Los Angeles Unified School District
Course Outline Form
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Course Outline

Course Title:	Intro to Biotechnology
Course Number:	#
Grade Level:	10, 11,12
Length of Course:	One Year
Credit:	10 Units
Meets Graduation Requirements:	Life Science Elective
Required for Graduation:	No
Prerequisite:	Biology or Biological Science with a B or better and Chemistry with a C or better or concurrent enrollment

Course Description:
Biotechnology is a lab-intensive course designed to combine molecular biology with practical applications. Students will be exposed to DNA fingerprinting, gene mapping, electrophoresis and DNA spooling, as well activities that relate biotechnology to daily life. Students will also have the opportunity to address social and ethical issues surrounding biotechnology. This course offers the student an opportunity to experience the basics of microbiology, human genetics, biotechnology, and exploration of bioethical issues. This course will encourage students to take more science in high school. Students will learn valuable skills that are transferable to biotechnology related technical fields and get on-the-job experience through a coordinated mentorship program in partnership with local biotechnology related companies. This course will be an elective option for students in the Health & Biosciences Academy.

Schools Offering:	Academy of Medical Arts @ Carson
Meets University of California Entrance Requirements:	Yes (d-Laboratory Science)
Meets California State University Entrance Requirements:	Yes (d-Laboratory Science)

I. Course Objectives: Content and Performance Standards

The content and performance standards listed below are in alignment with the California State Biology and Chemistry Content Standards and the state framework for grade 9-12.

Upon completion of Biotechnology, the student will be able to:

** State standard number is shown in parenthesis.*

1c) *Explain how* prokaryotic cells, eukaryotic cells (including those from plants and animals), and viruses differ in complexity and general structure.

(1d) *Describe how* the central dogma of molecular biology outlines the flow of information from transcription of ribonucleic acid (RNA) in the nucleus to translation of proteins on ribosomes in the cytoplasm.

(1h) *Explain how* most macromolecules (polysaccharides, nucleic acids, proteins, lipids) in cells and organisms are synthesized from a small collection of simple precursors.

(2d) *Explain how* new combinations of alleles may be generated in a zygote through the fusion of male and female gametes (fertilization).

(3a) *Explain how* to predict the probable outcome of phenotypes in a genetic cross from the genotypes of the parents and mode of inheritance (autosomal or X-linked, dominant or recessive).

(4a) *Explain* the general pathway by which ribosomes synthesize proteins, using tRNAs to translate genetic information in mRNA.

(4b) *Explain how* to apply the genetic coding rules to predict the sequence of amino acids from a sequence of codons in RNA.

(4c) *Explain how* mutations in the DNA sequence of a gene may or may not affect the expression of the gene or the sequence of amino acids in an encoded protein.

(5a) *Describe* the general structures and functions of DNA, RNA, and protein.

(5b) *Apply* base-pairing rules to explain precise copying of DNA during semiconservative replication and transcription of information from DNA into mRNA.

(5c) *Explain how* genetic engineering (biotechnology) is used to produce novel biomedical and agricultural products.

(5d*) *Describe how* basic DNA technology (restriction digestion by endonucleases, gel electrophoresis, ligation, and transformation) is used to construct recombinant DNA molecules.

(5e*) *Describe how* exogenous DNA can be inserted into bacterial cells to alter their genetic makeup and support expression of new protein products.

(7a) *Explain why* natural selection acts on the phenotype rather than the genotype of an organism.

(7e*) *Explain* the conditions for Hardy-Weinberg equilibrium in a population and why these conditions are not likely to appear in nature.

(8f*) *Describe how* to use comparative embryology, DNA or protein sequence comparisons, and other independent sources of data to create a branching diagram (cladogram) that shows probable evolutionary relationships.

(10f*) *Describe* the R-group structure of amino acids and know how they combine to form the polypeptide backbone structure of proteins.

(6d) *Calculate* the concentration of a solute in terms of grams per liter, molarity, parts per million, and percent composition.

(1l) *Analyze* situations and solve problems that require combining and applying concepts from more than one area of science.

(1m) *Investigate* a science-based societal issue by researching the literature, analyzing data, and communicating the findings. Examples of issues include irradiation of food, cloning of animals by somatic cell nuclear transfer, choice of energy sources, and land and water use decisions in California.

