# School District of Marshfield Course Syllabus

**Course Name: ES Biotechnology**
**Grade(s): 10-12**
**Length of Course: Semester**
**Credit: 1/2 Credit**

## Program Goal:

The School District of Marshfield Agriculture Education Program will provide learners the opportunity to explore and develop interests in various areas of agriculture while preparing young adults for their next steps in life. Whether it is pursuing a postsecondary education or entering the world of work, Marshfield's agriculture program offers diverse experiences for all students in agriculture, horticulture and natural resources. Marshfield's agriculture program will provide valuable learning experiences for all learners whether they want to learn more about the importance of agriculture on society, have a hobby related to agriculture or are preparing for an agriculture related career.

## Course Description:

ES Biotechnology is an equivalent science course that explores the everchanging world of agricultural. Hands-on classroom investigations will include gene splicing, DNA extraction, DNA fingerprinting, forensics, tissue culturing, and PCR testing. Use the electrophoresis lab and

greenhouse as tools to study DNA. Participate in a field trip to UW-Madison Biotechnology Center and other labs to tour cutting-edge facilities and use them to complete lab activities.

| **Wisconsin Standards for Agriculture, Food and Natural Resources (AFNR)** | |
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| **Animal Systems (AS)** | |
| **AS2:** Students will classify, evaluate, select and manage animals based on anatomical and physiological characteristics. | |
| **Apply principles of comparative anatomy and physiology to uses within various animal systems.**<br>AS2.b | 2.b.7.h: Detail the processes and application of meiosis and mitosis in animal growth, development, health and reproduction. |
| **AS5:** Students will evaluate and select animals based on scientific principles of animal production. | |
| **Evaluate the male and females reproductive systems in selecting animals.**<br>AS5.a | 5.a.3.h: Describe the functions of major organs in the male and female reproductive systems.<br>5.a.4.h: Select breeding animals based on characteristics of the reproductive organs. |
| **Apply scientific principles in the selection and breeding of animals.**<br>AS5.d | 5.d3.h: Explain the advantages of using genetically superior animals in the production of animals and animal products. |
| **Compare and contrast scientific methods associated with animal reproduction.**<br>AS5.f | 5.f.6.h: Explain the processes of natural and artificial breeding methods.<br>5.f.9.h: Explain the processes of major reproductive management practices, including estrous synchronization, superovulation, flushing and embryo transfer.<br>5.f.10.h: Perform procedures for estrous synchronization, superovulation, flushing, embryo transfer and other reproductive management practices.<br>5.f.11.h: Explain and demonstrate the materials, methods and processes of artificial insemination. |
| **AS6:** Students will prepare and implement animal handling procedures for the safety of animals, producers and consumers of animal products. | |
| **Formulate feed rations to provide for the nutritional needs of animals.**<br>AS6.b | 6.b.4.h: Discuss consumer concerns with animal production practices relative to human health. |
| **Biotechnology Systems (BT)** | |
| **BT1:** Students will recognize the historical, social, cultural and potential applications of biotechnology. | |
| **Distinguish major innovators, historical developments and potential applications of biotechnology in agriculture.**<br>BT1.a | 1.a.5.h: Create a timeline and use it to explain the developmental progression of biotechnology.<br>1.a.6.h: Research and report on current work being done in agricultural biotechnology.<br>1.a.7.h: Research and report on emerging problems and issues associated with agricultural biotechnology. |

