what is the density?
3) You have an unknown metal with a a volume of 4 cm3 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.

Answers

Here are the solutions to the listed practice problems.

Density Problem Solutions

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

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.

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

SUMMARY

Density is an important physical property of matter. It reflects how closely packed the particles of matter are.

The density of matter can be calculated by dividing its mass by its volume.

Vocabulary
Density: Amount of mass in a given volume of matter; calculated as mass divided by volume.

Review
1. What is density?
2. Find the density of an object that has a mass of 5 kg and a volume of 50 cm3.
3. Create a sketch that shows the particles of matter in two substances that differ in density. Label the sketch to show which substance has greater density.

Try It Yourself
Put various Earth materials (e.g. sand, gravel, and rocks) into a jar. Gently shake the jar and observe what happens.

How Flowing Water Causes Erosion and Deposition

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?

Sediment Transport

The size of particles determines how they are carried by flowing water. This is illustrated in Figure below.

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. (Figure below).

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

Photo by: Glen Westbroek

Deposition by Streams and Rivers

When a stream or river slows down, it starts dropping its sediments. Larger sediments are dropped in steep areas, but smaller sediments can still be carried. Smaller sediments are dropped as the slope becomes less steep.

Deposition by Flood Waters

A flood occurs when a river overflows it banks. This might happen because of heavy rains.

As the water spreads out over the land, it slows down and drops its sediment. If a river floods often, these deposits may develop a thick layer of rich soil

YouTube Video: Stream Erosion and Deposition Lab
http://www.youtube.com/watch?v=WWc5UeYvYZA
You can learn how different methods are used to mine minerals by reading more at
http://en.wikipedia.org/wiki/Spoil_Bank

STANDARD 2: I CAN ANALYZE HOW DENSITY AFFECTS EARTH'S STRUCTURE.

Terms to know

- Atmosphere
- Crust
- Inner Core
- Mantle
- Outer Core

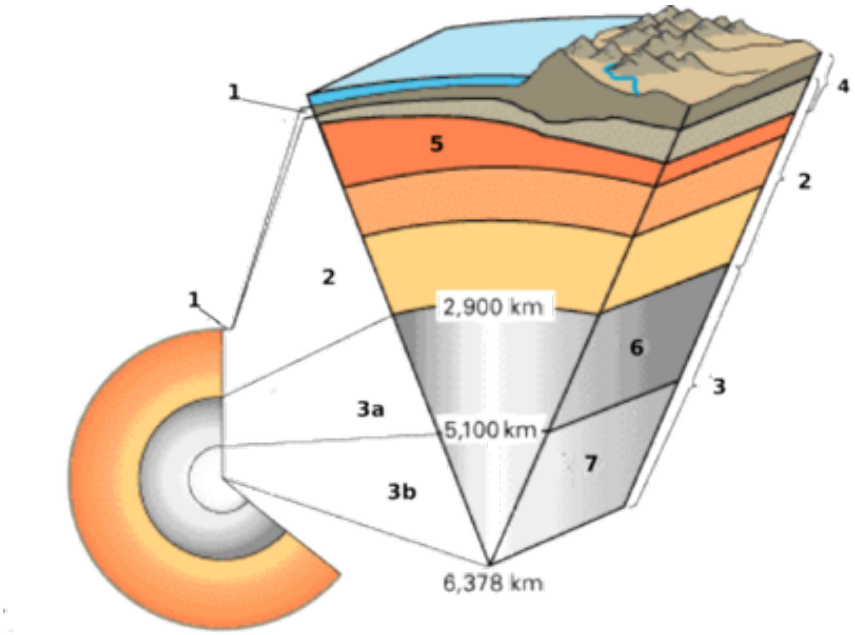
What's below our feet? What's way below?

If we could cut Earth open, we'd see the inner core at the center, then the outer core, the mantle in the middle and the crust on the outside. If you are talking about plates, though, there's the brittle lithosphere riding on the plastic asthenosphere. Whew!

Layers by Composition

The layers scientists recognize are pictured below (Figure below).

A cross section of Earth showing the following layers: (1) crust (2) mantle (3a) outer core (3b) inner core (4) lithosphere (5) asthenosphere (6) outer core (7) inner core.



Core, mantle, and crust are divisions based on composition:

The crust is less than 1% of Earth by mass. The crust is the least dense of Earth's solid layers.

The mantle is hot, molten rock. The mantle is separated into two layers based on its properties. The upper mantle behaves as a solid while the lower mantle has the ability to flow. The flow of this lower mantle is very slow. The mantle represents about 68% of Earth's mass.

The core is mostly iron metal and is divided into two layers. The outer core is liquid iron . and nickel The inner core is composed of the same materials but is in a solid state. Together the cores make up about 31% of the Earth. The inner core is the densest layer of Earth.

This animation shows the layers by composition and by mechanical properties:
http://earthguide.ucsd.edu/eoc/teachers/t_tectonics/p_layers.html

Layer	Approximate density
Water	1.0 g/mL
Crust	2.7-3.0 g/mL
Mantle	3.3-5.7 g/mL
Outer core	9.0-12.0 g/mL
Inner core	12.7-13.o g/mL

You are given the following materials and their densities and then asked to construct a model of the earth consisting of a core, mantle, crust, water, and air.

Cotton	0.2 g/mL
Glue	1.0 g/mL
clay	1.8 g/mL
Aluminum foil	2.4 g/mL
A Nickel	4.6 g/mL

Based on density, which of these materials would best represent the Earth's core?

How deep can we go into Earth's interior?

Not very deep, that's for sure! The deepest a drill hole has gone was the Kola Superdeep Borehole. That hole got to 40,230 feet (12,262 m), about one-third of the way into the crust in that area. So learning about what's deeper requires less direct methods. A few of these methods will be described in this lesson.

Learning About Earth's Interior

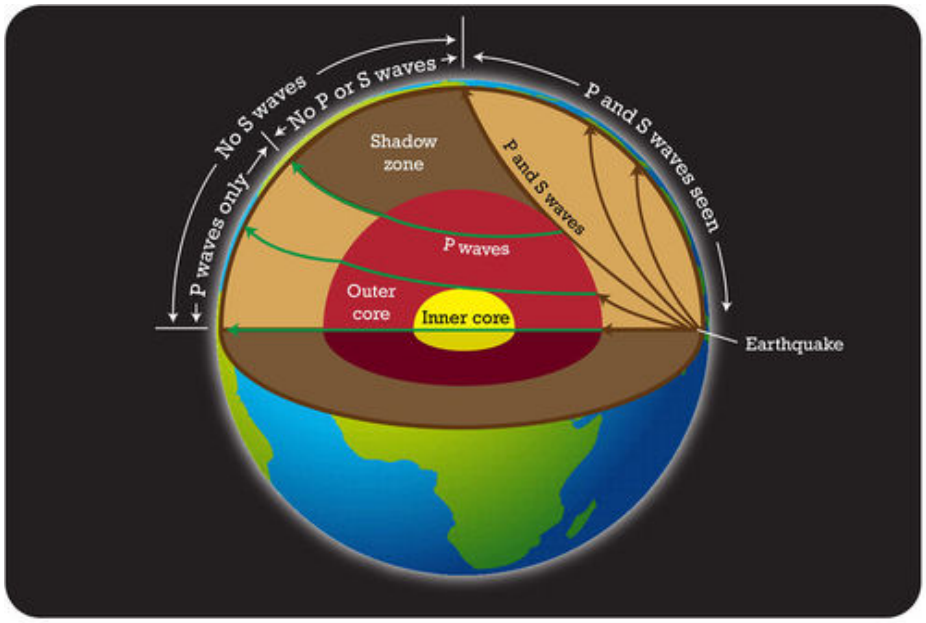
If someone told you to figure out what is inside Earth, what would you do? How could you figure out what is inside our planet? How do scientists figure it out?

Vocabulary

- Meteorite: Fragment of planetary bodies, such as moons, planets, asteroids, and comets, that strike Earth.
-
- seismic wave: Waves of energy that come from earthquakes.

Seismic Waves

Geologists study earthquake waves to "see" Earth's interior. Waves of energy radiate out from an earthquake's focus. These waves are called seismic waves (Figure below). Seismic waves go different speeds through different materials. They change speed when they go from one type of material to another. This causes them to bend. Some seismic waves do not travel through liquids or gases. They just stop. Scientists use information from seismic waves to understand what makes up the Earth's interior.



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!

Density

Earth's overall density is higher than the density of rocks on the crust, so the core must be made of something denser, like metal.

Magnetic Field
Since Earth has a magnetic field, there must be metal within the planet. Iron and nickel are both magnetic.

SUMMARY
Different types of seismic waves behave differently in different materials. Their behavior can tell scientists about the material they travel through.

Earth must contain metal. Its density, and the fact that it has a magnetic field, require it. Meteorites formed early in the solar system. They indicate something about Earth's interior.

Review Questions
1. What evidence do scientists use as proof that Earth's interior contains metal?
2. What do meteorites tell us about Earth's interior?
3. How do scientists use seismic waves to learn about Earth's interior?

Density of Air
Density is a measure of how closely molecules are packed together. The closer together they are, the greater the density. Since air is a gas, the molecules can pack tightly or spread out in a certain volume.

The density of air varies from place to place. Air density depends on several factors. One is temperature. Like other materials, warm air is less dense than cool air. Since warmer molecules have more energy, they are more active. The molecules bounce off each other and spread apart.

Gravity pulls more air molecules toward the center of the planet. Relative Densities: see the results from "Ask GeoMan"

http://jersey.uoregon.edu/~mstrick/AskGeoMan/geoQuerry57.html

Extension: Do the Earth Layers Project (.pdf file in image folder)

Reference:
http://adventuresinscience.edublogs.org/files/2009/02/earth-layers-project.doc
http://www.ouramazingplanet.com/3782-carbon-earth-core-model.html

Comparing models of Earth.

Visit each of the following websites and write down the accurate and inaccurate attributes for each layer of Earth in each Model.

http://scratch.mit.edu/projects/spatterwestga/2184758

Look closely at this model and write down accurate or inaccurate attributes.

Structure of the Earth

http://scign.jpl.nasa.gov/learn/plate1.htm

Questions:

1. Which of these sites provides the most accurate models of Earth's structure?
2. What evidence did you find to support your selection?

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.

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.

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.

