

Biotechnical Engineering 11-12 Grade

Class Overview: The major focus of this course is to expose students to the diverse field of biotechnology including biotechnical engineering, biomolecular genetics, bioprocess engineering, and agricultural and environmental engineering.

Course Norms/Materials

Texts: Biotechnology

1: What is Biotechnology?

Learning Intention One: TSWBAT Summarize the diverse products, issues and careers in the field of Biotechnology

Success Criteria

- Describe the science of biotechnology and identify its product domains
- Outline the evolution of biotechnical engineering
- Give examples of careers and job responsibilities associated with biotechnology
- Outline the steps in producing and delivering a product made through recombinant DNA technology
- Apply the strategy for values clarification to bioethical issues
- Summarize the components of effective communication
- List the forms of documentation needed for effective communication
- Outline the steps necessary to keep oneself safe in the laboratory.

2: Raw Materials of Biotechnology

Learning Intention Two: TSWBAT Explain the relationship between cell structure, function and organization and their significance in the research and development in biotechnology.

Success Criteria

- Identify the levels of biological organization and explain their relationships
- Describe cell structure and its significance in biotechnology research and product development
- Discuss the types of organisms researched and the types of cells grown and studied in biotechnology facilities plus the products with which they are associated.
- Define genetic engineering and identify products related with this technology
- Explain the Central Dogma Of Biology and its importance in genetic engineering
- Describe the applications of fermentation in food production and renewable energy.

3: Basic Skills of Biotechnology Workplace

Learning Intention Three: TSWBAT Perform the basic skills needed to select the proper tool and measure the specific columns and masses in a lab setting.

Success Criteria

- Determine the most appropriate tool for measuring specific volumes or masses
- Describe how to select, set, and use a variety of micropipette within their designated ranges to accurately measure small volumes
- Recognize the different expressions for units of concentration measurements and use their corresponding equations to calculate the amount of solute needed to make a specified solution or make a dilution.
- Describe what pH is and why it is important in solution preparation.

4 / 5: Introduction to Studying DNA / Introduction to Studying Proteins

Learning Intention Four: TSWBAT summarize the importance of DNA and protein synthesis and their role in their role in genetic engineering.

Success Criteria

- Describe the structure of DNA and explain the process by which it encodes for proteins
- Discuss the characteristics of viruses and their importances in genetic engineering
- Explain the fundamental process of genetic engineering and give an example of the

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following applications: - recombinant DNA technology - site-specific mutagenesis - gene therapy.

- Describe the structure of proteins, including the significance of the amino acid R-group and their impact on the three-dimensional structure of proteins.
- Describe the process of gel electrophoresis and discuss how the characteristics of molecules affect their migration through a gel.
- Summarize the polyacrylamide gel electrophoresis and identify its usefulness for studying proteins

6: Identifying a Potential Biotechnology Product

Learning Intention Five: TSWBAT explain the process involved in developing, researching, and analyzing a new biotechnical product all the way to market.

Success Criteria

- Give examples of biotechnology products derived from plant and animal sources and discuss the challenges of identifying potential product sources.
- Identify the steps in a Comprehensive Product Development Plan and use it to determine whether a potential biotechnology product is worth manufacturing.

- Discuss the types of assays done as potential products move through the process of development and identify the additional assays required for pharmaceutical development.
- Describe how an ELISA or a Western blot is conducted and what results of each assay can reveal.
- Explain how scientists test the effectiveness of antibiotics and antimicrobials and discuss the significance of antibiotic resistance.
- Describe the typical recombinant DNA protein product pipeline, additional steps required by FDA for pharmaceutical proteins and possible formulations of the final product.

7: Spectrophotometers and Concentration Assays

Learning Intention Six: TSWBAT summarize the process of setting up and correctly using a spectrophotometer to determine the concentration of a substance.

Success Criteria

- Describe how spectrophotometers operate, compare and contrast ultraviolet and visible spectrophotometers and give examples of their uses.

- Determine which type of spectrophotometer is needed for a particular application and the wavelength to be used.
- Explain the relationship between absorbance and transmittance in spectrophotometer and interpret the meaning of absorbance measurements.
- Justify the need for buffers, describe how buffers are prepared and calculate the amount of buffering agent needed when making a particular buffer.

10 / 11: Introduction to Plant Biotechnology / Biotechnology in Agriculture

Learning Intention Seven: TSWBAT summarize the importance of genetic engineering of plant cells, tissues and organs.

Success Criteria

- Describe the mechanisms of plant pollination and differentiate between haploid and diploid cells and their role in sexual reproduction.
- Identify various natural and artificial ways to propagate plants to increase genetic variety or maintain genetic composition.
- Discuss the function and composition of different plant structures, tissues and organelles and give examples of foods that are derived from various plant organs.

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- Perform the calculations to predict expected plant and phenotypes for specific genotypes using Punnett Square analysis in a plant breeding experiment.
- Describe the role of meristematic tissue in asexual plant propagation.
- Explain the role of plant growth regulator, as well as the advantages and disadvantages of plant tissue culture.
- Give specific examples of agricultural and horticultural biotechnology applications, including genetically modified organisms (GMO) crops, hydroponics and plant-made pharmaceuticals.
- Explain how genomic and plasmid DNA can be isolated from cells, including the additional steps required for plant cell DNA isolation.
- Describe the role of *Agrobacterium tumefaciens* plays a role in producing genetically modified plant crops.
- Summarize the methods used to produce transgenic plants, and explain the selection process for identifying transformed plant cells.
- Describe the role of biotechnologies in food production, processing and security.

12. Medical Biotechnologies

Learning Intention Eight: TSWBAT summarize the benefits of the biotechnical advancements made in the medical industry.

Success Criteria

- Discuss the scope and role of medical biotechnology in the healthcare industry
- Describe the function of drugs and how they may be created with combinatorial chemistry
- Explain how high-throughput screening methods are used to discover the potential drug activity.
- Describe the methods for synthesizing peptides and oligonucleotides and discuss the uses of each.
- Detail the multiple uses of antibodies and vaccines in medical biotechnology.
- List examples of recent advances in medical biotechnology and expected new applications.
- Demonstrate the application of engineering principles by improving upon existing hospital design or surgical equipment designs.
- Identify anatomical joint features and movements, then create a joint model with the same degree of freedom as the human counterpart.

- Summarize the most common forms of heart disease and disorders.
- Explain procedures involving artificial heart surgery