HANDS-ON HUMAN BIOLOGY

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Contents

Chapter 1

Lesson 1.1 Elements and Compounds

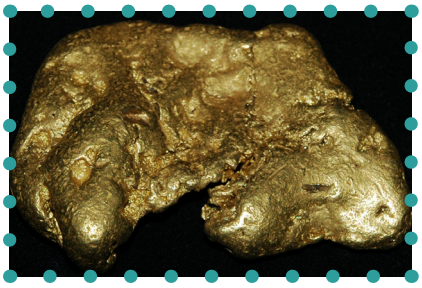
Building Blocks

Keep cutting an apple, and you will eventually get a piece too small to cut. This is like an atom, which is the smallest particle in a substance.

Think of a shiny, red apple. Imagine you cut it in half, and then into half again. If you keep on cutting it like that, you will eventually get a piece so small that you can't cut any more. This tiny piece of apple is like an **atom**. Atoms are the smallest particles that exist in a substance. They are so small that they can't even be seen with a microscope! Atoms are the building blocks of everything. Monkeys, chairs, and feathers are all made out of trillions of connected atoms. Even you are made from atoms! In the same way that lots of bricks stuck together make a wall, hundreds of atoms join together to form everything on Earth.[1]

Elements

A **pure substance** is something that is made from only one kind of particle. One type of pure substance is an **element**, which is a substance made from only one type of atom. There are more than one hundred different elements in the world. Each element is made from a different atom. Some elements you may have heard of are copper, oxygen, helium, and carbon.



A pure gold element contains only gold atoms.
Credit: James St. John, Wikimedia.

An atom can't be broken down into anything simpler, since atoms are the smallest particles that exist. Think of a gold necklace, which is made from a few elements mixed together. If you would break it down, you would get gold, silver, copper, and zinc elements. But a gold element contains only gold atoms, and nothing else.

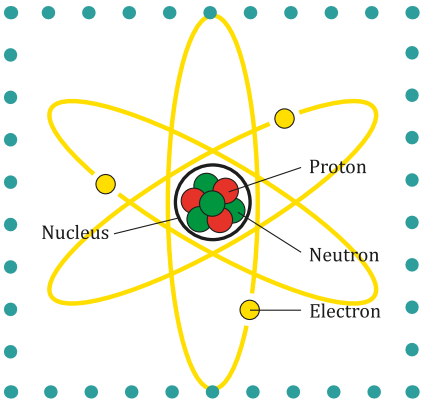
Symbols

Every element has a symbol to make it easier for scientists to write them down. The symbol is a letter, or several letters, that's short for its full name. Every element has its own symbol, and no two symbols are the same.

Pieces of calcium in a tube. The symbol for calcium is Ca.
Credit: W. Oelen, Wikimedia.

The symbol for some elements is the first letter of its name, like hydrogen (H) or nitrogen (N). For other elements, it's the first two letters of its name, like calcium (Ca) or helium (He). A few elements have a symbol from their Latin name. The symbol for gold is Au, which is short for aurum, the Latin word for gold. Iron has the symbol Fe, which comes from ferrum, the Latin word for iron.

Parts of an atom



A diagram showing the different parts of an atom.
Credit: AG Caesar, Wikimedia.

If you would look inside an atom, you would see that it is made up of a few parts.[2] In the center of the atom, the **nucleus**, there are particles called **protons** and **neutrons**. Protons have a positive charge, and neutrons have no charge. The nucleus also has **electrons** spinning around it in circles. Electrons have a negative charge.

The number of protons inside an atom is what makes it different from all the other atoms. An oxygen atom has eight protons; while a potassium atom has nineteen protons. Every single atom has its own set of properties because of its unique number of protons.

Molecules and Compounds

Atoms like to **bond** (join) with other atoms. When two or more atoms bond, they form a **molecule**. Sometimes the atoms in a molecule are all the same, like three oxygen atoms joining to make a molecule called ozone (O_3), or two hydrogen atoms joining to form a hydrogen molecule (H_2). This is called an element.

Some molecules have atoms that are different from each other. This kind of molecule is called a **compound**. A compound we are all familiar with is water (H_2O). Each water molecule is made from two hydrogen atoms and one oxygen atom. Some more examples of compounds are carbon dioxide (CO2) which is made from one carbon and two oxygen atoms; and ammonia (NH_3), which contains one nitrogen and three hydrogen atoms. These compounds have just a few atoms, but there are compounds with hundreds of atoms!

