



Agriculture, Food, and Natural Resources Frameworks

Animal Systems Pathway

Animal Systems

The Animal Systems (AS) Career Pathway encompasses the study of animal systems, including content areas such as life processes, health, nutrition, genetics, management, and processing, as applied to small animals, aquaculture, exotic animals, livestock, dairy, horses and/or poultry. 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 animal systems in Agriculture, Food, and Natural Resource (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 Future Farmers of America (FFA) Organization.

Table 1. Supervised Agricultural Experiences

<ul style="list-style-type: none"> • Agricultural Processing • Agricultural Sales • Beef Production • Dairy Production • Diversified Agricultural Production 	<ul style="list-style-type: none"> • Diversified Livestock Production • Equine Science • Goat Production • Poultry Production 	<ul style="list-style-type: none"> • Sheep Production • Small Animal Production and Care • Specialty Animal Production, Swine Production • Veterinary Science
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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. See Table 2 for example Career and Leadership Development Events related to the Animal Systems Pathway.

Table 2. FFA Activities

Career Development Events (CDE's)	Leadership Development Events (LDE's)
<ul style="list-style-type: none"> • Dairy Cattle Evaluation • Horse Evaluation • Livestock Evaluation • Milk Quality and Products • Meat Evaluation • Poultry Evaluation • Small Animals • Agriscience Fair 	<ul style="list-style-type: none"> • Agricultural Issues Forum • Marketing Plan • Prepared Public Speaking • Extemporaneous Speaking

Recommended Courses

Introductory Courses Number and Name	Intermediate Courses Number and Name	Advanced Courses Number and Name
<ul style="list-style-type: none"> • 03/04 Animal Science I and II (for Science Credit) • 11/12 Animal Science 1 and II • 22 Animal Production /Technology 	<ul style="list-style-type: none"> • 20 Large Animal Science • 21 Small Animal Science • 05 Vet Science I (for Science Credit) • 15 Vet Science I 	<ul style="list-style-type: none"> • 05 Vet Science II (for Science Credit) • 16 Vet Science II • 75 Livestock Management Science • 05 CIS Animal Science (for Science Credit)

Minnesota Animal Systems Standards

Minnesota Framework: MN.AS.01. Analyze historic and current trends impacting the animal systems industry.

Performance Indicator: MN.AS.01.01. Evaluate the development and implications of animal origin, domestication and distribution on production practices and the environment.

Minnesota 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.
- 9.1.3.2 Men and women throughout the history of all cultures, including Minnesota American Indian tribes and communities, have been involved in engineering design and scientific inquiry.
- 9.1.3.3 Science and engineering operate in the context of society and both influence and are influenced by this context.
- 9.3.4.1 People consider potential benefits, costs and risks to make decisions on how they interact with natural systems.
- 9.4.4.1 Human activity has consequences on living organisms and ecosystems.

MN.AS.01.01 Intro Course Benchmarks	MN.AS.01.01 Intermediate Course Benchmarks	MN.AS.01.01 Advanced Course Benchmarks
AS.01.01.01.a. Identify and summarize the origin, significance, distribution and domestication of different animal species.	AS.01.01.01.b. Describe the historical and scientific developments of different animal industries and summarize the products, services and careers associated with each.	AS.01.01.01.c. Evaluate the implications of animal adaptations on production practices and the environment.
AS.01.01.02.a. Research and summarizes the major component areas in different animal systems.	AS.01.01.02.b. Describe several characteristics of animals and evaluate reasoning that lead to their domestication.	AS.01.01.02.c. Predict possible trends and their implications within different animal industry and the impact on society and the environment.

Performance Indicator: MN.AS.01.02. Assess and select animal production methods for use in animal systems based upon their effectiveness and impacts.

Minnesota Academic Science Standards

- 9.4.2.1 The interrelationship and interdependence of organisms generate dynamic biological communities in ecosystems.
- 9.4.4.1 Human activity has consequences on living organisms and ecosystems.

MN.AS.01.02 Intro Course Benchmarks	MN.AS.01.02 Intermediate Course Benchmarks	MN.AS.01.02 Advanced Course Benchmarks
AS.01.02.01.a. Identify and categorize terms and methods related to animal production (e.g., sustainable, conventional, humanely raised, natural, organic, etc.).	AS.01.02.01.b. Compare and contrast the impact of methods of animal production on the quality of the final product.	AS.01.02.01.c. Evaluate the effectiveness of different production methods and defend the use of selected methods using data and evidence.
AS.01.02.02.a. Research and examine marketing methods for animal products and services (e.g., conventional, niche markets, locally grown, etc.).	AS.01.02.02.b. Calculate the value of different marketing methods as compared to variable income returns (e.g. direct markets, terminal markets, futures markets).	AS.01.02.02.c. Devise and evaluate marketing plans for an animal agriculture product or service.
AS.01.02.03.a. Summarize the types, purposes, and characteristics of effective record keeping and documentation practices for animal systems enterprises (e.g., managing records for animal identification, feeding, breeding, treatment, income/expense, etc.).	AS.01.02.03.b. Analyze and evaluate the accuracy and effectiveness of records used in an animal system business.	AS.01.02.02.c. Select and defend the use of a specific record management system based upon its effectiveness for a business related to animal systems.

