1. **COURSE TITLE: Introduction to Biotechnology and Laboratory Science**
2. **COURSE NUMBER: 1110 CATALOG PREFIX: BTNL**
3. **PREREQUISITE(S): High School Biology within the last three years, High School Biotechnology, Human Biology (BIOL 1104) or permission by the instructor**
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 exploration into the fascinating world of modern DNA science and laboratory analysis. The course will provide a lecture and hands-on participation in the application of modern DNA science and laboratory analysis to forensics, medicine, the environment, food science, agriculture, and the arts.

A background in basic biotechnology and laboratory science will lead to the performance and practice of advanced techniques including analysis of human genes, identification of genetic elements in commercial foods containing genetically modified organisms (GMOs), transformation of an organism with a new DNA element, using antibodies in identification of a foreign protein or organism. Students will perform techniques involved in modern forensic analysis such as restriction analysis and PCR which are often used on crime scene samples. Students will learn how to read and understand the new molecular genetic data often found in patient diagnoses of cancer and genetic diseases. The breakdown of oil by bacteria will be performed, a technique that is often used to clean the environment in oil spills.

1. **LEARNING OBJECTIVES:**

Upon completion of this course the student will be able to:

* 1. Define “Biotechnology”
  2. Describe people and events in the historic development of science, the scientific method, and biotechnology and laboratory science; explain the significance of the people and discoveries of science.
  3. Explain the steps of the scientific method and design an experiment with control variables, independent experimental variables, and dependent variables. Develop a detailed double blind study protocol. Explain and use positive and negative controls whenever applicable for an experiment.
  4. Understand, describe and practice good laboratory safety procedures including the use of personal protective equipment, reading chemical and biological labels, and using Material Safety Data Sheets.
  5. Understand, describe, and follow the applicable suggestions and requirements set forth in safety regulations regarding laboratory practices including those by the Food and Drug Administration (FDA) Current Good Laboratory Practices (GLP), Current Good Manufacturing Practices (GMP), and Occupational Safety and Health Administration (OSHA) Regulations
  6. Develop the habit of consistent and accurate record keeping of important laboratory conditions such as daily refrigerator temperatures or safety equipment conditions.
  7. Organize different laboratory documents, and maintain them in a neat consistent system so that they are readily accessible at all times.
  8. Identify and properly use basic laboratory equipment.
  9. Properly label, store and move laboratory chemicals. Explain how to neutralize acids and bases.
  10. Understand and use the metric system to make measurements. Convert metric measurements from one unit to another unit and convert metric units to English units. Use scientific notation. Perform calculations with the correct number of significant figures.
  11. Accurately measure length, mass, volume, and time by properly using the correct equipment.
  12. Use laboratory standard operating procedures (SOPs). Follow protocols in order to perform experiments accurately and consistently.
  13. Properly record experimental laboratory data using an accepted bound record book, analyze data using standard statistical methods, and present data in a number of forms including graphs.
  14. Write a journal format paper describing an investigative laboratory experiment performed in class.
  15. Describe the basic concepts of general chemistry, organic chemistry, and biochemistry.
  16. Prepare solutions with specific concentrations. Prepare a simple buffer solution. Measure the pH of acids and bases.
  17. Perform standard chemical tests for carbohydrates, lipids, proteins, and nucleic acids.
  18. Identify the parts of a microscope and correctly use a microscope.
  19. Describe the structure of prokaryote and eukaryote cells.
  20. Explain the principles and steps of mitosis and meiosis.
  21. Describe the structure of DNA, RNA, and Protein. Explain the processes of DNA replication, transcription, and translation. Explain the “Central Dogma” of molecular biology. Explain, compare, and contrast gene regulation in prokaryotes and eukaryotes.
  22. Define terms related to chromatography, explain the principles of chromatography, and perform investigative experiments using paper and thin layer chromatography.
  23. Describe principles of basic biotechnology and general laboratory techniques and perform basic biotechnology laboratory processes such as DNA extraction, PCR, Electrophoresis, Immunodiffusion tests, Bacterial Transformation, Protein Purification and Southern Blot Analysis.
  24. Explain the basic mode of action and use of restriction endonucleases.
  25. Separate nucleic acids using electrophoresis and determine the molecular weight of the DNA fragments.
  26. Explain the use of biotechnology in medicine.

