TENNESSEE DEPARTMENT OF EDUCATION
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Advanced Food Science

Primary Career Cluster:	Agriculture, Food and Natural Resources
Consultant:	Steven Gass, (615) 532-2847, Steven.Gass@tn.gov
Course Code(s):	TBD
Prerequisite(s):	Agriscience (5957), Principles of Food Production (TBD), and Food Science and Safety (TBD)
Credit:	1
Grade Level:	12
Graduation Requirements:	This course satisfies one of three credits required for an elective focus when taken in conjunction with other Agriculture courses.
Programs of Study and Sequence:	This is the fourth, and final, course in the *Food Science* program of study.
Necessary Equipment:	Refer to Teacher Resources page below.
Aligned Student Organization(s):	FFA: www.tnffa.org Allie Ellis, (615) 253-5207, Allie.Ellis@tn.gov
Coordinating Work-Based Learning:	All Agriculture students are encouraged to participate in a Supervised Agricultural Experience (SAE) program. In addition, if a teacher has completed work-based learning (WBL) training, he or she can offer appropriate student WBL opportunities. To learn more, please visit http://tennessee.gov/education/cte/wb/.
Available Student Industry Certifications:	None
Dual Credit or Dual Enrollment Opportunities:	There are no known dual credit/dual enrollment opportunities for this course. If interested in developing, reach out to a local postsecondary institution to establish an articulation agreement.
Teacher Endorsement(s):	048, 448
Required Teacher Certifications/Training:	None
Teacher Resources:	www.tn.gov/education/cte/AgricultureFoodNaturalResources.shtml

Course Description

Advanced Food Science is a capstone course designed to prepare students for further education and careers in food science and technology. This course covers advanced principles of food science, characteristics and properties of food products, processing and grading techniques and skills, and food labeling and packaging principles. Standards in this course are aligned with Tennessee Common Core State Standards for English Language Arts & Literacy in Technical Subjects and National Agriculture, Food and Natural Resources Career Cluster Content Standards.*

Program of Study Application

This course is the fourth, and final, course in the *Food Science* program of study. For more information on the benefits and requirements of implementing this program in full, please visit the Agriculture, Food, and Natural Resources website at www.tn.gov/education/cte/AgricultureFoodNaturalResources.shtml.

Course Standards

Introduction to Food Processing

1) Use local news media, organizational websites, and real-time labor market information to investigate occupations in food science. Compare and contrast the knowledge, skills, and abilities necessary for employment, as well as the typical level of education required. (TN CCSS Reading 2, 9; TN CCSS Writing 4, 7, 9)

2) Summarize how principles of food science are applied for the conversion of agricultural commodities into consumer products. Determine how food safety techniques applied in the home, at retail establishments, and in industrial food processing environments benefit human health. (TN CCSS Reading 2, 7, 9; TN CCSS Writing 9)

3) Review common laboratory safety procedures for tool and equipment operation in the food science laboratories, including but not limited to accident prevention and control procedures. Demonstrate the ability to follow safety and operational procedures in a lab setting and complete a safety test with 100 percent accuracy. (TN CCSS Reading 3)

4) Demonstrate the ability to prepare basic personal and business records to complete taxes, employment, and SAE related applications, including resume, budgets, income statements, balance sheets, cash flow statements, profit and loss statements, and equity statements. (TN CCSS Reading 3; TN CCSS Writing 4)

Processing and Evaluation of Red Meat

5) Identify major species and breeds of livestock utilized for red meat production. Describe the fabrication, processing, packaging, and quality analysis of red meats and their by-products.

6) Explain carcass preparation and fabrication procedures and identify associated equipment, safety, sanitation, and quality control procedures. Demonstrate in a live setting or in a presentation format the ability to identify wholesale and retail cuts of meat and meat by-products, and correlate them to major muscle groups. (TN CCSS Reading 3)

7) Analyze the United States Department of Agriculture (USDA) inspection and grading procedures and compose an argumentative essay justifying their purpose in the food industry, developing claim(s) and counterclaim(s) with specific evidence from case studies found in news media. Describe the principles of quality and yield grading. Demonstrate in a live setting or in a presentation format the ability to perform the evaluation and grading of carcasses, wholesale cuts, and retail cuts to determine maturity, final quality grade, and final yield grade, and provide

written and oral justification for evaluation conclusions. (TN CCSS Reading 1, 3; TN CCSS Writing 1, 4, 9)

8) Demonstrate in a live setting or in a presentation the ability to perform methods of further processing fabrication for processed and value added products including comminuted meat products, emulsions, and cured meats. Using quantitative reasoning and appropriate units, calculate proper meat product formulations based upon required protein levels and USDA allowances for various products. (TN CCSS Reading 3)

Processing and Evaluation of Milk and Dairy Products

9) Identify major breeds of livestock utilized for dairy production. Describe the products, by-products, processing, packaging, and quality analysis associated with each breed.

10) Summarize milk quality test and testing procedures in an explanatory narrative. Demonstrate in a live setting or in a presentation the ability to perform quality evaluations of milk and dairy products, providing written and oral justification for evaluation conclusions. (TN CCSS Reading 2, 3; TN CCSS Writing 2, 4)

11) Describe milk preparation and processing procedures, addressing procedures specific to equipment, safety, sanitation, and quality control. Analyze the composition of milk and examine concepts and principles that verify the scientific foundation for the pasteurization process. (TN CCSS Reading 3, 8; TN CCSS Writing 9)

12) Identify varieties and characteristics of cultured and frozen milk products. Demonstrate in a live setting or presentation the ability to follow procedures used to process buttermilk, yogurt, and ice cream. (TN CCSS Reading 3)

13) Identify varieties, characteristics, and classifications of cheeses. Demonstrate in a live setting or presentation format the ability to follow procedures used to process, classify, and grade cheese. (TN CCSS Reading 3)

Processing and Evaluation of Poultry, Eggs, and Fish

14) Identify major poultry breeds and fish species utilized for meat and egg production. Describe the fabrication, processing, packaging, and quality analysis of poultry meat, eggs, and fish. (TN CCSS Reading 3)

15) Compare and contrast the carcass preparation and fabrication procedures in poultry and fish, addressing procedures specific to equipment, safety, sanitation, and quality control. Demonstrate in a live setting or in a presentation the ability to identify retail cuts of poultry, fish, and related by-products. (TN CCSS Reading 3)

16) Outline the United States Department of Agriculture (USDA) inspection procedures and system for classes, standards, and grades of poultry products and fish. Demonstrate in a live setting or in a presentation the ability to perform the evaluation and grading of carcasses and parts of chickens and turkeys, pre-cooked, further processed, and poultry meat products, providing written and oral justification for evaluation and grading scores. Evaluate and grade eggs for

interior and exterior quality and provide written and oral justification for evaluation conclusions. (TN CCSS Reading 3; TN CCSS Writing 1, 4)

Processing and Evaluation of Vegetables, Fruits, and Nuts

17) Explain the processing, packaging, and quality analysis of vegetables, fruits, nuts and their by-products.

18) Describe preparation and processing procedures for vegetables, fruits, nuts, and their by-products, addressing procedures specific to equipment, safety, sanitation, and quality control. Research and cite texts explaining the use of various monitoring systems to appraise food quality, such as the Brix scale. (TN CCSS Reading 1, 8; TN CCSS Writing 4, 7)

Food Product Packaging and Labeling

19) Identify laws regulating the packaging and labeling of food products, and summarize industry requirements in an explanatory text. Demonstrate in a live setting or in a presentation the ability to perform packaging and labeling procedures for different food products. (TN CCSS Reading 2, 3; TN CCSS Writing 4)

20) Research storage and transportation issues pertaining to packaged food products and the extent to which noted evidence and reasoning justifies implications for safety and quality, citing specific examples from news media and academic journals. (TN CCSS Reading 1, 6, 8; TN CCSS Writing 7, 9)

Food Product Marketing

21) Write an informative essay illustrating the application of fundamental economic principles such as supply, demand, and profit to the food science industry. Describe marketing considerations and methods of merchandising food products. Discuss how quality and yield grade factors affect product marketing. Revise, edit, and rewrite essay with peer feedback. (TN CCSS Writing 2, 5)

22) Develop a food product and create a processing, packaging, and marketing plan incorporating the skills learned in this course. (TN CCSS Writing 2, 4)

Consumer Issues

23) Review data from news media and company product recall notices to explore consumer satisfaction issues. Cite specific evidence to assess the impact of organic, natural, religious-based, and other specialized processing methods in the food industry. Compare and contrast the advantages and disadvantages of value added and specialty products and conduct research to evaluate and summarize consumer interest and trends related to these products. (TN CCSS Reading 1, 2, 9; TN CCSS Writing 7, 9)

24) Investigate the food product development process. Evaluate the use of food batch procedures for the purpose of economic efficiency. Describe the application of sensory evaluation methods to test food product flavor, appearance, and texture by quantitative description and simple difference testing. (TN CCSS Writing 8)

25) Identify consumer concerns related to food quality and safety (such as antibiotic use, genetically modified organisms (GMOs), pesticide use, and food borne illnesses), and discuss the economic implications when low-quality and unsafe foods enter the market.

Standards Alignment Notes

*References to other standards include:

- TN CCSS Reading: Tennessee Common Core State Standards for English Language Arts & Literacy in History/Social Studies, Science, and Technical Subjects; Reading Standards for Literacy in Science and Technical Subjects 6-12; Grades 11-12 Students (page 62).
    - Note: While not directly aligned to one specific standard, students that are engaging in activities outlined above should be able to also demonstrate fluency in Standards 4, 5, 6, and 10 at the conclusion of the course.
- TN CCSS Writing: Tennessee Common Core State Standards for English Language Arts & Literacy in History/Social Studies, Science, and Technical Subjects; Writing Standards for Literacy in History/Social Studies, Science, and Technical Subjects 6-12; Grades 11-12 Students (pages 64-66).
    - Note: While not directly aligned to one specific standard, students that are engaging in activities outlined above should be able to also demonstrate fluency in Standards 3, 5, 6, and 10 at the conclusion of the course.
- AFNR: National Agriculture, Food and Natural Resources (AFNR) Career Cluster Content Standards: Students engaged in activities outlined above should be able to demonstrate fluency in Standards ABS, CR, and FPP at the conclusion of the course.
- P21: Partnership for 21st Century Skills Framework for 21st Century Learning
    - Note: While not all standards are specifically aligned, teachers will find the framework helpful for setting expectations for student behavior in their classroom and practicing specific career readiness skills.

TENNESSEE DEPARTMENT OF EDUCATION
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Agricultural and Biosystems Engineering

Primary Career Cluster:	Agriculture, Food and Natural Resources
Consultant:	Steven Gass, (615) 532-2847, Steven.Gass@tn.gov
Course Code(s):	TBD
Prerequisite(s):	Agriscience (5957)
Credit:	1
Grade Level:	12
Graduation Requirements:	This course satisfies one of three credits required for an elective focus when taken in conjunction with other Agriculture courses.
Programs of Study and Sequence:	This is the fourth, and final, course in the *Agricultural Engineering and Applied Technologies* program of study.
Necessary Equipment:	
Aligned Student Organization(s):	FFA: www.tnffa.org Allie Ellis, (615) 253-5207, Allie.Ellis@tn.gov
Coordinating Work-Based Learning:	All Agriculture students are encouraged to participate in a Supervisied Agricultural Experience (SAE) program. In addition, if a teacher has completed work-based learning training, they can offer apporpriate student WBL opportunitieis. To learn more, please visit http://tennessee.gov/education/cte/wb/.
Available Student Industry Certifications:	None
Dual Credit or Dual Enrollment Opportunities:	There are local dual credit opportunities available for this course, such as Tennessee Technological University (TTU).
Teacher Endorsement(s):	048, 448
Required Teacher Certifications/Training:	No
Teacher Resources:	www.tn.gov/education/cte/AgricultureFoodNaturalResources.shtml

Course Description

Agricultural and Biosystems Engineering is a capstone course that prepares students for further study or careers in engineering, environmental science, agricultural design and research, and agricultural mechanics. Special emphasis is given to the many modern applications of Geographic Information Systems (GIS) and Global Positioning Systems (GPS) to achieve various agribusiness goals. Standards in this course are aligned with Tennessee Common Core State Standards for English Language Arts & Literacy in Technical Subjects, Tennessee Common Core State Standards for Mathematics, and National Agriculture, Food and Natural Resources Career Cluster Content Standards.*

Program of Study Application

This course is the fourth, and final, course for the *Agricultural Engineering and Applied Technologies* program of study. For more information on the benefits and requirements of implementing this program in full, please visist the Agriculture, Food, and Natural Resources website at www.tn.gov/education/cte/AgricultureFoodNaturalResources.shtml.

Course Standards

Safety

1) Identify the benefits of knowing and applying basic safety procedures in both an agricultural laboratory and workplace. Interpret current Occupational Safety and Health Administration (OSHA) guidelines to conduct a compliance review of the agricultural laboratory, including a written summary justifying the findings with recommendations for improving the safety of working conditions. (TN CCSS Reading 1, 2; TN CCSS Writing 1, 4, 7, 9; AFNR CS.06, CS.07)

2) Review common laboratory safety procedures for tool and equipment operation in the agricultural and biosystems engineering laboratories, including but not limited to accident prevention and control procedures. Demonstrate the ability to follow safety and operational procedures in a lab setting and complete a safety test with 100 percent accuracy. (TN CCSS Reading 3; ARNR CS)

Occupational Research and Awareness

3) Gather and analyze information from multiple authoritative sources such as the United States Bureau of Labor Statistics to develop a written projection of the occupational trends related to agricultural engineering. Supplement the narrative with relevant and properly cited charts, graphs, and other visual representations. (TN CCSS Reading 1, 9; TN CCSS Writing 2, 7, 9)

Project Planning and Management

4) Design a project plan for an agricultural engineering project, outlining a strategy for working within a given set of parameters, constraints, and resources. Include in the plan components related to the budget, timeline, safety considerations, and strategies to minimize adverse environmental impacts. (TN CCSS Writing 4, 9)

Geographic Information Systems, Precision Measurements, and Management

5) Synthesize case studies and field experience to provide evidence of the impact of Geographic Information Systems (GIS) and Global Positioning Systems (GPS) on agricultural demographics, precision agriculture, pasture management, water quality, watershed management, and waste pollution. Discuss the implications for industry and labor with the incorporation of these technologies into more and more facets of agricultural life. (TN CCSS Reading 1, 9; TN CCSS Writing 2, 7, 9)

6) Identify various GIS and GPS applications and explain their uses in precision agriculture, including but not limited to the following: precision agriculture management zones, crop water and drought areas, crop imaging, land correlation to crop yields, yield map cleaning and management, drainage analysis and tile mapping, crop data analysis, soil darkness mapping, suitability modeling, and slope angle and accuracy. (TN CCSS Writing 2, 7, 9)

7) Demonstrate the ability to make land use, management, development, and equipment recommendations for a specific plot of land in rural and urban settings. Provide graphical and textual evidence to support each recommendation. (TN CCSS Reading 1, 3, 7; TN CCSS Writing 2, 7, 8, 9)

Geographic Information Systems, Irrigation, and Drainage

8) Analyze, map, and disseminate Geographic Information Systems (GIS) and Global Positioning Systems (GPS) data portraying a drainage map of a specified region. Citing specific evidence from findings, propose changes to drainage and irrigation systems and justify recommendations against accepted soil erosion control practices. (TN CCSS Reading 3, 9; TN CCSS Writing 1, 4, 6, 8, 9)

9) Describe the relationships between concepts of hydrostatics, kinematics, and dynamics of fluid flows used for agricultural industry irrigation systems, including but not limited to pipes and open channels, using domain-specific language. (TN CCSS Reading 4, 5; TN CCSS Writing 9)

Structures: Environmental Impacts, Efficiency, and Certifications

10) Research agricultural buildings and facilities that meet industry benchmarks for energy efficiency and environmental sustainability. Collect observations on the costs and benefits of such structures and make recommendations to conserve energy and decrease operational cost, developing claim(s) with specific evidence from research. (TN CCSS Reading 1, 7; TN CCSS Writing 1, 7, 9)

11) Create a detailed construction plan for an agricultural facility suitable for a designated site, using natural systems and renewable energy where possible, and conserving energy and material resources in construction and maintenance while meeting building certification requirements. (TN CCSS Reading 3, 7; TN CCSS Writing 2, 7, 9)

