Introduction to Biotechnology

Introduction to Biotechnology is a one-credit course designed to provide an overview of the biotechnology field. It is suggested that this elective course be offered to advanced senior level students. Subject matter includes career choices, skill development, and application of science concepts relative to biomedical research and development. Students gain a basic understanding of laboratory procedures fundamental to biomedical research through course topics that include Mendelian genetics, gene structure and function, inheritance patterns, genetic abnormalities, and the Human Genome Project. Additional topics include communication skills, history and development of the field of biomedical research, and comprehension of the legal environment, and technology transfer aspects of biomedical research. Upon completion of the course, job shadowing, virtual "job shadowing," or clinical internship opportunities may also be available through biotechnology companies, local universities, medical schools, and diagnostic laboratories.

Career and technical student organizations are integral, cocurricular components of each career and technical education course. These organizations serve as a means to enhance classroom instruction while helping students develop leadership abilities, expand workplace-readiness skills, and broaden opportunities for personal and professional growth.

Career Opportunities

Students will:

1. Trace the history of biotechnology.
    - Identifying scientific fields relevant to biotechnology
    - Describing both scientific and non-scientific careers and role and responsibilities of individuals working in biotechnology

Safety

2. Exhibit appropriate safety procedure in the laboratory.
    Examples: demonstrating proper use of personal protection devices, maintaining a sanitary laboratory environment, handling biological and chemical hazards properly, following laboratory protocols, maintaining proper documentation, labeling, and record keeping

Biochemistry Concepts

3. Explain concepts important to solution preparation.
    - Explaining concepts of molecular mass, mole, and formula weight
    - Calculating molecular mass of specific molecules and the molarity of a solution
    - Preparing solutions of defined concentration
        Example: preparing serial dilutions of specific solutions
    - Adjusting the pH of specific solutions with commonly used acids and bases

Genetics and Cell Biology Concepts

4. Correlate key cellular components to function.
   Examples: nucleus, chromosome, ribosome, mitochondria

5. Describe the process of meiosis and the cell cycle, including the hereditary significance of each.
   - Comparing typical and atypical chromosome karyotypes
   - Comparing spermatogenesis and oogensis using charts

6. Describe the significance of Mendel's work to the development of the modern science of genetics, including the laws of segregation and independent assortment.

7. Describe inheritance patterns based on gene interactions.
   - Predicting patterns of heredity using pedigree analysis
   - Identifying incomplete dominance, codominance, and multiple allelism

8. Describe occurrences and effects of sex linkage, autosomal linkage, crossover, multiple alleles, and polygenes.

9. Describe the structure and function of deoxyribonucleic acid (DNA), including replication, translation, and transcription.
   - Applying the genetic code to predict amino acid sequence
   - Describing methods cells use to regulate gene expression
   - Defining the role of ribonucleic acid (RNA) in protein synthesis
   - Performing DNA extraction and separation techniques
   - Analyzing DNA previously amplified using polymerase chain reaction (PRC)

10. Explain the structure of eukaryotic chromosomes, including transposons, introns, and exons.

11. Describe factors such as radiation, chemicals, and chance that cause mutations.
   - Describing effects of genetic variability on adaptations
   - Describing how DNA mutations impact both the organism and population

12. Explain how the Hardy-Weinberg principle provides a baseline for recognizing evolutionary changes in gene frequency due to genetic drift, gene flow, nonrandom mating, mutation, and natural selection.

13. Differentiate among major areas in modern biotechnology, including plant, animal, microbial, forensic, and marine.
   Examples: hybridization, cloning, insulin production, DNA profiling, bioremediation

   - Describing techniques used with recombinant DNA
     Examples: DNA sequencing, isolation of DNA segments, PCR
   - Demonstrate proper maintenance of bacterial cultures, including preparing growth media and culturing microorganisms
   - Demonstrating recombinant DNA techniques in bacteria, including performing a plasmid transformation and a restriction digest

14. Explain the development, purpose, findings, and applications of the Human Genome Project.
    - Analyzing results of the Human Genome Project to predict ethical, social, and legal implications
    - Describing medical uses of gene therapy, including vaccines and tissue and antibody engineering
    - Using computer bioinformatics resources to provide information regarding DNA, protein, and human genetic diseases

        Examples: National Center for Biotechnology Information (NCBI), protein data bank, gene reviews

15. Describe the replication of DNA and RNA viruses, including lytic and lysogenic cycles, using diagrams.