

Chemistry of Life

Guided Notes - Teachers Edition

An organism can be broken down into smaller levels of **organization**.

These levels are pictured below.

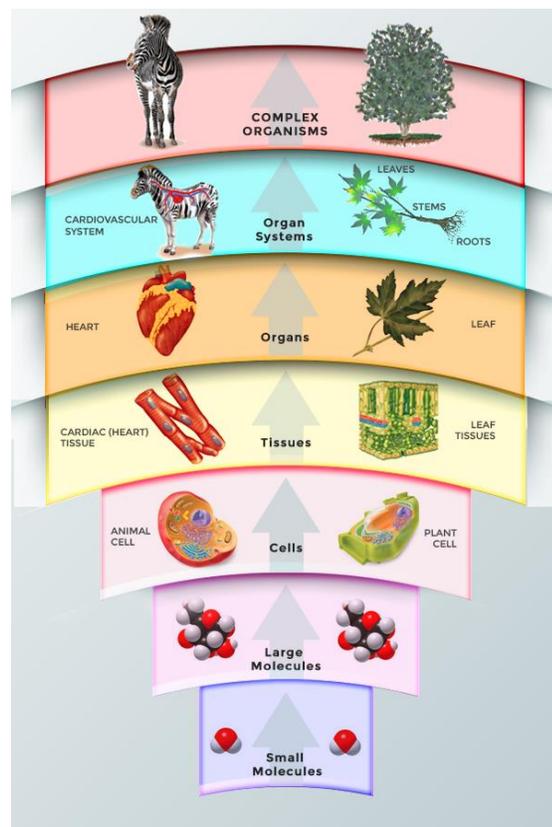
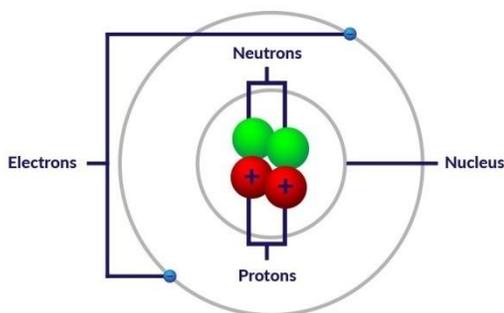
The Chemical Level

The smallest level of organization is called the **chemical** level and includes

atoms and **molecules**. Atoms are the smallest units which make up

matter – this is the case in both living and non-living things. The main

components of the atom are shown in the diagram below:



Atoms contain two regions:

1. The **nucleus** is found in the center of the atom. It contains two kinds of subatomic particles, positively charged particles known as **protons** and neutral, uncharged, particles known as **neutrons**. It is this region of the atom which gives it its mass.
2. The region surrounding the nucleus of the atom is called the **electron shells** or orbitals. In this area, one or more negatively charged particles called **electrons** orbit the nucleus in different energy levels.

The forces which operate between the oppositely charged particles - protons and electrons - hold the atom together.

Most atoms contain all three types of subatomic particles. Hydrogen atom (H) is an exception because it has one proton and one electron and no neutrons. The number of **protons** in the nucleus determines the kind of the element an atom is, this is known as the **atomic number**, while the number of electrons determines how the atom **reacts**.

Name: _____ Period: _____ Date: _____

Chemistry of Life

Guided Notes - Teachers Edition

Elements

An element is a substance which is made up of **one** type of atom. For this reason, elements are called **pure** substances. There are 94 naturally occurring elements known to scientists. These have been arranged on a chart called the **periodic** table (shown below).