CELLS

CHAPTER 3

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

INTRODUCTION TO CELLS

What are you made of?

Cells make up all living things, including your own body. This picture shows a typical group of cells. But not all cells look alike. Cells can differ in shape and sizes. And the different shapes usually means different functions.

A cell is the smallest structural and functional unit of an organism. Some organisms, like bacteria, consist of only one cell. Multicellular big organisms, like humans, 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.

Image by Rita Greer, Licensed under the Free Art License.

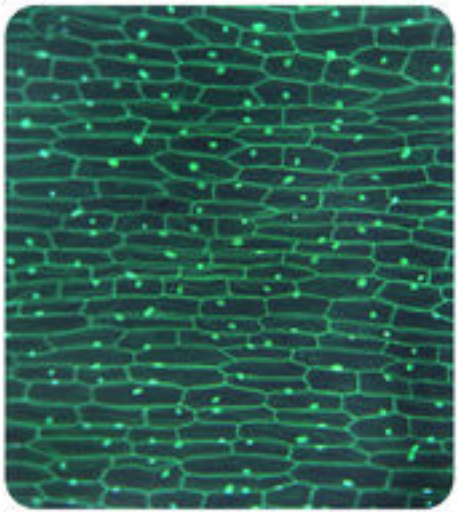
Observing Cells

Most cells are so small that you cannot see them without the help of a microscope. It was not until 1665 that English scientist Robert Hooke invented a basic light microscope and observed cells for the first time. You may use light microscopes in the classroom. You can use a light microscope to see cells. But 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?

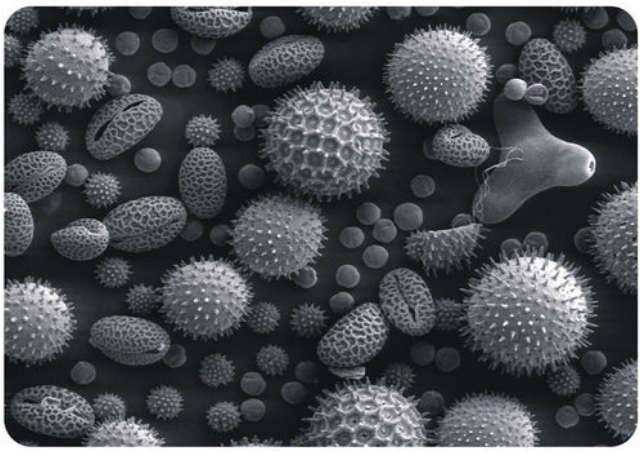
Terms to know

- Cell wall
- Central vacuole
- Chloroplast
- Cytoplasm
- Nucleus
- Organelle
- Cell membrane
- mitochondria

In the 1950s, scientists developed more powerful microscopes. A light microscope sends a beam of light through a specimen, or the object you are studying. 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.



The outline of onion cells are visible under a light microscope.



An electron microscope allows scientists to see much more detail than a light microscope, as with this sample of pollen.

Cell Theory

In 1858, after using microscopes much better than Hooke's first microscope, Rudolf Virchow developed the hypothesis that cells only come from other cells. For example, bacteria, which are single-celled organisms, divide in half (after they grow some) to make new bacteria. In the same way, your body makes new cells by dividing the cells you already have. In all cases, cells only come from cells that have existed before. This idea led to the development of one of the most important theories in biology, the cell theory.

Cell theory states that:

1. All organisms are composed of cells.
2. Cells are alive and the basic living units of organization in all organisms.
3. All cells come from other cells.

As with other scientific theories, many hundreds, if not thousands, of experiments support the cell theory. Since Virchow created the theory, no evidence has ever been identified to contradict it.

CELLS AND THEIR PARTS

You can think of the cell like a factory. A factory has many machines and people, and each has a specific role. Just like a factory, the cell is made up of many different parts. Each part has a special role. The different parts of the cell are called organelles, which means "small organs."

The Cell Membrane and Cytoplasm

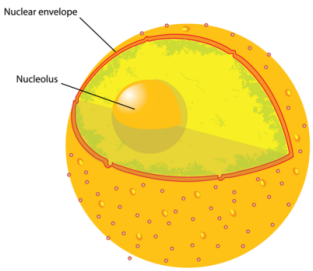
The function of the cell membrane is to control what goes in and out of the cell. Some molecules can go through the cell membrane to enter and leave the cell, but some cannot. "Permeable" means that anything can cross a barrier. An open door is completely permeable to anything that wants to enter or exit through the door. The cell membrane is semipermeable, meaning that some things can enter the cell and some things cannot.

The inside of cells is filled with cytoplasm, the gel-like substance between the cell membrane and the cell's nucleus, which holds the organelles in place and fills the cell. Everything in the cell - the nucleus and the organelles - sit in the cytoplasm, like fruit in a Jell-O mold.

Cell Parts

Just like a factory, the cell is made of different parts that do specific roles.

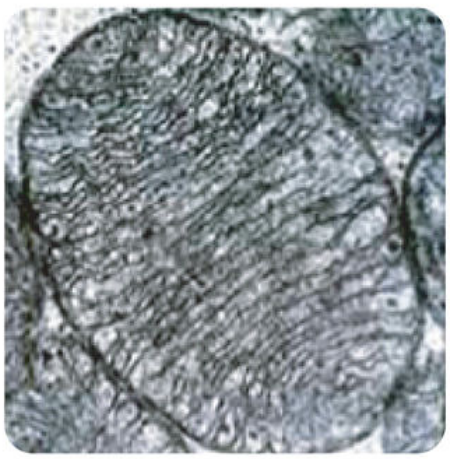
Below are the cell parts:
The Nucleus

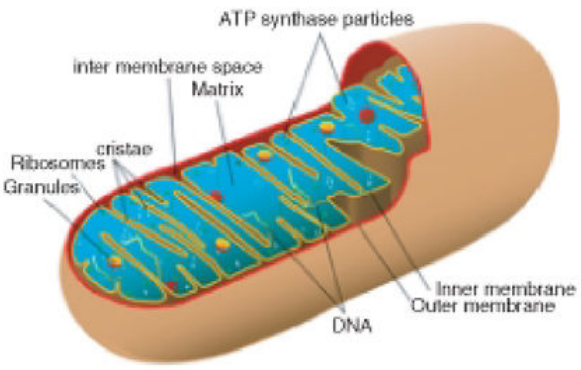


The nucleus of a cell is like a safe containing the factory's trade secrets, including information about how to build. The cell nucleus contains most of the genetic information and controls all the activities of the cell. Within the nucleus is the nucleolus (smaller yellow ball).

The Mitochondria

The mitochondria are powerhouses that create ATP (adenosine triphosphate), which provides the energy needed to power chemical reactions. This is called cellular respiration. The process requires energy in the form of glucose or sugar and oxygen from the blood stream. Cellular respiration produces energy from the sugar in the form of ATP as well as carbon dioxide or CO2 and water. The CO2 is removed by exhaling through the lungs in an organism.





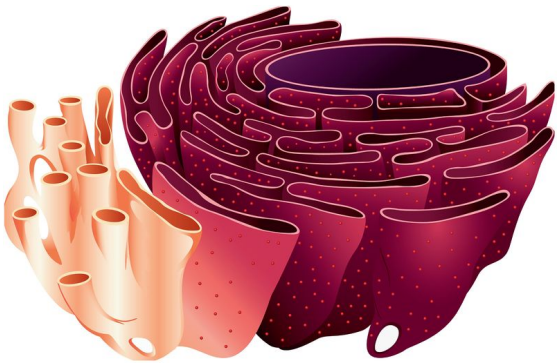
The Vacuole

The vacuoles are like storage centers. Plant cells have larger ones than animal cells because they need to store water and other nutrients. Vacuoles are membrane-bound organelles that can have secretory, excretory, and storage functions. Many organisms will use vacuoles as storage areas and some plant cells have very large vacuoles. Vesicles are much smaller than vacuoles and function in transporting materials both within and to the outside of the cell.

The Lysosome

The lysosomes are like the recycling trucks that carry waste away from the factory. Inside lysosomes are enzymes that break down old molecules into parts that can be recycled into new ones. Lysosomes are vesicles that are formed by the Golgi apparatus. They contain powerful enzymes that could break down (digest) the cell. Lysosomes break down harmful cell products, waste materials, and cellular debris and then force them out of the cell. They also digest invading organisms such as bacteria. Lysosomes also break down cells that are ready to die.

The Endoplasmic Reticulum

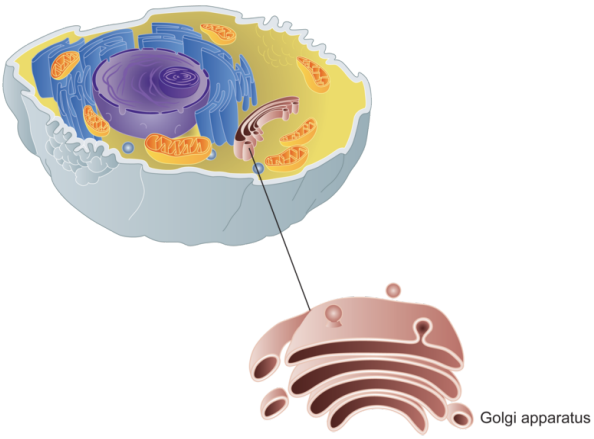


Some ribosomes can be found on folded membranes called the endoplasmic reticulum (ER). If the ER is covered with ribosomes, it looks bumpy and is called rough endoplasmic reticulum. If the ER does not contain ribosomes, it is smooth and called the smooth endoplasmic reticulum. Proteins are made on the rough ER. Lipids are made on the smooth ER. The endoplasmic reticulum (ER) (plural, reticuli) is a network of phospholipid membranes that form hollow tubes, flattened sheets, and round sacs. These flattened, hollow folds and sacs are called cisternae.

