1. **COURSE TITLE: Advanced Biotechnology and Laboratory Science**
2. **Course Number: 2220 CATALOG PREFIX: BTNL**
3. **PREREQUISITE(S): Introduction to Biotechnology and Laboratory Science (BTNL 1110)**
4. **COURSE TIME/LOCATION: (*Course Syllabus – Individual Instructor Specific*)**
5. **CREDIT HOURS: 4 LECTURE HOURS: 3**

**LABORATORY HOURS: 1 (3 contact hours)**

1. **FACULTY CONTACT INFORMATION: *(Course Syllabus – Individual Instructor Specific)***
2. **COURSE DESCRIPTION:**

An in-depth look into the application and business of modern biotechnology and laboratory science. Advanced Biotechnology will include an overview of fermentation processes, and identification of different types of bioreactors with an explanation of the use of each type. Useful products will be made with a bioreactor. The products made in the bioreactor will be purified and tested for impurities and contaminants using gas chromatography, NIR spectrometry, UV spectrophotometry and other methods. A research project to sequence a novel genetic segment will be developed. Bioinformatics will be used to investigate sequences in general, and sequences related to the research project. Electrophoretic properties of native proteins will be investigated. Model organisms such as *Caenorhabditis elegans*, *Drosophila melanogaster*, Zebrafish, and *Arabidopsis sp*. will be cultured.

An important part of this course will be the development of biotechnology and laboratory science equipment and processes from common every day materials to be used by schools and other individuals in the United States and in developing nations.

1. **LEARNING OBJECTIVES:**

Upon completion of this course the student will be able to

* 1. Describe the science and business of biotechnology and laboratory science.

Examine different careers in laboratory science and biotechnology. Locate global, country-wide, and local laboratory and biotechnology job opportunities.

* 1. Review safety practices and regulatory requirements for laboratory science and biotechnology
  2. Review biochemistry including molecular genetics. Discuss Epigenetics.
  3. Bioreactors and Fermentation. Describe the process of industrial fermentation and industrial cell culture. Compare and contrast the different types of bioreactors. Examine the mechanical differences and functions of different bioreactors. Explain how to set up, clean, use, and maintain different bioreactors. Explain the processes involved in the culture of organisms, prevention of contamination, monitoring of processes, and extraction, purification, and quality control of products. Describe the temperature/pressure relationship of steam in sterilization processes. Describe how entrapped air can affect sterilization. Compare the effectiveness and use of moist heat to dry heat. Describe the effect of suspended solids in media on sterilization. Explain the mode of action and role of enzymes in the fermentation process; explain the relationships and effects of simple and complex carbohydrates, proteins and lipids in the fermentation process. Describe the relationship of oxygen transfer rates to mass transfer. Explain the use of or disposal of waste products. Describe economic issues related to maintaining a commercial fermentation process. Describe the use of bioreactors in the production of pharmaceuticals.
  4. Set up and successfully run a bioreactor; obtain, purify and check the quality of a useful product.
  5. Perform simple DNA sequencing in the laboratory.
  6. Prepare a research project in DNA sequencing by doing library, on-line, and bioinformatic background research. Design experiments to sequence a small genetic segment from a plant or animal that has not been previously sequenced. Perform all the steps needed to obtain a sequence including if necessary using commercial sequencing of the selected segment of DNA. Analyze and present the results of the project.
  7. Explain microarray technology
  8. Bioinformatics. Define, give a history of, and describe the discipline of bioinformatics.
  9. Explain the theory of information developed by Claude Shannon. Describe information in mathematical terms.
  10. Explain what an algorithm is and how algorithms are used.
  11. Explain the global alignment algorithm of Needleman and Wunsch.
  12. Describe the local sequence alighment algorithm of Smith and Waterman. Describe the Smith-Waterman FASTA and BLAST methods. Describe hidden Markov models. Describe local alignment statistics and the *E* value.
  13. Become familiar with and use: PubMed, OMIM, NCBI in general, and GenBank
  14. Compare and Retrieve Similar Sequences using BLAST (Basic Local Alignment Search Tool) on nucleotides and proteins
  15. Use the DDBJ, Swiss-Prot and ExPASy
  16. Become familiar with GMOD (The Generic Model Organism Database) Resources
  17. Explain what the field of genomics is and how bioinformatics plays a crucial role. Define the words genomics and proteomics
  18. Use model organism databases including
      1. Mouse Genome Informatics (MGI)
      2. The Arabidopsis Information Resource (TAIR)
      3. The Zebrafish Model Organism Database, Zebrafish Information Network (ZFIN)
      4. *Saccharomyces* Genome Database (SGD)
      5. WormBase (*Caenorhabditis elegans*)
      6. FlyBase (*Drosophila* sp.)
      7. EcoCyc *E. coli* Database
  19. Perform a Western Blot Analysis
  20. Perform immunoelectrophoris
  21. Examine epigenetics
  22. Perform Real Time PCR and Reverse Transcriptase PCR

