COURSE OUTLINE OF RECORD FOR DEGREE CREDIT COURSE

X Transfer course X A.A. degree applicable course
(check all that apply)

COURSE NUMBER AND TITLE: BIOL 160 Biotechnology Preparatory Course

UNIT VALUE: 5

MINIMUM NUMBER OF SEMESTER HOURS: 144 (3 hours lecture, 6 hours laboratory)

BASIC SKILLS REQUIREMENTS: Appropriate language and computational skills.

ENTRANCE REQUIREMENTS: None

PREREQUISITE:

COREQUISITE:

RECOMMENDED PREPARATION: MATH 50- Beginning Algebra

SCOPE OF COURSE:
This course is intended as a preparation course for students interested in further studies in biotechnology. The course provides the basic knowledge in math, chemistry, biology, and microbiology for additional biotechnology coursework. Topics include the fundamental chemical processes common in prokaryotic and eukaryotic biology, chemistry of biomolecules, cellular and molecular biology, gene expression and genetic engineering. The laboratory experience provides basic skills and techniques essential to advanced biotechnology courses. CSU

SPECIFIC COURSE OBJECTIVES:
Upon successful completion of this course, students will be able to:

1. Explain the scientific method and the importance it has to the field of biotechnology;
2. Discuss the role of biotechnology in today's world including current applications of biotechnology to the areas of medicine, agriculture, and diagnostics;
3. Understand the regulation of the biotechnology industry in the United States, and the issues of quality control and safety;
4. Understand the essential structure and function of atoms and biological molecules;
5. Discuss the Laws of Thermodynamics and implications for cellular metabolism;
6. Explain the principles of cell membrane structure and transport;
7. Explain prokaryotic and eukaryotic gene expression and regulation;
8. Understand the prokaryotic and eukaryotic cell cycle and the importance of regulation;

9. Understand and properly use the metric system of measurement;

10. Accurately record data, maintain laboratory journals, and write proper laboratory reports;

11. Understand and safely perform laboratory techniques such as microscopy, solution and media preparation, aseptic techniques and tissue culture, protein purification, and DNA purification.

CONTENTS IN TERMS OF SPECIFIC BODY OF KNOWLEDGE:

I. An Overview of Biotechnology: A Collection of Technologies
- A. History of the Development of Biotechnology
- B. The Applications of Biotechnology
  1. Medicine
     - a) Genetically Engineered Products
     - b) Gene Therapy
  2. Agriculture
     - a) Crop Improvement
     - b) Livestock Improvement
- C. The Organization of a Biotechnology Company
- D. Biotechnology and Society
- E. Biotechnology Tools and Scientific Knowledge
- F. Good Laboratory and Manufacturing Practices
- G. Regulatory Agencies: FDA and EPA
- H. Quality Control Issues
- I. Quality Assurance Practices
  1. Documentation
  2. Validation
  3. Standard Operating Procedures (SOP)

II. General Chemistry
- A. Matter
  1. Classification of Matter
     - a) Elements
       - 1.) Names and Symbols of the Elements
       - 2.) Periodic Table
     - b) Homogeneous mixture
     - c) Heterogeneous mixture
     - d) Compounds
  2. Properties of Matter
     - a) Chemical vs. Physical
     - b) Intensive vs. Extensive
  3. States of Matter
     - a) Gas
     - b) Liquid
     - c) Solid
- B. Atomic Structure
  1. Elementary Particles
  2. Atomic Number
  3. Mass Number
  4. Isotopes
     - a) Radioactive
     - b) Stable
     - c) Half-life
     - d) Application in Biotechnology and Medicine

5. Electron Energy Levels
6. Valence Electrons

C. Chemical Bonding
1. Ionic Bonds and Ionic Compounds
    a) Electrolytes and Nonelectrolytes
    b) Anions and Cations
2. Covalent Bonds and Covalent Compounds
    a) Polar
    b) Non-Polar
    c) Hydrogen bonds
    d) Special Properties of Water
        1.) Cohesive and Adhesive Forces
        2.) Temperature Stabilization
        3.) Density of Water
        4.) Ionization in Water
        5.) Water as a Polar Solvent
3. Empirical Formulas vs. Molecular Formulas
4. Molecular Weight

