Atoms and Their Interactions
Chapter 6, Sections 1-3

I. Elements

A. Definition of an element
An element is a pure substance made of only 1 kind of atom & it can't be broken down into simpler substances.

B. Natural Elements in Living Things

1. __92__ elements occur naturally on Earth. Of these, about __25__ are essential to living organisms.
2. More than 96% of the mass of the human body is made of 4 elements: __C__, __H__, __O__, & __N__.
3. Abbreviations for elements

C. Trace Elements

1. Plants get these through the __roots__.
2. Animals get these through __the foods they eat.

Table 6.1 Some Elements That Make Up the Human Body

Element	Symbol	Percent By Mass in Human Body	Element	Symbol	Percent By Mass in Human Body
Oxygen	O	65.0	Iron	Fe	trace
Carbon	C	18.5	Zinc	Zn	trace
Hydrogen	H	9.5	Copper	Cu	trace
Nitrogen	N	3.3	Iodine	I	trace
Calcium	Ca	1.5	Manganese	Mn	trace
Phosphorus	P	1.0	Boron	B	trace
Potassium	K	0.4	Chromium	Cr	trace
Sulfur	S	0.3	Molybdenum	Mo	trace
Sodium	Na	0.2	Cobalt	Co	trace
Chlorine	Cl	0.2	Selenium	Se	trace
Magnesium	Mg	0.1	Fluorine	F	trace

D. The Periodic Table

1. The horizontal rows are called __periods.
2. The vertical columns are called __groups or families.

II. Atoms: The building Blocks of Elements

A. Definition of an atom
An atom is the smallest part of an element that still has all the properties of that element.

B. The structure of an atom

Name	Charge	Location	Symbol
Protons	+	Nucleus	p^+
Neutrons	0	Nucleus	n^0
Electrons	-	Electron cloud	e^-

C. Electron energy Levels

1. Number of energy levels based on the period the element is in: the # of E levels in an atom is = to the period #

2. Maximum # of electrons per energy level

   1st energy level = 2

   2nd energy level = 8

   3rd energy level = 18

***In general, the number of electrons that an energy level can hold is __$2n^2$__, where n is the number of the energy level.

How many electrons can the 7th energy level hold?

If there were a level that could hold 288 electrons, what energy level would it be?

3. Atomic number
   This is always the # of p^+ in the nucleus of an atom.

4. Mass number
   This is the TOTAL # of p^+ and n^0 in the nucleus of an atom.

5. In neutral atoms, the # of p^+ = the # of e^-.

6. Ions
   These are charged particles formed when a neutral atom gains or loses e^-.

   Fluorine atom

   Protons _____ Neutrons _____ Electrons _____

   Fluoride ion (F^{-1})

   Protons _____ Neutrons _____ Electrons _____

   Calcium atom

   Protons _____ Neutrons _____ Electrons _____

   Calcium ion (Ca^{+2})

   Protons _____ Neutrons _____ Electrons _____

III. Isotopes of an Element

A. Definition of an isotope
   Isotopes are atoms of the same element but with different #s of n^0.

B. Isotopes of a given element have the same number of ___p^+ and therefore have the same __atomic__ number. However, since they have different numbers of ______n^0___, they have different __mass___ numbers.

C. Compare the number of protons, neutrons, electrons, mass numbers, and atomic numbers for hydrogen-1, hydrogen-2, and hydrogen-3 by filling in the chart below.

Isotope	Protons	Neutrons	Electrons	Mass #	Atomic #
Hydrogen-1	1	0	1	1	1
Hydrogen-2	1	1	1	2	1
Hydrogen-3	1	2	1	3	1

D. Practical Uses of Isotopes – See Fig. 5 on p. 150

1. Diagnosing diseases
2. Treating diseases

IV. Compounds and Bonding

A. Definition of a compound

A compound is a pure substance made of 2 or more elements.

B. Examples of compounds

$NaCl$, H_2O, $C_6H_{12}O_6$, CO_2

C. Covalent Bonds –

1. How are covalent bonds formed?

   These are formed when atoms share e^-.

2. What types of elements form these bonds?

   Nonmetals bonding with other nonmetals

3. What is a molecule?

   This refers to a group of atoms bonded by covalent bonds.

4. Examples of covalently bonded substances?

   H_2O, $C_6H_{12}O_6$, CO_2

SEE FIGURE 9 on p. 152 & FIGURE 10 on p. 153

D. Ionic Bonds

1. How are ionic bonds formed?
   These are formed by a transfer of e^- from one atom to another. The oppositely charged particles are attracted to each other.
2. What types of elements form these bonds?

   These are formed b/w a metal and a nonmetal.

3. Examples of ionically bonded substances
   NaCl, KCl, $CaCl_2$

SEE FIGURE 11 on p. 153

Most compounds in organisms contain <u>covalent</u> **bonds. These include** <u>sugars</u>, <u>fats</u>, <u>proteins</u>, and <u>water</u>.

E. van der Waals Forces

These are forces of attraction b/w the oppositely charged regions of molecules. These oppositely charged regions are formed by the movement of the e^- causing unequal distribution of the electrons in the e^- cloud producing temporary regions of slightly + and – charges.