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| **Analyze the ethical, legal, social and cultural issues relating to biotechnology.**<br>BT1.b | 1.b.7.h: Interpret the major regulatory issues related to biotechnology.<br>1.b.8.h: Evaluate the benefits and risks associated with biotechnology.<br>1.b.9.h: Examine an ethical dilemma associated with biotechnology by identifying its components.<br>1.b.l0.h: Examine intellectual properties associated with biotechnology by defining their components. |
| **BT2:** Students will demonstrate laboratory skills as applied to biotechnology. | |
| **Demonstrate safe and proper laboratory procedures and record keeping using biological materials.**<br>BT2.a | 2.a.13.h: Analyze strengths of the research based on data and procedures and propose future investigation.<br>2.a.14.h: Operate advanced laboratory equipment and measurement devices.<br>2.a.15.h: Demonstrate advanced aseptic techniques in the biotechnology laboratory.<br>2.a.16.h: Select an appropriate standard operating procedure for working with biological materials. |
| **Perform microbiology, molecular biology, enzymology and immunology procedures.**<br>BT2.b | 2.b.12.h: Isolate, maintain, quantify and store cell cultures.<br>2.b.13.h: Explain the molecular basis for heredity and the tools and techniques used in DNA and RNA manipulations.<br>2.b.14.h: Perform electrophoresis techniques and interpret electrophoresis fragmentation patterns.<br>2.b.17.h: Research and describe the use of biotechnology to detect microbes. |
| **Evaluate the application of genetic engineering to improve products of AFNR systems.**<br>BT2.c | 2.c.7.h: Diagram the processes and describe the techniques used to produce transgenic eukaryotes.<br>2.c.8.h: Describe processes by which enzymes are produced through biotechnology.<br>2.c.9.h: Diagram the process by which organisms are genetically engineered for waste treatment. |
| **Perform biotechnology processes used in AFNR systems.**<br>BT2.d | 2.d.13.h: Describe the processes used to produce animal hormones from transgenic organisms.<br>2.d.14.h: Compare and contrast bioengineering and conventional pathways used in food processing.<br>2.d.15.h: Describe the process used in producing alcohol from biomass.<br>2.d.16.h: Diagram the process used in producing biodiesel from biomass.<br>2.d.17.h: Assess the characteristics of biomass that make it useful for biofuels production.<br>2.d.18.h: Illustrate the process used in producing methane from biomass. |

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| **Use biotechnology to monitor and evaluate procedures performed in AFNR systems.**<br>BT2.f | 2.f.14.h: Select biotechnology tools used to monitor and direct<br>plant breeding.<br>2.f.15.h: Assess the benefits, risks and opportunities associated with using biotechnology to promote animal health.<br>2.f.16.h: Describe the use of biotechnology in bioremediation.<br>2.f.17.h: Describe the processes involved in bio treatment of biological wastes and industrial chemical wastes. |
| **Food Production and Processing (FPP)** | |
| **FPP1:** Students will examine components of the food industry and historical development of food products and processing. | |
| **Evaluate the significance and implications of changes and trends in the food products and processing industry.**<br>FPP1.a | 1.a.5.h: Evaluate changes and trends in the food products and processing industry and be able to predict trends and implications in the food products and processing industry.<br>1.a.6.h: Determine appropriate industry response to consumer concerns to assure a safe and wholesome food supply. |
| **Wisconsin Common Career Technical Standards (WCCTS)** | |
| **Creativity, Critical Thinking, Communication and Collaboration (4C)** | |
| **4C1:** Students will think and work creatively to develop innovative solutions to problems and opportunities. | |
| **Develop original solutions, products and services to meet a given need.**<br>4C1.a | 1.a.7.h: Develop original ways to solve a given problem.<br>1.a.9.h: Apply past experiences to current problems in developing innovative solutions. |
| **Work creatively with others to develop solutions, products and services.**<br>4C1.b | 1.b.9.h: Work as part of a team to improve an existing product or process. |
| **4C2:** Students will formulate and defend judgments and decisions by employing critical thinking skills. | |
| **Develop effective resolutions for a given problem, decision or opportunity using available information.**<br>4C2.a | 2.a.16.h: Defend an action taken or a decision implemented. |
| **4C3:** Students will communicate and collaborate with others to accomplish tasks and develop solutions to problems and opportunities. | |
| **Work collaboratively with others.**<br>4C3.b | 3.b.7.h: Participate in group processes to generate consensus.<br>3.b.8.h: Lead group processes to generate consensus.<br>3.b.9.h: Incorporate the use of technology to productively plan, implement and evaluate a solution, process or procedure. |
| **Career Development (CD)** | |
| **CD1:** Students will consider, analyze and apply an awareness of self, identity and culture to identify skills and talents. | |

