2023 Aquaculture

Program CIP: 01.0303 — Aquaculture

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The Research and Curriculum Unit (RCU), located in Starkville, as part of Mississippi State University (MSU), was established to foster educational enhancements and innovations. In keeping with the land-grant mission of MSU, the RCU is dedicated to improving the quality of life for Mississippians. The RCU enhances intellectual and professional development of Mississippi students and educators while applying knowledge and educational research to the lives of the people of the state. The RCU works within the contexts of curriculum development and revision, research, assessment, professional development, and industrial training.

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Acknowledgments

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Mr. Michael D. Kent, interim state superintendent of education
Mrs. Rosemary G. Aultman, chair
Mr. Glen V. East, vice chair
Mrs. Mary Werner
Dr. Ronnie L. McGehee
Dr. Wendi Barrett
Mr. Matt Miller
Mr. Bill Jacobs
Ms. Micah Hill, student representative
Mr. Charlie Fruge', student representative

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Megan Gima, oyster hatchery manager at the University of Southern Mississippi Thad Cochran Marine Aquaculture Center
Michael Lee, aquaculture manager at the Mississippi Department of Marine Resources
Jason Snawder, biological program coordinator at the Mississippi Department of Marine Resources

Standards

Standards and alignment crosswalks are referenced in the appendix. Depending on the curriculum, these crosswalks should identify alignment to the standards mentioned below, as well as possible related academic topics as required in the Subject Area Testing Program in Algebra I, Biology I, English II, and U.S. History from 1877, which could be integrated into the content of the units. Mississippi's CTE aquaculture technology is aligned to the following standards:

National Agriculture, Food, and Natural Resources (AFNR) Career Cluster Content Standards

The National AFNR Career Cluster Content Standards were developed by the National Council on Agricultural Education to serve as a guide for what students should know or be able to do through a study of agriculture in Grades 9-12 and two-year postsecondary programs. The standards were extensively researched and reviewed by leaders in the agricultural industry, secondary and postsecondary instructors, and university specialists. The standards consist of a pathway content standard for each of the eight career pathways. For each content standard, performance elements representing major topic areas with accompanying performance indicators were developed. Measurements of assessment of the performance elements and performance indicators were developed at the basic, intermediate, and advanced levels. The National AFNR Career Cluster Content Standards are copyrighted by the National Council for Agricultural Education and are used with permission.
thecouncil.ffa.org/afnr

International Society for Technology in Education Standards (ISTE)

Reprinted with permission from *ISTE Standards for Students* (2016). All rights reserved. Permission does not constitute an endorsement by ISTE.
iste.org

College- and Career-Ready Standards

College- and career-readiness standards emphasize critical thinking, teamwork, and problem-solving skills. Students will learn the skills and abilities required by the workforce of today and the future. Mississippi adopted Mississippi College- and Career-Readiness Standards (MCCRS) to provide a consistent, clear understanding of what students are expected to learn so teachers and parents know what they need to do to help them.
mdek12.org/oae/college-and-career-readiness-standards

Framework for 21st Century Learning

In defining 21st-century learning, the Partnership for 21st Century Skills has embraced key themes and skill areas that represent the essential knowledge for the 21st century: global awareness; financial, economic, business, and entrepreneurial literacy; civic literacy; health literacy; environmental literacy; learning and innovation skills; information, media, technology skills; and life and career skills. 21 *Framework Definitions* (2019).
battelleforkids.org/networks/p21/frameworks-resources

Preface

Secondary CTE programs in Mississippi face many challenges resulting from sweeping educational reforms at the national and state levels. Schools and teachers are increasingly being held accountable for providing applied learning activities to every student in the classroom. This accountability is measured through increased requirements for mastery and attainment of competency as documented through both formative and summative assessments. This document provides information, tools, and solutions that will aid students, teachers, and schools in creating and implementing applied, interactive, and innovative lessons. Through best practices, alignment with national standards and certifications, community partnerships, and a hands-on, student-centered concept, educators will be able to truly engage students in meaningful and collaborative learning opportunities.

The courses in this document reflect the statutory requirements as found in Section 37-3-49, *Mississippi Code of 1972*, as amended (Section 37-3-46). In addition, this curriculum reflects guidelines imposed by federal and state mandates (Laws, 1988, Ch. 487, §14; Laws, 1991, Ch. 423, §1; Laws, 1992, Ch. 519, §4 eff. from and after July 1, 1992; Strengthening Career and Technical Education for the 21st Century Act, 2019 [Perkins V]; and Every Student Succeeds Act, 2015).

Mississippi Teacher Professional Resources

The following are resources for Mississippi teachers:

Curriculum, Assessment, Professional Learning

Program resources can be found at the RCU's website, rcu.msstate.edu.

Learning Management System: An Online Resource

Learning management system information can be found at the RCU's website, under Professional Learning.

Should you need additional instructions, call the RCU at 662.325.2510.

Executive Summary

Pathway Description
Aquaculture is an instructional program designed to prepare students to enter occupations related to the field. Upon completion of the two-year program, graduates may become employed at the entry level or further pursue the field in a postsecondary program. The concepts taught in this program include aquatic animal and plant husbandries, basic water management, hatchery and culture methods, and aquatic farm management.

College, Career, and Certifications
No national industry-recognized certifications are known to exist at this time in the field of agriscience. Competencies and suggested performance indicators in the aquaculture technology course have been correlated, however, to the National Agriculture, Food, and Natural Resources (AFNR) Career Cluster Content Standards that have been reviewed and endorsed at the national level by the National Council on Agricultural Education.

Grade Level and Class Size Recommendations
It is recommended that students enter this program as 10th graders. Exceptions to this are a district-level decision based on class size, enrollment numbers, student maturity, and CTE delivery method. This is a hands-on, lab- or shop-based course. Therefore, a maximum of 15 students is recommended per class with only one class with the teacher at a time.

Student Prerequisites
For students to experience success in the program, the following student prerequisites are suggested:

1. C or higher in English (the previous year)
2. C or higher in high school-level math (last course taken or the instructor can specify the level of math instruction needed)
3. Instructor approval and TABE reading score (eighth grade or higher)

or

1. TABE reading and math score (eighth grade or higher)
2. Instructor approval

or

1. Instructor approval

Assessment
The latest assessment blueprint for the curriculum can be found at rcu.msstate.edu/curriculum/curriculumdownload.

Applied Academic Credit
The latest academic credit information can be found at mdek12.org/ese/approved-course-for-the-secondary-schools.

Teacher Licensure
The latest teacher licensure information can be found at mdek12.org/oel/apply-for-an-educator-license.

Professional Learning

If you have specific questions about the content of any of training sessions provided, please contact the RCU at 662.325.2510.

Course Outlines

Option 1—Four 1-Carnegie Unit Courses

This curriculum consists of four 1-credit courses, which should be completed in the following sequence:

1. **Introduction to Aquaculture—Course Code: 991602**
2. **Basic Aquaculture—Course Code: 991603**
3. **Advanced Aquaculture—Course Code: 991604**
4. **Application of Aquaculture—Course 991605**

Course Description: Introduction to Aquaculture
Introduction to Aquaculture covers the history and scope of the aquaculture industry in the United States and Mississippi. Students will learn about the associated CTE student organization, how they can become involved in leadership and career development through the FFA and begin planning for their personalized supervised agricultural experience (SAE) program. Further studies in aquaculture will focus on water chemistry, aquatic-species health management, and fish-hatchery maintenance and operation.

Course Description: Basic Aquaculture
This course will take students on an in-depth journey into various aquatic environments. Students will explore the various organisms grown in these diverse environments, which are distinguished by the operating system, water temperature, and salinity levels. Students will also investigate aquatic plants while creating contained and controlled aquatic habitats for study and research.

Course Description: Advanced Aquaculture
In the Advanced Aquaculture course, students will learn advanced concepts and skills related to managing a controlled aquatic environment for animal and plant production. This hands-on, interactive course focuses on the maintenance and management of production systems with real-life aquaculture systems.

Course Description: Application of Aquaculture
In the Application of Aquaculture course, students will culminate the aquaculture program with independent study and research associated with aquatic plant or fish production. Students will apply practices, methods, and knowledge obtained throughout this course of study to produce a crop from an aquaculture system to effectively manage aquatic resources for the successful production of an aquatic crop.

Introduction to Aquaculture—Course Code: 991602

Unit	Unit Name	Hours
1	History and Overview of Aquaculture	30
2	Safety and Biosecurity	45
3	Professional and Student Organizations	20
4	Supervised Agriculture Experience (SAE)for All	45
Total		140

Basic Aquaculture—Course Code: 991603

Unit	Unit Name	Hours
5	Basic Water Chemistry and Management	45
6	Major and Minor Crops With Applications	40
7	Aquatic Resources Management	25
8	The Aquaculture Industry	30
Total		140

Advanced Aquaculture—Course Code: 991604

Unit	Unit Name	Hours
9	Hatchery Management and Operation	45
10	Aquatic Health Management	50
11	Immersion Into FFA and Supervised Agricultural Experience (SAE) for All	45
Total		140

Application of Aquaculture—Course Code: 991605

Unit	Unit Name	Hours
12	Aquaculture Wastes and Remediation	40
13	Advanced Culture Methods	45
14	Pond Aquaculture	35
15	Independent Research Project for Aquaculture	20
Total		140

Option 2—Two 2-Carnegie Unit Courses

This curriculum consists of two 2-credit courses, which should be completed in the following

sequence:

1. **Aquaculture Concepts—Course Code: 991600**
2. **Aquaculture Application-Course Code:991601**

Course Description: Aquaculture Concepts
Agriculture Concepts is designed to introduce basic concepts used in aquaculture farm production and maintenance. The material emphasizes a strong science background, which is taught through the application of concepts. These basic concepts provide an interesting background in the field of aquaculture (2-2.5 Carnegie Units, depending upon time spent in the course).

Course Description: Aquaculture Application
Aquaculture Application is an extension of Aquaculture Concepts in that the course completes preparation for entry-level employment or continuation into a postsecondary program. This course extends the science background through the application of concepts. Units of study for this course provide a working knowledge of aquaculture-farm production and maintenance and require independent performance of tasks (2-2.5 Carnegie Units. depending upon time spent in the course).