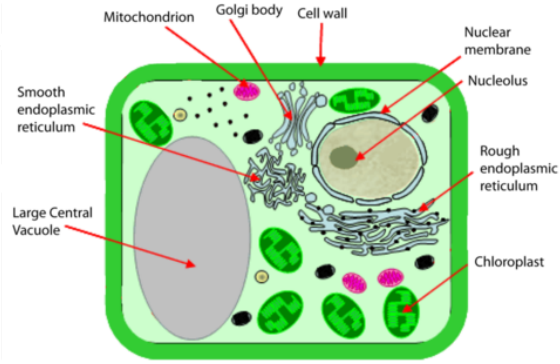
The Golgi Apparatus

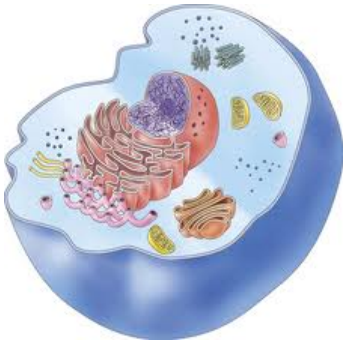
The Golgi apparatus, works like a mail room. The Golgi apparatus receives the proteins from the rough ER, puts "shipping addresses" on the proteins, packages them up in vesicles, and then sends them to the right place in the cell. The Golgi apparatus is a large organelle that is usually made up of five to eight cup-shaped, membrane-covered discs. They look a bit like a stack of deflated balloons. The Golgi apparatus modifies, sorts, and packages different substances for secretion out of the cell, or for use within the cell. The Golgi apparatus is found close to the nucleus of the cell, where it modifies proteins that have been delivered in transport vesicles from the RER. It is also involved in the transport of lipids around the cell. Pieces of the Golgi membrane pinch off to form vesicles that transport molecules around the cell. The Golgi apparatus can be thought of as similar to a post office; it packages and labels "items" and then sends them to different parts of the cell.

Both plant and animal cells have a Golgi apparatus. Plant cells can have up to several hundred Golgi stacks scattered throughout the cytoplasm. In plants, the Golgi apparatus contains enzymes that synthesize some of the cell wall polysaccharides.



Differences between Plant and Animal Cells

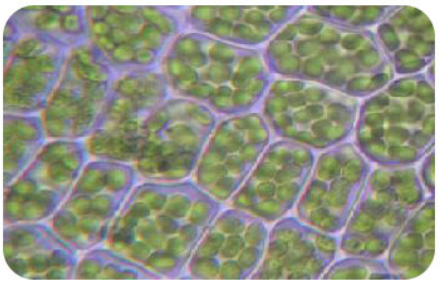




Plant Cell

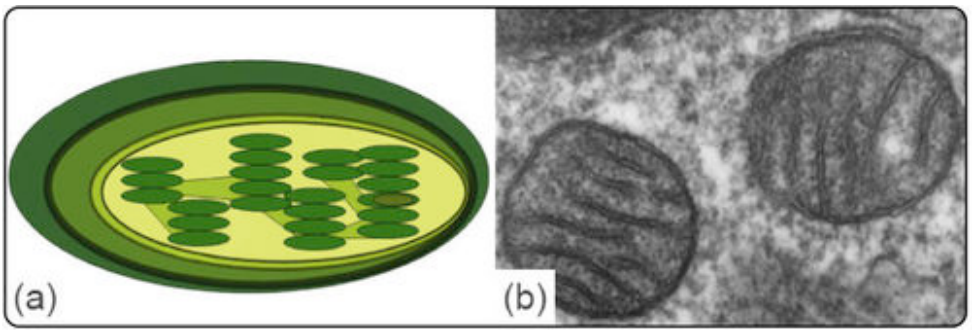
Animal Cell

http://monstara.deviantart.com/art/Animal-cell-49149164

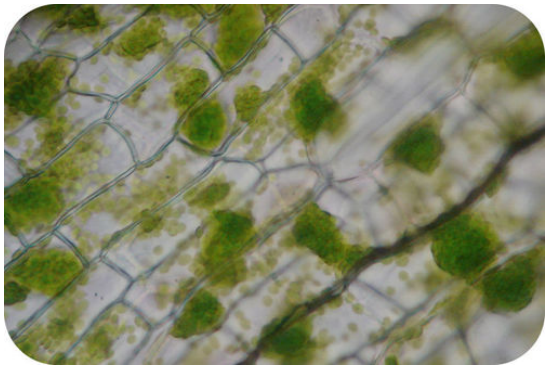


Even though plants and animals are both made of cells, plant cells differ in some ways from animal cells. First, plant cells have a cell membrane and a cell wall that supports and makes the cell somewhat rigid. Plant cells need this cell wall because they do not have a skeleton to offer the strength 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.



Chloroplasts are also found in plant cells. These green structures make food for the plant by converting sunlight into sugar. Plants need chloroplasts to make their own food because they cannot obtain it from other sources.



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.)

LESSON SUMMARY

Organelle	Plant	Animal
Cell Wall		
Cell Membrane		
Cytoplasm		
Nucleus		
Mitochondria		
Central Vacuole		
Lysosomes		
Endoplasmic Reticulum		
Golgi Complex		
Chloroplast		

Each component of a cell has a specific function.
Plant cells are different from animal cells. For example, plant cells contain chloroplasts, cell walls, and large vacuoles.

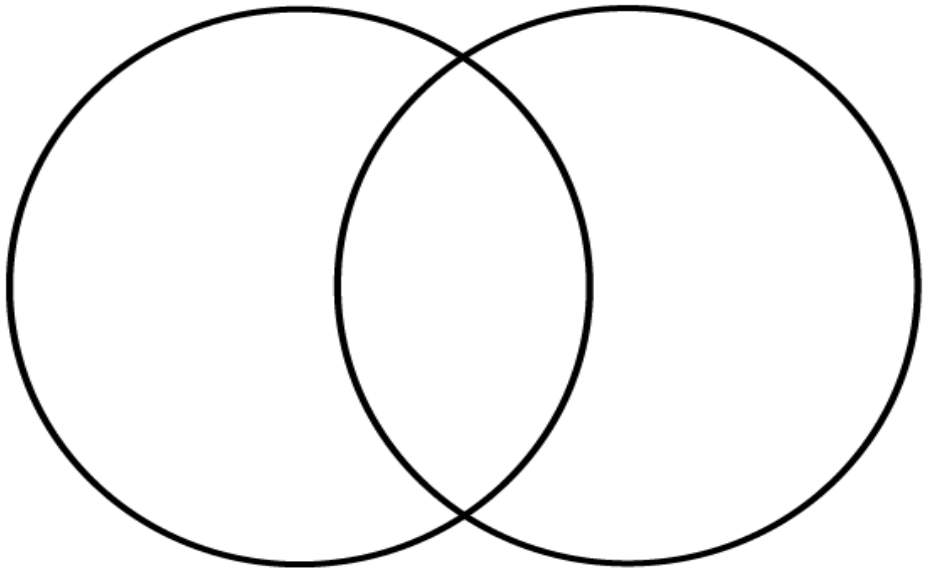
Review Questions

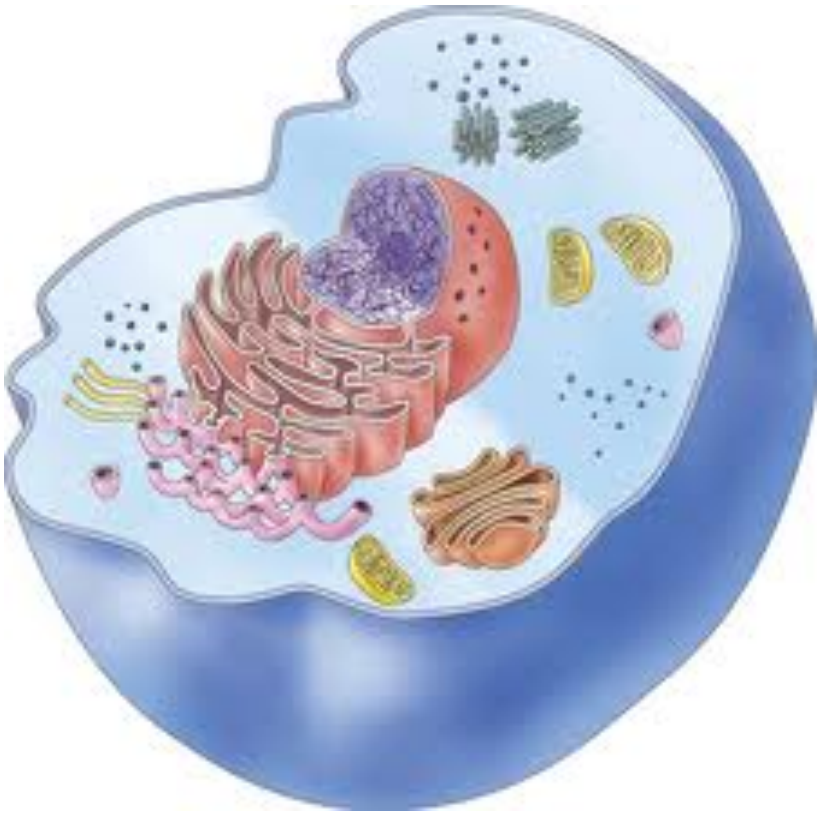
Recall

1. What are the differences between plant and animal cells?
2. What are organelles?
3. Fill out the following Venn diagram comparing and contrasting plant and animal cells.

Plant Cell Animal Cell

4.





http://monstara.deviantart.com/art/Animal-cell-49149164

Apply Concepts

5. What is the cell membrane and what is its role?
6. Why is the mitochondria known as the powerhouse of the cell?

Think Critically

7. Why does photosynthesis not occur in animal cells?

Further Reading / Supplemental Links

Baeuerle, Patrick A. and Landa, Norbert. The Cell Works: Microexplorers. Barron's; 1997, Hauppauge, New York.

Sneddon, Robert. The World of the Cell: Life on a Small Scale. Heinemann Library; 2003, Chicago.

Wallace, Holly. Cells and Systems. Heinemann Library; 2001, Chicago.

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.

STANDARD 3: STUDENTS WILL UNDERSTAND THAT THE ORGANS IN AN ORGANISM ARE MADE OF CELLS THAT HAVE STRUCTURES AND PERFORM SPECIFIC LIFE FUNCTIONS.

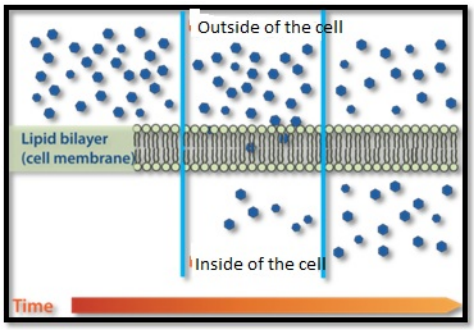
Objective: 1 Observe and describe cellular structures and functions.