1. Describe how modern medications including human insulin and human growth hormone are produced using recombinant DNA technology.

2. Describe the role of biotechnology in the treatment and prevention of diseases such as Ebola. Explain how Kentucky and tobacco are involved in the production of ZMapp.

3. Explain how genetically related diseases such as cancer are analyzed and described using biotechnology. Use bioinformatic databases for further study.

4. Read and understand medical laboratory reports from anonymous patient records relating the genetic origin of diseases such as cancer.

AA. Explain how biotechnology is used in crime scene investigations.

1. Perform a polymerase chain reaction analysis.

2. Use electrophoresis to identify an unknown DNA sample.

AB. Discuss the uses of biotechnology in agriculture.

AC. Explain basic problems and theories of bioethics. Work as a group to develop some proposed solutions to ethical problems. Communicate the proposed solutions in a group presentation.

AD. Look briefly at how the portrayal of laboratory science and biotechnology are used in television shows and the movies.

AE. Describe various careers available to those studying laboratory science. Discuss the local companies and organizations that hire those with skills in laboratory science and biotechnology. Study various steps used to obtain a job including the development of a resume. Find out which companies are hiring those with skills in laboratory science.

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. ISBN:978-0-321-57014-7

Basic Laboratory Calculations for Biotechnology. 2008. Lisa Seidman. San Francisco: Pearson. ISBN: 978-0-13-223810-6

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% |

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:**

History of Science and Biotechnology

The Scientific Method and Experimental Design

Safety and Regulations

Consistent Accurate Record Keeping and Document Organization

Maintaining an Accurate Bound Experimental Laboratory Notebook

Writing Journal Format Laboratory Reports

Basic Math for Laboratory Science and Biotechnology

Measurements

Basic Laboratory Equipment Identification

Basic Laboratory Procedures including proper use and storage of glassware and equipment, cleaning glassware and equipment, making and using distilled and deionized water, using the autoclave, and basic instrumentation

An overview of General, Organic and Biological Chemistry

The cell

Introduction to Mitosis and Meiosis

Molecular Biology including DNA Replication, Transcription and Translation

Introduction to Eukaryote and Prokaryote gene regulation

Biochemical Tests

DNA Extraction

Restriction Endonuclease Digestion of DNA

Electrophoresis

Polymerase Chain Reaction (PCR)

Bacterial Transformation

Protein Purification

Determination of the Concentration and Purity of DNA

Bioremediation

Southern Blot Analysis

Aquatic Biotechnology

Agricultural Biotechnology

Medical Biotechnology

Forensic Biotechnology

Industrial Biotechnology

Introduction to Bioethics

**Week 1:** (Chapter 1 in Thieman and Palladino) **Lecture**: Introduction to the course, History of science and biotechnology, Products of modern biotechnology, introduction to ethics. **Laboratory**: (Chapter 9 and 13, Laboratory Manual, Seidman and Moore) Basic Safety. Personal Protective Equipment. Chemical safety introduction including the reading of safety and reagent labels, storage of chemicals, transport of chemicals, and neutralization of acids and bases, and reading safety data sheets. Introduction to Laboratory Equipment use and cleaning. Begin an introduction to basic math, the metric system and metric and English conversions. Practice the use of written protocols and standard operating procedures. Begin careful record keeping of laboratory maintenance; start recording the refrigerator temperature at each class. Check safety equipment on a regular basis, keep a record of this maintenance. Use the triple beam balance, digital scale, and analytic balance. Measure length with rulers and a vernier caliper. Measure volume with graduated cylinders, graduated beakers, graduated flasks, and volumetric flasks. (Chapter 19 in the laboratory manual.) Dispense solutions with pipets and pipet controllers. Properly record the data from these exercises in a bound laboratory book.

**Week 2:** (Chapter 1 in Thieman and Palladino): **Lecture:** An overview of areas of biotechnology including microbial biotechnology, agricultural biotechnology, animal biotechnology, bioremediation, aquatic biotechnology, medical biotechnology, and biotechnology regulations. **Laboratory**: Laboratory Manual (Chapters 13,14) Math, metric system and proportions (continued). Problems; use the text Basic Laboratory. Calculations for Biotechnology. Write a basic journal format laboratory report. Discuss the parts of a microscope and use a microscope. Perform DNA extractions using two different methods; examine some of the properties of DNA. Use laboratory standard operating procedures (SOPs) and a protocol for the extractions. Use a centrifuge.