Biophysical Properties of Crops and Food Products

12) Analyze the physical properties of selected agricultural crops and food products as they impact harvesting, storage, processing, and transport requirements, including but not limited to density, shape, moisture content, water potential, friction and flow of particulate solids, terminal velocity, thermal properties, and viscoelastic behavior of solids. Develop a fact sheet detailing the appropriate harvesting, storage, processing, and transportation equipment required for the range of crops and products analyzed, providing written justification for the use of chosen equipment. (TN CCSS Reading 1, 7, 8, 9; Writing 2, 8; TN CCSS Math N, Q, SSE, REI, IF, LE, CO, C, GMD, MG)

Biochemistry of Agricultural Fertilizers and Chemicals

13) Develop a safety, storage, and disposal plan for agricultural chemicals such as pesticides, fertilizers, and veterinary medicines. Outline specific procedures pertaining to responsible selection and storage, mixing, transport, application, and disposal of waste, in compliance with applicable regulatory standards. (TN CCSS Reading 1, 3; Writing 2, 4, 8, 9)

14) Analyze the chemical and physical properties of selected agricultural fertilizers and chemicals in relation to specific crops and determine the most efficient and effective method of application. Demonstrate in a live setting or presentation the ability to calibrate equipment for liquid, solid, and gaseous applications. (TN CCSS Reading 3, 7, 9; Writing 2, 9)

Capstone Project

15) Participate in a team-driven agricultural engineering project approved by the instructor that includes research, planning, analysis, construction, testing, and evaluation phases to measure success and adherence to legal constraints. Prepare periodic oral and written reports to demonstrate progress. (TN CCSS Reading 1, 7, 9; Writing 2, 4, 8, 9)

Standards Alignment Notes

*References to other standards include:

- TN CCSS Reading: Tennessee Common Core State Standards for English Language Arts & Literacy in History/Social Studies, Science, and Technical Subjects; Reading Standards for Literacy in Science and Technical Subjects 6-12; Grades 11-12 Students (page 62).
    - Note: While not directly aligned to one specific standard, students that are engaging in activities outlined above should be able to demonstrate fluency in Standards 6, 8, and 10 at the conclusion of the course.
- TN CCSS Writing: Tennessee Common Core State Standards for English Language Arts & Literacy in History/Social Studies, Science, and Technical Subjects; Writing Standards for Literacy in History/Social Studies, Science, and Technical Subjects 11-12; Grades 11-12 Students (pages 64-66).
    - Note: While not directly aligned to one specific standard, students that are engaging in activities outlined above should be able to demonstrate fluency in Standards 3, 5 and 10 at the conclusion of the course.
- TN CCSS Math: Tennessee Common Core State Standards for Mathematics; Math Standards for High School: Number and Quantity, Algebra, Functions, Modeling, Geometry, Statistics and Probability (pages 58-83).
    - Note: The standards in this course are not meant to teach mathematical concepts. However, the concepts referenced above may provide teachers with opportunities to collaborate with mathematics educators to design project based activities or collaborate on lesson planning. Students that are engaging in activities listed above should be able to demonstrate quantitative, algebraic, and functional reasoning as applied to specific technical concepts. In addition, students will have the opportunity to practice the habits of mind as described in the eight Standards for Mathematical Practice.

- AFNR: National Agriculture, Food and Natural Resources (AFNR) Career Cluster Content Standards. Students engaged in activities outlined above should be able to demonstrate fluency in Standards in CS, PST, ABS, NRS, PS, and ESS systems at the conclusion of the course.
- P21: Partnership for 21st Century Skills Framework for 21st Century Learning
    - Note: While not all standards are specifically aligned, teachers will find the framework helpful for setting expectations for student behavior in their classroom and practicing specific career readiness skills.

TENNESSEE DEPARTMENT OF EDUCATION
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Agricultural Business and Finance

Primary Career Cluster:	Agriculture, Food and Natural Resources
Consultant:	Steven Gass, (615) 532-2847, Steven.Gass@tn.gov
Course Code(s):	5943
Prerequisite(s):	Agriscience (5957) and Principles of Agribusiness (TBD)
Credit:	1
Grade Level:	12
Graduation Requirements:	• Satisfies *Personal FInance* graduation requirement • Satisfies one of three credits required for an elective focus when taken in conjunction with other Agriculture courses
Programs of Study and Sequence:	This is the fourth, and final, course in the *Agribusiness* program of study.
Necessary Equipment:	Refer to the Teacher Resource page below.
Aligned Student Organization(s):	FFA: www.tnffa.org Allie Ellis, (615) 253-5207, Allie.Ellis@tn.gov
Coordinating Work-Based Learning:	All Agriculture students are encouraged to participate in a Supervised Agricultural Experience (SAE) program. In addition, if a teacher has completed work-based learning (WBL) training, he or she can offer appropriate student WBL opportunities. To learn more, please visit http://tennessee.gov/education/cte/wb/.
Available Student Industry Certifications:	None
Dual Credit or Dual Enrollment Opportunities:	A statewide articulation exists for this course for students to earn dual credit at Tennessee public postsecondary institutions that offer agriculture. For more information, please visit http://www.state.tn.us/education/opca/.
Teacher Endorsement(s):	048, 448
Required Teacher Certifications/Training:	None
Teacher Resources:	www.tn.gov/education/cte/AgricultureFoodNaturalResources.shtml

Course Description

Agricultural Business and Finance is an applied knowledge course that addresses the economic and business principles necessary to operate a successful agribusiness. The course covers a wide range of topics in business, finance, economics, and management. Students will learn to apply the principles drawn from these topics toward activities that support their own business aspirations in the agriculture industry. Standards in this course are aligned with Tennessee Common Core State Standards for English

Language Arts & Literacy in Technical Subjects and National Agriculture, Food and Natural Resources Career Cluster Content Standards.* *Agricultural Business and Finance* is a dual credit course with statewide articulation.

Program of Study Application

This course is the fourth, and final, course in the *Agribusiness* program of study. For more information on the benefits and requirements of implementing this program in full, please visit the Agriculture, Food, and Natural Resources website at www.tn.gov/education/cte/AgricultureFoodNaturalResources.shtml.

Course Standards

History and Evolution of Agribusiness

1) Explore the evolution of agribusiness in the United States by describing the modern agribusiness sectors and identifying historical milestones impacting their development. Using local job postings and labor and workforce data, research occupations in agribusiness and management, and identify the knowledge, skills, and abilities necessary for employment. (TN CCSS Reading 1, 2, 9; TN CCSS Writing 7, 9)

2) Write an informative essay that compares and contrasts different business and ownership models of agribusinesses (such as proprietorships, partnerships, corporations, limited liability companies, franchises, and cooperatives). Include the scope, economic impact, and future trends of a specific type of agribusiness locally, regionally, nationally, and globally, citing specific evidence from news articles or government publications. (TN CCSS Reading 1, 7; TN CCSS Writing 2, 8)

3) Demonstrate the ability to prepare basic personal and business records to complete taxes, employment and SAE related applications, including resume, budgets, income statements, balance sheets, cash flow statements, profit and loss statements, and equity statements. (TN CCSS Reading 3; TN CCSS Writing 4)

Saving, Investing, and Financing

4) Examine different forms of saving, investing, and financing by researching available financial services at banks, credit unions, and savings and loans. Justify a selected financial service option for a specific personal and/or agribusiness use by developing a claim and supporting it with reasoning and evidence pulled from the financial institution. (TN CCSS Reading 2; TN CCSS Writing 1, 7, 9)

5) Apply principles of consumer finance, savings, investing, and loans to develop personal and agribusiness budgets.

6) Using visual representations and mathematical equations, compare and contrast the differences between personal, business, and farm financing, including but not limited to sources, terms, and available risk management strategies (such as insurance, investments, and commodity trading).

Using quantitative reasoning and appropriate units, calculate simple and compound interest for a given financing option. (TN CCSS Reading 2, 4, 7)

Recordkeeping and Accounting

7) Articulate the components of a business plan, and research exemplars from national or local companies. Demonstrate the ability to prepare basic personal and business records, including budgets, income statements, balance sheets, cash flow statements, profit and loss statements, and equity statements. (TN CCSS Reading 3; TN CCSS Writing 4)

8) Differentiate between bookkeeping and accounting. Justify the need for organized recordkeeping processes as an integral part of a comprehensive management system.

9) Apply fundamental principles of financial recordkeeping to agribusiness planning, logistics, and operations, including at a minimum the following:
    a. Differentiating between fixed and variable costs
    b. Determining pricing methods
    c. Using general ledger and basic accounting principles (accrual vs. cash basis)
    d. Calculating depreciation
    e. Estimating simple and compound interest

10) Consult technical texts to research and generate connections regarding the relationships between depreciation, taxation, and insurance. (TN CCSS Reading 5)

Consumer Finance

11) Craft an argumentative essay that makes a claim about the importance of a specific responsible personal finance practice in agribusiness. Develop claim(s) and counterclaim(s) fairly with reasoning and evidence about the factors impacting credit and income. Include basic financial management and financial security tips. (TN CCSS Reading 2; TN CCSS Writing 1)

12) Examine essential principles of consumer finance by summarizing common banking procedures and services, including establishment of personal and operating accounts. Compare and contrast costs and benefits of financial services based on personal characteristics, wealth, debt, and risk management. (TN CCSS Reading 2, 4; TN CCSS Writing 7, 9)

Economics of Agribusiness

13) Explain how economic principles apply to agribusiness, including macro versus micro systems, factors and effects of competition, inflation, pricing, and supply and demand relationships. (TN CCSS Reading 2, 4, 5; TN CCSS Writing 2)

14) Analyze the role of government in setting monetary, fiscal, and taxation policies that affect the operations of agriculture businesses, including the sale of farm commodities. Investigate specific crops and discuss how economic policies set by the government impact the pricing and sale of a commodity, citing evidence from legislation and news articles. Determine the impact such policies have on consumers and producers. (TN CCSS Reading 1, 2, 4, 5; TN CCSS Writing 2, 7)

15) Assess the global impact of American commodities on world food markets. Select a commodity produced in America and research foreign trade laws governing its sale. Make a claim about how these laws affect supply and demand in world economies, developing claim(s) and counterclaim(s) with reasoning and evidence from governmental agencies, non-profits, and news articles. (TN CCSS Reading 1, 2, 4, 7; TN CCSS Writing 1, 7, 8, 9)

Business Planning and Management

16) Assess the importance of entrepreneurship in society. Differentiate between characteristics of successful and unsuccessful entrepreneurial endeavors. Evaluate methods for identifying opportunities in entrepreneurship and outline the major steps in starting an agribusiness. (TN CCSS Reading 2; TN CCSS Writing 4, 7)

17) Develop and present a comprehensive business plan for an agriculture-related business. Address at minimum the following components: type of agricultural ventures, projected profits, expenses, margins, returns on investment, and facilities and equipment needs. (TN CCSS Writing 4)

18) Analyze case studies to illuminate the specific challenges of running an agriculture-related business. Determine the role that effective managerial skills play in an agribusiness venture to hypothesize the appropriate managerial skills for a variety of operational issues. (TN CCSS Reading 7)

19) Summarize the history of agriculture-related policy development at the state and national levels. Research and identify major regulatory agencies and outline the principle policies governing modern agribusinesses, citing evidence from specific legislation. Compose an argumentative essay to make a claim supporting or opposing a specific government regulation in agriculture. (TN CCSS Reading 2, 8; TN CCSS Writing 1, 7)

Standards Alignment Notes

*References to other standards include:

- TN CCSS Reading: Tennessee Common Core State Standards for English Language Arts & Literacy in History/Social Studies, Science, and Technical Subjects; Reading Standards for Literacy in Science and Technical Subjects 6-12; Grades 11-12 Students (page 62).
    - Note: While not directly aligned to one specific standard, students that are engaging in activities outlined above should be able to also demonstrate fluency in Standards 6 and 10 at the conclusion of the course.
- TN CCSS Writing: Tennessee Common Core State Standards for English Language Arts & Literacy in History/Social Studies, Science, and Technical Subjects; Writing Standards for Literacy in History/Social Studies, Science, and Technical Subjects 6-12; Grades 11-12 Students (pages 64-66).
    - Note: While not directly aligned to one specific standard, students that are engaging in activities outlined above should be able to also demonstrate fluency in Standards 3, 5, 6, and 10 at the conclusion of the course.

- AFNR: National Agriculture, Food and Natural Resources (AFNR) Career Cluster Content Standards: Students engaged in activities outlined above should be able to demonstrate fluency in Standards ABS and CS at the conclusion of the course.
- P21: Partnership for 21st Century Skills Framework for 21st Century Learning
    - Note: While not all standards are specifically aligned, teachers will find the framework helpful for setting expectations for student behavior in their classroom and practicing specific career readiness skills.

TENNESSEE DEPARTMENT OF EDUCATION
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Agricultural Power and Equipment

Primary Career Cluster:	Agriculture, Food and Natural Resources
Consultant:	Steven Gass, (615) 532-2847, Steven.Gass@tn.gov
Course Code(s):	TBD
Prerequisite(s):	Agriscience (5957) and Principles of Agricultural Mechanics (TBD)
Credit:	1
Grade Level:	11
Graduation Requirements:	This course satisfies one of three credits required for an elective focus when taken in conjunction with other Agriculture courses.
Programs of Study and Sequence:	This is the third course in the *Agricultural Engineering and Applied Technologies* program of study.
Necessary Equipment:	Refer to Teacher Resources page below.
Aligned Student Organization(s):	FFA: www.tnffa.org Allie Ellis, (615) 253-5207, Allie.Ellis@tn.gov
Coordinating Work-Based Learning:	All Agriculture students are encouraged to participate in a Supervised Agricultural Experience (SAE) program. In addition, if a teacher has completed work-based learning (WBL) training, he or she can offer appropriate student WBL opportunities. To learn more, please visit http://tennessee.gov/education/cte/wb/.
Available Student Industry Certifications:	None
Dual Credit or Dual Enrollment Opportunities:	There are no known dual credit/dual enrollment opportunities for this course. If interested in developing, reach out to a local postsecondary institution to establish an articulation agreement.
Teacher Endorsement(s):	048, 448
Required Teacher Certifications/Training:	None
Teacher Resources:	www.tn.gov/education/cte/AgricultureFoodNaturalResources.shtml

Course Description

Agricultural Power and Equipment is an applied-knowledge course in agricultural engineering with special emphasis on laboratory activities involving small engines, tractors, and agricultural equipment. The standards in this course address navigation, maintenance, repair, and overhaul of electrical motors, hydraulic systems, and fuel-powered engines as well as exploration of a wide range of careers in agricultural mechanics. Standards in this course are aligned with Tennessee Common Core State Standards for English Language Arts & Literacy in Technical Subjects, Tennessee Common Core State Standards in Mathematics, and National Agriculture, Food and Natural Resources Career Cluster Content Standards.*

Program of Study Application

This course is the third course in the *Agricultural Engineering and Applied Technologies* program of study. For more information on the benefits and requirements of implementing this program in full, please visit the Agriculture, Food, and Natural Resources website at www.tn.gov/education/cte/AgricultureFoodNaturalResources.shtml.