What 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

Small molecules can pass through the cell membrane through a process called diffusion. Diffusion is the 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. The amount of a substance in relation to the total volume is the concentration. During diffusion, molecules move from an area of high concentration to an area of low concentration. This is a natural process and does not require energy. Diffusion can occur across a semipermeable membrane, such as the cell membrane. Molecules will continue to flow in this manner until equilibrium is reached. At equilibrium, there is no longer an area of high concentration or low concentration.



Diffusion is the movement of a substance from an area of a higher concentration toward an area of lower concentration. Equilibrium is reached when there is an equal amount of the substance on both sides of the membrane.

Terms to know:

- Diffusion
- Osmosis

Osmosis

Similar to diffusion, osmosis ONLY involves WATER moving across a semipermeable membrane. In the case of the cell, the semipermeable membrane is the cell membrane. The diffusion of water across a membrane because of a difference in concentration is called osmosis. Let's explore three different situations and analyze the flow of water.

Water Moving out of the Cell

A hypotonic solution means the environment outside of the cell has a lower concentration of dissolved material than the inside of the cell. If a cell is placed in a hypotonic solution, water will move into the cell. This causes the cell to swell, and it may even burst.

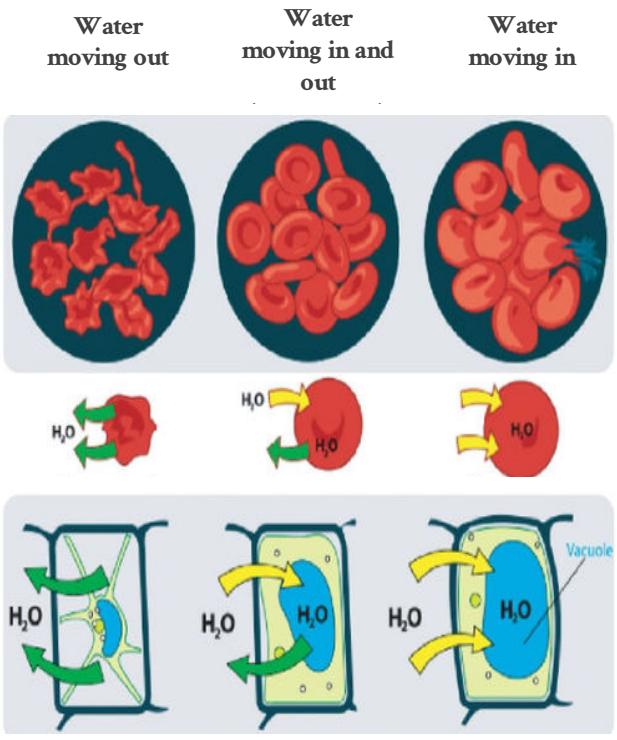
Water Moving in and out of the Cell

An isotonic solution is a solution in which the amount of dissolved material is equal both inside and outside of the cell. Water still flows in both directions, but an equal amount enters and leaves the cell.

Water Moving Into the Cell

A hypertonic solution means the environment outside of the cell has more dissolved material than inside of the cell. If a cell is placed in a hypertonic solution, water will leave the cell. This can cause a cell to shrink and shrivel.

A cell that does not have a rigid cell wall, such as a red blood cell, will swell and lyse (burst) when placed in a hypotonic solution. Cells with a cell wall will swell when placed in a hypotonic solution, but once the cell is turgid (firm), the tough cell wall prevents any more water from entering the cell. When placed in a hypertonic solution, a cell without a cell wall will lose water to the environment, shrivel, and probably die. In a hypertonic solution, a cell with a cell wall will lose water too. The cell membrane pulls away from the cell wall as it shrivels, a process called plasmolysis. Animal cells tend to do best in an isotonic environment and, plant cells tend to do best in a hypotonic environment.



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, which is a hypertonic environment; 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 isotonic to the blood cells. If the blood cells were put in pure water, the solution would be hypotonic to the blood cells, so 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?

SUMMARY

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

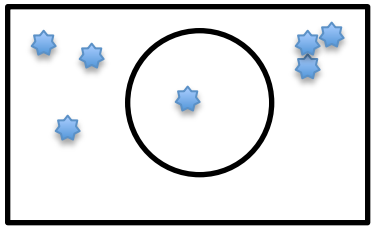
The diffusion of water across a membrane because of a difference in concentration is called osmosis.

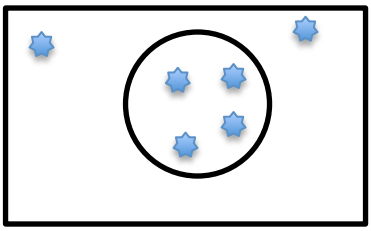
Review

Describe the process of diffusion.
Describe the process of osmosis and relate the motion of particles in your response.

Practice Problems:

An animal cell is placed in two different types of solutions. Draw arrows showing the flow of water.





Additional Practice:

Osmosis and Diffusion Interactive:
http://www.bbc.co.uk/schools/gcsebitesize/science/add_aqa_pre_2011/cells/osmosisact.shtml

Use the resource below to answer the following questions.
Osmosis at:
http://www.youtube.com/watch?v=7-QJ-UUXOiY
What is osmosis? What drives this process?

STANDARD 3: STUDENTS WILL UNDERSTAND THAT THE ORGANS IN AN ORGANISM ARE MADE OF CELLS THAT HAVE STRUCTURES AND PERFORM SPECIFIC LIFE FUNCTIONS.

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

ORGANIZATION OF LIVING THINGS.

What does this mean?

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.

Levels of Organization

The living world can be organized into different levels. For example, many individual organisms can be organized into the following levels:

Cell: Basic unit of all living things.

Tissue: Group of the same kind of cells working together.

Organ: Structure composed of two or more types of tissues working together.

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

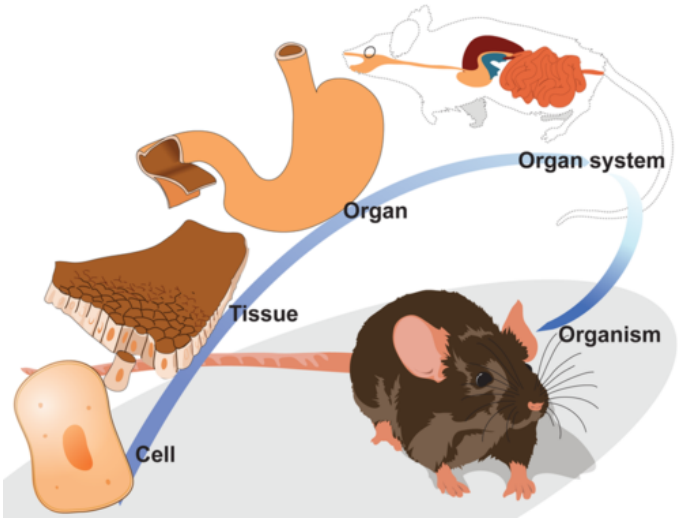
Organism: Individual living thing that may be made up of two or more organ systems.

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

Terms to know

- Cell
- Tissue
- Organ
- Organ System
- Organism

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



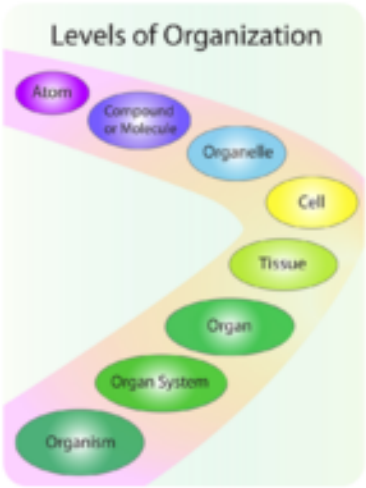
An individual mouse is made up of several organ systems. The system shown here is the digestive system, which breaks down food into a form that cells can use. One of the organs of the digestive system is the stomach. The stomach, in turn, consists of different types of tissues. Each type of tissue is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

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

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 component that can still be considered living. If a cell were broken down further, it would no longer be considered living on its own. But what makes up a cell? Cells are made up of smaller structures called organelles, which are made up of molecules, which are made up of the smallest unit of matter, the atom! See the figure below to see how all levels are related.



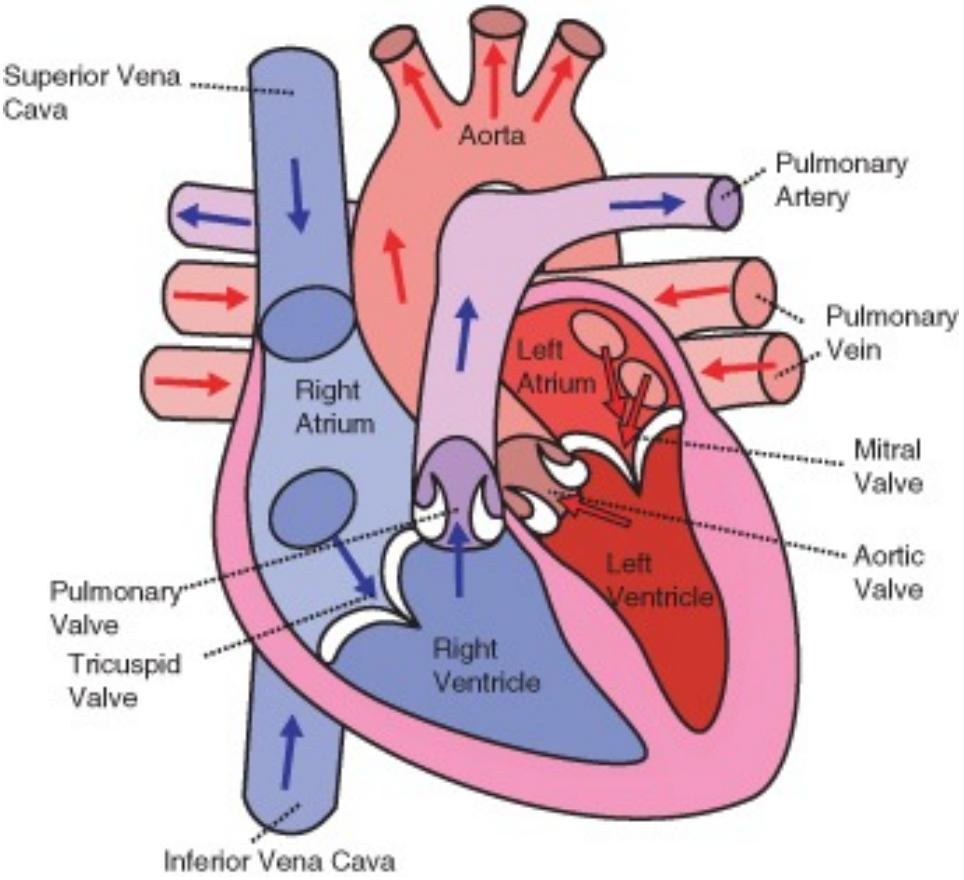
What about plants?