D. Writing Chemical Equations
1. Conservation of Mass
2. Chemical Equilibrium
3. Oxidation-Reduction

E. Types of Chemical Reactions

F. Energy in Chemical Reactions
1. Endergonic vs. Exergonic Reaction
    a) Enthalpy
    b) Entropy
    c) Free Energy
    d) Coupled reactions

G. Aqueous Solutions
1. Concentration based on Volume
    a) Molecular weight
    b) Moles
    c) Molarity
    d) Normality
    e) Weight/Volume Percent
2. Acids and Bases
    a) Ionization of Strong Acids and Bases
    b) Ionization of Water and pH
    c) Neutralization and Titration of Strong Acids and Bases
    d) Ionization of Weak Acids and Bases
3. Buffers
    a) Preparation of Buffers
    b) Buffer Capacity
    c) Ionic Strength

III. Organic Compounds
A. Hydrocarbons
B. Isomers
C. Nomenclature of Organic Compounds
D. Functional Groups
E. Polymers

IV. Biologically Important Molecules

A. Carbohydrates
   1. Monosaccharide
   2. Disaccharides
   3. Polysaccharides

B. Lipids
   1. Fats
   2. Phospholipids
   3. Steroids
   4. Waxes

C. Proteins
   1. Synthesis and hydrolysis of Peptide bonds
   2. Structure
      a) Primary
      b) Secondary
      c) Tertiary
      d) Quaternary
   3. Factors affecting Structure
      a) pH
      b) Ionic Strength
      c) Detergents
      d) Organic Solvents
      e) High Temperature
   4. Protein Purification
      a) Gel Filtration
      b) Ion Exchange Chromatography
      c) Affinity Chromatography
      d) Hydrophobic Chromatography
      e) Centrifugation
   5. Protein Analysis
      a) Gel Electrophoresis
      b) Spectrophotometry

D. Enzymes
   1. Active Site
   2. Coenzymes/Cofactors
   3. Mode of Enzyme Activity
      a) Activation Energy
      b) Transition State
   4. Factors Affecting Enzyme Activity
      a) Concentration
      b) Temperature
      c) pH
   5. Inhibitors
      a) Non-competitive
      b) Competitive
      c) Feedback Inhibition
      d) Enzyme Unit
   6. Restriction Enzymes

E. Nucleic Acids
   1. DNA and RNA Structure
      a) Nucleotide Subunits
      b) Phosphodiester Bonds
   2. Loss of Nucleic Acid Structure
      a) DNA Melting Temperature (T_m)

b) Nucleases
c) Shearing

3. Nucleic Acid Isolation
   a) Chromosomal DNA
   b) Plasmid DNA
4. DNA Analysis
   a) Gel Electrophoresis
   b) Spectrophotometry

V. Microscopy

A. Properties of Light
   1. Wavelength
   2. Resolution
   3. Reflection
   4. Transmission
   5. Absorption
   6. Refraction

B. Compound Microscope
   1. Total Magnification
   2. Resolving Power

VI. Cell Biology

A. Structure of Eukaryotic Cells
   1. Plasma Membrane
      a) Fluid-Mosaic Model of Membrane Structure
      b) Movement of Materials across Membranes
         1.) Diffusion and Osmosis
         2.) Carrier-Mediated Transport of Small Molecules
         3.) Transport of Large Molecules Across Membrane

B. Cell Cycle
   1. Organization of DNA in Chromosomes
   2. DNA Replication
   3. Mitosis and Asexual Reproduction
   4. Meiosis and Sexual Reproduction

C. Central Dogma
   1. Transcription from DNA to mRNA
   2. Translation from mRNA to Protein
   3. The Genetic Code
   4. Definition of a Gene
   5. Gene Mutations