Performance Indicator: MN.AS.01.03. Analyze and apply laws and sustainable practices to animal agriculture from a global perspective.

Minnesota 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.

MN.AS.01.03 Intro Course Benchmarks	MN.AS.01.03 Intermediate Course Benchmarks	MN.AS.01.03 Advanced Course Benchmarks
AS.01.03.01.a. Investigate local, national and global laws pertaining to different animal production systems.	AS.01.03.01.b. Analyze the structure of laws governing animal industries, international trade and animal production policies.	AS.01.03.01.c. Assess the compliance of production practices with established regulations and evaluate the impact of those laws pertaining to different animal agriculture.
AS.01.03.02.a. Summarize the value of sustainability in animals systems.	AS.01.03.02.b. Analyze the local and global impact of sustainable animal agriculture practices on human and environmental systems.	AS.01.03.02.c. Select, evaluate and defend the use of sustainable practices in animal agriculture.

Minnesota Framework: MN.AS.02. Utilize best-practice protocols based upon animal behaviors for animal husbandry and welfare.

Performance Indicator: MN.AS.02.01. Demonstrate management techniques that ensure animal welfare.

Minnesota Academic Science Standards

- 9.1.3.3 Science and engineering operate in the context of society and both influence and are influenced by this context.

MN.AS.02.01 Intro Course Benchmarks	MN.AS.02.01 Intermediate Course Benchmarks	MN.AS.02.01 Advanced Course Benchmarks
AS.02.01.01.a. Discuss possible implications of different animal welfare and animal rights based animal systems.	AS.02.01.01.b. Design programs that assure the welfare of animals and prevent abuse or mistreatment.	AS.02.01.01.c. Describe the implementation and evaluation of quality-assurance programs and procedures for animal production.
AS.02.01.02.a. Research different management practices to reduce the challenges faced in working with animals.	AS.02.01.02.b. Analyze and document animal welfare procedures used to ensure safety and maintain low stress when handling and working with animals.	AS.02.01.02.b. Devise and evaluate safety procedures and plans for working with animals by species using information based on animal behavior and responses.
AS.02.01.03.a. Distinguish between animal husbandry practices that promote animal welfare and those that do not.	AS.02.01.03.b. Analyze and document animal husbandry practices and their impact on animal welfare.	AS.02.01.03.c. Design recommendations to increase the welfare of animals while maintaining economical viability.

Performance Indicator: MN.AS.02.02. Analyze procedures to ensure that animal products are safe for consumption (e.g., use in food system, etc.).

- Minnesota Academic Science Standards**
- 9.1.1.2 Scientific inquiry uses multiple interrelated processes to pose and investigate questions about the natural world.
 - 9C.1.3.3 Developments in chemistry affect society and societal concerns affect the field of chemistry.

MN.AS.02.02 Intro Course Benchmarks	MN.AS.02.02 Intermediate Course Benchmarks	MN.AS.02.02 Advanced Course Benchmarks
AS.02.02.01.a. Identify tools, practices, technology and equipment used in animal systems to help provide an abundant and safe food supply	AS.02.02.01.b. Utilize tools, practices, technology and equipment to perform animal husbandry procedures while maintaining welfare standards	AS.02.02.01.c. Select, evaluate and defend the use of specific tools, practices, technology and/or equipment used to perform animal husbandry and welfare tasks.
AS.02.02.02.a. Research and summarize animal production practices that may pose health risks.	AS.02.02.02.b. Compare and discuss current consumer concerns with animal production practices relative to human health.	AS.02.02.02.c. Research and evaluate programs currently used to assure the safety of animal products for consumption.
AS.02.02.03.a. Identify and describe current animal tracking systems used in animal systems.	AS.02.02.03.b. Evaluate the different possible impacts of animal trace-back capabilities on producers and consumers.	AS.02.02.03.c. Evaluate the effectiveness of animal and/or premise identification programs for a given species.

Minnesota Framework: MN.AS.03. Design and provide proper animal nutrition to achieve desired outcomes for performance, development, reproduction and/or economic production.

Performance Indicator: MN.AS.03.01. Analyze the nutritional needs and available feed rations in an attempt to meet the animal's nutritional requirements.