Aquaculture Concepts—991600

Unit	Unit Name	Hours
1	History and Overview of Aquaculture	30
2	Safety and Biosecurity	45
3	Professional and Student Organizations	20
4	Supervised Agriculture Experience (SAE) for All	40
5	Basic Water Chemistry and Management	45
6	Major and Minor Crops with Applications	45
7	Aquatic Resources Management	25
8	The Aquaculture Industry	30
Total		280

Aquaculture Application—991601

Unit	Unit Name	Hours
9	Hatchery Management and Operation	40
10	Aquatic Health Management	50
11	Immersion Into FFA and Supervised Agricultural Experience (SAE) for All	30
12	Aquaculture Wastes and Remediation	45
13	Advanced Culture Methods	50
14	Pond Aquaculture	40
15	Independent Research Project for Aquaculture	25
Total		280

Career Pathway Outlook

Overview

According to the USDA's National Institute of Food and Agriculture (NIFA), the aquaculture industry is expected to produce two-thirds of the fish consumed by the world population by 2030. Wild fish harvesting is reaching a critical sustainability point; therefore, the need for controlled aquatic environments suitable for producing fish for human consumption is steadily increasing. Training a generation of students to produce healthy, highly nutritional crops in aquaculture; research new and improved production methods; reduce waste; and utilize existing natural resources is a considerable challenge, but not out of reach. Skilled and knowledgeable workers are needed to meet the growing demands of the aquaculture industry.

Aquaculture will target careers at the professional and technical levels in agriculture. Students enrolled in these courses should be better prepared to pursue degrees at the community college and four-year college levels.

Needs of the Future Workforce

Data for this synopsis were compiled from the Mississippi Department of Employment Security (2022). Employment opportunities for each of the occupations are listed below:

Table 1.1: Current and Projected Occupation Report

	Employment		Projected Growth 2018-2028		Average Wage 2021	
Occupation	Current (2018)	Projected (2028)	Number	Percent	Hourly	Annual
Animal Food Manufacturing	25,150	25,470	320	1.3%	$21.92	$45,604
Animal Production and Aquaculture	3,510	3,480	-30	-0.9%	$16.68	$34,730
Civil Engineers	1,590	1,670	90	4.1%	$42.84	$89,120
Conservation Scientists	880	1,330	60	4.6%	$27.21	$56,590
Environmental Engineers	450	470	20	4.4%	$38.92	$80,940
Environmental Engineering Technicians	70	70	0	0%	$19.41	$40,360
Environmental Scientists and Specialists, Including Health	540	570	30	5.6%	$24.45	$50,860
Farmworkers, Farm, Ranch and Aquaculture Animals	6,120	6,120	0	0%	$16.02	$33,320
Farming, Fishing, and Forestry Workers	12,600	12,270	-330	-2.6%	$18.20	$37,860
First-Line Supervisors of Farming, Fishing and Forestry Workers	830	830	0	0%	$26.11	$54,300
Meat, Poultry, and Fish Cutters and Trimmers	6,650	6,730	80	1.2%	$14.37	$29,880

Seafood Product Preparation and Packaging, Support Activities	2,350	2,460	110	4.7%	$12.17	$25,345
Zoologists and Wildlife Biologists	420	440	20	4.8%	$35.10	$73,010

Source: Mississippi Department of Employment Security; mdes.ms.gov (2022).

Perkins V Requirements and Academic Infusion

The Aquaculture curriculum meets Perkins V requirements of introducing students to and preparing them for high-skill, high-wage occupations in aquaculture fields. It also offers students a program of study, including secondary, postsecondary, and institutions of higher learning courses, that will further prepare them for aquaculture careers. Additionally, this curriculum is integrated with academic college- and career-readiness standards. Lastly, it focuses on ongoing and meaningful professional development for teachers and relationships with industry.

Transition to Postsecondary Education

The latest articulation information for secondary to postsecondary can be found at the Mississippi Community College Board website, mccb.edu.

Best Practices

Innovative Instructional Technologies

Classrooms should be equipped with tools that will teach today's digital learners through applicable and modern practices. The aquaculture educator's goal should be to include teaching strategies that incorporate current technology. To make use of the latest online communication tools—wikis, blogs, podcasts, and social media platforms, for example—the classroom teacher is encouraged to use a learning management system that introduces students to education in an online environment and places more of the responsibility of learning on the student.

Differentiated Instruction

Students learn in a variety of ways, and numerous factors—students' background, emotional health, and circumstances, for example—create unique learners. By providing various teaching and assessment strategies, students with various learning preferences can have more opportunity to succeed.

CTE Student Organizations

Teachers should investigate opportunities to sponsor a student organization. There are several here in Mississippi that will foster the types of learning expected from the Aquaculture curriculum. FFA is an example of a student organization outlet for aquaculture students. Student organizations provide participants and members with growth opportunities and competitive events. They also open the doors to the world of agriculture careers and scholarship opportunities.

Cooperative Learning

Cooperative learning can help students understand topics when independent learning cannot. Therefore, you will see several opportunities in the Aquaculture curriculum for group work. Students need to be able to work collaboratively with others and solve problems without excessive conflict to function in today's workforce. The Aquaculture curriculum provides opportunities for students to work together and help each other complete complex tasks. There are many field experiences within the Aquaculture curriculum that will allow and encourage collaboration with professionals currently in the aquaculture field.

Work-Based Learning

Work-based learning (WBL) is an extension of understanding competencies taught in the aquaculture classroom. This program may require students to obtain a minimum of 35 clinical-type hours, which may include but are not limited to clinicals/worksite field experiences, entrepreneurships, internships, pre-apprenticeships, school-based enterprises, job placements, and simulated worksites. These real-world connections and applications provide a link to all types of students regarding knowledge, skills, and professional dispositions. Thus, supervised collaboration and immersion into the agricultural industry are keys to students' success, knowledge, and skills development. For more information on embedded WBL, visit the Mississippi Work-Based Learning Manual on the RCU website, rcu.msstate.edu.

Professional Organizations

Agricultural Education Division of the Association for Career and Technical Education
acteonline.org

American Association for Agricultural Education
aaaeonline.org

Mississippi ACTE
mississippiacte.com

Mississippi Association of Agricultural Educators (MSAAE)
mississippiffa.org

National Association of Agricultural Educators
naae.org

National Association of Supervisors of Agricultural Education
ffa.org/thecouncil/nasae

National FFA Alumni Association
ffa.org/getinvolved/alumni

National FFA Foundation, Inc.
ffa.org/support/foundation

National Farm and Ranch Business Management Education Association
nfrbmea.org

National Postsecondary Agricultural Student Organization
nationalpas.org

National Young Farmer Educational Association
nyfea.org

U.S. Aquaculture Society
usaquaculture.org

World Aquaculture Society
was.org

Using This Document

Competencies and Suggested Objectives
A competency represents a general concept or performance that students are expected to master as a requirement for satisfactorily completing a unit. Students are expected to receive instruction on all competencies. The suggested objectives represent the enabling and supporting knowledge and performances that will indicate mastery of the competency at the course level. Teachers are welcome to teach the competencies in other ways than the listed objectives if it allows for mastery of the competencies. Teachers are also allowed to teach the units and competencies in the order they prefer, as long as they teach the necessary material allotted for the specific course or credit they are teaching at the time.

Teacher Resources
All teachers should request to be added to the Canvas Resource Guide for their course. For questions or to added to the guide send a help desk ticket to the RCU by emailing helpdesk@rcu.msstate.edu.

Perkins V Quality Indicators and Enrichment Material
Some of the units may include an enrichment section at the end. This material will greatly enhance the learning experiences for students. If the aquaculture program is using a national certification, work-based learning, or other measure of accountability that aligns with Perkins V as a quality indicator, this material could very well be assessed on that quality indicator. It is the responsibility of the teacher to ensure all competencies for the selected quality indicator are covered throughout the year.

Unit 1: History and Overview of Aquaculture

Competencies and Suggested Objectives
1. Investigate the origin and development of aquaculture. DOK3 a. Define aquaculture. b. Define aqua crop. c. Trace the history and development of aquaculture in the United States. • Brown trout eggs from Germany (late 1800s). • Pond aquaculture in the South (the 1950s). • Development of bivalve culture on coastlines.
2. Compare and contrast the relationship between aquatic and terrestrial farm animals (e.g., feed efficiency and feed conversion ratio, fighting gravity vs. drag, cold vs. warm-blooded. DOK3
3. Discuss the current status and practices in the aquaculture industry. DOK1 a. Compare the differences between aquaculture in the United States and other parts of the world. • Explore the availability of United States seafood (i.e., import vs. export). • Gulf of Thailand shrimp vs. Gulf of Mexico shrimp • Global food security b. Discuss the environmental, political, and economic issues affecting the aquaculture industry. c. Explore current aquaculture practices (i.e., intensive and extensive). • Pond • Cage • Integrated multi-trophic aquaculture (IMTA) • Aquaponics • Recirculating aquaculture systems (RAS) • Flow-through or single-pass d. Investigate new and emerging technologies, practices, trends, and issues associated with aquaculture.
4. Examine the different career opportunities in aquaculture and related fields. DOK2

Unit 2: Safety and Biosecurity

Competencies and Suggested Objectives
1. Review safety procedures for the school, aquaculture classroom, and laboratory. DOK 1 a. Demonstrate the safety procedures prescribed by school regulations. b. Discuss the concept of safety when working in the aquaculture industry.
2. Implement biosecurity measures and standard operating procedures. DOK 3 a. Review potential fomites (e.g., nets, tubes, pumps, etc.). b. Discuss disinfection techniques.
3. Demonstrate proper first aid procedures. DOK 3 a. Perform first aid procedures properly.
4. Describe proper safety procedures for aquaculture. DOK 1 a. Discuss general safety procedures. b. Demonstrate proper electrical safety procedures. c. Describe and discuss proper water safety. d. Describe and discuss proper mechanical safety procedures. e. Describe and discuss the proper safety procedures related to biological hazards. f. Describe and discuss the proper safety procedures related to chemical hazards. g. Describe and discuss the proper safety procedures related to the effects of weather (e.g., sun, heat, lightning, etc.).
5. Demonstrate proper tool safety procedures. DOK 3

