Name____________________________

Biology Unit 2 Chemistry of Life (Ch. 6) Guided Notes

Atoms, Elements, and Chemical Bonding
- I can draw atom models and identify the # protons, # neutrons, and # electrons in an atom.
- I can identify the 6 most common elements that make up living things.
- I can differentiate between ionic and covalent bonds.

_________________ are the building blocks of matter. ________________________________ are made of matter.

Atom = ____________________________________________________________________________
__________________________________________________________________________________.

Element = __________________________________________________________________________
__________________________________________________________________________________.

Structure of an ATOM
3 Parts:
1. Protons = _______ charge and located in the __________________ of an atom.
2. Neutrons = ______ charge (neutral) and located in the __________________ of an atom.
3. Electrons = __________ charge and located in the __________________ of an atom.
   1\textsuperscript{st} energy level can hold a maximum of __________ electrons
   2\textsuperscript{nd} energy level can hold a maximum of __________ electrons
   3\textsuperscript{rd} energy level can hold a maximum of __________ electrons

The periodic table identifies the atomic number and atomic mass of an element.

\begin{center}
\begin{tikzpicture}
\node at (0,0) [draw,shape=circle] {6};
\node at (0.5,0.5) {C};
\node at (0.5,1.5) {Carbon};
\node at (0.5,2) {12.01};
\end{tikzpicture}
\end{center}

Mass number = atomic mass rounded to nearest whole number

The periodic table is arranged in order of increasing ________________________________.

The vertical columns of the periodic table are called ________________________________.

The horizontal rows of the periodic table are called______________________________.
To calculate how many protons, electrons, and neutrons an atom or given element has use the following:

Atomic Number = # of Protons = # Electrons
Atoms are NEUTRAL/have NO CHARGE; therefore # Protons = # Electrons
# Neutrons = Atomic Mass (rounded) – Atomic Number

For each element identify the # Protons, # Electrons, # Neutrons, Atomic #, and Atomic Mass (Mass Number). Then, draw and label the atom.

<table>
<thead>
<tr>
<th>Lithium</th>
<th>Carbon</th>
<th>Oxygen</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Fill in the diagram and chart below.

Statement | Electron | Neutron | Proton
---|---|---|---
Positively charged particle | | | |
Located outside the nucleus | | | |
Can be shared by two atoms | | | |
Has no charge (neutral) | | | |
Atoms with different number of neutrons are called ______________________________.

Notice the type of notation used for atoms: \[ \frac{A}{Z}X \]

- \( X \) = chemical symbol of the element
- \( Z \) = “atomic number”
- \( A \) = “mass number”

\(^{12}\text{C}, \ ^{13}\text{C}, \text{and} \ ^{14}\text{C} \) are notations that represent isotopes of carbon atoms.

\(^{1}\text{H}, \ ^{2}\text{H}, \text{and} \ ^{3}\text{H} \) are notations that represent isotopes of hydrogen atoms.

Note the following symbols: (they are not to scale)

- \( \bigcirc \) = proton (positive charge)
- \( \bullet \) = electron (negative charge)
- \( \odot \) = neutron (no charge)

The following three diagrams are carbon atoms:

\[ ^{12}\text{C}, \ ^{13}\text{C}, \ ^{14}\text{C} \]

(6 protons, 6 neutrons) (6 protons, 7 neutrons) (6 protons, 8 neutrons)

The following three diagrams are hydrogen atoms:

\[ ^{1}\text{H}, \ ^{2}\text{H}, \ ^{3}\text{H} \]
List the ________ most common elements found in living things.

C____________________
H____________________
N____________________
O____________________
P____________________
S____________________

Why do atoms bond together?

Atoms bond together to fill their valence (outer) electrons to become _________________.
When atoms bond together they form __________________ and ____________________

Compound =__________________________________________________________________
Molecule =__________________________________________________________________

TYPES OF BONDING

1. ___________ bonding is when two or more atoms ___________ electrons to
   form molecules. Example: Water (H₂O)
2. ____________ bonding is the attractive force between two ions of opposite charge to form compounds. Example: NaCl (table salt)
The atomic mass unit (amu) is a special unit for measuring the mass of very small particles such as atoms. The relationship between amu and grams is the following: $1.00 \text{ amu} = 1.66 \times 10^{-24} \text{ g}$.