Minnesota Academic Science Standards

- 9.2.3.2 Energy can be transformed within a system or transferred to other systems or the environment, but is always conserved.

MN.AS.03.01 Intro Course Benchmarks	MN.AS.03.01 Intermediate Course Benchmarks	MN.AS.03.01 Advanced Course Benchmarks
AS.03.01.01.a. Identify and summarize essential nutrients required for animal health and analyze each nutrient's role in growth and performance.	AS.03.01.01.b. Differentiate between nutritional needs of animals in different growth/production stages and systems (e.g., maintenance, gestation, natural, organic, etc.).	AS.03.01.01.c. Assess nutritional needs for an individual animal based on its growth stage and production system.
AS.03.01.02.a. Differentiate between nutritional needs of animal species.	AS.03.01.02.b. Correlate a species' nutritional needs to possible and available feedstuffs to meet those needs.	AS.03.01.02.c. Design and defend a nutritional program by demonstrating the relationship between the nutrient requirements and the feedstuffs provided.

Performance Indicator: MN.AS.03.02. Analyze feed rations and assess if they meet the nutritional needs of animals.

- Minnesota Academic Science Standards**
- 9.1.1.2 Scientific inquiry uses multiple interrelated processes to pose and investigate questions about the natural world.
 - 9.2.3.2 Energy can be transformed within a system or transferred to other systems or the environment, but is always conserved.

MN.AS.03.02 Intro Course Benchmarks	MN.AS.03.02 Intermediate Course Benchmarks	MN.AS.03.02 Advanced Course Benchmarks
AS.03.02.01.a. Compare and contrast common types of feedstuffs and the roles they play in the diets of animals.	AS.03.02.01.b. Analyze and calculate the relative nutritional value of feedstuffs by evaluating their general quality and condition.	AS.03.02.01.c. Select appropriate feedstuffs for animals based on a variety of factors (e.g., economics, digestive system and nutritional needs, etc.).
AS.03.02.02.a. Discuss the importance of a balanced ration for animals based on the animal's growth stage (e.g., maintenance, newborn, gestation, lactation, etc.).	AS.03.02.02.b. Appraise the adequacy of feed rations using data from the analysis of feedstuffs compared to animal requirements and performance.	AS.03.02.02.c. Select and utilize animal feeds based on nutritional requirements, using rations for maximum nutrition and optimal economic production.
AS.03.02.03.a. Summarize the purpose, impact and mode of action of different feed additives and growth promotants in animal production.	AS.03.02.02.b. Compare and contrast methods that utilize feed additives and growth promotants with production practices that do not, (e.g., organic versus conventional production methods).	AS.03.02.03.c. Make and defend decisions regarding whether to use feed additives and growth promotants based on scientific evidence, production system needs and goals, and input from industry standards.

Performance Indicator: MN.AS.03.03. Utilize industry tools to make animal nutrition decisions.

Minnesota Academic Science Standards

- 9.1.3.4 Science, technology, engineering, and mathematics rely on each other to enhance knowledge and understanding.

MN.AS.03.03 Intro Course Benchmarks	MN.AS.03.03 Intermediate Course Benchmarks	MN.AS.03.03 Advanced Course Benchmarks
AS.03.03.01.a. Identify and categorize tools and equipment used to meet animal nutrition needs and ensure an abundant and safe food supply.	AS.03.03.01.b. Utilize tools and equipment to perform animal nutrition tasks.	AS.03.03.01.c. Select, evaluate and defend the use of specific tools or equipment used to perform animal nutrition tasks.
AS.03.03.02.a. Examine and summarize the meaning of various components of feed labels and feeding directions.	AS.03.03.02.b. Analyze and apply information from a feed label and feeding directions to feed animals.	AS.03.03.02.c. Evaluate and summarize the potential impacts, positive and negative, of compliance and/or noncompliance with a feed label and feeding directions.
AS.03.03.03.a. Examine the use of technology to provide animal nutrition.	AS.03.03.03.b. Analyze technologies used to provide animal nutrition and summarize their potential benefits and consequences.	AS.03.03.03.c. Research and recommend technology improvements to provide proper nutrition to animals.

Minnesota Framework: MN.AS.04. Apply principles of animal reproduction to achieve desired outcomes for performance, development and/or economic production.

Performance Indicator: MN.AS.04.01. Evaluate animals for breeding readiness and soundness.

Minnesota Academic Science Standards

- 9.4.3.1 Genetic information found in the cell provides information for assembling proteins which dictate expression of traits in an individual.
- 9.4.3.2 Variation within a species is the natural result of new inheritable characteristics occurring from new combinations of existing genes or from mutations of genes in reproductive cells.
- 9.4.4.1 Human activity has consequences on living organisms and ecosystems.

