TN Department of Education | Postsecondary, Workforce, CTE, and Military Readiness

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Agriscience Technologies

Primary Career Cluster:	Agriculture
Course Contact:	CTE.Standards@tn.gov
Course Code:	C18H27
Prerequisite:	Agriscience (C18H17)
Credit:	1
Grade Level:	10
Elective Focus - Graduation Requirements:	This course satisfies one of three credits required for an elective focus when taken in conjunction with other Agriculture courses.
POS Concentrator:	This course satisfies one out of two required courses to meet the Perkins V concentrator definition when taken in sequence in the approved program of study.
Programs of Study (POS) Sequence:	This is the second course in the *Technology in Production Agriculture* program of study.
Aligned Student Organization(s):	FFA: http://www.tnffa.org
Coordinating Work-Based Learning:	All Agriculture students are encouraged to participate in a Supervised Agricultural Experience (SAE) program. In addition, teachers who hold an active WBL certificate may offer placement for credit when the requirements of the state board's WBL Framework and the Department's WBL Policy Guide are met. For information, visit https://www.tn.gov/education/educators/career-and-technical-education/work-based-learning.html
Promoted Tennessee Student Industry Credentials:	Credentials are aligned with postsecondary and employment opportunities and with the competencies and skills that students acquire through their selected program of study. For a listing of promoted student industry credentials, visit https://www.tn.gov/education/educators/career-and-technical-education/student-industry-certification.html
Teacher Endorsement(s):	048, 150, 448, and 950
Required Teacher Certification:	None
Required Teacher Training:	None
Teacher Resources:	https://www.tn.gov/education/educators/career-and-technical-education/career-clusters/cte-cluster-agriculture-food-natural-resources.html

Course at a Glance

CTE courses allow students to develop specific academic, technical, and 21st-century skills necessary to succeed in their careers and lives. In pursuit of ensuring every student in Tennessee achieves this level of success, we begin with rigorous course standards that feed into intentionally designed programs of study.

Students engage in industry-relevant content through general education integration and experiences such as career & technical student organizations (CTSO) and work-based learning (WBL). Through these experiences, students are immersed with industry-standard content and technology, solve industry-based problems, meaningfully interact with industry professionals, and use/produce industry-specific, informational texts.

Using a Career and Technical Student Organization (CTSO) in Your Classroom

CTSOs are a great resource to turn classroom learning into real-life experiences for your students through classroom, regional, state, and national competitions, and leadership opportunities. Below are CTSO connections for this course. This is not an exhaustive list.

- Participate in the CTSO Fall Leadership Conference to engage with peers by demonstrating logical thought processes and developing industry-specific skills that involve teamwork and project management.
- Participate in FFA career and leadership events (CDE/LDE) that align with this course, including Agriscience Fair, Agricultural Communications, Agricultural Issues, Agronomy, Agriculture Technology and Mechanical Systems, Farm and Agribusiness Management, Employment Skills, Extemporaneous Speaking, Marketing Plan, Nursery Landscape, Parliamentary Procedure, and Public Speaking.

Using Work-Based Learning (WBL) in Your Classroom

Sustained and coordinated activities that relate to the course content are key to successful work-based learning. Possible activities for this course include the following. This is not an exhaustive list.

- **Standards 1.1** | Conduct an informational interviews with an agricultural industry partner.
- **Standards 3.1-3.4** | Tour heavy equipment operator or farm implement manufacturer.
- **Standards 3.5** | Review and discuss datasets provided by extension or local industry.
- **Standards 6.1** | Partner with local business for the course project.

Course Description

Agriscience Technologies is an applied science course that focuses on the use of scientific methods and data analysis to solve real-world problems. Emphasizing agricultural, food, and natural resource systems, this course provides students with hands-on experience in using technology and biology to address challenges in these fields. Students will develop a strong foundation in scientific principles and techniques, learning how to apply them to the development, implementation, and management of innovative solutions. Through practical application, students will gain insight into how science and technology can enhance agricultural practices and contribute to sustainable resource management.

By the end of this course, proficient students will be equipped with the knowledge and skills needed for continued success in the third-year course, *Precision Agriculture*, as well as further postsecondary education or training in related fields.