Course Standards

Occupational Awareness & Safety

1) Consult industry manuals to ascertain the specific safety prevention and control standards governing the agricultural engineering industry. Demonstrate adherence to recognized standards, and apply occupational safety concepts across all coursework, such as but not limited to procedures surrounding general safety, personal safety (such as the use of personal protective equipment), lifting, transporting, alerting, and reporting. (TN CCSS Reading 3)

2) Review common laboratory safety procedures for tool and equipment operation in the agricultural power and equipment laboratories, including but not limited to accident prevention and control procedures. Demonstrate the ability to follow safety and operational procedures in a lab setting and complete a safety test with 100 percent accuracy. (TN CCSS Reading 3)

3) Use local news media, organizational websites, and real-time labor market information to investigate occupations in agricultural engineering and technologies. Compare and contrast the knowledge, skills, and abilities necessary for employment, as well as the typical level of education required. (TN CCSS Reading 2, 9; TN CCSS Writing 4, 7, 9)

Career Awareness

4) Gather and analyze information from multiple authoritative sources such as the United States Bureau of Labor Statistics (BLS) to develop a written projection of the occupational trends related to agriculture power and equipment. Supplement the narrative with relevant and properly cited charts, graphs, and other visual representations. (TN CCSS Reading 1, 9; TN CCSS Writing 2, 9; AFNR CS.02, CS.03, CS.04)

5) Investigate opportunities to expand and diversify a Supervised Agricultural Experience (SAE) program as related to agriculture power and equipment. Accurately maintain an activity recordkeeping system and apply proper financial recordkeeping skills to summarize records by completing SAE related applications and reports. (TN CCSS Reading 9; TN CCSS Writing 2)

Engine and Motor Mechanics

6) Compare and contrast the first and second laws of thermodynamics as applied to the study of combustion engines. Analyze the theory of operation and efficiency of internal combustion engines with regard to fuels, engine displacement, ignition, lubrication, and cooling. (TN CCSS Reading 1; AFNR CS.08, CS.09, CS.11, PST.02, PST.03)

7) Evaluate and optimize engine performance under load and no-load operation, considering the effects of air temperature, humidity, fuel quality, and engine tuning. (TN CCSS Reading 4; TN CCSS Math F-IF, S-ID; AFNR PST.02, PST.03)

8) Citing technical data and documentation of prior work, develop a written recommendation outlining a specific task or procedure for a given engine or motor (such as using a three-phase 5 hp electric motor in order to drive a 125-foot conveyor belt for lifting grain to a 60-foot silo). (TN CCSS Reading 1; TN CCSS Writing 1, 4; TN CCSS Math N-Q, A-SSE, F-IF, F-LE; AFNR CS.03, CS.08, CS.09, ABS.01, PST.02)

9) Demonstrate the ability to troubleshoot single-cylinder engines and electric motors by creating a written estimate of repairs, including parts, labor, time, and total cost. (TN CCSS Reading 1, 3, 4; TN CCSS Writing 2, 4; AFNR CS.02, CS.03, CS.07, CS.08, CS.11, PST.02, PST.03)

Agriculture Machinery

10) Recommend the appropriate machinery for a given agricultural application by matching the mechanical need to the scale and magnitude of the specific task. Using clear and coherent writing, justify the recommendation based on availability of parts, operational costs, maintenance, safety, and total cost. For example, recommend the appropriate tractor for a specified task based on power ratings, engine and transmission systems, hydraulic capabilities, hitching, and ballasting. (TN CCSS Reading 1, 3, 4, 7, 9; TN CCSS Writing 1, 2, 4; AFNR CS.02, CS.03, CS.07, CS.08, CS.09, ABS.01, ABS.02, PST.01, PST.02, PST.05)

11) Research the basic types of fuel and lubricants; differentiate their chief components, characteristics and applications as related to agricultural equipment in an explanatory essay. (TN CCSS Writing 2, 4, 7, 8, 9; AFNR CS.02, CS.03, CS.11, PST.01)

12) Demonstrate the ability to maintain, troubleshoot, and repair agricultural equipment and create a written estimate of repairs including itemization of parts, labor, time, and total cost. (TN CCSS Reading 3; TN CCSS Writing 2, 4; AFNR CS.02, CS.03, CS.07, CS.08, CS.11, PST.01, PST.02, PST.03)

13) Compose an informational text comparing and contrasting the types and functions of precision and advanced technologies (such as geographic information systems [GIS], global positioning systems [GPS], and unmanned aerial vehicles [UAV]) available to the agriculture industry, citing technical data where appropriate. (TN CCSS Reading 1, 9; TN CCSS Writing 2, 4, 8, 9; AFNR CS.01, CS.02, CS.09, CS.10, PST.05)

14) Demonstrate in a live setting or in a presentation the ability to safely operate agriculture equipment, including precision-operated equipment if available. (TN CCSS Reading 3; AFNR CS.02, ESS.06, PST.01, PST.02)

Hydraulics

15) Write an explanatory text to summarize the components and operational theory of a basic hydraulic system used in an agriculture setting. (TN CCSS Writing 2, 7, 9; AFNR CS.02, CS.11, PST.01, PST.05)

16) Design a hydraulic system to perform a specific task, applying the principles of fluid kinematics and hydrostatics to outline how the system functions. The design should include specifications for pumps, pipes, and flow rates. (TN CCSS Writing 2, 4; TN CCSS Math G-GMD; AFNR CS.02, CS.11, PST.01, PST.02, PST.05)

17) Troubleshoot and repair hydraulic power and control systems used in agricultural equipment such as piston-driven lifts and compression devices (such as shears, crushers). Document the parts and labor involved and draft a repair bill for suitable compensation. (TN CCSS Reading 3; TN CCSS Writing 2, 8, 9; AFNR CS.02, CS.11, ABS.01, ABS.02, PST.01, PST.02, PST.03, PST.05)

Navigation and Surveying

18) Explain how agricultural enterprises employ geographic information systems (GIS) and global positioning systems (GPS) in their work, including GIS software, GPS receivers, data acquisition, and spatial analysis of data. Debate the legal, ethical, and economic implications of the use of these emerging technologies with regard to maximizing the efficiency and efficacy of agricultural processes, citing specific textual evidence from case studies and news media. (TN CCSS Reading 1, 9; TN CCSS Writing 2, 8, 9; AFNR CS.01, CS.02, CS.03, CS.08, CS.10, PST.01, PST.05)

19) Correctly and safely use precision surveying instruments to make measurements of large acreages. Compile a written survey report for use by a lay reader, supplementing the narrative with charts, graphs, and other visual representations to aid comprehension. (TN CCSS Reading 3; TN CCSS Writing 2, 7; AFNR CS.02, CS.03, CS.07, CS.08, PST.05)

Standards Alignment Notes

*References to other standards include:

- TN CCSS Reading: Tennessee Common Core State Standards for English Language Arts & Literacy in History/Social Studies, Science, and Technical Subjects; Reading Standards for Literacy in Science and Technical Subjects 6-12; Grades 11-12 Students (page 62).
    - Note: While not directly aligned to one specific standard, students that are engaging in activities outlined above should be able to demonstrate fluency in Standards 2, 5, 6, 8, and 10 at the conclusion of the course.
- TN CCSS Writing: Tennessee Common Core State Standards for English Language Arts & Literacy in History/Social Studies, Science, and Technical Subjects; Writing Standards for Literacy in History/Social Studies, Science, and Technical Subjects 6-12; Grades 11-12 Students (pages 64-66).
    - Note: While not directly aligned to one specific standard, students that are engaging in activities outlined above should be able to demonstrate fluency in Standards 3, 5, 6, and 10 at the conclusion of the course.
- TN CCSS Math: Tennessee Common Core State Standards for Mathematics; Math Standards for High School: Number and Quantity, Algebra, Functions, Modeling, Geometry, Statistics and Probability. (pages 58-83)
    - Note: The standards in this course are not meant to teach mathematical concepts. However, the concepts referenced above may provide teachers with opportunities to collaborate with mathematics educators to design project based activities or

collaborate on lesson planning. Students that are engaging in activities listed above should be able to demonstrate quantitative, algebraic, geometric, functional, and statistical reasoning as applied to specific technical concepts. In addition, students will have the opportunity to practice the habits of mind as described in the eight Standards for Mathematical Practice.

- AFNR: National Agriculture, Food and Natural Resources (AFNR) Career Cluster Content Standards. Students engaged in activities outlined above should be able to demonstrate fluency in Standards in CS, PST, ABS, NRS, PS, and ESS at the conclusion of the course.
- P21: Partnership for 21st Century Skills Framework for 21st Century Learning
    - Note: While not all standards are specifically aligned, teachers will find the framework helpful for setting expectations for student behavior in their classroom and practicing specific career readiness skills.

TENNESSEE DEPARTMENT OF EDUCATION
FIRST TO THE TOP

Agriscience

Primary Career Cluster:	Agriculture, Food and Natural Resources
Consultant:	Steven Gass, (615) 532-2847, Steven.Gass@tn.gov
Course Code(s):	5957
Prerequisite(s):	None
Credit:	1
Grade Level:	9
Graduation Requirements:	• Satisfies one credit of laboratory science requirement • Satisfies one of three credits required for an elective focus when taken in conjunction with other Agriculture courses
Programs of Study and Sequence:	This is the first course in the following programs of study: • *Agribusiness* • *Agricultural Engineering and Applied Technologies* • *Environmental and Natural Resources* • *Food Science* • *Horticulture Science* • *Veterinary and Animal Science*
Necessary Equipment:	Refer to the Teacher Resources page below.
Aligned Student Organization(s):	FFA: www.tnffa.org Allie Ellis, (615) 253-5207, Allie.Ellis@tn.gov
Coordinating Work-Based Learning:	All Agriculture students are encouraged to participate in a Supervised Agricultural Experience (SAE) program. In addition, if a teacher has completed work-based learning (WBL) training, he or she can offer appropriate student WBL opportunities. To learn more, please visit http://tennessee.gov/education/cte/wb/.
Available Student Industry Certifications:	None
Dual Credit or Dual Enrollment Opportunities:	There are no known dual credit/dual enrollment opportunities for this course.
Teacher Endorsement(s):	048, 448
Required Teacher Certifications/Training:	None
Teacher Resources:	www.tn.gov/education/cte/AgricultureFoodNaturalResources.shtml

Course Description

Agriscience is an introductory laboratory science course that prepares students for biology, subsequent science and agriculture courses, and postsecondary study. This course helps students understand the

important role that agricultural science and technology serves in the 21st century. In addition, it serves as the first course for all programs of study in the Agriculture, Food and Natural Resources Cluster. Standards in this course are aligned with Tennessee Common Core State Standards for English Language Arts & Literacy in Technical Subjects, Tennessee Common Core State Standards in Mathematics, and Tennessee state standards in Anatomy and Physiology, Biology I, Biology II, Chemistry I, Chemistry II, Environmental Science, Physical Science, Physics, and Physical World Concepts, as well as the National Agriculture, Food and Natural Resources Career Cluster Content Standards. This course counts as a lab science credit toward graduation and college entrance requirements.*

Program of Study Application

This course is the foundational course for all Agriculture, Food and Natural Resources programs of study. For more information on the benefits and requirements of implementing these programs in full, please visit the Agriculture, Food and Natural Resources website at www.tn.gov/education/cte/AgricultureFoodNaturalResources.shtml.

Course Standards

Agriscience Investigation and Overview

1) Synthesize research on the historical importance of agriscience, identifying major events and technological developments influenced by agriscience theories and practices. (TN CCSS Writing 8)

2) Identify and review general common laboratory safety procedures including but not limited to prevention and control procedures in agriscience laboratories. Incorporate safety procedures and complete safety test with 100 percent accuracy. (TN CCSS Reading 3)

Agriculture and Society

3) Gather and analyze information from multiple authoritative sources, such as the United States Bureau of Labor Statistics and Tennessee labor data, to summarize the economic impact of the agricultural industry. Describe major career trends in Tennessee, the United States, and worldwide. (TN CCSS Writing 8, 9; TN CCSS Math S-ID)

4) Determine how a Supervised Agricultural Experience (SAE) program functions as a method to apply concepts of the scientific investigation process. Compare and contrast the types of SAEs as related to their importance to the scientific investigation process. (TN CCSS Reading 1, 9; TN CCSS Writing 2, 7, 9)

5) Conduct a research project exploring a specific social and/or political impact on the agriculture industry at the local, state, national, or international level. For example, explore how the increase in availability of genetically modified organisms has impacted crop production. Summarize findings in an informative essay. Revise, edit or rewrite as needed to strengthen writing. (TN CCSS Writing 2, 5, 8, 9)

Fundamentals of Environmental Systems

6) Describe the biogeochemical cycles impacting the agriculture industry by creating illustrative models and informative texts for the following:
    a. Carbon cycle
    b. Nitrogen cycle
    c. Oxygen cycle
    d. Water cycle

    (TN CCSS Reading 2; TN CCSS Writing 2, 4, 9)

7) Critique the dynamics of biomass and energy flow in ecosystems by analyzing the major components of a food chain. Analyze the structure of the relationships among the concepts of carrying capacity, species populations, and organism interactions within multiple ecosystems and natural habitats. (TN CCSS Reading 5; TN CCSS Writing 1, 9; TN Biology I 2, 3; TN Biology II 2, 3)

8) Produce an informative essay to distinguish between types of pollution and their sources, defining and applying ecology- and conservation-specific terminology. Compare and contrast important connections between pollution and its effects on environmental conditions, animal populations, and plant populations. (TN CCSS Reading 4; TN CCSS Writing 2, 4, 8, 9; TN Environmental Science 6)

Fundamentals of Cell Biology

9) Compare basic plant and animal cell biology, including structure and function. Create a visual representation that identifies cellular organelles and major cell processes. (TN CCSS Reading 2, 7; TN Biology I 1; TN Biology II 1)

10) Compare and contrast the roles of proteins, carbohydrates, lipids, and nucleic acids as they relate to cell growth and cell reproduction. (TN Biology I 1; TN Biology II 1)

Fundamentals of Genetics and Heredity

11) Determine the significance of and relationships between genes, chromosomes, proteins, and hereditary traits. Analyze the role of genes in determining genetic make-up, gender, and hereditary characteristics. Using systems of equations, explain the variation and distribution of genotypes and phenotypes expressed in plants and animals. (TN CCSS Math A-CED; TN Biology I 4; TN Biology II 4)

Fundamentals of Anatomy and Physiology

12) Using graphic illustrations and supporting text, identify and describe major animal body systems (skeletal, muscular, respiratory, digestive, nervous, circulatory, respiratory, and reproductive) to establish a basic knowledge of their purpose, structure, and function. (TN A&P 1, 2, 4, 5, 6)

Chemistry of Animal Digestion

13) Classify the types of digestive systems in domestic animals, and compare and contrast their anatomical and physiological differences. Synthesize research on animal nutrition (using academic journals or publications from Tennessee Extension Service) to produce an informative narrative, including defining and applying nutrition specific terminology, to examine the stages of digestion and associated processes. (TN CCSS Reading 4, 9; TN CCSS Writing 2, 4; TN A&P 5)

14) Use the periodic table and the atomic chart to compare differences between ionic and covalent bonding as related to digestion. Demonstrate an understanding of the interdependence of the complex chemical and biological processes involved in the digestion process including, but not limited to, the following: elements, compounds, mixtures, and acids. (TN CCSS Reading 1; TN A&P 5; TN Chemistry I 1; TN Chemistry II 1, 2, 3)

15) Research the relationship between metabolism, energy, and nutrition. Evaluate life stage and activity level to determine the nutritional needs of animals. Differentiate types of rations to maximize animal performance. (TN CCSS Writing 8, 9)

Fundamentals of Plant and Soil Science

16) Apply concepts related to the basic cellular and biochemical processes in plants to demonstrate the following:
    a. Create a graphic illustration of the parts and functions of plant cells
    b. Use quantitative reasoning to balance chemical equations related to plant processes
    c. Interpret the role of physics within the cohesion-tension theory and its significance to plant life
    d. Examine the roles of photopigments and the effects of different colors of light on plant growth

    (TN CCSS Reading 7; TN CCSS Writing 9; TN CCSS Math N-Q, A-REI; TN Biology II 7)

17) Formulate a hypothesis about the correlation between plant nutrient deficiencies and soil composition. Conduct basic soil analysis to determine the chemical elements and nutritional levels available in soils essential for plant growth. Draw conclusions about the ability of soils to meet the nutritional requirements of plants. (TN CCSS Reading 3, 9; TN CCSS Writing 8; TN Biology II 7)

Reproductive Systems

18) Research and develop illustrative models that compare and contrast the reproductive structures of plants, drawing out key differences between sexual and asexual reproduction processes. (TN Biology II 7)

19) Describe the structure and function of different seed components and summarize their roles in plant reproduction and propagation. (TN Biology II 7)

20) Describe the structures and functions of the male and female animal reproductive systems. Compare and contrast the differences of the reproductive systems between small and large animal species. (TN A&P 5)

Principles of Power and Energy

21) Apply fundamental principles of physics as they relate to agricultural power and technology concepts in order to demonstrate the following:
    a. Analyze the relationship between speed, distance, and time
    b. Relate the types of simple machines to the law of machines and mechanical advantages
    c. Specify groups, sources, and forms of energy
    d. Analyze the principle of heat energy and describe the way heat travels
    e. Explain the law of conservation of energy
    f. Explain the production of energy and relate it to the invisible light spectrum

    (TN Physical Science 2)

Fundamentals of Electricity

22) Identify different methods by which electrical energy can be produced. Discuss the safety hazards involved in each method as well as prevention and control methods relevant to electrical power supplies. Justify the use of different precautions for the prevention or management of electrical hazards and evaluate the efficacy of the prevention measures. (TN CCSS Writing 1, 4, 7, 9; TN Physical World Concepts 4; TN Physics 5)

23) Utilize the appropriate instruments needed to calculate and measure voltage, amperage, resistance, and wattage. (TN CCSS Reading 3; TN CCSS Math N-Q; TN Physical World Concepts 4; TN Physics 5)

Fundamentals of Engines

24) Apply basic principles of thermodynamics to analyze the function of major components of gasoline and diesel fuel engines. (TN Physics 2)

25) Using quantitative reasoning and employing appropriate unit conversions, calculate horsepower and thermal efficiency in internal combustion engines by creating systems of equations that describe numerical relationships. (TN CCSS Math N-Q, A-CED)

Standards Alignment Notes

*References to other standards include:

- TN CCSS Reading: Tennessee Common Core State Standards for English Language Arts & Literacy in History/Social Studies, Science, and Technical Subjects; Reading Standards for Literacy in Science and Technical Subjects 6-12; Grades 9-10 Students (page 62).
    - Note: While not directly aligned to one specific standard, students that are engaging in activities outlined above should be able to also demonstrate fluency in Standards 5, 6, 8, and 10 at the conclusion of the course.
- TN CCSS Writing: Tennessee Common Core State Standards for English Language Arts & Literacy in History/Social Studies, Science, and Technical Subjects; Writing Standards for Literacy in History/Social Studies, Science, and Technical Subjects 6-12; Grades 9-10 Students (pages 64-66).