1. **ADOPTED TEXT(S):**

*Introduction to Biotechnology. Third Edition.* 2013. William J. Thieman and Michael A. Palladino. Columbus: Pearson. ISBN: 0-321-76611-3.

*Basic Laboratory Methods for Biotechnology, Second Edition*. 2009. Lisa Seidman and Cynthia J. Moore. San Francisco: Pearson.

*Molecular Biology of the Cell*, Fifth Edition. 2008. Bruce alberts, Alexander Johnson, Julian Leis, Martin Raff, Keith Roberts, and Peter Walter. New York: Garland Science.

*Biotechnology*, Fifth Edition. 2009. John Smith. Cambridge: Cambridge University Press.

*Bioinformatics and Functional Genomics*. Jonathan Pevsner. Hoboken: John Wiley and Sons.

1. **OTHER REQUIRED MATERIALS:**

A bound laboratory notebook with numbered pages, a scientific calculator, and safety goggles are required. Supplementary lecture and laboratory handouts will be provided to students.

1. **GRADING SCALE:**

Grading will follow the policy in the catalog. The scale is as follows:

A: 90 – 100

B: 80 – 89

C: 70 – 79

D: 60 – 69

F: 0 – 59

1. **GRADING PROCEDURES OR ASSESSMENTS: (*Course Syllabus – Individual Instructor Specific)***

|  |  |  |
| --- | --- | --- |
| *Category* | ***EXAMPLE ONLY***  *Total Points* | *% of Grade* |
| Chapter Assignments (10x30) | 300 | 30% |
| Quizzes (10x20) | 200 | 20% |
| Unit Exams (3x100) | 300 | 30% |
| Assignments (5x10) | 50 | 5% |
| Annual Report Project (100) | 100 | 10% |
| Attendance | 50 | 5% |
| Total | 1000 | 100% |



Instructor will specify which criteria will apply to a particular assignments. Students will be expected to complete work utilizing course material covered. Other assignments, assessments, projects, presentations, hands-on exercises and reports may be assigned and graded at the discretion of the instructor.

1. **COURSE METHODOLOGY:**

May include but not limited to: Lectures, visual and audio presentations, independent and group projects, in-class and home assignments, tests, quizzes and lab exercises. Laboratory exercises will include an investigative approach with a hypothesis and controls whenever possible. Laboratory Reports will be written in journal format.

**14. COURSE OUTLINE:**

The Science and Business of Laboratory Science and Biotechnology

Careers in Laboratory Science and Biotechnology

Biochemistry

Epigenetics

DNA Sequencing and DNA Sequencing Project

Fermentation and Bioreactors

Culture of Algae

Use Infrared Spectrophotometry and High Performance Liquid Chromatography.

Immunology

The Western Blot

Bioinformatics

Epigenetics

Development of Laboratory Equipment

**Week 1:** **Lecture**: Course Introduction and syllabus. The science and business of laboratory science and biotechnology. Careers in laboratory science and biotechnology (Chapter 1 in Thieman and Palladino) (Chapter 1 in Smith). **Laboratory**: Basic Safety: (Chapters 9-12 in Laboratory Manual, Seidman and Moore) Clean and prepare photoreactors for algae growth and clean and prepare table top fermenters for yeast growth project. Begin laboratory and bioinformatic research into the sequencing project.