Course Standards

1. History of Emerging Technology

1.1 Early Industrial Discoveries: Outline the **historical, social, cultural, and potential applications of technology**. Recognize the **developments in biotechnology** that accompanied the Industrial Revolution. Explain the changes that occurred during the period defined as classical biotechnology.

1.2 Trends in Technology: Distinguish between **current and emerging applications of biotechnology in the food and fiber industry**.

1.3 Modern Technology: Examine **technological advancements** to analyze their impact in the workplace and explain how each advancement maximizes productivity.

1.4 Sustainable Technologies: Research, evaluate, and present the application of **agricultural innovations in farming,** including genetically engineered (GE) crops, precision agriculture, and conservation-based practices. Analyze case studies to determine how specific **technologies align with United States Department of Agriculture (USDA) sustainability criteria.**

2. Introduction to Biotechnology in Agriculture

2.1 Biotechnology in Agriculture: Research and outline the historical impact of **biotechnology in agriculture** including but not limited to:

a. developmental progression of biotechnology and how it has evolved scientific knowledge; and
b. current and emerging applications of biotechnology, along with alternative approaches to improve agriculture.
c. Compare and contrast the benefits and risks associated with using biotechnology to improve agriculture. Analyze emerging concerns and applications associated with agricultural biotechnology.

2.2 Food Processing: Explore **foods produced through fermentation**. Describe the process and **role of fermentation** in biotechnology applications, explain the study of microbiology and the

work of Louis Pasteur. Compare and contrast **bioengineering and conventional pathways used in food processing**.

2.3 Biofuels: Investigate the **products used in biofuels** and the importance of how **biotechnology optimizes renewable energy.** Analyze and communicate **the process used to produce methane and biodiesel from biomass**.

3. Economic, Occupational, and Technological Implications

3.1 Economic Implications: Evaluate and compare the general **economic impact biotechnology has on cost, efficiency, and profitability in production agriculture.** Map or chart the differences in the **economic outcomes** of conventional and biotech-based farming. Evaluate the role of biotechnology in global agricultural markets and food supply chains.

3.2 Innovations: Explain **key tools and techniques in the plant and animal industries** used in biotechnology. Investigate how technological advances are shaping the workforce demand. Research and communicate how **technological advancements contribute to innovation and problem-solving** in agriculture.

3.3 Business and SAE Financial Recordkeeping: Accurately maintain an active **recordkeeping system** and apply proper **accounting and financial records** as they relate to a large animal science **supervised agricultural experience (SAE) program or enterprise**. Demonstrate the ability to **summarize business records** such as individual enterprise budgets, profit and loss statements, inventory management, transportation costs, and other specific reports by completing SAE and related financial applications.

4. Laws and Regulations

4.1 Regulatory Agencies: Research and summarize the **agencies responsible for regulating biotechnology in agriculture**. Investigate the relationship between **regulatory agencies and the protection of public interests such as health, safety, and the environment**. Examine factors and data that regulatory agencies use to evaluate the potential risks a new application of biotechnology may pose to health, safety, and the environment.

4.2 US and Global Regulations: Discuss the **purpose and development of biotechnology regulation** in the United States and globally. Create a presentation to explain how countries with **different biotechnology regulatory systems impact trade and innovation**, including the following:

a. balance between regulation and innovation;
b. basic regulatory process and the challenges; and
c. regulatory issues related to health, safety, and the environment.

4.3 Laws: Research and present implications of **bioethics may have on future advancements in biotechnology** and associated fields. Research and present legal concerns related to biotechnology in agriculture, including protection of intellectual property through patents, copyright, and trademarks.

4.4 Policy: Create and propose a hypothetical **policy related to biotechnology** that could impact the current agriculture industry. Debate why this policy is necessary.

4.5 Health and Safety: Research and explain the **components** required for **health and safety performance plans** of bioethics. Investigate the **implications of bioethics on the agriculture industry**.

4.6 Environmental Compliance: Investigate and communicate **environmental compliance plans** in the agriculture industry. Create an environmental plan that includes **proactive measures for physical dangers and other risks, including financial risk** for a Supervised Agricultural Experience or a school-based enterprise.

