

# Applied Biochemistry

## Course Outcome Summary

### Course Information

Organization	MATC-Madison - Madison Area Technical College
Developers	Joy A. McMillan, Ph.D.
Development Date	10/1/1989
Revised Date	7/14/1995
Course Number	10-007-121
Instructional Level	Two-Year Technical Diploma
Potential Hours of Instruction	90
Total Credits	3

### Description

Introduces major chemical constituents of cells including proteins, carbohydrates, lipids and nucleic acids. The structure and kinetics of enzymes, reaction mechanisms, and metabolic pathways will also be included. Emphasis is on the laboratory identification and assay of these constituents, particularly in areas of current biotechnological application.

### Types of Instruction

Instruction Type	Contact Hours	Credits
A. Classroom Presentation	36	3
B. On Campus Laboratory and Clinicals	54	

### Prerequisites

Chemistry 1 (10-806-111)

Chemistry 2 (10-806-112)

Biotechnology Laboratory Skills for a Regulated Workplace (10-007-103)

General Cell Biology (10-007-103)

OR consent of instructor

### Competencies

#### Unit 1. ORGANIZATION WITHIN CELLS

##### A. Explore the major biochemicals within cells

**You will demonstrate your competence:**

1. through completion of written assignments
2. through written examinations with 80% accuracy

**Your performance will be successful when:**

1. learner explores cell organization and composition
2. learner identifies the major biochemicals within cells

#### Unit 2. pH, BUFFERS AND WATER

##### A. Standardize the pH meter

**You will demonstrate your competence:**

1. by using of pH meter to complete laboratory assignments
2. through completion of process during proficiency examinations

**Your performance will be successful when:**

1. learner standardizes pH meter to within 0.1 unit

**B. Prepare a buffer**

**You will demonstrate your competence:**

1. through the completion of laboratory assignments
2. by completing proficiency examinations

**Your performance will be successful when:**

1. buffer has concentration and pH within 1% of value given
2. learner calculates the correct volumes and masses of chemicals needed to prepare the buffer
3. learner assembles the needed materials and instruments
4. learner uses the buffers to complete additional laboratory work

**Unit 3. AMINO ACIDS AND PEPTIDES**

**A. Draw the structure of an amino acid**

**You will demonstrate your competence:**

1. through the completion of written assignments
2. through written examinations

**Your performance will be successful when:**

1. diagram of amino acid structure is 100% correct
2. reactive end groups are labelled

**B. Build a model of an amino acid**

**You will demonstrate your competence:**

1. through the completion of written assignments
2. through the completion of 3-D ball and stick model

**Your performance will be successful when:**

1. model is 100% correct
2. model is labelled correctly with functional groups identified and peptide bond identified
3. model is labelled with N terminus and C terminus

**C. Restate the properties of the peptide bond**

**You will demonstrate your competence:**

1. through the completion of written assignments
2. through written examinations

**Your performance will be successful when:**

1. learner explores the structure of the peptide bond
2. learner identifies the chemical properties of the peptide bond

**D. Identify factors that determine the isoelectric point of an amino acid and a protein**

**You will demonstrate your competence:**

1. through the completion of written assignments
2. through the completion of laboratory activities
3. through written examinations

**Your performance will be successful when:**

1. learner summarizes the factors that determine the isoelectric point of an amino acid and a protein
2. learner determines the polarity of functional groups on individual amino acids
3. learner explains the impact of certain functional groups on the overall isoelectric point of a protein
4. learner explains the solubility of an amino acid and a protein in terms of isoelectric points

**E. Determine the isoelectric point of amino acids and proteins**

**You will demonstrate your competence:**

1. through the completion of laboratory activities

**Your performance will be successful when:**

1. learner determines point within 01 units

**F. Predict the effect of the isoelectric point on the molecular behavior of amino acid and proteins**

**You will demonstrate your competence:**

1. through the completion of written assignments
2. through written examinations

**Your performance will be successful when:**

1. learner's explanation effect of the isoelectirc point on the molecular behavior of amino acid and proteins

**Unit 4. PROTEINS**

**A. Perform colorimetric assays for proteins and amino acids**

**You will demonstrate your competence:**

1. through the completion of laboratory activities
2. through the completion of laboratory proficiency examinations

**Your performance will be successful when:**

1. assay performed--optical density within 01 units of expected values
2. learner identifies the appropriate assay to use for varying protein and amino acids preparations

