

Food Products and Processing Systems

The food products and processing systems pathway encompasses the study of food safety and sanitation; nutrition, biology, microbiology, chemistry and human behavior in local and global food systems; food selection and processing for storage, distribution and consumption; and the historical and current development of the food industry. Students completing a program of study in this pathway will demonstrate competence in the application of principles and techniques for the development, application, and management of food products and processing in AFNR settings.

Experiential Learning

Experiential Learning consists of Supervised Agriculture Experience (SAE), Work-based Learning (WBL), Apprenticeship, Job Shadow, and Service Learning experiences. Experiential Learning is a required component of a total agricultural education program and intended for every student. Through their involvement in Experiential Learning activities, students are able to consider multiple careers and occupations, learn expected workplace behavior, develop specific skills within an industry, and are given opportunities to apply academic and occupational skills in the workplace or a simulated workplace environment. Through these strategies, students learn how to apply what they are learning in the classroom as they prepare to transition into the world of college and career opportunities. Table 1 contains example Supervised Agricultural Experiences defined by the National FFA Organization.

Table 1. Supervised Agricultural Experiences

<ul style="list-style-type: none"> • Ag Sales – Placement/Entrepreneurship • Agriscience Integrated Systems Research 	<ul style="list-style-type: none"> • Food Science and Technology • Ag Processing Placement/Entrepreneurship
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National FFA Organization

The FFA Organization is dedicated to making a positive difference in the lives of students by developing their potential for premier leadership, personal growth, and career success through agricultural education. FFA award and degree programs recognize students for excellence in academics, career development, leadership, and community service. Career and leadership development activities encompass the entire AFNR Career Cluster and each AFNR Pathway and are available at the local chapter, regional, state, and national levels. Refer to Table 2 for example Career Development Events.

Table 2. FFA Activities

Career Development Events (CDE's)		Leadership Development Events (LDE's)	
<ul style="list-style-type: none"> • Ag Sales • Ag Issues • Food Science and Technology • Milk Quality 	<ul style="list-style-type: none"> • Meats Evaluation • Poultry • Agriscience Fair 	<ul style="list-style-type: none"> • Agricultural Issues Forum • Marketing Plan 	<ul style="list-style-type: none"> • Prepared Public Speaking • Extemporaneous Speaking

Recommended Courses

Introductory Courses		Intermediate Courses		Advanced Courses	
Number	Name	Number	Name	Number	Name
01	Ag Science 1/Aquaculture 1	06	Food Science /Food Chemistry (Chemistry Credit)	39	Food Science 2
02	Ag Science 2/Aquaculture 2	38	Food Science		
03	Animal Science/ Large Animal Science	58	Sustainable Food Production		
11	Animal Science 1				
13	Biotechnology				
24	Intro to Ag Science 1				
25	Intro to Ag Science 2				
26	Ag Exploration				
27	Ag Exploration 2				
62	Greenhouse Operation and Management				

Minnesota Food Products and Processing Systems Standards

Minnesota Framework: MN.FPP.01. Develop and implement procedures to ensure safety, sanitation and quality in food product and processing facilities.		
Performance Indicator: MN.FPP.01.01. Analyze and manage operational and safety procedures in food products and processing facilities.		
MN Academic Science Standards		
<ul style="list-style-type: none"> • 9.1.1.1 Science is a way of knowing about the natural world and is characterized by empirical criteria, logical argument and skeptical review. • 9C.1.3.3. Developments in chemistry affect society and societal concerns affect the field of chemistry. 		
Benchmarks		
Intro Courses	Intermediate Courses	Advanced Courses
FPP.01.01.01.a. Research and summarize the purposes and objectives of safety programs in food products and processing facilities (e.g., Sanitation Standard Operating Procedures (SSOP); Good Manufacturing Practices (GMP); worker safety, etc.).	FPP.01.01.01.b. Analyze and document attributes and procedures of current safety programs in food products and processing facilities.	FPP.01.01.01.c. Construct plans that ensure implementation of safety programs for food products and processing facilities.
FPP.01.01.02.a. Research and categorize types of equipment used in food products and processing systems.		<p>FPP.01.01.02.c. Devise and implement strategies to maintain equipment and facilities for food products and processing systems.</p> <p>FPP.01.01.02.c. Assess specifications and maintenance needs for equipment and facilities used in food products and processing systems (e.g., specifications for machines, sanitation procedures, repair protocol, etc.).</p>

Performance Indicator: MN.FPP.01.02. Apply food safety and sanitation procedures in the handling and processing of food products to ensure food quality.

