Mt. San Jacinto College
Integrated Course Outline of Record

Form B

Submitted by: Nick Reeves **Date:** 12/17/2020

Department	Subject	Course Number	Title
Biology	Biology BIOL	131	Genes and Biotechnology in Society

Units/Hours

Each lecture unit requires 1 hour per week of class time, and 2 hours per week of study outside of class.
Each laboratory unit requires 3 hours per week of class time.
Each activity unit requires 2 hours per week of class time and 1 hour per week of study outside of class.

Lecture Units	Lab Units	Total Units
3.00	1.00	4.00
Lecture Contact Hours	**Lab Contact Hours**	**Total Contact Hours**
48.00 - 54.00	48.00 - 54.00	96.00 - 108.00
Lecture Homework Hours	**Lab Homework Hours**	
96.00 - 108.00	0	

Stand Alone:

Program Applicable

AA/AS Degree General Ed Breadth Area(s):

A NATURAL AND PHYSICAL SCIENCES

General Education Justification:

BIOL-131 is a natural science biology course for science majors that satisfies the General Education Learning Outcomes for Option A, Area A - Natural and Physical Sciences. In BIOL-131 students consider modern DNA technologies that are transforming society. Biotechnologies are developed by making novel connections between concepts in biology and desired applications that result in innovative new approaches (GELO1). In this course, students will apply the scientific process that is evidence based to test hypotheses about life (GELO2). Students will learn that to generate knowledge in a scientific way they must accept uncertainty because all scientific claims are falsifiable and a negative case disproves a claim (GELO3). Biotechnology focuses on the application of living process to modern problems that requires students to interpret and create graphics, models and simulations (GELO3). Quantitative analysis and mathematical reasoning will be applied to better evaluate data produced through experimentation, modeling, and simulation (GELO4). Integration among subfields in biology, as well as integration between biology and other disciplines, have been used to develop fundamentally new biotechnologies that have revolutionized medicine, forensics, and industry resulting in a significant impact on modern society (GELO1, GELO2, GELO3, and GELO5). Biology is a collaborative enterprise. Critical skills in writing and presenting scientific observations and results to other scientists and other disciplines will be developed (GELO3). The laboratory portion of the

class will develop technical laboratory skills with a variety of tools used in all areas of the biotechnology field. Students will learn how to apply the appropriate biotechnology tools (GELO6).

Maximum Enrollment: 32

Maximum Enrollment Justification: Justification:

Grading Method: Letter Grade or P/NP

TOP code: 0430.00*

Can be Taken 1 **time(s) for credit** (max 4)

- ___ - Visual or Performing Arts course that is required to meet major requirements for UC/CSU
- ___ - Intercollegiate athletics course
- ___ - Academic/vocational competition course

Catalog Description:

(Please do not refer to transferability or degree, certificate, or employment concentration applicability. Please only describe the course).
(**75 words** or less in gray box below).

This course examines a variety of topics in biology related to genes and DNA technologies. Topics emphasized include the structure and biochemical processes of cells, classical and molecular genetics, gene expression, stem cell technologies and biotechnology. The laboratory experience develops fundamental skills used in biotechnology labs including performing biological assays, laboratory documentation, microscopy, DNA manipulation, and genetic modification of bacterial cells. Field trips may be required.

Schedule Description:

(Please do not refer to transferability or degree, certificate, or employment concentration applicability. Please only describe the course).
(**25 words** or less in gray box below).

This course is an introduction to genes and biotechnology for any interested student. This course examines current concepts in biology and develops basic laboratory skills.

Need for the course:

This course provides a general education option for students that want to learn about current concepts in biology and develop basic laboratory skills. Students may be inspired by this course to continue their training in biotechnology. We want to develop a series of biotechnology courses for a new career education certificate in biotechnology at MSJC. This course can be used to complete the following awards: IDS - Liberal Arts: Mathematics & Science Emphasis - Associate in Arts (Active) IDS - AS Associate in Science - Science (Elective)

Prerequisite(s):

Prerequisites go through a separate approval process. See Forms E1-E6 for details.
(For further clarification, contact the Prerequisite Subcommittee)

-none-

Corequisite(s):

Corequisites go through a separate approval process. See Forms E1-E6 for details.