**B. Differentiate the levels of protein structure**

**You will demonstrate your competence:**

1. through the completion of written assignments
2. through written examinations

**Your performance will be successful when:**

1. learner differentiates between the levels of protein structure
2. learner analyzes the characteristics of each level of protein structure

**C. Explore the methods of denaturing proteins**

**You will demonstrate your competence:**

1. through the completion of written assignments
2. through the completion of laboratory proficiency examinations
3. through written examinations

**Your performance will be successful when:**

1. learner summarizes the chemical and physical methods of denaturing proteins
2. learner explains the chemical properties important to each method of denaturation

**D. Explore the ways proteins can be renatured**

**You will demonstrate your competence:**

1. through the completion of written assignments
2. through written examinations

**Your performance will be successful when:**

1. learner summarizes the methods of renaturation of proteins
2. learner explains the properties that will allow for molecular renaturation

**Unit 5. ENZYMES**

**A. Generalize the factors affecting the rates of reactions**

**You will demonstrate your competence:**

1. through the completion of written assignments
2. through written explanations

**Your performance will be successful when:**

1. learner summarizes the factors affecting rates of reactions
2. learner summarizes the feature of enzymes in terms of biological catalysis

**B. Explain the factors optimizing the rates of reactions**

**You will demonstrate your competence:**

1. through the completion of written assignments
2. through written examinations

**Your performance will be successful when:**

1. learner explains the factors optimizing the rates of reactions
2. learner distinguishes between the substrate and product from catalyst in function and role in reactions

**C. Isolate and characterize an enzyme**

**You will demonstrate your competence:**

1. through the completion of laboratory activities
2. through the completion of written explanations of results and observations of laboratory activities

**Your performance will be successful when:**

1. enzyme is isolated and assayed on correct substrate
2. learner explains the parameters of the reaction being studied

**D. Perform enzyme assays**

**You will demonstrate your competence:**

1. through the completion of laboratory activities
2. through the completion of written documentation and explanation of laboratory work

**Your performance will be successful when:**

1. correct reaction is assayed
2. learner assembles the correct supplies needed for the assay

**E. Determine the kinetics of an enzyme catalyzed reaction**

**You will demonstrate your competence:**

1. through the completion of laboratory activities
2. through the completion of written explanations of laboratory data
3. through the completion of written assignments
4. through written examinations

**Your performance will be successful when:**

1. order of the reaction is determined

2. learner correctly graphs the data
3. learner distinguishes between the various methods for graphing the data

**Unit 6. NUCLEOTIDES AND NUCLEIC ACIDS**

**A. Identify the components of a nucleotide**

**You will demonstrate your competence:**

1. through the completion of written assignments
2. through written examinations

**Your performance will be successful when:**

1. learner identifies the components of a nucleotide
2. learner differentiates between nucleotides and nucleosides
3. learner explains the chemical reactivity of each of the components

**B. Build a model of a nucleotide**

**You will demonstrate your competence:**

1. through the completion of 3-D ball and stick model
2. through written diagrams explaining the ball and stick model
3. through the correct labelling of the 3-D model
4. through written examinations

**Your performance will be successful when:**

1. model is 100% correct
2. model is labelled with functional groups
3. model is stereochemically correct

**C. Isolate and characterize nucleic acids**

**You will demonstrate your competence:**

1. through the completion of laboratory activities
2. through the completion of written explanations of laboratory observations and data

**Your performance will be successful when:**

1. Either DNA or RNA is isolated
2. learner assembles the correct supplies and materials for isolating the nucleic acid
3. learner documents the process used in isolating the nucleic acid

**D. Perform colorimetric assays of nucleotides and nucleic acids**

**You will demonstrate your competence:**

1. through the completion of laboratory activities
2. through the completion of written explanations of laboratory observations and data
3. through laboratory proficiency examinations

**Your performance will be successful when:**

1. assay is performed with optical density within 05% of range
2. learner identifies the functional group that is reactive in the assay process

**E. Perform UV spectra of proteins and nucleic acids**

**You will demonstrate your competence:**

1. through the completion of laboratory activities
2. through the completion of written explanations of laboratory observations and data
3. through written and laboratory proficiency examinations

**Your performance will be successful when:**

1. spectra shows protein and nucleic acids and the correct wavelengths used

2. learner explains the limitations of the technique being used
3. learner assembles the correct materials and supplies
4. learner standardizes the correct spectrophotometer for the assay
5. learner selects the correct cuvettes for the assay