**Week 2**: Lecture: DNA sequencing (Chapter 3 in Thieman and Palladino). The biology of algae and yeast. Fermentation and Industrial Cell Technology. Biodiesel (Chapter 6 in Smith). **Laboratory**: Begin the culture of algae.

**Week 3:** **Lecture**: Fermentation and Industrial Cell Culture Technology. Types of Bioreactors (Chapters 2,4, 10 in Smith) (Chapters 9,10,11 in Okafor). **Laboratory**: Continue the culture of algae. Begin the culture of yeast. Work on the sequencing project.

**Week 4:** **Lecture**: DNA sequencing technology (Chapter 3 in Thieman and Palladino). **Laboratory**: Perform the sequencing of a small DNA segment in the laboratory.

**Week 5:** **Lecture**: Bioinformatics (Chapters 1-4 in Pevsner). **Laboratory:** Use bioinformatic databases including PubMed, NCBI in general, and OMIM. Perform Real Time PCR and Reverse Transcriptase PCR.

**Week 6:** **Lecture**: DNA sequencing technology (Chapter 3 in Thieman and Palladino). **Laboratory**: Continue laboratory work on the DNA sequencing project. Perform a BLAST analysis on a nucleotide and a protein sequence. Continue work on the Reverse Transcriptase PCR experiment if needed.

**Week 7:** **Lecture**: DNA sequencing technology (Chapter 8 in Alberts). Bioinformatics (Chapter 5 in Pevsner) **Laboratory**: Continue the sequencing project.

**Week 8:** **Lecture**: Bioinformatics Work and Sequencing Project. **Laboratory**: Bioinformatics and Sequencing Project. Methylation and epigenetics experiment.

**Week 9:** **Lecture**: Bioinformatics Work and Sequencing Project. **Laboratory**: Bioinformatics and Sequencing Project. Methylation and epigenetics experiment continued.

**Week 10:** **Lecture**: Bioinformatics Work and Sequencing Project. **Laboratory**: Bioinformatics and Sequencing Project. Western Blot Analysis.

**Week 11:** **Lecture**: Bioinformatics Work and Sequencing Project. **Laboratory**: Bioinformatics Work and Sequencing Project. Extract and begin purification of materials from the bioreactor. Use an infrared spectrophotometer to test for impurities in bioreactor products.

**Week 12:** **Lecture:** Bioinformatics Work, Yeast (Chapter 15, Pevsner)**.** Quality Contrtol of bioreactor products Fermentation and Industrial Cell Culture Technology. (Chapters 2,4, 10 in Smith). **Laboratory**: Continue purification and analysis of bioreactor product. Use high performance liquid chromatography to test for impurities in bioreactor products.

**Week 13:** **Lecture:** Bioinformatics Work, Human Genome Project (Chapters 16, 17 Pevsner) Algae in agriculture **Laboratory**: Prepare a biofuel from algae. Develop laboratory equipment from common readily-available materials.

**Week 14:** **Lecture**: Bioinformatics Work, Human Disease (Chapters 18 Pevsner) Algae in agriculture **Laboratory**: Prepare a biofuel from algae. Develop laboratory equipment from common, readily-available materials. Complete the sequencing project.

**Week 15:** **Lecture**: Complete and review bioinformatics and the sequencing and bioreactor projects. **Laboratory**: Develop laboratory equipment from common, readily-available materials.

**Week 16: Final Examination**

**15. SPECIFIC MANAGEMENT REQUIREMENTS:**

Assignments will be evaluated according to instructor directives.

**16. OTHER INFORMATION:**

**FERPA:** Students need to understand that your work may be seen by others. Others may see your work when being distributed, during group project work, or if it is chosen for demonstration purposes. Students also need to know that there is a strong possibility that your work may be submitted to other entities for the purpose of plagiarism checks.

**DISABILITIES:** Students with disabilities may contact the Disabilities Service Office, Central Campus, at 800-628-7722 or 937-393-3431.