-none-

Recommend Preparation:

Recommended Preparation goes through a separate approval process. See Forms E1-E6 for details.

-none-

Other Enrollment Criteria:

-none-

Learning Objectives:

(please number each objective and express in behavioral terms)

Upon the completion of the course the student will be able to do the following:

Core Biology Concepts

1. Relate the four major types of molecules, carbohydrates, lipids, proteins, and nucleic acids, that are made by all life to the atoms, chemical bonds, and chemical reactions that form them.
2. Compare prokaryotic and eukaryotic cells as the fundamental units of life by describing their cellular structures and biochemical processes.
3. Relate the Mendelian genetic laws of allele dominance, allele segregation, and independent assortment that explain the inheritance of traits in sexually reproducing life forms at the organismal level to the process of meiotic cell division at the cellular level and DNA sequence variation at the molecular level.
4. Consider how the genotypic information in the sequence of nucleotides in a gene is transcribed into a messenger RNA copy of the gene and then translated into an amino acid sequence that folds into a functional protein that produces a phenotype through the process of gene expression.

Concepts in Biotechnology

1. Investigate how scientists use recombinant DNA technologies that leverage innovations from several scientific disciplines to manipulate gene expression and function in cells.
2. Consider the societal implications of DNA technologies including genetic modification and organismal cloning by weighing the benefits and the potentially risks of these new technologies.

Basic Biotechnology Laboratory Skills

1. Perform measurements, calculations, and assays following protocol instructions and using the standard chemicals and equipment of biotechnology.
2. Document laboratory investigations including experimental procedures, experimental results, interpretation of data, and the necessary mathematical calculations and conversions for preparation of reagents in a laboratory notebook.

Course Content:

(please number the outline of main topics and subtopics)

1. Introduction to Biotechnology
    1. Biotechnology in the 21st Century
    2. Types of Biotechnology
    3. Challenges
    4. Biotechnology and the Workforce
2. Introduction to Genes and Genomes
    1. Chemistry of Living Things
    2. Cell Theory - Prokaryotic and Eukaryotic Cell Structure and Function
    3. Mendelian Genetics and Extensions to Mendel's Laws
    4. Molecular Genetics
    5. Chromosome Structure – DNA
    6. Reproduction and Growth - DNA Replication
    7. RNA and Protein Synthesis
    8. Mutation and Evolution
3. History of Recombinant DNA Technology
    1. Recombinant Technology and Genetic Manipulation

2. Restriction Enzymes and Vectors
3. Applications of Recombinant Technology - Cloning Genes
4. Bioinformatics – Molecular Biology and Information Technology

4. Introduction to Proteins
    1. Proteins as biotech products
    2. Structure of Protein
    3. Protein Production
    4. Protein Purification
    5. Proteomics
5. Microbial Biotechnology
    1. Everyday applications
    2. Microorganisms as a tool for Biotechnology
    3. CRISPR technology
    4. Vaccines
    5. Bioterrorism
6. Plant Biotechnology
    1. Genetically Modified Organisms
    2. Practical Applications
    3. Health and Environmental Concerns
7. Animal Biotechnology
    1. Animals in Biotechnology
    2. Animal Research
    3. Clones
    4. Transgenic Animals
8. Forensic Biotechnology
    1. Introduction to DNA Fingerprinting
    2. DNA Extraction and Preparation
    3. Familial Relationships and DNA
9. Medical Biotechnology
    1. Detecting and Diagnosing Human Disease
    2. Medical Products and Applications
    3. Gene Therapies
    4. Regenerative Medicine
    5. Human Genome Project
10. Ethics and Biotechnology
    1. Ethical Decision Making
    2. Biotechnology and Nature
    3. Economics, Science and Communication