    - Note: While not directly aligned to one specific standard, students that are engaging in activities outlined above should be able to also demonstrate fluency in Standards 3, 6, and 10 at the conclusion of the course.
- TN CCSS Math: Tennessee Common Core State Standards for Mathematics; Math Standards for High School: Number and Quantity, Algebra, Statistics and Probability (pages 58-83).
    - Note: The standards in this course are not meant to teach mathematical concepts. However, the concepts referenced above may provide teachers with opportunities to collaborate with mathematics educators to design project based activities or collaborate on lesson planning. Students that are engaging in activities listed above should be able to demonstrate quantitative, algebraic, and statistical reasoning as applied to specific technical concepts. In addition students will have the opportunity to practice the habits of mind as described in the eight Standards for Mathematical Practice.
- TN A&P: Tennessee Science: Anatomy and Physiology standards 1, 2, 4, 5, and 6 may provide additional insight and activities for educators.
- TN Biology I: Tennessee Science: Biology I standards 1, 2, 3, and 4 may provide additional insight and activities for educators.
- TN Biology II: Tennessee Science: Biology II standards 1, 2, 3, 4, and 7 may provide additional insight and activities for educators.
- TN Chemistry I: Tennessee Science: Chemistry I standard 1 may provide additional insight and activities for educators.
- TN Chemistry II: Tennessee Science: Chemistry II standards 1, 2, and 3 may provide additional insight and activities for educators.
- TN Environmental Science: Tennessee Science: Environmental Science standard 5 may provide additional insight and activities for educators.
- TN Physical Science: Tennessee Science: Physical Science standard 2 may provide additional insight and activities for educators.
- TN Physical World Concepts: Tennessee Science: Physical World Concepts standard 4 may provide additional insight and activities for educators.
- TN Physics: Tennessee Science: Physics standards 2 and 5 may provide additional insight and activities for educators.
- AFNR: National Agriculture, Food and Natural Resources (AFNR) Career Cluster Content Standards: Students engaged in activities outlined above should be able to demonstrate fluency in Standards AS, CS, and PS at the conclusion of the course.
- P21: Partnership for 21st Century Skills Framework for 21st Century Learning
    - Note: While not all standards are specifically aligned, teachers will find the framework helpful for setting expectations for student behavior in their classroom and practicing specific career readiness skills.

Applied Environmental Science

Primary Career Cluster:	Agriculture, Food and Natural Resources
Consultant:	Steven Gass, (615) 532-2847, Steven.Gass@tn.gov
Course Code(s):	TBD
Prerequisite(s):	Agriscience (5957)
Credit:	1
Grade Level:	10
Graduation Requirements:	• This course satisfies one laboratory science credit. • This course satisfies one of three credits required for an elective focus when taken in conjunction with other Agriculture courses.
Programs of Study and Sequence:	This is the second course in the *Environmental and Natural Resources Systems* program of study.
Necessary Equipment:	Refer to Teacher Resources page below.
Aligned Student Organization(s):	FFA: www.tnffa.org Allie Ellis, (615) 253-5207, Allie.Ellis@tn.gov
Coordinating Work-Based Learning:	All Agriculture students are encouraged to participate in a Supervised Agricultural Experience (SAE) program. In addition, if a teacher has completed work-based learning (WBL) training, he or she can offer appropriate student WBL opportunities. To learn more, please visit http://tennessee.gov/education/cte/wb/.
Available Student Industry Certifications:	None
Dual Credit or Dual Enrollment Opportunities:	There are no known dual credit/dual enrollment opportunities for this course. If interested in developing, reach out to a local postsecondary institution to establish an articulation agreement.
Teacher Endorsement(s):	048, 448
Required Teacher Certifications/Training:	None
Teacher Resources:	www.tn.gov/education/cte/AgricultureFoodNaturalResources.shtml

Course Description

Applied Environmental Science focuses on the knowledge, information, and skills related to the fundamental science and management of ecosystems as well as careers, leadership and history of the industry. This course covers principles of environmental impacts, energy consumption, and ecosystem management. Standards in this course are aligned with Tennessee Common Core State Standards for English Language Arts & Literacy in Technical Subjects, Tennessee Biology I, Tennessee Biology II,

Tennessee Ecology, and Tennessee Environmental Science, as well as National Agriculture, Food and Natural Resourses Career Cluster Content Standards.*

Program of Study Application

This is the second course in the *Environmental and Natural Resources* program of study. For more information on the benefits and requirements of implementing this program in full, please visit the Agriculture, Food, & Natural Resource website at www.tn.gov/education/cte/AgricultureFoodNaturalResources.shtml.

Course Standards

Occupational Awareness & Safety

1) Use local news media, organizational websites, and real-time labor market information to investigate occupations in environmental science. Compare and contrast the knowledge, skills, and abilities necessary for employment, as well as the typical level of education required. (TN CCSS Reading 2, 9; TN CCSS Writing 4, 7, 9)

2) Review common laboratory safety procedures for tool and equipment operation in the environmental and natural resources laboratories, including but not limited to accident prevention and control procedures. Demonstrate the ability to follow safety and operational procedures in a lab setting and complete a safety test with 100 percent accuracy. (TN CCSS Reading 3)

Studying the Environment

3) Define the scope and impact of contemporary environmental science. Describe the interdisciplinary nature of this field and provide examples of how other sciences such as biology, chemistry, earth science, and physics relate to environmental science. Research scholarly, peer-reviewed academic journals focused on the biophysical environment and identify leading academic and professional organizations publishing results of environmental research. (TN CCSS Reading 2, 5; TN CCSS Writing 7)

4) Define the term *biome* and indicate on a map the major biomes of the world. Develop an annotated graphic that can be used to compare and contrast the climates, seasons, soil characteristics, water availability, and other defining features of each biome. Differentiate between biomes within the following categories: aquatic, grasslands, forest, desert, and tundra. (TN CCSS Reading 4, 7; TN CCSS Writing 4, 9; TN Biology I 2; TN Biology II 2; TN Ecology 5; TN Environmental Science 2)

5) Apply basic business and entrepreneurship principles to plan, set up, operate, or expand an environmental science related Supervised Agricultural Experience (SAE) program. Compare the components of SMART goals in relation to evaluating the success of the program. Accurately maintain the prescribed activity recordkeeping system and apply proper financial recordkeeping skills as they relate to the SAE program. (TN CCSS Reading 2; TN CCSS Writing 4, 9)

Human Impact on the Environment

6) Using instructional materials and news media, research the evolving impact of humans on the environment, from primitive societies to contemporary civilizations. Synthesize analysis in an explanatory essay or presentation that highlights specific milestones and events, citing textual evidence of both positive and negative impacts. (TN CCSS Reading 1, 2; TN CCSS Writing 2, 4, 7, 9)

7) Synthesize census data and other resources to compare U.S. population statistics to those of other countries around the world. Specifically examine growth rate, age structure, life expectancy, and total population, among other key parameters. Analyze the factors that impact population growth, and assess the impact of population growth in the U.S. and the world on the following: availability of natural resources, land usage, waste production and pollution, and global economic health. (TN CCSS Reading 2, 4, 5, 9; TN Environmental Science 3)

Ecosystems

8) Research the components of an ecosystem. Synthesize findings by developing a glossary of terms essential to the study of ecosystems, defining at least the following: habitat, niche, producers, consumers, and vertical stratification. (TN CCSS Reading 4, 5; TN CCSS Writing 4, 7, 9; TN Biology I 3; TN Biology II 3; TN Ecology 4; TN Environmental Science 4, 5)

9) Compare and contrast grassland, forest, aquatic, and wetland ecosystems, and explain how biogeochemical cycles and food webs facilitate the flow of energy and the recycling of matter, supplying examples of species that fulfill key roles in each ecosystem. Illustrate similarities in the structure and life processes of ecosystems despite key differences across types of ecosystems. (TN CCSS Reading 5, 9; TN CCSS Writing 4, 7, 9; TN Biology I 3; TN Biology II 3; TN Ecology 4; TN Environmental Science 4, 5)

10) Analyze how the abiotic and biotic components of the ecosphere interact with and impact one another. Apply knowledge of these interactions to determine the suitability of an area for different types of development (such as commercial, industrial, and primary residential). Develop a claim about the appropriate ecosphere for a given development, supporting the claim with evidence and sound reasoning from research. (TN CCSS Reading 2, 5; TN CCSS Writing 1, 9; TN Biology I 3; TN Biology II 3; TN Ecology 4; TN Environmental Science 2)

11) Create a graphic and accompanying text illustrating primary and secondary succession in a selected biome. Include a discussion of the pioneer species for that biome. Compare immature and mature ecosystems and discuss indicators that can be observed to determine maturity and quality of the ecosystem. (TN CCSS Reading 7; TN CCSS Writing 4, 9; TN Ecology 5; TN Environmental Science 2)

12) Citing case studies from news media, academic journals or instructional materials, discuss the importance of biodiversity in an ecosystem. Assess how various land uses might impact biodiversity in a given area. Summarize findings an informational essay on one of the following topics:
    a. Impact of the intentional or unintentional introduction of non-native species to an ecosystem

b. Threatened and endangered species
c. Agricultural Best Management Practices that promote biodiversity

(TN CCSS Reading 1, 2; TN CCSS Writing 2, 4, 7, 8, 9; TN Biology I 2; TN Biology II 2; TN Ecology 5; TN Environmental Science 2)

Energy Consumption

13) Identify energy resources used in the United States and abroad, distinguishing between renewable and nonrenewable resources. Research the global distribution of energy resources; determine major resource-rich regions and how they intersect with geopolitical boundaries. (TN Environmental Science 4, 5, 7)

14) Synthesize public data from government agencies and news organizations to compare energy consumption in the United States to the energy consumption of other countries. Create a series of graphs and charts to inform an average citizen about energy use trends and statistics, including the percentage of each resource that comes from domestic and foreign sources. Investigate claims made about the political and economic implications of using foreign energy resources, analyzing author's purpose and assess the extent to which the reasoning and evidence provided support the author's claim. (TN CCSS Reading 2, 6, 7, 8; TN CCSS Writing 4, 7, 8; TN Environmental Science 5, 7)

15) Investigate available print and digital tools for conducting an audit of personal energy use. Compile and analyze self-collected data on total energy use, including transportation, water, and electricity consumption, among others. Create and implement a plan to reduce personal energy use. Compare the usage data after one month of implementing the plan, and discuss key takeaways learned from the project. (TN CCSS Writing 4, 7; TN Environmental Science 5, 7)

Managing Ecosystems

16) Research standard methods for monitoring a variety of environmental conditions, including but not limited to air, water, and soil, as well as the biological components of an ecosystem. For each domain, create a fact sheet outlining common tests and procedures and the kinds of information learned from the analysis of test results. Demonstrate at least one procedure for learning about each domain. (TN CCSS Reading 2, 3; TN CCSS Writing 2, 4, 7; TN Biology I 2; TN Biology II 2; TN Ecology 5; TN Environmental Science 2)

17) Research sustainability as it applies to ecosystems and natural resources. Explain the importance of ensuring sustainability when developing a management plan for a specific resource or ecosystem. Outline the components of a management plan, and summarize best practices for the management of forest, wetland, aquatic, and grassland ecosystems. (TN CCSS Reading 2, 5; TN CCSS Writing 2, 4, 7, 9; TN Environmental Science 2, 4)

18) Describe the evolution of integrated pest management (IPM) strategies through history. Create a brochure that explains the purpose and principles of IPM. Present specific IPM strategies for controlling common home and landscape pests. Create additional informational sheets for large-scale pest control in a variety of natural and human engineered environments. (TN CCSS Reading 2; TN CCSS Writing 4; TN Environmental Science 4)

Legal and Civic Responsibility

19) Citing specific legislation and international conventions and treaties, create a timeline depicting the historical development of environmental regulation at the state, national and global levels. For each regulation represented on the timeline, summarize the intended goals and ultimate impact of that regulation. Include legislation related to air, water, toxic substances, wastes, energy resources, and mandated environmental impact studies. (TN CCSS Reading 1, 2, 7; TN CCSS Writing 4, 7, 9; TN Environmental Science 7)

20) Describe the role of federal, state, and local governments in enforcing environmental legislation. Differentiate between key agencies at each level and justify the need for general regulations of environmental hazards. (TN CCSS Reading 2)

21) Choose a current environmental issue and conduct research on environmental and ethical implications for potential solutions. Craft an argumentative essay, developing a claim supporting a specific solution and develop both claim(s) and counterclaim(s) with logical evidence and reasoning. (TN CCSS Reading 1, 8; TN CCSS Writing 1, 7, 8, 9; TN Environmental Science 7)

Standards Alignment Notes

*References to other standards include:

- TN CCSS Reading: Tennessee Common Core State Standards for English Language Arts & Literacy in History/Social Studies, Science, and Technical Subjects; Reading Standards for Literacy in Science and Technical Subjects 6-12; Grades 10-11 Students (page 62).
    - Note: While not directly aligned to one specific standard, students that are engaging in activities outlined above should be able to demonstrate fluency in Standard 10 at the conclusion of the course.
- TN CCSS Writing: Tennessee Common Core State Standards for English Language Arts & Literacy in History/Social Studies, Science, and Technical Subjects; Writing Standards for Literacy in History/Social Studies, Science, and Technical Subjects 6-12; Grades 10-11 Students (pages 64-66).
    - Note: While not directly aligned to one specific standard, students that are engaging in activities outlined above should be able to demonstrate fluency in Standards 3, 5, 6, and 10 at the conclusion of the course.
- TN Biology I: Tennessee Science: Biology I standards 2 and 3 may provide additional insight and activities for educators.
- TN Biology II: Tennessee Science: Biology II standards 2 and 3 may provide additional insight and activities for educators.
- TN Ecology: Tennessee Science: Ecology standards 4 and 5 may provide additional insight and activities for educators.
- TN Environmental Science: Tennessee Science: Environmental Science standards 2, 3, 4, 5, and 7 may provide additional insight and activities for educators.
- AFNR: National Agriculture, Food and Natural Resources (AFNR) Career Cluster Content Standards: Students engaged in activities outlined above should be able to demonstrate fluency in Standards ESS.01, .02, .03, .04, .05, .06; NRS.01, .02, .04, and .05 at the conclusion of the course.

- P21: Partnership for 21st Century Skills Framework for 21st Century Learning
    - Note: While not all standards are specifically aligned, teachers will find the framework helpful for setting expectations for student behavior in their classroom and practicing specific career readiness skills.

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Food Science and Safety

Primary Career Cluster:	Agriculture, Food and Natural Resources
Consultant:	Steven Gass, (615) 532-2847, Steven.Gass@tn.gov
Course Code(s):	TBD
Prerequisite(s):	Agriscience (5957) and Principles of Food Production (TBD)
Credit:	1
Grade Level:	11
Graduation Requirements:	This course satisfies one of three credits required for an elective focus when taken in conjunction with other Agriculture courses.
Programs of Study and Sequence:	This is the third course in the *Food Science* program of study.
Necessary Equipment:	Refer to the Teacher Resources page below.
Aligned Student Organization(s):	FFA: www.tnffa.org Allie Ellis, (615) 253-5207, Allie.Ellis@tn.gov
Coordinating Work-Based Learning:	All Agriculture students are encouraged to participate in a Supervised Agricultural Experience (SAE) program. In addition, if a teacher has completed work-based learning (WBL) training, he or she can offer appropriate student WBL opportunities. To learn more, please visit http://tennessee.gov/education/cte/wb/.
Available Student Industry Certifications:	None
Dual Credit or Dual Enrollment Opportunities:	There are no known dual credit/dual enrollment opportunities for this course. If interested in developing, reach out to a local postsecondary institution to establish an articulation agreement.
Teacher Endorsement(s):	048, 448
Required Teacher Certifications/Training:	None
Teacher Resources:	www.tn.gov/education/cte/AgricultureFoodNaturalResources.shtml

Course Description

Food Science and Safety is an applied-knowledge course designed for students interested in food science. The course covers fundamental principles of food science, food safety and sanitation, foodborne pathogens, and food-related standards and regulations. Upon completion of this course, students will be versed in the technical knowledge and skills necessary for further education and careers in food science. Standards in this course are aligned with Tennessee Common Core State Standards for English Language Arts & Literacy in Technical Subjects and Tennessee state standards in Chemistry I and

Environmental Science, as well as National Agriculture, Food and Natural Resources Career Cluster Content Standards.*

Program of Study Application

This course is the third course in the *Food Science* program of study. For more information on the benefits and requirements of implementing this program in full, please visist the Agriculture, Food, and Natural Resources website at www.tn.gov/education/cte/AgricultureFoodNaturalResources.shtml.

