

Chemical Reactions

Dr Joanna Ho

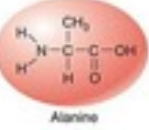


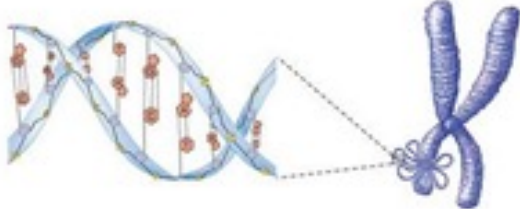
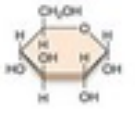
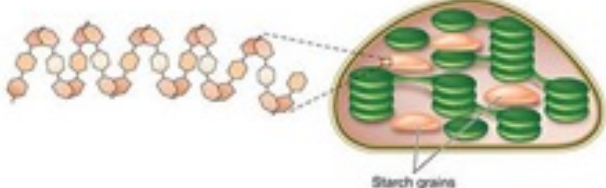
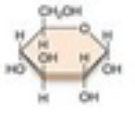
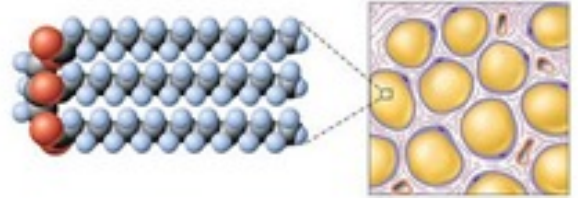
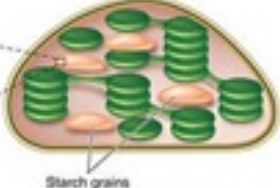

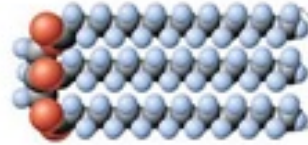
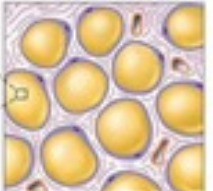
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Elements for life

TABLE 4.1 MACROMOLECULES		
Monomer	Polymer	Cellular structure
<p>Amino Acid</p>  <p>Alanine</p>	<p>Polypeptide</p> 	<p>Intermediate filament</p> 
<p>Nucleotide</p> 	<p>DNA strand</p> 	<p>Chromosome</p> 
<p>Monosaccharide</p> 	<p>Starch</p> 	<p>Starch grains in a chloroplast</p> 
<p>Fatty acid</p> 	<p>Fat molecule</p> 	<p>Adipose cells with fat droplets</p> 

- You could start really small...
- Particles of matter
 - Atoms
 - - Elements
 - - Molecules
 - - Macromolecules
 - - Cell organelles
 - Cells
 - Tissues
 - Organs
 - Systems
 - **Organisms**
 - Populations
 - Ecosystems
 - Biospheres
 - Planets
 - Planetary Systems with Stars
 - Galaxies
 - The Universe
- .And finish really big.

Chemical cooking - Chemical Reactions

- Learning Objectives
 - **Explain** basic features of chemical reactions (versus physical changes)
 - **Recognise** the four basic combinatory changes in chemical reactions
 - **Identify** major types of chemical reactions occurring in the body
 - Oxidation-Reduction
 - Acid-base
 - Hydrolysis
 - Condensation

<https://www.youtube.com/watch?v=2S6e11NBwiw>

CHEMICAL REACTIONS – MAJOR FEATURES

- Synthesis of matter
 - Conservation of matter
 - Energy is involved
 - Kinetic is involved
-
- Distinct from physical changes such as
 - Change of states, eg. ice to water is NOT a chemical reaction!

CHEMICAL REACTIONS – MAJOR FEATURES

- Synthesis of matter
 - Old bonds are broken and new bonds forms

CHEMICAL REACTIONS – MAJOR FEATURES

- Synthesis of matter
- Conservation of matter

**Chemical
Reactions –
major
features**

The Law of Conservation of Matter

“Matter is conserved”

- Matter cannot be created or destroyed during any chemical or physical change.