To really understand this well, think of an ice cream store with twenty delicious flavors of ice cream. Each flavor is like an element. There are many flavors, or elements, but each one is different from all the other ones. The smallest amount you can buy is one scoop. This is like an atom, which is the smallest part of an element. Two or more scoops of ice cream is like a molecule. The flavors can either be the same or different. Two or more scoops of different flavors is like a compound.

A compound is like two scoops of different ice cream flavors.

How Atoms Bond

You know how two magnets are **attracted** (pulled) to each other? Atoms bond with other atoms in the same way. Atoms with a positive charge are attracted to atoms with a negative charge. The atoms are held together by strong forces called **chemical bonds**. One type of bond is a covalent bond, which is when two atoms share electrons. Another type of bond is an **ionic bond**, which is when one atom gives electrons to a different atom.

Word Match:

compound	A pure substance containing one type of atom.
symbol	The particles in an atom that have a positive charge
neutrons	The smallest particle of an element
element	A letter that is short for an element's full name
bond	Something that is made from only one kind of particle
protons	The particles in an atom that have a negative charge
molecule	A molecule containing two or more different element
pure substance	Join
electrons	The center of an atom
atom	The particles in an atom that have no charge
nucleus	Two or more atoms joined together

Review Questions

1. **What is an element made out of?**

2. **What are the different parts of an atom?**

3. **What is the difference between an element and a compound?**

Exercise

Elements

Each Lego brick represents one atom:

- Remove the Lego bricks from the bag.
- Sort the Lego bricks by color. Each color is a different element.
- Using boxes to represent the Lego bricks, draw and color the atoms for each of the 3 elements.

Compounds

A compound has to have 2 or more different elements bonded together:

- Using the elements, create at least 3 different compounds.
- Draw and color the compounds.

Mixtures

Mixtures are not chemically bonded; they are just physically mixed together:

- Create a mixture of at least two different elements. Draw and color the element mixture.
- Create a mixture of 3 different compounds. Draw and color the compounds mixture.
- Create a mixture of elements and compounds. Draw and color the element and compound mixture.

ELEMENTS	COMPOUNDS	MIXTURES
		ELEMENT MIXTURE
		COMPOUND MIXTURE
		ELEMENTS AND COMPOUND MIXTURE

Lesson 1.2 The Compounds of Life

Essential Molecules

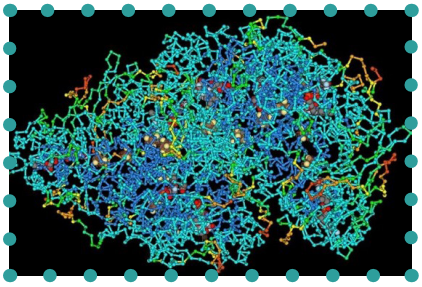
There are some molecules that are essential for life, which means that we can't survive without them. Let's take a look at two of them.

Water is one of the most important molecules on Earth. Each water molecule is made from two hydrogen atoms and one oxygen atom. Every living thing depends on water to survive, but why is it so important? Water keeps the body working properly. It carries oxygen around our body, allowing us to breathe. Water dissolves nutrients and minerals, so we can absorb them. It also helps keep the body at the right temperature. There are also many other ways that water helps us function. When you make sure to drink the right amount of water every day, you are helping to keep your body healthy and working well.

Salt is a molecule that is essential for life.

Salt is another molecule we can't live without. The scientific name for salt is sodium chloride. It has this name because each salt molecule is made from one sodium and one chloride atom. Salt does a lot more than make your food taste good! Salt helps our nerves and muscles function properly. It plays a role in maintaining the right blood pressure. Salt also helps keep up the right level of water and minerals. We absorb salt from the foods we eat. Foods like meat and fish are naturally salty, and most of the other foods we eat are seasoned with salt.

Macromolecules



An illustration of a protein macromolecule, with thousands of atoms joined together.

When huge numbers of atoms join together, they form a large molecule called a **macromolecule**.[1] There are four macromolecules that all living things are made from. They are **carbohydrates**, **lipids**, **proteins**, and **nucleic acids**. Without any of these four macromolecules, living things would not be able to survive. Each one has its own function (job) to make the body work properly. Let's look at each one to see what it's made of, what its jobs are, and which foods they can be found in.