Course Standards

Introduction to Food Science Industry and Careers

1) Using news media and relevant academic journals, investigate current applications of food science and describe the scope and economic importance of the food industry in the United States, including imports and exports. Citing specific textual evidence, describe how the study of food science and related sciences impacts quality of life and enhances a Supervised Agricultural Experience (SAE) program. (TN CCSS Reading 1; TN CCSS Writing 8)

2) Use local news media, organizational websites, and real-time labor market information to investigate occupations in food science. Compare and contrast the knowledge, skills, and abilities necessary for employment, as well as the typical level of education required. (TN CCSS Reading 2, 9; TN CCSS Writing 4, 7, 9)

3) Create a chart, table, or graphic to illustrate significant trends with regard to supply and demand of food products across the world population, citing specific textual evidence from news media and government agency reports. Identify and summarize common environmental and safety concerns regarding food production and the food supply. (TN CCSS Reading 1, 2, 7; TN CCSS Writing 9; TN Env. Science 3)

4) Review common laboratory safety procedures for tool and equipment operation in the food science laboratories, including but not limited to accident prevention and control procedures. Demonstrate the ability to follow safety and operational procedures in a lab setting and complete a safety test with 100 percent accuracy. (TN CCSS Reading 3)

Food Chemistry

5) Differentiate between each food group and compare and contrast their nutritive values. Explain how chemical and physical properties of foods influence nutritional value and quality. Examine the basic principles of proper nutrition, including the identification and evaluation of the six essential nutrients needed for good health. (TN CCSS Reading 4; TN CCSS Writing 7; TN Chemistry 1)

6) Investigate and apply the concepts of basic chemical processes and interactions of constituent components of foods. Through experimentation and observation, identify chemical properties of food that are affected by production, processing, and storage. (TN CCSS Reading 3)

7) Identify common food additives (preservatives, antioxidants, stabilizers, colors, and flavors) and describe their general purposes. Synthesize information from academic journals and news media to summarize safety issues associated with food additives, assessing the extent to which the reasoning and evidence provided supported claims made. (TN CCSS Reading 2, 8; TN CCSS Writing 8)

Food Microbiology

8) Examine the role of microorganisms in food products and evaluate the implications for human consumption. (TN CCSS Writing 7)

9) Research common microorganisms that cause fermentation, discuss the benefits or dangers of fermentation in food products and processing. Develop an annotated chart that illustrates fermentation techniques and the foods they are used to create, describing the basic chemical principles of fermentation and the factors that affect the fermentation process. (TN CCSS Reading 2; TN CCSS Writing 2, 4)

Food Preservation

10) Differentiate among the various microorganisms that cause food spoilage and determine their life cycles. Compare and contrast the application of food preservation methods to prevent the growth of microbes in food. Outline the processes for heating, refrigerating, and freezing for food preservation. (TN CCSS Reading 2; TN CCSS Writing 4)

Food Safety and Sanitation

11) Research and cite texts identifying types and general characteristics of microorganisms associated with foodborne illnesses. Summarize safe food habits and practices by researching proper procedures for safe handling, storage, preparation, and cooking; to compose a checklist of general safety guidelines for different food groups, such as fruits and vegetables, red meat, fish, eggs, and dairy products. (TN CCSS Reading 1, 2; TN CCSS Writing 4)

12) Describe procedures and inspection standards for sanitation in the food production industry. Demonstrate in a live setting or in a presentation format the ability to follow procedures for appropriate chemical selection, cleaning techniques, and insect and rodent control methods. Identify concepts and principles that provide the scientific foundation for current food sanitation standards. (TN CCSS Reading 3; TN CCSS Writing 7, 8)

13) Research principles and applications of the Hazard Analysis and Critical Control Point (HACCP) system and describe how they apply to food safety. Interpret food industry inspection standards to assess conditions related to food safety and sanitation. Create a model HACCP plan including a summary of procedures to control biological, chemical, and physical hazards in food production. (TN CCSS Reading 2, 3, 4; TN CCSS Writing 4)

Food Safety Laws and Regulations

14) Analyze state and federal laws and regulations governing food inspection standards, and argue for their importance to public health, citing specific evidence from case studies to develop your

claim. Define the roles of state and government agencies responsible for the establishment and enforcement of food safety regulations. Compose a narrative that interprets the regulations governing the "Local Foods for Local Schools" program in Tennessee. (TN CCSS Writing 1, 2)

Food Science Trends and Issues

15) Research major development trends in the food science industry by analyzing documents authored by for-profit companies and lobbying organizations, defining the question each seeks to address. Compare and contrast the use of advanced technologies in food production, such as but not limited to biotechnology, irradiation, and genetically modified organisms (GMOs), citing specific textual evidence. Summarize technology principles, process effects, and consumer concerns, referencing the extent to which reasoning and evidence presented for each supports specific claims. (TN CCSS Reading 2, 6, 8)

16) Formulate a hypothesis regarding a current food science issue. Design and conduct an original experiment to prove or disprove the hypothesis. Collect the appropriate data to evaluate claims, synthesizing and communicating results within the broader context of food science. (TN CCSS Writing 7)

Standards Alignment Notes

*References to other standards include:

- TN CCSS Reading: Tennessee Common Core State Standards for English Language Arts & Literacy in History/Social Studies, Science, and Technical Subjects; Reading Standards for Literacy in Science and Technical Subjects 6-12; Grades 11-12 Students (page 62).
    - Note: While not directly aligned to one specific standard, students that are engaging in activities outlined above should be able to also demonstrate fluency in Standards 5, 6, and 10 at the conclusion of the course.
- TN CCSS Writing: Tennessee Common Core State Standards for English Language Arts & Literacy in History/Social Studies, Science, and Technical Subjects; Writing Standards for Literacy in History/Social Studies, Science, and Technical Subjects 6-12; Grades 11-12 Students (pages 64-66).
    - Note: While not directly aligned to one specific standard, students that are engaging in activities outlined above should be able to also demonstrate fluency in Standards 3, 5, 6, and 10 at the conclusion of the course.
- TN Chemistry: Tennessee Science: Chemistry I standard 1 may provide additional insight and activities for educators.
- TN Env. Science: Tennessee Science: Environmental Science standard 3 may provide additional insight and activities for educators.
- AFNR: National Agriculture, Food and Natural Resources (AFNR) Career Cluster Content Standards: Students engaged in activities outlined above should be able to demonstrate fluency in Standards CR, FPP, and PS at the conclusion of the course.
- P21: Partnership for 21st Century Skills Framework for 21st Century Learning
    - Note: While not all standards are specifically aligned, teachers will find the framework helpful for setting expectations for student behavior in their classroom and practicing specific career readiness skills.

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Greenhouse Management

Primary Career Cluster:	Agriculture, Food and Natural Resources
Consultant:	Steven Gass, (615) 532-2847, Steven.Gass@tn.gov
Course Code(s):	5954
Prerequisite(s):	Agriscience (5957) and Principles of Plant Science and Hydroculture (TBD)
Credit:	1
Grade Level:	11
Graduation Requirements:	This course satisfies one of three credits required for an elective focus when taken in conjunction with other Agriculture courses.
Programs of Study and Sequence:	This is the third course in the *Horticulture Science* program of study.
Necessary Equipment:	Refer to the Teacher Resources page below.
Aligned Student Organization(s):	FFA: www.tnffa.org Allie Ellis, (615) 253-5207, Allie.Ellis@tn.gov
Coordinating Work-Based Learning:	All Agriculture students are encouraged to participate in a Supervised Agricultural Experience (SAE) program. In addition, if a teacher has completed work-based learning (WBL) training, he or she can offer appropriate student WBL opportunities. To learn more, please visit http://tennessee.gov/education/cte/wb/.
Available Student Industry Certifications:	Worker Protection Standard (WPS) for Agricultural Pesticides
Dual Credit or Dual Enrollment Opportunities:	A state-wide articulation exists for this course for students to earn dual credit at Tennessee public postsecondary institutions, which offer agriculture. For more information, please visit http://www.state.tn.us/education/opca/.
Teacher Endorsement(s):	048, 448
Required Teacher Certifications/Training:	Teachers are required to receive a Commerical Pesticide Applicators License C10 and C15 prior to teaching this course.
Teacher Resources:	www.tn.gov/education/cte/AgricultureFoodNaturalResources.shtml

Course Description

Greenhouse Management is a applied-knowledge course designed to prepare students to manage greenhouse operations. This course covers principles of greenhouse structures, plant health and growth, growing media, greenhouse crop selection and propagation, and management techniques. It provides students with the technical knowledge and skills needed to prepare for further education and careers in horticulture production. Greenhouse Management is a dual credit course with statewide articulation. Standards in this course are aligned with Tennessee Common Core State Standards for English Language

Arts & Literacy in Technical Subjects, Tennessee Common Core State Standards for Mathematics, and Tennessee state standards for Biology I and Biology II, as well as National Agriculture, Food and Natural Resources Career Cluster Content Standards.*

Program of Study Application

This course is the third course for the *Horticulture Science* program of study. For more information on the benefits and requirements of implementing this program in full, please visit the Agriculture, Food, and Natural Resources website at www.tn.gov/education/cte/AgricultureFoodNaturalResources.shtml.

Course Standards

Greenhouse Industry Introduction

1) Analyze the global nature of the horticulture industry and assess the economical impact and technological advancements associated with greenhouse production practices. Create a timeline to summarize the history and development of the greenhouse production industry, citing specific textual evidence. (TN CCSS Reading 1, 2; TN CCSS Writing 4)

2) Accurately maintain an activity recordkeeping system and apply proper financial recordkeeping skills as they relate to a greenhouse industry. Demonstrate the ability to analyze records by generating reports and completing related applications (i.e., employment application, efficiency reports, SAE applications, and profit and lost statements). (TN CCSS Reading 9; TN CCSS Writing 2, 9)

3) Apply the concepts of occupational safety and industry safety prevention and control standards by interpreting information from industry manuals.
    a. Assess the purpose of worker protection standards and obtain the worker protection standards student industry certification.
    b. Review common laboratory safety procedures for tool and equipment operation in horticulture laboratories, including but not limited to accident prevention and control procedures. Demonstrate the ability to follow safety and operational procedures in a lab setting and complete a safety test with 100 percent accuracy.

    (TN CCSS Reading 3)

Greenhouse Design, Construction, and Components

4) Describe characteristics of successful greenhouses and create a list of factors for planning and designing greenhouse facilities. Factors must include physical location, market potential, utilities, climatic conditions, and production goals. (TN CCSS Writing 4)

5) Classify greenhouse structures by comparing and contrasting greenhouse construction materials, including but not limited to frames, coverings, and glazing materials. Justify selection of greenhouse construction materials based on cost effectiveness, stability, maintenance, and function. (TN CCSS Reading 8, 9; TN CCSS Writing 9)

6) Create an annotated model representing research-based practices in greenhouse planning and design and justify the process outlined in the model. The design must include at least the

following items: structure materials, layout, lighting, bench arrangements, traffic flow, and physical location. (TN CCSS Reading 7; TN CCSS Writing 4, 8)

7) Compare general maintenance and upkeep requirements for a variety of greenhouses in relation to the type of structure and associated systems. Create a checklist of prescribed maintenance, preventative maintenance, monitoring, and troubleshooting schedules for greenhouse facilities and equipment. Demonstrate the mechanical skills needed for the general maintenance and repair of greenhouses and associated systems (such as basic wiring, plumbing, and general construction). (TN CCSS Reading 2, 3; TN CCSS Writing 4, 8)

Growing Media

8) Compare and contrast the attributes of growing mediums. Write an informative essay to describe the major components of soil, and identify basic physical and chemical characteristics of soil including structure and texture. (TN CCSS Reading 9; TN CCSS Writing 2)

9) Identify and provide written justification to describe the effects of soil and soilless composition (pH, organic matter content, and mineral content) on plant health and growth. Perform basic soil sampling and testing techniques and interpret test data to formulate corrective actions as needed. (TN CCSS Reading 1, 3; TN CCSS Writing 7, 9; TN CCSS Math S-ID)

10) Explain the principles of media preparation; develop a check sheet to guide media preparation. Describe the purpose, methods, and importance for sterilizing media. Compare and contrast the cost effectiveness of premix and personal mix media to soil media. (TN CCSS Reading 7; TN CCSS Writing 8)

Plant Structure, Function, and Growth

11) Apply concepts of scientific taxonomy and industry-specific terminology in distinguishing different species and types of plants. Create a visual chart, brochure, or fact sheet that identifies common plant species used in greenhouse production by classification, care, and use. (TN CCSS Reading 4)

12) Research the basic plant structure components and create an illustrative plant model to identify and differentiate among components. Demonstrate a working knowledge of plant physiology, including:
    a. The relationship between form and function for major plant structures
    b. The anatomical and physiological differences of specific plant species
    (TN Biology II 7)

13) Select relevant technical information to analyze and support claims regarding the relationships between light, temperature, and water on plant growth. Draw conclusions about the interrelationships between plant life processes (such as photosynthesis, respiration, and transpiration), plant growth, and maintenance. (TN CCSS Reading 8; TN Biology I 2; TN Biology II 7)

14) Compare and contrast current industry approved methods to regulate plant growth including, but not limited to, environmental, physical, genetic and chemical. Demonstrate in a live setting

or in a presentation the ability to apply the best growth regulator to specific plants to obtain selected outcomes. (TN CCSS Reading 3, 8, 9; TN Biology II 7)

Plant Nutrition

15) Analyze the nutrient requirements of plants and assess the importance of the 17 essential plant nutrients for plant health. Identify the chemical and biological processes needed to make nutrients available for growth and maintenance, and distinguish among nutrient deficiency and toxicity signs and symptoms in plants. (TN Biology II 7)

16) Research case studies to cite specific textual evidence determining the significance of safety hazards associated with fertilizer use. In an informative essay, justify the use of different precautions for the prevention or management of hazards and evaluate the efficacy of prevention measures. (TN CCSS Reading 1, 8, 9; TN CCSS Writing 2, 4, 7, 9)

17) Identify the basic types of fertilizers and their applications for greenhouse production crops. Differentiate the effects of fertilizer ratios on plant growth and health to hypothesize possible outcomes of each ratio. Calculate proper formulations of fertilizers based upon label directions using systems of equations. Demonstrate in a live setting or in a presentation the ability to follow fertilizer label procedures precisely as they pertain to selection, handling, application, storage, and disposal. (TN CCSS Reading 3; TN CCSS Math N-Q, A-CED)

Plant Propagation

18) Differentiate between the methods of sexual and asexual plant propagation by summarizing valid research. Compare and contrast the different techniques of propagation, explaining advantages and disadvantages of each in an informative text. Conduct at least the following: cutting, budding, layering, sowing, germination rate calculation, and seed viability. (TN CCSS Reading 2, 8; TN CCSS Writing 4, 9)

Environmental Control Systems

19) Assess the procedures required for producing multiple commercial plant species in a controlled environment, and apply these procedures to produce a variety of specific greenhouse crops. Evaluate environmental factors that affect greenhouse crops to justify management methods. (TN CCSS Reading 2; TN CCSS Writing 4)

20) Evaluate the greenhouse climate and recommend the proper climate control equipment to maintain an optimum growing climate, including but not limited to ventilation, humidifiers, heating, cooling, and shading. Provide written justification for each recommendation. (TN CCSS Writing 1, 4).