CHEMICAL REACTIONS – MAJOR FEATURES

- Synthesis of matter
- Conservation of matter
- Energy is involved
 - Energy is the capacity to do work
 - Energy transfer is associated with reactions

CHEMICAL REACTIONS – MAJOR FEATURES

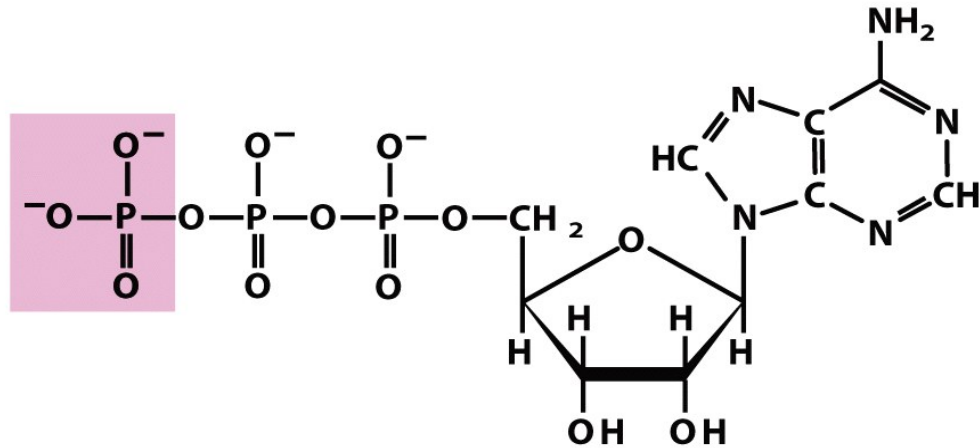
First Law of Thermodynamics

“Energy is conserved”

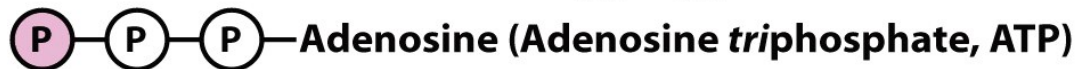
- The total energy of a system and its surroundings is constant
- For any cyclic process, there is no net change in energy
- Energy cannot be created or destroyed
- Energy can take different forms, such as heat and light etc.

Laws of Thermodynamics Apply to Living Organisms

- Living organisms cannot create energy from nothing
- Living organisms cannot destroy energy into nothing
- Living organisms may transform energy from one form to another
- In the process of transforming energy, living organisms must increase the entropy of the universe
- In order to maintain organization within themselves, living systems must be able to extract useable energy from the surrounding, and release useless energy (heat) back to the surrounding



Adenosine triphosphate (ATP) provides energy for many endergonic reactions



Inorganic phosphate



Inorganic pyrophosphate

Figure 1-25

Lehninger Principles of Biochemistry, Fifth Edition

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CHEMICAL REACTIONS – MAJOR FEATURES

- First reaction in glycolysis is a coupled reaction to ATP conversion to ADP

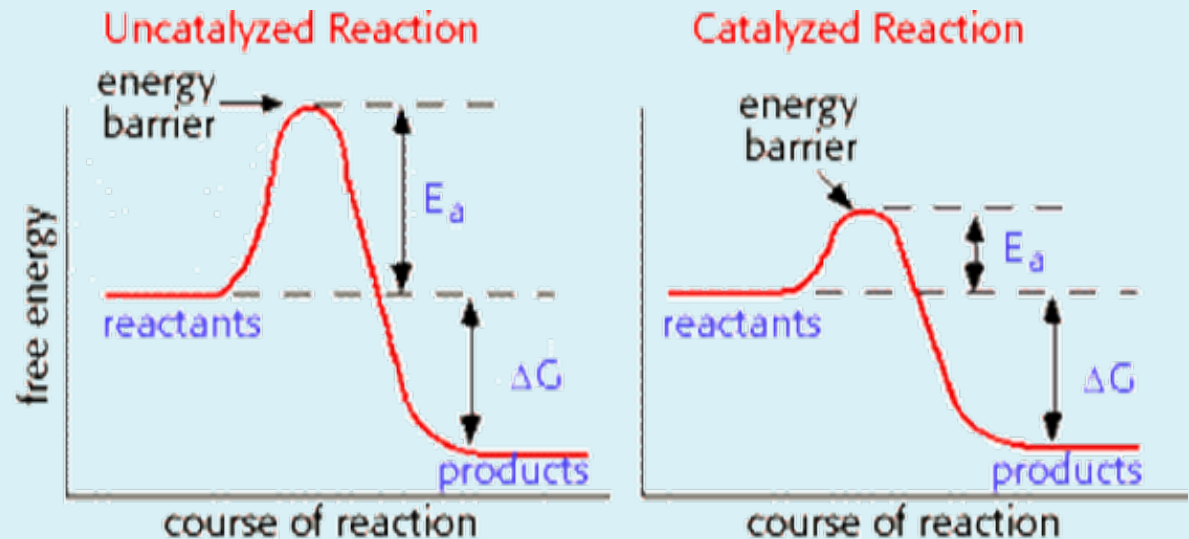


CHEMICAL REACTIONS – MAJOR FEATURES

- Synthesis of matter
- Conservation of matter
- Energy is involved
- Kinetic is involved