- MN Academic Science Standards**
- 9.1.1.1 Science is a way of knowing about the natural world and is characterized by empirical criteria, logical argument and skeptical review.
 - 9.1.1.2. Scientific inquiry uses multiple interrelated processes to pose and investigate questions about the natural world.
 - 9C.1.3.3. Developments in chemistry affect society and societal concerns affect the field of chemistry.
 - 9C.2.1.3. Chemical reactions describe a chemical change in which one or more reactants are transformed into one or more products.

Benchmarks		
Intro Courses	Intermediate Courses	Advanced Courses
FPP.01.02.01.a. Examine and identify contamination hazards associated with food products and processing (e.g., physical, chemical and biological).	FPP.01.02.01.b. Outline procedures to eliminate possible contamination hazards associated with food products and processing.	FPP.01.02.01.c. Identify sources of contamination in food products and/or processing facilities and develop ways to eliminate contamination.
FPP.01.02.02.a. Research and summarize procedures of safe handling protocols (e.g., Hazard Analysis and Critical Control Points Plan (HACCP); Critical Control Point procedures (CCP); Good Agricultural Practices Plan (GAP), etc.).	FPP.01.02.02.b. Construct plans that ensure implementation of safe handling procedures on food products.	FPP.01.02.02.c. Examine, interpret and report outcomes from safe handling procedures and results from quality assurance tests.
FPP.01.02.03.a. Research and summarize the purposes and objectives of quality assurance tests on food products (e.g., produce safety regulation, safe food transport, food contaminants, etc.).	FPP.01.02.03.b. Design and construct experiments for quality assurance tests on food products.	FPP.01.02.03.c. Interpret and evaluate results of quality assurance tests on food products and examine steps to implement corrective procedures.
FPP.01.02.04.a. Describe the effects foodborne pathogens have on food products and humans.	FPP.01.02.04.b. Explain, document and execute the procedures of microbiological tests used to detect food-borne pathogens.	FPP.01.02.04.c. Conduct and interpret microbiological tests for food-borne pathogens.

Performance Indicator: FPP.01.03. Apply food safety procedures when storing food products to ensure food quality.

- MN Academic Science Standards**
- 9.1.1.1. Science is a way of knowing about the natural world and is characterized by empirical criteria, logical argument and skeptical review.
 - 9C.1.3.3. Developments in chemistry affect society and societal concerns affect the field of chemistry.

Benchmarks		
Intro Courses	Intermediate Courses	Advanced Courses
FPP.01.03.01.a. Identify and summarize purposes of food storage procedures (e.g., first in/first out, temperature regulation, monitoring, etc.).	FPP.01.03.01.b. Analyze characteristics of food products and determine appropriate storage procedures.	FPP.01.03.01.c. Prepare plans that ensure implementation of proper food storage procedures.
FPP.01.03.02.a. Research and describe different electronic and paper-based documentation methods used to meet food safety and quality goals in food products and processing systems.	FPP.01.03.02.b. Demonstrate and explain methods of documentation procedures within food products and processing systems.	FPP.01.03.02.c. Implement and evaluate the effectiveness of a documentation procedure used within a food products and processing facility and recommend improvements.

Minnesota Framework: MN.FPP.02. Apply principles of nutrition, biology, microbiology, chemistry and human behavior to the development of food products.

Performance Indicator: MN.FPP.02.01. Apply principles of nutrition and biology to develop food products that provide a safe, wholesome and nutritious food supply for local and global food systems.

MN Academic Science Standards

- 9.4.1.2 Cells and cell structures have specific functions that allow an organism to grow, survive and reproduce.
- 9C.1.3.4. Physical and mathematical models are used to describe physical systems.
- 9C.2.1.1. The periodic table illustrates how patterns in the physical and chemical properties of elements are related to atomic structure.
- 9C.2.1.2. Chemical and physical properties of matter result from the ability of atoms to form bonds.
- 9C.2.1.3. Chemical reactions describe a chemical change in which one or more reactants are transformed into one or more products.

Benchmarks

Intro Courses	Intermediate Courses	Advanced Courses
FPP.02.01.01.a. Research and summarize properties of common food constituents (e.g., proteins, carbohydrates, fats, vitamins, minerals).	FPP.02.01.01.b. Compare and contrast the relative value of food constituents relative to food product qualities (e.g., taste, appearance, etc.).	FPP.02.01.01.c. Analyze the properties of food products to identify food constituents and evaluate nutritional value.
FPP.02.01.02.a. Research and report methods of nutritional planning to meet essential needs for the human diet (e.g., My Plate).	FPP.02.01.02.b. Compare and contrast the nutritional needs of different human diets.	FPP.02.01.02.c. Construct methods to design a healthy daily food guide for a variety of nutritional needs.
FPP.02.01.03.a. Recognize that cells are composed primarily of a few elements (carbon, hydrogen, oxygen, nitrogen, phosphorus, and sulfur), and describe the basic molecular structures and the primary functions of carbohydrates, lipids and proteins.	FPP.02.01.03.b. Recognize that the work of the cell is carried out primarily by proteins, most of which are enzymes.	