21) Demonstrate effective methods to meet water requirements for healthy plant growth. Examine and explain how water pH influences plant growth. Research from multiple technical texts the function and operating principles of greenhouse irrigation systems (such as misting, drip, and overhead systems) to meet watering requirements for the purposes of maintaining optimum moisture level for a variety of plants. (TN CCSS Reading 3; TN CCSS Writing 8; TN Biology II 7)

Diseases, Disorders, and Pests

22) Determine the economic and aesthetic impact of plant diseases, disorders, and pests. Identify and diagnose the symptoms of common plant diseases, disorders, and pests, and summarize methods of prevention, treatment, and control by drawing evidence from informational texts and relevant scientific literature. (TN CCSS Writing 2, 9; TN Biology II 7)

23) Identify the types of pesticides and their applications for greenhouse production. Research the safety hazards associated with pesticide use for multiple greenhouse pesticides. Calculate proper formulations of pesticides based upon label directions for specific pests by creating systems of equations that describe numerical relationships. (TN CCSS Reading 1; TN CCSS Writing 1, 4, 7, 9; TN CCSS Math N-Q, A-CED)

24) Demonstrate in a live setting or in a presentation the ability to follow pesticide procedures precisely according to label and safety guidelines, including selection, handling, personal protective equipment (PPE), application, storage, and disposal. (TN CCSS Reading 3)

25) Evaluate the basic principles and assess the overall effectiveness of integrated pest management (IPM) for controlling greenhouse pests and diseases. Compare with traditional chemical controls.

Hydroponic Applications

26) Examine the roles of hydroponic systems in greenhouse crop production. Describe essential elements of hydroponic systems; explore recent trends and advancements to design a hydroponic system for a specific greenhouse crop. (TN CCSS Reading 7; TN CCSS Writing 8)

27) Apply basic principles of hydroponics to compare hydroponic and soil-based growing methods for providing nutrients to plants. Summarize the advantages and disadvantages of using soilless media systems to evaluate the efficacy for specific crops. (TN CCSS Reading 7; TN CCSS Writing 8)

Greenhouse Business Management

28) Debate laws and regulations affecting horticulture businesses. Demonstrate the use of general business and recordkeeping skills necessary to manage a greenhouse business, including but not limited to scheduling, inventory control, profit and loss statements, marketing, advertising, and merchandise handling. (TN CCSS Reading 1, 9; TN CCSS Writing 2, 9)

29) Research, develop, and implement greenhouse production schedules for a representative sampling of greenhouse crops that includes at least the following: plant selection, plant material cost (seed, plug, cuttings), growth media, fertilizers, water, testing kits, pricing guides, profit margin, labor, and other expenses. (TN CCSS Reading 3; TN CCSS Writing 4; TN CCSS Math S-ID, Modeling)

Standards Alignment Notes

*References to other standards include:

- TN CCSS Reading: Tennessee Common Core State Standards for English Language Arts & Literacy in History/Social Studies, Science, and Technical Subjects; Reading Standards for Literacy in Science and Technical Subjects 6-12; Grades 11-12 Students (page 62).
    - Note: While not directly aligned to one specific standard, students that are engaging in activities outlined above should be able to also demonstrate fluency in Standards 5, 6, and 10 at the conclusion of the course.
- TN CCSS Writing: Tennessee Common Core State Standards for English Language Arts & Literacy in History/Social Studies, Science, and Technical Subjects; Writing Standards for Literacy in History/Social Studies, Science, and Technical Subjects 6-12; Grades 11-12 Students (pages 64-66).
    - Note: While not directly aligned to one specific standard, students that are engaging in activities outlined above should be able to also demonstrate fluency in Standards 3, 5, 6, and 10 at the conclusion of the course.
- TN CCSS Math: Tennessee Common Core State Standards for Mathematics; Math Standards for High School: Number and Quantity, Algebra, Modeling, Statistics and Probability (pages 58-83).
    - Note: The standards in this course are not meant to teach mathematical concepts. However, the concepts referenced above may provide teachers with opportunities to collaborate with mathematics educators to design project based activities or collaborate on lesson planning. Students that are engaging in activities listed above should be able to demonstrate quantitative, algebraic, and statistical reasoning as applied to specific technical concepts. In addition students will have the opportunity to practice the habits of mind as described in the eight Standards for Mathematical Practice.
- TN Biology I: Tennessee Science: Biology I standard 2 may provide additional insight and activities for educators.
- TN Biology II: Tennessee Science: Biology II standard 7 may provide additional insight and activities for educators.
- AFNR: National Agriculture, Food and Natural Resources (AFNR) Career Cluster Content Standards: Students engaged in activities outlined above should be able to demonstrate fluency in Standards ABS.03, ABS.07, CS, PS.01, PS.02, and PS.03 at the conclusion of the course.
- P21: Partnership for 21st Century Skills Framework for 21st Century Learning
    - Note: While not all standards are specifically aligned, teachers will find the framework helpful for setting expectations for student behavior in their classroom and practicing specific career readiness skills.

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Introduction to Agricultural Sciences

Primary Career Cluster:	Agriculture, Food and Natural Resources
Consultant:	Steven Gass, (615) 532-2847, Steven.Gass@tn.gov
Course Code(s):	TBD
Prerequisite(s):	None
Credit:	1
Grade Level:	7-8
Graduation Requirements:	N/A
Programs of Study and Sequence:	This course serves as a middle school primer for all programs of study in the Agriculture, Food and Natural Resources career cluster.
Necessary Equipment:	Refer to the Teacher Resources page below.
Aligned Student Organization(s):	FFA: www.tnffa.org Allie Ellis, (615) 253-5207, Allie.Ellis@tn.gov
Coordinating Work-Based Learning:	All Agriculture students are encouraged to participate in a Supervisied Agricultural Experience (SAE) program.
Available Student Industry Certifications:	None
Dual Credit or Dual Enrollment Opportunities:	There are no dual credit/dual enrollment opportunities for this course.
Teacher Endorsement(s):	048, 448
Required Teacher Certifications/Training:	None
Teacher Resources:	www.tn.gov/education/cte/AgricultureFoodNaturalResources.shtml

Course Description

Introduction to Agricultural Sciences is a middle school course designed to provide a general introduction to the agriculture, food, fiber, and natural resource industry. This course helps students understand the importance of agriculture in daily life by exploring basic principles of agribusiness, agricultural mechanics, animal science, natural resources, and horticulture. Depending on LEA capacity and preference, the course may be tailored for seventh and eighth grades, with the additional option for flexible implementation schedules. Standards in this course are aligned with the Tennessee Common Core State Standards for English Language Arts & Literacy in Technical Subjects, as well as Tennessee state science standards for grades 7 and 8.*

Program of Study Application

This course can serve as an introductory course leading to all programs of study in the Agriculture, Food and Natural Resourecs Career Cluster. For more information on the benefits and requirements of implementing these programs in full, please visit the Agriculture, Food, and Natural Reources website at www.tn.gov/education/cte/AgricultureFoodNaturalResources.shtml.

Course Standards

Agriculture and Society

1) Create an accurate summary of the importance of agriculture in daily life. Identify sources of different types of food and fiber products and depict them in a visual representation.* (TN CCSS Reading 2; TN CCSS Writing 8)

2) Review the historical importance of agriculture and its role in the formation of the United States. Write an informative essay that identifies the major changes and advancements that have occurred in agriculture over the last 200 years, specifying the societal and economical impacts of these advancements. (TN CCSS Writing 2, 4)

3) Explore local career opportunities in agriculture and examine the importance of the agriculture industry to Tennessee's economy. Use local job postings and Tennessee labor and workforce data.*

Agriscience Investigation

4) Draw evidence from informational and technical texts to evaluate the role of scientific investigation in the agriculture industry. Design and conduct an Agriscience Fair project using the scientific investigation process.* (TN CCSS Writing 2, 4, 6, 7, 8, 9)

5) Demonstrate in a live setting or in a presentation the ability to follow procedures precisely, attending to special cases or exceptions noted in appropriate materials, to safely utilize agricultural lab equipment. Demonstrate ability to pass a safety test at 100 percent accuracy on all lab equipment.* (TN CCSS Reading 3)

Introduction to Agribusiness

6) Identify types of agribusiness and explore the different roles of local and regional career opportunities in agribusiness. Use local job postings and Tennessee labor and workforce data.*

7) Develop a list summarizing fundamental agribusiness skills, including but not limited to:
    a. Leadership roles
    b. Types of organizational structures
    c. Importance of teamwork
    d. Roles of communication
    e. Principles of recordkeeping
    f. Basic public speaking skills

Introduction to Agricultural Mechanics

8) Examine the impact of the agricultural mechanics industry on United States society and the economy at large, addressing technological developments and career options. Produce an informational essay or model (such as a timeline, graphic illustration, or presentation) to illustrate findings. (TN CCSS Reading 1, 2; TN CCSS Writing 4, 9)

9) Demonstrate conceptual understanding of the following current practices in agricultural mechanics:
    a. Calculate horsepower and explain its importance and uses
    b. Explain the different types of power units
    c. Explain the functions of basic hand and power tools
    d. Demonstrate the safe use and maintenance of basic hand and power tools, including passing a safety test at 100 percent accuracy
    e. Describe common building methods and materials used in the agricultural industry
    f. Appropriately apply unit conversions and calculate acreage, length, and volumes

    (TN CCSS Reading 3)

Introduction to Animal Science

10) Investigate local and regional career opportunities in animal science, drawing on information from multiple print and digital resources such as local job postings and Tennessee labor and workforce data.* (TN CCSS Reading 8)

11) Compare and contrast small companion and large domesticated animals, synthesizing informational texts, graphic illustrations, and models to describe the following:
    a. Their historical and contemporary roles in society and the agriculture industry specifically
    b. The social and economic implications for maintaining animal health
    c. Common domesticated breeds and their uses in society

    (TN CCSS Reading 1, 9; TN CCSS Writing 2, 9)

12) Review illustrative models of major animal body systems (skeletal, muscular, respiratory, digestive, nervous, integumentary, urinary, reproductive) in conjunction with technical information from scientific texts to establish a basic knowledge of animal anatomy and physiology. (TN CCSS Reading 5; TN CCSS Writing 9)

Introduction to Environmental and Natural Resources Systems

13) Compare and contrast information gathered from a variety of sources to identify local and regional career opportunities in environmental and natural resources systems. Use local job postings and Tennessee labor and workforce data.*

14) Draw conclusions about the interrelationships among plants and animals, citing specific textual evidence to justify conclusions. Identify native wildlife species and describe their environmental and economic impacts in Tennessee, incorporating visual representations such as diagrams or models. (TN CCSS Reading 1; TN Science Grade 7: 2, 5; TN Science Grade 8: 2, 5)

15) Explore the basic principles of soil science by analyzing soil structure and formations. Write recommendations for basic methods of soil conservation, citing evidence from news articles, academic journals or agriculture texts. (TN CCSS Reading 1, 2; TN CCSS Writing 4, 9)

16) Analyze visual representations (charts, diagrams, tables) to summarize important connections and distinctions concerning the flow of energy in ecosystems. (TN CCSS Writing 2; TN Science Grade 7: 3, 7; TN Science Grade 8: 3, 7)

17) Identify the types of pollution found in air and water. Citing evidence from academic journals and news articles, determine pollution sources and the general effects of pollutants on the environment. (TN CCSS Reading 1, 2)

Introduction to Horticulture

18) Compare and contrast information gathered from a variety of sources to identify local and regional career opportunities in horticulture using local job postings and Tennessee labor and workforce data.* (TN CCSS Reading 8)

19) Examine illustrative models of plants to differentiate basic plant structures. Describe how form and function of structures are related. Explain components and processes involved in plant reproduction and growth. (TN CCSS Reading 2; TN Science Grade 7: 2; TN Science Grade 8: 2)

20) Analyze the relationship between soil quality and plant health and growth, including impact of pH, organic matter content, and mineral content. (TN CCSS Reading 2; TN Science Grade 7: 2)

21) Describe the general characteristics of common plants used in food production, greenhouse, landscaping, and turfgrass applications.

22) Explore basic concepts of sustainable agriculture by researching general principles of aquaculture and hydroponics. Citing relevant research, write an informative essay detailing sustainable practices in aquaculture and hydroponics and their contributions to society. (TN CCSS Reading 2; TN CCSS Writing 2, 7)

Implementation Notes

Implementation options for eighth grade

*Marked areas to be taught in nine-week rotation format.

Implementation options for seventh grade

Depending on the needs of faculty and students, seventh grade instructors may elect to follow the implementation suggestion for the eighth grade nine-week rotation format. Seventh grade instructors may also choose to concentrate on specific content areas that have unique connections to their district or region, which can provide for a more relevant, customized experience for students.

Standards Alignment Notes

**References to other standards include:

- TN CCSS Reading: Tennessee Common Core State Standards for English Language Arts & Literacy in History/Social Studies, Science, and Technical Subjects; Reading Standards for Literacy in Science and Technical Subjects grades 6-12 (page 62).
    - Note: While not directly aligned to one specific standard, students that are engaging in activities outlined above should be able to also demonstrate fluency in Standards 5, 6 and 10 at the conclusion of the course.
- TN CCSS Writing: Tennessee Common Core State Standards for English Language Arts & Literacy in History/Social Studies, Science, and Technical Subjects; Writing Standards for Literacy in History/Social Studies, Science, and Technical Subjects grades 6-12 (pages 64-66).
    - Note: While not directly aligned to one specific standard, students that are engaging in activities outlined above should be able to also demonstrate fluency in Standards 1, 3, 5 and 10 at the conclusion of the course.
- TN Science Grade 7: Tennessee Science Grade 7 standards 2, 3, 5, and 7 may provide additional insight and activities for educators.
- TN Science Grade 8: Tennessee Science Grade 8 standards 2, 3, 5, and 7 may provide additional insight and activities for educators.
- AFNR: National Agriculture, Food and Natural Resources (AFNR) Career Cluster Content Standards:
    - Note: While not directly aligned to one specific standard, students engaged in activities outlined above should be able to demonstrate fluency in Standards AS.01 and PS.01 at the conclusion of the course.
- P21: Partnership for 21st Century Skills Framework for 21st Century Learning
    - Note: While not all standards are specifically aligned, teachers will find the framework helpful for setting expectations for student behavior in their classroom and practicing specific career readiness skills.

TENNESSEE DEPARTMENT OF EDUCATION
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Landscaping and Turf Science

Primary Career Cluster:	Agriculture, Food and Natural Resources
Consultant:	Steven Gass, (615) 532-2847, Steven.Gass@tn.gov
Course Code(s):	5951
Prerequisite(s):	Agriscience (5957) and Principles of Plant Science and Hydroculture (TBD)
Credit:	1
Grade Level:	12
Graduation Requirements:	This course satisfies one of three credits required for an elective focus when taken in conjunction with other Agriculture courses.
Programs of Study and Sequence:	This is the fourth, and final, course in the *Horticulture Science* program of study.
Necessary Equipment:	Refer to the Teacher Resources page below.
Aligned Student Organization(s):	FFA: www.tnffa.org Allie Ellis, (615) 253-5207, Allie.Ellis@tn.gov
Coordinating Work-Based Learning:	All Agriculture students are encouraged to participate in a Supervised Agricultural Experience (SAE) program. In addition, if a teacher has completed work-based learning (WBL) training, he or she can offer appropriate student WBL opportunities. To learn more, please visit http://tennessee.gov/education/cte/wb/.
Available Student Industry Certifications:	• Worker Protection Standard (WPS) for Agricultural Pesticides • Tennessee Certified Nursery Professional Certification (Note: Must be 18 years old for this credential)
Dual Credit or Dual Enrollment Opportunities:	There are no known dual credit/dual enrollment opportunities for this course. If interested in developing, reach out to a local postsecondary institution to establish an articulation agreement.
Teacher Endorsement(s):	048, 448
Required Teacher Certifications/Training:	None
Teacher Resources:	www.tn.gov/education/cte/AgricultureFoodNaturalResources.shtml

Course Description

Landscaping and Turf Science is a applied-knowledge course designed to provide challenging academic standards and relevant technical knowledge and skills needed for further education and careers in landscape design, maintenance, and turf management. Content includes site analysis and planning, principles of design, and plant selection and care techniques. Standards in this course are aligned with Tennessee Common Core State Standards for English Language Arts & Literacy in Technical Subjects,

Tennessee Common Core State Standards for Mathematics, and Tennessee state standards for Biology II, as well as National Agriculture, Food and Natural Resources Career Cluster Content Standards.*

Program of Study Application

This course is the fourth, and final, course in the *Horticulture Sciences* program of study. For more information on the benefits and requirements of implementing this program in full, please visit the Agriculture, Food, and Natural Resources website at www.tn.gov/education/cte/AgricultureFoodNaturalResources.shtml.