**Week 3:** (Chapter 2 in Thieman and Palladino) **Lecture**: An introduction to general, organic and biochemistry. **Laboratory**: Prepare solutions with specific concentrations. Prepare buffer solutions. Determine pH using different methods; use and calibrate a pH meter.

**Week 4:** (Chapter 2, and beginning of chapter 3 in Thieman and Palladino) **Lecture**: An introduction to general, organic and biochemistry continued. An introduction to prokaryote and eukaryote cells. Introduction to Replication of DNA, Transcription, and Translation. **Laboratory**: Pour electrophoresis gels. Electrophoresis of DNA. Compare the base-pair size of the experimental DNA samples to known DNA size standards on the gel; use semi-log graph paper to plot and analyze the data.

**Week 5:** (Chapter 3 in Thieman and Palladino) **Lecture**: Recombinant DNA Technology and Genomes. **Laboratory:** Perform an investigative experiment with positive and negative controls using paper and thin layer chromatography to determine the presence or absence of contaminants in a sample.

**Week 6:** (Chapter 4 in Thieman and Palladino) **Lecture**: Proteins as Biotechnology Products. **Laboratory**: Use column chromatography to purify a protein product.

**Week 7:** (Chapter 5 in Thieman and Palladino) **Lecture**: Microbial Biotechnology. **Laboratory**: Practice aseptic technique and create a bacterial culture streak plate. Analyze proteins from different organisms using vertical polyacrylamide gel electrophoresis (PAGE).

**Week 8:** (Chapter 5 in Thieman and Palladino): **Lecture**: Microbial Biotechnology. **Laboratory**: Transform a bacterium to show bioluminescence. Set up a simple desk-top fermenter using yeast. Briefly study the yeast life cycle.

**Week 9:** (Chapter 6 in Thieman and Palladino): **Lecture**: Agricultural and Food Biotechnology (Plants). The PCR process. **Laboratory**: Perform an investigative experimental PCR analysis. Observe the model organism, *Caenorhabditis elegans*.

**Week 10:** (Chapter 7 in Thieman and Palladino) **Lecture**: Introduction to Mendelian Genetics and Animal Biotechnology. **Laboratory**: Quality control analysis: Use immunologic, antibody-antigen, testing to assess the purity of animal food products. Field Trip to local ethanol plant.

**Week 11:** (Chapter 8 in Thieman and Palladino) **Lecture**: Forensics and DNA Fingerprinting. **Laboratory**: Analyze a sample of saliva using PCR followed by restriction enzyme digestion of PCR products and electrophoresis to identify a genetic element that predicts and corresponds to a readily observable phenotype.

**Week 12:** (Chapter 9 in Thieman and Palladino) **Lecture**: Bioremediation. **Laboratory**: Demonstrate the value of bacteria in bioremediation of oil spills by inoculating an oil mixture with oil-degrading bacteria; use a control to help analyze the effect of the oil-degrading bacteria on oil.

**Week 13:** (Chapter 10 in Thieman and Palladino) **Lecture**: Aquatic Biotechnology. **Laboratory**: Observe and help maintain fluorescent fish that are genetically engineered with a fluorescent protein. Discuss the procedures that were used in creating these fish, the economic value of the fish, and ethical issues involved. Determine the concentration and purity of DNA using a UV spectrophotometer; use and explain positive and negative control samples used in performing the analysis of the experimental DNA sample.

**Week 14:** (Chapter 11 in Thieman and Palladino) **Lecture**: Medical Biotechnology. **Laboratory**: Discuss Medical and Forensic biotechnology procedures. Perform a Southern blot analysis.

**Week 15:** (Chapter 11 in Thieman and Palladino) Lecture: Medical Biotechnology. Laboratory: Read and explain a molecular genetic description of a type of cancer. Use bioinformatic techniques to identify the sequences associated with Sickle Cell Anemia. Explain the parts of the DNA, RNA, and protein sequences associated with sickle cell anemia, and demonstrate an understanding of descriptive genetic language and abbreviations.

**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.