STRANDS AND STANDARDS
BIOTECHNOLOGY

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CTE®

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
Skill Certification Cut Score	**71%**
Test Weight	1.0
License Area of Concentration	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 (Human Genome Project, fermentation products, structure of Deoxyribonucleic Acid [DNA], pasteurization, etc).
- 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., genetically modified organisms [GMO], cloning, genetic engineering, immunizations, and data privacy).
- Describe the technologies that have been developed to identify, diagnose, and treat genetic diseases (e.g., gene therapy, genetic testing, Real-time PCR, Next Gen sequencing, CRISPR).
- Obtain, evaluate, and communicate biotechnology concepts and methods using effective communication skills (e.g., Pharmacogenomics, Therapeutic cloning, Genetic Engineering).

Standard 3

Explore the various careers associated with biotechnology.

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

Performance Skill

Research and present biotechnology concepts using effective communication skills.

STRAND 2

Students will practice appropriate safety procedures in the laboratory.

Standard 1

Select and use appropriate personal protective equipment (PPE).

- Describe how personal protective equipment (PPE) protects the experiment and the lab worker.
- Wear personal protective equipment (PPE) when appropriate (i.e., lab coats, gloves, eye protection).

Standard 2

Maintain a sanitary laboratory environment.

- Explain sterilization methods.
  - Autoclave
  - Chemical (ethanol, bleach)
- Practice proper aseptic and sterilizing procedures.

Standard 3

Exhibit appropriate laboratory behavior that protects coworkers and self.

- Explain the dangers of contamination of food, drink, electronics, or other personal items.
- Follow proper disposal and clean-up procedures of chemicals and laboratory equipment as indicated by Standard Operating Procedures (SOP) and Safety Data Sheet (SDS) guidelines (e.g., broken glass, sharps, spills, biohazard waste).
- Locate emergency exits and equipment (e.g., fire extinguisher, fire blanket, eye wash, shower).

Performance Skills
Demonstrate appropriate use of personal protective devices and the safe removal of gloves.

Standard 4
Practice proper handling of chemicals.
- Label chemicals and samples according to laboratory SOP.
- Comply with safe handling and storage guidelines as specified by chemical hazard labels.
  - Pictograms
    - Flammable
    - Corrosive
    - Toxic
    - Environmental Hazard
    - Biohazard
    - Electrical Shock Hazard
- National Fire Protection Association (NFPA) 704
  - White
  - Yellow
  - Red
  - Blue
- Locate and interpret SDS guidelines for chemicals.

STRAND 3
Students will follow laboratory procedures.

Standard 1
Follow laboratory protocols.
- Explain 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.
- Follow standard operating procedures (SOP).
- Maintain accurate records and documentation according to good documentation practices (GDP).
  - Attributable
  - Legible
  - Contemporaneous
  - Original
  - Accurate

Performance Skill
Maintain a laboratory notebook according to good documentation practices (GDP).

Standard 3
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 Skill

Demonstrate proper use and handling of micropipettes.

STRAND 4

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

Standard 1

Explain chemical concepts relevant to biotechnology.

- Atomic mass, molar mass, and formula weight.
- Bonding
  - Ionic
  - Covalent
  - Hydrogen
- Characteristics of the four types of biomolecules/ macromolecules.
  - Carbohydrates
  - Lipids
  - Proteins
  - Nucleic Acids
- Characteristics of molecules in water
  - Hydrophobic vs. hydrophilic
  - Polar vs. nonpolar
- Acid base chemistry, pH scale, and uses of buffers.

Standard 2

Calculate 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 (mg/mL)
    - mg/ml (mg/mL)
    - X concentration
- Calculate how to dilute a stock solution to make the following:
  - Working solution (C1V1= C2V2)
  - Serial dilutions

Standard 3

Prepare and use solutions in the laboratory.

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

Performance Skill
Prepare a solution of defined concentration and pH.

STRAND 5
Students will relate cell structure to bacterial identification and culture maintenance.

Standard 1
Compare and contrast prokaryotic and eukaryotic cells.
- Cell structure
- Reproduction
- Applications in biotechnology

Standard 2
Describe how to prepare bacterial growth media.
- Identify growth requirements for common microorganisms.
- Use media preparation techniques needed for specific experiments.
  - Antibiotics/selective media
  - Temperatures (avoid inactivation in media)

Performance Skills
Demonstrate proper aseptic/sterilizing procedures.
Prepare bacterial growth media.

Standard 3
Inoculate agar and broth media.
- Explain different methods of inoculation.
- Select the appropriate media and methods of inoculation.
- Inoculate media using various techniques.
  - Streak
  - Spread
- Correctly label specimen samples (e.g., bacterial strain, antibiotic/media, date, initials).

Performance Skill
Demonstrate the ability to culture and maintain microorganisms.

Standard 4
Explain and identify bacterial properties useful for classification.
- Cell wall composition
- Morphology (cell and/or colony)
- Metabolism

Performance Skill
Perform gram stain tests to identify bacteria.

STRAND 6
Students will describe the structure, function, and application of DNA replication.

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.

Performance Skill
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 needed for DNA replication. (i.e. helicase, single strand binding proteins, primase, DNA polymerase, and ligase.)
- Outline the process of DNA replication

Standard 3
Describe the components and mechanism of Polymerase Chain Reaction (PCR).
- Explain the steps of the PCR cycle (ie. denature, anneal, extend)
- Identify the components and their function.
- Compare PCR to DNA replication in a cell.
    - Recognize the applications of PCR. (e.g. genetic testing, DNA sequencing, forensics, cloning)

Performance Skill
Demonstrate the ability to use PCR technology.

STRAND 7
Students will distinguish between the different types of nucleic acids and proteins and illustrate the flow of genetic information within the cell.

Standard 1
Outline the process of transcription and 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.

Standard 2
Describe how DNA mutations affect the organism.

- Characterize the different types of mutations.
  - Point mutation/substitution
    - Silent
    - Missense
    - Nonsense
  - Frame shift
- 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).

Standard 3

Describe the relationship between the structure and function of proteins.

- Describe and illustrate the four levels of protein structure.
  - Primary
  - Secondary
  - Tertiary
  - Quaternary
- Identify functional classes of proteins (e.g., structural, regulatory, enzymes, transport, cell signaling, defense).
- 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

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.
- Describe the uses of recombinant proteins in biotechnology (e.g., medicine, agriculture, etc.).
- Manipulate the production of recombinant protein in bacteria (e.g., Green Fluorescent Protein [GFP]).

Standard 2

Describe the process of plasmid DNA isolation.

- Analyze the protocol for isolating plasmid DNA.

- Explain how to quantify the amount of DNA purified.

Performance Skill
Perform a bacterial transformation and analyze results.

STRAND 9
Students will investigate how biotechnology relates to bioindustrial manufacturing.

Standard 1
Explore non-medical applications of biotechnology (e.g., energy, bioindustrial materials, textiles, food and agricultural technology, environmental remediation etc.)

Standard 2
Compare and contrast upstream and downstream processing.

Standard 3
Identify and describe the function of the components of a bioreactor.

Standard 4
Describe the Biomanufacturing Readiness Levels (BioMRLs).

Performance Skill
Using the BioMRLs, outline a bioindustrial manufacturing process for a product.

Duarable Skills
- Problem solving
- Teamwork
- Critical Thinking
- Dependability
- Accountability
- Legal requirements/expectations

Skill Certification Test Points by Strand- test will be revised when updated course approved.

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