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. Roots and leaves would be examples of organs.

Why do organs have different structures?

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



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

We can also consider the respiratory system. One organ in the respiratory system is the trachea. The trachea is made of stiff rings made of cartilage (touch the tip of your nose, the stiff tissue you feel is cartilage) that keep it from collapsing. What would happen to the respiratory system if the trachea were made of a soft, flexible tissue instead of the stiff cartilage?

You can also watch a detailed animation of the respiratory system at this link: **http://www.youtube.com/watch?v=HiT621Prr00.**

How do cells, tissues, organs, and organ systems meet the needs of the organism?

This section is adapted from **http://lyceum.algonquincollege.com/lts/AandPResources/module1-4.htm?sectionID=1. The images are by Mariana Ruiz Villarreal.**

Organisms must be able to carry out several functions in order to maintain life. If any of these necessary life functions are disrupted, the organism may not survive. In addition to carrying out necessary life functions, organisms have basic survival needs that must be present within an acceptable range in order to sustain life.

Each species of organism is uniquely capable of performing its necessary life functions and fulfilling its survival needs.

PART 1: NECESSARY LIFE FUNCTIONS

1. Maintain boundaries
Separate the internal and external environments. This can be done by the body's largest organ, the skin. Can you imagine if all your organs were exposed to the outside environment?

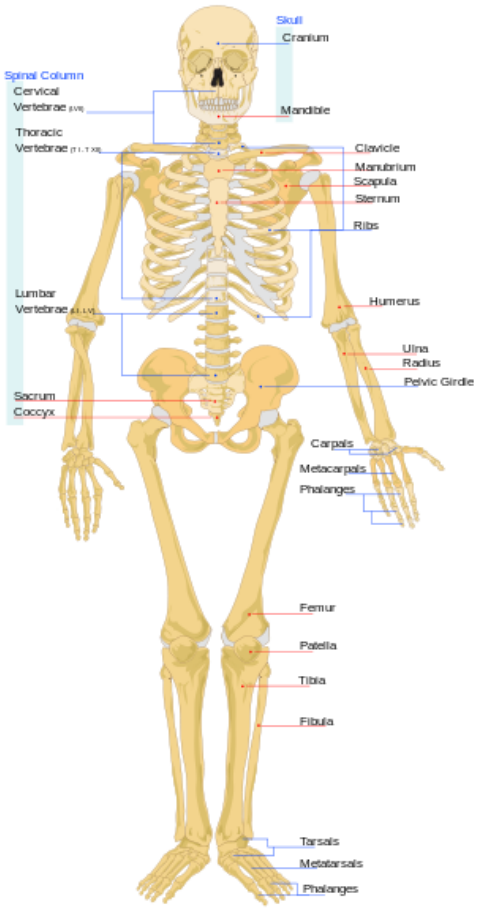
2. Move
Locomotion. Did you know that your bones are considered organs? Without muscle and bone making up the musculoskeletal system, movement would not be possible. The organs making up the nervous system, like the brain and spinal cord are also necessary for movement. In fact, if the spinal cord is severely damaged a person can lose the ability to move.

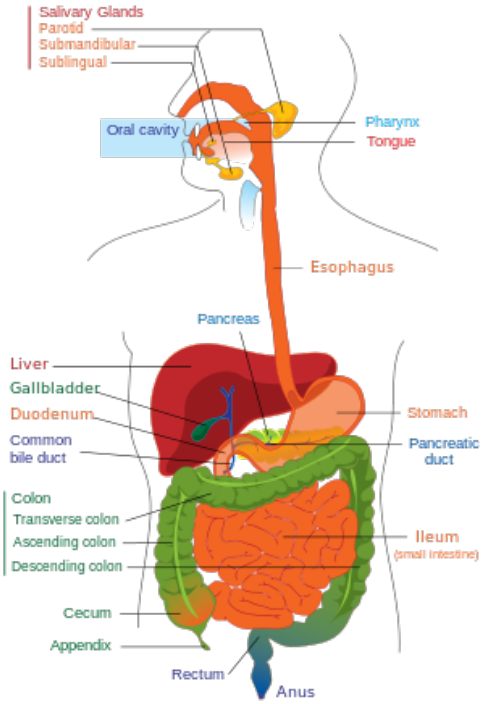
3. Respond and react
Behavioral reactions and responses. This is also a main job of the nervous system. Sensory information has to be brought to the brain where it is processed, and then the appropriate reaction can occur. Imagine you touch your hand to a hot stove. Your nervous system allows a response and then allows you to react by removing your hand. Plants also have this ability. The stoma, present in the leaves of plants, can open or close depending on changing conditions.

4. Ingest and digest nutrients
Food is taken in (ingested) and broken down (digested) into molecules that can be used by the body for energy and the maintenance of the balance of body chemicals. In animals, the digestive system allows for this process. The organs you probably think if when you think of your digestive system are the stomach and intestines. What would happen if you could not take in or process any nutrients?

6. Eliminate wastes
The by-products of digestion and metabolism must be eliminated from the body.
Body wastes are toxic and must be eliminated before they reach damaging levels.
The digestive and excretory systems help with this process. For example, the kidney, which is part of the excretory system, filters the blood in order to get rid of waste.
What do you think would happen if you could not get rid of waste?

7. Respiration
This is the process of bringing oxygen into the organism in order to be delivered to the cells. At the cellular level, this process occurs in the mitochondria.
Oxygen is removed from the air and transported to body cells by the respiratory and cardiovascular systems.


Skull
Cranium
Spinal Column
Cervical
Vertebrae (C1–C7)
Mandible
Thoracic
Vertebrae (T1–T12)
Clavicle
Manubrium
Scapula
Sternum
Ribs
Lumbar
Vertebrae (L1–L5)
Humerus
Ulna
Radius
Pelvic Girdle
Sacrum
Coccyx
Carpals
Metacarpals
Phalanges
Femur
Patella
Tibia
Fibula
Tarsals
Metatarsals
Phalanges


Salivary Glands
Parotid
Submandibular
Sublingual
Oral cavity
Pharynx
Tongue
Esophagus
Pancreas
Liver
Gallbladder
Duodenum
Common
bile duct
Stomach
Pancreatic
duct
Colon
Transverse colon
Ascending colon
Descending colon
Ileum
(small intestine)
Cecum
Appendix
Rectum
Anus

REVIEW QUESTIONS:

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

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

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

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

5. 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.
_____
_____
_____

6. 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.

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.

Golgi apparatus: Organelle that processes and packages proteins.

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

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

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).

Tissue: Group of cells of the same kind.

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

GENETICS

CHAPTER 4

STANDARD 4
STUDENTS WILL UNDERSTAND THAT OFFSPRING INHERIT TRAITS THAT MAKE THEM MORE OR LESS SUITABLE TO SURVIVE IN THE ENVIRONMENT.

Terms To Know

- Dna
- Genetics
- Offspring
- Chromosomes

GENETICS

What Is Genetics?

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

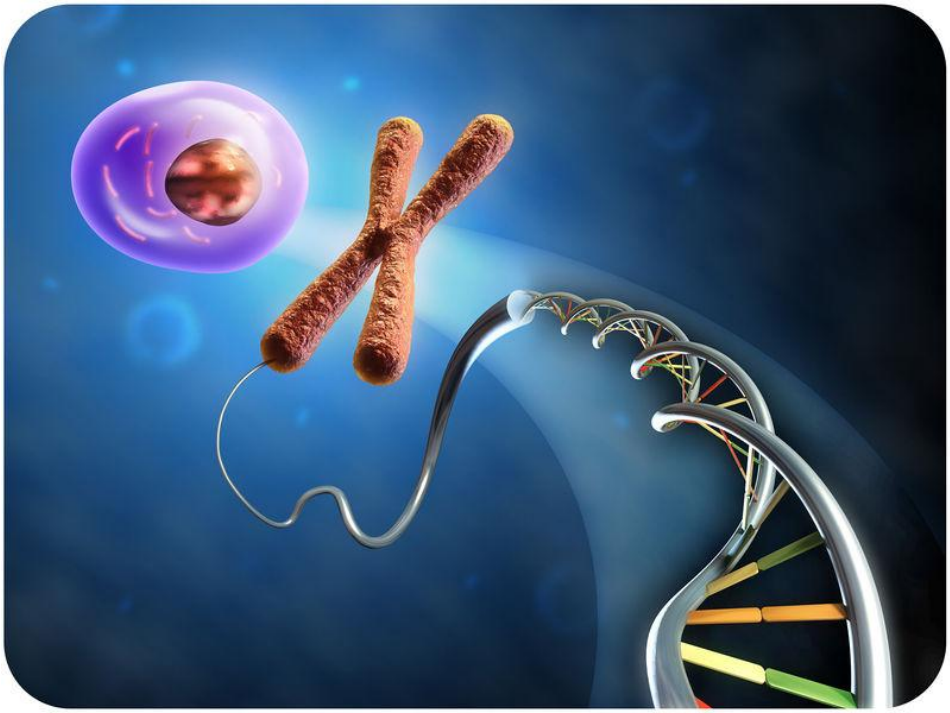
The above puppies are offspring from the same parents. Why don't the puppies look identical to each other? Do you think they are identical to their parents? Or do you think they have some traits from their mother and some from their father?

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 in the DNA. It is just not expressed. You don't look identical to your parents or to your grandparents. But many of their traits are passed down to you.

Genetics is the study of inheritance. The field of genetics seeks to explain how traits are passed on from one generation to the next.

What is DNA?

DNA is the material that makes up our chromosomes 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.



STANDARD 4: OBJECTIVE 1– GENETIC INFORMATION IS PASSED FROM PARENT TO OFFSPRING

Students will be able to compare sexual and asexual reproduction
Students will be able to identify genetic information as an inherited trait

STANDARD 4: OBJECTIVE 1: A
Students will be able to distinguish between inherited and acquired traits.