Course Standards

Introduction to Landscaping and Turf Management

1) Gather and analyze labor data from sources such as the United States Bureau of Labor Statistics and the Tennessee Department of Labor to predict the employment outlook in landscaping and turf management careers. Summarize the interpersonal, business, and technical skills needed for a career in landscaping or turf management. Develop a resume for a selected occupation that includes documented development of industry-related skills (i.e., work experience, SAE records, and proficiency applications). (TN CCSS Reading 2; TN CCSS Writing 4, 9)

2) Explain general occupational and horticulture industry safety standards. Identify commonly used machinery and equipment and develop a checklist of associated safety and maintenance procedures. Assess the purpose of worker protection standards, complete required safety tests with 100 percent accuracy, and obtain the worker protection standards student industry certification. (TN CCSS Reading 3)

Tree and Shrub Selection and Maintenance

3) Develop illustrative models that identify the basic parts of trees and shrubs. Demonstrate the ability to visually identify and distinguish between common tree and shrub species used for landscaping and describe research-based practices in harvesting, transportation, transplanting, and care. (TN CCSS Reading 7; TN CCSS Writing 4, 8; TN Biology II 7)

4) Using descriptive text, summarize methods for general care and maintenance of trees and shrubs, including planting, pruning, mulching, and fertilizing techniques. Drawing on research and technical data, justify the importance of site evaluation, preparation, and consideration of hardiness zones in the selection of trees and shrubs. (TN CCSS Reading 2, 3; TN CCSS Writing 2)

Plant Selection and Maintenance

5) Visually identify and distinguish among common ground cover, vines, and plants used for landscaping. Differentiate function, form, and growth requirements for common perennials, annuals, and biennials.

6) Assess methods for general care and maintenance of ground cover, vines, and plants, including planting, pruning, mulching, and fertilizing techniques. Recommend specific vines and ground

covers to solve special landscaping issues, and justify recommendations in an argumentative text citing textual and technical evidence. (TN CCSS Reading 2; TN CCSS Writing 1)

Turf Grass Selection and Maintenance

7) Cite specific textual evidence to compare and contrast the functions and components of turf grasses of common turf grass species. Demonstrate the ability to visually identify and distinguish between turf grass species and cultivars and compose an argument justifying their applications for specific uses. (TN CCSS Reading 1; TN CCSS Writing 1, 9)

8) Describe methods for the establishment and maintenance of turf grasses, including soil preparation, installation, water, nutrient and pH needs, and fertilizing techniques. Draw conclusions about the importance of site selection, site preparation, and consideration of hardiness zones in the selection of turf grass species and cultivars. (TN CCSS Reading 3, 9)

9) Evaluate and compare special management needs of residential, commercial, and sports turf. Identify management practices and associated equipment requirements for mowing, irrigation and weed, disease, and fungus control for common turf grass species. (TN CCSS Reading 1, 3)

Commercial Interior Plantscaping

10) Identify and classify basic ornamental flowers and plants used for the commercial interior plantscape, and summarize their propagation, installation techniques, and maintenance requirements, citing applicable technical texts. (TN CCSS Reading 2; TN Biology II 7)

11) Recommend effective management practices for the interior environment, including light, humidity, growing media, and disease and pest control. Compare and contrast the use of different items (containers, planters, water features, artificial plants, live plants) in the interior plantscape. (TN CCSS Reading 9)

Pest Management

12) Identify and compare the common landscape and turf grass pests and their respective prevention and control methods. Categorize the basic types of pesticides and describe their application methods, including but not limited to rate, environmental conditions, and reentry times. Using quantitative reasoning and appropriate units, calculate proper formulations of pesticides based upon label directions by creating systems of equations that describe numerical relationships. (TN CCSS Reading 3)

13) Demonstrate in a live setting or in a presentation the ability to properly mix and apply pesticides precisely, attending to important safety standards, selection, handling, application, storage, and disposal. (TN CCSS Reading 3)

Water Management

14) Develop a written resource describing the seven principles of xeriscaping and indications for use in landscapes, citing specific textual evidence. (TN CCSS Reading 2; TN CCSS Writing 4, 8)

15) Examine the various types of water gardens and pools and their applications for landscape enhancement. Develop a customer information packet outlining best management practices to maintain a healthy water garden and pool, addressing at minimum the following considerations: pH, nitrate, dissolved oxygen, algae, pollutants, filter requirements, and feed schedules. (TN CCSS Reading 3, 7, 9; TN CCSS Writing 2)

16) Compare and contrast different irrigation systems and summarize their advantages and disadvantages. Identify irrigation tools and system components and their function or application. Applying basic plumbing principles, calculate the water supply flow rate, head pressure requirements, and pipe and pump size considerations for a water garden, pool, or irrigation system. Identify and demonstrate the plumbing skills required to install irrigation and water features in a landscape or turf setting. (TN CCSS Reading 3; TN CCSS Math N-Q, A-CED, F-BF)

17) Design an irrigation system for a residential landscape and develop a bid presentation that identifies the project timeline, required permits, costs of installation and selected materials. (TN CCSS Writing 4; TN CCSS Math N-Q, G-MG)

Landscape Design

18) Interpret topographical and soil maps to evaluate site suitability for selected landscape plants. Create a site analysis checklist to evaluate a proposed landscape site. (TN CCSS Writing 4; TN CCSS Math N-Q, G-MG)

19) Develop a list of tools and skills necessary for drafting landscape designs, including computer-assisted methods. Demonstrate the use of drafting tools and design equipment to create a basic landscape design. (TN CCSS Writing 6)

20) Explore landscape design principles to outline the components of a comprehensive landscape design plan. Prepare comprehensive landscape plans using prospective residential and commercial plots and develop a landscape bid package and presentation for each plan. (TN CCSS Writing 7)

Business Principles of Landscaping and Turf Management

21) Compare and contrast different business models. Create a chart to illustrate the use, advantages, and disadvantages of each. Research successful landscaping and turf grass management businesses locally and use evidence from research to evaluate the skills and resources utilized for successful small business implementation. (TN CCSS Reading 7; TN CCSS Writing 4, 7, 8)

22) Using industry-specific terminology, explain the process for preparing a price estimate for landscape designs and packages. Create a price estimate and develop a presentation to secure a bid on a landscape project. (TN CCSS Reading 2, 4; TN CCSS Writing 4; TN CCSS Math N-Q)

23) Demonstrate the ability to interpret and read landscape drawings by measuring and calculating materials needed to execute the plan. Evaluate factors that affect profitability. (TN CCSS Reading 3; TN CCSS Math N-Q, G-MG, S-MD)

Standards Alignment Notes

*References to other standards include:

- TN CCSS Reading: Tennessee Common Core State Standards for English Language Arts & Literacy in History/Social Studies, Science, and Technical Subjects; Reading Standards for Literacy in Science and Technical Subjects 6-12; Grades 11-12 Students (page 62).
    - Note: While not directly aligned to one specific standard, students that are engaging in activities outlined above should be able to also demonstrate fluency in Standards 5, 6, 8, and 10 at the conclusion of the course.
- TN CCSS Writing: Tennessee Common Core State Standards for English Language Arts & Literacy in History/Social Studies, Science, and Technical Subjects; Writing Standards for Literacy in History/Social Studies, Science, and Technical Subjects 6-12; Grades 11-12 Students (pages 64-66).
    - Note: While not directly aligned to one specific standard, students that are engaging in activities outlined above should be able to also demonstrate fluency in Standards 3, 5, and 10 at the conclusion of the course.
- TN CCSS Math: Tennessee Common Core State Standards for Mathematics; Math Standards for High School: Number and Quantity, Algebra, Functions, Geometry, Modeling, Statistics and Probability (pages 58-83).
    - Note: The standards in this course are not meant to teach mathematical concepts. However, the concepts referenced above may provide teachers with opportunities to collaborate with mathematics educators to design project based activities or collaborate on lesson planning. Students that are engaging in activities listed above should be able to demonstrate quantitative, algebraic, functional, geometric, and statistical reasoning as applied to specific technical concepts. In addition students will have the opportunity to practice the habits of mind as described in the eight Standards for Mathematical Practice.
- TN Biology II: Tennessee Science: Biology II standard 7 may provide additional insight and activities for educators.
- AFNR: National Agriculture, Food and Natural Resources (AFNR) Career Cluster Content Standards: Students engaged in activities outlined above should be able to demonstrate fluency in Standards PS and CS at the conclusion of the course.
- P21: Partnership for 21st Century Skills Framework for 21st Century Learning
    - Note: While not all standards are specifically aligned, teachers will find the framework helpful for setting expectations for student behavior in their classroom and practicing specific career readiness skills.

TENNESSEE DEPARTMENT OF EDUCATION
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Large Animal Science

Primary Career Cluster:	Agriculture, Food and Natural Resources
Consultant:	Steven Gass, (615) 532-2847, Steven.Gass@tn.gov
Course Code(s):	TBD
Prerequisite(s):	Agriscience (5957)
Credit:	1
Grade Level:	11
Graduation Requirements:	This course satisfies one of three credits required for an elective focus when taken in conjunction with other Agriculture courses.
Programs of Study and Sequence:	This is the third course in the *Veterinary and Animal Science* program of study.
Necessary Equipment:	Refer to the Teacher Resources page below.
Aligned Student Organization(s):	FFA: www.tnffa.org Allie Ellis, (615) 253-5207, Allie.Ellis@tn.gov
Coordinating Work-Based Learning:	All Agriculture students are encouraged to participate in a Supervised Agricultural Experience (SAE) program. In addition, if a teacher has completed work-based learning (WBL) training, he or she can offer appropriate student WBL opportunities. To learn more, please visit http://tennessee.gov/education/cte/wb/.
Available Student Industry Certifications:	None
Dual Credit or Dual Enrollment Opportunities:	There are no known dual credit/dual enrollment opportunities for this course. If interested in developing, reach out to a local postsecondary institution to establish an articulation agreement.
Teacher Endorsement(s):	048, 448
Required Teacher Certifications/Training:	None
Teacher Resources:	www.tn.gov/education/cte/AgricultureFoodNaturalResources.shtml

Course Description

Large Animal Science is an applied course in veterinary and animal science for students interested in learning more about becoming a veterinarian, vet tech, vet assistant, or pursuing a variety of scientific, health, or agriculture professions. This course covers anatomy and physiological systems of different groups of large animals, as well as careers, leadership, and history of the industry. Standards in this course are aligned with Tennessee Common Core State Standards for English Language Arts & Literacy in Technical Subjects, as well as Tennessee Anatomy and Physiology standards and National Agriculture, Food and Natural Resources Career Cluster Content Standards.*

Program of Study Application

This course is the third course in the *Veterinary and Animal Sciences* program of study. For more information on the benefits and requirements of implementing this program in full, please visit the Agriculture, Food, and Natural Resource website at www.tn.gov/education/cte/AgricultureFoodNaturalResources.shtml.

Course Standards

History of Domestication

1) Synthesize research on the history of large animal domestication to produce an informative essay, including defining and applying industry-specific terminology to classify animals in the correct taxonomy. Justify the historical uses and roles of domesticated animals, and compare historical processes of large animal domestication. (TN CCSS Reading 1, 4, 9; TN CCSS Writing 2, 4, 9)

Economic, Occupational and Technological Implications

2) Determine the general economic impact of the large animal industry by investigating both recreational and business implications of large animal domestication through governmental and news publications. Develop a summary including both graphical representations and descriptive text to summarize findings. (TN CCSS Reading 1; TN CCSS Writing 7)

3) Explore and compare local and regional career opportunities in the large animal industry and evaluate labor data to predict the employment outlook. Describe in a written or visual representation the knowledge, skills, and abilities necessary for a diverse range of careers in large animal sciences citing specific textual evidence from local job postings and Tennessee labor data. (TN CCSS Reading 1, 2; TN CCSS Writing 2, 9)

4) Accurately maintain an activity recordkeeping system and apply proper financial recordkeeping skills as they relate to a large animal science supervised agricultural experience (SAE) program. Demonstrate the ability to summarize records and reports by completing SAE and related applications. (TN CCSS Reading 9; TN CCSS Writing 2, 9)

5) Examine specific technologies that have evolved within the large animal industry (such as, but not limited to equipment, procedures, healthcare) and evaluate the economic and societal implications of each. (TN CCSS Reading 1, 2, 4)

Personal and Occupational Health and Safety

6) Identify, research, and determine the significance of zoonotic diseases associated with large animals. Compare and contrast findings from multiple credible sources relating to a specific disease (including student's own experience or laboratory experiment, case studies, and scholarly journals). Justify the use of different methods of infection control in the prevention or management of a zoonotic disease and evaluate the efficacy of existing large animal biosecurity measures. (TN CCSS Reading 1, 5, 9)

7) Correctly identify and summarize laws and regulations that pertain to large animal health and safety in an explanatory text, citing specific textual evidence from state and national legislation. Describe health requirements and necessary documentation for large animal transportation and change of ownership. (TN CCSS Reading 1, 9; TN CCSS Writing 2, 4)

8) Review common laboratory safety procedures for tool and equipment operation in the large animal laboratories, including but not limited to accident prevention and control procedures. Demonstrate the ability to follow safety and operational procedures in a lab setting and complete a safety test with 100 percent accuracy. (TN CCSS Reading 3)

9) Demonstrate in a live setting or in a presentation the ability to follow procedures precisely, attending to special cases or exceptions noted in appropriate materials, and apply them to the following areas:
    a. Animal restraint and handling
    b. Techniques for transportation
    c. Appropriate use of chemicals (such as pesticide, fungicide, disinfectants)

    Differentiate between effective methods for handling large animals and methods proven to be less effective. (TN CCSS Reading 3)

Animal Ethics

10) Identify the fundamental philosophies related to animal rights and animal welfare. Compare the impact of specific persons, organizations, and legislation related to animal rights and welfare of large animals. (TN CCSS Reading 1, 9; TN CCSS Writing 9)

11) Investigate current large animal issues by analyzing an author's purpose and assessing the extent to which the reasoning and evidence in a specific text support the author's claim. Debate specific issues by forming and supporting claims and counterclaims with specific data and evidence. Issues related to animal rights and animal welfare may include, but are not limited to:
    a. Abuse and/or neglect
    b. Environmental implications
    c. Consumer product implications
    d. Exhibiting and showing
    e. Global issues in large animal ethics and their relation to local problems

    (TN CCSS Reading 6, 8, 9; TN CCSS Writing 1)

Nutrition and Digestive Systems

12) Create a visual representation to differentiate between ruminant and non-ruminant animals and monogastric and polygastric animals, comparing and contrasting their anatomical and physiological differences. Explain the relationships of digestive system types to the ability of an animal to digest and absorb different classes of feed. (TN CCSS Reading 7, TN A&P 5)

13) Using information from scholarly journals or Tennessee Extension Service, research nutrient requirements of the diets of large animals and organize these into various nutrient groups. Differentiate between roughages and concentrates and their nutritional values. (TN CCSS Reading 7; TN CCSS Writing 9)

14) Interpret feed labeling and evaluate factors such as life stage and activity level to determine the nutritional needs and then recommend balance rations for each large animal species, justifying recommendations with evidence from the text. (TN CCSS Reading 1, 3, 7; TN CCSS Writing 1, 4, 9)

15) Diagnose the symptoms of nutritional diseases relevant to large animals and recommend the appropriate control procedures, citing specific evidence to support recommendations. (TN CCSS Reading 7; TN CCSS Writing 1, 7, 8, 9)

Genetics and Reproduction

16) Research and develop illustrative models of the major components of male and female reproductive systems in large animals and prepare a short narrative to distinguish the function of reproductive organs, endocrine glands, and hormones. Produce an explanatory essay comparing the physiological changes that occur across different species during reproductive phases, including the estrus cycle, fertilization, gestation, parturition and lactation. (TN CCSS Reading 7, 9; TN CCSS Writing 2, 4; TN A&P 6)

17) Using graphical representations and descriptive text, explain how the roles of heritability, selection intensity, generation interval, and other advanced principles of genetics (such as DNA testing for disorders) apply to predict gene and trait transfer in large animal species. Principles include but are not limited to:
    a. Economically important traits in production animals
    b. Interpretation and utilization of animal performance records
    c. Hybrid vigor

    (TN CCSS Reading 1, 4, 7, 9; TN CCSS Writing 2, 4, 7, 9; TN Biology I 4; TN Biology II 4)

Fundamental Care and Health of Horses

18) Synthesize research on the historical importance of horses, noting major economic, social, and medical advances impacting domestication. Produce an informational essay or model (such as a timeline, graphical illustration, or presentation) that formulates comparisons among different horse breeds and hybrids. Demonstrate conceptual understanding and technical skill in current practices of comprehensive health care and management for the following:
    a. Design appropriate facilities based on assessment of needs and present plans in a visual format
    b. Compare appropriate owner/handler responses to behaviors and instincts to ensure safety of both handler and animal in a variety of situations
    c. Distinguish between clinical signs of proper health and poor health, justifying explanations with data and evidence (TN CCSS Reading 1)
    d. Using quantitative reasoning and appropriate units, calculate appropriate rations based on animal characteristics (age, weight, breed, activity level) and nutritional needs by creating systems of equations that describe numerical relationships.
    e. Illustrate the reproductive cycle graphically, and summarize available breeding methods and current reproductive technologies (TN CCSS Reading 2, 7)
    f. Research common diseases and parasites and their effects on the health of horses, and draw evidence from the most recent medical literature to recommend the best prevention or control measures.

