

I. INTRODUCTION

1. Eukaryotes
 - A. Important organelles: nucleus, mitochondrion, endoplasmic reticulum (with and without bound ribosomes)
 - B. Cytosol, cytoplasm, supramolecular assembly (ribosomes)
 - C. Cell membrane
2. Metals/nonmetals
3. Functional Groups based on carbon chemistry
4. The hydrogen bond
 - A. Water as the ideal case of hydrogen bonding
 - B. Geometry as the hydrogen bond in water
 - C. Other biologically important hydrogen bonds
5. The polar nature of the water molecule
 - A. Electronegativity
 - B. Polar bonds and polar molecules
6. Solvent properties of water
 - A. Ion-dipole and dipole-dipole interactions with ionic and polar solutes
 - B. Unfavorable dipole-induced dipole interactions with nonpolar solutes
 - C. Amphiphilic solutes
7. Molecular interactions
 - A. Hydrogen bonds
 - B. Electrostatic interactions (attractions and repulsions) formal charges
 - C. Hydrophilic and hydrophobic (polarity)
 - D. London Forces-induced dipoles
8. Acids and bases
 - A. Definition of acid and base
 - B. Acid dissociation constants-pK
 - C. pH scale
 - D. The Henderson-Hasselbalch equation
 - E. Titration curves
9. Buffers
 - A. The nature of a buffer solution: relationship to titration curves
 - B. Examples of buffers: phosphate, carbonate, TRIS
 - C. Physiological consequences of blood buffering
10. Terminology-metabolism (anabolism, catabolism), enzyme, ATP, aerobic, anaerobic, orthophosphate, pyrophosphate, redox=reducing equivalents

II. Amino Acids

1. The nature of amino acids
 - A. Chemical structure: the importance of side chains
 - B. Stereochemistry: L and D amino acids
2. Properties of individual amino acids
 - A. Polar and nonpolar side chains
 - B. Acidic and basic side chains
3. Titration curves of amino acids
 - A. Carboxyl and amino group ionization
 - B. Side chain ionization
4. Peptide bonds
5. Small peptides of biological interest

III. Proteins

1. Levels of structure in protein
 - A. Primary
 - B. Secondary
 - C. Tertiary
 - D. Quaternary
2. Denaturation
3. Myoglobin
4. Hemoglobin
 - A. Conformational changes in hemoglobin
 - B. The Bohr effect
 - C. 2,3-Bisphosphoglycerate binding

IV. Enzymes as catalysts

1. Kinetic aspects of reaction
2. Allosteric and nonallosteric enzymes
3. Michaelis-Menten model
4. Inhibitors
 - A. Irreversible inhibitors
 - B. Reversible inhibitors: competitive and noncompetitive inhibition
5. Zymogens
6. Isoenzymes

V. Coenzymes

- A. Vitamins as precursors
- B. Coenzymes
- C. Metabolic roles

VI. Electron transport in mitochondria

- a. The proton gradient
- b. Electron transport from NADH to O₂
- c. Coupling of oxidation to phosphorylation
- d. The chemiosmotic coupling mechanism
- e. Cytochromes and accessory molecules
- f. Respiratory inhibitors
- g. Shuttle mechanisms that mediate transport between the cytosol and mitochondria
- h. ATP yield from complete oxidation of glucose

VII. Carbohydrates

- a. Monosaccharides-nomenclature
 1. Aldo, ketotriose (glyceraldehydes) and (DHA)
 2. Aldo, keto pentoses (ribose and ribulose)
 3. Aldo, keto hexoses (glucose, fructose, galactose, mannose)
 4. Structures-Fischer and Haworth
 5. Reactions-redox, esterification
- b. Disaccharides-maltose, sucrose, lactose and cellobiose
 1. Linkage
 2. Composition
- c. Polysaccharides
 1. Homopolysaccharides
 - a. Glycogen-repeat units and linkages
 - b. Starch- repeat units and linkages
 2. Heteropolysaccharides
 - a. Hyaluronic acid-repeat units and linkages
 - b. Chondroitin sulfate – repeat unit and linkages
 - c. Heparin

VII. Glycolysis

1. Overview of the glycolytic pathway
2. Reactions of glycolysis
 - a. Phase 1-primer
 - b. Phase 2-payback
 - c. Substrate level phosphorylation
 - d. Redox reaction
 - e. Lactate fermentation
 - f. Recycling of NAD⁺
 - g. Substrate cycling steps-Control points
 - h. Energy considerations under aerobic vs anaerobic conditions
 - i. Feeder paths for
 - (1) Glucose from diet
 - (2) Glucose from storage (glycogen)
 - (3) Mannose

- (4) Fructose
- (5) Galactose
- j. Sugar nucleotide carrier

VIII. Gluconeogenesis

1. Purpose
2. Location
3. Overall view of the pathway
4. Control points/substrate cycling
 - a. Pyruvate kinase
 - b. PFK-I and PFK-2
 - c. F1,6BPtase
 - d. Hexokinase/Glucokinase

IX. Glycogen Metabolism

1. Glycogenin
2. Synthesis
3. Catabolism
4. Control
 - a. Short term-allosteric (ATP and G-6-P concentrations)
 - b. Long term (hormonal- glucagon and epinephrine)
 - (1) Cascade
 - (2) activation
 - (3) inactivation
5. Enzymes
 - a. Glucose-6-phosphatase
 - b. α -1,6-glucosidase
 - c. Synthase
 - d. Phosphorylase

X. Pentose Phosphate shunt (HMP)

1. Location
2. Function (Ribose and NADPH for fatty acid synthesis)

XI. Pyruvate Dehydrogenase Complex (PDC some books call it PDH)

- a. Location
- b. Structural components
- c. Enzymes: catalytic and regulatory
- d. CoE: in order of appearance and vitamin precursor
- e. General reaction
- f. Regulation

XII. The Citric Acid Cycle (Kreb's cycle, TCA)

- a. The role of TCA in metabolism
- b. Location of the cycle

- c. Aerobic requirements and regeneration of starting material
 - d. Conversion of pyruvate to acetyl-CoA
 - 1. Pyruvate Dehydrogenase
 - 2. Control
 - e. Individual reactions of the cycle
 - 1. Oxidative decarboxylation
 - 2. Rearrangement
 - 3. Isomerization
 - 4. SLP
 - 5. Main line sequence (redox, hydration, redox)
 - f. Energy realized from the cycle
 - g. Control of the cycle
5. Amino acid metabolism
- a. Role of pyridoxal phosphate in transamination reactions
 - b. Oxidative deamination
 - c. The urea cycle
 - 1. Characteristics
 - 2. Energy used
 - 3. Location

XIV. Lipid

- 1. Structure and characteristics
 - a. Fatty acids
 - b. Triacylglycerols
 - c. Phosphoacylglycerols
 - d. Eicosanoids
- 2. Catabolism of lipids (β -oxidation)
 - a. The role of thioesters
 - b. The β -oxidation cycle for fatty acids
 - c. Energy yield from the oxidation of fatty acids
 - d. "Ketone bodies"
- 3. Anabolism of fatty acids
 - a. The role of thioesters
 - b. Comparison with β -oxidation

XV. Nucleotides

- 1. Overview
- 2. Structure
 - A. Purines
 - B. Pyrimidines
- 3. Nucleosides
- 4. Nucleotides