Terms to know

- Inherited trait
- Acquired trait
- Traits
- Recessive
- Homozygous
- Heterozygous
- Factors

ACQUIRED VERSUS INHERITED TRAITS

Mendel's Experiments

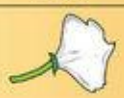
What does the word "inherit" mean? You may have inherited something of value from a grandparent or another family member. To inherit is to receive something from someone who came before you. You can inherit objects, but you can also inherit traits. A trait is a genetically determined characteristic. 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!

Gregor Mendel

An introduction to heredity can be seen at **http://www.youtube.com/user/khanacademy#p/c/7A9646BC5110CF64/12/eEUvRrhmcxM (17:27).**

In the late 1850s, an Austrian monk named Gregor Mendel (Figure below) performed the first genetics experiments. To study genetics, Mendel chose to work with pea plants because they have easily identifiable traits (Figure below). 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

Traits of pea plants.

He 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 had two hereditary factors for each trait. There were two possibilities for each hereditary factor, such as short or tall. One factor is dominant to the other. Dominant traits are represented by a capital letter in a Punnett Square. For example, purple is a dominant trait and is represented by B. The other trait that is masked is called the recessive factor, meaning that when both factors are present, only the effects of the dominant factor are noticeable. Recessive traits are represented by a lower case letter in a Punnett Square. For example, white is a recessive trait and is represented by b.

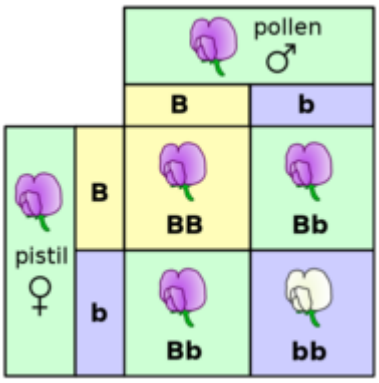
When you have two dominant factors together (ex. BB) it is called homozygous dominant. When you have one of each factor (ex. Bb), it is called heterozygous . When you have two recessive factors together (ex. bb) it is called homozygous recessive.

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.

An explanation of Punnett squares can be viewed at
http://www.youtube.com/user/khanacademy#p/c/7A9646BC5110CF64/13/D5ymMYcLtv0 (25:16).

This 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.

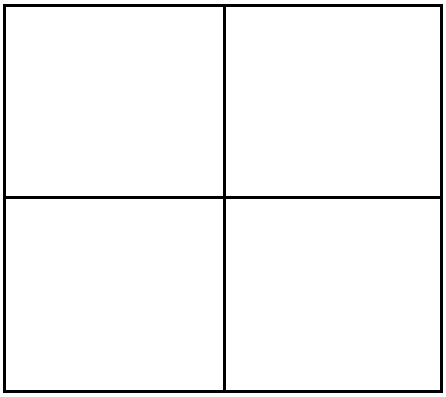
How to Make a Punnett Square
To create a Punnett Square, perform the following steps:

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 next to them.**

Practice filling in a Punnett square below:

Trait - Seed Color
Y = Yellow
y = green

Trait - Plant Height
T = Tall
t = Short



(Please put Punnett square practice boxes and explanations side by side.)

Practice more Punnett squares here:

http://www.zerobio.com/drag_gr11/mono.htm
http://www2.edc.org/weblabs/WebLabDirectory1.html

Acquired and Inherited

In all of Mendel's experiments, the traits he observed in the plants were inherited from the parent plants, like color. These are called inherited traits. Some traits are learned, like playing the piano, and are called acquired traits. These are not inherited from parents. The chart below lists some inherited and acquired traits. Fill in the rest on your own.

ACQUIRED	INHERITED
Good at basketball	Eye color
Artistic	Hair color
Good at math	Height

STANDARD 4: OBJECTIVE 1: B AND C STUDENTS WILL BE ABLE TO CONTRAST THE EXCHANGE OF GENETIC INFORMATION IN SEXUAL AND ASEXUAL REPRODUCTION.

Students will be able to identify organisms that reproduce sexually
Students will be able to identify organisms that reproduce asexually

Terms to know

- Sexual reproduction
- Asexual reproduction
- Reproduce

SEXUAL VERSUS ASEXUAL REPRODUCTION

Do plants and animals always have two parents? No, not all living things have two parents. Some plants and animals can be produced from just one parent. Some reptiles, such as this Komodo dragon, have only one parent.

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

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:

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

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. 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.

Quaking aspen trees can grow from the roots of adult plants. The process of creating offspring from just one individual is called asexual reproduction. When two parents, such as cows, cats, and dogs create a new organism, it is called sexual reproduction.

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

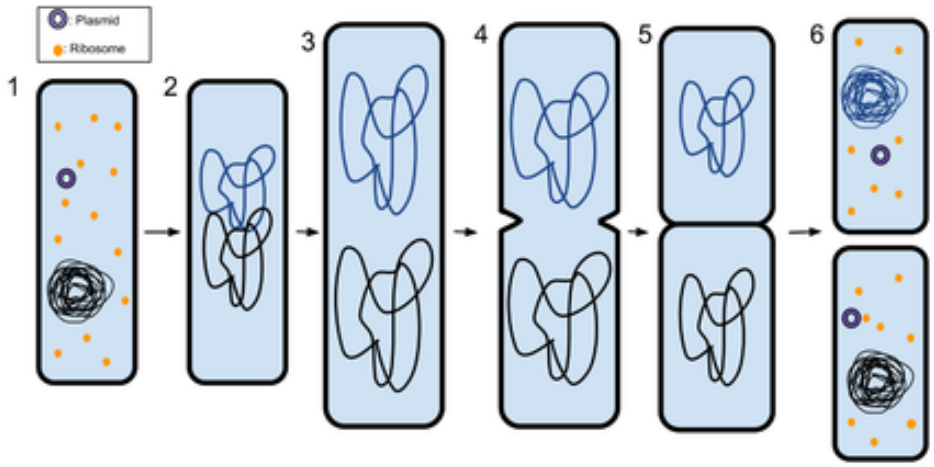
Asexual reproduction: the process of forming a new individual from a single parent. The offspring have no genetic variation.

Sexual reproduction: the process of forming a new individual from two parents. The offspring have new combinations of their parents' genes.

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.



CC BY SA image from http://en.wikipedia.org/wiki/Fission_(biology)

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?

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

STANDARD 4: OBJECTIVE 1:D STUDENTS WILL BE ABLE TO IDENTIFY STRUCTURAL TRAITS OF OFFSPRING STUDENTS WILL BE ABLE TO IDENTIFY STRUCTURAL TRAITS OF PARENTS

Terms to know

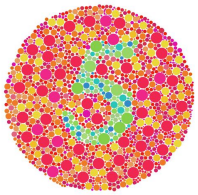
- Structure
- Inherited
- Traits

INHERITED STRUCTURAL TRAITS

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/

What number can you see?



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.

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.

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.

You can watch a video explaining how pedigrees are used and what they reveal at this link:
http://www.youtube.com/watch?v=HblHjsn5cHo.

Widow's peak and hitchhiker's thumb are dominant traits controlled by a single autosomal gene.

STANDARD 4: OBJECTIVE 2 STUDENT WILL BE ABLE TO RELATE ADAPTABILITY OF AN ORGANISM IN AN ENVIRONMENT TO THEIR INHERITED TRAITS AND STRUCTURES.

Terms to know

- Adaptability
- Environment

ADAPTABILITY AND INHERITED TRAITS

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 evolution 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 is the habitat that an organism lives. It can influence the traits that are expressed by an organism.

Darwin's Observations And 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 (Figure below) was also fascinated by the diversity of living things on earth.

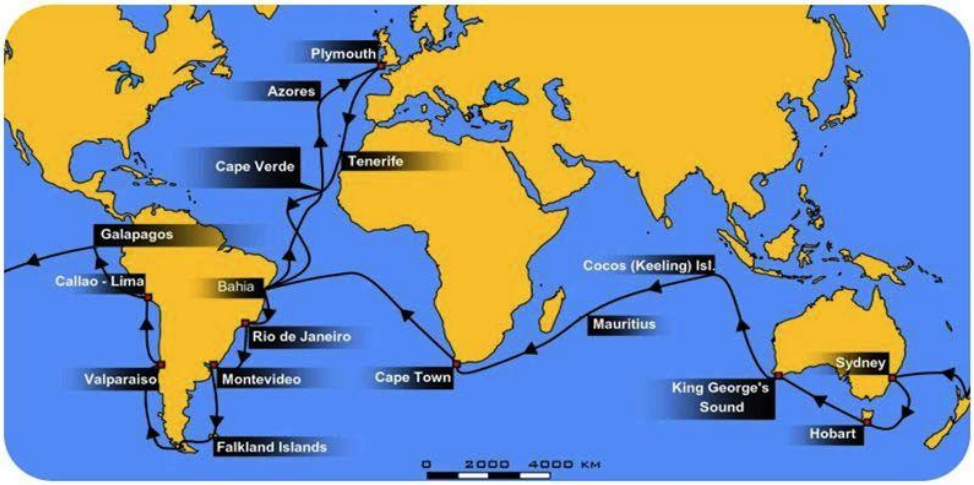
He set out to answer the following questions:
Why are organisms different?
Why are organisms similar?
Why are there so many different types of organisms?

To answer his questions, he developed what we now call "the theory of evolution by natural selection." This theory is one of the most important theories in the field of life science. In everyday English, "evolution" simply means "change". In biology, evolution is the process that explains why species change over time. Darwin spent over 20 years traveling around the world and making observations before he fully developed his theory.

Charles Darwin was one of the most influential scientists who has ever lived. Darwin introduced the world to the theory of evolution by natural selection, which laid the foundation for how we understand the living world today.

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.

STANDARD 4: OBJECTIVE 2: A STUDENTS WILL BE ABLE TO PREDICT WHY CERTAIN TRAITS ARE MORE LIKELY TO OFFER AN ADVANTAGE FOR SURVIVAL OF AN ORGANISM.

Terms to know

- Adaptation
- Inherited Traits
- Trait

SURVIVAL AND TRAITS

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. Darwin spent months on foot exploring the islands. The specimens he collected from the Galápagos greatly influenced his ideas of evolution (Figure below).