Unit 3: Professional and Student Organizations

Competencies and Suggested Objectives

1. Explore the integral relationship between the FFA and agricultural education. DOK3
   a. Examine historical events that shaped school-based agricultural education.
      - Smith-Hughes Act (1917)
      - Establishment of the National FFA Organization (1928)
      - Mississippi FFA Association chartered (1934)
      - Establishment of the New Farmers of America (1935)
      - Public Law 740 (1950)
      - Merger of the FFA and the NFA (1965)
      - Female membership (1969)
      - Organizational name change (1988)
   b. Identify types of FFA membership.
      - Active
      - Collegiate
      - Alumni
      - Honorary
   c. Compare the degree levels of FFA membership and describe the requirements for each.
      - Discovery FFA degree
      - Greenhand FFA degree
      - Chapter FFA degree
      - State FFA degree
      - American FFA degree

2. Explore the role of the FFA in promoting leadership, personal growth, and career success through 21st-century skills standards. DOK3
   a. Explain the role of effective leadership.
   b. Have students self-evaluate their leadership traits and develop a plan for improvement.
   c. Identify and put into practice FFA activities that promote personal and career development, teamwork, and leadership skills.
      - Public speaking and communication skills
      - Career-development events
      - Proficiency awards
      - Community service activities
      - Conventions and leadership conferences
   d. Demonstrate basic parliamentary procedures.
      - Conducting a meeting
      - Stating a main motion
      - Voting on a motion
      - Understanding the use of the gavel

e. Distinguish between the types of motions used in parliamentary procedure (i.e., main, subsidiary, incidental, and privileged).
3. Participate in local, state, or national FFA activities that provide opportunities for leadership development and career exploration. DOK4 a. Leadership Development Events b. Leadership retreats or conferences c. Industry-related seminars, workshops, or conferences d. Agriscience fair
4. Discuss aquaculture-specific professional organizations. DOK1 a. National Aquaculture Association (NAA) b. United States Aquaculture Society (USAS) c. Aquaculture America/World Aquaculture Society (WAS) d. America Fisheries Society (AFS)

Unit 4: Supervised Agricultural Experience (SAE) for All

Competencies and Suggested Scenarios

1. Describe the purposes and requirements of the Supervised Agricultural Experience (SAE) for All program. DOK 1
   a. Establish objectives for the SAE program.
      - Personal growth
      - Career development
      - Responsible citizenship
      - Practical application of work experience and/or skill attainment
   b. Determine the benefits of participation in an SAE program.
      - Assist with career and personal choices
      - Apply business practices, such as record-keeping and money management
      - Nurture individual talents and develop a cooperative attitude
      - Build character and encourage citizenship and volunteerism
      - Provide an environment for practical learning
   c. Describe the types of programs under SAE For All.
      - Foundational SAE
        - Career exploration and planning
        - Employability skills for college and career readiness
        - Personal financial management and planning
        - Workplace safety
        - Agricultural literacy
      - Immersion SAE
        - Placement/internship
        - Ownership/entrepreneurship
        - Research
          - Experimental
          - Analytical
          - Invention
        - School-based enterprise
        - Service learning
   d. Explore the Mississippi Work-Based Learning Manual as a companion to Immersion SAE.

2. Launch a Foundational SAE plan. DOK 2
   a. Identify potential career interests.
   b. Determine the availability of time and money/resources to invest.
   c. Set short-range goals for the SAE program.
   d. Project long-range goals for the SAE program.
   e. Complete a training agreement for an SAE project.

f. Establish requirements of the student, parents, supervisor, and/or employer.

3. Develop a record-keeping system for an individual student's SAE program. DOK 3
   a. Determine the types of records to keep.
      - Hours worked/spent on a project or enterprise
      - Inventory of assets
      - Expenses
      - Income
      - Skills attained during a project or enterprise
      - Leadership record
      - Community service record
      - Journal of experiences
      - Pictures
   b. Use an electronic/computer-based record-keeping system to maintain records for the SAE program.

Unit 5: Basic Water Chemistry and Management

Competencies and Suggested Objectives

1. Examine the chemical and physical properties of water. DOK 3
   a. Define terms related to the physical properties of water.
      - Temperature
      - Water density
      - Volume
      - Specific heat
   b. Define terms related to the chemical properties of water.
      - Polarity
      - Adhesion
      - Cohesion
      - Universal solvent
   c. Measure water quality parameters using standard industry methods.
      - Temperature
      - Salinity
      - pH
      - Alkalinity
      - Dissolved oxygen
      - Ammonia, nitrite, nitrate (i.e., nitrogen cycle)

2. Investigate mechanical and biological filtration in recirculating systems. DOK 3
   a. Define mechanical and biological filtration.
      - Nitrogen cycle
   b. Discuss and illustrate methods and equipment for maintaining water quality and correcting water quality problems.
   c. Compare the types of filtration systems, their function, and maintenance.
      - Mechanical filtration
      - Chemical filtration
   d. Compare the types of aeration devices and systems, their function, and maintenance.
   e. Examine system cycling for system preparation.

3. Prepare aquatic systems for fish and plants. DOK 4
   a. Understand species and life stage selection.
   b. Take inventory of the aquatic system and begin building the system.
   c. Prepare the water and begin filling the tanks.
   d. Prepare seed tanks to establish biological filtration and test the water quality.
   e. Assess the water quality until the tanks are within the parameters for livestock.
   f. Demonstrate the procedure for cleaning and maintaining the systems under fish loads.

Unit 6: Major and Minor Crops With Applications

Competencies and Suggested Objectives

1. Describe major food aqua crops and their typical production techniques. DOK 2
   a. Investigate and critique common carp production in Asia.
   b. Investigate and critique catfish aquaculture in the southern United States.
   c. Investigate and critique tilapia aquaculture in Central America and Southeast Asia.
   d. Investigate and critique shrimp and prawn production in the Gulf of Thailand .
   e. Investigate and critique hydroponic/aquaponic vegetable aqua crops.
   f. Investigate and critique bivalve production and techniques.
   g. Investigate and critique Salmonid production and techniques.
   h. Investigate and critique microalgae and macroalgae.
2. Describe stock enhancement and the application of aquaculture to support it. DOK 2
   a. Discuss stock enhancement species for recreational fisheries.
      - Salmonids in cold water (e.g., rainbow trout, brown trout, etc.)
      - Percids in cool-water fisheries (e.g., perch, walleye, etc.)
      - Centrarchids in warm-water fisheries (e.g., bass, bream, crappie, etc.)
      - Catfish for put-and-take fisheries
      - Sea trout, striped bass, and red drum on the Gulf Coast
   b. Discuss stock enhancement conservation species.
      - Discuss darters in the Appalachian Mountains (e.g., Tellico River darters).
   c. Discuss stock enhancement species for ecosystem management.
      - Oyster reef restoration for erosion control and wave attenuation
      - Triploid grass carp for vegetation control
3. Describe major baitfish species and their typical production techniques. DOK 2
   a. Identify specific characteristics of the baitfish species grown in controlled environments.
      - Golden shiners
      - Fathead minnows
      - Goldfish
   b. Discuss the environmental requirements for raising baitfish.
   c. Explain how baitfish seed stock is obtained and managed for production.
      - Use of spawning habitat for improved hatching success
   d. Explain general feeding guidelines for baitfish.
      - Pond fertilization for natural food production
      - Prepared feed for broodstock
   e. Describe how baitfish are harvested and marketed.
   f. Describe minor baitfish production techniques.
      - Winterkill lake stocking in the northern United States (e.g., white sucker)
4. Describe major ornamental crops and their typical production techniques. DOK 2
   a. Analyze freshwater aquarium species.

- Fancy goldfish
- Cichlids
- Tetras
- Mollies and guppies

b. Analyze saltwater aquarium species.
- Clownfish
- Blue tang
- Corals and anemones

c. Analyze ornamental ponds and water gardens.
- Koi fish
- Water lilies
- Water hyacinth

5. Describe major live feed species and their typical production techniques. DOK 2
   a. Discuss the major zooplankton species used as live first feeds.
      - Rotifers
      - Copepods
      - Artemia
   b. Discuss the major photosynthesizing live feeds.
      - Microalgae in photobioreactor systems
      - Duckweed
      - Kelp ranching for abalone and other marine gastropod species
   c. Discuss pond fertilization for natural food production.
      - Phytoplankton
      - Zooplankton
      - Mosquito and other insect larvae

6. Describe minor and emerging aqua crops and their typical production techniques. DOK 2
   a. Explore zebra fish in medical research.
   b. Explore microalgae as fossil fuel substitutes.
      - Biopolymers
      - Net zero carbon addition biofuels
   c. Explore algae as food and health supplements.
      - Spirulina
      - Kelp
   d. Explore freshwater clam pearl production.

Unit 7: Aquatic Resources Management

Competencies and Suggested Objectives
1. Discuss the principles of fish and wildlife ecology. DOK 2 a. Examine how fish and wildlife relate to each other and their nonliving environment. b. Identify endangered species, the causes for endangerment, and the role of the aquaculture industry in preserving those species.
2. Trace the history of natural resource management as related to aquaculture. DOK 3 a. Examine the history and basic principles of natural resource management. b. Explore issues and techniques involved in the management of aquatic resources. c. Comprehend the role of aquaculture in natural resource management.
3. Examine and investigate the basic principles of pond/lake management. DOK 4 a. List and discuss the requirements for maintaining good sportfishing conditions in ponds and lakes. b. Sample a pond and make specific management recommendations to the owner for the maintenance or improvement of sportfishing.
4. Classify freshwater and saltwater fish species in Mississippi. DOK 2 a. Recognize all major fish families in Mississippi.
5. Practice farm pond management. DOK 4 a. Discuss farm pond management practices. b. Perform appropriate sampling techniques. c. Evaluate the results of the sampling. d. Make farm pond management recommendations to improve production outcomes.
6. Explore the opportunities for aquaculturists in the design, construction, and maintenance of ornamental fishponds. DOK 4 a. Investigate and critique existing ornamental fishponds. b. Design an ornamental fishpond.