CHEMICAL REACTIONS – MAJOR FEATURES

- Kinetic refers to the rate of reactions
- Enzymes can change the rate of reactions and speed up reactions



CHEMICAL REACTIONS – MAJOR FEATURES

- Synthesis of matter
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- Distinct from physical changes such as
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Four basic types of combinatory changes



1. Synthesis
2. Decomposition
3. Single displacement
4. Double displacement

CHEMICAL REACTIONS

– CLASSIFY BY TYPES

- Chemical reactions can be classified in many ways, for example by the:
 - Types of products
 - **Types of reactants**
 - **Reaction outcome**
 - Reaction mechanism

CHEMICAL REACTIONS – CLASSIFY BY TYPES

- **By the types of reactants**
 - Redox (oxidation-reduction) reactions
 - Acid-base reactions
- **By the reaction outcome**
 - Condensation
 - Hydrolysis

CHEMICAL REACTIONS

– CLASSIFY BY TYPES

- By **the types of reactants**
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CHEMICAL REACTIONS – CLASSIFY BY TYPES

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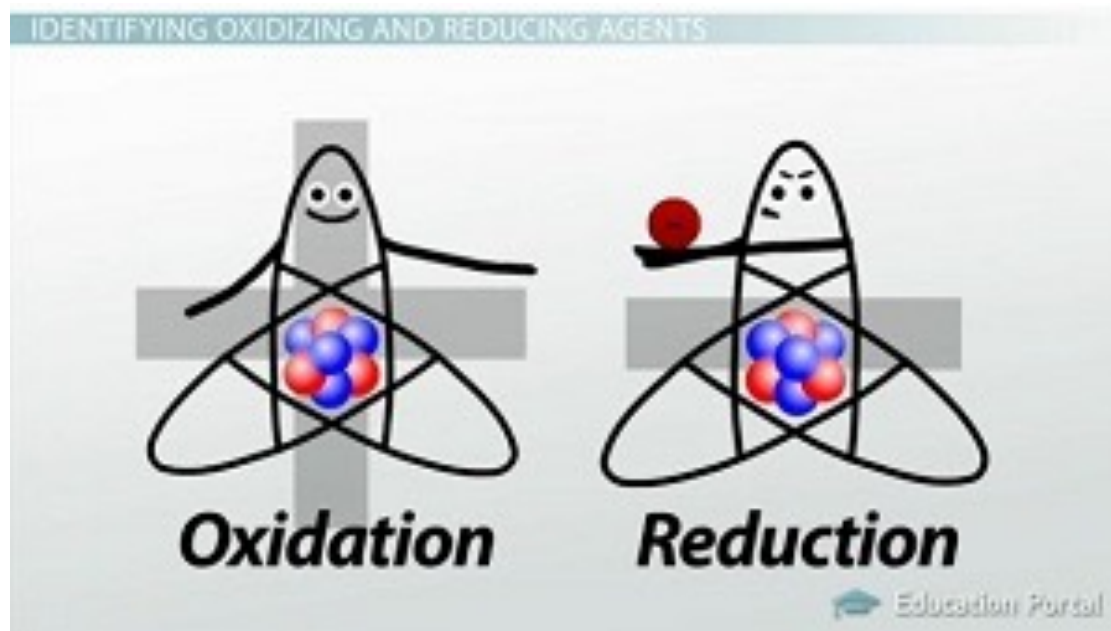
CHEMICAL REACTIONS – OXIDATION- REDUCTION

- Involves transfer of one or more electrons from a reducing agent to an oxidizing agent



- Magnesium burns in oxygen to form magnesium oxide. The product is an ionic compound, made up of Mg^{2+} and O^{2-} .
- Each magnesium atom gives up 2 electrons and gets oxidized.
- Each oxygen atom accepts 2 electrons and gets reduced.

