1. **COURSE TITLE\*: Intermediate Biotechnology and Laboratory Science**
2. **CATALOG – PREFIX/COURSE NUMBER/COURSE SECTION\*: BTNL 1120**
3. **PREREQUISITE(S)\*: BTNL 1110 or BIOL 1101**

**COREQUISITE(S)\*:**

1. **COURSE TIME/LOCATION: (*Course Syllabus – Individual Instructor Specific*)**
2. **CREDIT HOURS\*: 4 LECTURE HOURS\*: 3**

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

1. **FACULTY CONTACT INFORMATION: *(Course Syllabus – Individual Instructor Specific)***
2. **COURSE DESCRIPTION\*:** This course studies and performs many of the fascinating technological applications of biotechnology to agriculture and aquaculture. This course will perform plant tissue culture from obtaining an explant in a sterile environment to forming a commercial enterprise for the sale of the mature plants.

 There will be a survey of currently used transgenic plants and animals in Ohio. This will include transgenic soy beans and corn. There will be an examination of the culture and use of algae in Ohio and an examination of Ohio aquaculture in general.

The course will discuss the use of recombinant DNA technology to produce genetically engineered plants and animals. Recombinant DNA technology will be applied to transfer genetic material into plants using *Agrobacterium tumefaciens.* PCR will be used to test for and identify the presence of genetically modified organisms (GMOs) in grocery store products. Genetic use restriction technology (GURT) will be evaluated.

Biotechnology is used to identify and verify strains and pedigrees. A plant variant will be identified using molecular biological methods.

The mammalian immune system will be studied. There will be an examination of the application of principles of immunology to the production of vaccines, medical and veterinary tests, and quality control tests for food purity; a diagnostic immunoblot will be constructed and used. The production of monoclonal antibodies for pharmaceuticals will be investigated. The use of farm animals in Ohio to produce antibodies will be examined. The use of plants in Ohio such as tobacco to produce antibodies will be discussed.

Algae will be maintained in a bioreactor. Fish maintenance and culture will be studied.

 Animal tissue culture will be studied and performed.

The purity of agricultural products will be analyzed using Visible Spectrophotometry,

 UV Spectrophotometry, and NIR Spectrometry.

1. **LEARNING OBJECTIVES\*:**

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

1. Discuss the origins of the word, biotechnology, in 1917 from the writings of Karl Ereky (1878-1952) in the context of agriculture and food science.

2. Explain the importance of agricultural developments in the supply of food to the world, and in biotechnological applications such as the production of alcohol and medicines.

3. Describe different areas of agricultural biotechnology and laboratory science such as plant biotechnology, animal biotechnology, food science, and aquaculture.

 4. Describe and apply proper safety procedures for laboratory and field work.
 5. Explain how to work safely with biological and chemical materials.

6. Explain regulations and recommendations concerning biotechnology and laboratory science from the U.S. Department of Agriculture, The Animal and Plant Health Inspection Service (APHIS), the Environmental Protection Agency, the U.S. Food and Drug Administration (FDA), and the Centers for Disease Control (CDC).

 7. Use basic statistical measures such as mean, median, mode, variance, and

 standard deviation to describe data.

 8. Use the basic laws of probability to analyze genetic and laboratory data.

 9. Explain the use of the standard curve for analysis of laboratory data. Perform

 basic hypothesis testing using probability and statistical methods. Explain different types of error in statistical methods and hypothesis testing.

 10. Use line, bar, and pie graphs to present laboratory data. Plot data from

 experiments and predict values using the plot.

11. Use the principles of Mendelian genetics for pedigree analysis and the prediction of future offspring of plants and animals.

12.Review the structure of the prokaryote chromosome, eukaryote chromosome, and bacterial plasmid. Review the structure of DNA. Review the processes of DNA replication, transcription, and translation. Review prokaryote and eukaryote gene regulation. Discuss the function of promoters and the use of promoters when using recombinant DNA methods. Investigate the molecular requirements for gene expression. Investigate the action of enzymes.