II. Course Content: Scope/Sequence Summary of Major Units of Study

Outlined below is a summary of the major units of study teachers should cover when teaching each of the course objectives/performance standards listed above. These major units of study are listed with the numbering that correlates to the California Science Content Standards. The following standards are presented in a suggested sequence of study.

UNIT 1

Biotechnology methodologies (2 weeks) chapter 1

Standard:

(5c) *Explain how* genetic engineering (biotechnology) is used to produce novel biomedical and agricultural products.

A. Scientific method
   - Cheese lab
   - Stock project

B. Lab Notebook- Standard operating procedures

UNIT 2

Raw materials of biotechnology (2 weeks) chapter 2

Standards:

(1c) *Explain how* prokaryotic cells, eukaryotic cells (including those from plants and animals), and viruses differ in complexity and general structure.

(1h) *Explain how* most macromolecules (polysaccharides, nucleic acids, proteins, lipids) in cells and organisms are synthesized from a small collection of simple precursors.

A. Cell structure and function
   1. Prokaryotic vs. Eukaryotic
   2. Molecular components of an egg cell lab
   3. Bioethics- Moore vs. UC Regents

B. Biochemistry
    1. Comparing carbohydrates lab
        a. Nucleic Acids
        b. Proteins
        c. Carbohydrates
        d. Lipids

UNIT 3

Basic chemistry for the biotechnician – skills (4 weeks) chapter 3

Standards:

(6d) *Calculate* the concentration of a solutions in terms of grams per liter, molarity, parts per million, and percent composition.

A. Skills labs
    Serological pipets lab
    Measuring very small volumes lab- micropipetting
    Making solutions mass/volume lab
    Making solutions by percent lab
    Making solutions by molarity lab
    Making dilutions of concentrated solutions lab

UNIT 4

DNA isolation and analysis (Amgen Biotech Experience labs)

Standards:

(1d) *Describe how* the central dogma of molecular biology outlines the flow of information from transcription of ribonucleic acid (RNA) in the nucleus to translation of proteins on ribosomes in the cytoplasm.

(4a) *Explain* the general pathway by which ribosomes synthesize proteins, using tRNAs to translate genetic information in mRNA.

(4b) *Explain how* to apply the genetic coding rules to predict the sequence of amino acids from a sequence of codons in RNA.

(4c) *Explain how* mutations in the DNA sequence of a gene may or may not affect the expression of the gene or the sequence of amino acids in an encoded protein.

(5a) *Describe* the general structures and functions of DNA, RNA, and protein.

(5b) *Apply* base-pairing rules to explain precise copying of DNA during semiconservative replication and transcription of information from DNA into mRNA.

A. DNA Structure and Function
    1. DNAi website activities
    2. DNA isolation from salmon sperm

3. Strawberry DNA isolation
4. E.coli DNA isolation
5. DNA isolation from human cheek cells
6. Electrophoresis labs- visualizing DNA

B. Transcription, Translation, Replication
   1. Rice Krispie Treats- protein synthesis simulation

UNIT 5

Protein isolation and analysis + spectrophotometer analysis (5 weeks) Chapter 5

Standards:

(4c) *Explain how* mutations in the DNA sequence of a gene may or may not affect the expression of the gene or the sequence of amino acids in an encoded protein

A. Antibody specificity
   a. Structure and function of antibodies
B. Action of different enzymes on apple juice
   a. Enzyme function of commercial products
C. Vertical Gel electrophoresis labs: enzymes and muscle proteins
   a. Prepare PAGE (polyacrylamide Gel Electrophoresis) buffers
   b. Prepare dilutions of enzymes and animal muscle proteins
D. Amylase assays
   a. Use amylase (enzyme) to study protein structure and function

UNIT 6

Protein purification and transformation (Amgen Biotech Experience Labs)

Standards:

(10f*) *Describe* the R-group structure of amino acids and know how they combine to form the polypeptide backbone structure of proteins.

(5c) *Explain how* genetic engineering (biotechnology) is used to produce novel biomedical and agricultural products.

(5d*) *Describe how* basic DNA technology (restriction digestion by endonucleases, gel electrophoresis, ligation, and transformation) is used to construct recombinant DNA molecules.

(5e*) *Describe how* exogenous DNA can be inserted into bacterial cells to alter their genetic makeup and support expression of new protein products.