Periodic Table of the Elements

1 H Hydrogen 1.008																	2 He Helium 4.003
3 Li Lithium 6.941	4 Be Beryllium 9.012											5 B Boron 10.811	6 C Carbon 12.011	7 N Nitrogen 14.007	8 O Oxygen 15.999	9 F Fluorine 18.998	10 Ne Neon 20.180
11 Na Sodium 22.990	12 Mg Magnesium 24.305											13 Al Aluminum 26.982	14 Si Silicon 28.086	15 P Phosphorus 30.974	16 S Sulfur 32.064	17 Cl Chlorine 35.453	18 Ar Argon 39.948
19 K Potassium 39.098	20 Ca Calcium 40.078	21 Sc Scandium 44.956	22 Ti Titanium 47.867	23 V Vanadium 50.942	24 Cr Chromium 51.996	25 Mn Manganese 54.938	26 Fe Iron 55.845	27 Co Cobalt 58.933	28 Ni Nickel 58.693	29 Cu Copper 63.546	30 Zn Zinc 65.38	31 Ga Gallium 69.723	32 Ge Germanium 72.631	33 As Arsenic 74.922	34 Se Selenium 78.972	35 Br Bromine 79.904	36 Kr Krypton 84.798
37 Rb Rubidium 85.468	38 Sr Strontium 87.62	39 Y Yttrium 88.906	40 Zr Zirconium 91.224	41 Nb Niobium 92.906	42 Mo Molybdenum 95.95	43 Tc Technetium 98.907	44 Ru Ruthenium 101.07	45 Rh Rhodium 102.906	46 Pd Palladium 106.42	47 Ag Silver 107.868	48 Cd Cadmium 112.411	49 In Indium 114.818	50 Sn Tin 118.711	51 Sb Antimony 121.760	52 Te Tellurium 127.6	53 I Iodine 126.904	54 Xe Xenon 131.294
55 Cs Cesium 132.905	56 Ba Barium 137.328	57-71 Lanthanide Series	72 Hf Hafnium 178.49	73 Ta Tantalum 180.948	74 W Tungsten 183.84	75 Re Rhenium 186.207	76 Os Osmium 190.23	77 Ir Iridium 192.217	78 Pt Platinum 195.085	79 Au Gold 196.967	80 Hg Mercury 200.592	81 Tl Thallium 204.383	82 Pb Lead 207.2	83 Bi Bismuth 208.980	84 Po Polonium [208.982]	85 At Astatine 209.987	86 Rn Radon 222.018
87 Fr Francium 223.020	88 Ra Radium 226.025	89-103 Actinide Series	104 Rf Rutherfordium [261]	105 Db Dubnium [262]	106 Sg Seaborgium [266]	107 Bh Bohrium [264]	108 Hs Hassium [269]	109 Mt Meitnerium [268]	110 Ds Darmstadtium [269]	111 Rg Roentgenium [272]	112 Cn Copernicium [277]	113 Nh Nihonium unknown	114 Fl Flerovium [289]	115 Mc Moscovium unknown	116 Lv Livermorium [298]	117 Ts Tennessine unknown	118 Og Oganesson unknown
		57 La Lanthanum 138.905	58 Ce Cerium 140.116	59 Pr Praseodymium 140.908	60 Nd Neodymium 144.242	61 Pm Promethium 144.913	62 Sm Samarium 150.36	63 Eu Europium 151.964	64 Gd Gadolinium 157.25	65 Tb Terbium 158.925	66 Dy Dysprosium 162.500	67 Ho Holmium 164.930	68 Er Erbium 167.259	69 Tm Thulium 168.934	70 Yb Ytterbium 173.055	71 Lu Lutetium 174.967	
		89 Ac Actinium 227.028	90 Th Thorium 232.038	91 Pa Protactinium 231.036	92 U Uranium 238.029	93 Np Neptunium 237.048	94 Pu Plutonium 244.064	95 Am Americium 243.061	96 Cm Curium 247.070	97 Bk Berkelium 247.070	98 Cf Californium 251.080	99 Es Einsteinium [254]	100 Fm Fermium 257.095	101 Md Mendelevium 258.1	102 No Nobelium 259.101	103 Lr Lawrencium [262]	

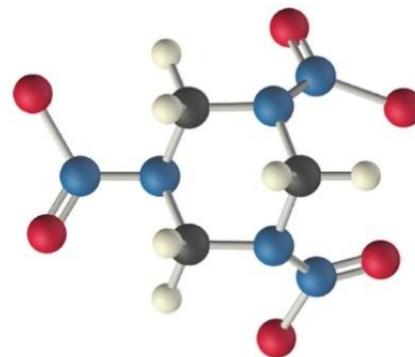
Alkali Metal	Alkaline Metal	Transition Metal	Basic Metal	Semimetal	Nonmetal	Halogen	Noble Gas	Lanthanide	Actinide
--------------	----------------	------------------	-------------	-----------	----------	---------	-----------	------------	----------

Chemistry of Life

Guided Notes - Teachers Edition

The main elements found in living things are:

- Carbon (**C**)
- Hydrogen (**H**)
- Oxygen (**O**)
- Sulfur (**S**)
- Nitrogen (**N**)
- Phosphorous (**P**)



It is the bonding between the atoms of the six elements mentioned above that makes all life possible. Chemical bonding involves atoms gaining, **losing** or sharing electrons in order to form larger structures. In doing this, they are able to complete any partially full electron shells and become more **stable** in the process.