13. Explain the different tests including those using molecular biology to identify a particular plant or animal strain or particular pedigree.

 14. Describe the components of blood including plasma and formed elements. Explain the function of each cellular component. Identify the cells using a microscope.

15. Describe the immune system including the action of leukocytes. Explain the structure of an antibody and how it reacts with antigen. Discuss the clonal selection theory of antibody production. List the different antibody types and the primary function of each type.

16. Explain the production of vaccines. Explain how antibodies are produced against rattle snake venom. Explain natural and artificial, active and passive immunity.

17. Describe the modern production of antibodies in goats, rabbits and other organisms. Explore how some farms with goats and rabbits produce different forms of antibodies. Describe the economic value of these farms for the farmers and community. Explore How can this type of farming can be established in the local area.

 18. Explain how antibodies are used to make tests for diseases in man and animals. With the help of a veterinarian review some of the latest tests using immunology.

19. Perform an immunodiffusion test, ELISA, and make and perform an immunoblot test. Explain the medical and commercial significance of the ELISA and immunoblot in human and veterinary medicine.

 20. Use an immunodiffusion test to identify impurities in meat products.

21. Describe how Idex Corporation started as a tiny laboratory making immunologic tests for veterinary medicine and is now a large multinational company. Describe the process of starting a small biotechnology company and how a trained individual can start a company in the local area.

22. Explain the general processes associated with recombinant DNA technology. Discuss many of the different genetically modified organisms including “FlavRSavR” Tomatoes, “Golden Rice,” “BT Corn,” and “Roundup Ready” crops. Describe “pharming” in which plants and animals are genetically modified to produce pharmaceuticals such as insulin made by the safflower, or the anithrombic protein, Atryn, made in milk from genetically engineered goats. Discuss the production of ZMapp which is used to assist Ebola disease patients.

23. With the help of experts in agriculture review the latest transgenic plant and animal strains including the most recent corn and soy strains available for use on the farm. Visit a farm or seed supply that uses genetically modified plants.

24. Explore he production of genetically modified organisms. Explain the use of restriction enzymes to cut plasmids, the insertion of desired genes, use of particular promoters, introduction of the recombinant plasmid into a bacterium and the production of useful products.

 25. Discuss the use of corn and other plants to make commercial alcohol. Visit the local commercial alcohol plant. Examine and monitor a working yeast fermenter.

 26. Discuss the use of algae to produce biofuel. Observe and monitor an algae bioreactor.

 27. Describe the introduction of desired genes into plants to form recombinant organisms to produce useful products and medicines. Explain the process of using *Agrobacterium tumefaciens* to form genetically engineered plants.

 28. Transfer genetic material into a plant by using *Agrobacterium tumefaciens.*

29. Describe animal and plant tissue culture.

30. Perform plant and animal tissue culture. Use a tissue culture hood and sterile technique. Use various plant hormones to promote development and growth of plants. As a group project take the plants from tissue culture to sale. Discuss legal issues associated with plant tissue culture. Explain the commercial value of tissue culture, accounting and business practice, and how this technology can be used by the local farming community.

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-13: 978-0-321-57014-7

*Plants from Tubes*. *An Introduction to Micro-Propagation*. 2013. Lydiane Kyte, John Kleyn, Holly Scoggins, Mark Bridgen. Portland: Timber Press.

ISBN: 978-1-60469-206-8.

 The Plant Propagator's Bible. Miranda Smith. 2007. Emmaus, Pennsylvania: Rodale. ISBN-13: 978-1-59486-448-3

**9a: SUPPLEMENTAL TEXTS APPROVED BY FULL TIME DEPARTMENTAL FACULTY (INSTRUCTOR MUST NOTIFY THE BOOKSTORE BEFORE THE TEXTBOOK ORDERING DEADLINE DATE PRIOR TO ADOPTION) \*\*\*.**

1. **OTHER REQUIRED MATERIALS: (SEE APPENDIX C FOR TECHNOLOGY REQUEST FORM.)\*\***

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. Technical information from agricultural organizations and companies will be distributed.