Performance Indicator: MN.FPP.02.02. Apply principles of microbiology and chemistry to develop food products to provide a safe, wholesome and nutritious food supply for local and global food systems

MN Academic Science Standards

- 9.1.1.2. Scientific inquiry uses multiple interrelated processes to pose and investigate questions about the natural world.
- 9.4.1.2. Cells and cell structures have specific functions that allow an organism to grow, survive and reproduce.
- 9C.1.3.3. Developments in chemistry affect society and societal concerns affect the field of chemistry.
- 9C.1.3.4. Physical and mathematical models are used to describe physical systems.
- 9C.2.1.1. The periodic table illustrates how patterns in the physical and chemical properties of elements are related to atomic structure.
- 9C.2.1.2. Chemical and physical properties of matter result from the ability of atoms to form bonds.
- 9C.2.1.3. Chemical reactions describe a chemical change in which one or more reactants are transformed into one or more products.
- 9C.2.1.4. States of matter can be described in terms of motion of molecules and that the properties and behavior of gases can be explained using the kinetic molecular theory.

Benchmarks		
Intro Courses	Intermediate Courses	Advanced Courses
FPP.02.02.01.a. Examine and describe the basic chemical makeup of different types of food.	FPP.02.02.01.b. Explain how the chemical and physical properties of foods influence nutritional value and eating quality.	FPP.02.02.01.c. Design and conduct experiments to determine the chemical and physical properties of food products.
FPP.02.02.02.a. Identify common food additives and identify their properties (e.g., preservatives, antioxidants, buffers, stabilizers, colors, flavors, etc.).	FPP.02.02.02.b. Describe the purpose of common food additives and how they influence the chemistry of food.	FPP.02.02.02.c. Devise and apply strategies to determine what additives are utilized and why they are included in a variety of food products.
FPP.02.02.03.a. Research and summarize the application of biochemistry in the development of new food products (e.g., value added food products, genetically engineered food products, etc.).	FPP.02.02.03.b. Analyze how food products and processing facilities use biochemistry concepts to develop new food products.	FPP.02.02.03.c. Develop and implement plans to engineer new food items using biochemistry concepts.
FPP.02.02.04.a Explain the arrangement of the elements on the Periodic Table, including the relationships among elements in a given column or row	FPP.02.02.04.b. Describe the role of valence electrons in the formation of chemical bonds.	
FPP.02.02.05.a. Describe the role of valence electrons in the formation of chemical bonds.	FPP.02.02.05.b. Explain how the rearrangement of atoms in a chemical reaction illustrates the law of conservation of mass.	
FPP.02.02.06.a Describe a chemical reaction using words and symbolic equations. <i>For example:</i> The reaction of hydrogen gas with oxygen gas can be written: $2\text{H}_2 + \text{O}_2 \rightarrow 2\text{H}_2\text{O}$.	FPP.02.02.06.b Relate exothermic and endothermic chemical reactions to temperature and energy changes.	
FPP.02.02.07.a. Explain the relationship of an element's position on the periodic table to its atomic number and electron configuration.	FPP.02.02.07.b. Identify and compare trends on the periodic table, including reactivity and relative sizes of atoms and ions; use the trends to explain the properties of subgroups, including metals, non-metals, alkali metals, alkaline earth	
FPP.02.02.08.a. Explain how elements combine to form compounds through ionic and covalent bonding.	FPP.02.02.08.b. Compare and contrast the structure, properties and uses of organic compounds, such as hydrocarbons, alcohols, sugars, fats and proteins.	FPP.02.02.08.c. Classify chemical reactions as double replacement, single replacement, synthesis, decomposition or combustion.
FPP.02.02.09.a Use IUPAC (International Union of Pure and Applied Chemistry) nomenclature to write chemical formulas and name molecular and ionic compounds.	FPP.02.02.09.b. Determine the molar mass of a compound from its chemical formula and a table of atomic masses; convert the mass of a molecular substance to moles, number of particles, or volume of gas at standard temperature	FPP.02.02.09.c. Relate the properties of acids and bases to the ions they contain and predict the products of an acid-base reaction.