Note the following diagrams comparing atoms and ions.

How many protons, neutrons, and electrons does the Fluorine ATOM have?

What is different in the Fluorine ION?

How many protons, neutrons, and electrons does the Magnesium ATOM have?

What is different in the Magnesium ION?
Chemical Reactions & Enzymes

- I can differentiate between reactants and products in a chemical reaction.
- I can summarize the functions of enzymes.
- I can create a model showing how enzymes function.
- I can explain how pH, temperature, and other substances affect enzyme function.

**Physical change** = a change in which the physical form (________________ or ________________) of a substance is changed, but not what it is made of.
Ex. Water changing states from solid (ice) to liquid to gas (vapor), cutting paper, painting a house

**Chemical change** = a change in which a substance is converted into a __________ substance with _______________ composition and properties.
- Involves chemical reactions that break the _______________ _______________ of _______________ to rearrange and make new _________________.
Ex. Photosynthesis, cellular respiration, combustion of methane (natural gas)

**PHOTOSYNTHESES CHEMICAL REACTION**

\[
\begin{align*}
6\text{CO}_2 & \quad + \quad 6\text{H}_2\text{O} \\
\text{Carbon dioxide} & \quad \text{Light} \quad \text{C}_6\text{H}_{12}\text{O}_6 \\
\text{Water} & \quad \text{Sugar} \quad 6\text{O}_2 \\
\end{align*}
\]

**Chemical Reactions**

- Written as chemical formulas using symbols.
- Atoms from the reactants (left side of arrow) are the atoms that form the products (right side of arrow).
- Subscripts (numbers below and to right of symbol) identify how many of that atom are in the compound/molecule.
- Coefficients (numbers in front of compound/molecule) identify the number of that compound/molecule.
- Reactions must be balanced to show conservation of matter.
- NEVER CHANGE SUBSCRIPTS WHEN BALANCING CHEMICAL REACTIONS!
- ONLY CHANGE THE COEFFICIENTS TO BALANCE CHEMICAL REACTIONS!
- An arrow shows the reaction (breaking and making of chemical bonds).
- Activation energy is needed for reactants to become products.
- Reactions are either endothermic (absorb energy) or exothermic (release energy).
Circle the subscripts and underline the coefficients in the following chemical reaction.

\[ 2 \text{H}_2 + \text{O}_2 \rightarrow 2 \text{H}_2\text{O} \]

Practice: Add the correct coefficient to balance the chemical equations below.

1. \[ \underline{} \text{N}_2 + \underline{} \text{O}_2 \rightarrow \underline{} \text{N}_2\text{O} \]

2. \[ \underline{} \text{H}_2\text{O}_2 \rightarrow \underline{} \text{H}_2\text{O} + \underline{} \text{O}_2 \]

3. \[ \underline{} \text{N}_2 + \underline{} \text{H}_2 \rightarrow \underline{} \text{NH}_3 \]

4. \[ \underline{} \text{CH}_4 + \underline{} \text{O}_2 \rightarrow \underline{} \text{CO}_2 + \underline{} \text{H}_2\text{O} \]

5. Sodium (solid) + Chlorine (gas) → Sodium Chloride (solid)
Enzymes

➢ ________________ that speed up chemical reactions by ________________ activation energy.
➢ Biological catalysts ending in -____________.
➢ Involved in ________________ (energy needed for all the chemical reactions in your body.
➢ Are ________________ and do not get used up during the chemical reaction.
➢ Changes to factors such as __________, ________________, and ________________ affect an enzyme’s ability to work.
➢ When an enzyme changes shape and loses its function, it becomes ________________.

Label and briefly describe what is happening at each step in the chemical reaction above.