MN.AS.04.01 Intro Course Benchmarks	MN.AS.04.01 Intermediate Course Benchmarks	MN.AS.04.01 Advanced Course Benchmarks
AS.04.01.01.a. Identify and categorize the male and female reproductive organs of the major animal species.	AS.04.01.01.b. Analyze the functions of major organs in the male and female reproductive systems.	AS.04.01.01.c. Select breeding animals based on characteristics of the reproductive organs.
AS.04.01.02.a. Compare and contrast how age, size, life cycle, maturity level and health status affect the reproductive efficiency of male and female animals.	AS.04.01.02.b. Assess and describe factors that lead to reproductive maturity.	AS.04.01.02.c. Evaluate and select animals for reproductive readiness.
AS.04.01.03.a. Summarize the importance of efficient and economic reproduction in animals.	AS.04.01.02.b. Evaluate reproductive problems that occur in animals.	AS.04.01.03.c. Treat or cull animals with reproductive problems.

Performance Indicator: MN.AS.04.02. Apply scientific principles for the selection of breeding animals.

- Minnesota Academic Science Standards**
- 9.4.3.1 Genetic information found in the cell provides information for assembling proteins which dictate expression of traits in an individual.
 - 9.4.3.2 Variation within a species is the natural result of new inheritable characteristics occurring from new combinations of existing genes or from mutations of genes in reproductive cells.
 - 9.4.4.1 Human activity has consequences on living organisms and ecosystems.

MN.AS.04.02 Intro Course Benchmarks	MN.AS.04.02 Intermediate Course Benchmarks	MN.AS.04.02 Advanced Course Benchmarks
AS.04.02.01.a. Summarize genetic inheritance in animals.	AS.04.02.01.b. Compare and contrast the use of genetically superior animals in the production of animals and animal products.	AS.04.02.01.c. Select and evaluate a breeding system based on the principles of genetics.
AS.04.02.02.a. Identify and summarize inheritance and terms related to inheritance in animal breeding (e.g., dominate, co-dominate, recessive, homozygous, heterozygous, etc.).	AS.04.02.02.b. Demonstrate how to determine probability trait inheritance in animals.	AS.04.02.02.c. Select and evaluate breeding animals and determine the probability of a given trait in their offspring.
AS.04.02.03.a. Identify and summarize genetic defects that affect animal performance.	AS.04.02.03.b. Analyze how DNA analysis can detect genetic defects in breeding stock.	AS.04.02.03.c. Perform a DNA analysis and use the data to make and defend breeding decisions.
AS.04.02.04.a. Identify and summarize different needs of breeding animals based on their growth stages (e.g., newborn, parturition, gestation, gestation lengths, etc.).	AS.04.02.04.b. Analyze the care needs for breeding stock in each stage of growth.	AS.04.02.04.c. Create a plan to differentiate care of a species of breeding animals throughout their growth stages.

Performance Indicator: MN.AS.04.03. Apply scientific principles to breed animals.

- Minnesota Academic Science Standards**
- 9.1.1.2 Scientific inquiry uses multiple interrelated processes to pose and investigate questions about the natural world.
 - 9.1.3.4 Science, technology, engineering, and mathematics rely on each other to enhance knowledge and understanding.
 - 9.4.1.1 Organisms use the interaction of cellular processes to as well as tissues and organ systems to maintain homeostasis.
 - 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.
 - 9.4.3.2 Variation within a species is the natural result of new inheritable characteristics occurring from new combinations of existing genes or from mutations of genes in reproductive cells.
 - 9.4.3.3 Evolution by natural selection is a scientific explanation for the history and diversity of life on Earth.

MN.AS.04.03 Intro Course Benchmarks	MN.AS.04.03 Intermediate Course Benchmarks	MN.AS.04.03 Advanced Course Benchmarks
AS.04.03.01.a. Identify and categorize natural and artificial breeding methods (e.g., natural breeding, artificial insemination, estrous synchronization, flushing, cloning, etc.).	AS.04.03.01.b. Calculate the potential economic benefits of natural versus artificial breeding methods.	AS.04.03.01.c. Select animal breeding methods based on reproductive and economic efficiency.
AS.04.03.02.a. Analyze the materials, methods and processes of artificial insemination.	AS.04.03.02.b. Demonstrate artificial insemination techniques.	AS.04.03.02.c. Evaluate the implementation and effectiveness of artificial insemination techniques.
AS.04.03.03.a. Identify and summarize the advantages and disadvantages of major reproductive management practices, including estrous synchronization, superovulation, flushing and embryo transfer (e.g., cost, labor, equipment, etc.).	AS.04.03.03.b. Analyze the processes of major reproductive management practices, including estrous synchronization, superovulation, flushing and embryo transfer.	AS.04.03.03.c. Create and evaluate plans and procedures for estrous synchronization, superovulation, flushing, embryo transfer and other reproductive management practices.
AS.04.03.04.a. Examine the use of quantitative breeding values (e.g., EPDs, Performance records, pedigrees) in the selection of genetically superior breeding stock.	AS.04.03.04.b. Compare and contrast quantitative breeding value differences between genetically superior animals and animals of average genetic value.	AS.04.03.04.c. Select and assess animal performance based on quantitative breeding values for specific characteristics.

