Animal Systems (AS); Agriculture, Food, and Natural Resources Field/Cluster

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 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 AFNR settings.

Recommended Animal Systems (AS) Courses and Pathway Sequence

Agriculture Combined Program (019901)

| Introductory (Intro.) Courses | Intermediate (Interm.) Courses | Advanced (Adv.) Courses |
| --- | --- | --- |
| Number and Name | Number and Name | Number and Name |
| * 01 Principles of Ag., Food, and Natural Resources * 02 Advanced Principles of Ag., Food, and Natural Resources * 03 Principles of AFNR Biology (Science-Elective Credit) * 04 Advanced Principles of AFNR Biology (Science-Elective Credit) * 15 Animal Science and Small Animal Care * 16 Advanced Animal Science and Large Animal Care * 17 Animal Biology (Science-Elective Credit) * 18 Advanced Animal Biology (Science-Elective Credit) | * 19 Equine Science * 20 Livestock and Poultry Production * 21 Livestock, Poultry, and Equine Operations (Simulated WBL: School Farm) * 22 Aquaculture Operations (Simulated WBL: School Farm) * 23 Aquacultural Chemistry (Science Credit; Simulated WBL: School Farm) * 24 Veterinary Science * 25 Advanced Veterinary Science * 26 Veterinary Biology (Science-Elective Credit) * 27 Advanced Veterinary Biology (Science-Elective Credit) * 28 Small Animal Care Operations (Simulated WBL: School Business) | * 13 Agricultural Education, Research, and Development * 29 Specialty and Emerging Animal Systems Topics * 75 Food Science * 76 Advanced Food Science * 77 Food Chemistry (Science Credit) * 78 Advanced Food Chemistry (Science Credit) * 85 Animal and Plant Biotechnology * 86 Advanced Animal and Plant Biotechnology * 87 Agricultural Biotechnology and Biology (Science-Elective Credit) * 88 Advanced Agricultural Biotechnology and Biology (Science-Elective Credit) * 93 Extended/ Summer AFNR Work-Based Learning (SAE) and Leadership (FFA) * 94 Agricultural Leadership Development * 95 Agricultural Career Seminar * 96 Advanced Agricultural Career Seminar * 97 AFNR Work Experience: Immersion SAE (Adv. Internship/Placement, Entrepreneurship, Research) |

Work-Based Learning and Supervised Agricultural Experiences

Supervised Agricultural Experience (SAE) is a student-led, instructor-supervised, Work-Based Learning (WBL) experience that results in measurable outcomes within a predefined, agreed upon set of AFNR Technical Standards and Career Ready Practices aligned to a Career Plan of study. SAE teaches technical skills and knowledge within the psychomotor domain of learning. SAE includes both experiential learning (i.e., pre-WBL) and WBL (federally defined as sustained interactions with industry or community professionals in real workplace settings, to the extent practicable, or simulated environments, at an educational institution that foster in-depth, firsthand engagement with the tasks required in a given career field, that are aligned to curriculum and instruction; Sec. 3 [20 U.S.C. 2302] 55).

SAE/WBL is a required component of an AFNR program, first established in the Smith-Hughes Act (1917) and reinforced in each of the federal Perkins Career and Technical Education (CTE) Acts (1984 – I; 1990 – II; 1998 – III; 2006 – IV; 2018 – V, Public Law No. 115-224). Minnesota also requires WBL/SAE as a component of CTE Program Approval (Rule 3505). Table 1 contains example SAE opportunities, as defined by the National Council for Agricultural Education, Perkins V federal legislation, and the Minnesota Department of Education.

Table 1.