Label the diagram below.
Draw a dotted line to represent how the chemical reaction would occur with an enzyme. Label the reactants and products on the energy diagram.
Label the type of reaction (exothermic or endothermic) shown by the energy diagrams below and justify your reasoning below the pictures.
Properties of Water, Acids, Bases, & pH

- I can describe the importance of water.
- I can describe the properties of water.
- I can explain why hydrogen bonds form.
- I can describe dehydration synthesis (condensation) and hydrolysis reactions.
- I can differentiate between acids and bases and provide examples of each.

Water is a compound/molecule formed by ___________________________ bonds.

The oxygen atom and hydrogen atoms __________________ their valence electrons.

Since __________________ is a very electronegative atom, it DOES NOT share the electrons equally with the two hydrogen atoms in a water molecule.

The unequal sharing of electrons results in charged ends (poles) of the molecule.

____________________ molecules result when atoms do not share electrons equally between atoms.

Water is a __________________ molecule.

Water molecules are attracted to one another and form __________________________ bonds.

Hydrogen bonding is also known as ____________________________.

Circle and count the number of water molecules in the picture to the right. Label the types of bonds that form between the atoms in individual water molecules and between different water molecules.
**Properties of Water**

<table>
<thead>
<tr>
<th>Property</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Polar</td>
<td></td>
</tr>
<tr>
<td>Universal Solvent</td>
<td></td>
</tr>
<tr>
<td>Cohesion</td>
<td></td>
</tr>
<tr>
<td>Adhesion</td>
<td></td>
</tr>
<tr>
<td>High Surface Tension</td>
<td></td>
</tr>
<tr>
<td>High Heat Capacity</td>
<td></td>
</tr>
<tr>
<td>Density</td>
<td></td>
</tr>
</tbody>
</table>

Water is important in _______________________. It is involved in _________________ and _________________ of chemical bonds in macromolecules.

**Acids and Bases**

Water dissociates into ______________________ and ________________________ ions.

\[
\text{H}_2\text{O} \rightleftharpoons \text{H}^+ + \text{OH}^- 
\]

Acids release ______________________ ions or ______________________ ions in solution.

Bases release ______________________ ions in solution.
The pH scale is used to measure the concentration of __________________________ ions.
The ______________________________ the H⁺ concentration, the more _______________________.
______________________________ have a low concentration of H⁺ ions.

**The relationship between H⁺, OH⁻ and pH**

<table>
<thead>
<tr>
<th>OH⁻ concentration (mol/l)</th>
<th>pH</th>
<th>H⁺ concentration (mol/l)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 x 10⁻⁴</td>
<td>14</td>
<td>1 x 10⁻¹³</td>
</tr>
<tr>
<td>1 x 10⁻³</td>
<td>13</td>
<td>1 x 10⁻¹²</td>
</tr>
<tr>
<td>1 x 10⁻²</td>
<td>12</td>
<td>1 x 10⁻¹¹</td>
</tr>
<tr>
<td>1 x 10⁻¹</td>
<td>11</td>
<td>1 x 10⁻¹⁰</td>
</tr>
<tr>
<td>1 x 10⁰</td>
<td>10</td>
<td>1 x 10⁻⁹</td>
</tr>
<tr>
<td>1 x 10¹</td>
<td>9</td>
<td>1 x 10⁻⁸</td>
</tr>
<tr>
<td>1 x 10²</td>
<td>8</td>
<td>1 x 10⁻⁷</td>
</tr>
<tr>
<td>1 x 10³</td>
<td>7</td>
<td>1 x 10⁻⁶</td>
</tr>
<tr>
<td>1 x 10⁴</td>
<td>6</td>
<td>1 x 10⁻⁵</td>
</tr>
<tr>
<td>1 x 10⁵</td>
<td>5</td>
<td>1 x 10⁻⁴</td>
</tr>
<tr>
<td>1 x 10⁶</td>
<td>4</td>
<td>1 x 10⁻³</td>
</tr>
<tr>
<td>1 x 10⁷</td>
<td>3</td>
<td>1 x 10⁻²</td>
</tr>
<tr>
<td>1 x 10⁸</td>
<td>2</td>
<td>1 x 10⁻¹</td>
</tr>
<tr>
<td>1 x 10⁹</td>
<td>1</td>
<td>1 x 10⁰</td>
</tr>
</tbody>
</table>

Identify examples from the pH diagram below to fill in the table.