Lab Content:

(please number the outline of main topics and subtopics)

1. Local Biotechnology Company Investigation and Report
    1. Type of Company and Products
2. Laboratory Safety
    1. Personal Protective Equipment
    2. Chemical Safety
        1. Material Data Safety Sheets (MSDS)
    3. Biological Safety Levels
    4. General Laboratory Hazards
    5. Waste Disposal
3. Laboratory Documentation
    1. Protocols
    2. Laboratory Notebooks

3. Standards Operating Procedure (SOP)
4. Basic Laboratory Equipment Use and Validation
    1. Graduated Cylinders
    2. Flasks, Bottles, and Beakers
    3. Volumetric Pipets
    4. Micropipettes
    5. Balances
    6. Thermometers
    7. pH Meters
    8. Centrifuges
    9. Autoclave
5. Preparation of Laboratory Solutions and Basic Solution Calculations
    1. Scientific Notation, Metric Units of Measurement, and Significant Figures
6. Microbiological Techniques
    1. Aseptic Technique
    2. Microbiology Media
        1. Broth and Agar Plates
        2. Antibiotics
7. Light Microscopy
    1. Care and Use of Microscopes
    2. Wet Mount and Staining of Animal and Plant Cells
8. Molecular Biology Techniques
    1. Casting Agarose Gels and Agarose Gel Electrophoresis
    2. Restriction Digestion
    3. Polymerase Chain Reaction
    4. CRISPR Demonstration
9. Recombinant DNA and Protein Purification Module
    1. Restriction Digest and Ligation of Insert and Plasmid
    2. Chemical Transformation of Bacterial Cells
    3. Antibiotic Selection of Transformed Bacterial Cells
    4. Protein Chromatography
10. Computer Assisted Data Analysis
    1. Spreadsheets and Graphing

Methods of Instruction:

Methods of instruction may include, but are not limited to the following:

- **Method:** Lecture
  Integration: Lecture presentations will explore the objectives listed under the headings Core Biology Concepts and Concepts in Biotechnology. Lecture will relate the four major types of biological molecules to the atoms, chemical bonds, and chemical reactions that form them. Prokaryotic and eukaryotic cells will be compared and their cellular structures and biochemical processes will be described in lecture. Lecture will relate the Mendelian genetic laws to the inheritance of traits, the process of meiotic cell division, and DNA sequence variation. How the genotypic information in a gene produces a phenotype through the process of gene expression will be considered in lecture. Lecture will investigate modern recombinant DNA technologies used by scientists to manipulate gene expression in cells. The societal implications of modern DNA technologies will be considered in lecture.
- **Method:** Visiting Lecturers
  Integration: Guest expert lecturers will address the objectives of investigating recombinant DNA technologies and considering the societal implications of DNA technologies.
- **Method:** Lab Activities
  Integration: Hands-on laboratory activities address the objectives under the heading Basic Biotechnology Laboratory Skills. During lab activities students will perform measurements, calculations, and assays using the standard chemicals and equipment of biotechnology. While performing the lab activities students will document

laboratory investigations in a laboratory notebook following a standard scientific documentation format.

- **Method:** Field Trips
  Integration: When possible, a field trip to a biotechnology company or research facility will address the objectives under the headings of Concepts in Biotechnology and Basic Biotechnology Laboratory Skills. Field trips will allow students to investigate recombinant DNA technologies in use at biotechnology companies. Students will discover the laboratory methods and equipment used at biotechnology companies. Students will also consider how biotechnology companies document their laboratory work.
- **Method:** Discussion
  Integration: In class discussions address the objectives under the headings Core Biology Concepts and Concepts in Biotechnology. During discussion students will relate biological molecules to the atoms, chemical bonds, and chemical reactions that form them. Students will also compare prokaryotic and eukaryotic cell structure and function. Discussions will relate the Mendelian genetic laws to the inheritance of traits. Students will consider the connection between genotypic information and phenotypes during discussion. Discussions will also investigate recombinant DNA technologies and the societal implications of these technologies.
- **Method:** Projects
  Integration: Students will investigate biotechnology companies and report on the types of careers and products at biotechnology companies. This project will address the objectives under the headings of Concepts in Biotechnology and Basic Biotechnology Laboratory Skills. Students will investigate recombinant DNA technologies and the societal implications of these technologies through the project. The laboratory methods and equipment used at biotechnology companies will be investigated. Students will consider how biotechnology companies document their laboratory work.