**Unit 7. TRANSCRIPTION AND TRANSLATION**

**A. Explore the processes of transcription and translation**

**You will demonstrate your competence:**

1. through the completion of written assignments
2. through written examinations

**Your performance will be successful when:**

1. pathways are outlined with a minimum of 80%
2. learner distinguishes transcription from translation
3. learner explains the conditions under transcription and translation can occur
4. learner compares the processes as they occur in procaryotic cells versus eucaryotic cells

**B. Identify the important enzymes of translation and transcription**

**You will demonstrate your competence:**

1. through the completion of written assignments
2. through written examinations

**Your performance will be successful when:**

1. learner explores the major enzymes of translation and transcription
2. learner explains the factors that modify the enzymes in transcription and translation processes

**Unit 8. DNA REPLICATION**

**A. Explore the DNA replication cycle**

**You will demonstrate your competence:**

1. through the completion of written assignments
2. through written examinations

**Your performance will be successful when:**

1. learner discusses the DNA replication cycle
2. learner identifies the conditions under which the replication can occur

**B. Differentiate the replication cycles of procaryotes and eucaryotes**

**You will demonstrate your competence:**

1. through the completion of written assignments
2. through written examinations

**Your performance will be successful when:**

1. learner summarizes the differences between the replication cycles of procaryotes and eucaryotes
2. learner identifies the location of replication in each cell type

**C. Identify mutagenic and repair mechanisms of DNA**

**You will demonstrate your competence:**

1. through the completion of written assignments
2. through written examinations

**Your performance will be successful when:**

1. learner identifies the mutagenic processes and repair mechanisms

2. learner explains how mutagenic mechanisms can be used in modifying organisms
3. learner summarizes how repair mechanisms are used to maintain cellular integrity

**D. Mutagenize DNA with UV light and assay for light/dark repair**

**You will demonstrate your competence:**

1. through the completion of laboratory activities
2. through the written explanation of laboratory observations and data
3. through written examinations

**Your performance will be successful when:**

1. mutated cells are selected for and isolated

**Unit 9. CARBOHYDRATES**

**A. Identify the components of monosaccharides**

**You will demonstrate your competence:**

1. through the completion of written assignments
2. through written examinations

**Your performance will be successful when:**

1. learner identifies the elements and class of monosaccharides
2. learner explains the functional groups of monosaccharides

**B. Explore the structural formula for a disaccharide**

**You will demonstrate your competence:**

1. through the completion of written assignments
2. through written examinations

**Your performance will be successful when:**

1. learner explores the formula for a disaccharide
2. learner distinguishes placement of functional groups in discerning the particular disaccharide in question

**C. Build a model of a disaccharide**

**You will demonstrate your competence:**

1. through the building of a 3-D ball and stick model
2. through the completion of written assignments
3. through written examinations

**Your performance will be successful when:**

1. model is 100% correct
2. model is labelled correctly
3. model is stereochemically correct

**D. Perform colorimetric assays of carbohydrates**

**You will demonstrate your competence:**

1. through the completion of laboratory activities
2. through the written explanations of laboratory observations and data
3. through the selection of the appropriate assay on laboratory proficiency examinations

**Your performance will be successful when:**

1. spectra and optical densities are within 5% of range
2. learner distinguishes the uses and limitations of the various assay

**Unit 10. LIPIDS**

**A. Compare and contrast the major classes of lipids**

**You will demonstrate your competence:**

1. through the completion of written assignments
2. through written examinations

**Your performance will be successful when:**

1. learner compares and contrasts the major classes of lipids
2. learner compares and contrasts the major characteristics of the major classes of lipids
3. learner identifies the functional groups and chemical reactivity of various classes of lipids

**B. Perform colorimetric assays of lipids**

**You will demonstrate your competence:**

1. through the completion of laboratory activities
2. through written explanations of laboratory observations and data
3. through written examinations

**Your performance will be successful when:**

1. spectra and optical density are within 5% limits
2. learner assembles the correct materials and supplies
3. learner identifies the basis of the chemical reactions of the assay

**Unit 11. BIOMEMBRANES**

**A. Prepare a membrane fraction**

**You will demonstrate your competence:**

1. through the completion of laboratory activities
2. through the written explanation of laboratory observations and data

**Your performance will be successful when:**

1. membranes are isolated as determined by microscopy and enzyme assays

**B. Diagram the cell membrane**

**You will demonstrate your competence:**

1. through the completion of written assignments
2. through written examinations

**Your performance will be successful when:**

1. membrane features are diagrammed
2. learner summarizes the function of molecules within the membrane structure
3. learner relates the diagram to an explanation of fluid mosaic model of membranes