FPP.02.02.10.a. Balance chemical equations by applying the laws of conservation of mass and constant composition.	FPP.02.02.10.b. Describe the factors that affect the rate of a chemical reaction, including temperature, pressure, mixing, concentration, particle size, surface area and catalyst.	FPP.02.02.10.c. Recognize that some chemical reactions are reversible and that not all chemical reactions go to completion.
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Performance Indicator: MN.FPP.02.03. Apply principles of human behavior to develop food products to provide a safe, wholesome and nutritious food supply for local and global food systems.

MN Academic Science Standards

- 9.1.1.1. Science is a way of knowing about the natural world and is characterized by empirical criteria, logical argument and skeptical review.
- 9.1.1.2. Scientific inquiry uses multiple interrelated processes to pose and investigate questions about the natural world.
- 9.1.2.1. Engineering is a way of addressing human needs by applying science concepts and mathematical techniques to develop new products, tools, processes and systems.
- 9.1.2.2. Engineering design is an analytical and creative process of devising a solution to meet a need or solve a specific problem.
- 9.4.1.2. Cells and cell structures have specific functions that allow an organism to grow, survive and reproduce.
- 9C.1.3.3. Developments in chemistry affect society and societal concerns affect the field of chemistry.

Benchmarks

Intro Courses	Intermediate Courses	Advanced Courses
FPP.02.03.01.a. Examine and explain the importance of food labeling to the consumer.	FPP.02.03.01.b. Examine, interpret and explain the meaning of required components on a food label.	FPP.02.03.01.c. Determine a strategy to prepare and label foods according to the established standards of regulatory agencies.
FPP.02.03.02.a. Research and summarize relevant factors in planning and developing a new food product (e.g., regulation, creativity, economics, etc.).	FPP.02.03.02.b. Determine consumer preference and market potential for a new food product using a variety of methods (e.g., double-blind testing, etc.).	FPP.02.03.02.c. Design new food products that meet a variety of goals (e.g., consumer preferences, market, nutritional needs, regulatory requirements, etc.).

Minnesota Framework: MN.FPP.03. Select and process food products for storage, distribution and consumption.

Performance Indicator: MN.FPP.03.01. Implement selection, evaluation and inspection techniques to ensure safe and quality food products.

MN Academic Science Standards

- 9.1.1.1. Science is a way of knowing about the natural world and is characterized by empirical criteria, logical argument and skeptical review.
- 9.1.1.2. Scientific inquiry uses multiple interrelated processes to pose and investigate questions about the natural world.

Benchmarks

Intro Courses	Intermediate Courses	Advanced Courses
FPP.03.01.01.a. Summarize characteristics of quality and yield grades of food products.	FPP.03.01.01.b. Analyze factors that affect quality and yield grades of food products.	FPP.03.01.01.c. Outline procedures to assign quality and yield grades to food products according to industry standards.
FPP.03.01.02.a. Summarize procedures to select raw food products based on yield grades and quality grades.	FPP.03.01.02.b. Assemble procedures to perform quality-control inspections of raw food products for processing.	FPP.03.01.02.c. Develop, apply and evaluate care and handling procedures to maintain original food quality and yield.

FPP.03.01.03.a. Identify and describe protocols for inspection and harvesting techniques for animal food products (e.g., pre-mortem and post-mortem inspections, Food Safety Inspection Service guidelines (FSIS), etc.).	FPP.03.01.03.b. Examine and evaluate inspection and harvesting of animals using regulatory agency approved or industry-approved techniques.	
FPP.03.01.04.a. Identify and describe foods derived from different classifications of food products (e.g., meat, egg, poultry, fish, dairy, fruits, vegetables, grains, legumes, oilseeds, etc.).	FPP.03.01.04.b. Examine and summarize desirable qualities of food products derived from different classifications of food products.	FPP.03.01.04.c. Evaluate and grade food products from different classifications of food products.

Performance Indicator: MN.FPP.03.02. Design and apply techniques of food processing, preservation, packaging and presentation for distribution and consumption of food products.

MN Academic Science Standards

- 9.1.1.2. Scientific inquiry uses multiple interrelated processes to pose and investigate questions about the natural world.
- 9.1.2.1. Engineering is a way of addressing human needs by applying science concepts and mathematical techniques to develop new products, tools, processes and systems.
- 9.1.2.2. Engineering design is an analytical and creative process of devising a solution to meet a need or solve a specific problem.
- 9.4.1.2. Cells and cell structures have specific functions that allow an organism to grow, survive and reproduce.
- 9C.1.3.4. Physical and mathematical models are used to describe physical systems.
- 9C.2.1.2. Chemical and physical properties of matter result from the ability of atoms to form bonds.
- 9C.2.1.3. Chemical reactions describe a chemical change in which one or more reactants are transformed into one or more products.