The Galápagos Islands are a group of 16 volcanic islands 600 miles off the west coast of South America. The islands are famous for their many species found nowhere else.

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?

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

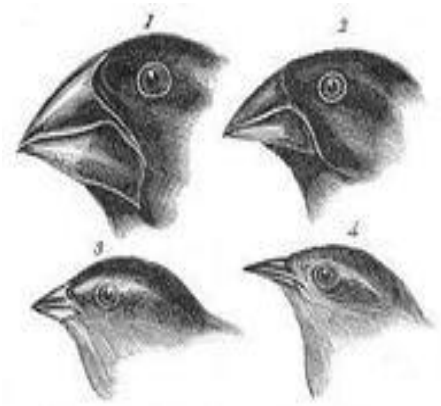
Giant Tortoises

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

Four of Darwin's finch species from the Galápagos Islands. 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.

STANDARD 4: OBJECTIVE 2:B STUDENTS WILL BE ABLE TO CITE EXAMPLES OF TRAITS THAT PROVIDE AN ADVANTAGE FOR SURVIVAL IN ONE ENVIRONMENT BUT NOT OTHER ENVIRONMENTS.

TRAITS FOR VARIED ENVIRONMENTS

Camouflage

Both predators and prey have adaptations to predation that evolves 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. It is 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.



Terms to know

- Camouflage

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.

Antifreeze Fish

Some of the coldest ocean waters on earth, where temperatures fall below the freezing point of fresh water, are found in the Southern Ocean surrounding Antarctica. Nearly every fish on the planet would freeze to death if it tried to brave such harsh conditions. The Antarctic toothfish, however, thrives in this icy environment. How does it do it?

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.

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

STANDARD 4: OBJECTIVE 2:C STUDENTS WILL BE ABLE TO GIVE EXAMPLES OF MAN-MADE AND NATURAL INFLUENCES THAT CAN CHANGE GENETIC TRAITS.

Terms to know

- Natural Influences
- Manmade Influences
- Hybridization
- Mimicry

MAN-MADE AND NATURAL CHANGES IN TRAITS

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.

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. Evolution occurs by natural selection. 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.

Why So Many Species?

Scientists estimate that there are between 5 million and 100 million species 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.

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.

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.**

Here is an example:

When the Grand Canyon in Arizona formed, two populations of one squirrel species were separated by the giant canyon, shown in Figurebelow and Figure 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.

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.

Figure 9. Abert squirrel on the southern rim of the Grand Canyon.

Here is an example of sympatric speciation: 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 (Figure below).

Figure 10. Kaibab squirrel found on northern rim of the Grand Canyon.

Scientists that two types of orca whales live in the same part of the Pacific Ocean for part of the year, but do not mate.

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.

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

CC BY SA photo from http://www.flickr.com/photos/zenera/525271784/
This is a fly that has mimicked a bee to avoid being eaten by predators.

Walking Stick Mimicry Example

CC BY SA photo from http://en.wikipedia.org/wiki/File:Ctenomorpha_chronus02.jpg

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

CC BY SA photo from http://www.flickr.com/photos/schoschie/3532346051/
These insects have changed over time to mimic a bee.

STANDARD 4: OBJECTIVE 2:D STUDENTS WILL BE ABLE TO RELATE THE STRUCTURE OF ORGANS TO AN ORGANISMS ABILITY TO SURVIVE IN A SPECIFIC ENVIRONMENT.

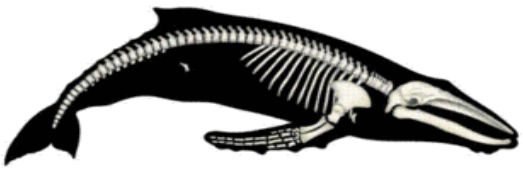
STRUCTURE AND SURVIVAL

Structural Adaptations

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

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

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.



Terms to know

- Adaptability
- Structure

A comparison of the skeletal structure of an elephant and blue whale. CC BY SA image from http://adaptations-of-organisms.wikispaces.com/2.+Structural+adaptations

For the aquatic mammal, the buoyant affect of water tends to offset the affect 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.

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.

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

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.

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

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.

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

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.

This section includes text from
http://adaptations-of-organisms.wikispaces.com/2.+Structural+adaptations
and
https://share.ehs.uen.org/node/20578

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

CLASSIFICATION SYSTEMS

CHAPTER 5

STANDARD 5: STUDENTS WILL UNDERSTAND THAT STRUCTURE IS USED TO DEVELOP CLASSIFICATION SYSTEMS.
STANDARD 5, OBJECTIVE 1: CLASSIFY BASED ON OBSERVABLE PROPERTIES

Terms to Know

- Cell
- Organism
- Growth
- Development
- Reproduction
- Cellular respiration
- Classification
- Living
- Nonliving

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"? Image 1 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.

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.

What Are Observations?

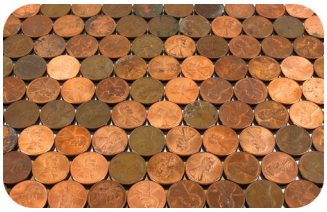
An ***observation*** is any information that is gathered with the senses. Our senses include vision, hearing, touch, smell, and taste. We see with our eyes, hear with our ears, touch with our hands, smell with our nose, and taste with our tongue. We can also extend our senses and our ability to make 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.

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.

Breakout 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:

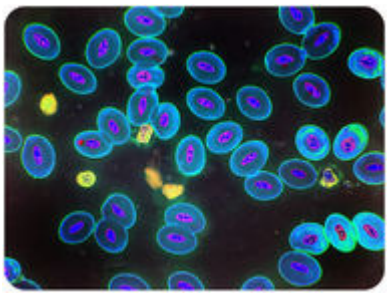
1. **Cells – Organisms made of one or more cells.**
2. **Metabolism – Organisms need to get and use energy, and get rid of wastes in order to carry out life processes.**
3. **Response – respond to their environment .**
4. **Growth/Devlopment – organisms grow and develop.**
5. **Reproduce – organisms 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.

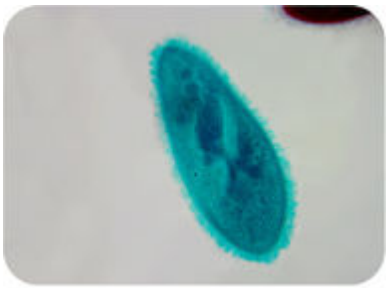
Living Things Are Made of Cells

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.

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.



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.

Living Things Metabolize

Why do you eat everyday? 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 this rotting log.

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

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.

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, which grow up and develop into adults. A kitten has not developed into an adult cat.

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.

http://www.flickr.com/photos/jdhancock/7823214508/

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

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

Think Critically
5. 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?

STANDARD 5, 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.

Linnaean System of Classification

People have been concerned with classifying organisms for thousands of years. Over 2,000 years ago, the Greek philosopher Aristotle developed a classification system that divided living things into several groups that we still use today, including mammals, insects, and reptiles.

Terms to Know
- Archaea
- bacteria
- binomial nomenclature
- classify
- domain
- Eukarya
- genus
- species
- taxonomy

Carl Linnaeus (1707-1778) (Figure) built on Aristotle's work to create his own classification system. He invented the way we name organisms today. Linnaeus is considered the inventor of modern taxonomy, the science of naming and grouping organisms. See **http://www.ucmp.berkeley.edu/history/linnaeus.html for additional information.**

In the 18th century, Carl Linnaeus invented the two-name system of naming organisms (genus and species) and introduced the most complete classification system then known.

Linnaeus developed binomial nomenclature, a way to give a scientific name to every organism. Each species receives a two-part name in which the first word is the genus (a group of species) and the second word refers to one species in that genus. For example, a coyote's species name is Canis latrans. The name latrans is the species and Canis is the genus, a larger group that includes dogs, wolves, and other dog-like animals.

Here is 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.

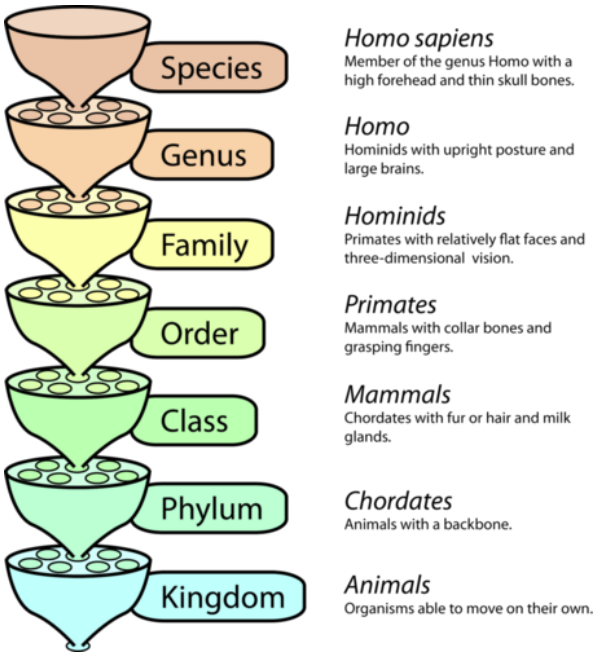
Maple leaves. Their scientific names are Acer saccarum (sugar maple) and Acer palmatum (Japanese maple)

One of the characteristics of the maple genus is winged seeds.

Modern Classification

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.

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.



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 (3:18).**

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.

So how is a species defined? A species is group of individuals that can interbreed with one another and produce fertile offspring; a species does not interbreed with other groups. By this definition, two species of animals or plants that do not interbreed are not the same species. See Biological Classification of Organisms for additional information: **http://www.physicalgeography.net/fundamentals/9b.html.**

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.**

Archaea and Bacteria

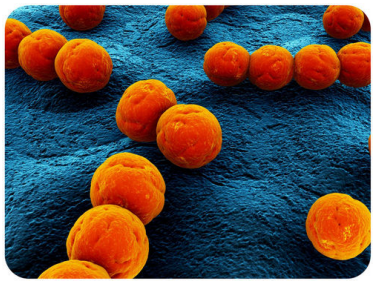
Archaea and Bacteria seem very similar, but they also have significant differences.

Similarities:

- Do not have a nucleus
- Small cells
- One-celled
- Can reproduce without sex 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.

