

02: Chemical Basis of Life

Key Terms	Organic Chemicals
<p>Atoms:</p> <ul style="list-style-type: none"> ○ Electrons: both energy and substance particles ○ Neutrons ○ Protons <p>Molecules:</p> <ul style="list-style-type: none"> ○ Formed by atoms ○ Joined by chemical bonds ○ Molecular formula and structure formula <p>Organic Molecules/macromolecules:</p> <ul style="list-style-type: none"> ○ Amino acids --> proteins ○ Monosaccharides --> polysaccharides ○ Fatty acids --> lipids ○ Nucleotides --> nucleic acids <p>Isotope: Atoms have same proton numbers but may differ in neutron numbers</p> <p>Energy shell: Electrons occupy orbital around nucleus, these are called energy shells. The most inner shell (K) contains 2 electron maximum, the L and M shell contain 8 maximum each.</p> <p>Organic chemicals: Chemicals are made from living organisms and contain carbon backbones.</p> <p>Isomers: Chemicals that have same molecular formula but different structure formula.</p> <p>Buffers: Solutions which resist change in pH upon addition of small amounts of acid or base.</p> <p>Electrolytes: Chemicals that can release ions into solutions</p> <p>pH: pH represents the concentration of hydrogen ions $[H^+]$ in solution. $pH = -\log [H^+]$</p> <p>Enzymes: Proteins that serve as catalysts for biochemical reactions.</p> <p>Entropy: A measure for a system's degree of disorder. It increases with increasing disorder.</p> <p>Law of thermodynamics:</p> <ul style="list-style-type: none"> • The first Law: The total energy of the universe is always conserved. Energy can neither be created nor destroyed. • The second Law: The universe tends towards maximum disorder, or, in other words: the direction of all spontaneous processes is such as to increase the entropy of a system plus its surroundings <p>ΔG: Change of free energy of a system.</p> <ul style="list-style-type: none"> • ΔG negative reaction: spontaneous • ΔG positive reaction: non-spontaneous 	<p>Classified by the functional groups:</p> <ul style="list-style-type: none"> ■ Alcohols, R-OH ■ Aldehydes, R-CHO, R-C=O <div style="text-align: center;"> $\begin{array}{c} \text{O} \\ \\ \text{R}-\text{C}-\text{H} \end{array}$ </div> <ul style="list-style-type: none"> ■ Ketones, R-C-R, R-CO-R <div style="text-align: center;"> $\begin{array}{c} \text{O} \\ \\ \text{R}-\text{C}-\text{OH} \end{array}$ </div> <ul style="list-style-type: none"> ■ Carboxylic Acids, R-COOH, R-C-OH ■ Amines, R-NH₂, R-N-H <div style="text-align: center;"> $\begin{array}{c} \text{H} \\ \\ \text{R}-\text{N}-\text{H} \end{array}$ </div> <ul style="list-style-type: none"> ■ Organic Phosphates, R-OPO₃²⁻, R-O-P(=O)(O⁻)₂ <div style="text-align: center;"> $\begin{array}{c} \text{O}^- \\ \\ \text{R}-\text{O}-\text{P}=\text{O} \\ \\ \text{O}^- \end{array}$ </div> <ul style="list-style-type: none"> ■ Thiols, R-SH
Important Biochemical Molecules	
	<p>Organic Molecules/macromolecules:</p> <ul style="list-style-type: none"> ■ Polysaccharides <ul style="list-style-type: none"> ○ Monomer unit: monosaccharide ○ Store energy, provide building unit ■ Lipids <ul style="list-style-type: none"> ○ Monomer unit: fatty acids, glycerol ○ Store energy, membrane construction, hormones ■ Proteins: <ul style="list-style-type: none"> ○ Monomer unit: amino acids ○ Structure protein, enzymes ■ Nucleic Acids: <ul style="list-style-type: none"> ○ Monomer unit: nucleotides ○ Genetic material
Chemical Reactions	
	<p>Coupled reactions: Many biosynthesis reactions are coupled to ATP hydrolysis which can provide energy and therefore the overall reaction can be delta G negative.</p> <ul style="list-style-type: none"> • ΔG negative reaction: spontaneous • ΔG positive reaction: non-spontaneous <p>Enzyme catalyzed reactions: Lower the activation free energy but do not change the ΔG.</p>
Chemical Bonds	Biochemical Reaction Types and Enzymes
<p>Chemical bonds store energy. For covalent bonds, the more electrons a bond share, the more energy it stores.</p> <p>Ionic bond: ionic bond forms when atoms lose or gain electrons.</p> <p>Covalent bond: Covalent bonds form when atoms share electrons, very strong bonds. The major one in organic chemicals.</p> <p>Hydrogen bond: Weak electrical attraction between the positive end of one molecule and the negative end of another</p>	<ul style="list-style-type: none"> ■ Oxidation-reduction reactions: oxidoreductase ■ Intramolecular or intermolecular functional group-transfer reactions: transfease ■ Hydrolysis of esters, ethers, and amides: hydrolase ■ Elimination or addition reactions: lyase. ■ Isomerization reactions: isomerase ■ Formation of ester, thiol ester, and amide linkages: ligase

How to Use This Cheat Sheet: These are the keys related this topic. Try to read through it carefully twice then rewrite it out on a blank sheet of paper. Review it again before the exams.