Benchmarks

Intro Courses	Intermediate Courses	Advanced Courses
FPP.03.02.01.a. Identify and explain English and metric measurements used in the food products and processing industry.	FPP.03.02.01.b. Compare weights and measurements of products and perform conversions between units of measure.	FPP.03.02.01.c. Design plans to formulate and package food products using a variety of weights and measures.
FPP.03.02.02.a. Differentiate between methods and materials used for processing food for different markets (e.g., fresh food products, ready to eat food products, etc.).	FPP.03.02.02.b. Outline appropriate methods and prepare foods for sale and distribution for different markets.	FPP.03.02.02.c. Evaluate food quality factors on foods prepared for different markets (e.g., shelf life, shrinkage, appearance, weight, etc.).
FPP.03.02.03.a. Identify methods of food preservation and give examples of foods preserved by each method.	FPP.03.02.03.b. Analyze and document food preservation processes and methods on a variety of food products.	FPP.03.02.03.c. Devise and apply strategies to preserve different foods using various methods and techniques.
FPP.03.02.04.a. Summarize types of materials and methods used in food packaging and presentation.	FPP.03.02.04.b. Analyze the degree of desirable food qualities of foods stored in various packaging.	FPP.03.02.04.c. Construct and implement methods of selecting packaging materials to store a variety of food products.

Performance Indicator: MN.FPP.03.03. Create food distribution plans and procedures to ensure safe delivery of food products.

MN Academic Science Standards

- 9.1.1.1. Science is a way of knowing about the natural world and is characterized by empirical criteria, logical argument and skeptical review.
- 9.1.1.2. Scientific inquiry uses multiple interrelated processes to pose and investigate questions about the natural world.
- 9C.1.3.3. Developments in chemistry affect society and societal concerns affect the field of chemistry.

Benchmarks		
Intro Courses	Intermediate Courses	Advanced Courses
FPP.03.03.01.a. Assess and describe the environmental impact of distributing food locally and globally.	FPP.03.03.01.b. Research and document ways to reduce environmental impact from food distribution activities.	FPP.03.03.01.c. Devise and defend a strategy to determine ways for food distribution to reduce environmental impacts.
FPP.03.03.02.a. Examine the various paths food products take to get from food processing centers to consumers.	FPP.03.03.02.b. Interpret safety procedures used in food distribution to ensure a safe product is being delivered to consumers.	FPP.03.03.02.c. Make recommendations to improve safety procedures used in food distribution scenarios to ensure a safe product is being delivered to consumers.
FPP.03.03.03.a. Research and summarize different types of market demands for food products (e.g., local food, organic, non-GMO, etc.).	FPP.03.03.03.b. Assess and explain how market demand for food products influences the distribution of food products.	FPP.03.03.03.c. Propose distribution plans for food products that meet specific market demands.

Minnesota Framework: MN.FPP.04. Explain the scope of the food industry and the historical and current developments of food product and processing.

Performance Indicator: MN.FPP.04.01. Examine the scope of the food industry by evaluating local and global policies, trends and customs for food production.

MN Academic Science Standards

- 9.1.1.1. Science is a way of knowing about the natural world and is characterized by empirical criteria, logical argument and skeptical review.
- 9.1.1.2. Scientific inquiry uses multiple interrelated processes to pose and investigate questions about the natural world.
- 9C.1.3.3. Developments in chemistry affect society and societal concerns affect the field of chemistry.
- 9.4.3.1. Genetic information found in the cell provides information for assembling proteins which dictate expression of traits in an individual.

Benchmarks		
Intro Courses	Intermediate Courses	Advanced Courses
FPP.04.01.01.a. Research and summarize examples of policy and legislation that affect food products and processing systems in the United States and around the world (e.g., labeling, GMOs, biosecurity, food system policy, dietary guidelines, etc.).	FPP.04.01.01.b. Analyze the similarities and differences amongst policies and legislation that affect the food products and processing system in the U.S. or around the world.	FPP.04.01.01.c. Articulate and defend a personal point of view on policies and legislation that affect the food products and processing system in the U.S. or around the world.
FPP.04.01.02.a. Examine the impact of consumer trends on food products and processing practices (e.g., health and nutrition, organic, information about food products, local food movements, farm-to-fork supply chains, food system transparency, etc.).	FPP.04.01.02.b. Construct and implement methods to obtain data on food consumer trends in a specific market.	FPP.04.01.02.c. Devise and implement a strategy to create food products that meet a specific consumer trend in a specific market.
FPP.04.01.03.a. Compare and contrast cultural differences regarding food products and processing practices.	FPP.04.01.03.b. Analyze food production and distribution outcomes based on cultural customs.	FPP.04.01.03.c. Propose and implement culturally sensitive food processing and distribution practices.