Molecules vs Compounds:

Molecules are defined as any group of atoms which are **chemically** bonded together. These atoms can be **identical**; for example, oxygen gas is made up of two oxygen atoms (**O₂**). Compounds are two or more **different** atoms bonded together. For example, water contains two hydrogen atoms and one oxygen atom (**H₂O**).

Atoms are able to form three different types of chemical bonds - **ionic**, **covalent**, and **hydrogen** bonds.

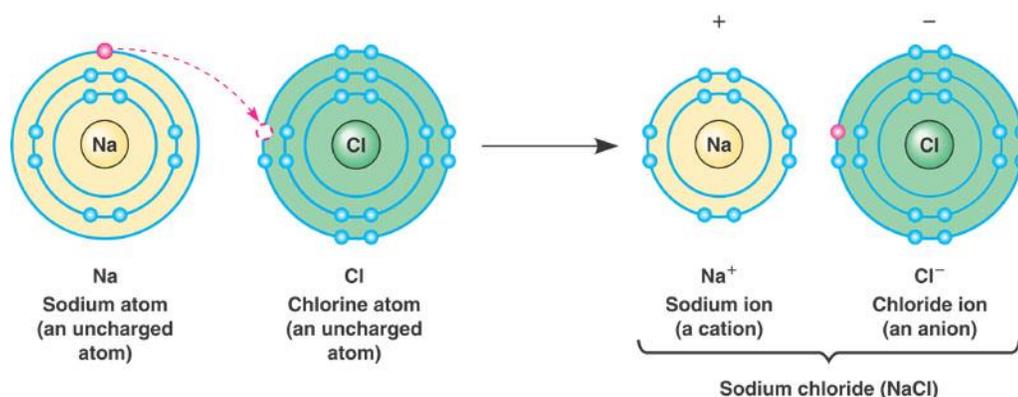
1. Ionic bonds

Ionic bonds are formed when atoms gain or lose **electrons** and become ions. When an atom donates an electron from its outer shell, it forms a positive ion called a **cation**. Atoms which accept electrons form negatively charged ions known as **anions**.

Since opposite charges **attract**, the positive and negative ions are pulled together and form an **ionic bond**. These bonds are **strong** and therefore require large amounts of **energy** in order to be broken. An example of the exchange of electrons between a sodium and chlorine atom can be seen in the diagram below.

Chemistry of Life

Guided Notes - Teachers Edition

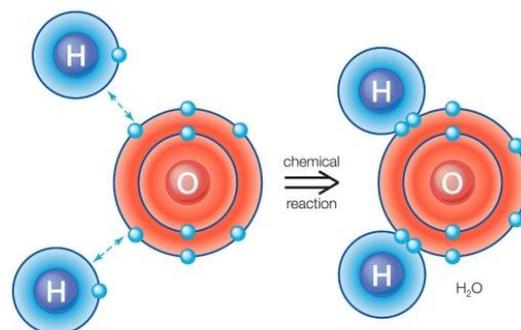


Generally, the donation of an electron by one atom cannot happen without an electron recipient, so these two processes of electron donation and electron acceptance must occur at the same time.

Certain ions such as sodium, potassium and calcium are referred to **electrolytes** in biology. These ions are essential for the function of the nervous system, **muscle** contraction and water **balance** in the body.

2. Covalent Bonds

The covalent bond is the most common and **strongest** form of chemical bonding existing in living organisms. This type of bond is formed when electrons are **shared** between atoms. This is commonly seen in carbon-based molecules and also in **water**, an essential molecule found in all living things. In the water molecule, each hydrogen atom shares one electron with the oxygen atom and the oxygen atom shares two electrons (one electron with each hydrogen atom).



The shared electrons complete each atom's outermost (**valence**) shell, making the water molecule more stable than its component **atoms**.

3. Hydrogen Bonds

Hydrogen bonds are relatively **weak** bonds which require little energy to break. These bonds occur between two molecules as a result of the **electrostatic** attraction between a proton in one molecule and an electronegative atom in the other. Both covalent and hydrogen bonds can be seen in the section of DNA molecule, shown below, The covalent bonds hold the backbone of the DNA molecule together, whereas the hydrogen bonds act to stabilize the two strands allowing it to form a double helix.

