Virginia Western Community College
CHM 260
General
Biochemistry

Prerequisites:

CHM 111 and CHM 112, or equivalent

Course Description:

Explores the fundamentals of biological chemistry. Includes study of structure and function of amino acids, proteins, carbohydrates, lipids and nucleic acids; cell membrane structure and cell signaling, enzyme kinetics and mechanisms of catalysis, metabolic pathways, aerobic respiration, and fermentation.

Semester Credits: 3 **Lecture Hours: 3**

Required Materials:

Textbook: Biochemistry: A Short Course. Tymoczko, Berg, Gatto, and Stryer, 4th edition: ISBN -13: 978-131924808

Course Outcomes

At the completion of this course, the student should be able to:

1. Determine the charge and protonation state of biomolecules in physiological solution, and describe their behavior and function in terms of their state, using the Henderson-Hasselbalch equation.
2. Understand how the R groups of the 20 canonical amino acids contribute to protein structure
3. Master the basic principles of protein structure, including the nature of peptide bonds.
4. Understand various methods of protein purification, and outline basic protocols to purify proteins
5. Master the basic principles of nucleic acid structure and function.
6. Visualize and understand how the conformational flexibility of proteins regulates their functions.
7. Analyze and quantify the kinetics of enzyme reactions.
8. Analyze the mechanisms of enzyme inhibition through Lineweaver-Burke plots
9. Analyze catalytic mechanisms of enzymes.
10. Master the principles of the structure and function of carbohydrates, nucleic acids and lipids.
11. Be introduced to the components and organization of cell membranes.
12. Be introduced to signal-transduction pathways.
13. Understand how biomolecules work together to carry out the myriad tasks in cells.
14. Understand metabolic pathways such as glycolysis, the citric acid cycle, and gluconeogenesis
15. Understand how proton motive force is generated
16. Understand how ATP is produced during aerobic respiration and fermentation

Topical Description Listed in the Order Taught

Topics	Chapter
1. **Water, weak bonds, pH and buffers** A. Hydrogen bonding B. Van der waals forces C. Hydrophobic effect D. Henderson- Hasselbach equation and its applications E. pH and buffers	2
2. **Amino acids** A. Structures of the 20 common amino acids B. Other amino acids and amino acid derivatives C. Ionization of amino acids D. Peptide bonds	3
3. **Protein Structure** A. Nature of the peptide bond B. Levels of protein structure: Primary C. Secondary protein structure D. Tertiary protein structure E. Quaternary protein structure F. Protein-protein interactions G. Protein folding and denaturation H. Collagen and prion proteins	4

4. Protein purification techniques **5**

A. Ion exchange chromatography
B. Size exclusion chromatography
C. Affinity chromatography
D. Differential centrifugation
E. 1D and 2D gel electrophoresis
F. Immunological techniques
    a. Immunoprecipitation
    b. ELISA
G. Edman degradation and determination of protein structure
H. Introduction to mass spectroscopy & X-ray crystallography

5. Basic concepts of enzyme action **6**

A. Classes of enzymes
B. Gibbs free energy
C. Features of the enzyme active site

6. Kinetics and regulation **7**

A. Michaelis Menten equation and kinetics
B. Explanation of Km and Vmax
C. Lineweaver Burke plots and their applications
D. Allosteric regulation
E. Alterations of quaternary structure and regulation of allosteric enzymes

7. Enzyme mechanisms and inhibitors **8**

A. Modulation by temperature and pH
B. Competitive, uncompetitive, noncompetitive inhibition
C. Use of Lineweaver Burke plots to determine mechanism of inhibition
D. Reversible vs irreversible inhibition
E. Penicillin as a model of irreversible inhibition
F. Mechanism of chymotrypsin catalysis

8. Hemoglobin, an allosteric protein **9**

A. Structure of hemoglobin
B. How myoglobin and hemoglobin bind oxygen
C. Cooperative binding and conformational changes of hemoglobin
D. Regulation of affinity of hemoglobin for oxygen by allosteric regulation

9. **Carbohydrates** **10**

A. Isomers of sugars
B. Structures of glucose
C. Monosaccharides and different linkages to form polysaccharides
D. Disaccharides
E. Polysaccharides
F. Glycoconjugates- glycoproteins and proteoglycans

10. **Lipids** 11
    A. Fatty acids
    B. Triacylglycerols
    C. Phospholipids
    D. Steroids
    E. Biological membranes
    F. Membrane transport
    G. Signal transduction

11. Membranes **12**
    A. Structure of phospholipid bilayer
    B. Fluidity of membranes
    C. Membrane protein functions

12. Nucleic acids **33**
    A. Nucleotides as building blocks of nucleic acids
    B. Structure of double stranded DNA
    C. A, B and Z DNA
    D. Histones and DNA binding proteins

13. Signal transduction pathways **13**
    A. G protein coupled receptor pathways
    B. Tyrosine kinase receptor pathways
    C. First and second messengers

15. Introduction to Metabolism **15**
    A. Metabolic pathways
    B. Major cellular pathways
    C. Metabolic roles of ATP hydrolysis

16. Glycolysis **16**
    A. Ten steps of glycolysis
    B. Enzymatic reactions of glycolysis
    C. Fate of pyruvate
    D. Regulation of glycolysis

17. Gluconeogenesis
    A. Gluconeogenesis as a reversal of glycolysis
    B. Control of the pathway
    C. Reciprocal regulation of gluconeogenesis and glycolysis

19. Harvesting electrons from the citric acid cycle **19**
    A. Transition step-oxidation of pyruvate
    B. Steps of the citric acid cycle
    C. Citric acid cycle enzymes
    D. Regulation of the citric acid cycle

20. Electron transport chain **20**
    A. The mitochondrion

B. Structure and function of the ETC complexes
C. Electron transport
D. ATP synthase

21. Proton Motive Force **21**
A. Chemiosmotic theory and proton motive force
B. Mechanism of ATP Synthase

22. Photosynthesis (time permitting): Light reactions
23. Photosynthesis (time permitting): Calvin Cycle

Notes to Instructors

1. Departmental policy dictates that instructors do not allow students to keep tests.
2. A comprehensive final exam counting 15%-20% of the total grade will be given at the end of the semester.
3. The syllabus should state what the course grade will be based on, such as tests, quizzes, a comprehensive final exam, and any other assignments made by the instructor.

ADA Statement (PDF)
Title IX Statement (PDF)