Unit 8: The Aquaculture Industry

Competencies and Suggested Objectives
1. Examine the environmental impact of the aquaculture industry on our state, nation, and world. DOK 2 a. Research and assess the environmental impact of the aquaculture industry as a global food source. b. Explain the concept of sustainable fisheries as it applies to aquaculture production. c. Compare and contrast the costs and rewards of saltwater aquaculture versus freshwater aquaculture.
2. Examine trends and changes related to aquaculture and global economic factors. DOK 2 a. Define and discuss the concept of global economics and competition. b. Define and discuss how trade deficits affect global economics. c. Describe global economic factors and competition as related to aquaculture. d. Research and use geographic and economic data of various countries or regions to address food insecurity or hunger issues. e. Identify public policies and laws that impact aquaculture production (e.g., labeling, import/export regulations, etc.).
3. Examine self-sustaining aquaculture applications. DOK 2 a. Limited fish meal diets and alternative protein sources b. Bivalve aquaculture and carbon sequestration c. Biotechnical waste solutions d. Integrated multi-trophic aquaculture (IMTA) • Aquaponics

Unit 9: Hatchery Management and Operation

Competencies and Suggested Objectives

1. Identify and evaluate the operational requirements of a hatchery. DOK 1
   a. Identify the water source.
      - Delivery
      - Effluent
   b. Determine the species and their specific husbandry requirements.
      - Requirements of different life stages
      - Optimal water quality parameters
        - Temperature
        - Salinity
      - Nutritional requirements and source
   c. Identify an aquaculture system.
      - Pond
      - Cage
      - Recirculating aquaculture system (RAS)
      - Flow-through

2. Explore and apply the proper operational requirements of a hatchery. DOK 4
   a. Maintain and condition brood stock.
      - Proper nutrition
      - Photothermal manipulation
   b. Describe the sexual reproduction processes in fish, crustaceans, and mollusks.
      - Induced spawning
      - Natural spawning
   c. Describe and operate typical hatchery equipment used in producing the eggs, larvae, and juveniles of all aquatic livestock.
      - Microscope
      - Incubation equipment
      - Egg collector
   d. Calculate fish stocking rates and feed conversions required during the growth cycle.
   e. Determine and produce larval stage feed requirements.
      - Live vs. formulated feeds
   f. Raise juveniles to the desired stocking size or grow-out requirements.

3. Discuss safety procedures for the school and classroom. DOK1
   a. Demonstrate safety procedures as prescribed by the local school regulations.

4. Demonstrate proper first aid procedures. DOK3
   a. Perform first aid procedures properly.

5. Practice proper safety procedures for working in aquaculture facilities. DOK3
   a. Discuss general safety procedures.

b. Demonstrate proper electrical safety procedures.
c. Describe and discuss proper water safety.
d. Describe and discuss proper mechanical safety procedures.
e. Describe and discuss the proper safety procedures related to biological hazards.
f. Describe and discuss the proper safety procedures related to chemical hazards.
g. Describe and discuss the proper safety procedures related to the effects of weather (e.g., sun, heat, lightning, etc.).
h. Discuss safety data sheets (SDS).
i. Discuss the standard operating procedures (SOP).

Unit 10: Aquatic Health Management

Competencies and Suggested Objectives
1. Discuss aquatic health management practices. DOK 1 a. Define and describe some common disease agents in aquaculture. • Parasitic infections (e.g., *Amlyoodinium ocellatum, Cryptocaryan irritans*, etc.) • Bacterial infections (e.g., *Vibrio spp., Aeromonas spp.*, etc.) b. Examine the establishment of biosecurity and disease mitigation protocols (i.e., preventative measures). • Recognize the role of stress factors on aqua crop immune system strength. • Recognize signs of disease in aqua crops.
2. Examine the causes of infectious and noninfectious diseases. DOK 3 a. Define stress response. • Cortisol (i.e., stress hormone) b. Discover possible stressors and confounding factors. • Mishandling • Overfeeding • Poor water quality • Noise/abrupt change • Presence of pathogens
3. Recognize the signs and symptoms of disease. DOK 2 a. Summarize atypical behavior. • Erratic swimming • Change in feeding response • Reduced vigor b. Identify and discuss external abnormalities. • Lesions and ulcers • Abnormal coloring • Fin rot
4. Understand common disease treatments in aqua crops. DOK 1 a. Medications (i.e., dose and duration) • Medicated feed • Baths • Dips b. Whole-system treatments c. Culling/euthanasia

5. Examine the role of nutrition in aquatic species. DOK 2
    a. Compare and contrast the major types of aquaculture feeds.
    b. Explore ingredients typically used in aquaculture feeds.
    c. Calculate feed rates and conversions for selected crops.

Unit 11: Immersion Into FFA and Supervised Agricultural Experience (SAE) for All

Competencies and Suggested Scenarios

1. Participate in local, state, and/or national FFA activities that provide opportunities for leadership development and career exploration. DOK 3
   a. Actively participate in FFA activities.
      - Leadership Development Events (LDEs)
      - Career Development Events (CDEs)
      - Leadership retreats or conferences
      - Industry-related seminars, workshops, or conferences
      - Other related FFA activities

2. Apply concepts learned from the school-based agricultural education program to continue the progression of immersion SAEs. DOK 4
   a. Redefine and adjust the requirements of agreements between the student, parents, supervisor, and/or employer.
   b. Update SAE records utilizing an electronic/computer-based system of record-keeping.
      - SAE program goals
      - Student inventory related to the SAE program
      - Expense records
      - Income/gift and scholarship records
      - Skill-attainment records
      - Leadership-activity records and participation in FFA activities
      - Community service hours
   c. Complete degree and proficiency award applications as they apply to the SAE.

Unit 12: Aquaculture Wastes and Remediation

Competencies and Suggested Objectives

1. Examine waste products at the cellular and organism levels. DOK 3
   a. Define cellular and metabolic waste products.
      - Carbon dioxide (CO_2) cellular respiration
      - Ammonia (NH_3) protein synthesis
   b. Define feces and detritus as an organism's solid wastes.
      - Detritus acts as food for microorganisms.
      - Microorganisms, in turn, produce metabolic wastes.
   c. Define biologically oxidized nitrogenous wastes and their origins.
      - Nitrogen cycle and nitrification by nitrifying bacteria
      - Ammonia to nitrite by Nitrosomonas spp.
      - Nitrite to nitrate by Nitrobacter spp.
      - Ammonia to nitrate by Nitrospyra spp.
   d. Discuss denitrification and the removal of nitrate nitrogen.
      - Anaerobic bacterial denitrification with the introduction of a carbon source
      - Plant and photoautotroph-based denitrification

2. Examine the health issues and conditions associated with metabolic waste products. DOK 3
   a. Discuss the effects of carbon dioxide and hypercapnia (acidosis) on hemoglobin.
      - Functional hypoxia
      - Stress
      - Immunosuppression
      - Disease and death
   b. Discuss the effects of carbon dioxide on pH.
      - Chemical irritation of gill tissue
   c. Discuss the effects of toxicity and pH.
      - Un-ionized ammonia (NH_3) vs. ionized ammonia (NH_4+)
   d. Discuss nitrite toxicity and methemoglobinemia (brown blood disease) and their effects on hemoglobin.
      - Functional hypoxia and stress
      - Immunosuppression
      - Infectious disease
      - Death
   e. Compare the effects of nitrate toxicity on freshwater and saltwater organisms.

3. Examine the various processes and equipment used to remediate aqua crop and aquatic organism wastes. DOK 3

a. Examine the aeration devices used to remediate CO_2. Consider their common uses and typical system applications.
    - Packed column aerators in flow-through systems
    - Paddlewheel aerators and surface agitators in ponds and large tanks
    - Air diffusers in recirculating aquaculture systems
        - Linear air pumps
        - Centrifugal blowers
b. Discuss the biofiltration (nitrification) design parameters and requirements for optimal performance.
    - Limit sunlight
    - Add oxygen
    - Bio media agitation to promote new bacterial growth
    - Nitrogenous waste inputs
    - Nitrification capacities of different biofilter designs
c. Compare natural biofiltration in ponds to supplementary biofilter devices in recirculating aquaculture systems.
d. Explore biofiltration devices and applications.
    - Trickling biofilters
    - Rotating biological contactors
    - Moving bed bioreactors
    - Bio clarifiers
    - Bead filters.
e. Explore mechanical filtration design parameters and equipment.
    - Solid wastes and detritus size categories
        - Settleable
        - Suspended
        - Colloidal
        - Dissolved
    - Solid waste remediation processes
        - Settling
        - Physical straining
        - Biofilm interception
    - Physical-chemical elimination
        - Electrocoagulation
        - Chemical precipitation
        - UV degradation
        - Ozone oxidation
f. Explore commonly used mechanical filtration and clarification devices and applications.
    - Screen and rotating drum filters
    - Bag and sock filters

- Canister and pleated filters
- High-density media filters (sand/bead filters)
- Low-density media filters (bio clarifiers)

Unit 13: Advanced Culture Methods

Competencies and Suggested Objectives
1. Assess and operate aquatic-culture methods currently in use. DOK 3 a. Describe aquatic-culture methods. b. Discuss the advantages and disadvantages of various aquatic-culture methods. c. Review selection criteria for appropriate culture methods based on aquatic species and locale.
2. Construct aquatic-culture systems. DOK 4 a. Develop plumbing skills. • Measure, cut, and glue PVC pipes. • Identify various pipe diameters. • Identify various fitting types. b. Develop carpentry skills. • Decking • Securing equipment • Finishing c. Assemble aquaculture equipment. • Pump maintenance
3. Stock, manage, sample, feed, and harvest appropriate species from a culture system. DOK 4 a. Calculate feed rates based on nutritional requirements. b. Perform stock assessments as needed. c. Monitor and track growth and feed efficiency.
4. Analyze the performance of life support equipment in selected aquaculture systems. DOK 3 a. Investigate the following life support equipment. • Aeration equipment performance • Biofilter performance • Mechanical filter performance
5. Review and apply aquatic health management practices. DOK 4 a. List and identify the signs, symptoms, and causes of selected major aquatic diseases. b. Review environmental stressors and their effect on the immune systems. c. Review procedural stressors and their effect on aqua crop health. d. Select, calculate, and administer proper treatment.
6. Apply culture and management requirements specific to individual aquatic species. DOK 4 a. Investigate the characteristics related to the culture of common aquaculture species (e.g., catfish, crawfish, trout, tilapia, hybrid bass, baitfish, prawns, tropical fish,

ornamental fish, oysters, sturgeons, paddlefish, flounder, clams, redfish, bluegills, largemouth bass, flounder, etc.).

b. Apply aquaculture technology practices to grow, manage, and maintain representative living specimens of as many aquaculture species as possible.