Minnesota Framework: MN.AS.05. Evaluate environmental factors affecting animal performance and implement procedures for enhancing performance and animal health.

Performance Indicator: MN.AS.05.01. Design animal housing, equipment and handling facilities for the major systems of animal production.

Minnesota 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.
- 9.1.3.1 Natural and designed systems are made up of components that act within a system and interact with other systems.
- 9.1.3.3 Science and engineering operate in the context of society and both influence and are influenced by this context.
- 9.1.3.4 Science, technology, engineering, and mathematics rely on each other to enhance knowledge and understanding.
- 9.3.4.1 People consider potential benefits, costs and risks to make decisions on how they interact with natural systems.
- 9.4.4.1 Human activity has consequences on living organisms and ecosystems.

MN.AS.05.01 Intro Course Benchmarks	MN.AS.05.01 Intermediate Course Benchmarks	MN.AS.05.01 Advanced Course Benchmarks
AS.05.01.01.a. Differentiate between the types of facilities needed to house and produce animal species safely and efficiently.	AS.05.01.01.b. Critique designs for an animal facility and prescribe alternative layouts and adjustments for the safe, sustainable and efficient use of the facility.	AS.05.01.01.c. Design an animal facility focusing on animal requirements, economic efficiency, sustainability, safety and ease of handling.
AS.05.01.02.a. Identify and summarize equipment, technology and handling facility procedures used in modern animal production (e.g., climate control devices, sensors, automation, etc.).	AS.05.01.02.b. Analyze the use of modern equipment, technology and handling facility procedures and determine if they enhance the safe, economic and sustainable production of animals.	AS.05.01.02.c. Select, use and evaluate equipment, technology and handling procedures to enhance sustainability and production efficiency.

Performance Indicator: MN.AS.05.02. Comply with government regulations and safety standards for facilities used in animal production.

- Minnesota Academic Science Standards**
- 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.
 - 9.1.3.1 Natural and designed systems are made up of components that act within a system and interact with other systems.
 - 9.1.3.4 Science, technology, engineering, and mathematics rely on each other to enhance knowledge and understanding.
 - 9.4.4.1 Human activity has consequences on living organisms and ecosystems.
 - 9.4.4.2 Personal and community health can be affected by the environment, body functions and human behavior.

MN.AS.05.02 Intro Course Benchmarks	MN.AS.05.02 Intermediate Course Benchmarks	MN.AS.05.02 Advanced Course Benchmarks
AS.05.02.01.a. Identify and summarize the general standards that must be met in facilities for animal production (e.g., environmental, zoning, construction, etc.).	AS.05.02.01.b. Analyze animal facilities to determine if standards have been met.	AS.05.02.01.c. Evaluate facility designs and make recommendations to ensure that it meets standards for the legal, safe, ethical, economical and efficient production of animals.
AS.05.02.02.a. Distinguish between the types of laws and regulations pertaining to animal systems.	AS.05.02.02.b. Analyze the structure of laws pertaining to animal systems.	AS.05.02.02.c. Evaluate the impact of laws pertaining to animal systems.

Minnesota Framework: MN.AS.06. Classify, evaluate and select animals based on anatomical and physiological characteristics.

Performance Indicator: MN.AS.06.01. Classify animals according to taxonomic classification systems and use (e.g. agricultural, companion, etc.).

Minnesota 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.
- 9.1.3.1 Natural and designed systems are made up of components that act within a system and interact with other systems.

MN.AS.06.01 Intro Course Benchmarks	MN.AS.06.01 Intermediate Course Benchmarks	MN.AS.06.01 Advanced Course Benchmarks
AS.06.01.01.a. Explain the importance of the binomial nomenclature system for classifying animals.	AS.06.01.01.b. Explain how animals are classified using a taxonomic classification system.	AS.06.01.01.c. Assess taxonomic characteristics and classify animals according to the taxonomic classification system.
AS.06.01.02.a. Compare and contrast major uses of different animal species (e.g., agricultural, companion, etc.).	AS.06.01.02.b. Appraise and evaluate the economic value of animals for various applications in the agriculture industry.	AS.06.01.02.c. Recommend different uses for an animal species based upon an analysis of local market needs.
AS.06.01.03.a. Identify and summarize common classification terms utilized in animal systems (e.g., external and internal body parts, maturity, mature male, immature female, animal products, breeds, etc.).	AS.06.01.03.b. Analyze the visual characteristics of an animal or animal product and select correct classification terminology when referring to companion and production animals.	AS.06.01.03.c. Apply knowledge of classification terms to communicate with others about animal systems in an effective and accurate manner.