V. Chemical Reactions

A. Metabolism
This refers to all the chem. rxns. that take place in an organism.

B. Writing Chemical Equations

REACTANTS → PRODUCTS

Ex. $2H_2 + O_2 \rightarrow 2H_2O$

* the 2 in front of the H_2 & in front of the H_2O are called coefficients to balance the equation

C. Why must chemical equations be balanced?
This shows that matter has been neither created nor destroyed (the Law of Conservation of Mass).

D. Balance the following equations:

1. $Na\ (s) + Cl_2\ (g) \rightarrow NaCl\ (s)$

2. $CO_2\ (g) + H_2O\ (l) \rightarrow C_6H_{12}O_6\ (s) + O_2\ (g)$

VI. Mixtures and Solutions

A. Definition of a Mixture
This is a combination of substances where each substance retains its own properties.

B. Two types of mixtures

1. Heterogeneous mixtures
These mixtures have substances that are NOT evenly distributed.

2. Homogeneous mixtures (also known as _solutions_)
These mixtures have substances that ARE evenly distributed.

C. Concentration of solutions & its importance to living things
Most organisms live in a watery environment or their cells are surrounded by water. So the solutions in their environment determine if they will maintain homeostasis.

D. Acids & Bases

1. Fill in the chart below regarding acids & bases

	Ion concentration	**Red litmus test**	**Blue litmus test**	**pH values**
Acidic	$H^+ > OH^-$	Stays red	Turns red	$0 \leq pH < 7$
Basic	$OH^- > H^+$	Turns blue	Stays blue	$7 < pH \leq 14$
Neutral	$H^+ = OH^-$	Stays red	Stays blue	7

2. Importance of acids & bases to living things
Plants grow in certain soils based on the pH of the soil.
Many of the foods we eat contain acids (like oranges)

VII. Water and Its Importance (see handout)

Life Substances
Chapter 6, Section 4

I. The Role of Carbon in Organisms

A. Each carbon atom has **4** electrons for bonding and thus can form **4** bonds that are **covalent** bonds.

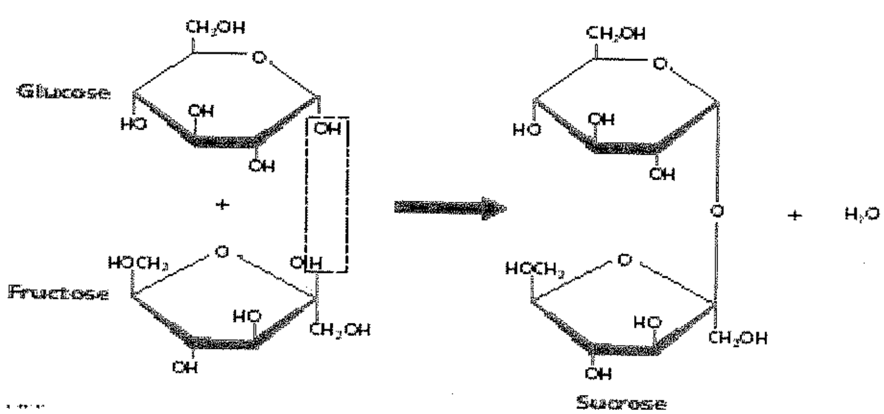
B. So many carbon structures are possible because:

1. **Carbon can bond with other carbon atoms in straight chains, branched chains, or rings.**
2. **Carbon can bond with atoms of other elements.**

See Fig. 25 on p. 166

C. In addition, some elements combine so they have the same **simple** formula but different **3-D** formulas. Such compounds are called **isomers**.

Examples: **glucose** and **fructose** have the same simple formula of **$C_6H_{12}O_6$** but the 3-D structures of these differ.

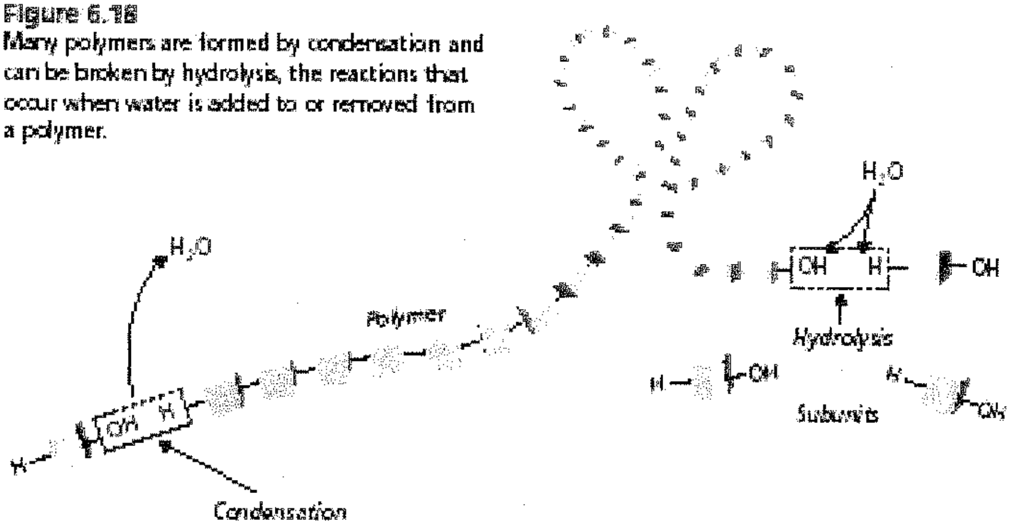


D. Carbon atoms can bond to form compounds with **tens**, **hundreds**, or even **thousands** of carbon atoms. The large molecules are called **macromolecules**. **Proteins** are one example of these.