Methods of Evaluation:

A student's grade shall be determined by the instructor using multiple measures of performance related to the course objectives. Methods of evaluation may include but are not limited to the following:

- **Method:** Exams/Tests
  Integration: Exams will be utilized as summative assessments of student learning for several objectives under the headings Core Biology Concepts and Concepts in Biotechnology that make up a major unit of the course. Exams will assess student ability to relate the four major types of biological molecules to the atoms, chemical bonds, and chemical reactions that form them. Exams will assess student ability to compare the cellular structures and biochemical processes of prokaryotic and eukaryotic cells. Student ability to relate Mendelian genetic laws to the inheritance of traits, the process of meiotic cell division, and DNA sequence variation will be assessed by the exams. Student ability to demonstrate how genotypic information in a gene produces a phenotype through the process of gene expression will be assessed by exams. The exams will assess student understanding of recombinant DNA technologies used by scientists to manipulate gene expression and function in cells. Each exam will be evaluated for completeness and the questions will assess student ability to identify the most accurate answer, synthesize multiple concepts to derive a new insight, describe a process accurately, justify a proposed explanation, and predict future outcomes by applying the scientific method. Exam feedback will be provided by the instructor to correct misunderstanding and promote continued learning.
- **Method:** Class Participation
  Integration: Students will apply their knowledge of the objectives under the headings Core Biology Concepts and Concepts in Biotechnology for class participation. During class students will relate biological molecules to the atoms, chemical bonds, and chemical reactions that form them. Students will also participate in comparisons of prokaryotic and eukaryotic cell structure and function. Class participation will relate the Mendelian genetic laws to the inheritance of traits. Students will participate in connecting genotypic information and phenotypes during class. Class participation will also investigate recombinant DNA technologies and the societal implications of these technologies. Class participation will be assessed based on the quantity and quality of participation and the depth and breadth of contributions. Instructors will contribute to the discussion and provide feedback that helps students learn how to contribute more and better.
- **Method:** Lab Skills Demonstration
  Integration: The ability to use basic biotechnology equipment properly and follow protocols will be assessed during lab to achieve the objectives under the heading Basic Biotechnology Laboratory Skills. At the end of a major lab unit, students will be assessed on their ability to perform lab skills and correct document their

laboratory work. Lab skills demonstrations will be evaluated based on completeness and the demonstrations will assess student ability to perform a laboratory skill, document laboratory information using a standardized format, and troubleshoot mistakes. Lab skill demonstration feedback will be provided by the instructor to correct misunderstanding and promote development of lab skills.

- **Method:** Lab Work
  Integration: Students will engage in weekly lab work and submit lab assignments to the instructor to achieve the objectives under the heading Basic Biotechnology Laboratory Skills. During lab students will be assessed on their ability to perform measurements, calculations, and assays using the standard chemicals and equipment of biotechnology. Students will be assessed on their ability to document laboratory investigations in a laboratory notebook following a standard scientific documentation format. Lab work will be evaluated for completeness and the students will be assessed on their ability to accurately keep experimental records, analyze lab data, and evaluate their data to create thoughtful conclusions. Prompt lab work feedback will be provided by the instructor to correct misunderstandings about lab concepts and build lab skills.
- **Method:** Quizzes
  Integration: Periodic quizzes will be given to assess a single objective under the headings Core Biology Concepts and Concepts in Biotechnology. A quiz will assess student ability to relate the four major types of biological molecules to the atoms, chemical bonds, and chemical reactions that form them. A quiz will assess student ability to compare the cellular structures and biochemical processes of prokaryotic and eukaryotic cells. Student ability to relate Mendelian genetic laws to the inheritance of traits, the process of meiotic cell division, and DNA sequence variation will be assessed by a quiz. Student ability to demonstrate how genotypic information in a gene produces a phenotype through the process of gene expression will be assessed by a quiz. A quiz will assess student understanding of recombinant DNA technologies used by scientists to manipulate gene expression and function in cells. Each quiz will be evaluated for completeness and the questions will assess student ability to identify the most accurate answer and eliminate flawed answers. Rapid feedback from the instructor will allow students to gauge their learning progress and prepare for the exams/tests.