<table>
<thead>
<tr>
<th>Acids</th>
<th>Bases</th>
<th>Neutral</th>
</tr>
</thead>
<tbody>
<tr>
<td>weak</td>
<td>Weak</td>
<td></td>
</tr>
<tr>
<td>strong</td>
<td>strong</td>
<td></td>
</tr>
</tbody>
</table>

__________ help neutralize acids and bases to maintain a certain pH level. Many organisms need buffers to maintain a certain pH allowing them to maintain ________________.
Macromolecules

- I can identify the specific elements in each of the organic macromolecules.
- I can identify examples of the organic macromolecules.
- I can summarize the major functions of each organic macromolecule.
- I can recognize the structural formulas of each organic macromolecule.
- I can describe the individual subunits in each of the organic macromolecules.
- I can predict what would happen to my body if certain organic macromolecules were not available.
- I can describe hydrolysis and dehydration reactions.

Life on earth is _____________________ - based. = ______________________________.

Each carbon atom is special because it forms _________________________________.

Carbon joins in ways that it forms large molecules in 3 shapes:

1) Straight chain
2) Branched
3) Ring

The six most common elements that make up living things are _____________________.
____________________ - large molecules formed from smaller molecules (monomers).

4 Major Categories of Organic Macromolecules:

1. _________________________________
2. _________________________________
3. _________________________________
4. _________________________________

Made by ___________________________  Broken down by ___________________________

![dehydration synthesis]

![hydrolysis]
“Sugars and Starches”

Elements: ________________________________

Jobs/Functions:
> ________________________________
> ________________________________
> ________________________________

Examples of Carbohydrates:

**Monosaccharides (subunits of carbohydrates)** - ________________________________

**Monosaccharides**

![](image1)

- Glucose
- Fructose
- Galactose

**Disaccharides** - ________________________________

**Polysaccharides** - ________________________________

**Polysaccharides**

![](image2)

- Glucose molecules
- Starch (a polysaccharide)
Elements: ____________________________

General Structure:
- Fatty acids – chain of carbon/hydrogen “tails”
- Glycerol – 3-carbon alcohol “backbone”
- Other components – phosphate chain (ATP) or 4-carbon rings (steroids)

Jobs/Functions:
- ____________________________
- ____________________________
- ____________________________

Types of Lipids:
1. ____________________________ - chains with phosphate groups (found in cell membrane)
2. ____________________________ - lipids like cholesterol and sex hormones (estrogen and testosterone)
3. ____________________________ (fats) – long-term energy storage

Three Structures of Fatty Acids:
1. ____________________________
   - No double bonds between carbon atoms in chain [all single bonds (−)]

Examples: ____________________________

2. ____________________________
   - One double bond (=) between carbon atoms in chain

Examples: ____________________________

3. ____________________________
   - Two or more double bonds (=, =) between carbon atoms in carbon chain

Examples: ____________________________

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(2) ____________________________ “Fats, Oils, and Waxes”

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Elements:

General Structure:
- subunits held together by _______________ bonds.

**Amino Acid Structure**

**Dipeptide = 2 Amino Acids**

Jobs/Functions:

Examples of Proteins:

**Levels of Protein Structure**:

Primary protein structure
- is sequence of a chain of amino acids

Secondary protein structure
- occurs when the sequence of amino acids are linked by hydrogen bonds

Tertiary protein structure
- occurs when certain attractions are present between alpha helices and pleated sheets

Quaternary protein structure
- is a protein consisting of more than one amino acid chain
“Genetic Information”

Elements:

General Structure:

_____________________________ - subunits of nucleic acids.

Nucleotides (subunits) are made of 3 parts:

(1) _______________________
(2) _______________________
(3) _______________________

Jobs/Functions:

 _______________________________________________________________________
 _______________________________________________________________________
 _______________________________________________________________________

2 Types of Nucleic Acids:

1) DNA = ____________________________________________________________
2) RNA = ____________ ____________________________________________