5. Biotechnology and Sustainable Agriculture

5.1 Sustainable Technologies: Research, evaluate, and present **agricultural innovations,** including genetically engineered (GE) crops, precision agriculture, and conservation-based practices. Analyze case studies to determine how specific **technologies align with USDA sustainability criteria.**

5.2 Pharmaceuticals: Distinguish between **plant-based and animal-based pharmaceuticals**. Evaluate the process used to **produce pharmaceuticals from transgenic organisms** (e.g., hormones for animals). Research types of **pharmaceuticals developed for animals and humans through biotechnology**.

5.3 Bioproducts: Apply **biotechnology principles, techniques, and processes to produce bioproducts** (e.g., fermentation, transesterification, methanogenesis). Analyze the impact of the **production and use of bioproducts** on the environment.

5.4 Waste Management: Investigate the use of **natural organisms and genetically engineered organisms in the treatment of waste**. Communicate the importance of **microorganisms in biological waste treatment**.

5.5 Bioremediation: Research and create a model or use a model to explain how **bioremediation can be applied to clean up environmental contamination**.

6. Genomics and DNA Sequencing in Agriculture

6.1 Genetics: Create a timeline of **the historical development of the study of genetics,** including Mendel's experiments and their significance.

6.2 Genetic Inheritance: Apply **genetic principles to agricultural production**. Investigate and communicate **genetic inheritance in plants and animals**. Analyze **genetic defects and the diverse needs of breeding animals**. Predict **probable results of single or multiple trait crosses,** including the scientific research of: Mendelian Laws of Inheritance, The Law of Segregation, The Law of Independent Assortment, and The Law of Dominance.

6.3 Selective Traits: Research and report on the **techniques of selective breeding** processes in both plants and animals. Create a chart to evaluate **biotechnology principles of breeding techniques** (e.g., plant tissue culture, artificial insemination, semen sexing, embryo transfer, and cloning).

6.4 Scientific Research: Create a **timeline to exhibit changes in agricultural biotechnology** in the 19th century. Include the following:

a. hybridization and the impact of hybrids;
b. double crossbreeding changed plants;
c. technological advances led to genetic modification in modern agriculture; and
d. developments that led to the Green Revolution.

6.5 Breeding Technologies: Investigate the **various breeding technologies** (e.g., natural, estrous synchronization, artificial insemination, embryo transfer, sex selection). Use mathematical models to **communicate the benefits and disadvantages of reproductive management** (cost, labor, and equipment).

6.6 Breeding Values: Examine the use of **quantitative breeding values**, such as EPDs, performance records, and pedigrees, in the selection of genetically superior breeding stock. Use and create various **quantitative and qualitative breeding values to create a breeding program** for various scenarios in the agriculture industry.

6.7 DNA and RNA: Compare and contrast the **structures of DNA and RNA and investigate how genotype influences phenotype**. Extract and purify **DNA and RNA according to standard operating procedures**. Analyze and create a graphic to **explain factors that influence gene expression**.

6.8 Artificial Intelligence (AI): Investigate how **AI can improve breeding programs**. Examine the uses of **machine learning algorithms** and explain how these **practices can revolutionize breeding programs**.

7. Genetic Engineering

7.1 Modifications: Research how **organisms are genetically modified**. Evaluate and create a graphic to explain the impact, risks, and benefits of modified organisms on the natural environment. In class, students will take a stance and debate about the **role of GMOs in our food supply**. In class, students will debate the role of GMOs in our food supply.

7.2 Gene Altering: Create a graphic to explain the various ways to **alter genetics,** including mutation breeding, molecular marker-assisted breeding, genetic engineering, and genome editing.

7.3 Technology and Tools: Investigate and communicate how **modern technology and tools have modified production of agricultural products,** and their advantages include biological, agronomic, and economic reasons for genetic modification and genetic engineering.

7.4 Processes and Procedures: Research and create procedures about biotechnology principles, techniques, and processes to modify a species including **techniques and processes used to produce transgenic organisms** (e.g., microbial synthetic biology, gene knockout therapy, traditional gene insertion).