Performance Indicator: MN.FPP.04.02. Evaluate the significance and implications of changes and trends in the food products and processing industry in the local and global food systems.

MN Academic Science Standards

- 9.1.1.1. Science is a way of knowing about the natural world and is characterized by empirical criteria, logical argument and skeptical review.
- 9.1.1.2. Scientific inquiry uses multiple interrelated processes to pose and investigate questions about the natural world.
- 9C.1.3.3. Developments in chemistry affect society and societal concerns affect the field of chemistry.

Benchmarks

Intro Courses	Intermediate Courses	Advanced Courses
FPP.04.02.01.a. Describe and explain the components of the food products and processing industry (e.g., processing, distribution, byproducts, etc.).	FPP.04.02.01.b. Analyze and document significant changes and trends in the food products and processing industry.	FPP.04.02.01.c. Predict and defend upcoming changes and trends in the food products and processing industry.
FPP.04.02.02.a. Identify and explain environmental and safety concerns about the food supply.	FPP.04.02.02.b. Research and summarize current issues related to the safety and environmental concerns about foods and food processing (e.g., GMOs, irradiation, microorganisms, contamination, etc.).	FPP.04.02.02.c. Examine and respond to consumer concerns about the environment and safety of the food supply using accurate information regarding food products and processing systems and practices.
FPP.04.02.03.a. Research and describe current and emerging technologies related to food products and processing (e.g., high pressure processing of foods, automation, biotechnology, etc.).	FPP.04.02.03.b. Evaluate desirable and undesirable outcomes of emerging technologies used in the food products and processing systems.	FPP.04.02.03.c. Research and evaluate the feasibility of implementing a current or emerging technology to improve a current food product or process used in a facility.

Performance Indicator: MN.FPP.04.03. Identify and explain the purpose of industry organizations, groups and regulatory agencies that influence the local and global food systems.

MN Academic Science Standards

- 9C.1.3.3. Developments in chemistry affect society and societal concerns affect the field of chemistry.

Benchmarks

Intro Courses	Intermediate Courses	Advanced Courses
FPP.04.03.01.a. Examine and summarize the purposes of organizations that influence or regulate the food products and processing industry.	FPP.04.03.01.b. Evaluate the changes in the food products and processing industry brought about by industry organizations or regulatory agencies.	FPP.04.03.01.c. Construct and implement methods to obtain data about organizations, groups, and regulatory agencies that affect the food products and processing industry.
FPP.04.03.02.a. Examine and describe the importance and usage of regulatory oversight of food safety and security in food products and processing (e.g., internationally, nationally, state and local).	FPP.04.03.02.b. Assess and summarize the application of industry standards in the food products and processing industry.	FPP.04.03.02.c. Construct and implement plans that ensure adherence to industry standards for food products and processing facilities.

Minnesota Framework: MN.FPP.05. Assess factors that have influenced the evolution of biotechnology in agriculture (e.g., historical events, societal trends, ethical and legal implications, etc.).

Performance Indicator: MN.FPP.05.01. Investigate and explain the relationship between past, current and emerging applications of biotechnology in agriculture (e.g., major innovators, historical developments, potential applications of biotechnology, etc.).

MN Academic Science Standards

- 9C.1.3.3. Developments in chemistry affect society and societal concerns affect the field of chemistry.
- 9.4.1.2. Cells and cell structures have specific functions that allow an organism to grow, survive and reproduce.

Benchmarks

Intro Courses	Intermediate Courses	Advanced Courses
FPP.05.01.01.a. Research and summarize the evolution of biotechnology in food science.	FPP.05.01.01.b. Analyze the developmental progression of biotechnology and the evolution of scientific knowledge.	FPP.05.01.01.c. Evaluate and explain how scientists use the scientific method to build upon previous findings in current and emerging research.
FPP.05.01.02.a. Examine and categorize current applications and gains achieved in applying biotechnology to food science.	FPP.05.01.02.b. Assess and summarize current work in biotechnology being done to add value to food science and society.	FPP.05.01.02.c. Evaluate the outcomes and impacts of biotechnology on the globalization of food science.
FPP.05.01.03.a. Distinguish between current and emerging applications of biotechnology in food science.	FPP.05.01.03.b. Analyze and document emerging problems and issues associated with food science biotechnology.	
FPP.05.01.04.a. Compare and contrast the benefits and risks of biotechnology compared with alternative approaches to improving food science.	FPP.05.01.04.b. Assess the benefits and risks associated with using biotechnology to improve food science.	FPP.05.01.04.c. Evaluate the short-term and long-term benefits and risks of applying biotechnology to food science.