Unit 14: Pond Aquaculture

Competencies and Suggested Objectives
1. Discuss the types of ponds (e.g., watershed, levee, and excavated). DOK 2 a. Compare lined and earthen ponds.
2. Discuss viable site selection for a pond-based aquafarm. DOK 2 a. Determining the water source and depth of the water table. b. Discuss how soil composition affects pond design. c. Discuss how the climate will affect selection. d. Analyze the topography and how it will affect drainage and flooding.
3. Determine the sources and materials needed for pond construction. DOK 2
4. Analyze the engineering and construction requirements for pond construction. DOK 3 a. Determine the size of the pond (e.g., acreage, shape, capacity, depth management). b. Address dam inspection and repair. c. Address the maintenance of plant cover and clean water. d. Address the best practices for pond fertilization.
5. Discuss species selection for pond culture (e.g., catfish, crawfish, bass, tilapia, etc.). DOK 2
6. Determine stocking densities based on the species and size of the pond. DOK 2 a. Consider the following for stocking density: • Delivery • Buyer • Management • Temperature • pH • Access to the pond
7. Analyze the feeding methods used in ponds (e.g., hand, mechanical, natural). DOK 2 a. Investigate the following pond feeding methods. • Types of feed o Floating o Sinking o Neutral buoyancy pellets • Frequency of feed • Amount of feed
8. Develop a strategy for oxygen management (e.g., aeration devices). DOK 3

9. Discuss sustainable aquaculture as related to environmental and social impacts. DOK 2
   a. Understand environmental impacts on land use, water use, energy consumption, and effluent discharge.
   b. Discuss the possible negative social impacts and how to avoid these issues.

Unit 15: Independent Research Project for Aquaculture

Competencies and Suggested Objectives
1. Propose, conduct, and report on a basic aquaculture research project. DOK 4 a. Identify an aquaculture research project for approval. b. Conduct the approved project utilizing appropriate research procedures. c. Present the results of the project as an oral report.

Student Competency Profile

Student's Name: _____

This record is intended to serve as a method of noting student achievement of the competencies in each unit. It can be duplicated for each student, and it can serve as a cumulative record of competencies achieved in the course.

In the blank before each competency, place the date on which the student mastered the competency.

Unit 1: History and Overview of Aquaculture		
	1.	Investigate the origin and development of aquaculture.
	2.	Compare and contrast the relationship between aquatic and terrestrial farm animals. (e.g., feed efficiency and feed conversion ratio, fighting gravity vs. drag, cold vs. warm-blooded)
	3.	Discuss the current status and practices in the aquaculture industry.
	4.	Examine the different career opportunities in aquaculture and related fields.
Unit 2: Safety and Biosecurity		
	1.	Review safety procedures for the school, aquaculture classroom, and laboratory.
	2.	Implement biosecurity measures and standard operating procedures.
	3.	Demonstrate proper first aid procedures.
	4.	Describe proper safety procedures for aquaculture.
	5.	Demonstrate proper tool safety procedures.
Unit 3: Professional and Student Organizations		
	1.	Explore the integral relationship between the FFA and agricultural education.
	2.	Explore the role of the FFA in promoting leadership, personal growth, and career success through 21st-century skills standards.
	3.	Participate in local, state, or national FFA activities that provide opportunities for leadership development and career exploration.
	4.	Discuss aquaculture-specific professional organizations.
Unit 4: Supervised Agricultural Experience (SAE) for All		
	1.	Describe the purposes and requirements of the Supervised Agricultural Experience (SAE) for All program.
	2.	Launch a Foundational SAE plan.
	3.	Develop a record-keeping system for an individual student's SAE program.

Unit 5: Basic Water Chemistry and Management		
	1.	Examine the chemical and physical properties of water.
	2.	Investigate mechanical and biological filtration in recirculating systems.
	3.	Prepare aquatic systems for fish and plants.
Unit 6: Major and Minor Crops with Applications		
	1.	Describe major food aqua crops and their typical production techniques.
	2.	Describe stock enhancement and the application of aquaculture to support it.
	3.	Describe major baitfish species and their typical production techniques.
	4.	Describe major ornamental crops and their typical production techniques.
	5.	Describe major live feed species and their typical production techniques.
	6.	Describe minor and emerging aqua crops and their typical production techniques.
Unit 7: Aquatic Resources Management		
	1.	Discuss the principles of fish and wildlife ecology.
	2.	Trace the history of natural resource management as related to aquaculture.
	3.	Examine and investigate the basic principles of pond/lake management.
	4.	Classify freshwater and saltwater fish species in Mississippi.
	5.	Practice farm pond management.
	6.	Explore the opportunities for aquaculturist in the design, construction, and maintenance of ornamental fishponds.
Unit 8: The Aquaculture Industry		
	1.	Examine the environmental impact of the aquaculture industry on our state, nation, and world.
	2.	Examine trends and changes related to aquaculture and global economic factors.
	3.	Examine self-sustaining aquaculture applications.
Unit 9: Hatchery Management and Operation		
	1.	Identify and evaluate the operational requirements of a hatchery.
	2.	Explore and apply the proper operational requirements of a hatchery.
	3.	Discuss safety procedures for the school and classroom.
	4.	Demonstrate proper first aid procedures.
	5.	Practice proper safety procedures for working in aquaculture facilities.
Unit 10: Aquatic Health Management		

	1.	Discuss aquatic health management practices.
	2.	Examine the causes of infectious and non-infectious diseases.
	3.	Recognize the signs and symptoms of disease.
	4.	Understand common disease treatments in aqua crops.
	5.	Examine the role of nutrition in aquatic species.
Unit 11: Immersion into FFA and Supervised Agricultural Experience (SAE) for All		
	1.	Participate in local, state, and/or national FFA activities that provide opportunities for leadership development and career exploration.
	2.	Apply concepts learned from the school-based agricultural education program to continue the progression of immersion SAEs.
Unit 12: Aquaculture Wastes and Remediation		
	1.	Examine waste products at a the cellular and organism levels.
	2.	Examine the health issues and conditions associated with metabolic waste products.
	3.	Examine the various processes and equipment used to remediate aqua crop and aquatic organism wastes.
Unit 13: Advanced Culture Methods		
	1.	Assess and operate aquatic-culture methods currently in use.
	2.	Construct aquatic-culture systems.
	3.	Stock, manage, sample, feed, and harvest appropriate species from a culture system.
	4.	Analyze the performance of life support equipment in selected aquaculture systems.
	5.	Review and apply aquatic health management practices.
	6.	Apply culture and management requirements specific to individual aquatic species.
Unit 14: Pond Aquaculture		
	1.	Discuss the types of ponds (e.g., watershed, levee, and excavated).
	2.	Discuss viable site selection for a pond-based aquafarm.
	3.	Determine the sources and materials needed for pond construction.
	4.	Analyze the engineering and construction requirements for pond construction.
	5.	Discuss species selection for pond culture (e.g., catfish, crawfish, bass, tilapia, etc.).
	6.	Determine stocking densities based on the species and size of the pond.
	7.	Analyze the feeding methods used in ponds (e.g., hand, mechanical, natural).

	8.	Develop a strategy for oxygen management (e.g., aeration devices).
	9.	Discuss sustainable aquaculture as related to environmental and social impacts.
Unit 15: Independent Research Project for Aquaculture.		
	1.	Propose, conduct, and report on a basic aquaculture research project.

Appendix: Industry Standards

Framework for AFNR Content Standards and Performance Elements Crosswalk for Aquaculture Technology																
AFNR	Unit	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
ABS- Agribusiness Systems		X	X	X		X		X	X	X	X	X	X	X	X	X
AS- Animal Systems		X			X	X	X	X	X		X	X	X	X	X	
BS- Biotechnology		X			X	X	X	X	X		X	X	X	X	X	
CRP- Career Ready Practices		X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
CS- AFNR Cluster Skill		X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
ES- Environmental Service Systems		X		X		X	X	X	X	X	X	X	X	X	X	X
FPP- Food Products and Processing Systems						X				X			X			
NRS- Natural Resource Systems		X			X	X	X	X	X		X	X	X	X		
PS- Plant Systems					X	X	X		X		X	X	X			
PST- Power, Structural, and Technical Systems		X	X	X		X		X	X		X		X		X	

AFNR Pathway
Content Standards and Performance Elements

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ABS AGRIBUSINESS SYSTEMS
AS ANIMAL SYSTEMS
BS BIOTECHNOLOGY
CRP CAREER READY PRACTICES
CS AGRICULTURE FOOD AND NATURAL RESOURCES CLUSTER SKILL

ES ENVIRONMENTAL SERVICE SYSTEMS
FPP FOOD PRODUCTS AND PROCESSING SYSTEMS
NRS NATURAL RESOURCE SYSTEMS
PS PLANT SYSTEMS
PST POWER, STRUCTURAL, AND TECHNICAL SYSTEMS

Agribusiness Systems Career Pathway Content Standards

The Agribusiness Systems (ABS) Career Pathway encompasses the study of agribusinesses and their management including, but not limited to, record keeping, budget management (cash and credit), and 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.

Within each pathway, the standards are organized as follows:

- ***Common Career Technical Core (CCTC) Standards*** – These are the standards for Agribusiness Systems (AG-ABS) from the 2012 version of the Common Career and Technical Core Standards, which are owned by the National Association of State Directors of Career and Technical Education/National Career Technical Education Foundation and are used here with permission. These statements define what students should know and be able to do after completing instruction in a program of study for this pathway.
- ***Performance Indicators*** – These statements distill each CCTC Standard into more discrete indicators of the knowledge and skills students should attain through a program of study in this pathway. Attainment of the knowledge and skills outlined in the performance indicators is intended to demonstrate an acceptable level of proficiency with the related CCTC Standard at the conclusion of a program of study in this area.

ABS.01. CCTC Standard: Apply management planning principles in AFNR businesses.

ABS.01.01. Performance Indicator: Apply micro- and macroeconomic principles to plan and manage inputs and outputs in an AFNR business.

ABS.01.02. Performance Indicator: Read, interpret, evaluate and write statements of purpose to guide business goals, objectives and resource allocation.

ABS.01.03. Performance Indicator: Devise and apply management skills to organize and run an AFNR business in an efficient, legal and ethical manner.

ABS.01.04. Performance Indicator: Evaluate, develop and implement procedures used to recruit, train and retain productive human resources for AFNR businesses.

ABS.02. CCTC Standard: Use record keeping to accomplish AFNR business objectives, manage budgets and comply with laws and regulations.

ABS.02.01. Performance Indicator: Apply fundamental accounting principles, systems, tools and applicable laws and regulations to record, track and audit AFNR business transactions (e.g., accounts, debits, credits, assets, liabilities, equity, etc.).

