1. **COURSE TITLE: Biotechnology and Laboratory Science of Microorganisms**
2. **Course Number: 2210 CATALOG PREFIX: BTNL**
3. **PREREQUISITE(S) : Introduction to Biotechnology (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:**

This course explores many fascinating areas of genetic engineering and DNA science. Sterile laboratory technique, the preparation of different types of culture media, transformation, conjugation, and transduction of bacteria will be studied and practiced. Bacteria, bacteriophages, yeast, multicellular fungi, and nematodes will be cultured. Many molecular biotechnology techniques will be performed on microorganisms or using microorganism products. Restriction sites on plasmid DNA and Lambda virus DNA will be mapped. Bacteria will be transformed to make Green Fluorescent Protein (GFP); the Green Fluorescent Protein will be purified and analyzed. Epigenetics and RNA interference will be studied and RNA interference will be examined in the laboratory. The course examines and practices safe handling procedures for chemicals, equipment, and living organisms, especially microorganisms, and the use of personal protective equipment. Regulations of different governmental and advisory agencies will be studied.

1. **LEARNING OBJECTIVES:**

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

* 1. Describe and apply proper safety procedures for handling microorganisms, chemicals and equipment. Understand and describe regulations and recommendations from governmental and advisory organizations.
  2. Compare and contrast cellular structure and function in prokaryotes and eukaryotes.
  3. Distinguish between major groups of microscopic biologic entities including viruses, bacteria, protists, fungi, helminths and arthropods.
  4. Describe bacterial structure, metabolism, growth, and reproduction.
  5. Identify bacteria by their size, morphological characteristics, gram staining, and biochemical properties. Discuss antibiotics and gram negative and positive bacteria.
  6. Explain microbial taxonomy and classification systems and use them to identify microbial organisms.
  7. Describe virulence and pathogenicity.
  8. Perform assays to distinguish various types of microorganisms.
  9. Explain how to culture bacteria in solid, liquid and semisolid media. Culture bacteria in petri plates and slants. Make a streak plate and isolate individual colonies. Isolate and culture bacteria that come from one cell.
  10. Describe bacterial genomic DNA and plasmid DNA. Explain and perform bacterial conjugation.
  11. Explain and perform bacterial transformation.
  12. Explain and perform transduction of bacteria using a bacteriophage.
  13. Explain and perform electroporation of bacteria in one of the transformation experiments.
  14. Perform molecular biology processes including
      1. The determination of the size of DNA fragments from restriction enzyme cleavage of DNA.

2. Restriction Mapping of Lamda virus DNA.

3. Restriction Mapping of a bacterial plasmid.

4. Use PCR to identify a DNA segment that predicts a readily observable phenotype in *Halobacterium sp.*

5. Perform Southern Blot Hybridization.

6. Insert a desired DNA segment into a plasmid and transform bacteria using the plasmid.

* 1. Discuss CRSPR biochemistry and application.
  2. Culture *Saccharomyces cerevisiae*, study the life cycle, mate strains, perform a mutagenesis experiment, perform a genetic cross, and use yeast in a table-top fermenter to produce useful products.
  3. Observe a culture of *Sordaria fimicola,* cross a wild type and mutant strain and perform tetrad analysis.
  4. Culture and study *Caenorhabditis elegans*. Identify stages of the worm and the major organs visible. Demonstrate RNA Interference in the worm.

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

*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.

*Modern Industrial Microbiology and Biotechnology*. 2007. Nduka Okafor. Enfield, New Hampshire: Science Publishers. ISBN: 978-1-5708-513-2.

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 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:**

Safety and Regulations

General Laboratory Procedures and Equipment

Aseptic Technique and Working with Microorganisms

Prokaryote and Eukaryote Structure

Molecular Biology

Antibiotics

Restriction Endonucleases

CRISPR Technology

Mapping of Lambda DNA and a Bacterial Plasmid

Transformation

Conjugation

Transduction

Electroporation

Yeast: Culture, Life Cycle, and Genetics

*Caenorhabditis* *elegans*: Culture, Life Cycle, Genetics.

RNA Interference

*Sordaria sp*. : Culture, Life Cycle, and Genetics

Molecular Genetic Identification of a *Halobacterium salinarium* Phenotype

Recombinant DNA Production of a Protein followed by Protein Purification

**Week 1:** **Lecture**: Course Introduction and syllabus. Review the structure and general physiology of prokaryotic and eukaryotic cells (Chapter 2 in Thieman and Palladino). **Laboratory**: Basic Safety: (Chapters 9-12 in Laboratory Manual, Seidman and Moore) Review and practice aseptic techniques. Prepare different forms of media. Use micropipets, pipet controllers, and multiple channel micropipets (Chapter 20 in Laboratory Manual, Seidman and Moore). Perform a simple DNA extraction from a microorganism. Use a spin column in a DNA extraction.