A. pGLO and Fluorescent proteins
   1. Transformation lab that produce new traits in E.coli bacteria
B. Secrets of the rainforest- isolation of GFP (green fluorescent protein)
   2. Column chromatography
C. Restriction digest and ligation (pARA, pKAN, pARAr Amgen Biotech Experience)
   1. Restriction sites, Restriction enzymes
   2. Ligation of fragments- plasmid mapping
   3. Transformation

UNIT 7:

Polymerase chain reaction (Amgen labs)

Standards:

(2d) *Explain how* new combinations of alleles may be generated in a zygote through the fusion of male and female gametes (fertilization).

(3a) *Explain how* to predict the probable outcome of phenotypes in a genetic cross from the genotypes of the parents and mode of inheritance (autosomal or X-linked, dominant or recessive).

(7a) *Explain why* natural selection acts on the phenotype rather than the genotype of an organism.

(7e*) *Explain* the conditions for Hardy-Weinberg equilibrium in a population and why these conditions are not likely to appear in nature.

(8f*) *Describe how* to use comparative embryology, DNA or protein sequence comparisons, and other independent sources of data to create a branching diagram (cladogram) that shows probable evolutionary relationships.

A. Alu PCR
    1. PCR fundamentals
    2. Evolutionary relationships
    3. Human genome project
B. Genetically modified organisms (food) (GMO)
    1. Testing foods to determine if they are genetically modified
    2. Bioethics of GMO's
C. Mitochondrial DNA PCR
    1. DNA sequencing fundamentals
    2. Evolutionary clock
    3. Blast searching

UNIT 8:

FORENSICS

(1l) *Analyze* situations and solve problems that require combining and applying concepts from more than one area of science.

(1m) *Investigate* a science-based societal issue by researching the literature, analyzing data, and communicating the findings. Examples of issues include irradiation of food, cloning of animals by somatic cell nuclear transfer, choice of energy sources, and land and water use decisions in California.

A. Blood spatter
    1. Patterns of blood drops
    2. Analysis of crime scene
B. Blood analysis
    1. Blood typing
    2. Components of blood
C. DNA fingerprinting
    1. Analyze DNA of suspects

BIOTEHICS- interspersed throughout the curriculum

A. DNA Database – should a criminal database of criminals DNA exist?

1. Mock trial

B. Designer Babies
   1. Allowing people to pick traits of their unborn child

C. Genetic Screening and Employment round table

III. Course Methodology: Instructional Strategies/Types of Assignments/Tasks/Activities

UNIT 1 Biotechnology methodologies

- Students setup and maintain a legal scientific notebook that includes an account of all laboratory procedures, data, and reflections.
- Students follow written protocols and oral directions to perform a variety of laboratory and technical tasks.
- Students will recognize laboratory safety hazards and avoid them. Identify the location and use of emergency equipment
- Students make cheese using different curdling agents, including a bioengineered agent.
- Student research biotech companies
- Students choose companies to pretend invest in and track stock for 16 weeks. A stock project culminates at the end of the semester.

UNIT 2 Raw materials of biotechnology

- Students use an egg cell to learn about the organic components of cells. (lipids, proteins, carbohydrates)
- Students make standard solutions of lipids, proteins, carbohydrates to use as comparisons for their egg components
- Students draw different carbohydrates, noting structure and function of each
- Students taste different carbohydrates and gain a better understanding of how structure affects a compounds properties.

UNIT 3 Basic chemistry for the biotechnician

- Students do skills labs in which they learn how to use electronic and analytical balances to measure mass.
- Students do skills labs in which they learn how to use a variety of volume measurement instruments including graduated cylinders, pipets, and micropipettes.
- Students do skills labs in which they learn how to Calculate and prepare solutions based on mass/volume, % mass/volume, and molar concentrations.
- Students do skills labs in which they learn how to prepare dilutions of concentrated solutions.
- Students do skills labs in which they are able to determine which equipment is appropriate to use for a given task and what units of measurement are used.
- Students do skills labs in which they are able to use laboratory apparatus, materials, and technology in an appropriate and safe manner.

UNIT 4 DNA isolation and analysis

- Students will use their solution making skills to make solutions for DNA isolation from themselves, strawberries, *E.Coli*, and salmon sperm.

