

STRANDS AND STANDARDS

BIOTECHNOLOGY



Course Description

Biotechnology is an exploratory course designed to introduce students to methods and technologies that support bioscience research and practice. Students are also introduced to career possibilities in the field of biotechnology.

Intended Grade Level	11-12
Units of Credit	1.0
Core Code	36.01.00.00.080
Concurrent Enrollment Core Code	36.01.00.13.080
Prerequisite	Biology or Chemistry
Skill Certification Test Number	708
Test Weight	1.0
License Type	CTE and/or Secondary Education 6-12
Required Endorsement(s)	
Endorsement 1	Biotechnology
Endorsement 2	N/A
Endorsement 3	N/A

STRAND 1

Students will investigate the past, present, and future applications of Biotechnology as well as relevant careers.

Standard 1

Describe historical applications of Biotechnology.

- Create a timeline of historical biotechnology developments.
- Discuss or replicate a historical application of biotechnology (e.g., yogurt, cheese, sauerkraut, bread).

Standard 2

Describe applications of present technology and theorize future implications.

- Evaluate the ethical, legal, and social implications in biotechnology (e.g., vaccines, genetically modified organisms (GMO), cloning, genetic engineering).
- Describe the technologies that have been developed to identify, diagnose, and treat genetic diseases (e.g., gene therapy, genetic testing, genetic counseling, Human Genome Project, Real-time PCR, Next Gen sequencing).
- Research and present biotechnology concepts and methodologies using effective communication skills (e.g., Pharmacogenomics, Therapeutic cloning, Transgenics).

Performance Skills

Research and present biotechnology concepts using effective communication skills.

Standard 3

Explore the various science and non-science fields and careers associated with biotechnology.

- Use the Internet, field trips, job fairs, interviews, and speakers to explore biotechnology.
- Outline career paths for various occupations in the biotechnology field.

STRAND 2

Students will demonstrate appropriate safety procedures and equipment use in the laboratory.

Standard 1

Demonstrate appropriate use of personal protective equipment (PPE).

- Describe how personal protective equipment (PPE) protect the experiment and the lab worker.
- Wear personal protective equipment (PPE) when appropriate (e.g., lab coats, gloves, eye protection).
- Demonstrate safe removal of gloves.

Standard 2

Maintain a sanitary laboratory environment.

- Explain the appropriate sterilization methods (e.g., autoclave/steam, chemical-ethanol and bleach).
- Demonstrate proper aseptic/sterilizing procedures.

Standard 3

Exhibit appropriate behavior to protect coworkers and self.

- Explain the dangers of contamination via food, drink, electronics, cosmetics, lotion, eye drops, and contact lenses.
- Follow proper disposal and clean-up procedures with respect to chemicals and laboratory equipment as indicated by SOP and SDS guidelines (e.g., broken glass, sharps, spills).
- Show locations of emergency exits and equipment (e.g., fire extinguishers, blankets, eye washes, showers).

Performance Skills

Demonstrate appropriate use of personal protective devices.

Standard 4

Use biotechnology laboratory equipment correctly and safely.

- Identify equipment and describe when to use it.
- Demonstrate the proper use of biotechnology equipment.
 - Micropipette
 - Centrifuge
 - Spectrophotometer
 - pH meter
 - Electrophoresis apparatus-protein & DNA
 - Thermocycler
 - Microscope
 - Autoclave
 - Balance
 - Water baths

Performance Skills

Demonstrate proper use and handling of micropipettes.

STRAND 3

Students will follow laboratory procedures properly.

Standard 1

Follow laboratory protocols.

- Understand the purpose of individual steps within a protocol.
- Perform the steps of laboratory protocols accurately and in sequence.

Standard 2

Comply with policies and requirements for documentation and record keeping.

- Follow standard operating procedures.
- Maintain accurate records and documentation according to minimum good documentation practices (GDP).

Performance Skills

Maintain accurate records and documentation according to minimum good documentation practices (GDP).

Standard 3

Demonstrate proper handling of chemicals.

- Communicate the rationale for various laboratory-labeling procedures.
- Recognize and comply with the labeling of chemicals used in a laboratory setting for safe handling and storage.
 - Flammable
 - Corrosive
 - Toxic
 - Environmental Hazard
 - Biohazard
 - Electrical Shock Hazard
 - NFPA 704
 - White
 - Yellow
 - Red
 - Blue
- Reference and interpret the guidelines in Safety Data Sheets (SDS).

STRAND 4

Students will describe the properties of atoms and molecules and prepare lab reagents.

Standard 1

Explain chemical concepts relevant to biotechnology.

- Atomic and Molecular mass
 - Molecular weight/formula weight
- Bonding
 - Ionic
 - Covalent
 - Hydrogen
- Characteristics of the four types of bio-molecules
 - Carbohydrates
 - Lipids
 - Proteins

- Nucleic Acids
- Characteristics of molecules in water
 - Hydrophobic vs. hydrophilic
 - Polar vs. nonpolar
- Acid base chemistry, pH scale, and buffer properties

Performance Skills

Research and present biotechnology concepts using effective communication skills.

Standard 2

Demonstrate accurate and correct solution preparation.

- Use the metric system, common conversions, and proper units of scientific measurement.
- Calculate concentrations of solutions.
 - Moles
 - Molarity
 - % volume per volume
 - % weight per volume
 - Concentration
 - mg/ml
 - ug/ul
 - x concentration
- Calculate how to dilute a stock solution to make the following:
 - Working solution ($C_1V_1=C_2V_2$)
 - Serial dilutions
- Measure and adjust the pH of specific solutions with commonly used acids and bases.
- Correctly label reagents with the following:
 - Chemical
 - Concentration and pH
 - Initials
 - Date
- Prepare solutions of defined concentrations and pH.