ABS.02.02. Performance Indicator: Assemble, interpret and analyze financial information and reports to monitor AFNR business performance and support decision-making (e.g., income statements, balance sheets, cash-flow analysis, inventory reports, break-even analysis, return on investment, taxes, etc.).

ABS.03. CCTC Standard: Manage cash budgets, credit budgets and credit for an AFNR

business using generally accepted accounting principles.

ABS.03.01. Performance Indicator: Develop, assess and manage cash budgets to achieve AFNR business goals.

ABS.03.02. Performance Indicator: Analyze credit needs and manage credit budgets to achieve AFNR business goals.

ABS.04. CCTC Standard: Develop a business plan for an AFNR business.

ABS.04.01. Performance Indicator: Analyze characteristics and planning requirements associated with developing business plans for different types of AFNR businesses.

ABS.04.02. Performance Indicator: Develop production and operational plans for an AFNR business.

ABS.04.03. Performance Indicator: Identify and apply strategies to manage or mitigate risk.

ABS.05. CCTC Standard: Use sales and marketing principles to accomplish AFNR business objectives.

ABS.05.01. Performance Indicator: Analyze the role of markets, trade, competition and price in relation to an AFNR business sales and marketing plans.

ABS.05.02. Performance Indicator: Assess and apply sales principles and skills to accomplish AFNR business objectives.

ABS.05.03. Performance Indicator: Assess marketing principles and develop marketing plans to accomplish AFNR business objectives.

Animal Systems Career Pathway Content Standards

The Animal Systems (AS) Career Pathway encompasses the study of animal systems, including content areas such as life processes, health, nutrition, genetics, and 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 AFNR settings.

Within each pathway, the standards are organized as follows:

- ***Common Career Technical Core (CCTC) Standards*** – These are the standards for Animal Systems (AG-AS) from the 2012 version of the Common Career and Technical Core Standards, which are owned by the National Association of State Directors of Career and Technical Education/National Career Technical Education Foundation and are used here with permission. These statements define what students should know and be able to do after completing instruction in a program of study for this pathway.
- ***Performance Indicators*** – These statements distill each CCTC Standard into more discrete indicators of the knowledge and skills students should attain through a program of study in this pathway. Attainment of the knowledge and skills outlined in the performance indicators is intended to demonstrate an acceptable level of proficiency with the related CCTC Standard at the conclusion of a program of study in this area.

AS.01. CCTC Standard: Analyze historic and current trends impacting the animal systems industry.

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

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

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

AS.02. CCTC Standard: Utilize best-practice protocols based upon animal behaviors for animal husbandry and welfare.

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

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

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

AS.03.01. Performance Indicator: Analyze the nutritional needs of animals.

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

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

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

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

AS.04.02. Performance Indicator: Apply scientific principles to select and care for breeding animals.

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

AS.05. CCTC Standard: Evaluate environmental factors affecting animal performance and implement procedures for enhancing performance and animal health.

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

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

AS.06. CCTC Standard: Classify, evaluate and select animals based on anatomical and physiological characteristics.

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

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

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

AS.07. CCTC Standard: Apply principles of effective animal health care.

A**S.07.01. Performance Indicator:** Design programs to prevent animal diseases, parasites and other disorders and ensure animal welfare.

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

AS.08. CCTC Standard: Analyze environmental factors associated with animal production.

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

AS.08.02. Performance Indicator: Evaluate the effects of environmental conditions on animals and create plans to ensure favorable environments for animals.

Common Career Technical Core Career Ready Practices Content Standards

The CCTC CRPs encompass fundamental skills and practices that all students should acquire to be career ready such as: responsibility, productivity, healthy choices, maintaining personal finances, communication, decision-making, creativity and innovation, critical-thinking, problem solving, integrity, ethical leadership, management, career planning, technology use and cultural/global competency. Students completing a program of study in any AFNR career pathway will demonstrate the knowledge, skills and behaviors that are important to career ready through experiences in a variety of settings (e.g., classroom, CTSO, work-based learning, community etc.).

DEFINITIONS: Within each pathway, the standards are organized as follows:

- ***Common Career Technical Core (CCTC) Standards*** – These are the standards for CRPs from the 2012 version of the Common Career and Technical Core Standards, which are owned by the National Association of State Directors of Career and Technical Education/National Career Technical Education Foundation and are used here with permission. These statements define what students should know and be able to do after completing instruction in a program of study for this pathway.
- ***Performance Indicators*** –These statements distill each CCTC Standard into more discrete indicators of the knowledge and skills students should attain through a program of study in this pathway. Attainment of the knowledge and skills outlined in the performance indicators is intended to demonstrate an acceptable level of proficiency with the related CCTC Standard at the conclusion of a CTE program of study.

CRP.01. CCTC Standard: Act as a responsible and contributing citizen and employee.

CRP.01.01. Performance Indicator: Model personal responsibility in the workplace and community.

CRP.01.02 Performance Indicator: Evaluate and consider the near-term and long-term impacts of personal and professional decisions on employers and community before taking action.

CRP.01.03. Performance Indicator: Identify and act upon opportunities for professional and civic service at work and in the community.

CRP.02. CCTC Standard: Apply appropriate academic and technical skills.

CRP.02.01. Performance Indicator: Use strategic thinking to connect and apply academic learning, knowledge and skills to solve problems in the workplace and community.

CRP.02.02. Performance Indicator: Use strategic thinking to connect and apply technical concepts to solve problems in the workplace and community.

CRP.03. CCTC Standard: Attend to personal health and financial well-being.

CRP.03.01. Performance Indicator: Design and implement a personal wellness plan.

CRP.03.02. Performance Indicator: Design and implement a personal financial management plan.

CRP.04. CCTC Standard: Communicate clearly, effectively and with reason.

CRP.04.01. Performance Indicator: Speak using strategies that ensure clarity, logic, purpose and professionalism in formal and informal settings.

CRP.04.02. Performance Indicator: Produce clear, reasoned and coherent written and visual communication in formal and informal settings.

CRP.04.03. Performance Indicator: Model active listening strategies when interacting with others in formal and informal settings.

CRP.05. CCTC Standard: Consider the environmental, social and economic impacts of decisions.

CRP.05.01. Performance Indicator: Assess, identify and synthesize the information and resources needed to make decisions that positively impact the workplace and community.

CRP.05.02. Performance Indicator: Make, defend and evaluate decisions at work and in the community using information about the potential environmental, social and economic impacts.

CRP.06. CCTC Standard: Demonstrate creativity and innovation.

CRP.06.01. Performance Indicator: Synthesize information, knowledge and experience to generate original ideas and challenge assumptions in the workplace and community.

CRP.06.02. Performance Indicator: Assess a variety of workplace and community situations to identify ways to add value and improve the efficiency of processes and procedures.

CRP.06.03. Performance Indicator: Create and execute a plan of action to act upon new ideas and introduce innovations to workplace and community organizations.

CRP.07. CCTC Standard: Employ valid and reliable research strategies.

CRP.07.01. Performance Indicator: Select and implement reliable research processes and methods to generate data for decision-making in the workplace and community.

CRP.07.02. Performance Indicator: Evaluate the validity of sources and data used when considering the adoption of new technologies, practices and ideas in the workplace and community.

CRP.08. CCTC Standard: Utilize critical thinking to make sense of problems and persevere in solving them.

CRP.08.01. Performance Indicator: Apply reason and logic to evaluate workplace and community situations from multiple perspectives.

CRP.08.02. Performance Indicator: Investigate, prioritize and select solutions to solve problems in the workplace and community.

CRP.08.03. Performance Indicator: Establish plans to solve workplace and community problems and execute them with resiliency.

CRP.09. CCTC Standard: Model integrity, ethical leadership and effective management.

CRP.09.01. Performance Indicator: Model characteristics of ethical and effective leaders in the workplace and community (e.g. integrity, self-awareness, self-regulation, etc.).

CRP.09.02. Performance Indicator: Implement personal management skills to function effectively and efficiently in the workplace (e.g., time management, planning, prioritizing, etc.).

CRP.09.03. Performance Indicator: Demonstrate behaviors that contribute to a positive morale and culture in the workplace and community (e.g., positively influencing others, effectively communicating, etc.).

CRP.10. CCTC Standard: Plan education and career path aligned to personal goals.

CRP.10.01. Performance Indicator: Identify career opportunities within a career cluster that match personal interests, talents, goals and preferences.

CRP.10.02. Performance Indicator: Examine career advancement requirements (e.g., education, certification, training, etc.) and create goals for continuous growth in a chosen career.

CRP.10.03. Performance Indicator: Develop relationships with and assimilate input and/or advice from experts (e.g., counselors, mentors, etc.) to plan career and personal goals in a chosen career area.

CRP.10.04. Performance Indicator: Identify, prepare, update and improve the tools and skills necessary to pursue a chosen career path.

CRP.11. CCTC Standard: Use technology to enhance productivity.

CRP.11.01. Performance Indicator: Research, select and use new technologies, tools and applications to maximize productivity in the workplace and community.

CRP.11.02. Performance Indicator: Evaluate personal and organizational risks of technology use and take actions to prevent or minimize risks in the workplace and community.

CRP.12. CCTC Standard: Work productively in teams while using cultural/global competence.

CRP.12.01. Performance Indicator: Contribute to team-oriented projects and builds consensus to accomplish results using cultural global competence in the workplace and community.

CRP.12.02. Performance Indicator: Create and implement strategies to engage team members to work toward team and organizational goals in a variety of workplace and community situations (e.g., meetings, presentations, etc.).

Agriculture, Food, and Natural Resources Cluster Skill Content Standards

The AFNR Cluster Skills (CS) encompasses the study of fundamental knowledge and skills related to all AFNR professions. Students completing a program of study in any AFNR career pathway will demonstrate fundamental knowledge of the nature, scope and relationships of AFNR systems and the skills necessary for analysis of current and historical issues and trends; application of technologies; safety, health and environmental practices; stewardship of natural resources; and exploration of career opportunities.

Within each pathway, the standards are organized as follows:

- ***Common Career Technical Core (CCTC) Standards*** – These are the standards for Agriculture, Food and Natural Resources Career Cluster® (AG) from the 2012 version of the Common Career and Technical Core Standards, which are owned by the National Association of State Directors of Career and Technical Education/National Career Technical Education Foundation and are used here with permission. These statements define what students should know and be able to do after completing instruction in a program of study for this pathway.
- ***Performance Indicators*** –These statements distill each CCTC Standard into more discrete indicators of the knowledge and skills students should attain through a program of study in this pathway. Attainment of the knowledge and skills outlined in the performance indicators is intended to demonstrate an acceptable level of proficiency with the related CCTC Standard at the conclusion of a program of study in this area.