Examples of Assignments:

Students will be expected to understand and critique college level texts or the equivalent. Reading and writing, as well as out of class assignments are required. These assignments may include but are not limited to the following:

Example Portion of an Exam/Test
Exam 1
Multiple Choice
2. Any technological application that uses biological systems, living organisms, or derivatives thereof, to make or modify products or processes for specific use is
a. bioethics
b. biotechnology
c. genome
d. recombinant DNA
e. genetic engineering

15. a part of an experiment that can vary or change is the
a. variable
b. control
c. theory
d. question
e. observation

16. A suggested and testable explanation for an event is called a _____.
a. hypothesis
b. variable
c. theory
d. control

e. observation

Short Answer Question:
41. (10 points) Look carefully at the lab notebook entry below. Describe two correct items in the entry and one incorrect item in this lab notebook entry.

Example Field Trip Assignment

As you go through the tour take note of two products that Life Technologies makes. Research these two products on their website at http://www.lifetechnologies.com and answer the two following questions. This assignment will be due on the date of the next class meeting after the field trip.
1) Describe what type of research applications the two products are used for. Be specific and descriptive.
2) Describe the components of the products and explain why each component is in the product. Be specific and descriptive.

Example Laboratory Notebook Activity
Purpose
This purpose of this laboratory exercise is to familiarize you with keeping a laboratory notebook and its place in a system of documentation. During this exercise you will:

- Set up your laboratory notebook for future use.
- Practice recording important information regarding materials and equipment.
- Practice recording raw data with the correct number of significant figures.

Example Laboratory Activity - Making Solutions
Learning to use graduated cylinders, serological pipets, volumetric flasks, and electronic balances to make solutions builds fundamental skills that are used again and again in any laboratory career.
Objectives

1. Make 500 ml of 1x TAE buffer
2. Make 50 ml of 1 M NaCl from solid NaCl
3. Write up the procedures in a laboratory notebook

Skills to Master

1. Perform solution calculations using the $C_1V_1 = C_2V_2$ equation
2. Follow laboratory protocols
3. Use balances, graduated cylinders, and pipets
4. Make solutions from concentrated solutions
5. Wash glassware properly
6. Wrlte a label for a reagent bottle
7. Maintain a laboratory notebook

Textbooks:

- Brown, K., J. (2018). *Biotechnology: A Laboratory Skills Course, Second Edition* Bio-Rad. ISBN: 978-0-9832396-3-5
- Daugherty, E. (2017). *Biotechnology: Science for the New Millennium, Second Edition* Paradigm. ISBN: 978-0763868062
- Thieman, W., J. Palladino, M., A. (2019). *Introduction to Biotechnology, 4th Edition* Pearson. ISBN: 9780134995854

Other Resources:

- MSJC Biology Department. Biology 131 Laboratory Manual. MSJC Biology Department , 01-01-2020.
- Daugherty, E.. Biotechnology: Science for the New Millennium Laboratory Manual, Second Edition. Paradigm , 01-01-2017.

Minimum Qualification

- Biological Sciences (Masters Required) **or**
- Biotechnology **or**
- Chemistry (Masters Required)