

# BIOTECHNOLOGY I I ESSENTIAL CURRICULUM

## OVERVIEW OF COURSE

This course examines the various applications of biotechnology in the modern world. Topics explored include: biotechnology related to agriculture and industry; biotechnology and the environment; bioinformatics tools and databases, focusing particularly on biological sequence data; theories and research in the field of genetics, including the molecular aspects of gene function in various genetic disorders and genetic counseling; and the ethical, legal, and social implications of the field of biotechnology.

In addition to classroom material and laboratory investigations, students are also responsible for completing an individual, hands-on research project in the field of biotechnology. Students are required to: write and submit a research proposal, abstract, and final paper based on their research project work; and maintain an accurate, comprehensive, professional-grade lab notebook. Students will give culminating multimedia senior presentations on their research for their final exam grades.

## UNIT I: GENETICS

**This unit is designed to expand the student's knowledge of basic Mendelian and molecular genetics to include current trends in Biotechnology. Students will explore the molecular basis of disease as well as discuss current techniques used to diagnose, treat and cure these illnesses. The Human Genome Diversity: Student Allele Database project will help the student develop an educational analog of the human genome project that "personalizes" gene technology and provides an appropriate mechanism for increased collaboration between genome research centers and high schools.**

**Goal 1. The student will demonstrate the ability to explain how genetic variation influences population trends.**

Objectives - The student will be able to:

- a. Calculate gene frequencies using the Hardy Weinberg theorem.
- b. Use DNA technology to compare allele frequencies of the class to those in a worldwide allele database (Cold Spring Harbor Laboratory).

**Goal 2. The student will demonstrate the ability to describe the molecular process and epidemiology of cancer.**

Objectives - The student will be able to:

- a. Describe the cell processes and genes involved in the development of the disease.

- b. Analyze the way in which technology can help identify potential cancer risks and can assist with cancer staging, treatment and possible cure.
- c. Explain how molecular techniques such as microarray technology can be used for genetic testing.
- d. Discuss ethical issues associated with genetic testing and privacy rights.

**Goal 3. The student will demonstrate the ability to extend their knowledge of the role of genetic mutations in disease to the potential development of appropriate drug therapy.**

Objectives - The student will be able to:

- a. Explain why single nucleotide polymorphisms may provide important clues about genetic diseases in humans.
- b. Define pharmacogenomics, and provide examples of why pharmacogenomics will change how many human genetic disease conditions will be treated in the future.

## **UNIT II: BIOINFORMATICS**

**This unit is designed to introduce students to the field of Bioinformatics and Genomics. An examination of the genomic organization of viral, bacterial, plant, animal and the human organism will be performed. The central role of bioinformatics in managing and mining the vast amounts of biological information generated from the genome projects will be emphasized. This unit is designed to be project-oriented with hands-on experience using DNA/protein analysis software and molecular databases.**

**Goal 1. The student will demonstrate the ability to retrieve genomic information online resources.**

Objectives - The student will be able to:

- a. Navigate through the NCBI Website for a variety of applications.
- b. Identify the difference between a nucleotide and a protein sequence.
- c. Identify the differences among genomic, cDNA, and EST nucleotide sequences.
- d. Distinguish between the available BLAST databases and determine when each database is appropriate to use for different applications.

**Goal 2. The student will demonstrate the ability to classify genes according to gene ontology standards.**

Objectives - The student will be able to:

- a. Recognize the different categories of genes.
- b. Classify genes according to structure, function, and location.

**Goal 3. The student will demonstrate the ability to use the tools necessary for finding functional genes within genomic sequences.**

Objectives - The student will be able to:

- a. Understand and identify start and stop codons and open reading frames in reference to gene mining.
- b. Identify the difference between intron and exon nucleotide sequences by understanding gene splicing.
- c. Assemble a multi-exon gene from genomic sequence.

**Goal 4. The student will demonstrate the ability to use the computer to generate 3D molecular models.**

Objectives - The student will be able to:

- a. Use the computer to develop 3-D images of various molecules using RasMol and CHIME.
- b. Construct an informative html web page containing 3-D images of a specific molecule.
- c. Report on how computer modeling is currently being used in the medical field.

