Miami Dade College

Course Description

BCH3023| Introductory Biochemistry | 3.00 credits

This course surveys the fundamental components of biochemistry. In this course, students will learn concepts such as the structure and function of amino acids, proteins, carbohydrates, lipids, and nucleic acids, together with discussions of oxidative metabolism and regulation. Prerequisites: BSC 2010/L, 2011/L, CHM 2200 or CHM 2211/L. Corequisites: BCH 3023L.

Course Competencies

Competency 1: The student will write lab reports demonstrating proper English usage and logical organization by:

1. Describing how the properties of water affect and are critical to biological systems and the processes of studying biochemistry.
2. Explaining how the degree of ionization of an acid/base relates to its strength.
3. Explaining the relevance of polar covalent/hydrogen bonding to the understanding of acid/base theory.
4. Describing the ionization of water and its acid/base properties.
5. Describing how addition of acids/bases affects the pH of aqueous solutions.
6. Explaining how buffers maintain the pH of a solution by being able to resist abrupt changes in pH.
7. Describing important physiological buffers and describing the interplay of body systems involved in keeping acid/base balance and physiological pH.

Competency 2: The student will demonstrate knowledge of nucleic acid structure and function by:

1. Relating the discoveries of nucleic acid structure and function to the history of the study of biochemistry.
2. Defining the terms mono-, oligo-, and polysaccharide.
3. Identifying and naming the base, pentose, and phosphate components of a nucleotide.
4. Defining the primary structure of a DNA molecule.
5. Illustrating hydrogen bonding between complementary nucleotides.
6. Defining the secondary structure of DNA using Watson and Crick's model of the double helix.
7. Distinguishing the minor and major grooves in the DNA double helix.
8. Contrasting the B-, A-, and Z-forms of DNA.
9. Describing the thermal denaturation of DNA.
10. Inferring melting curve profiles of DNA.
11. Comparing mRNA, rRNA, tRNA, and snRNA.

Competency 3: The student will demonstrate knowledge of amino acid structure and function by:

1. Identifying the general structure of an amino acid.
2. Describing the three-dimensional structure of an amino acid and discussing the significance of D and L-stereoisomers.
3. Categorizing the 20 amino acids on the basis of their structure.
4. Relating the chemical properties of amino acids to their chemical structure.
5. Illustrating the zwitterion of amino acids under basic, acidic, and neutral conditions.
6. Determining the pI of amino acids.

Competency 4: The student will demonstrate knowledge of protein structure and function by:

1. Identifying the general structure of an amino acid.
2. Describing the formation of a peptide bond.
3. Differentiating an amino acid chain as a peptide or polypeptide.

4. Identifying the amino (N-) and carboxyl (C-) termini of a peptide.
5. Describing the Edman method of peptide sequencing.
6. Identifying the primary structure of a protein.
7. Identifying α-helix and β-pleated sheet secondary structures.
8. Describing the role of hydrogen bonding in α-helix formation.
9. Identifying the important features of β-pleated sheets such as: interchain bonds, parallel pleated sheets, and antiparallel pleated sheets.
10. Describing the impact of amino acid R groups on secondary structure.
11. Differentiating between fibrous and globular secondary protein conformations.
12. Describing the contributions of noncovalent stabilizing forces (hydrogen bonding, hydrophobic interactions, electrostatic interactions, metal ion coordination), and disulfide bond formation to tertiary protein structure.
13. Describing the processes of denaturation and renaturation.
14. Differentiating between monomeric and oligomeric proteins.
15. Defining quaternary structure as homo- or heterotypic.
16. Describing allosteric interactions.
17. Using collagen, myoglobin, and hemoglobin as models to describe the various features that contribute to overall protein structure.

Competency 5: The student will demonstrate knowledge of carbohydrate structure and function by:

1. Defining the terms mono-, oligo-, and polysaccharide.
2. Differentiating between D- and L- stereoisomers of monosaccharides.
3. Defining the term epimer.
4. Drawing Fischer and Haworth projections of monosaccharides.
5. Differentiating between an aldose and a ketose.
6. Identifying furanoses and pyranoses.
7. Describing oxidation and reduction reactions of carbohydrates.
8. Describing how monosaccharides undergo glycoside bond formation.
9. Differentiating between storage and structural polysaccharides.
10. Listing examples and functions of biologically important polysaccharides.

Competency 6: The student will demonstrate knowledge of lipid structure and function by:

1. Defining the terms mono-, oligo-, and polysaccharide.
2. Differentiating between open chain and fused ring lipids.
3. Identifying the structures and biological functions of open-chain lipids.
4. Identifying the structure and biological function of steroids.
5. Describing micellar formation of amphiphilic lipids in aqueous environments.
6. Describing the biological functions of lipid-soluble vitamins.

Competency 7: The student will demonstrate knowledge of biological membranes and transportation by:

1. Describing the structure of biological membranes.
2. Describing the functions of biological membranes in terms of transport, catalysis, and protein receptors.
3. Describing the structure/function relationship of biological membranes using the fluid-mosaic model.
4. Differentiating between active and passive transport.
5. Relating the tenets of active transport using the sodium-potassium pump as a model.