Examples of WBL/SAE Curricula and Programs that Relate to Animal Systems, Non-Exhaustive.

| Experiential Learning (Foundational SAE; Pre-WBL) | None |
| --- | --- |
| * Job shadow * Service learning * Field trips * Career exploration | * Showing or judging livestock * Job shadowing in the animal industry * Field trip to local animal shelter * Train an animal basic commands |

| Internship (Placement SAE; Immersion WBL) | Entrepreneurship (Entrepreneurship SAE; Immersion WBL) |
| --- | --- |
| * Working at a Veterinary Clinic/Humane Society/Groomer * Working for a livestock producer * Working in a livestock feed processing/testing facility | * Breeding/raising animal herd for market animals * Animal care business (i.e., pet sitting, dog grooming, etc.) * Livestock fitting and trimming business |
| Research (Research SAE; Immersion WBL) | School-Based Enterprise (School-Based SAE; Simulated WBL) |
| * Consumer research perceptions of grass-fed beef * Animal weight gain research * Animal health or reproduction research | * Aquaculture Operations SBE WBL * Animal Production/School Farm Operations SBE WBL * Honey Production/Operations SBE WBL |
| Apprenticeship (Adv. Placement SAE; Immersion WBL) | FFA Work-Based Learning and SAE Proficiency Award Areas |
| * More than 450 hours in an internship, combined with coursework. Contact MDE for support. | * Agriscience Research – Animal Systems * Dairy Production * Veterinary Science * Wildlife Production and Management |

Leadership Development and National FFA Organization

The National FFA Organization (FFA) is a student-led, instructor-supervised, Career and Technical Student Organization (CTSO) that results in measurable outcomes within a predefined, agreed upon set of AFNR Social-Emotional Standards and Career Ready Practices aligned to a Career Plan of study. FFA teaches social-emotional and leadership skills and knowledge within the affective domain of learning. FFA includes programs that provide essential employability skills such as critical thinking, consensus building, communication, teamwork, and leadership. FFA was founded in 1928 and is federally defined as intracurricular (within the curriculum; cf. extracurricular: external, co-curricular: alongside) and an integral (necessary to comprise the whole) component of School-Based AFNR Education (Public Law No. 116-7).

Leadership/FFA is a required component of an AFNR program, formalized in the FFA Federal Charter in 1950 (Public Law No. 116-7) and reinforced in federal Perkins CTE Acts (1984 – I; 1990 – II; 1998 – III; 2006 – IV; 2018 – V, Public Law No. 115-224). Minnesota also requires leadership/FFA as a component of CTE Program Approval (Rule 3505). Table 2 contains example FFA opportunities, as defined by the National Council for Agricultural Education, Perkins V federal legislation, the Minnesota Department of Education, and the Minnesota FFA Association.

Table 2.

Examples of Leadership/FFA Curricula and Programs that Relate to Animal Systems, Non-Exhaustive.

| Student Development Programs (Growing Leaders) | Community Development/ Service (Building Communities) |
| --- | --- |
| * Agriscience or SAE Fair * Animal facility tours * Career Day/Guest speakers | * Host a pet supply drive for local animal shelter * Raising an animal to donate to food shelf * Raising/training a service animal |
| Literacy, Advocacy, and Safety (Strengthening Agriculture) | Conferences, Conventions, and Banquets |
| * CHS Miracle of Birth Barnyard attendant * Animal welfare project * Safe animal handling education * County fair animal exhibit | * #FFANextGen Animal Science conference * InTENse * Horizon conference * Livestock Industry Events (e.g., Cattlemen’s Association, Pork Producers, Turkey Growers) |
| Career Development Events (CDE) | Leadership Development Events (LDE) |
| * Dairy Evaluation * Horse Evaluation * Livestock Evaluation * Meats Evaluation and Technology * Milk Quality and Products * Poultry Evaluation * Small Animal Veterinary Science | * Agricultural Issues Forum * Marketing Plan * Prepared Public Speaking * Extemporaneous Speaking |