CHEMICAL REACTIONS



<http://www.youtube.com/watch?v=lQ6FBA1HM3s>

<https://www.youtube.com/watch?v=lQ6FBA1HM3s> (2.20-2.35)

CHEMICAL REACTIONS – OXIDATION-REDUCTION

CHEMICAL REACTIONS –

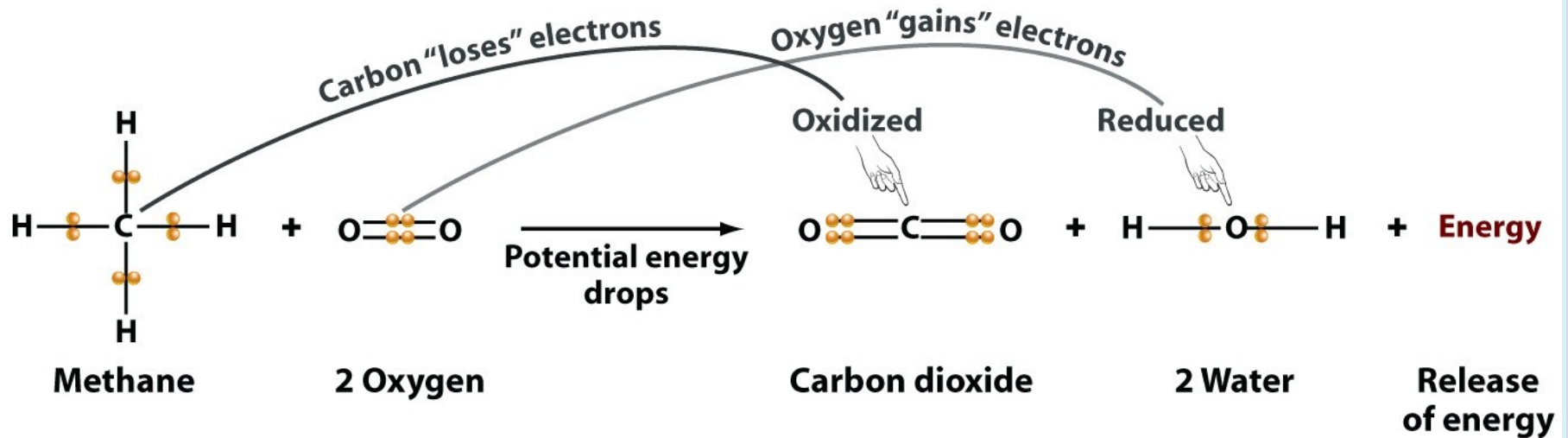
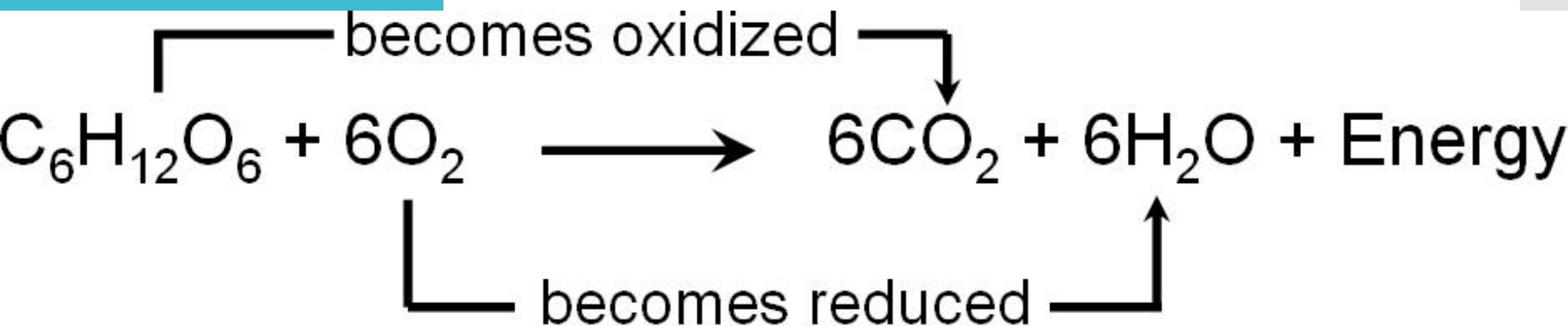


Figure 2-20 Biological Science, 2/e

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CHEMICAL REACTIONS – OXIDATION- REDUCTION

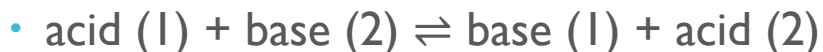


CHEMICAL REACTIONS – ACID-BASE

- Three theories of acid-base behaviour
 - The Arrhenius theory
 - **The Bronsted-Lowry theory**
 - The Lewis theory

CHEMICAL REACTIONS – ACID-BASE

Using the Bronsted-Lowry theory, an acid is defined as a proton donor and a base as a proton acceptor.