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)***

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.

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| --- | --- | --- |
| *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 OR COURSE FORMAT: *(Course Syllabus – Individual Instructor Specific)***

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.

1. **COURSE OUTLINE: *(Course Syllabus – Individual Instructor Specific)***

Laboratory Safety Review

Laboratory Regulations Review

Basic Laboratory Equipment and Procedures Review

 Mathematics Review; Graphing

 Introduction to Probability and Statistics

 Review of Molecular Biology including the Structure and Function of Enzymes

 Plant Structure and Physiology

 Plant Cultivation and Tissue Culture

 Animal Tissue Culture

 Location and isolation of Cell Organelles

 Using *Agrobacterium tumefaciens* to insert genetic material into plants

 Identification of a Plant Variety by PCR

Transgenic Organisms, “Genetically Modified Organisms” (GMOs), An Overview

 Transgenic Organisms, Some Legal and Ethical Issues

 Transgenic Plants and Animals, A Commercial Survey

 The Use of Transgenic, “Genetically Modified” Crop Plants Including Soy Beans and Corn in Ohio Farms

 Transgenic Animals in Ohio, Including the Production of Pharmaceuticals

 Identification of the Presence of Genetically Modified Organisms (GMOs)

 in Food by PCR

 Veterinary Medicine and Laboratory Testing

 Immunology Overview

Immunological Testing: Immunodiffusion, ELISA, Immunoblot, Immunoelectrophoresis

 Fermentation and Commercial Alcohol Production

 Aquaculture a form of Agriculture Including Fish and Algae

 Instrumentation, the Visible Spectrophotometer, Quality Control of Agricultural Products

Instrumentation, the Ultraviolet Spectrophotometer, Quality Control of Agricultural Products

 Instrumentation, the NIR Spectrometer, Quality Control of Agricultural Products.

Instrumentation, the Plate Reader for Enzyme Linked Immunosorbent Assay (ELISA)

**Week 1:** **Lecture**: Course Introduction and syllabus. Plant Biotechnology: (Chapters 1 and 6 in Thieman and Palladino). **Laboratory**: Review basic laboratory safety: (Chapters 9,10 in Laboratory Manual, Seidman and Moore) Plant Tissue Culture:(Chapter 1 and 2 in *Plants* *from Test Tubes*.) Review aseptic technique. Prepare solutions and other materials for plant tissue culture.

**Week 2:** **Lecture**: Plant Biotechnology: (Chapter 6 in Thieman and Palladino). **Laboratory**: Chemical Safety Review: (Chapter 11, Seidman and Moore) Basic statistical analysis of data (Chapter 16 Laboratory Manual, Seidman and Moore). Culture plant tissue (Chapters 3, 4 and 7 in *Plants* *from Test Tubes*) . Use a tissue culture hood and clean room.

**Week 3:** **Lecture**: Transgenic Plants. Chloroplast Engineering. (Chapter 6 in Thieman and Palladino). **Laboratory**: Continue the plant tissue culture project. Throughout the semester monitor the development of the cultures, administer plant hormones as required (Chapter 10 in *Plants* *from Test Tubes*)., change and isolate individual plants as needed. Throughout the semester work as a group to prepare a plan to use plant tissue culture in a commercial enterprise (Chapter 12 in *Plants* *from Test Tubes*). Discuss the science of tissue culture, scale up the process, study accounting procedures, understand legal issues including those of proprietary strains, and understand how to market the plants.