Performance Indicator: MN.FPP.05.02. Analyze the relationship and implications of bioethics, laws and public perceptions on applications of biotechnology in agriculture (e.g., ethical, legal, social, cultural issues).

MN Academic Science Standards

- 9.1.1.1. Science is a way of knowing about the natural world and is characterized by empirical criteria, logical argument and skeptical review.
- 9C.1.3.3. Developments in chemistry affect society and societal concerns affect the field of chemistry.

Benchmarks

Intro Courses	Intermediate Courses	Advanced Courses
FPP.05.03.02.a. Research and summarize public perceptions of biotechnology in food science (e.g., social and cultural issues).	FPP.05.03.02.b. Analyze the impact of public perceptions on the application of biotechnology in different AFNR systems.	

Minnesota Framework: MN.FPP.06. Demonstrate proficiency by safely applying appropriate laboratory skills to complete tasks in a biotechnology research and development environment (e.g., standard operating procedures, record keeping, aseptic technique, equipment maintenance, etc.).

Performance Indicator: MN. FPP.06.01. Read, document, evaluate and secure accurate laboratory records of experimental protocols, observations and results.

MN Academic Science Standards

- 9.1.1.2. Scientific inquiry uses multiple interrelated processes to pose and investigate questions about the natural world.
- 9C.1.3.4. Physical and mathematical models are used to describe physical systems.

Benchmarks		
Intro Courses	Intermediate Courses	Advanced Courses
FPP.06.01.01.a. Compare and contrast common record-keeping methods used in a laboratory (e.g., paper notebook, electronic notebook, etc.).	FPP.06.01.01.b. 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, etc.).	
FPP.06.01.02.a. Research and summarize the need for data and information security in a laboratory and demonstrate best practices.	FPP.06.01.02.b. Assess when security procedures for data and information collected in a laboratory should be implemented.	
Performance Indicator: MN.FPP.06.02. Implement standard operating procedures for the proper maintenance, use and sterilization of equipment in a laboratory.		
MN Academic Science Standards		
<ul style="list-style-type: none"> 9.1.1.2. Scientific inquiry uses multiple interrelated processes to pose and investigate questions about the natural world. 9C.1.3.4. Physical and mathematical models are used to describe physical systems. 		
Benchmarks		
Intro Courses	Intermediate Courses	Advanced Courses
FPP.06.02.01.a. Identify, interpret, and implement standard operating procedures for laboratory equipment.	FPP.06.02.01.b. Develop a maintenance program for laboratory equipment based upon the standard operating procedures.	
FPP.06.02.02.a. Categorize and identify laboratory equipment according to its purpose in scientific research.	FPP.06.02.02.b. Manipulate basic laboratory equipment and measurement devices (e.g., water bath, electrophoresis equipment, micropipettes, laminar flow hood, etc.).	
FPP.06.02.03.a. Differentiate between sterilization techniques for equipment in a laboratory (e.g., media bottles vs. laminar flow hood, etc.).		
Performance Indicator: MN.FPP.06.03. Apply standard operating procedures for the safe handling of biological and chemical materials in a laboratory.		
MN Academic Science Standards		
<ul style="list-style-type: none"> 9C.1.3.4. Physical and mathematical models are used to describe physical systems. 9.1.1.2. Scientific inquiry uses multiple interrelated processes to pose and investigate questions about the natural world. 9C.2.1.2. Chemical and physical properties of matter result from the ability of atoms to form bonds. 9C.2.1.3. Chemical reactions describe a chemical change in which one or more reactants are transformed into one or more products. 		
Benchmarks		
Intro Courses	Intermediate Courses	Advanced Courses
FPP.06.03.01.a. Classify and document basic aseptic techniques in the laboratory.	FPP.06.03.01.b. Demonstrate advanced aseptic techniques in the laboratory (e.g., sterile work area, sterile handling, personal hygiene, etc.).	

FPP.06.03.02.a. Examine and implement standard operating procedures for the use of biological materials according to directions and their classification (e.g., proper handling of bacteria or DNA before, during and after use).	FPP.06.03.02.b. Analyze and select an appropriate standard operating procedure for working with biological materials based upon their classification.	
FPP.06.03.03.a. Categorize and label the types of solutions that are commonly prepared in a laboratory (e.g., buffers, reagents, media, etc.).	FPP.06.03.03.b. Formulate and prepare solutions using standard operating procedures (e.g., proper labeling, storage, etc.).	FPP.06.03.03.c. Verify the physical properties of solutions (e.g., molarity, percent mass/volume, dilutions, etc.).

