BIOTECHNOLOGY (708)

DESCRIPTION

Biotechnology is designed to create an awareness of career possibilities in the field of biotechnology. Students are introduced to diagnostic and therapeutic laboratory procedures that support bioscience research and practice.

Total Test Questions: 71	Levels: Grades 10-12	Units of Credit: 1.0
Prerequisites: Biology or Chemistry		

STANDARDS, OBJECTIVES, AND INDICATORS

STANDARD 1

- **STUDENTS WILL INVESTIGATE THE PAST, PRESENT, AND FUTURE APPLICATIONS OF BIOTECHNOLOGY AS WELL AS RELEVANT CAREERS.**

Objective 1: Describe historical applications of biotechnology.

- Create a timeline of historical biotechnology developments.
- Replicate a historical application of biotechnology (e.g., yogurt, cheese, sauerkraut, and bread).

Objective 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, 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, and Human Genome Project, Real-time PCR, Next Gen sequencing).
- Research and present biotechnology concepts using effective communication skills (e.g., Pharmacogenomics, Therapeutic cloning, Transgenics).

Objective 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.

STANDARD 2

- **STUDENTS WILL DEMONSTRATE APPROPRIATE SAFETY PROCEDURES AND EQUIPMENT USE IN THE LABORATORY.**

Objective 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, and eye protection).
- Demonstrate safe removal of gloves.

Objective 2: Maintain a sanitary laboratory environment.

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

Objective 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 (e.g., broken glass, sharps, and spills).
- Show locations of emergency exits and equipment (e.g., fire extinguishers, blankets, eyewashes, and showers).

Objective 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 and DNA
  - Thermocycler
  - Microscope
  - Autoclave
  - Balance
  - Water baths
- Demonstrate proper use and handling of micropipettes.

STANDARD 3

STUDENTS WILL FOLLOW LABORATORY PROCEDURES PROPERLY.

Objective 1: Follow laboratory protocols.

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

Objective 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).

Objective 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.
    - Flammability
    - Corrosive
    - Toxic
    - Environmental Hazard
    - Biohazard
    - Electrical Shock Hazard
    - NFPA 704
        - White
        - Yellow
        - Red
        - Blue
- Reference and interpret the guidelines in Safety Data Sheets (SDS).

STANDARD 4

STUDENTS WILL DESCRIBE THE PROPERTIES OF ATOMS AND MOLECULES AND PREPARE LAB REAGENTS.

Objective 1: Explain chemical concepts relevant to biotechnology.

- Atomic 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. non polar
- Acid base chemistry, pH scale, and buffer properties

Objective 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 (C1V1 = C2V2)
    - 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.

Objective 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)

STANDARD 5

STUDENTS WILL DESCRIBE THE STRUCTURE AND FUNCTION OF CELLS AND THEIR COMPONENTS.

Objective 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

Objective 2: Compare and contrast prokaryotic and eukaryotic cells.

- Describe a prokaryotic cell including the following:

- Cell structure
- Reproduction
- Applications in biotechnology

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

STANDARD 6

STUDENTS WILL DEMONSTRATE PROPER BACTERIAL IDENTIFICATION AND MAINTENANCE OF CULTURES.

Objective 1: Prepare bacterial growth media.

- Identify growth requirements for common microorganisms.
- Utilize the appropriate media and conditions for specific experiments.
  - Antibiotics
  - Temperatures
  - Selective media

Objective 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).

Objective 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.

STANDARD 7

STUDENTS WILL COMPARE AND CONTRAST DIFFERENT TYPES OF NUCLEIC ACIDS AND PROTEINS AND ILLUSTRATE THE FLOW OF GENETIC INFORMATION WITHIN THE CELL.

Objective 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.

Objective 2: Describe how DNA functions as a template for DNA replication.

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

Objective 3: Describe the structure and function of proteins.

- Describe 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, and 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

Objective 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
  - Posttranscriptional 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).

Objective 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 and genetic disease).
- Explore how DNA differs between individuals within a species.
  - Identify single nucleotide polymorphisms (SNP)
  - Describe the role of single nucleotide polymorphisms (SNP) in biotechnology applications (e.g., paternity, forensics, pharmacogenomics, evolutionary origins).

STANDARD 8

STUDENTS WILL EXPLAIN RECOMBINANT DNA TECHNIQUES IN BACTERIA.

Objective 1: Describe the use of plasmids in bacterial transformation.

- Describe the elements of a functional plasmid
  - 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.

Objective 2: Describe the process of plasmid DNA isolation.

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