Performance Skills

Prepare solutions of defined concentrations and pH.

Standard 3

Relate dilution to solution preparation.

- Explain dilution principles.
- Prepare serial dilutions of specific solutions.
- Measure absorbance and determine concentration of solutions (e.g., spectrophotometer, fluorometry).

STRAND 5

Students will describe the structure and function of cells and their components.

Standard 1

Identify key cellular components and correlate with function.

- Describe the structure of the following and explain the major function of each.
 - Nucleus
 - Ribosomes
 - Mitochondria
 - Cell wall
 - Cell membrane

Standard 2

Compare and contrast the Three-domain system.

- Describe a prokaryotic cell including the following:
 - Cell structure
 - Reproduction
 - Applications in biotechnology
- Describe an eukaryotic cell including the following:
 - Cell structure
 - Reproduction
 - Applications in biotechnology

STRAND 6

Students will demonstrate proper bacterial identification and maintenance of cultures.

Standard 1

Prepare bacterial growth media.

- Identify growth requirements for common microorganisms.
- Utilize appropriate media preparation techniques and use appropriate conditions for specific experiments (e.g., avoid inactivation in media).
 - Antibiotics
 - Temperatures
 - Selective media

Performance Skills

Prepare bacterial growth media.

Standard 2

Inoculate agar and broth media.

- Explain the different methods of inoculation.
- Select the appropriate media and methods of inoculation.
- Inoculate media using various techniques.

- Streak
- Spread
- Demonstrate the ability to culture and maintain microorganisms.
- Correctly label specimen samples (e.g., bacterial strain, antibiotic, date, media).

Performance Skills

Demonstrate the ability to culture and maintain microorganisms.

Standard 3

Identify common categories of bacteria.

- Explain and identify bacterial properties useful for classification.
 - Cell wall composition
 - Morphology
 - Metabolism
- Perform gram stain tests to identify bacteria.

STRAND 7

Students will compare and contrast different types of nucleic acids and proteins and illustrate the flow of genetic information within the cell.

Standard 1

Describe the structure of nucleic acids.

- Identify the components of nucleotides.
- Compare and contrast the structure and function of DNA and RNA.
- Explain how the chemical structure of DNA applies to gel electrophoresis.
- Perform a restriction digest and analyze the results with gel electrophoresis.

Standard 2

Describe how DNA functions as a template for DNA replication.

- Identify the major components and outline the process of DNA replication.
- Explain the process of DNA replication and how it applies to the amplification of nucleic acids in PCR and DNA sequencing.
- Demonstrate the ability to use PCR technology by amplifying and analyzing DNA using PCR and gel electrophoresis.

Performance Skills

Demonstrate the ability to use PCR technology.

Standard 3

Describe the structure and function of proteins.

- Describe and illustrate the four levels of protein structure.
 - Primary
 - Secondary
 - Tertiary

- Quaternary
- Explain the relationship between the structure and function of proteins.
- Identify functional classes of proteins (e.g., structural, regulatory, enzymes, transport).
- Discuss ways proteins are used in biotechnology.
- Use computer resources to visualize the three dimensional structure of proteins (e.g., Protein data bank, Cn3D).
- Explain proper separation techniques to differentiate between proteins based on size and structure (e.g., chromatography, SDS-PAGE).
- Discuss the effects of environment on the function of enzymes.
 - Temperature
 - pH
 - Salt concentration

Standard 4

Outline the process of protein synthesis as related to the Central Dogma of Molecular Biology.

- Explain the progression of information from DNA to traits.
- Identify the major components, outline the process, and describe the products of transcription.
- Distinguish between transcription in prokaryotic and eukaryotic systems.
 - Introns
 - Exons
 - Post transcriptional modifications
- Identify the major components, outline the process, and describe the product of translation.
- Describe the uses of recombinant proteins in biotechnology (e.g., medicine, agriculture, etc.).
- Manipulate the production of recombinant protein in bacteria (e.g., GFP).

Standard 5

Describe how DNA mutations affect the organism.

- Characterize the different types of mutations.
 - Silent
 - Missense
 - Frame shift
 - Nonsense
- Explore the consequences of mutations on the organism (e.g., cancer, genetic disease).
 - Identify single nucleotide polymorphisms (SNP).
 - Describe the role of single nucleotide polymorphisms (SNP) in biotechnology applications (e.g., paternity, forensics, pharmacogenomics, evolutionary origins).

STRAND 8

Students will explain recombinant DNA techniques in bacteria.

Standard 1

Describe the use of plasmids in bacterial transformation.

- Describe the elements of a functional plasmid vector.
 - Origin of replication
 - Selection gene
 - Multiple cloning sites
 - Promoter
- Explain the role of restriction enzymes in generating recombinant plasmids.
- Describe competent cells, transformation, and selection methods.
- Perform a bacterial transformation and analyze results.

Standard 2

Describe the process of plasmid DNA isolation.

- Analyze the protocol for isolating plasmid DNA.
- Understand how to quantify the amount of DNA purified.

Performance Skills

Demonstrate proper aseptic/sterilizing procedures.

Performance Skills

Perform a restriction digest and analyze the results with gel electrophoresis.

Skill Certificate Test Points by Strand

Test Name	Test #	Number of Test Points by Standard															Total Points	Total Questions
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15		
Biotechnology	708	1	11	6	13	3	12	22	3								71	71