CS.01. CCTC Standard: Analyze how issues, trends, technologies and public policies impact systems in the Agriculture, Food & Natural Resources Career Cluster.

CS.01.01. Performance Indicator: Research, examine and discuss issues and trends that impact AFNR systems on local, state, national and global levels.

CS.01.02. Performance Indicator: Examine technologies and analyze their impact on AFNR systems.

CS.01.03. Performance Indicator: Identify public policies and examine their impact on AFNR systems.

CS.02. CCTC Standard: Evaluate the nature and scope of the Agriculture, Food & Natural Resources Career Cluster and the role of agriculture, food and natural resources (AFNR) in society and the economy.

CS.02.01. Performance Indicator: Research and use geographic and economic data to solve problems in AFNR systems.

CS.02.02. Performance Indicator: Examine the components of the AFNR systems and assess their impact on the local, state, national and global society and economy.

CS.03. CCTC Standard: Examine and summarize the importance of health, safety and environmental management systems in AFNR workplaces.

CS.03.01. Performance Indicator: Identify and explain the implications of required regulations to maintain and improve safety, health and environmental management systems.

CS.03.02. Performance Indicator: Develop and implement a plan to maintain and improve health, safety and environmental compliance and performance.

CS.03.03. Performance Indicator: Apply health and safety practices to AFNR workplaces.

CS.03.04. Performance Indicator: Use appropriate protective equipment and demonstrate safe and proper use of AFNR tools and equipment.

CS.04. CCTC Standard: Demonstrate stewardship of natural resources in AFNR activities.

CS.04.01. Performance Indicator: Identify and implement practices to steward natural resources in different AFNR systems.

CS.04.02. Performance Indicator: Assess and explain the natural resource related trends, technologies and policies that impact AFNR systems.

CS.05. CCTC Standard: Describe career opportunities and means to achieve those opportunities in each of the Agriculture, Food & Natural Resources career pathways.

CS.05.01. Performance Indicator: Evaluate and implement the steps and requirements to pursue a career opportunity in each of the AFNR career pathways (e.g., goals, degrees, certifications, resumes, cover letter, portfolios, interviews, etc.).

CS.06. CCTC Standard: Analyze the interaction among AFNR systems in the production, processing and management of food, fiber and fuel and the sustainable use of natural resources.

CS.06.01. Performance Indicator: Examine and explain foundational cycles and systems of AFNR.

CS.06.02. Performance Indicator: Analyze and explain the connection and relationships between different AFNR systems on a national and global level.

Biotechnology Systems Career Pathway Content Standards

The Biotechnology Systems (BS) Career Pathway encompasses 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 in the context of AFNR.

Within each pathway, the standards are organized as follows:

- ***National Council for Agricultural Education (NCAE) Standard**** – These are the standards set forth by the National Council for Agricultural Education for Biotechnology Systems. They define what students should know and be able to do after completing instruction in a program of study focused on applying biotechnology to AFNR systems.
- ***Performance Indicators*** – These statements distill each performance element into more discrete indicators of the knowledge and skills students should attain through a program of study in this pathway. Attainment of the knowledge and skills outlined in the performance indicators is intended to demonstrate an acceptable level of proficiency with the related performance element at the conclusion of a program of study in this area.

BS.01. NCAE Standard: Assess factors that have influenced the evolution of biotechnology in agriculture (e.g., historical events, societal trends, ethical and legal implications, etc.).

BS.01.01. **Performance Indicator**: Investigate and explain the relationship between past, current and emerging applications of biotechnology in agriculture (e.g., major innovators, historical developments, potential applications of biotechnology, etc.).

BS.01.02. Performance Indicator: Evaluate the scope and implications of regulatory agencies on applications of biotechnology in agriculture and protection of public interests (e.g., health, safety, environmental issues, etc.).

BS.01.03. Performance Indicator: Analyze the relationship and implications of bioethics, laws and public perceptions on applications of biotechnology in agriculture (e.g., ethical, legal, social, cultural issues).

BS.02. NCAE Standard: Demonstrate proficiency by safely applying appropriate laboratory skills to complete tasks in a biotechnology research and development environment (e.g., standard operating procedures, record keeping, aseptic technique, equipment maintenance, etc.).

BS.02.01. **Performance Indicator**: Read, document, evaluate and secure accurate laboratory records of experimental protocols, observations and results.

BS.02.02. Performance Indicator: Implement standard operating procedures for the proper maintenance, use and sterilization of equipment in a laboratory.

BS.02.03. Performance Indicator: Apply standard operating procedures for the safe handling of biological and chemical materials in a laboratory.

BS.02.04. Performance Indicator: Safely manage and dispose of biological materials, chemicals and wastes according to standard operating procedures.

BS.02.05. Performance Indicator: Examine and perform scientific procedures using microbes, DNA, RNA and proteins in a laboratory.

BS.03. NCAE Standard: Demonstrate the application of biotechnology to solve problems in Agriculture, Food and Natural Resources (AFNR) systems (e.g., bioengineering, food processing, waste management, horticulture, forestry, livestock, crops, etc.).

BS.03.01. Performance Indicator: Apply biotechnology principles, techniques and processes to create transgenic species through genetic engineering.

BS.03.02. Performance Indicator: Apply biotechnology principles, techniques and processes to enhance the production of food through the use of microorganisms and enzymes.

BS.03.03. Performance Indicator: Apply biotechnology principles, techniques and processes to protect the environment and maximize use of natural resources (e.g., biomass, bioprospecting, industrial biotechnology, etc.).

BS.03.04. Performance Indicator: Apply biotechnology principles, techniques and processes to enhance plant and animal care and production (e.g., selective breeding, pharmaceuticals, biodiversity, etc.).

BS.03.05. Performance Indicator: Apply biotechnology principles, techniques and processes to produce biofuels (e.g., fermentation, transesterification, methanogenesis, etc.).

BS.03.06. Performance Indicator: Apply biotechnology principles, techniques and processes to improve waste management (e.g., genetically modified organisms, bioremediation, etc.).

Environmental Service Systems Career Pathway Content Standards

The Environmental Service Systems (ESS) Career Pathway encompasses the study of systems, instruments and technology used to monitor and minimize the impact of human activity on environmental 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 environmental service systems in AFNR settings.

Within each pathway, the standards are organized as follows:

- ***Common Career Technical Core (CCTC) Standards*** – These are the standards for Environmental Service Systems (AG-ESS) from the 2012 version of the Common Career and Technical Core Standards, which are owned by the National Association of State Directors of Career and Technical Education/National Career Technical Education Foundation and are used here with permission. These statements define what students should know and be able to do after completing instruction in a program of study for this pathway.
- ***Performance Indicators*** – These statements distill each CCTC Standard into more discrete indicators of the knowledge and skills students should attain through a program of study in this pathway. Attainment of the knowledge and skills outlined in the performance indicators is intended to demonstrate an acceptable level of proficiency with the related CCTC Standard at the conclusion of a program of study in this area.

ESS.01. CCTC Standard: Use analytical procedures and instruments to manage environmental service systems.

ESS.01.01. Performance Indicator: Analyze and interpret laboratory and field samples in environmental service systems.

ESS.01.02. Performance Indicator: Properly utilize scientific instruments in environmental monitoring situations (e.g., laboratory equipment, environmental monitoring instruments, etc.).

ESS.02. CCTC Standard: Evaluate the impact of public policies and regulations on environmental service system operations.

ESS.02.01. Performance Indicator: Interpret and evaluate the impact of laws, agencies, policies and practices affecting environmental service systems.

ESS.02.02. Performance Indicator: Compare and contrast the impact of current trends on regulation of environmental service systems (e.g., climate change, population growth, international trade, etc.).

ESS.02.03. Performance Indicator: Examine and summarize the impact of public perceptions and social movements on the regulation of environmental service systems.

ESS.03. CCTC Standard: Develop proposed solutions to environmental issues, problems and applications using scientific principles of meteorology, soil science, hydrology, microbiology, chemistry and ecology.

ESS.03.01. Performance Indicator: Apply meteorology principles to environmental service systems.

ESS.03.02. Performance Indicator: Apply soil science and hydrology principles to environmental service systems.

ESS.03.03. Performance Indicator: Apply chemistry principles to environmental service systems.

ESS.03.04. Performance Indicator: Apply microbiology principles to environmental service systems.

ESS.03.05. Performance Indicator: Apply ecology principles to environmental service systems.

ESS.04. CCTC Standard: Demonstrate the operation of environmental service systems (e.g., pollution control, water treatment, wastewater treatment, solid waste management and energy conservation).

ESS.04.01. Performance Indicator: Use pollution control measures to maintain a safe facility and environment.

ESS.04.02. Performance Indicator: Manage safe disposal of all categories of solid waste in environmental service systems.

ESS.04.03. Performance Indicator: Apply techniques to ensure a safe supply of drinking water and adequate treatment of wastewater according to applicable rules and regulations.

ESS.04.04. Performance Indicator: Compare and contrast the impact of conventional and alternative energy sources on the environment and operation of environmental service systems.

ESS.05. CCTC Standard: Use tools, equipment, machinery and technology common to tasks in environmental service systems.

ESS.05.01. Performance Indicator: Use technological and mathematical tools to map land, facilities and infrastructure for environmental service systems.

ESS.05.02. Performance Indicator: Perform assessments of environmental conditions using equipment, machinery and technology.

Food Products and Processing Systems Career Pathway Content Standards

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

Within each pathway, the standards are organized as follows:

- ***Common Career Technical Core (CCTC) Standards*** – These are the standards for Food Products and Processing Systems (AG-FPP) from the 2012 version of the Common Career and Technical Core Standards, which are owned by the National Association of State Directors of Career and Technical Education/National Career Technical Education Foundation and are used here with permission. These statements define what students should know and be able to do after completing instruction in a program of study for this pathway.
- ***Performance Indicators*** – These statements distill each CCTC Standard into more discrete indicators of the knowledge and skills students should attain through a program of study in this pathway. Attainment of the knowledge and skills outlined in the performance indicators is intended to demonstrate an acceptable level of proficiency with the related CCTC Standard at the conclusion of a program of study in this area.