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| **Identify person strengths, aptitudes and passions.**<br>CD1.a | 1.a.3.h: Evaluate various occupations and career pathways to identify personal, academic and career goals based on personal strengths, aptitudes and passions. |
| **CD2:** Students will identify the connection between educational achievement and work opportunities in order to reach personal and career goals. | |
| **Apply academic experiences to the world of work, inter-relationships and the community.**<br>CD2.a | 2.a.4.h: Determine those opportunities that best support attainment of a specific career goal. |
| **Assess attitudes and skills that contribute to successful learning in school and across the life span.**<br>CD2.b | 2.b.7.h: Interpret and analyze the impact of current education, training and work trends on life, learning and career plans.<br>2.b.8.h: Assess education and training opportunities to acquire new skills necessary for career advancement. |
| **CD3:** Students will create and manage a flexible and responsive individualized learning plan to meet their career goals. | |
| **Investigate the world of work in order to gain knowledge of self in order to make informed career decisions.**<br>CD3.a | 3.a.12.h: Evaluate changes in local, national and global employment trends, societal needs and economic conditions related to career planning. |
| **Examine and evaluate opportunities that could enhance life and career plans and articulate plan to guide decisions and actions.**<br>CD3.b | 3.b.5.h: Evaluate the relationship between educational achievement and career development. |
| **CD4:** Students will identify and apply employability skills. | |
| **Develop positive relationships with others.**<br>CD4.d | 4.d.5.h: Participate in cocurricular and community activities to enhance the school experience. |
| **Information, Media and Technology Skills (IMT)** | |
| **IMT1:** Students will access, interpret and evaluate information from a variety of sources in order to inform and support premises, arguments, decisions, ideas and initiatives. | |
| **Determine the relevance, validity and timeliness of data and information.**<br>IMT1.b | 1.b.7.h: Use raw data and information appropriately to support an argument, idea or initiative.<br>1.b.9.h: Defend a position or decision using relevant, valid and timely data and information. |
| **Select relevant information necessary for making decisions and solving problems.**<br>IMT1.c | 1.c.5.h: Defend a solution or conclusion using appropriate data and information.<br>1.c.6.h: Interpret and select appropriate information to develop a resolution for a given situation. |
| **IMT2:** Students will apply information literacy skills to access and evaluate media to design and produce media products. | |
| **Analyze media messages to determine biases and objectivity.**<br>IMT2.a | 2.a.9.h: Portray information in different ways to account for different audiences. |

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| **IMT3:** Students will use available information and communication technology to improve productivity, solve problems and create opportunities. | |
| **Adopt new technological tools to increase personal and organizational productivity.**<br>IMT3.a | 3.a.10.h: Integrate technological tools to efficiently create and manage correspondence in daily activity.<br>3.a.12.h: Manage use of technology to reduce negative impacts on productivity. |
| **Select and use communication and information technology to help solve problems and provide opportunities.**<br>IMT3.b | 3.b.7.h: Use communication and information technology to effectively solve a given problem. |
| **Leadership (LE)** | |
| **LE1:** Students will apply leadership skills in real-world, family, community and business and industry applications. | |
| **Identify the role of community service and service learning in family, community and business and industry.**<br>LE1.c | 1.c.6.h: Assess the roles and responsibilities of citizenship and formulate an activity or event to showcase community service.<br>1.c.7.h: Plan a community service event, participate in the event and evaluate its impact.<br>1.c.8.h: Plan and participate in activities that rate skills necessary to be a successful leader and citizen. |
| **Wisconsin Standards for Science (SCI)** | |
| **Crosscutting Concepts (CC)** | |
| **CC3:** Students use science and engineering practices, disciplinary core ideas, and an understanding of ***scale, proportion and quantity*** to make sense of phenomena and solve problems. | |
| **Scale, Proportion, and Quantity** | CC3.h: Students understand the significance of a phenomenon is dependent on the scale, proportion, and quantity at which it occurs. They recognize patterns observable at one scale may not be observable or exist at other scales, and some systems can only be studied indirectly as they are too small, too large, too fast, or too slow to observe directly. They use orders of magnitude to understand how a model at one scale relates to a model at another scale. They use algebraic thinking to examine scientific data and predict the effect of a change in one variable on another (e.g., linear growth vs. exponential growth). |
| **Life Science (LS)** | |
| **LS1:** Students use science and engineering practices, crosscutting concepts, and an understanding of ***structures and processes (on a scale from molecules to organisms)*** to make sense of phenomena and solve problems. | |
| **Structure and Function**<br>LS1.A | LS1.A.h: Systems of specialized cells within organisms help perform essential functions of life. Any one system in an organism is made up of numerous parts. Feedback mechanisms maintain an organism's internal conditions within certain limits and mediate behaviors. |
| **Growth and Development of Organisms** | LS1.B.h: Growth and division of cells in organisms occurs by mitosis and differentiation for specific cell types. |