Eukarya

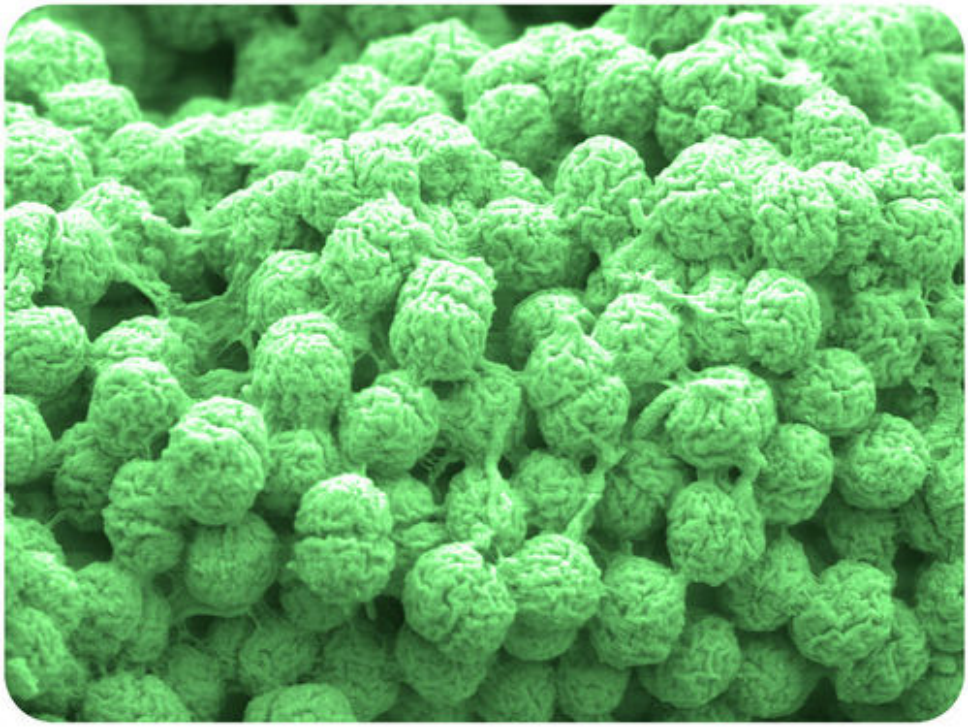
All of the cells in the domain Eukarya keep their genetic material, or DNA, inside the nucleus. The domain Eukarya is made up of four kingdoms:

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.

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).



This microscopic alga is a protist in the domain Eukarya.

The Western Gray Squirrel is in the domain Eukarya, one of the three domains of life.

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.

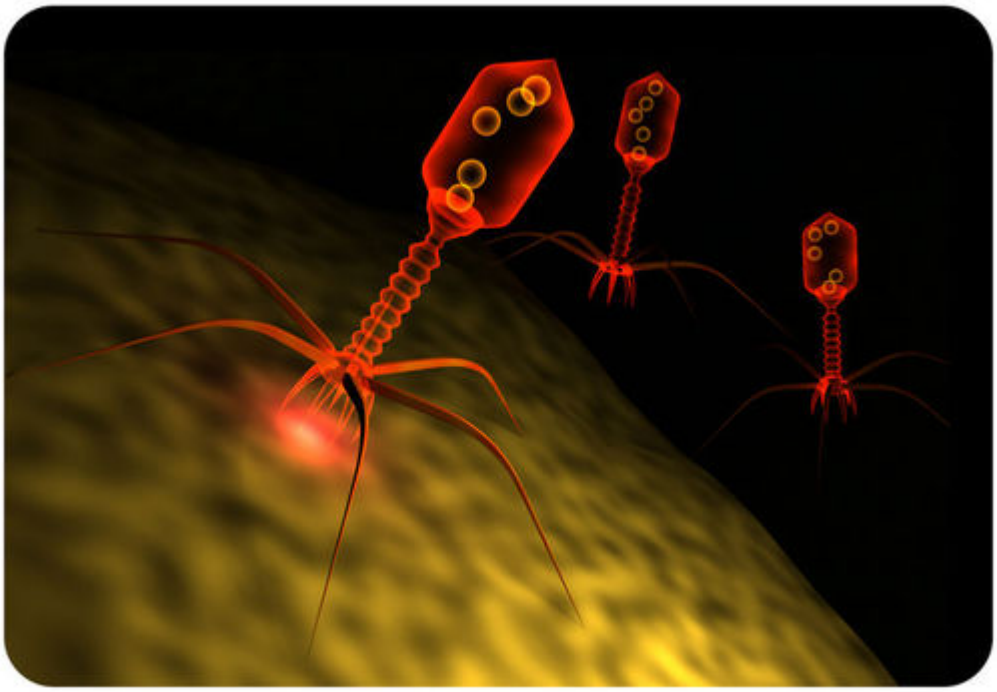
	Archaea	Bacteria	Eukarya
Multicelluar	No	No	Yes
Cell Wall	Yes, without peptidoglycan	Yes, with peptidoglycan	Varies. Plants and fungi have a cell wall; animals do not.
Nucleus (DNA inside a membrane)	No	No	Yes
Organelles inside a membrane	No	No	Yes

Three domains of life: Bacteria, Archaea, and Eukarya

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 infects Escherichia coli bacteria.

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=ctpjj0kUtEU.**

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

The plant kingdom contains a diversity of organisms.

Groups of Plants

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

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

ORDERS OF 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. Pictured here is the Northern short-tailed shrew.

The ungulates (hoofed animals), like the giraffe here, is one of the orders belonging to the placental mammals.

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?

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.

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. 6. In what domain are humans?
7. 7. Quercus rubra is the scientific name for the red oak tree. What is the red oak's genus?
8. 8. In what domain are mushrooms?
9. 9. What information do scientists use to classify organisms?

Think Critically

10. 10. Is it possible for organisms in two different classes to be in the same genus?
11. 11. If molecular data suggests that two organisms have very similar DNA, what does that say about their evolutionary relatedness?
12. 12. Can two different species ever share the same scientific name?
13. 13. If two organisms are in the same genus, would you expect them to look much alike?

Points to Consider

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?

Do you think human cells are different from bacterial cells?

Do you think it is possible for a single cell to be a living organism?

STANDARD 5, OBJECTIVE 3: CLASSIFY ORGANISMS USING AN ORDERLY PATTERN BASED UPON STRUCTURE

CLASSIFICATION STRUCTURE

Taxonomic systems are based on similar characteristics. These systems attempt to model the natural order, thus helping research by classifying different organisms.

How are these organisms different from each other? CC BY SA image from http://commons.wikimedia.org/wiki/File:Animal_diversity_October_2007_for_thumbnail.jpg

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.

Classification with Keys

Taxonomic systems are based on similar characteristics or increasingly on DNA analysis. The systems attempt to model the natural order, thus helping research by classifying different organisms. Taxonomic systems vary, but the following system has been found useful:

- Domain
- Kingdom
- Phylum (called Division in plants)
- Class
- Order
- Family
- Genus
- Species

There are many sub units in use. Keys usually start with a first selection from the following:

- 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.

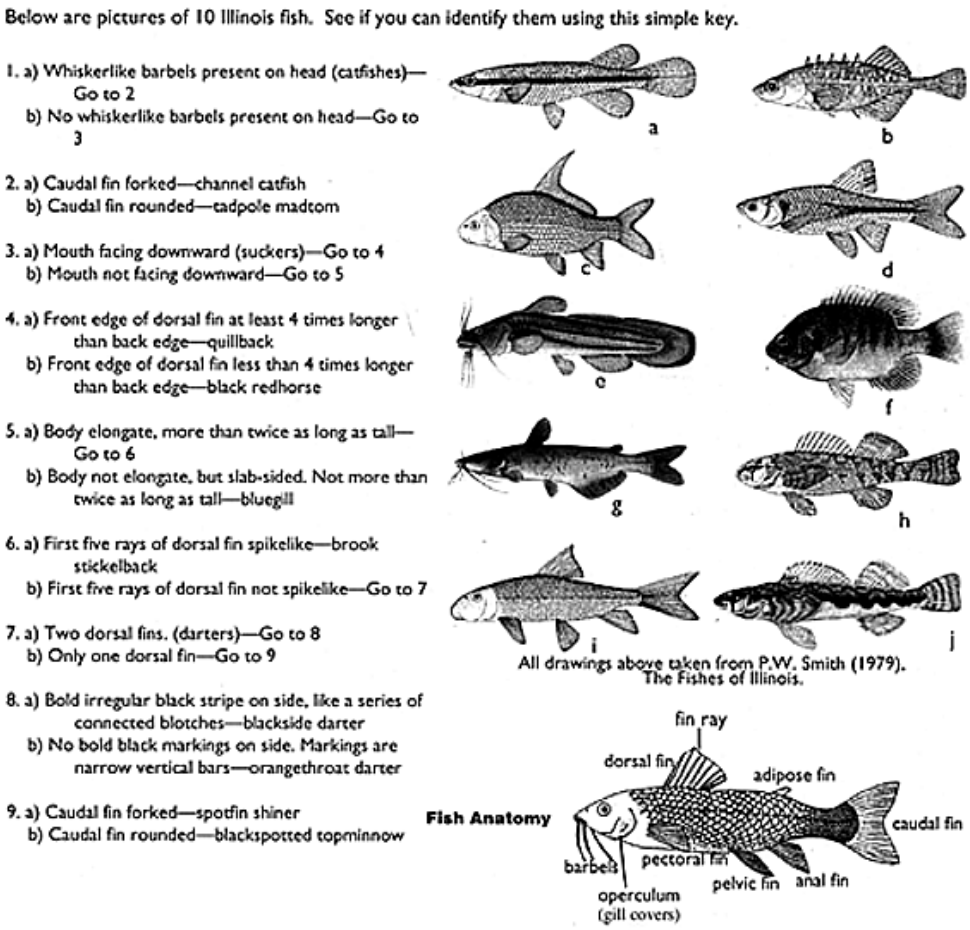
Limitations of a Dichotomous Key

If the organism is not included in this key - it would never be found and this volume remains a work in progress. Whilst dichotomous keys have proved useful, they often offer dilemmas due to individual variations, 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.

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.



To learn how to classify Utah species of fish, see this link:
http://utahfish.usu.edu/downloads/HookedonClassification.pdf

Attribution

This section includes material from http://en.wikibooks.org/wiki/Dichotomous_Key

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

THIS BOOK BELONGS TO: