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**PROGRAM CONCENTRATION:**  
**CAREER PATHWAY:**  
**COURSE TITLE:**

**Agriculture**  
**Agriscience**  
**Biotechnology**

This course is designed as a supplemental or support course for agricultural career pathways such as Agriscience. The course introduces the major areas of biotechnology research and applications. It presents problem solving lessons and introductory skills and knowledge in biotechnology. The course prepares students for further study in biotechnology while giving them hands-on examples of real world applications in biotechnology. Classroom and laboratory activities are supplemented through supervised agricultural experiences and leadership programs and activities.

**AG-BT-1. Students will become oriented to the comprehensive program of agricultural education, learn to work safely in the agriculture lab and work sites, demonstrate selected competencies in leadership through the FFA and agricultural industry organizations necessary for productive contribution to the Bioscience and Agriculture Biotechnology skill standards, and develop plans for a supervised agricultural experience (SAE) program.**

- a. Explain the role of the Agriculture Education program and the FFA in personal development.
- b. Demonstrate knowledge learned through a Supervised Agricultural Experience (SAE) program.
- c. Develop leadership and personal development skills through participation in the FFA.
- d. Explore career opportunities in agriscience and biotechnology through the FFA and Agriculture Education Program.
- e. Explore the professional agricultural organizations associated with the course content.

**ACADEMIC STANDARDS:**

*SCsh1. Students will evaluate the importance of curiosity, honesty, openness, and skepticism in science.*

*SCSh2. Students will use standard safety practices for all classroom laboratory and field investigations.*

*SCSh8. Students will understand important features of the process of scientific inquiry.*

**AG-BT-2. Students will become oriented to the field of biotechnology while developing employable skills as defined by the Bioscience and Agricultural Biotechnology Skill Standards.**

- a. Define biotechnology.

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- b. Describe how biological technology differs from technology derived from physical science.
- c. Define genetically manipulated organisms.
- d. Explain why biotechnology is so important in feeding the world's population.
- e. Explain how biotechnology is used.
- f. Analyze the career opportunities in the field of biotechnology.

**ACADEMIC STANDARDS:**

*SCSh9. Students will enhance reading in all curriculum areas by:*

- a. Reading in all curriculum areas.*
- b. Discussing books.*
- c. Building vocabulary knowledge.*
- d. Establishing context.*

*SB1. Students will analyze the nature of the relationships between structures and functions in living cells.*

*SB5. Students will evaluate the role of natural selection in the development of the theory of evolution.*

*MM1P1. Students will solve problems (using appropriate technology).*

*MM1P3. Students will communicate mathematically.*

**AG-BT-3. Students will develop a technical vocabulary that will allow the students to follow a protocol, maintain a laboratory log, write and update relevant materials, and interact with vendors, colleagues, and clients.**

- a. Comprehend a technical vocabulary as it relates to biotechnology.
- b. Perform activities associated with an established protocol.
- c. Write or update protocols, Standard Operating Procedures (SOP's), manuals, reports, and technical summaries.
- d. Maintain a professional laboratory notebook.
- e. Interact with vendors, colleagues, and clients in an appropriate manner.

**ACADEMIC STANDARDS:**

*SCSh5. Students will demonstrate the computation and estimation skills necessary for analyzing data and developing reasonable scientific explanations.*

*SCSh6. Students will communicate scientific investigations and information clearly.*

*MM1P4. Students will make connections among mathematical ideas and to other disciplines.*

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*ELA9W1. The student produces writing that establishes an appropriate organizational structure, sets a context and engages the reader, maintains a coherent focus throughout, and signals closure.*

**AG-BT-4. Students will recognize, follow, evaluate, and implement safety practices related to laboratory, greenhouse, and field operations.**

- a. Maintain and use personal protective equipment.
- b. Evaluate use of personal protective equipment.
- c. Participate in emergency drills.
- d. Perform safety inspections.
- e. Participate in a safety training program.
- f. Define common terms used on Material Safety Data Sheets (MSDS).
- g. Follow MSDS guidelines for handling, storage, and disposal of chemicals.
- h. Follow established protocol for handling, storage, and disposal of biological materials.
- i. Identify, locate, and use first aid equipment.
- j. Obey safety signs/symbols and demonstrate knowledge of chemical safety.
- k. Identify and properly use common lab equipment such as glassware.

**ACADEMIC STANDARDS:**

*SCSh2. Students will use standard safety practices for all classroom laboratory and field investigations.*

*MM1P4. Students will make connections among mathematical ideas and to other disciplines.*

**AG-BT-5. Students will perform basic laboratory skills including basic mathematical calculations and operations of standard lab equipment.**

- a. Perform mathematical calculations such as solution concentration, serial dilutions, algebraic operations, laboratory measurements, and analysis of data.
- b. Check equipment according to SOP.
- c. Sterilize equipment where appropriate.
- d. Prepare glassware according to SOP.
- e. Organize compounds.
- f. Operate centrifuges.
- g. Use titration and pipetting techniques.
- h. Prepare and dispense stock reagents, buffers, media, and solutions.
- i. Maintain reagent integrity (store properly, avoid cross-contamination, use at proper temperature, etc.).
- j. Sterilize reagents, buffers, media, and solutions where appropriate.
- k. Calculate and prepare dilution's series.
- l. Monitor physical properties of reagents, buffers, media, and solution.
- m. Determine acceptability and optimum conditions of reagents for tests.
- n. Request tests and match request to test sample.

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- o. Set up and work reactions.
- p. Assess acceptability/appropriateness of specimen.
- q. Obtain and label sample/specimen.
- r. Prepare sample for testing.
- s. Perform tests/assays: chemical, biological, clinical, environmental robotic, mechanical.
- t. Perform histotechniques where needed.
- u. Perform basic separation techniques.
- v. Operate chromatography equipment.
- w. Return, archive, or dispose of samples appropriately.
- x. Package, handle, and ship biological materials.
- y. Maintain inventory of laboratory supplies.
- z. Order supplies and reagents.
- aa. Date, label, and store supplies and/or reagents.

**ACADEMIC STANDARDS:**

*SCSh3. Students will identify and investigate problems scientifically.*

*SCSh4. Students use tools and instruments for observing, measuring, and manipulating scientific equipment and materials.*

*SCSh5. Students will demonstrate the computation and estimation skills necessary for analyzing data and developing reasonable scientific explanations.*

*SC7. Students will characterize the properties that describe solutions and the nature of acids and bases.*

*MM1A1. Students will explore and interpret the characteristics of functions, using graphs, tables, and simple algebraic techniques.*

*MM1P1. Students will solve problems (using appropriate technology).*

**AG-BT-6. Students will use the scientific method as related to test procedures and protocols utilized in biotechnology research.**

- a. Discuss why research is so important to our way of life.
- b. Explain the steps in the scientific method.
- c. Describe the scientific method.
- d. Design and implement a scientific experiment related to agricultural biotechnology.

**ACADEMIC STANDARDS:**

*SCSh6. Students will communicate scientific investigations and information clearly.*

*SCSh7. Students will analyze how scientific knowledge is developed.*

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*SCSh8. Students will understand important features of the process of scientific inquiry.*

**AG-BT-7. Students will establish, maintain, quantify, and identify microbiology samples from a variety of different sources.**

- a. Maintain workshop and equipment hygiene.
- b. Identify and quantify microorganisms and cells.
- c. Isolate, maintain, and store pure cultures.
- d. Maintain and analyze fermentation materials.
- e. Harvest cells.
- f. Decontaminate and dispose of equipment, glassware, and biologicals.

**ACADEMIC STANDARDS:**

*SB1. Students will analyze the nature of the relationships between structures and functions in living cells.*

*SB3. Students will derive the relationship between single-celled and multi-celled organisms and the increasing complexity of systems.*

*SB4. Students will assess the dependence of all organisms on one another and the flow of energy and matter within their ecosystems.*

*MM1P4. Students will make connections among mathematical ideas and to other disciplines.*

**AG-BT-8. Students will use sectioning, staining, and microscopic techniques to characterize samples.**

- a. Isolate and characterize cell lines.
- b. Identify microscope parts and their function.
- c. Use cryogenic techniques.
- d. Use research quality microscopes properly.
- e. Perform cytological tests, i.e. sectioning and staining with a variety of stains and biological materials.

**ACADEMIC STANDARDS:**

*SB1. Students will analyze the nature of the relationships between structures and functions in living cells.*

*SB3. Students will derive the relationship between single-celled and multi-celled organisms and the increasing complexity of systems.*

*SC7. Students will characterize the properties that describe solutions and the nature of acids and bases.*

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**AG-BT-9. Students will perform standard molecular biology techniques.**

- a. Detect specific nucleic acid sequences.
- b. Isolate nucleic acids.
- c. Perform restriction digests.
- d. Perform gel electrophoresis.
- e. Label nucleic acids.
- f. Perform nucleic acid sequencing procedures.
- g. Perform Polymerase Chain Reaction (PCR) procedures.
- h. Use sequence database.
- i. Perform basic cloning techniques.
- j. Detect specific proteins.
- k. Precipitate/solubilize proteins.
- l. Separate proteins and isolate or characterize proteins.
- m. Concentrate proteins.
- n. Perform protein assays.

**ACADEMIC STANDARDS:**

*SCSh3. Students will identify and investigate problems scientifically.*

*SCSh4. Students use tools and instruments for observing, measuring, and manipulating scientific equipment and materials.*

*SPS6. Students will investigate the properties of solutions.*

*SPS10. Students will investigate the properties of electricity and magnetism.*

*MM2D2. Students will determine an algebraic model to quantify the association between two quantitative variables.*

**AG-BT-10. Students will establish and maintain tissue culture.**

- a. Prepare plant and animal tissue for culturing.
- b. Establish plant and animal tissue cultures.
- c. Maintain proper growing conditions for plant and animal tissue cultures.
- d. Explain the importance of media components to the outcome of plant and animal tissue cultures.
- e. Explain the role of plant and animal tissue culture techniques to genetic modification procedures.

**ACADEMIC STANDARDS:**

*SCSh4. Students use tools and instruments for observing, measuring, and manipulating scientific equipment and materials.*

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*SB1. Students will analyze the nature of the relationships between structures and functions in living cells.*

*SB2. Students will analyze how biological traits are passed on to successive generations.*

*SB4. Students will assess the dependence of all organisms on one another and the flow of energy and matter within their ecosystems.*

*SC7. Students will characterize the properties that describe solutions and the nature of acids and bases.*

**AG-BT-11. Students will identify, maintain, label, correctly calibrate, perform system diagnostics, and troubleshoot and report necessary repairs on standard lab equipment.**

- a. Check calibration and perform systems diagnostics.
- b. Validate or confirm processes, equipment, facilities, kits, and vendor products.
- c. Perform or schedule preventive maintenance.
- d. Clean work area according to SOPs.
- e. Sample environment to make certain it is properly maintained (ex: temperature, air quality, etc.).
- f. Implement systems updates.
- g. Maintain equipment logs.
- h. Troubleshoot and repair equipment (work order).
- i. Label equipment and facilities.

**ACADEMIC STANDARDS:**

*SCSh4. Students use tools and instruments for observing, measuring, and manipulating scientific equipment and materials.*

*SPS9. Students will investigate the properties of waves.*

*SPS10. Students will investigate the properties of electricity and magnetism.*

*MM1P3. Students will communicate mathematically.*

*ELA9RC3. The student acquires new vocabulary in each content area and uses it correctly.*

**AG-BT-12. Students will set up, maintain, and ensure clean room integrity.**

- a. Explain why a clean room is needed.
- b. Discuss how a clean room is established.
- c. Demonstrate techniques to maintain clean room integrity.

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*SCSh3. Students will identify and investigate problems scientifically.*

*SCSh4. Students use tools and instruments for observing, measuring, and manipulating scientific equipment and materials.*

**AG-BT-13. Students will perform small-scale field tests according to protocol, collect biological data, and use field databases.**

- a. Perform small-scale field tests according to protocol.
- b. Apply plant pesticides for evaluation.
- c. Inoculate plants and/or soil with biological and biochemical materials.
- d. Manage plants/animals for optimal growth.
- e. Collect biological data.
- f. Use field databases.

**ACADEMIC STANDARDS:**

*SCSh1. Students will evaluate the importance of curiosity, honesty, openness, and skepticism in science.*

*SCSh2. Students will use standard safety practices for all classroom laboratory and field investigations.*

*SCSh3. Students will identify and investigate problems scientifically.*

*SCSh4. Students will use tools and instruments for observing, measuring, and manipulating scientific equipment and materials.*

*SCSh5. Students will demonstrate the computation and estimation skills necessary for analyzing data and developing reasonable scientific explanations.*

*SCSh6. Students will communicate scientific investigations and information clearly.*

*SCSh7. Students will analyze how scientific knowledge is developed.*

*SCSh8. Students will understand important features of the process of scientific inquiry.*

*SB3. Students will derive the relationship between single-celled and multi-celled organisms and the increasing complexity of systems.*

*SB4. Students will assess the dependence of all organisms on one another and the flow of energy and matter within their ecosystems.*

*MM1A1. Students will explore and interpret the characteristics of functions, using graphs, tables, and simple algebraic techniques.*

*MM1D3. Students will relate samples to a population.*

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*MM2D1. Using sample data, students will make informal inferences about population means and standard deviations.*

*MM2D2. Students will determine an algebraic model to quantify the association between two quantitative variables.*

**AG-BT-14. Students will maintain proper care and health of research animals and plants.**

- a. Monitor health and maintain health records.
- b. Feed, water, and observe plants and animals and monitor intake.
- c. Receive and transport animals.
- d. Monitor housing conditions.
- e. Restrain and handle animals.
- f. Clean housing and sterilize cages.
- g. Maintain health records.
- h. Monitor and maintain animal safety.
- i. Prepare food/feed and prescription diets.
- j. Collect and process specimens.
- k. Maintain separate in-process, quarantine, and release areas.
- l. Maintain plants for optimal growth.
- m. Gather pollen and demonstrate pollination.
- n. Apply agrichemicals safely.
- o. Maintain and monitor insect populations.
- p. Apply plant pesticides safely.
- q. Mix growth media.
- r. Pot and repot plants.
- s. Monitor growth and development of plants.
- t. Operate computerized equipment.

**ACADEMIC STANDARDS:**

*ELA10C1. The student demonstrates understanding and control of the rules of the English language, realizing that usage involves the appropriate application of conventions and grammar in both written and spoken formats.*

*ELA10LSV1(d). Actively solicits another person's comments or opinion. (e) Offers own opinion forcefully without domineering.*

*SCSh1. Students will evaluate the importance of curiosity, honesty, openness, and skepticism in science.*

*SCSh3. Students will identify and investigate problems scientifically.*

*SB4. Students will assess the dependence of all organisms on one another and the flow of energy and matter within their ecosystems.*

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### **CTAE Foundation Skills**

The Foundation Skills for Career, Technical and Agricultural Education (CTAE) are critical competencies that students pursuing any career pathway should exhibit to be successful. As core standards for all career pathways in all program concentrations, these skills link career, technical and agricultural education to the state's academic performance standards.

The CTAE Foundation Skills are aligned to the foundation of the U. S. Department of Education's 16 Career Clusters. Endorsed by the National Career Technical Education Foundation (NCTEF) and the National Association of State Directors of Career Technical Education Consortium (NASDCTEc), the foundation skills were developed from an analysis of all pathways in the sixteen occupational areas. These standards were identified and validated by a national advisory group of employers, secondary and postsecondary educators, labor associations, and other stakeholders. The Knowledge and Skills provide learners a broad foundation for managing lifelong learning and career transitions in a rapidly changing economy.

**CTAE-FS-1 Technical Skills:** Learners achieve technical content skills necessary to pursue the full range of careers for all pathways in the program concentration.

**CTAE-FS-2 Academic Foundations:** Learners achieve state academic standards at or above grade level.

**CTAE-FS-3 Communications:** Learners use various communication skills in expressing and interpreting information.

**CTAE-FS-4 Problem Solving and Critical Thinking:** Learners define and solve problems, and use problem-solving and improvement methods and tools.

**CTAE-FS-5 Information Technology Applications:** Learners use multiple information technology devices to access, organize, process, transmit, and communicate information.

**CTAE-FS-6 Systems:** Learners understand a variety of organizational structures and functions.

**CTAE-FS-7 Safety, Health and Environment:** Learners employ safety, health and environmental management systems in corporations and comprehend their importance to organizational performance and regulatory compliance.

**CTAE-FS-8 Leadership and Teamwork:** Learners apply leadership and teamwork skills in collaborating with others to accomplish organizational goals and objectives.

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**CTAE-FS-9 Ethics and Legal Responsibilities:** Learners commit to work ethics, behavior, and legal responsibilities in the workplace.

**CTAE-FS-10 Career Development:** Learners plan and manage academic-career plans and employment relations.

**CTAE-FS-11 Entrepreneurship:** Learners demonstrate understanding of concepts, processes, and behaviors associated with successful entrepreneurial performance.