Performance Indicator: MN.FPP.06.04. Safely manage and dispose of biological materials, chemicals and wastes according to standard operating procedures.

Benchmarks		
Intro Courses	Intermediate Courses	Advanced Courses
FPP.06.04.01.a. Classify different types of personal protective equipment and demonstrate how to properly utilize the equipment.	FPP.06.04.01.b. Assess the need for personal protective equipment in a variety of situations and select the appropriate equipment to wear when working with biological and chemical materials.	

Performance Indicator: MN.FPP.06.05. Examine and perform scientific procedures using microbes, DNA, RNA and proteins in a laboratory.

MN Academic Science Standards

- 9.1.1.2. Scientific inquiry uses multiple interrelated processes to pose and investigate questions about the natural world.
- 9.4.1.2. Cells and cell structures have specific functions that allow an organism to grow, survive and reproduce.
- 9.4.3.1. Genetic information found in the cell provides information for assembling proteins which dictate expression of traits in an individual.
- 9C.1.3.4. Physical and mathematical models are used to describe physical systems.
- 9C.2.1.3. Chemical reactions describe a chemical change in which one or more reactants are transformed into one or more products.

Benchmarks		
Intro Courses	Intermediate Courses	Advanced Courses
FPP.06.05.01.a. Differentiate types of organisms and demonstrate safe handling to maintain organism purity and personal safety (e.g., plant and animal tissue, cell cultures, microbes, etc.).	FPP.06.05.01.b. Characterize the physical and biological properties of organisms.	
FPP.06.05.02.a. Compare and contrast the structures of DNA and RNA and investigate how genotype influences phenotype.	FPP.06.05.02.b. Analyze and interpret the molecular basis for heredity and the tools and techniques used in DNA and RNA manipulations.	
FPP.06.05.03.a. Extract and purify DNA and RNA according to standard operating procedures.	FPP.06.05.03.b. Perform electrophoretic techniques and interpret electrophoresis fragmentation patterns (e.g., gel electrophoresis, southern blotting, etc.).	FPP.06.05.03.c. Manipulate and analyze DNA and RNA through advanced scientific procedures (e.g., southern blotting, cloning, PCR, RT-PCR, etc.).
FPP.06.05.04.a. Examine and document the role and applications of proteins in agricultural biotechnology.		

FPP.06.05.05.a. Synthesize the relationship between proteins, enzymes and antibodies.	FPP.06.05.05.b. Analyze and document how antibodies are formed and describe how they can be used in agricultural biotechnology.	
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Minnesota Framework: FPP.07. Demonstrate the application of biotechnology to solve problems in AFNR systems (e.g., bioengineering, food processing, waste management, horticulture, forestry, livestock, crops, etc.).

Performance Indicator: MN.FPP.07.01. Apply biotechnology principles, techniques and processes to enhance the production of food through the use of microorganisms and enzymes.

- MN Academic Science Standards**
- 9.4.1.2. Cells and cell structures have specific functions that allow an organism to grow, survive and reproduce.
 - 9.4.3.1. Genetic information found in the cell provides information for assembling proteins which dictate expression of traits in an individual.
 - 9C.2.1.1. The periodic table illustrates how patterns in the physical and chemical properties of elements are related to atomic structure.
 - 9C.2.1.2. Chemical and physical properties of matter result from the ability of atoms to form bonds.
 - 9C.2.1.3. Chemical reactions describe a chemical change in which one or more reactants are transformed into one or more products.
 - 9C.2.1.4. States of matter can be described in terms of motion of molecules and that the properties and behavior of gases can be explained using the kinetic molecular theory.

Benchmarks		
Intro Courses	Intermediate Courses	Advanced Courses
FPP.07.01.01.a. Summarize reasons for detecting microbes and identify sources of microbes.	FPP.07.01.01.b. Assess and describe the use of biotechnology to detect microbes.	
FPP.07.01.02.a. Examine enzymes, the changes they cause and the physical and chemical parameters that affect enzymatic reactions (e.g., food, cellulosic bioenergy, etc.).	FPP.07.01.02.b. Analyze processes by which enzymes are produced through biotechnology.	
FPP.07.01.03.a. Identify and categorize foods produced through the use of biotechnology (e.g., fermentation, etc.) to change the chemical properties of food for an intended purpose (e.g., create desirable nutritional profile, preservation, flavor, etc.)	FPP.07.01.03.b. Compare and contrast the effectiveness, purpose, and outcomes associated with biotechnology as well as conventional processes used in food processing.	FPP.07.01.03.c. Process food using biotechnology to achieve an intended purpose (e.g., preservation, flavor enhancement, etc.).