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| LS1.B | |
| **Information Processing**<br>LS1.D | LS1.D.h: Organisms can process and store a variety of information through specific chemicals and interconnected networks. |
| **LS3:** Students use science and engineering practices, crosscutting concepts, and an understanding of ***heredity*** to make sense of phenomena and solve problems. | |
| **Inheritance of Traits**<br>LS3.A | LS3.A.h: DNA carries instructions for forming species' characteristics. Each cell in an organism has the same genetic content, but genes expressed by cells can differ. |
| **Variation of Traits**<br>LS3.B | LS3.B.h: The variation and distribution of traits in a population depend on genetic and environmental factors. Genetic variation can result from mutations caused by environmental factors or errors in DNA replication, or from chromosomes swapping sections during meiosis. |
| **LS4:** Students use science and engineering practices, crosscutting concepts, and an understanding of ***biological evolution*** to make sense of phenomena and solve problems. | |
| **Evidence of Common Ancestry and Diversity**<br>LS4.A | LS4.A.h: The ongoing branching that produces multiple lines of descent can be inferred by comparing DNA sequences, amino acid sequences, and anatomical and embryological evidence of different organisms. |
| **Engineering, Technology, and the Application of Science (ETS)** | |
| **ETS1:** Students use science and engineering practices, crosscutting concepts, and an understanding of engineering design to make sense of phenomena and solve problems. | |
| **Defining and Delimiting Engineering Problems**<br>ETS1.A | ETS1.A.h:<br>Criteria and constraints also include satisfying any requirements set by society, such as taking issues of risk mitigation into account, and they should be quantified to the extent possible and stated in such a way that one can tell if a given design meets them.<br><br>Humanity faces major global challenges today, such as the need for supplies of clean water and food or for energy sources that minimize pollution, which can be addressed through engineering. These global challenges also may have manifestations in local communities. |
| **Developing Possible Solutions**<br>ETS1.B | ETS1.B.h:<br>When evaluating solutions, it is important to take into account a range of constraints, including cost, safety, reliability, and aesthetics, and to consider social, cultural, and environmental impacts.<br><br>Both physical models and computers can be used in various ways to aid in the engineering design process. Computers are useful for a variety of purposes, such as running simulations to test different ways of solving a problem or to see which one is most efficient or economical. They are also useful in making a persuasive |

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| | presentation to a client about how a given design will meet his or her needs. |
| **Optimizing the Design Solution**<br>ETS1.C | ETS1.C.h: Criteria may need to be broken down into simpler ones that can be approached systematically, and decisions about the priority of certain criteria over others (trade-offs) may be needed. |
| **ETS2:** Students use science and engineering practices, crosscutting concepts, and an understanding of the ***links among Engineering, Technology, Science, and Society*** to make sense of phenomena and solve problems. | |
| **Interdependence of Science, Engineering, and Technology**<br>ETS2.A | ETS2.A.h: Science and engineering complement each other in the cycle known as research and development (R&D).<br><br>Many research and development projects may involve scientists, engineers, and others with wide ranges of expertise |
| **Influence of Engineering, Technology, and Science on Society and the Natural World.**<br>ETS2.B | ETS2.B.h:<br>Modern civilization depends on major technological systems, such as agriculture, health, water, energy, transportation, manufacturing, construction, and communications.<br><br>Engineers continuously modify these systems to increase benefits while decreasing costs and risks.<br><br>New technologies can have deep impacts on society and the environment, including some that were not anticipated.<br><br>Analysis of costs and benefits is a critical aspect of decisions about technology. |
| **ETS3:** Students use science and engineering practices, crosscutting concepts, and an understanding of the ***nature of science and engineering*** to make sense of phenomena and solve problems. | |
| **Science and Engineering are Human Endeavors**<br>ETS3.A | ETS3.A.h:<br>Individuals from diverse backgrounds bring unique perspectives that are valuable to the outcomes and processes of science and engineering.<br><br>Scientists' and engineers' backgrounds, perspectives, and fields of endeavor influence the nature of questions they ask, the definition of problems, and the nature of their findings and solutions.<br><br>Some cultures have historically been marginalized in science and engineering discourse.<br><br>Scientists and engineers embrace skepticism and critique as a community. Deliberate deceit in science is rare and is likely exposed through the peer review process. When |