Performance Indicator: MN.AS.06.02. Apply principles of comparative anatomy and physiology to uses within various animal systems.

- Minnesota Academic Science Standards**
- 9.4.1.1 Organisms use the interaction of cellular processes to as well as tissues and organ systems to maintain homeostasis.
 - 9.4.1.2 Cells and cell structures have specific functions that allow an organism to grow, survive and reproduce.
 - 9.4.3.2 Variation within a species is the natural result of new inheritable characteristics occurring from new combinations of existing genes or from mutations of genes in reproductive cells.

MN.AS.06.02 Intro Course Benchmarks	MN.AS.06.02 Intermediate Course Benchmarks	MN.AS.06.02 Advanced Course Benchmarks
AS.06.02.01.a. Research and summarize characteristics of a typical animal cell and identify the organelles.	AS.06.02.01.b. Analyze the functions of each animal cell structure.	AS.06.02.01.c. Correlate the functions of animal cell structures to animal growth, development, health and reproduction.
AS.06.02.02.a. Examine the basic functions of animal cells in animal growth and reproduction.	AS.06.02.02.b. Analyze the processes of meiosis and mitosis in animal growth, development, health and reproduction.	AS.06.02.02.c. Apply the processes of meiosis and mitosis to solve animal growth, development, health and reproductive problems.
AS.06.02.03.a. Identify and summarize the properties, locations, functions and types of animal cells, tissues, organs and body systems.	AS.06.02.03.b. Compare and contrast animal cells, tissues, organs, body systems types and functions among animal species.	AS.06.02.03.c. Apply knowledge of anatomical and physiological characteristics of animals to make production and management decisions.

Performance Indicator: MN.AS.06.03. Select and train animals for specific purposes and maximum performance based on anatomy and physiology.

- Minnesota 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.

MN.AS.06.03 Intro Course Benchmarks	MN.AS.06.03 Intermediate Course Benchmarks	MN.AS.06.03 Advanced Course Benchmarks
AS.06.03.01.a. Identify and summarize how an animal’s health can be affected by anatomical and physiological disorders.	AS.06.03.01.b. Compare and contrast desirable anatomical and physiological characteristics of animals within and between species.	AS.06.03.01.c. Evaluate and select animals to maximize performance based on anatomical and physiological characteristics that affect health, growth and reproduction
AS.06.03.02.a. Evaluate an animal against its optimal anatomical and physiological characteristics.	AS.06.03.02.b. Compare and contrast procedures to sustainably and efficiently develop an animal to reach its highest performance potential with respect to its anatomical and physiological characteristics.	AS.06.03.02.c. Choose, implement and evaluate sustainable and efficient procedures (e.g., selection, housing, nutrition and management) to produce consistently high-quality animals that are well suited for their intended purposes.
AS.06.03.03.a. Research and summarize the use of products and by-products derived from animals.	AS.06.03.03.b. Evaluate and select products from animals based on industry standards.	AS.06.03.03.c. Evaluate and select animals to produce superior animal products based on industry standards.

Minnesota Framework: MN.AS.07. Apply principles of effective animal health care.

Performance Indicator: MN.AS.07.01. Design programs for identification, prevention and treatment of animal diseases, parasites and other disorders and ensure animal welfare.

Minnesota 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.
- 9.1.3.1 Natural and designed systems are made up of components that act within a system and interact with other systems.
- 9.1.3.4 Science, technology, engineering, and mathematics rely on each other to enhance knowledge and understanding.
- 9.4.2.1 The interrelationship and interdependence of organisms generate dynamic biological communities in ecosystems.
- 9.4.4.2 Personal and community health can be affected by the environment, body functions and human behavior.

