CASE

APB Detailed Course Outline

Unit 1 Introduction to Biotechnology

Lesson 1.1 Foundations of Biotechnology

1. Modern biotechnology has foundations in historical technologies, such as fermentation and selective breeding, while utilizing newer fields, such as molecular biology, bioengineering, and bioinformatics.
    - Complete a series of activities to explore the applications of biotechnology.
    - Write a definition of biotechnology.
2. Organization and record keeping are important to success in biotechnology.
    - Develop and maintain an Agriscience Notebook to store information for the course.
    - Develop a Laboratory Notebook to record observations and protocols.
3. Innovations in biotechnology have led to more efficient production of agricultural goods and may support sustainable agricultural practices in the future.
    - Determine the date and significance of a biotechnological discovery.
    - Work collaboratively to develop a timeline of biotechnology discoveries.
4. Ethical questions surrounding applications of biotechnology, which generate discussions and varying opinions that drive policy and regulation, are based on personal beliefs.
    - Explore their personal beliefs and knowledge to gain perspective on practices in biotechnology.

Lesson 1.2 Standard Operating Procedures

1. Working in a biotechnology laboratory requires diligence in following safety procedures and rules.
    - Review the Lab Safety Manual and determine safe practices for the biotechnology laboratory.
2. Knowledge of the location of safety equipment is essential when working in the laboratory.
    - Diagram and describe where emergency equipment and safety hazards in the biotechnology laboratory are located.
    - Explain appropriate uses of safety and emergency equipment.
    - Safety Data Sheets (SDS) contain important information related to the proper use and cleanup of biological and chemical materials.
    - Use SDS forms to determine the proper use and clean up of compounds used in the course.
3. Proper and accurate measurement is important for laboratory investigation.
    - Mix diluted solutions based on the percentage of a substance desired.
    - Prepare solutions based on the desired molar concentration.
- Use pipets to transfer accurate volumes of solutions.
- Transfer microliters of solutions using a micropipet.

4. Good Laboratory Procedures (GLPs) ensure the quality and integrity of laboratory data used to support registration of a product.
    - Prepare and pour nutrient agar plates using sterile procedures.

Lesson 1.3 Basics of Cells and DNA

1. Culturing research specimen in the laboratory requires the use of sterile techniques to limit contamination.
    - Prepare culture plates using proper sterile and streaking techniques.
2. Prokaryotic and eukaryotic cells, which are used for biotechnological applications, can be cultured and observed easily in the laboratory.
    - Observe differences in growth patterns of prokaryote and eukaryote model organisms.
3. Understanding DNA structure is essential for bioengineering processes.
    - Develop a model of a DNA strand as a class and using simulation materials.
4. DNA is studied in order to understand how living things work.
    - Research DNA replication and develop a visual representation of the replication process.
    - Determine the location of a specific gene sequence in a DNA segment.

Unit 2 DNA Technologies

Lesson 2.1 Diving into DNA

1. DNA is extracted from cellular matter to be studied.
    - Write an experiment to extract DNA from kiwi fruit.
    - Extract DNA from kiwi fruit using procedures developed.
    - Mix solutions and pour gel trays to prepare agarose gels.
    - Conduct gel electrophoresis to observe the migration of dyes and extracted DNA.
2. Restriction enzymes are used to cut DNA in order to compare organisms, isolate and transfer genes, and genetically modify organisms.
    - Demonstrate the action of restriction enzymes using paper DNA strands.
3. DNA profiles are created using fragments produced through Restriction Fragment Length Polymorphism.
    - Digest a DNA sample using restriction enzymes and conduct gel electrophoresis to analyze the results.
    - Solve a problem determining the culprit of a crime using restriction enzymes and gel electrophoresis.

Lesson 2.2 Genetic Transformers

1. Transformation is used to synthetically produce proteins for increased animal and plant production.
    - Prepare agar plates and LB broth for transformation.
    - Transform bacterial cells to exhibit ampicillin resistance and bioluminescence.
2. Plasmids are used to insert the genes for desired traits into bacterial cells.
    - Use the pGLO plasmid to transform bacterial cells to exhibit desired traits.
    - Research how the Ti plasmid is used to transform a bacteria of interest for agricultural biotechnology applications.
3. Proteins of interest can be purified from bacterial cultures for further study.
    - Culture transformed cells and purify a protein of interest from the bacteria.
4. Conducting background research is important to identify what is already known about the research objective.
    - Research *Agrobacterium tumefaciens* to determine applications in the agricultural field.

- Write a scientific research paper using valid resources and parenthetical citations.

Unit 3 Proteins

Lesson 3.1 Protein Processes

1. Transcription and translation are processes that produce proteins of which all living things are made.
    - Research the processes of transcription and translation and complete a simulation of amino acid production.
2. Colorimetric assays can be used to identify and determine the amount of protein in a biological sample extract.
    - Perform an experiment using a spectrophotometer to assess the protein content of milk and other high protein drinks.
    - Compare the results of Bradford assays to Biuret assays.
3. The presence of specific proteins in a biological sample can indicate the presence of disease, exposure to disease, or identify genetically modified products.
    - Complete an enzyme-linked immunosorbent assay to determine the presence of protein.
    - Write an outline of their research paper on Agrobacterium tumefaciens.