Minnesota AFNR: Animal Systems Standards

| [MN.AS.01. Analyze historic and current trends impacting the animal systems industry.](#as1) |
| --- |
| MN.AS.01.01. Evaluate the development and implications of animal origin, domestication, and distribution on production practices and the environment. |
| MN.AS.01.02. Assess and select animal production methods for use in animal systems based upon their effectiveness and impacts. |
| MN.AS.01.03. Analyze and apply laws and sustainable practices to animal agriculture from a global perspective. |

| [MN.AS.02. Utilize best-practice protocols based upon animal behaviors for animal husbandry and welfare.](#as2) |
| --- |
| MN.AS.02.01. Demonstrate management techniques that ensure animal welfare. |
| MN.AS.02.02. Analyze procedures to ensure that animal products are safe for consumption (e.g., use in food system). |

| [MN.AS.03. Design and provide proper animal nutrition to achieve desired outcomes for performance, development, reproduction, and economic production.](#as3) |
| --- |
| MN.AS.03.01. Analyze the nutritional needs and available feed rations in an attempt to meet the animal’s nutritional requirements. |
| MN.AS.03.02. Analyze feed rations and assess if they meet the nutritional needs of animals. |
| MN.AS.03.03. Utilize industry tools to make animal nutrition decisions. |

| [MN.AS.04. Apply principles of animal reproduction to achieve desired outcomes for performance, development, and economic production.](#as4) |
| --- |
| MN.AS.04.01. Evaluate animals for breeding readiness and soundness. |
| MN.AS.04.02. Apply scientific principles for the selection of breeding animals. |
| MN.AS.04.03. Apply scientific principles to breed animals. |

| [MN.AS.05. Evaluate environmental factors affecting animal performance and implement procedures for enhancing performance and animal health.](#as5) |
| --- |
| MN.AS.05.01. Design animal housing, equipment, and handling facilities for the major systems of animal production. |
| MN.AS.05.02. Comply with government regulations and safety standards for facilities used in animal production. |

| [MN.AS.06. Classify, evaluate, and select animals based on anatomical and physiological characteristics.](#as6) |
| --- |
| MN.AS.06.01. Classify animals according to taxonomic classification systems and use (e.g., agricultural, companion). |
| MN.AS.06.02. Apply principles of comparative anatomy and physiology to uses within various animal systems. |
| MN.AS.06.03. Select and train animals for specific purposes and maximum performance based on anatomy and physiology. |

Minnesota AFNR: Animal Systems Standards Continued

| [MN.AS.07. Apply principles of effective animal health care.](#as7) |
| --- |
| MN.AS.07.01. Design programs for identification, prevention, and treatment of animal diseases, parasites, and other disorders and ensure animal welfare. |
| MN.AS.07.02. Analyze biosecurity measures utilized to protect the welfare of animals on a local, state, national, and global level. |
| MN.AS.07.03. Demonstrate technical skills through clinical, hospital, and other laboratory procedures (e.g., restraints, injections, bandaging, physical exams, fecal exam). |

| [MN.AS.08. Analyze environmental factors associated with animal production.](#as8) |
| --- |
| MN.AS.08.01. Design and implement methods to reduce the effects of animal production on the environment. |
| MN.AS.08.02. Evaluate the effect of environmental conditions on animals and create plans to ensure favorable environments for animals. |

| 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. |
| MN Academic Science Standards (2009)   * 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. Interm. Course Benchmarks | MN.AS.01.01. Adv. 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 led 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. |

| Minnesota Framework: MN.AS.01. Analyze historic and current trends impacting the animal systems industry. |
| --- |
| Performance Indicator: MN.AS.01.02. Assess and select animal production methods for use in animal systems based upon their effectiveness and impacts. |
| MN Academic Science Standards (2009)   * 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. Interm. Course Benchmarks | MN.AS.01.02. Adv. 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). | 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). | 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). | 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. |

| Minnesota Framework: MN.AS.01. Analyze historic and current trends impacting the animal systems industry. |
| --- |
| Performance Indicator: MN.AS.01.03. Analyze and apply laws and sustainable practices to animal agriculture from a global perspective. |
| MN Academic Science Standards (2009)   * 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. Interm. Course Benchmarks | MN.AS.01.03. Adv. 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. |
| MN Academic Science Standards (2009)   * 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. Interm. Course Benchmarks | MN.AS.02.01. Adv. 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.c. 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 economic viability. |
| AS.02.01.04.a. Research animal training practices that promote and ensure animal welfare. | AS.02.01.04.b. Analyze and document animal training practices and their impact on animal welfare. | AS.02.01.04.c. Design an animal training program with recommendations to increase the welfare of animals. |