MN.AS.07.01 Intro Course Benchmarks	MN.AS.07.01 Intermediate Course Benchmarks	MN.AS.07.01 Advanced Course Benchmarks
AS.07.01.01.a. Identify and summarize specific tools and technology used in animal health management.	AS.07.01.01.b. Describe and demonstrate the proper use and function of specific tools and technology related to animal health management.	AS.07.01.01.c. Select and use tools and technology to meet specific animal health management goals.
AS.07.01.02.a. Explain methods of determining animal health and disorders.	AS.07.01.02.b. Perform simple health-check evaluations on animals and practice basic emergency response procedures related to animals.	AS.07.01.02.c. Determine when an animal health concern needs to be referred to an animal health professional.
AS.07.01.03.a. List and summarize the characteristics of wounds, common diseases, parasites and physiological disorders that affect animals.	AS.07.01.03.b. Identify and describe common illnesses and disorders of animals based on symptoms and problems caused by wounds, diseases, parasites and physiological disorders.	AS.07.01.03.c. Treat common diseases, parasites and physiological disorders of animals according to directions prescribed by an animal health professional.
AS.07.01.04.a. Identify and summarize characteristics of causal agents and vectors of diseases and disorders in animals.	AS.07.01.04.b. Research and analyze data to evaluate preventive measures for controlling and limiting the spread of diseases, parasites and disorders among animals.	AS.07.01.04.c. Design and implement health maintenance and a disease and disorder prevention plan for animals in their natural and/or confined environments.
AS.07.01.05.a. Explain the clinical significance of common veterinary methods and treatment (e.g., aseptic techniques, antibiotic use, wound management, etc.).	AS.07.01.05.b. Assess the safety and effectiveness of facilities and equipment used for surgical and nonsurgical veterinary treatments and procedures.	AS.07.01.05.c. Identify and describe surgical and nonsurgical veterinary treatments and procedures to meet specific animal health care objectives.

Performance Indicator: MN.AS.07.02. Analyze biosecurity measures utilized to protect the welfare of animals on a local, state, national, and global level

- Minnesota Academic Science Standards**
- 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.
 - 9.1.3.1 Natural and designed systems are made up of components that act within a system and interact with other systems.
 - 9.1.3.4 Science, technology, engineering, and mathematics rely on each other to enhance knowledge and understanding.

MN.AS.07.02 Intro Course Benchmarks	MN.AS.07.02 Intermediate Course Benchmarks	MN.AS.07.02 Advanced Course Benchmarks
AS.07.02.01.a. Summarize the importance of biosecurity to the animal industry at multiple levels (e.g., local, state, national, global).	AS.07.02.01.b. Analyze procedures at the local, state and national levels to ensure biosecurity of the animal industry.	AS.07.02.01.c. Design and evaluate a biosecurity plan for an animal production operation.
AS.07.02.02.a. Identify and describe zoonotic diseases including their historical significance and potential future implications.	AS.07.02.02.b. Analyze the health risk of different zoonotic diseases to humans and identify prevention methods.	AS.07.02.02.c. Research and evaluate the effectiveness of zoonotic disease prevention methods and procedures to identify those that are best suited to ensure public safety and animal welfare.

Minnesota Framework: MN.AS.08. Analyze environmental factors associated with animal production.

Performance Indicator: MN.AS.08.01. Design and implement methods to reduce the effects of animal production on the environment.

Minnesota Academic Science Standards

- 9.1.3.1 Natural and designed systems are made up of components that act within a system and interact with other systems.
- 9.4.2.1 The interrelationship and interdependence of organisms generate dynamic biological communities in ecosystems.

MN.AS.08.01 Intro Course Benchmarks	MN.AS.08.01 Intermediate Course Benchmarks	MN.AS.08.01 Advanced Course Benchmarks
AS.08.01.01.a. Identify and summarize the effects of animal agriculture on the environment (e.g., waste disposal, carbon footprint, air quality, environmental efficiencies, etc.).	AS.08.01.01.b. Assess the effectiveness of methods of reducing the effects of animal agriculture on the environment.	AS.08.01.01.c. Devise a plan that includes measures to reduce the impact of animal agriculture on the environment.
AS.08.01.02.a. Research and summarize environmental conditions that impact animals (e.g., weather, sources of water, food resources, etc.).	AS.08.01.02.b. Critique the reliability and validity of evidence presented to support claims regarding the effects of environmental conditions on animal populations and performance (e.g., population changes, emerging species, extinction, etc.).	AS.08.01.02.c. Apply valid and reliable research evidence to predict the potential effects of different environmental conditions for an animal population.
AS.08.01.03.a. Identify and summarize methods for ensuring optimal environmental conditions for animals.	AS.08.01.03.b. Implement and evaluate the effectiveness of methods to ensure optimal environmental conditions for animals.	AS.08.01.02.c. Devise and improve plans to establish favorable environmental conditions for animal growth and performance based on a variety of factors (e.g., economic feasibility, environmental sustainability, impact on animals, etc.).

Minnesota Framework: MN.AS.09. Demonstrate the application of biotechnology to solve problems in Agriculture, Food and Natural Resources systems (e.g., bioengineering, food processing, waste management, horticulture, forestry, livestock, crops, etc.).