**Week 2:** **Lecture**: Biochemistry Review (Chapter 2 in Thieman and Palladino). (Chapters 4-7 in Alberts) **Laboratory**: Culture bacteria: Start a streak plate, bacterial lawn, tube slant, and liquid culture. Perform a gram stain of bacteria. Begin the transformation of bacteria to produce green fluorescent protein.

**Week 3:** **Lecture**: Molecular Genetics including chromosome structure, DNA and RNA structure; DNA replication, transcription and translation into protein; prokaryote and eukaryote gene regulation (Chapter 2 in Thieman and Palladino). (Chapters 4-7 in Alberts). **Laboratory**: Continue the transformation experiment. Separate and purify Green Fluorescent Protein from the transformation experiment.

**Week 4:** **Lecture**: Microbial Biotechnology, Restriction Endonucleases, CRISPR Technology. (Chapter 5 in Thieman and Palladino). **Laboratory**: Perform restriction analysis of Bacteriophage Lambda DNA.

**Week 5:** **Lecture**: Recombinant DNA Technology and Genomes (Chapters 3 and 5 in Thieman and Palladino). **Laboratory:** Use PCR to identify a DNA segment that predicts a readily observable phenotype in *Halobacterium sp.*

**Week 6:** **Lecture**: Recombinant DNA Technology and Genomes (Chapters 3 and 5 in Thieman and Palladino)(Chapter 8 in Alberts). **Laboratory**: Use Southern Blot Hybridization to identify a sequence within the bacteriophage lambda. Begin studies of *Caenorhabditis elegans* andprepare for RNA interference experiment.

**Week 7:** **Lecture**: *Caenorhabditis elegans* (pp. 1321-1328 in Alberts). RNA interference (Chapter 2,3,11 in Thieman and Palladino)(pp. 495-497 and 571-572 in Alberts). **Laboratory**: Culture and study *Caenorhabditis elegans*. Identify stages of the worm and the major organs visible. Demonstrate RNA Interference in the worm, *Caenorhabditis elegans*.

**Week 8:** **Lecture**: *Caenorhabditis elegans* (pp. 1321-1328 in Alberts). RNA interference (Chapter 2,3,11 in Thieman and Palladino)(pp. 495-497 and 571-572 in Alberts). **Laboratory**: Continue to Culture and study *Caenorhabditis elegans*. Continue the RNA Interference project in *Caenorhabditis elegans*.

**Week 9:** **Lecture**: Yeast (Chapter 5 in Thieman and Palladino)(Chapters 1 and 2 in Okafor). **Laboratory**: Finish RNA interference experiment. Clean and prepare table top fermenters for yeast fermentation. Culture, maintain and study yeast cultures. Use various types of media to grow yeast. Perform a monohybrid and or dihybrid cross using yeast.

**Week 10:** **Lecture**: Yeast (Chapter 5 in Thieman and Palladino)(Chapters 4 and 9 in Okafor). **Laboratory**: Culture, maintain, monitor, and study yeast cultures using a table top fermenter. Observe *Sordaria fimicola* and do a tetrad analysis.

**Week 11:** **Lecture**:Yeast (Chapter 5 in Thieman and Palladino)(Chapters 10, 11 and 20 in Okafor). **Laboratory**: Continue to study and culture yeast in the table top fermenter. Monitor conditions in the fermenter. Discuss downstream processing. When alcohol concentrations are sufficient, distil the alcohol and test the concentration and purity of the alcohol (Chapters 23-25 in Seidman and Moore).

**Week 12:** **Lecture:** Recombinant DNA Technology and Genomes (Chapters 3 and 5 in Thieman and Palladino). **Laboratory**: Observe past experiment results. Recombinant DNA technology: Insert a DNA fragment into a plasmid and transform bacteria. Observe gene expression. Isolate plasmids from these bacteria, cleave the plasmids with restriction enzymes, and analyze the restriction fragments using electrophoresis.

**Week 13:** **Lecture:** Recombinant DNA Technology and Genomes (Chapters 3 and 5 in Thieman and Palladino). **Laboratory**: Recombinant DNA technology continued. Continue experiment: Insert a DNA fragment into a plasmid and transform bacteria. Isolate plasmids from these bacteria, cleave the plasmids with restriction enzymes, and analyze the restriction fragments using electrophoresis.

**Week 14:** **Lecture**: Recombinant DNA Technology and Genomes (Chapters 3 and 5 in Thieman and Palladino). **Laboratory**: Bacterial Conjugation. Preparation for Bacterial Transduction.

**Week 15:** **Lecture**: **Lecture**: Recombinant DNA Technology and Genomes (Chapters 3 and 5 in Thieman and Palladino). **Laboratory**:Observe the bacterial conjugation experiment. Complete the bacterial transduction experiment. Give a group presentation of the different ways to genetically modify bacteria and how this is used in producing medicines.

**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.