**Week 4:** **Lecture**: Transgenic Plants (Chapter 6 in Thieman and Palladino).**Laboratory**: Locate peroxidases in plant tissues. Isolate Chloroplasts, Mitochondria, and Genomic DNA from plant tissue. Instrumentation: Use the UV spectrophotometer to determine DNA concentration and purity of some of the isolated DNA; use a positive and negative control in the analysis. (Chapter 25, Seidman and Moore)

**Week 5:** **Lecture**: Recombinant DNA Technology and Genomes (Chapters 3 and 6 in Thieman and Palladino). An overview of biotechnology and agricultural regulations (Chapter 12 in Thieman and Palladino and handouts). Laboratory: Insert genetic material into a plant using *Agrobacterium tumefaciens.* Throughout the semester, screen the plants for gene expression.

**Week 6:** **Lecture**: Animal Biotechnology, Animals in Research. (Chapter 7 in Thieman and Palladino). **Laboratory**: Identify a phenotypic variant of *Arabidopsis thaliana* using PCR.

 **Week 7:** **Lecture**: Animal Biotechnology, Transgenic Animals. (Chapter 7 in Thieman and Palladino). **Laboratory**: Visit a veterinary clinic laboratory, seed consultant facility, farm, biofuel or other biotechnology or laboratory related site.

**Week 8:** **Lecture**: Animal Biotechnology, Transgenic Animals. Knoockouts. (Chapter 7 in Thieman and Palladino). **Laboratory**: Principles of Animal Tissue Culture. Culture animal cells.

**Week 9:** **Lecture**: Animal Biotechnology, Animal Cloning. (Chapter 7 in Thieman and Palladino). **Laboratory**: Principles of Animal Tissue Culture. Continue the animal tissue culture project. Throughout the semester examine and test the cultures for growth, viability, and contaminants.

**Week 10:** **Lecture**: The Immune System, an overview. (Chapter 7 in Thieman and Palladino). Investigate commercial farms with animals that produce antibodies for pharmaceutical purposes. Discuss the start and development of commercial immunology companies such as Idex. Laboratory: Perform a slide agglutination test, immunodiffusion assay, and an ELISA. Instrumentation: use a plate reader to evaluate ELISA samples.

**Week 11:** **Lecture**: Agricultural and Food Biotechnology. The PCR process. **Laboratory**: Veterinary and medical serologic disease diagnosis with the immunoblot test. Construct and use a diagnostic immunoblot.

**Week 12:** **Lecture**: Aquaculture. Transgenic Fish. Antifreeze Proteins (AFPs) and Antifreeze Protein molecular genetics. Green fluorescent protein (GFP) and Reporter Genes. (Chapter 10 in Thieman and Palladino). **Laboratory**: Use PCR to identify genetically modified organisms (GMOs) present in grocery store products.

**Week 13:** **Lecture**: Aquaculture. Overview of genetically engineered fish and shellfish. Overview of genetically modified species being developed and tested for use in aquaculture (Chapter 10 in Thieman and Palladino). Laboratory: Observe and help maintain Zebra Fish and genetically engineered fluorescent fish. Test the aquarium water for temperature, pH, and waste. Identify different species of commercial fish.

**Week 14:** **Lecture**: The Harvesting and Culture of Algae. (Chapters 6 and 10 in Thieman and Palladino). **Laboratory**: Brief overview of bioreactor types. Observe algal growth in bioreactors, take readings of temperature, pH, nutrient concentration and waste concentration. Briefly discuss the production of biofuel.

**Week 15:** **Lecture**: Making useful products from algae. (Chapters 6 and 10 in Thieman and Palladino) **Laboratory**: Continue the plant tissue project as needed. Continue to observe the animal cell cultures, observe the transgenic plants for expression of the desired products. Give a group presentation of the observed results from these experiments.

 **Week 16: Final Examination**

1. **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.

**SYLLABUS TEMPLATE KEY**

**\*** Item cannot be altered from that which is included in the master syllabus approved by the Curriculum Committee.

**\*\*** Any alteration or addition must be approved by the Curriculum Committee

**\*\*\*** Item should begin with language as approved in the master syllabus but may be added to at the discretion of the faculty member.