FPP.01. CCTC Standard: Develop and implement procedures to ensure safety, sanitation and quality in food product and processing facilities.

FPP.01.01. Performance Indicator: Analyze and manage operational and safety procedures in food products and processing facilities.

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

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

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

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

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

FPP.02.03. Performance Indicator: Apply principles of human behavior to develop food products to provide a safe, wholesome and nutritious food supply for local and global food systems.

FPP.03. CCTC Standard: Select and process food products for storage, distribution and consumption.

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

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

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

FPP.04. CCTC Standard: Explain the scope of the food industry and the historical and current developments of food product and processing.

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

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

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

Natural Resource Systems Career Pathway Content Standards

The Natural Resource Systems (NRS) Career Pathway encompasses the study of the management, protection, enhancement and improvement of soil, water, wildlife, forests and air as natural resources. 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 natural resource systems in AFNR settings.

Within each pathway, the standards are organized as follows:

- ***Common Career Technical Core (CCTC) Standards*** – These are the standards for Natural Resource Systems (AG-NRS) from the 2012 version of the Common Career and Technical Core Standards, which are owned by the National Association of State Directors of Career and Technical Education/National Career Technical Education Foundation and are used here with permission. These statements define what students should know and be able to do after completing instruction in a program of study for this pathway.
- ***Performance Indicators*** – These statements distill each CCTC Standard into more discrete indicators of the knowledge and skills students should attain through a program of study in this pathway. Attainment of the knowledge and skills outlined in the performance indicators is intended to demonstrate an acceptable level of proficiency with the related CCTC Standard at the conclusion of a program of study in this area.

NRS.01. CCTC Standard: Plan and conduct natural resource management activities that apply logical, reasoned and scientifically based solutions to natural resource issues and goals.

NRS.01.01. Performance Indicator: Apply methods of classification to examine natural resource availability and ecosystem function in a particular region.

NRS.01.02. Performance Indicator: Classify different types of natural resources in order to enable protection, conservation, enhancement and management in a particular geographical region.

NRS.01.03. Performance Indicator: Apply ecological concepts and principles to atmospheric natural resource systems.

NRS.01.04. Performance Indicator: Apply ecological concepts and principles to aquatic natural resource systems.

NRS.01.05. Performance Indicator: Apply ecological concepts and principles to terrestrial natural resource systems.

NRS.01.06. Performance Indicator: Apply ecological concepts and principles to living organisms in natural resource systems.

NRS.02. CCTC Standard: Analyze the interrelationships between natural resources and humans.

NRS.02.01. Performance Indicator: Examine and interpret the purpose, enforcement, impact and effectiveness of laws and agencies related to natural resource management, protection, enhancement and improvement (e.g., water regulations, game laws, historic preservation laws, environmental policy, etc.).

NRS.02.02. Performance Indicator: Assess the impact of human activities on the availability of natural resources.

NRS.02.03. Performance Indicator: Analyze how modern perceptions of natural resource management, protection, enhancement and improvement change and develop over time.

NRS.02.04. Performance Indicator: Examine and explain how economics affects the use of natural resources.

NRS.02.05. Performance Indicator: Communicate information to the public regarding topics related to the management, protection, enhancement, and improvement of natural resources.

NRS.03. CCTC Standard: Develop plans to ensure sustainable production and processing of natural resources.

NRS.03.01. Performance Indicator: Sustainably produce, harvest, process and use natural resource products (e.g., forest products, wildlife, minerals, fossil fuels, shale oil, alternative energy, recreation, aquatic species, etc.).

NRS.03.02. Performance Indicator: Demonstrate cartographic skills, tools and technologies to aid in developing, implementing and evaluating natural resource management plans.

NRS.04. CCTC Standard: Demonstrate responsible management procedures and techniques to protect, maintain, enhance, and improve natural resources.

NRS.04.01. Performance Indicator: Demonstrate natural resource protection, maintenance, enhancement and improvement techniques.

NRS.04.02. Performance Indicator: Diagnose plant and wildlife diseases and follow protocols to prevent their spread.

NRS.04.03. Performance Indicator: Prevent or manage introduction of ecologically harmful species in a particular region.

NRS.04.04. Performance Indicator: Manage fires in natural resource systems.

Plant Science Systems Career Pathway Content Standards

The Plant Systems (PS) Career Pathway encompasses the study of plant life cycles, classifications, functions, structures, reproduction, media and nutrients, as wells as growth and cultural practices through the study of crops, turf grass, trees, shrubs and/or ornamental plants. 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 plant systems in AFNR settings.

Within each pathway, the standards are organized as follows:

- ***Common Career Technical Core (CCTC) Standards*** – These are the standards for Plant Systems (AG-PS) from the 2012 version of the Common Career and Technical Core Standards, which are owned by the National Association of State Directors of Career and Technical Education/National Career Technical Education Foundation and are used here with permission. These statements define what students should know and be able to do after completing instruction in a program of study for this pathway.
- ***Performance Indicators*** – These statements distill each CCTC Standard into more discrete indicators of the knowledge and skills students should attain through a program of study in this pathway. Attainment of the knowledge and skills outlined in the performance indicators is intended to demonstrate an acceptable level of proficiency with the related CCTC Standard at the conclusion of a program of study in this area.

PS.01. CCTC Standard: Develop and implement a crop management plan for a given

production goal that accounts for environmental factors.

PS.01.01. Performance Indicator: Determine the influence of environmental factors on plant growth.

PS.01.02. Performance Indicator: Prepare and manage growing media for use in plant systems.

PS.01.03. Performance Indicator: Develop and implement a fertilization plan for specific plants or crops.

PS.02. CCTC Standard: Apply principles of classification, plant anatomy, and plant physiology to plant production and management.

PS.02.01. Performance Indicator: Classify plants according to taxonomic systems.

PS.02.02. Performance Indicator: Apply knowledge of plant anatomy and the functions of plant structures to activities associated with plant systems.

PS.02.03. Performance Indicator: Apply knowledge of plant physiology and energy conversion to plant systems.

PS.03. CCTC Standard: Propagate, culture and harvest plants and plant products based on current industry standards.

PS.03.01. Performance Indicator: Demonstrate plant propagation techniques in plant system activities.

PS.03.02. Performance Indicator: Develop and implement a management plan for plant production.

PS.03.03. Performance Indicator: Develop and implement a plan for integrated pest management for plant production.

PS.03.04. Performance Indicator: Apply principles and practices of sustainable agriculture to plant production.

PS.03.05. Performance Indicator: Harvest, handle and store crops according to current industry standards.

PS.04. CCTC Standard: Apply principles of design in plant systems to enhance an environment (e.g., floral, forest landscape, and farm).

PS.04.01. Performance Indicator: Evaluating, identifying and preparing plants to enhance an environment.

PS.04.02. Performance Indicator: Create designs using plants.

Power, Structural and Technical Systems Career Pathway Content Standards

The Power, Structural and Technical Systems (PST) Career Pathway encompasses the study of agricultural equipment, power systems, alternative fuel sources and precision technology, as well as woodworking, metalworking, welding and project planning for agricultural structures. 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 power, structural and technical systems in AFNR settings.

Within each pathway, the standards are organized as follows:

- ***Common Career Technical Core (CCTC) Standards*** – These are the standards for Power, Structural and Technical Systems (AG-PST) from the 2012 version of the Common Career and Technical Core Standards, which are owned by the National Association of State Directors of Career and Technical

Education/National Career Technical Education Foundation and are used here with permission. These statements define what students should know and be able to do after completing instruction in a program of study for this pathway.

- ***Performance Indicators*** – These statements distill each CCTC Standard into more discrete indicators of the knowledge and skills students should attain through a program of study in this pathway. Attainment of the knowledge and skills outlined in the performance indicators is intended to demonstrate an acceptable level of proficiency with the related CCTC Standard at the conclusion of a program of study in this area.

PST.01. CCTC Standard: Apply physical science principles and engineering applications to solve problems and improve performance in AFNR power, structural and technical systems.

PST.01.01. Performance Indicator: Apply physical science and engineering principles to assess and select energy sources for AFNR power, structural and technical systems.

PST.01.02. Performance Indicator: Apply physical science and engineering principles to design, implement and improve safe and efficient mechanical systems in AFNR situations.

PST.01.03. Performance Indicator: Apply physical science principles to metal fabrication using a variety of welding and cutting processes (e.g., SMAW, GMAW, GTAW, fuel-oxygen and plasma arc torch, etc.).

PST.02. CCTC Standard: Operate and maintain AFNR mechanical equipment and power systems.

PST.02.01. Performance Indicator: Perform preventative maintenance and scheduled service to maintain equipment, machinery and power units used in AFNR settings.

PST.02.02. Performance Indicator: Operate machinery and equipment while observing all safety precautions in AFNR settings.

PST.03. CCTC Standard: Service and repair AFNR mechanical equipment and power systems.

PST.03.01. Performance Indicator: Troubleshoot, service and repair components of internal combustion engines using manufacturers' guidelines.

PST.03.02. Performance Indicator: Service electrical systems and components of mechanical equipment and power systems using a variety of troubleshooting and/or diagnostic methods.

PST.03.03. Performance Indicator: Utilize manufacturers' guidelines to diagnose and troubleshoot malfunctions in machinery, equipment and power source systems (e.g., hydraulic, pneumatic, transmission, steering, suspension, etc.).

PST.04. CCTC Standard: Plan, build and maintain AFNR structures.

PST.04.01. Performance Indicator: Create sketches and plans for AFNR structures.

PST.04.02. Performance Indicator: Determine structural requirements, specifications and estimate costs for AFNR structures

PST.04.03. Performance Indicator: Follow architectural and mechanical plans to construct, maintain and/or repair AFNR structures (e.g., material selection, site preparation and/or layout, plumbing, concrete/masonry, etc.).

PST.04.04. Performance Indicator: Apply electrical wiring principles in AFNR structures.

PST.05. CCTC Standard: Use control, monitoring, geospatial and other technologies in AFNR power, structural and technical systems.

PST.05.01. Performance Indicator: Apply computer and other technologies (e.g., robotics, CNC, UAS, etc.) to solve problems and increase the efficiency of AFNR systems.

PST.05.02. Performance Indicator: Prepare and/or use electrical drawings to design, install and troubleshoot electronic control systems in AFNR settings.

PST.05.03. Performance Indicator: Apply geospatial technologies to solve problems and increase the efficiency of AFNR systems.