Course Outcomes/Course Outline

Course Title: **Biochemistry**
Prefix and Course Number: **Chem 260**

Course Learning Outcomes:
By the end of this course, a student should:

- Understand the chemical foundations of biochemistry
- Develop a working knowledge of biological systems and processes
- Recognize that metabolism is a highly integrated network of chemical reactions
- Be able to identify the different classes of biomolecules and their functions within biological systems
- Understand protein functions and the correlation between protein conformation and biological activity
- Be able to describe how enzymes catalyze reactions in terms of kinetics and mechanistic strategies
- Understand the structure of biological membranes and be able to describe membrane transport
- Be able to recognize and describe the metabolism of carbohydrates, lipids, and proteins
- Understand and be able to explain how metabolic pathways are regulated
- Develop the ability to predict how environmental changes effect the rates of metabolic pathways
- Be able to describe gene expression and how the process is regulated
- Understand the endocrine system and be able to predict hormonal changes and effects on target cells when environmental conditions vary
- Understand the immune system and different immune responses

Course Outline:

I. Chemical Components and Structure of the Cell
  A. Function and Biological Classification
    i. Biomolecules and Chemical Reactions of Life
    ii. Principal Metabolic Strategies
    iii. Role of Membrane
    iv. Organelle Functions
    v. Five Kingdoms – Fungi, Plants, Animals, Protists (unicellular eukaryotes), and Monera (prokaryotes)
    vi. Catabolic and Anabolic Pathways
    vii. Biological Energy Transformations
  B. Water
    i. Polarity
    ii. Hydrogen Bonding
    iii. Solvent Properties
    iv. pH and Acidity
    v. Biological Buffers
  C. Amino Acids, Peptides, and Proteins
    i. Types of Amino Acids (hydrophobic, polar, acidic, and basic)
    ii. pka and Ionization
    iii. Formation of Peptide Bonds
    iv. Polypeptide Chains (N-terminus, C-terminus, main chain, and side chains)

v. Primary, Secondary, Tertiary, and Quaternary Structure in Polypeptides
vi. Protein Folding
vii. Protein Conformation and Activity
viii. Conditions that Cause Protein Conformational Changes
ix. Denaturation
x. Fibrous, Membrane, and Globular Proteins
xi. Protein Functions
xii. Structure and Function of Myoglobin, Hemoglobin, Serum Albumin, Glucokinase, Growth Hormone, Actin, Immunoglobulin and Collagen)

D. Enzymes
i. Enzyme Structure and Mechanisms
ii. Enzyme Kinetics
iii. Factors that Affect Enzyme Activity
iv. Metabolic Regulation (temperature, pH, substrate concentration, enzyme concentration, competitive inhibitors, allosteric inhibitors, allosteric activators, covalent modification, and genetic control)
v. Vitamins, Cofactors, and Coenzymes

E. Carbohydrates
i. Classification of Carbohydrates
ii. Chemical and Physical Properties of Carbohydrates
iii. Formation of Disaccharides and Polysaccharides
iv. Structure of Disaccharides and Polysaccharides
v. Glycoproteins

F. Lipids
i. Structure and Classification of Lipids
ii. Fatty Acids, Waxes and Triacylglycerols
iii. Glycerophopholipids
iv. Sphingolipids
v. Glycolipids
vi. Steroids
vii. Fat Soluble Vitamins
viii. Prostaglandins

G. Biological Membranes
i. Fluid Mosaic Model
ii. Lipid Bilayer
iii. Membrane Proteins (integral, peripheral, and anchored)
iv. Membrane Fluidity (effects of lipid unsaturation and chain length)
v. Effects of Cholesterol
vi. Membrane Transport (passive diffusion, facilitated diffusion, active transport, exocytosis and endocytosis)

H. Nucleic Acids
i. Common Bases
ii. Nucleosides and Nucleotides
iii. DNA
iv. RNA

II. Metabolism

A. Carbohydrate Metabolism and Regulation
i. Glycolysis
ii. Citric Acid Cycle (Tricarboxylic Acid Cycle or Krebs Cycle)
iii. Oxidation Phosphorylation and the Electron Transport Chain
iv. Thermogenin and Non-Shivering Thermogenesis
v. Pentose Phosphate Pathway
vi. Gluconeogenesis

vii. Cori Cycle
viii. Glycogen Metabolism (Glycogenesis and Glycogenolysis)
ix. Cellular and Hormonal Regulation of Carbohydrate Metabolism

B. Lipid Metabolism and Regulation
i. Lipolysis
ii. Lipid Transport (chylomicrons, serum albumin, and lipoprotein complexes)
iii. Formation of acyl CoA and Transport into Mitochondria
iv. Beta Oxidation
v. Catabolism of Odd-Number Fatty Acids and Unsaturated Fatty Acids
vi. Lipogenesis
vii. Synthesis of Triacylglycerols
viii. Ketogenesis
ix. Synthesis of Steroids
x. Synthesis of Membrane Lipids
xi. Cellular and Hormonal Regulation of Lipid Metabolism

C. Amino Acid and Polypeptide Metabolism and Regulation
i. Cellular Proteolysis (lysosomes and ubiquitin-proteasomes)
ii. Amino Acid Degradation (transamination and deamination)
iii. Urea Cycle
iv. Nitrogen Molecules Produced from Amino Acid Catabolism
v. Amino Acid Synthesis
vi. Amino Acid Derivatives (serotonin, dopamine, and epinephrine)
vii. Cellular and Hormonal Regulation of Amino Acid and Polypeptide Metabolism

D. DNA, RNA, and Protein Synthesis
i. DNA Replication
ii. DNA Repair
iii. Transcription
iv. Post-Transcriptional Modification of RNA
v. Translation
vi. Post-Translational Modifications
vii. Regulation of Transcription, Post-Transcription, Translation, and Post-Translation

III. Complex Molecular Processes

A. Molecular Immunology
i. Types of Pathogens
ii. Types of Antigens
iii. Innate Immune Response
iv. Adaptive Immune Response

B. Hormone Function
i. Endocrine System (endocrine organs, hormones, and target cells)
ii. Release of Hormones
iii. Hormone Effect on Target Cells
iv. Interaction with Immune System
v. Regulation of Blood Glucose