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| | discovered, intellectual dishonesty is condemned by the scientific community. |
| **Science and Engineering Are Unique Ways of Thinking with Different Purposes**<br>ETS3.B | ETS3.B.h:<br>Science is both a body of knowledge that represents current understanding of natural systems and the processes used to refine, elaborate, revise and extend this knowledge. These processes differentiate science from other ways of knowing.<br><br>Science knowledge has a history that includes the refinement of, and changes to, theories, ideas and beliefs over time.<br><br>Science and engineering innovations may raise ethical issues for which science and engineering, by themselves, do not provide answers and solutions. |
| **Science and Engineering Use Multiple Approaches to Create New Knowledge and Solve Problems**<br>ETS3.C | ETS3.C.h:<br>Scientists use a variety of methods, tools and techniques to develop theories. A scientific theory is an explanation of some aspect of the natural word, based on evidence that has been repeatedly confirmed through observation, experimentation (hypothesis-testing), and peer review.<br><br>The certainty and durability of science findings varies based on the strength of supporting evidence. Theories are usually modified if they are not able to accommodate new evidence.<br><br>Engineers use a variety of approaches, tools, and techniques to define problems and develop solutions to those problems. Successful engineering solutions meet stakeholder needs and safety requirements and are economically viable. Trade-offs in design aspects balance competing demands. |

| **Key Vocabulary:** | | | |
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| agar | allele | antibody | aseptic technique |
| artificial insemination | autosome | biodegradation | bioethics |
| biohazard | biopharming | biomediation | catalyst |
| bovine somatotropin | cloning | crossbreeding | culture |
| DNA sequencing | DNA isolation | donor cell | electroporation |
| elisa test | explants | gel electrophoresis | gene therapy |
| gene transfer | genetic engineering | genome | GMO |
| plant tissue culture | in vitro fertilization | marker gene | microinjection |
| proteome | genomics | ultrasound | patent |

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| polymerase chain reaction | restriction enzyme analysis | human genome project | restriction endonuclease |
| recombinant DNA | pharmaceutical | ribosome | transcription |
| transformation | transgenic | translation | vector |

## Topics/Content Outline- Units and Themes:

# Course Outline:

- History of Biotechnology
  - Definitions & examples
  - Benefits of biotechnology
  - History of biotechnology
  - Safety with biotechnology
- Aseptic (Sterile) Technique
  - Importance to biotech research
  - Proper procedures
    - Lab
- DNA/Genetics
  - DNA structure
  - Heredity and genetics
  - Protein synthesis
  - Genetic transformation
    - Lab
- Plant Tissue Culture
  - Definitions, terms and how to
  - Role of nutrients in culture media
  - Plant hormones
  - Care of plant tissue culture experiments
  - Role of plant tissue culture in biotechnology companies and new products
    - Lab
- Animal Reproductive Biotechnology
  - Artificial insemination
  - Embryo transfer
  - Cloning
  - Ultrasounding
- Electrophoresis
  - Purpose, equipment and procedure
  - Use of restriction enzymes
  - DNA fingerprinting
    - Lab
  - DNA sequencing
    - Lab
  - Polymerase chain reaction
    - Lab

- Biotechnology in Food Science
  - History of fermentation
  - Anaerobic fermentation
  - Use of rennin in producing cheese
  - Biotechnology food uses
    - Labs – yogurt/cheese
- Immunology
  - Antibody and antigen relationships
  - Medical uses
    - Lab
- Ethics
  - Should biotech be used, where, when and what limits should be imposed?
  - Who should and who does regulate?
- Biotechnology Careers
  - Career opportunities in Wisconsin
  - Education requirements for various biotech careers

## Primary Resource(s):

**Introduction to Biotechnology, 2nd Edition**
Cengage Learning
ISBN: 978-143-5498-37-2