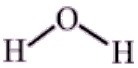
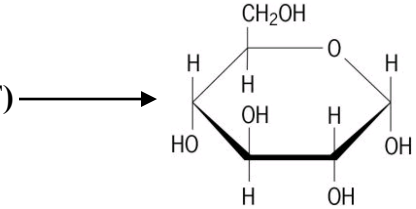
Visualizing Photosynthesis and Cellular Respiration

Photosynthesis

Photosynthesis is one of the most important biological events that occur on this planet. It is defined as the process by which plants use solar energy to convert the raw materials carbon dioxide (CO_2) and water (H_2O) into glucose ($C_6H_{12}O_6$) for use as an energy source. Also during this process, oxygen gas is produced as the byproduct that all aerobically-respiring organisms (such as ourselves) are dependent upon. The general chemical equation for photosynthesis is

In your notebook, draw out the entire reaction listed below. Be sure to include ALL the molecules and use the following color code: carbon is black, oxygen is red, hydrogen is green.

$\underline{6}\ H_2O + \underline{6}\ CO_2 +$ solar energy $\longrightarrow C_6H_{12}O_6 + \underline{6}\ O_2$

6  **+ 6 O = C= O + SUN (LIGHT)**  **+ 6 O = O**

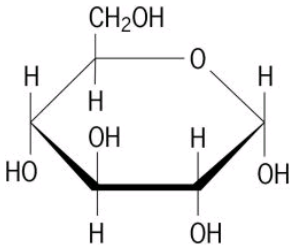
Following photosynthesis, the glucose constructed within plant cells can then be used as a source of energy and materials for cellular activities such as growth, reproduction and the synthesis of more complex materials such as starch, proteins, and fats. The existence of all naturally-occurring organic molecules (any molecule containing carbon, hydrogen, and oxygen), and therefore, all sources of energy, can be traced back to the process of photosynthesis.

Respiration

Energy is defined as the ability to do work. The cells of all organisms, and therefore, all organisms, require a continuous supply of energy for the performance of their daily, vital activities. Carbohydrates, especially glucose, generally provide this energy through the process of respiration. Simply stated, respiration is the release of energy from energy-storing compounds. It is represented by the chemical equation:

In your notebook, draw out the entire reaction listed below. Be sure to include ALL the molecules and use the following color code: carbon is black, oxygen is red, hydrogen is green.

$C_6H_{12}O_6 + \underline{6}\ O_2 \longrightarrow \underline{6}\ CO_2 + \underline{6}\ H_2O +$ energy (heat, light, ATP, etc.)

 + 6 O = O ⟶ 6 O = C = O + 6  + ATP (ENERGY)

You should be careful to notice that the process of cellular respiration is essentially the reverse of photosynthesis. The catabolic breakdown (burning) of glucose requires the presence of oxygen and yields energy and carbon dioxide. This process is generally the same when any organic molecule is respired (or burned) whether it is glucose in a living animal or plant cell, wood in a fire, or gasoline in a car. The breakdown of any energy storing chemical releases carbon dioxide as a byproduct, which may then be used by plants in the photosynthetic process.

Table of Average Bond Dissociation Energies

Bond	Energy (kJ/mol)	Bond	Energy (kJ/mol)
H - H	436	N - N	160
C - H	413	N = O	631
N - H	393	N triple N	941
O = O	498	N - O	201
C - C	347	C = O	805
C - O	358	O - H	464
Cl-Cl	242	H-Cl	433
C - Cl	397	O - Cl	269
C = C	607	O - O	204

Step 1 (complete on Student Handout):
Calculate the bond energies of the reactants and products. Determine whether the reaction is endothermic or exothermic and provide the appropriate graph. Explain why light energy is required for the reaction to occur.

Using colored pencils/crayons color the chemicals in both equations above. Be sure to use the following colors for each molecule(s)

Chemical in equation	**Color**		**Chemical in equation**	**Color**
Water	Blue		Oxygen	Orange
Carbon Dioxide	Red		Sunlight (ENERGY)	Yellow
Glucose	Green			

Step 2(complete on Student Handout):
Calculate the bond energies of the reactants and products. Determine whether the reaction is endothermic or exothermic and provide the appropriate graph. Explain why light energy is not required for the reaction to occur.

Using colored pencils/crayons color the chemicals in both equations above. Be sure to use the following colors for each molecule(s)

Chemical in equation	**Color**		**Chemical in equation**	**Color**
Water	Blue		Oxygen	Orange
Carbon Dioxide	Red		ATP (ENERGY)	Yellow
Glucose	Green			