| Minnesota Framework: MN.AS.02. Utilize best-practice protocols based upon animal behaviors for animal husbandry and welfare. |
| --- |
| Performance Indicator: MN.AS.02.02. Analyze procedures to ensure that animal products are safe for consumption (e.g., use in food system). |
| MN Academic Science Standards (2009)   * 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. Interm. Course Benchmarks | MN.AS.02.02. Adv. 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 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 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 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. |
| MN Academic Science Standards (2009)   * 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. Interm. Course Benchmarks | MN.AS.03.01. Adv. 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). | 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. |

| Minnesota Framework: MN.AS.03. Design and provide proper animal nutrition to achieve desired outcomes for performance, development, reproduction, and economic production. |
| --- |
| Performance Indicator: MN.AS.03.02. Analyze feed rations and assess if they meet the nutritional needs of animals. |
| MN Academic Science Standards (2009)   * 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. Interm. Course Benchmarks | MN.AS.03.02. Adv. 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, nutritional needs). |
| 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). | 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.03.02.03.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. |

| Minnesota Framework: MN.AS.03. Design and provide proper animal nutrition to achieve desired outcomes for performance, development, reproduction, and economic production. |
| --- |
| Performance Indicator: MN.AS.03.03. Utilize industry tools to make animal nutrition decisions. |
| MN Academic Science Standards (2009)   * 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. Interm. Course Benchmarks | MN.AS.03.03. Adv. 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 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 economic production. |
| --- |
| Performance Indicator: MN.AS.04.01. Evaluate animals for breeding readiness and soundness. |
| MN Academic Science Standards (2009)   * 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. Interm. Course Benchmarks | MN.AS.04.01. Adv. 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.04.01.03.b. Evaluate reproductive problems that occur in animals. | AS.04.01.03.c. Treat or cull animals with reproductive problems. |

| Minnesota Framework: MN.AS.04. Apply principles of animal reproduction to achieve desired outcomes for performance, development, and economic production. |
| --- |
| Performance Indicator: MN.AS.04.02. Apply scientific principles for the selection of breeding animals. |
| MN Academic Science Standards (2009)   * 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. Interm. Course Benchmarks | MN.AS.04.02. Adv. 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). | 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). | 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. |

| Minnesota Framework: MN.AS.04. Apply principles of animal reproduction to achieve desired outcomes for performance, development, and economic production. |
| --- |
| Performance Indicator: MN.AS.04.03. Apply scientific principles to breed animals. |
| MN Academic Science Standards (2009)   * 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. Interm. Course Benchmarks | MN.AS.04.03. Adv. 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). | 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). | 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. |
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| Performance Indicator: MN.AS.05.01. Design animal housing, equipment, and handling facilities for the major systems of animal production. |
| MN Academic Science Standards (2009)   * 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. Interm. Course Benchmarks | MN.AS.05.01. Adv. Course Benchmarks |
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| 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). | 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. |

| Minnesota Framework: MN.AS.05. Evaluate environmental factors affecting animal performance and implement procedures for enhancing performance and animal health. |
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| Performance Indicator: MN.AS.05.02. Comply with government regulations and safety standards for facilities used in animal production. |
| MN Academic 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. Interm. Course Benchmarks | MN.AS.05.02. Adv. Course Benchmarks |
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| 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). | 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, economic, 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. |
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| Performance Indicator: MN.AS.06.01. Classify animals according to taxonomic classification systems and use (e.g., agricultural, companion). |
| MN Academic Science Standards (2009)   * 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. Interm. Course Benchmarks | MN.AS.06.01. Adv. Course Benchmarks |
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| 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). | 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). | 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. |