### **UNIT III: BIOTECHNOLOGY IN INDUSTRY AND AGRICULTURE**

**This unit illustrates the applications of biotechnology in agriculture and industry, linking scientific discoveries to business and manufacturing practices.**

**Goal 1. The student will demonstrate the ability to describe the principles of genetic engineering and the application of these techniques to crop sciences.**

Objectives - The student will be able to:

- a. Describe the role of genetic engineering in agriculture and test for genetic modification in common food items.
- b. Initiate and sustain plant tissue cultures.
- c. Describe the role of biotechnology in food processing and preservation.

**Goal 2. The student will demonstrate the ability to apply concepts of biotechnology to environmental issues.**

Objectives - The student will be able to:

- a. Define bioremediation and describe why it is important to the environment.
- b. Describe advantages of bioremediation strategies over other types of clean-up approaches.

### **UNIT IV: BUSINESS AND BIOTECHNOLOGY**

**Goal. The student will demonstrate the ability to apply basic business principles to the field of biotechnology.**

Objectives - The student will be able to:

- a. Research publicly traded biotechnology companies and describe their key research and products as well as the impact of these organizations on the overall field.
- b. Investigate market trends by completing a stock watch.
- c. Use knowledge of current companies and potential areas for research to create and promote a novel biotechnology company.
- d. Appreciate the wealth of biotechnology career opportunities in the Baltimore/Washington area.

## **UNIT V: INTRODUCTION TO INDEPENDENT RESEARCH**

**This unit highlights the research process. After completion, students will be able to formally design, implement, report and present “real-world” scientific research.**

**Goal 1. The student will demonstrate the ability to employ technical reading and writing skills.**

Objectives - The student will be able to:

- a. Identify different types of technical reading and writing.
- b. Read, interpret, and apply technical information.
- c. Write a summary of technical information.

**Goal 2. The student will demonstrate the ability to define standard research methods.**

Objectives - The student will be able to:

- a. Define empirical research and identify the different types of research.
- b. Identify and classify research variables.

**Goal 3. The student will demonstrate the ability to formulate a statement of the problem.**

Objectives - The student will be able to:

- a. Understand research hypotheses, purposes, and questions.
- b. Formulate research hypotheses, purposes, and questions.

**Goal 4. The student will demonstrate the ability to complete a formal review of the literature.**

Objectives - The student will be able to:

- a. Determine appropriate strategies for finding and gathering information in specific sources.
- b. Gather information from a variety of sources.
- c. Organize, store, and access information using appropriate formats.
- d. Cite sources of information in written publication to avoid plagiarism.

**Goal 5. The student will demonstrate the ability to complete a research paper proposal.**

Objectives - The student will be able to:

- a. Design and develop a research plan.
- b. Identify and use available resources needed to implement research plans, including timeline, materials, and equipment.

**Goal 6. The student will demonstrate the ability to complete a final laboratory research report.**

Objectives - The student will be able to:

- a. Prepare drafts and review them for content.
- b. Revise drafts in terms of purposes and proposed messages.
- c. Plan for written publication appropriate for intended audiences, message content, organization, format, style, and tone.
- d. Proofread for spelling, punctuation, grammar, and style.
- e. Evaluate effectiveness of writing process and uses of writing strategies, and plan for future improvements in writing.
- f. Respond to audience feedback and seek expert advice when necessary.

**Goal 7. The student will demonstrate the ability to present final laboratory research.**

Objectives - The student will be able to:

- a. Use presentation strategies, support materials, and technologies appropriate to communicating research.
- b. Present verbal information or messages orally with appropriate staging, volume, pitch, stress, pace, modulation, visibility, and clarity.
- c. Use appropriate nonverbal communication strategies in oral presentations including posture, gesture, and facial expressions.
- d. Demonstrate technology skills through use of *PowerPoint* and multimedia strategies in final presentation.
- e. Respond appropriately to audience feedback.