Review of L1-L5

Joanna Ho

Some Basic Chemistry: Elements and Compounds

L1

Atom

- Same atom has an identical number of protons in each nucleus
- Protons are positively charged and in the nucleus of the atom
- Neutrons are uncharged in the nucleus of the atom
- Electrons are negatively charged and in orbitals around the nucleus

Four major atoms to know

Carbon (C) - Form backbones of organic molecules; can form four bonds with other atoms

Nitrogen (N) - Component of all proteins and nucleic acids

Oxygen (O) - For cellular respiration; found in most organic compound, e.g. food stuff

Hydrogen (H) - Present in all organic compounds; maintain acid-base balance

Atom form molecules together

Atoms hold up together to form molecules by chemical bonds

Chemical bonds are all about how the outer shell of electrons of an atom interact with the electrons of another atom

Chemical bonds and interactions to know

Covalent bonds

- refer to when two atoms share electrons - kind of like 2 atoms holding hands. When at least 2 atoms get together by sharing electrons, they form a *molecule*.

Four types of

non-covalent interactions

to bring molecules together in a cell

- Ionic bonds
- Hydrogen bonds
- *van der waals* attraction
- Hydrophobic forces

Chemical Reactions

L2

Major features of chemical reactions

Synthesis of matter	• **Old bonds are broken and new bonds forms**
Conservation of matter	• **Matter cannot be created or destroyed during any chemical or physical change**
Energy is involved	• **Energy cannot be created or destroyed**
Kinetics is involved	• **Kinetic refers to the rate of reactions** • **Enzymes can change the rate of reactions and speed up reactions**

Basic types of chemical reactions to know

By the types of reactants

- **Redox (oxidation-reduction) reactions**
  - **Involves transfer of one or more electrons from a reducing agent to an oxidizing agent**
- **Acid-base reactions**
  - **An acid is defined as a proton donor and a base as a proton acceptor.**

By the reaction outcome

- **Condensation**
  - **Combining 2 molecules (either the same or different) with the elimination of a stable small molecule such as water (H_2O)**
- **Hydrolysis**
  - **Water is involved in a reaction**

Water: Its structure and life supporting properties

L3

Simple structure of water

2 hydrogen + 1 oxygen

Essential features of water

The 2 hydrogen atoms each share a pair of electrons with the oxygen by covalent bonding

The oxygen still has 2 pairs of unshared electrons

The oxygen is thus an “electronegative” atom compared to the two hydrogen

The polarity of water

Due to the uneven distribution of electron density, water is a “polar” molecule

Partial “-ve” charge near the oxygen, partial “+ve” charge near the hydrogen atoms

Hence

- Electrostatic attraction occurs between water molecules
  - Interactions between water molecules
    - by hydrogen bond formed due to the electrostatic attraction
- Interactions of water molecule with others
  - Hydrogen bonds between water and polar molecules
  - Hydration shells surrounding anions and cations

The ionization of water

For pure water, experimentally, it has been found that the concentration of: $H^+ = OH^- = 10^{-7}$

Thus indicates that the equilibrium favors the reactant (water molecules).

In other words, only very small amounts of H^+ and OH^- ions are present.

As a near universal solvent

Concentration is a measure of how much solute is dissolved in a given amount of solution

Other features of water

High heat of vaporization;

Strong surface tension;

High specific heat,

The Building Blocks of Life

L4

Lipids

Fatty Acids	• **Long hydrocarbon chain** • **Saturated vs unsaturated**
Triacylglycerols	• **Glycerol backbone + 3 fatty acids tail** • **Long-term fuel storage**
Phosphlipids	• **Phosphoglycerol head + 2 fatty acid tail** • **Cellular membrane**
Steroids	• **Cholesterol as precursor**

Carbohydrates

Monosaccharides

- Glucose
- Fructose
- Galactose

Disaccharides

- Lactose
- Sucrose

Polysaccharides

- Cellulose
- Starch
- Glycogen
  - Short term fuel storage

Proteins

Amino acids

- **Known its general structure,**
- **Basic building block of protein**

The four hierarchy of protein structure

- **Primary**
  - **Peptide bond**
- **Secondary**
  - **alpha helix and beta sheets**
  - **both alpha helix and beta sheets are held together by hydrogen bond**
- **Tertiary**
- **Quaternary**

Two general shapes of protein structure

- **Globular**
- **Fibrous**

Nucleic acids

DNA and RNA

Bases and base pairing

Nucleotide:

- its three components and as a basic building block of a nucleic acid strand

Fuels and Metabolism

L5

Major fuels from food and where do they go and do

Carbohydrates	• **glycogen** • **our smaller fuel stores** • **mainly in liver and muscles**
Proteins	• **Form large muscle masses in particular** • **Used as fuel when we fast**
Fats	• **Triacylglycerols** • **our major fuel store!** • **In adipose tissues** • **Found throughout our bodies** • **May accumulate more in hips, thighs and abdomens**

Cellular fuel is ATP

Energy is released by oxidation of the fuels molecules to CO_2 and H_2O

Through such oxidation reaction, general HEAT and/or ATP (adenosine triphosphate)

What does ATP do?

- $ATP \rightleftharpoons ADP + Pi$
- Provide energy that is needed to drive such as
  - Biosynthetic reactions
  - Muscle contractions
  - Active transport across membranes

Two processes of metabolism

Catabolism	• **To break down molecules**
Anabolism	• **To build up molecules from building blocks**

THE END

Thank you!

List of videos for your reference:

1. https://www.youtube.com/watch?v=0fKBhvDjuy0
2. https://www.youtube.com/watch?v=_INF3_30lUE
3. https://www.youtube.com/watch?v=NgD9yHSJ29I
4. https://www.youtube.com/watch?v=2S6e11NBwiw
5. https://www.youtube.com/watch?v=8m6RtOpqvtU
6. https://www.youtube.com/watch?v=YO244P1e9QM
7. https://www.youtube.com/watch?v=wvTv8TqWC48 – what is a protein
8. https://www.youtube.com/user/khanacademy – I'd like to recommend the "biology" channel