E. These large molecules are formed when many smaller molecules are bonded together to form long chains called **polymers**. ***(Poly – means "many", -mers means "parts")***

F. To form these polymers, a process called **condensation** occurs. This occurs when one of the smaller molecules contains a –H and the other contains an –OH group. This removes H-OH or **water** from the substance. To break polymers apart, **water** is added to the polymer in a process called **hydrolysis**. The prefix **hydro-** means water; the suffix **lysis** means to break apart. Thus, **hydrolysis** literally means to "break something apart by using water".

Figure 6.18
Many polymers are formed by condensation and can be broken by hydrolysis, the reactions that occur when water is added to or removed from a polymer.



II. The Structure of Carbohydrates.

A. Carbohydrates contain **C**, **H**, and **O** in a ratio of **1C:2H:1O**.

B. Carbohydrates are used by cells to **store and release energy**.

C. **Monosaccharrides** – **"Mono-" means** **one**

1. Definition – **These are the simplest carbohydrates made of only 1 sugar unit.**
2. Examples: **glucose and fructose**

D. **Disaccharides** – **"Di-" means** **two**

1. Definition – **These are carbohydrates made of 2 monosaccharides.**
2. Examples: **sucrose**

E. **Polysaccharides** – **"Poly-" means** **many**

1. Definition – **These are carbohydrates made of many monosaccharides.**
2. Examples:
   a. **Starch – This is a highly branched chain of glucose units used for food storage by plants.**
   b. **Glycogen – This is a more highly branched chain of glucose units than starch. It is the way animals store food.**

c. **<u>Cellulose</u> – This is made of many glucose units hooked together like a chain link fence. It is used by plants to form cell walls & to give structural support.**

III. The Structure of Lipids

A. Lipids are commonly called **<u>fats</u>** and **<u>oils</u>**. They contain **<u>less</u>** oxygen that carbohydrates. Because these molecules are **<u>nonpolar</u>**, they are **<u>insoluble</u>** in water.

B. Functions of Lipids

1. **long term energy storage**
2. **provide a layer of insulation**
3. **to form protective coverings as in the membranes surrounding a cell**

C. Saturated vs. Unsaturated fats

1. **<u>Saturated</u>** fats contain only single bonds and thus have the max. amount of H bonded to the tail.
2. **<u>Unsaturated</u>** fats have double bonds and thus have room for at least one more H atom.

D. Phospholipids

<u>Phospholipids</u> form the structure of **<u>cell membranes.</u>** Lipids are **<u>hydrophobic</u>** which means they do NOT dissolve in water. This allows them to form barriers in biological membranes.

See Figure 28 on p. 169

E. Steroids

Steroids include **cholesterol** and **hormones.** Cholesterol is often considered "bad" but it forms the basis for forming other lipids, including **vitamin D** and the hormones **estrogen** and **testosterone.**

IV. The Structure of Proteins

A. Proteins are composed of __**C**__, __**H**__, __**O**__, __**N**__, and sometimes __**S**__. The smaller subunits of proteins are called __**amino acids**__ of which there are about __**20**__. These subunits are bonded __**covalently**__ by bonds called __**peptide**__ bonds. The kind of protein formed is determined by the __**number**__ and __**order**__ in which these amino acids are connected.

B. Functions of proteins

1. **build structures**
2. **help to carry out metabolism**
3. **muscle contraction**
4. **transport O_2 in the bloodstream**
5. **provide immunity**
6. **carry out chemical reactions**

C. Proteins that speed up chemical reactions are called __**enzymes**__. These are used to speed up reactions in __**digestion**__ of food, __**synthesis**__ of molecules, and __**storage**__ and __**release**__ of energy.

See Figures 29 & 30 on p. 170.

V. The Structure of Nucleic Acids

A. Nucleic acids are biomolecules that are made of smaller subunits called __**nucleotides**__. Nucleic acids are made of __**C**__, __**H**__, __**O**__, __**N**__, and __**P**__. The 3 groups that make up a nucleotide are a 1) a __**base**__, 2) a **simple sugar**, and 3) a __**phosphate**__ group. **See Figure 31 on p. 171.**

B. DNA

This stands for __**deoxyribonucleic acid**__. It is the master copy of an organism's __**genetic**__ code and carries all the information to form all an organism's **enzymes** and **structural proteins**. It determines how the organism looks and acts. It is passed on every time a cell __**divides**__ and is also passed on from __**generation**__ to __**generation**__.

C. RNA

This stands for **ribonucleic acid**. It is used to form a copy of __**DNA**__ for use in __**protein synthesis**__.