Where acid (1) and base (1) are a conjugate acid-base pair, as are acid (2) and base (2).

- Acids are defined weak or strong depending on whether the equilibrium favor the reactants or products



CHEMICAL REACTIONS – ACID-BASE

Completely ionized in water, hence favour product, so HCl is a strong acid!



The proton transfer from HCl to NH_3 is poor, hence favor reactant, so NH_3 and NH_4^+ are weak base and acid



CHEMICAL REACTIONS – CONDENSATION

- Polymers can be formed in basically 2 ways:
 - A. Linking small molecules together, which is a kind of addition reaction
 - B. Combining 2 molecules (either the same or different) with the elimination of a stable small molecule such as water (H_2O)

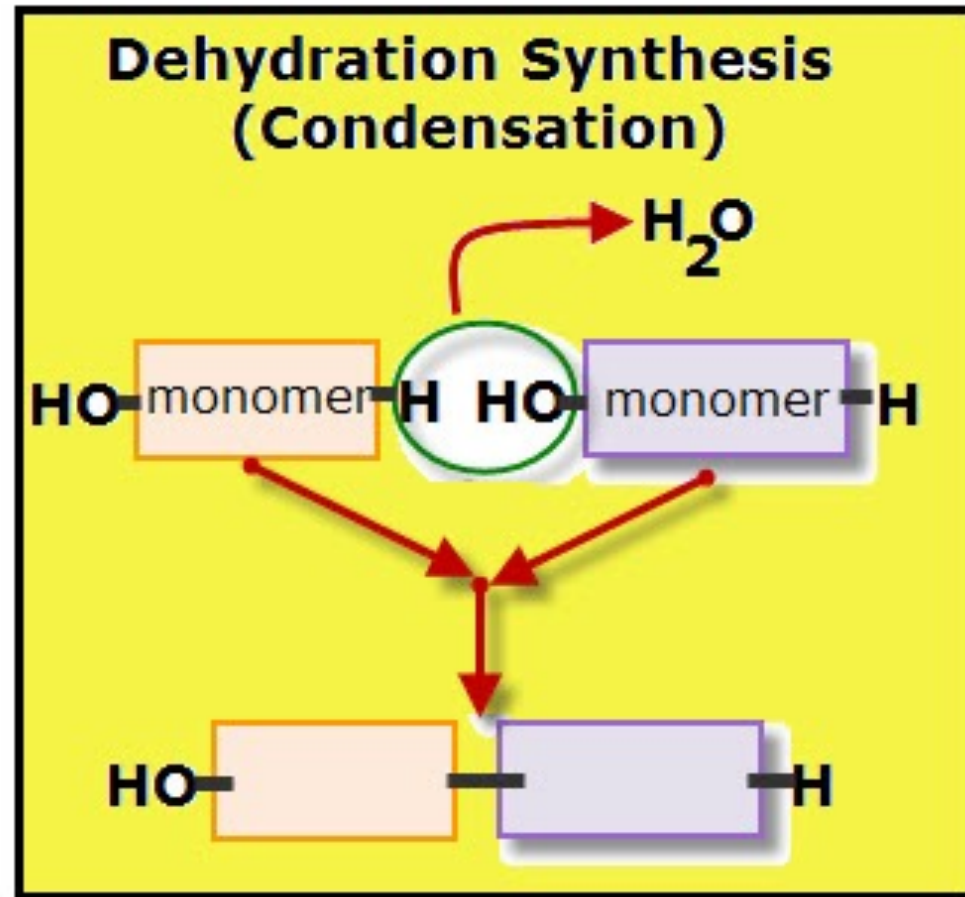
CHEMICAL REACTIONS – CONDENSATION

- **B** is a condensation reaction! (**A** is NOT) –featuring BOTH addition and elimination reactions.
- Eg. Starch and cellulose are both polymers of glucose, where glucose are joined together with concurrent elimination of water.



CHEMICAL REACTIONS – CONDENSATION

CHEMICAL REACTIONS – CONDENSATION



CHEMICAL REACTIONS – HYDROLYSIS

- When water is involved in a reaction
- $AB + HOH \rightleftharpoons AH + BOH$

CHEMICAL REACTIONS – HYDROLYSIS

- Proteins are hydrolyzed to amino acids
- Fats are hydrolyzed to fatty acids and glycerol
- Starch and complex sugars are hydrolyzed to simple sugars
- Anions of weak acids dissolve in water to give basic solutions.



CHEMICAL REACTIONS – HYDROLYSIS