Competency 8: The student will demonstrate knowledge of enzyme catalysts by:

1. Identifying the primary structure of a protein.
2. Defining enzymes as biomolecular catalysts.
3. Differentiating between regulatory (allosteric) and nonregulatory enzymes.
4. Describing how enzymes affect activation energy profiles.
5. Describing the lock-and-key and induced-fit models of enzyme-substrate binding.
6. Describing enzyme kinetics using Michaelis-Menten and Lineweaver-Burk calculations.
7. Distinguishing between reversible and irreversible inhibitors.
8. Describing the effects of noncompetitive and competitive inhibitors on Km and V max.
9. Describing the effects of pH, temperature, and enzyme concentration on enzyme activity.
10. Describing how substrate binding, inhibitors, and activators affect the kinetics of allosteric enzymes.
11. Describing the concerted and sequential models of allosteric enzyme action.
12. Discussing cellular regulation of enzymes via covalent modifications, proteolytic cleavage, and isozyme regulation.
13. Describing reactions at the active site of an enzyme in terms of amino acid sequence, spatial arrangement, and reaction mechanism.
14. Compiling examples of coenzymes.

Competency 9: The student will demonstrate knowledge of the basic concepts of metabolism by:

1. Defining the terms metabolism, catabolism, and anabolism.
2. Identifying catabolism as an oxidative process.
3. Identifying anabolism as a reductive process.
4. Classifying a metabolic process as one of the following: oxidation-reduction; group transfer; hydrolysis, nonhydrolytic cleavage, isomerization, bond formation.
5. Defining the terms endergonic and exergonic processes.
6. Describing how endergonic and exergonic processes are coupled in metabolism.
7. Describing the energy requirements of metabolism in terms of ΔG.
8. Describing how the breakdown of ATP yields energy for endergonic processes.

Competency 10: The student will demonstrate knowledge of carbohydrate metabolism by:

1. Defining glycolysis.
2. Analyzing the steps of the glycolytic pathway.
3. Describing the aerobic and anaerobic metabolism of pyruvate.
4. Describing the process of gluconeogenesis.
5. Describing the production of ATP during glycolysis.
6. Describing the formation of glycogen.
7. Identifying ATP and the reduced cofactors (NADH, NADPH, and FADH) as energy-storage compounds.
8. Describing the production of NADH from the pyruvate dehydrogenase-catalyzed oxidation of pyruvate.
9. Describing the steps, enzymes, and intermediates of the citric acid cycle.
10. Describing the importance of citric acid cycle intermediates in amino acid synthesis.
11. Describing the glyoxylate cycle.
12. Explaining the phosphogluconate pathway.

Competency 11: The student will demonstrate knowledge of electron transport chains by:

1. Analyzing the steps and mechanisms of the electron transport chain.
2. Identifying the site of the electron transport chain.
3. Describing the steps, intermediates, enzymes and mechanisms of oxidative phosphorylation.
4. Calculating the number of ATP molecules generated per NADH and FADH2 that enters the electron transport chain.
5. Identifying the respiratory complexes and electron carriers of the electron transport chain.

6. Defining the role of respiratory complexes in the electron transport chain.
7. Describing the structure and function of the ATP synthase (mitochondrial ATPase complex).
8. Defining and describing the process of chemiosmotic coupling.
9. Describing the conformational coupling mechanism.
10. Describing the glycerol-phosphate and maleate-aspartate electron shuttle mechanisms.

Competency 12: The student will demonstrate knowledge of the basic concepts of photosynthesis by:

1. Describing photosynthesis in photoautotrophs.
2. Describing the chemical nature of the photosynthetic pigments.
3. Contrasting the light-dependent (light) and light-independent (dark) reactions of photosynthesis.
4. Comparing, and explaining the functions of cyclic and noncyclic photophosphorylation.
5. Describing the major products of the light-dependent reactions of photosynthesis.
6. Describing the reactions of the Calvin-Benson cycle.
7. Describing the reaction catalyzed by RUBISCO.transport chain.

Competency 13: The student will demonstrate knowledge of DNA replication, repair, and recombination by:

1. Listing the flow of genetic information as DNA → RNA →protein.
2. Listing and describing the functions of the major enzymes involved in DNA replication.
3. Comparing and contrasting the prokaryotic model of DNA replication with the eukaryotic model.
4. Defining the term mutation.

Competency 14: The student will demonstrate knowledge of transcription and RNA processing by:

1. Describing the transcription process in prokaryotes.
2. Describing the transcription process in eukaryotes.
3. Contrasting the prokaryotic and eukaryotic models of transcription.
4. Identifying key promoter elements in prokaryotes and eukaryotes.
5. Describing how protein binding to DNA affects transcription.
6. Describing the post-transcriptional modifications involved in the mRNA, rRNA, and tRNA processing.
7.

Competency 15: The student will demonstrate knowledge of transcription and RNA processing by:

1. Identifying the site of protein synthesis.
2. Describing the function of ribosomes, mRNA, tRNA, and protein factors in translation.
3. Defining the term codon.
4. Converting between a codon and its amino acid or termination signal.
5. Describing the activation of amino acids by tRNA to yield aminoacyltRNA.
6. Describing post-translational modifications of polypeptides that yield active proteins.