D. Tissue Culture
   1. Cell Lines
   2. Cell Culture Media
   3. Environmental Factors in Cell Culture
   4. Contamination (Prevention and Detection)
   5. Determining Cell Viability
   6. Harvesting
   7. Freezing and Storage
   8. Transfection
   9. Stable Cell Lines

VII. Bacteriology

A. Prokaryotic vs. Eukaryotic
   1. Structure

2. Gene Expression and Regulation

B. Microbial Growth and Culturing Methods
   1. Bacterial Reproduction
   2. Phases of Growth
   3. Sterilization and Aseptic Techniques
   4. Measuring Bacterial Growth
      a) Serial Dilution and Plate Counts
      b) Microscopic Counts
      c) Turbidity
   5. Factors Affecting Bacterial Growth
      a) Physical Factors
      b) Nutritional Factors

C. Culturing Bacteria

D. Microbial Genetics
   1. Gene Transfer
   2. Genetic Engineering
      a) Gene Cloning
      b) Recombinant DNA Techniques

VIII. Viruses
   A. General characteristics
   B. Components
   C. Classification
   D. Viral replication
   E. Properties of Bacteriophages
   F. Role in Genetic Engineering

LABORATORY OUTLINE

I. Laboratory Safety
   A. Advanced Preparation
   B. Protective Clothing
   C. Material Safety Data Sheet (MSDS)
   D. Handling Microorganisms in the Laboratory
      1. Sterilization
      2. Disinfection
   E. Proper Handling of Laboratory Waste

II. Keeping a Professional Laboratory Notebook
   A. Format
   B. The Ten Commandments of Record Keeping

III. Following, Revising and Evaluating Standard Operating Procedures (SOPs)

IV. "Soft" Skills for Success in Biotech Industry
   A. Team Interactions
   B. Oral and Written Communication Skills
   C. Computer Literacy

V. Scientific Method
   A. Sources of Scientific Information
      1. Primary
      2. Secondary
      3. Tertiary

B Scientific Information Retrieval

VI. Math in the Biotechnology Laboratory
- A. Significant Figures
- B. Exponents and Scientific Notation
- C. Logarithms
- D. Units of Measurement
  1. Metric System
  2. SI System
  3. Arithmetic with Units
- E. Use of Equations to Describe a Relationship
- F. Ratios and Proportions
- G. Percents
- H. Unit conversions
- I. Uncertainty in Measurements
  1. Accuracy
  2. Precision and Reproducibility
  3. Limit of Detection
  4. Limit of Quantitation
  5. Linearity and Range
  6. Importance of Collecting Meaningful Data
- J. Basic Techniques of Graphing

VII. Laboratory Measurements
- A. Measurement of Weight
  1. Mass vs. Weight
  2. Types of Balances
     a) Sensitivity, Capacity and Range
     b) Calibration and Maintenance of a Balance
- B. Measurement of Volume
  1. Glassware Calibration
  2. Quantitative Pipetting
  3. Digital Micropipettors
- C. Measurement of Temperature
- D. Measurement of pH
  1. The Importance and Definition of pH
  2. pH Indicators
  3. Operation of a pH meter
     a) Calibration
     b) Proper storage of Electrodes

VIII. Preparation of Buffers, Solutions and Culture Media
- A. Determination of Concentration
- B. Dilutions
- C. Serial Dilutions
- D. Percent Solutions

IX. Microscopy
- A. Compound and Dissecting Microscope
  a) Preparing Wet Mounts
  b) Measuring the Size of Objects Using Compound Microscope
  c) Determination of Viable Cells
  d) Determination of Cell Number

X. Isolation of Genomic DNA
- A. Purification
- B. Quantitation

XI. Enzymes
- A. Factors Affecting Enzyme Activity
- B. Restriction Digestion and Agarose Gel Electrophoresis

XII. Bacterial Culture Techniques
- A. Handling and Examining Bacterial Cultures
- B. Quantification of Bacterial Concentrations
  1. Viable Count
  2. Direct Count
  3. Turbidometric Method
- C. Isolation of Individual Colonies
- D. Plaque Purification of Bacteriophage Lambda
- E. Antibiotic-Resistant Growth
- F. Overnight Culture
- G. Competent Cell production

XIII. Bacterial Transformation with Plasmid DNA

XIV. Protein Purification
- A. Centrifugation
- B. Precipitation
- C. Gel Filtration
- D. SDS-PAGE

REQUIRED READING:
Reading assignments may include, but are not limited to, the following:
1. Assigned textbook readings;
2. Articles that relates to biotechnology in newspapers and magazines;
3. Articles in Scientific American.