Carbohydrates

Carbohydrates are made from carbon, hydrogen, and oxygen elements. The main function of carbohydrates is to give us energy. It is also the brain's main source of energy. Energy is like fuel for the body, and keeps it functioning.

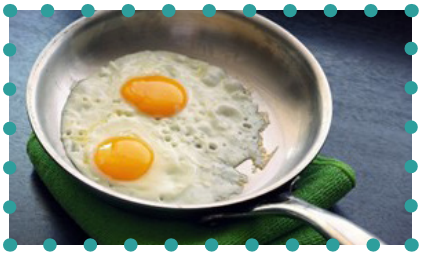
Pasta is high in carbohydrates.

When we eat foods that contain carbohydrates, it is broken down into **glucose** (a type of sugar). The glucose is used by the cells to give us energy. Some foods, such as fruit or milk, are **simple carbohydrates**. They are broken down into glucose quickly, so the energy from these foods only lasts for a short time. Plant-based foods, including wheat, rice, and potatoes, are **complex carbohydrates**. This type of carbohydrates is broken down into glucose slowly, so the energy lasts for a longer amount of time. These foods also contain a lot of nutrients that are good for the body.

Proteins

Proteins are made from a lot of **amino acids** joined together. Amino acids are molecules made from carbon, hydrogen, oxygen, nitrogen, and sulfur elements. There are twenty different amino acids that form all the proteins we need. They make up a large part of every cell in the body.

Proteins have a wide range of functions in the body. Some proteins give our cells shape and help them move. Some proteins protect us from being sick, and other proteins speed up chemical reactions in the body. There are proteins that carry nutrients around our body, and proteins that help to build and repair muscles. Hair and nails are made from a protein.



Chicken, nuts, fish, and eggs are all foods that are high in protein. When we eat these foods, the protein is broken down into amino acids. They travel around the body to different cells, where they each do their important job!

Eggs are a good source of protein.

Lipids

Lipids are mainly made from carbon, hydrogen, and oxygen elements. The main function of lipids is to store energy for the body. They also have some other functions, such as helping with the structure of the cells and keeping us warm.

Fats are one type of lipids. The two main groups of fats are **saturated fats** and **unsaturated fats**. Saturated fats are solid at room temperature. They can be found in foods like meat, butter, and cheese. Eating too much saturated fats is unhealthy. Unsaturated fats are liquid at room temperature. They are found in foods like nuts, avocados, and olives. Unsaturated fats are much better for you.[2]

Avocados contain unsaturated fats.

Waxes are another type of lipids. They mainly act as protection, like the earwax protecting the eardrums. Another group of lipids are phospholipids. They have a lot of different functions within the cells to keep them working properly.

Nucleic Acids

Nucleic acids are made from molecules called **nucleotides**. Nucleotides are formed from carbon, hydrogen, oxygen, nitrogen, and phosphorous elements. Nucleic acids store and pass on genetic information. They are like instructions telling each cell in the body what its job is. Nucleic acids help make each person who they are!

The two main nucleic acids are **DNA** (deoxyribonucleic acid) and **RNA** (ribonucleic acid). DNA has a special shape that looks like a twisted ladder. The rungs of the ladder are made from four different nucleotides.[3] Short segments of the DNA are called **genes**, which are the instructions for the cells. Genes determine things like your hair color and your height.

RNA is a copy of DNA. It takes the instructions from the DNA, and actually carries them out.

Word Match:

protein	A very large molecule
DNA	A macromolecule that stores and passes on genetic information
macromolecule	A type of carbohydrates that is broken down easily
lipids	Ribonucleic acid
simple carbohydrates	A macromolecule made from amino acids
saturated fats	A type of carbohydrates that breaks down slowly
nucleic acids	A macromolecule that provides energy for the body
carbohydrates	Deoxyribonucleic acid
unsaturated fats	A type of fat that is solid at room temperature
complex carbohydrates	A macromolecule that stores energy for the body
RNA	A type of fat that is liquid at room temperature

Review Questions

1. **What is a water molecule made from, and why is it so essential to life?**

2. **What are the four macromolecules that are essential for life?**

3. **What is the similarity between carbohydrates and lipids?**

4. **Where in the body is protein found?**

Exercise

Food Sample	Color change with Iodine Solution	Oily Patch on Paper	Contains Starch	Contains Fat
Raw Potato				
Milk				
Cooked Rice				
Boiled Egg				
Salt				