| Minnesota Framework: MN.AS.06. Classify, evaluate, and select animals based on anatomical and physiological characteristics. |
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| Performance Indicator: MN.AS.06.02. Apply principles of comparative anatomy and physiology to uses within various animal systems. |
| MN Academic Science Standards (2009)   * 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. Interm. Course Benchmarks | MN.AS.06.02. Adv. Course Benchmarks |
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| 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. |

| Minnesota Framework: MN.AS.06. Classify, evaluate, and select animals based on anatomical and physiological characteristics. |
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| Performance Indicator: MN.AS.06.03. Select and train animals for specific purposes and maximum performance based on anatomy and physiology. |
| MN Academic Science Standards (2009)   * 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. Interm. Course Benchmarks | MN.AS.06.03. Adv. Course Benchmarks |
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| 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, 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. |
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| Performance Indicator: MN.AS.07.01. Design programs for identification, prevention, and treatment of animal diseases, parasites, and other disorders and ensure animal welfare. |
| MN Academic Science Standards (2009)   * 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. Interm. Course Benchmarks | MN.AS.07.01. Adv. Course Benchmarks |
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| 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 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). | 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. |

| Minnesota Framework: MN.AS.07. Apply principles of effective animal health care. |
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| Performance Indicator: MN.AS.07.02. Analyze biosecurity measures utilized to protect the welfare of animals on a local, state, national, and global level. |
| MN Academic Science Standards (2009)   * 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. Interm. Course Benchmarks | MN.AS.07.02. Adv. Course Benchmarks |
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| 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.07. Apply principles of effective animal health care. |
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| Performance Indicator: MN.AS.07.03. Demonstrate technical skills through clinical, hospital, and other laboratory procedures (e.g., restraints, injections, bandaging, physical exams). |
| MN Academic Science Standards (2009)   * 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.07.03. Intro. Course Benchmarks | MN.AS.07.03. Interm. Course Benchmarks | MN.AS.07.03. Adv. Course Benchmarks |
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| AS.07.03.01.a. Summarize the importance of technical skills and clinical procedures in the veterinary industry. | AS.07.03.01.b. Analyze when the procedures would be utilized in the clinic setting and describe how they would be performed. | AS.07.03.01.c. Demonstrate the clinical procedures performed in the veterinary medicine industry. |

| Minnesota Framework: MN.AS.08. Analyze environmental factors associated with animal production. |
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| Performance Indicator: MN.AS.08.01. Design and implement methods to reduce the effects of animal production on the environment. |
| MN Academic Science Standards (2009)   * 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. Interm. Course Benchmarks | MN.AS.08.01. Adv. Course Benchmarks |
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| 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). | 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). | 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). | 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.08.01.03.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). |

**Secondary/Interdisciplinary AFNR Pathways that Align with Animal Systems**

* [**Agribusiness Systems (ABS)**](#ABS_Standards)—a secondary or multidisciplinary AFNR pathway, often integrating standards or cumulating from coursework from the AFNR animal, plant, natural resources, and power systems pathways—encompassing the study of agribusinesses and their management including, but not limited to, record keeping, budget management (cash and credit), business planning, and sales and marketing. Students completing a program of study in this pathway will demonstrate competence in the application of principles and techniques for the planning, development, application, and management of agribusiness systems in AFNR settings.
* [**Food Products and Processing Systems (FPP)**](#FPP_Standards)—a secondary or multidisciplinary AFNR pathway—often integrating standards or cumulating from coursework from the AFNR animal and plant systems pathways—encompassing 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 systems in AFNR settings.
* [**Biotechnology Systems (BS)**](#BS_Standards)—a secondary or multidisciplinary AFNR pathway—often integrating standards or cumulating from coursework from the AFNR animal, plant, and natural resources pathways—encompassing the study of using data and scientific techniques to solve problems concerning living organisms with an emphasis on applications to agriculture, food, and natural resource systems. 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 biotechnology systems in AFNR settings.