- Students will isolate DNA from themselves, strawberries, *E.Coli*, and salmon sperm and use gel electrophoresis to compare the samples.
- Students will Isolate genomic DNA from cells and analyze its purity and concentration.
- Students will outline the steps in cell culture, sterile technique, and media preparation.
- Students will prepare and maintain plate and broth cultures of bacteria.
- Students will prepare and aliquot samples, reagents and buffers. Perform chemical reactions and purification procedures similar to those used in product development, testing, and manufacture.
- Students will perform specimen collection, label samples, and prepare samples for testing. Handle, transport, and store samples
- Students will explain the principles involved in agarose gel electrophoresis.
- Students will prepare, load, run, visualize, and analyze DNA samples on an agarose gel.

Unit 5 Protein isolation and analysis + spectrophotometer analysis

- Students will research different proteins, identify their structure and function, and prepare posters and present them to the class
- Students will explain how antigens and antibodies interact
- Students will run polyacrylmadie gels to separate enzymes at different dilutions

UNIT 6 Protein purification and transformation

- Students will transform E.Coli by adding new genes from a jellyfish.
- Students will discuss methods to isolate DNA and specific genes for engineering purposes
- Students will conduct a restriction digestion and ligation of plasmids.
- Students will list the steps in the production of a recombinant DNA molecule.
- Students will cite examples of vectors used in transformation, transduction, and transfection.
- Students will describe the steps in a bacterial transformation including competency, recovery, and selection.
- Students will conduct a bacterial transformation and select for transformants.
- Students will describe methods by which transformants may be selected including antibiotic resistance, GFP and RFP activity.
- Students will conduct a mini-prep to retrieve plasmids from transformed cells.
- Students will use Hydrophobic Interaction Columns (HIC) to purify green fluorescent protein and RFP. (column chromatography)
- Students will look at the social, economical, and moral values behind purified proteins that are used for medicinal value.

UNIT 7: Polymerase chain reaction

- Students will extract DNA from cheek cells and use the PCR method to amplify a region of DNA called Alu.
- Students will use PCR and gel electrophoresis to determine if they have the jumping gene called Alu.

- Students will compare their Alu DNA to their classmates and calculate allele and gene frequencies within the class.
- Students will use bioinformatics databases to do population studies of Alu.
- Students will use bioinformatics databases to calculate allele and gene frequencies of populations around the world.
- Students will bring in foods they eat, extract DNA, and test them for genetically modified organisms.
- Students will debate the ethics of GMO's in the market.

UNIT 8: FORENSICS

- Students will learn how forensics is used to study crime.
- Students will participate in labs about blood spatter, blood typing, blood analysis.

IV. Career Awareness or Preparation Applications

FIELDTRIPS to Ambry Genetics and Kaiser Reference Laboratory.

Workplace Skills

i. Lab safety
ii. Record keeping
iii. Data presentation
iv. Professional behavior
v. Teamwork
vi. Performance review
vii. Ethics in the workplace
viii. Guest Speakers from Industry
ix. Field Trips to Biotech Companies

V. Character Education Reinforcement and Connections

i. Students will work cooperatively in lab groups.
ii. Students will apply scientific principals to solve problems.
iii. Students will take responsibility for lab equipment.
iv. Students will discuss bioethics issues.

VI. Course Evaluation: Means of Assessment

i. Written Quizzes/Tests
ii. Skills quizzes
iii. Lab Notebook
iv. Lab Practical Exams
v. Projects
vi. Presentations
    i. Oral
    ii. Using Technology

VII. Instructional Materials

Biotechnology: Science for the New Millennium, 1st edition, by Ellyn Daughtery Lab Manual and Textbook

Encore Student CD- Biotechnology: Science for the New Millennium, 1st edition, by Ellyn Daughtery

Audio Visual Materials

Technology Materials
Labs for the Course
Amgen Biotech Experience Laboratory Member part of Fullerton College Hub.

Alu PV92 - Introduces students to PCR, issues of identity and issues of privacy.

mtDNA - Students use mitochondrial DNA as a Molecular Clock

PCR Optimization - Students learn how experimental variables affect the Polymerase Chain Reaction

D1S80 - Students use the VNTR Locus D1S80 for human identification

pGLO Transformation - Eerie, neon green glowing bacteria

GFP Purification - "Secrets of the Rainforest"