**Unit 12. BIOENERGETICS**

**A. Explore the major pathways of energy generation in the cell**

**You will demonstrate your competence:**

1. through the completion of written assignments
2. through written examinations

**Your performance will be successful when:**

1. learner summarizes the major pathways of energy generation in the cell
2. learner explains how glycolysis is used in all procaryotic and eucaryotic cells
3. learner distinguishes the use of glycolysis in procaryotes and eucaryotes
4. learner identifies conditions under pathways other than glycolysis would be used

**B. Explore the principles of bioenergetics**

**You will demonstrate your competence:**

1. through the completion of written assignments
2. through written examinations

**Your performance will be successful when:**

1. learner explores the major principles principles of bioenergetics

**C. Explore the electron transport system**

**You will demonstrate your competence:**

1. through the completion of written assignments
2. through written examinations

**Your performance will be successful when:**

1. outline of system is 80% correct
2. learner identifies when the electron transport would be used by a cell

**Unit 13. CARBOHYDRATE METABOLISM**

**A. Explore the major pathways of carbohydrate metabolism**

**You will demonstrate your competence:**

1. through the completion of written assignment
2. through written examination

**Your performance will be successful when:**

1. learner identifies the major substrates and products of the pathways of carbohydrate metabolism, noting the integration in catabolism and anabolism
2. learner distinguishes catabolism from anabolism
3. learner explains why most pathways cannot be reversed (reversal is theoretical)

**B. Compare the efficiency of the major pathways of carbohydrate metabolism**

**You will demonstrate your competence:**

1. through the completion of written assignments
2. through written examination

**Your performance will be successful when:**

1. learner notes the efficiencies of the major pathways of carbohydrate metabolism

**Unit 14. OXIDATIVE PHOSPHORYLATION**

**A. Explore the oxidative phosphorylation cycles**

**You will demonstrate your competence:**

1. through the completion of written assignments
2. through written examinations

**Your performance will be successful when:**

1. learner summarizes the oxidative phosphorylation cycles
2. learner distinguishes oxidative phosphorylation from substrate level phosphorylation and photophosphorylation
3. learner correlates ATP production to the oxidative-reductive processes

**B. Identify the enzymes important in oxidative phosphorylation**

**You will demonstrate your competence:**

1. through the completion of written assignments
2. through written examinations

**Your performance will be successful when:**

1. learner identifies various enzymes
2. learner identifies the activities of each of the enzymes

**Unit 15. PHOTOSYNTHESIS**

**A. Compare and contrast the light and dark paths of photosynthesis**

**You will demonstrate your competence:**

1. through the completion of written assignments
2. through written examination

**Your performance will be successful when:**

1. learner identifies the light and dark pathways
2. learner identifies the similarities and differences between the light and dark pathways

**B. Separate plant pigments by chromatography**

**You will demonstrate your competence:**

1. through the completion of laboratory activities
2. through the written explanation of laboratory observations and data
3. through written examination

**Your performance will be successful when:**

1. learner determines R<sub>f</sub> values for pigments, within 5% error
2. learner assembles the correct materials and supplies
3. learner explains the chemical or physical properties functional in the separation process

**C. Assay chloroplasts for photosynthetic activity**

**You will demonstrate your competence:**

1. through the completion of laboratory activities
2. through the written explanation of the laboratory observations and data
3. through written examination

**Your performance will be successful when:**

1. enzymes isolated, activity within 5% error
2. learner assembles the correct materials and supplies
3. learner explains the chemical nature of the activity

**Unit 16. NITROGEN FIXATION**

**A. Summarize the process of elemental nitrogen fixation**

**You will demonstrate your competence:**

1. through the completion of written assignments
2. through written examinations

**Your performance will be successful when:**

1. learner explores the elemental nitrogen fixation process
2. learner explains the cell systems of nitrogen fixation
3. learner distinguishes between symbiotic and nonsymbiotic processes of nitrogen fixation

**B. Perform acetylene reduction assays for nitrogen fixation**

**You will demonstrate your competence:**

1. through the completion of laboratory activities
2. through the written explanation of laboratory observations and data
3. through written examination

**Your performance will be successful when:**

1. acetylene is reduced, quantities are within 5% error
2. learner assembles the correct materials and supplies

3. learner explains the chemical basis for the use of acetylene in measuring nitrogenase activities