Performance Indicator: MN.AS.09.01. Apply biotechnology principles, techniques and processes to create transgenic species through genetic engineering

Minnesota 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.
- 9.4.3.2 Variation within a species is the natural result of new inheritable characteristics occurring from new combinations of existing genes or from mutations of genes in reproductive cells

MN.AS.09.01 Intro Course Benchmarks	MN.AS.09.01 Intermediate Course Benchmarks	MN.AS.09.01 Advanced Course Benchmarks
AS.09.01.01.a. Summarize biological, social, agronomic and economic reasons for genetic modification of eukaryotes.	AS.09.01.01.b. Analyze and document the processes and describe the techniques used to produce transgenic eukaryotes (e.g., microbial synthetic biology, gene knockout therapy, traditional gene insertion, etc.).	AS.09.01.01.c. Design and conduct experiments to evaluate an existing transgenic eukaryote.
AS.09.01.02.a. Summarize the process of transformation of eukaryotic cells with transgenic DNA.	AS.09.01.02.b. Assess and argue the pros and cons of transgenic species in agriculture.	AS.09.01.02.c. Transform plant or animal cells by performing a cellular transformation.
AS.09.01.03.a. Analyze the benefits and risks associated with the use of biotechnology to increase productivity and improve quality of living species (e.g., plants, animals such as aquatic species, etc.).	AS.09.01.03.b. Research and evaluate genetic engineering procedures used in the production of living species.	AS.09.01.03.c. Conduct field or clinical trials for genetically modified species.
AS.09.01.04.a. Define and summarize epigenetics and synthesize the relationship between mutation, migration and evolution of transgenes in the environment.	AS.09.01.04.b. Analyze data to identify changes and patterns of transgenic species in the environment.	AS.09.01.04.c. Conduct studies to track the movement of transgenes in the environment.

Performance Indicator: MN.AS.09.02. Apply biotechnology principles, techniques and processes to enhance the production of food through the use of microorganisms and enzymes.

Minnesota Academic Science Standards

- 9.4.1.2 Cells and cell structures have specific functions that allow an organism to grow, survive and reproduce.

MN.AS.09.02 Intro Course Benchmarks	MN.AS.09.02 Intermediate Course Benchmarks	MN.AS.09.02 Advanced Course Benchmarks
AS.09.02.01.a. Summarize reasons for detecting microbes and identify sources of microbes.	AS.09.02.01.b. Assess and describe the use of biotechnology to detect microbes.	AS.09.02.01.c. Design and perform an assay to detect a target microorganism in food, water or the environment.
AS.09.02.02.a. Examine enzymes, the changes they cause and the physical and chemical parameters that affect enzymatic reactions (e.g., food, cellulosic bioenergy, etc.).	AS.09.02.02.b. Analyze processes by which enzymes are produced through biotechnology.	AS.09.02.02.c. Conduct studies using scientific techniques to improve or discover enzymes for use in biotechnology (e.g., microbial strain selection).
AS.09.02.03.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.)	AS.09.02.03.b. Compare and contrast the effectiveness, purpose, and outcomes associated with biotechnology as well as conventional processes used in food processing.	AS.09.02.03.c. Process food using biotechnology to achieve an intended purpose (e.g., preservation, flavor enhancement, etc.).

Performance Indicator: MN.AS.09.03. Apply biotechnology principles, techniques and processes to enhance animal care and production (e.g., selective breeding, pharmaceuticals, biodiversity, etc.).

Minnesota 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.
- 9.1.3.4 Science, technology, engineering, and mathematics rely on each other to enhance knowledge and understanding.
- 9.4.1.2 Cells and cell structures have specific functions that allow an organism to grow, survive and reproduce.

MN.AS.09.03 Intro Course Benchmarks	MN.AS.09.03 Intermediate Course Benchmarks	MN.AS.09.03 Advanced Course Benchmarks
AS.09.03.01.a. Examine and classify biotechnology processes applicable to animal health (e.g., genetic testing, etc.).	AS.09.03.01.b. Assess the benefits, risks and opportunities associated with using biotechnology to promote animal health.	AS.09.03.01.c. Design animal-care protocols to ethically monitor and promote animal systems associated with biotechnology.
AS.09.03.02.a. Research and categorize the types of pharmaceuticals developed for animals and humans through biotechnology.	AS.09.03.02.b. Distinguish the difference between plant-based and animal-based pharmaceuticals and describe their role in agriculture.	AS.09.03.02.c. Evaluate the process used to produce pharmaceuticals from transgenic organisms (e.g., hormones for animals, etc.).
AS.09.03.03.a. Summarize the need for global biodiversity and applications of biotechnology to reduce threats to biodiversity.	AS.09.03.03.b. Assess whether current threats to biodiversity will have an unsustainable impact on human populations.	AS.09.03.03.c. Select and utilize techniques to measure biodiversity in a population.