Unit 4 Agricultural Biotechnology

Lesson 4.1 Genetically Modified Organisms

1. Ethical and moral questions arise from the science of genetically modifying organisms.
    - Reflect upon the term genetically modified and develop personal perceptions and beliefs pertaining to the term.
    - Research published perceptions of genetically modified organisms of different groups and organizations and discuss in class.
    - Conduct a public perception survey of genetically modified foods.
2. Genetic testing, such as polymerase chain reactions and lateral flow tests, is used to make production based decisions and identify genetically modified organisms.
    - Perform a lateral flow test to determine the presence of Round-Up Ready® genes in corn.
    - Conduct a polymerase chain reaction to determine the presence of genetic modifications in a common food item.
3. Organisms are genetically modified to improve agricultural products by inserting genes into cells.
    - Complete the annotated bibliography, the rough draft, and a peer review of the *A. tumefaciens* research paper.

Lesson 4.2 Performance Enhanced Plants

1. Plants are genetically modified to improve agricultural products by inserting genes into cells.
    - Research and compare methods of inserting genes into plants and discuss the advantages and disadvantages of each.
2. The totipotency of plants allows a minute portion of tissue to be cultured into a complete plant.
    - Propagate ferns using tissue culture.
3. A sterile environment, including media, work area, equipment, and lab technician is required to produce viable plants by micropropagation.

- Sanitize, sterilize, and maintain an aseptic environment to promote success during tissue culture.

4. Deoxyribonucleic acid (DNA) can be cut, replicated, and inserted into the genome of an organism for the improvement of agricultural production.
    - Complete a simulation of the process for developing transgenic plants.
    - Develop and write a protocol to insert a gene of interest in plants.

Lesson 4.3 Animal Applications

1. The immune response of mammals can be used to detect proteins of interest.
    - Perform enzyme-linked immunosorbent assays to detect the immunological response of animals.
2. Animal reproductive technologies are used by producers in order to achieve management goals.
    - Research and present their findings on reproductive technologies used in animal agriculture.
3. Markers are used to identify the successful insertion of genes.
    - Perform PCR and electrophoresis to use marker assisted selection to determine ideal genotypes for specific situations.
4. Genetic testing and disease diagnosis are used to make production based decisions.
    - Complete a WebQuest to study the diagnostic tools available for detection of diseases and genetic abnormalities.

Lesson 4.4 Everyday Biotechnology

1. Biotechnological practices, such as bioremediation, use naturally occurring processes to provide industrial applications.
    - Design and conduct an experiment determining the effectiveness of oil-eating microbes in various environmental conditions.
2. Biofuels are a source of renewable energy derived from organisms.
    - Research a type of biofuel.
3. Fermentation and esterification are processes in which agricultural products are converted into biofuels.
    - Determine a method of producing the fuel in a laboratory.
4. The precautionary principle serves as a guiding statement for determining the ethical considerations of biotechnology and other scientific endeavors.
    - Review a case study and interpret the application of the precautionary principle by interest groups.

Unit 5 Research Methods

Lesson 5.1 Independent Researchers

1. Research is driven by questions and backed by literature reviews, experimentation, and communication of results.
    - Brainstorm ideas for research projects and define a problem to solve in order to frame research.
2. Conducting background research is important to identify what is known about the research question.
    - Collect and summarize similar research conclusions.

3. Experiments are designed in such a way that the control is apparent and the researcher can conduct multiple trials.
    - Write a research proposal outlining the background and need for their research as well as a plan for conducting the research.
    - Conduct a self-designed research project and collect data for results and analysis.
4. Results of research experiments include interpretation of data in the form of posters, papers, or oral presentations.
    - Write a research paper summarizing the findings of their research.
    - Prepare a research poster to present to the class and at local science fairs.

Lesson 5.2 From Lab to Production

1. The genome of multiple organisms can be analyzed in order to understand genetic variations.
    - Use web-based resources to find information on the genetic sequence of a protein.
2. Regulatory agencies monitor research and development, production, and use of biotech products in order to ensure safety for consumers and the environment.
    - Determine the influence of governmental regulatory agencies.
    - Write a case study pertaining to a biotechnological application and the role of governmental agencies in determining the safety of the application.
3. Results of research undergo multiple steps and trials before reaching consumers.
    - Develop a model depicting the steps from laboratory research through production to end use of a biotechnology.
4. Ethical questions surrounding applications of biotechnology, which generate discussions and varying opinions, are based on personal feelings and beliefs.
    - Review their ethical perspectives of biotechnological practices and reflect on how their opinions have developed over the length of the course.
5. Biotechnology is a fast growing industry with many emerging technologies and future career opportunities.
    - Write a letter outlining their vision for future biotechnological innovations and practices.