7.5 Genetic Research Project: Hypothetically create a **genetically engineered species to solve an agricultural problem**. Analyze the **data, including similarities and differences** between the original and new species, record the findings, and review dominant and recessive traits. Communicate how it is possible to determine if whether the traits you have researched are dominant or recessive and explain how future generations may be altered.

8. Management of Biological Materials, Chemicals, and Waste

8.1 Proper Handling: Characterize the **physical and biological properties of organisms**. Differentiate types of organisms and create a model to explain **safe handling to maintain organism purity and personal safety** (e.g., plant and animal tissue, cell cultures, microbes).

8.2 Equipment Procedures: Identify and apply **standard laboratory procedures and equipment maintenance to create and maintain reliable data**.

a. maintenance of laboratory equipment according to the standard operating procedures (e.g., calibration, testing, etc.);
b. proper operation of laboratory equipment and measurement devices to get accurate and repeatable results; and
c. sterilizing equipment in a laboratory according to standard operating procedures.

8.3 Hazards: Apply standard operating procedures for the **safe handling of biological and chemical materials in a laboratory,** including:

a. types of biological and chemical hazards;
b. personal protective equipment in a variety of situations; and
c. formulate solutions (e.g., proper labeling, dilution).

8.4 Handling, Storage, and Disposal: Apply standard operating procedures by **creating a protocol for biological and chemical materials in a laboratory to maintain reliable data**, including the following:

a. disposal of biological and chemical waste;
b. working with biological materials based on their classification; and
c. storage of solutions (e.g., temperature, volatility, neighboring solutions, light sensitivity).

9. Scientific Procedures & Data Science

9.1 Scientific Procedures: Discuss differences between **scientific law and scientific theories**.

9.2 Securing Data: Research and summarize the need for **data information security in the laboratory**. Maintain and interpret laboratory **records documented in a laboratory** to ensure

data accuracy and integrity (e.g., avoid bias, record any conflicts of interest, avoid misinterpreted results).

9.3 Record Keeping: Compare and contrast common **record-keeping methods used in research and/or commercial laboratories** (e.g., paper notebook, electronic notebook).

9.4 Team Project with Data Analysis: Design or build on a prior project or an agricultural experiment to solve a real-world problem. **Research and utilize the Engineering Design Process to design a solution**. Document the following steps in an engineering design notebook for inclusion in the program portfolio. When possible, connect the problem to an FFA Career Development Event. Apply advanced techniques of biotechnology and data science to create a solution including:

a. **Problem Identification**: Brainstorm specific problems and challenges within the program of study. Conduct basic research to understand the scope and implications of the identified problem. Identify one problem as a focus area.
b. **Research and Analysis**: Conduct in-depth research on chosen topics related to the problem. Locate and analyze a dataset related to the problem and explain methodologies and techniques.
c. **Review the Stages of the Engineering Design Process**: Define the problem, research, brainstorm solutions, develop prototypes, assess, and evaluate. Consider constraints such as cost, efficiency, and environmental impact during the design process.
d. **Project Implementation**: Assign specific roles within the design teams (e.g., project manager, researcher, designer, and tester). Design a solution tailored to address the identified problem or scenario. Document progress through design journals, sketches, diagrams, and digital presentations. (Note: Prototype is optional in the Year 2 course.)
e. **Presentation and Reflection**: Highlight the problem and solution to the class. Share the analyzed data and how it affected the solution. Discuss the design process and challenges. As a class, critically evaluate the effectiveness and feasibility of the solutions and propose potential improvements.

Standards Alignment Notes

References to other standards include:

- SAE for All: Evolving the Essentials: All Agriculture students are encouraged to participate in a Supervised Agricultural Experience (SAE) program to practice and demonstrate the knowledge and skills learned in their agriculture courses.
- AFNR: National Agriculture, Food, & Natural Resources (AFNR) Career Cluster Content Standards:
    - Note: While not directly aligned to one specific standard, students engaged in the activities outlined above should demonstrate fluency in Standards AS.01 and PS.01 at the course end.
- P21: Partnership for 21st Century Skills Framework for 21st Century Learning
    - Note: While not all standards are specifically aligned, teachers will find the framework helpful for setting expectations for student behavior in their classroom and practicing specific career readiness skills.