Examples of appropriate textbooks include:
1. Sackheim, George I., An Introduction to Chemistry for Biology Students, 7th Edition. San Francisco: Benjamin Cummings, 2001.
2. Seidman, Lisa A., and Cynthia J. Moore. Basic Laboratory Methods for Biotechnology, 1st Edition. Upper Saddle River, NY: Prentice Hall, 2000.
3. Becker, Jeffrey M.M., Guy A. Caldwell, and Eve Ann Zachgo. Biotechnology, a Laboratory Course, 2nd Edition. San Diego: Academic Press, 1996.
4. Winfrey, Michael R., Marc A. Rott, and Alan Wortman. Unraveling DNA: Molecular Biology for the Laboratory, 1st Edition. Upper Saddle River, NY: Prentice Hall. 1997
5. Bloom, M. V., Gary A. Freyer, and David A. Micklos . Laboratory DNA Science. Menlo Park, CA, Benjamin/Cummings.1996

SUGGESTED READING:
None

REQUIRED WRITING:

Students are required to answer short answer/essay type questions on each of their lecture examinations and laboratory quizzes. Students will be required to critique several scientific articles, prepare short (two pages) research papers, and maintain a laboratory notebook.

OUTSIDE ASSIGNMENTS:

Students are expected to spend a minimum of three hours per unit per week in class and on outside assignments.

Outside assignments include required readings and preparation for lecture and laboratory examinations, and critiques of scientific articles, research papers, and industrial SOPs (Standard Operating Procedures). In addition, student may be required to attend scientific seminars and tour local biotech companies.

INSTRUCTIONAL METHODOLOGY:

The instructional methods used will include lecture, discussion, demonstration, laboratory observation and investigation, films, video tapes, biological charts and models, computer-assisted instruction and field trips or field assignments.

Check all that apply:
__x_ lecture
__x_ laboratory
____ lecture-laboratory combination
____ directed study

This course may be offered as a distance learning course and meets Title 5 regulations 55370, 55372, 55374, 55376, 55378, and 55380.
Yes _____ No__x__

If yes, check all that apply.

_____ Television Course (Video one-way, e.g. ITV, video cassette, etc.)
_____ Online Course (Text one-way, e.g. newspaper, correspondence, electronic file, etc.)
_____ Two-Way Video Conferencing (Two-way interactive video and audio)
_____ One-Way Video Conferencing (One-way interactive video and two-way interactive audio)
_____ Computer Assisted Instruction (A specialized form of mediated instruction relying primarily on student access to information and prepared lessons or teaching materials through a computer terminal, but not under immediate supervision of a qualified instructor.)

GRADING POLICY AND STANDARDS (include methods of determining whether the stated objectives have been met by students):

Lecture examinations typically include a combination of multiple choice objective questions, diagrams, and matching, as well as a short answer essay. Laboratory quizzes typically include drawings and short answer questions. Fifty percent of the final grade is based on the lecture assignments (3 lecture exams, lecture quizzes, and homework assignments), while the remaining fifty percent is based on the laboratory assignments which include laboratory quizzes, laboratory notebook oral presentations and homework assignments.

IS COURSE REPEATABLE FOR REASON(S) OTHER THAN DEFICIENT GRADE?

Yes ___ No _x__ Number of times course may be taken for credit: _1__
If yes, identify specific provision of Title 5 Division 2 section(s), 55761-55763 and 58161 which qualifies course as repeatable:

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SIGNATURES ON FILE