(TN CCSS Reading 1, 2, 3, 7, 8, 9; TN CCSS Writing 2, 7, 8, 9)

Fundamental Care and Health of Cattle

19) Synthesize research on the historical importance of cattle, noting major economic, social, and medical advances impacting domestication. Produce an informational essay or model (such as a timeline, graphical illustration, or presentation) that formulates comparisons among different cattle breeds. Demonstrate conceptual understanding and technical skill in current practices of comprehensive health care and management for the following:
    a. Design appropriate facilities based on assessment of needs and present plans in a visual format
    b. Compare appropriate owner/handler responses to behaviors and instincts to ensure safety of both handler and animal in a variety of situations
    c. Distinguish between clinical signs of proper health and poor health, justifying explanations with data and evidence
    d. Using quantitative reasoning and appropriate units, calculate rations based on animal characteristics (age, weight, breed, activity level) and nutritional needs by creating systems of equations that describe numerical relationships
    e. Illustrate the reproductive cycle graphically, summarize available breeding method, and current reproductive technologies
    f. Research common diseases and parasites and their effects on the health of cattle, and draw evidence from the most recent medical literature to recommend the best prevention or control measures
    g. Evaluate the economic implications of livestock management practices (such as dehorning)

    (TN CCSS Reading 1, 2, 3, 7, 8, 9; TN CCSS Writing 2, 7, 8, 9)

Fundamental Care and Health of Sheep and Goats

20) Synthesize research on the historical importance of sheep and goats, noting major economic, social, and medical advances impacting domestication. Produce an informational essay or model (such as a timeline, graphical illustration, or presentation) that formulates comparisons among different sheep and goat breeds. Demonstrate conceptual understanding and technical skill in current practices of comprehensive health care and management for the following:
    a. Design appropriate facilities based on assessment of needs and present plans in a visual format
    b. Compare appropriate owner/handler responses to behaviors and instincts to ensure safety of both handler and animal in a variety of situations
    c. Distinguish between clinical signs of proper health and poor health, justifying explanations with data and evidence
    d. Using quantitative reasoning and appropriate units, calculate appropriate rations based on animal characteristics (age, weight, breed, activity level) and nutritional needs by creating systems of equations that describe numerical relationships
    e. Illustrate the reproductive cycle graphically, and summarize available breeding methods and current reproductive technologies
    f. Research common diseases and parasites and their effects on the health of sheep and goats, and draw evidence from the most recent medical literature to recommend the best prevention or control measures

(TN CCSS Reading 1, 2, 3, 7, 8, 9; TN CCSS Writing 2, 7, 8, 9)

Fundamental Care and Health of Swine

21) Synthesize research on the historical importance of swine, noting major economic, social, and medical advances impacting domestication. Produce an informational essay or model (such as a timeline, graphical illustration, or presentation) that formulates comparisons among different swine breeds. Demonstrate conceptual understanding and technical skill in current practices of comprehensive health care and management for the following:
    a. Design appropriate facilities based on assessment of needs and present plans in a visual format
    b. Compare appropriate owner/handler responses to behaviors and instincts to ensure safety of both handler and animal in a variety of situations
    c. Distinguish between clinical signs of proper health and poor health, justifying explanations with data and evidence
    d. Using quantitative reasoning and appropriate units, calculate appropriate rations based on animal characteristics (age, weight, breed, activity level) and nutritional needs by creating systems of equations that describe numerical relationships
    e. Illustrate the reproductive cycle graphically, and summarize available breeding methods and current reproductive technologies
    f. Research common diseases and parasites and their effects on the health of swine, and draw evidence from the most recent medical literature to recommend the best prevention or control measures

    (TN CCSS Reading 1, 2, 3, 7, 8, 9; TN CCSS Writing 2, 7, 8, 9)

Standards Alignment Notes

*References to other standards include:

- TN CCSS Reading: Tennessee Common Core State Standards for English Language Arts & Literacy in History/Social Studies, Science, and Technical Subjects; Reading Standards for Literacy in Science and Technical Subjects 6-12; Grades 9-10 Students (page 62).
    - Note: While not directly aligned to one specific standard, students that are engaging in activities outlined above should be able to also demonstrate fluency in Standard 10 at the conclusion of the course.
- TN CCSS Writing: Tennessee Common Core State Standards for English Language Arts & Literacy in History/Social Studies, Science, and Technical Subjects; Writing Standards for Literacy in History/Social Studies, Science, and Technical Subjects 6-12; Grades 9-10 Students (pages 64-66).
    - Note: While not directly aligned to one specific standard, students that are engaging in activities outlined above should be able to also demonstrate fluency in Standards 3, 5, 6, and 10 at the conclusion of the course.
- TN A&P: Tennessee Science: Anatomy and Physiology standards 5 and 6 may provide additional insight and activities for educators.
- AFNR: National Agriculture, Food and Natural Resources (AFNR) Career Cluster Content Standards: Students engaged in activities outlined above should be able to demonstrate fluency in Standards AS and CS at the conclusion of the course.

- P21: Partnership for 21st Century Skills Framework for 21st Century Learning
    - Note: While not all standards are specifically aligned, teachers will find the framework helpful for setting expectations for student behavior in their classroom and practicing specific career readiness skills.

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Natural Resource Management

Primary Career Cluster:	Agriculture, Food and Natural Resources
Consultant:	Steven Gass, (615) 532-2847, Steven.Gass@tn.gov
Course Code(s):	TBD
Prerequisite(s):	Agriscience (5957) and Applied Environmental Science (TBD) *or* Plant and Soil Science (5950)
Credit:	1
Grade Level:	12
Graduation Requirements:	This course satisfies one of three credits required for an elective focus when taken in conjunction with other Agriculture courses.
Programs of Study and Sequence:	This is the fourth, and final, course in the *Environmental and Natural Resources Systems* program of study.
Necessary Equipment:	Refer to Teacher Resources page below.
Aligned Student Organization(s):	FFA: www.tnffa.org Allie Ellis, (615) 253-5207, Allie.Ellis@tn.gov
Coordinating Work-Based Learning:	All Agriculture students are encouraged to participate in a Supervised Agricultural Experience (SAE) program. In addition, if a teacher has completed work-based learning (WBL) training, he or she can offer appropriate student WBL opportunities. To learn more, please visit http://tennessee.gov/education/cte/wb/.
Available Student Industry Certifications:	Hunter Education Licence
Dual Credit or Dual Enrollment Opportunities:	There are no known dual credit/dual enrollment opportunities for this course. If interested in developing, reach out to a local postsecondary institution to establish an articulation agreement.
Teacher Endorsement(s):	048, 448
Required Teacher Certifications/Training:	None
Teacher Resources:	www.tn.gov/education/cte/AgricultureFoodNaturalResources.shtml

Course Description

Environmental and Natural Resource Management is an applied knowledge course for students interested in learning more about becoming good stewards of our environment and natural resources, as an environmental scientist, conservationist, forester, or wildlife manager. This course covers major types of natural resources and their management, public policy, the role of public education in managing resources, as well as careers, leadership, and history of the industry. Standards in this course are aligned with Common Core State Standards for English Language Arts & Literacy in Technical

Subjects, as well as, the National Agriculture, Food and Natural Resourses Career Cluster Content Standards.*

Program of Study Application

This course is the fourth and final course in the *Environmental and Natural Resources* program of study. For more information on the benefits and requirements of implementing this program in full, please visist the Agriculture, Food, & Natural Resources website at www.tn.gov/education/cte/AgricultureFoodNaturalResources.shtml.

Course Standards

Occupational Awareness & Safety

1) Review common laboratory safety procedures for tool and equipment operation in the natural resource management laboratories, including but not limited to accident prevention and control procedures. Demonstrate the ability to follow safety and operational procedures in a lab setting and complete a safety test with 100 percent accuracy. (TN CCSS Reading 3)

2) Investigate opportunities to expand and diversify a Supervised Agricultural Experience (SAE) program in the area of natural resource management. Demonstrate the ability to prepare basic personal and business records to complete employment, taxes, and SAE related applications, including resume, budgets, income statements, balance sheets, cash flow statements, profit and loss statements, and equity statements. (TN CCSS Reading 3; TN CCSS Writing 4)

3) Use local news media, organizational websites, and real-time labor market information to investigate occupations in natural resource management. Compare and contrast the knowledge, skills, and abilities necessary for employment, as well as the typical level of education required. (TN CCSS Reading 2, 9; TN CCSS Writing 4, 7, 9)

Managing Water Resources

4) Research the physical and chemical properties of fresh and salt water. Create a chart or graph depicting the essential uses of water, differentiating the amount of water available for human use from that which is inaccessible to humans. (TN CCSS Reading 2; TN CCSS Writing 4, 9)

5) Research major issues with water quantity and quality impacting global water supply using government reports and news media. Distinguish between point source and non-point source pollution. Debate benefits and costs of various management strategies that have been implemented to solve water quality and quantity issues by creating a rubric that can be used to judge each technique, citing specific textual evidence. (TN CCSS Reading 1, 2, 4, 9; TN CCSS Writing 4, 7, 9)

6) Evaluate water sources and uses in the local community. Compare and contrast how various water uses (such as agricultural, industrial, power-plant cooling, recreational, and public) impact overall water quality and quantity. Describe how legal issues and water costs impact consumption in an informational narrative. (TN CCSS Reading 2; TN CCSS Writing 2, 4, 8, 9)

Managing Mineral Resources

7) Research the global distribution of mineral resources. Compare the distribution of various minerals to the regions of the world with the highest demand and/or usage. Investigate current and projected rates of depletion and assess the extent to which reasoning and evidence presented by news media on the consequences of the depletion of readily available reserves support claims or recommendations for management of resources. (TN CCSS Reading 8, 9)

8) Describe the four step process of extracting minerals for human consumption (locating a mineral deposit, mining the mineral, processing/refining the mineral, and using the mineral to make a product) using domain-specific words and phrases. Develop an argument about the environmental impact of one, or more, steps in the process, supporting claim(s) and counterclaim(s) with valid evidence and reasoning from research. (TN CCSS Reading 2, 4; TN CCSS Writing 1, 4, 7, 9)

9) Using the Copper Basin Mine in Tennessee as an example, research claims made about the environmental impact of the mining operation and the methods and processes that have been used to restore the land to its present state. Prepare a presentation of lessons learned from Copper Basin, or another major mining site in modern or contemporary times, citing specific textual evidence that supports or refutes investigated claims. (TN CCSS Reading 5, 8; TN CCSS Writing 4, 6, 9)

Managing Plant and Animal Resources

10) Apply concepts of scientific taxonomy and industry-specific terminology to distinguish different species and types of plants (such as trees, grasses, legumes, food crops). Create a graphic illustration or fact sheet that compares and contrasts common plant species used in the management of environmental and natural resources by classification, care, and use. (TN CCSS Reading 4, 7)

11) Using information presented by local, state, and national government agencies, prepare a presentation on the importance of fish and wildlife as it pertains to such topics as ecosystem stability, genetic reserves, and medicinal, agricultural, aesthetic, recreational, and industrial uses. (TN CCSS Reading 2, 5; TN CCSS Writing 4, 6, 8, 9)

12) Investigate research-based practices in wildlife management and conservation used by governmental agencies and non-profit organizations dedicated to wildlife preservation. Compose a persuasive essay justifying the use of one such practice (including but not limited to carrying capacity, population control, and habitat management), and make recommendations for scaling the practice to vulnerable regions or habitats, citing specific textual evidence to develop reasoning. (TN CCSS Reading 2; TN CCSS Writing 1, 4, 7, 9)

13) Using news media and academic journal articles, research the accidental or intentional introduction of exotic species into an environment. Citing specific textual examples, describe the environmental and economic impact associated with their introduction, including the management and eradication of exotic plant and animal species. (TN CCSS Reading 1; TN CCSS Writing 7, 9)

14) Research, discuss, and evaluate the effects of fish and game laws and their enforcement on maintaining sustainable wildlife populations. Compare and contrast specific case studies describing both successful and failed legislation. Analyze how ecological principles are used to inform game management regulation by investigating environmental challenges a specific law is meant to address. Describe unique issues that arise in managing migratory species. (TN CCSS Reading 2, 6)

Managing Land Resources

15) Create a presentation to defend the need for public, state, and federal lands and forest resources, including but not limited to forests, resource areas, wildlife refuges, parks, and wilderness preservation areas, developing claim(s) and counterclaim(s) with valid reasoning and evidence. Describe the increasing pressures being placed on the agencies managing these lands to open them for various forms of development, citing specific examples from news media. (TN CCSS Reading 1; TN CCSS Writing 1, 4, 6, 9)

16) Explain the importance and impact of state park systems, and justify the use of tax dollars to support them. Differentiate between state parks and state natural areas, their uses, and the ways each are managed.

17) Compare and contrast various forest management methods for monitoring ecosystems, harvesting trees, protecting forests from pathogens and insects, managing fire, managing wildlife, and implementing sustainable forestry practices. Draw conclusions about important wildlife management practices after evaluating case studies of recent natural disasters, such as large wildfires in the western United States, citing specific textual evidence. (TN CCSS Reading 1, 2, 9; TN CCSS Writing 4, 9)

18) Describe, in detail, the thirteen components required in developing an environmental forestry stewardship plan, including how the components relate to, and impact, one another. Develop, edit, and revise an environmental forestry stewardship plan for a specific plot of land with peer reviews. (TN CCSS Reading 2, 5; TN CCSS Writing 2, 4, 5, 7, 9)

19) Referencing maps that indicate the distribution of the world's rangeland resources, create informational materials that describe the characteristics of rangeland vegetation, the concept of carrying capacity, and the consequences of overgrazing. Based on this research, assess the general quality of the world's rangelands, and outline specific strategies for their management. (TN CCSS Reading 7, 9; TN CCSS Writing 2, 4, 7, 9)

Impact of Technology on the Management of Natural Resources

20) Research the application of geographic information systems (GIS) and global positioning systems (GPS), including GIS software, GPS receivers, data acquisition, and spatial analysis of data, to solve problems and increase efficiency in the management of natural resources. Develop an informational text explaining the process of how GIS and GPS are used in the environment and natural resource industry. (TN CCSS Reading 2; TN CCSS Writing 2, 4, 7, 9)

21) Compare and contrast the types and functions of precision and advanced technologies (such as GIS, GPS, and unmanned aerial vehicles) available to the agriculture industry. Citing technical

data and academic research, debate the legal, ethical, and economic impact of using emerging technologies to improve efficiency and efficacy within the environment and natural resource industry by making a claim about the implications of technology use, developing it with reasoning and evidence from the text. (TN CCSS Writing 1, 9)

Policy and Governance

22) Compare and contrast Tennessee policies and regulations pertaining to natural resource preservation and management with those of the federal government and international organizations such as the World Wildlife Fund (WWF). Articulate the United States' responsibility to cooperate with the global community to solve issues related to natural resource quality and quantity. (TN CCSS Reading 2, 7; TN CCSS Writing 1, 9)

Standards Alignment Notes

*References to other standards include:

- TN CCSS Reading: Tennessee Common Core State Standards for English Language Arts & Literacy in History/Social Studies, Science, and Technical Subjects; Reading Standards for Literacy in Science and Technical Subjects 6-12; Grades 11-12 Students (page 62).
    - Note: While not directly aligned to one specific standard, students that are engaging in activities outlined above should be able to demonstrate fluency in Standards 3 and 10 at the conclusion of the course.
- TN CCSS Writing: Tennessee Common Core State Standards for English Language Arts & Literacy in History/Social Studies, Science, and Technical Subjects; Writing Standards for Literacy in History/Social Studies, Science, and Technical Subjects 6-12; Grades 11-12 Students (pages 64-66).
    - Note: While not directly aligned to one specific standard, students that are engaging in activities outlined above should be able to demonstrate fluency in Standards 3 and 10 at the conclusion of the course.
- AFNR: National Agriculture, Food and Natural Resources (AFNR) Career Cluster Content Standards: Students engaged in activities outlined above should be able to demonstrate fluency in Standards ESS.01, .02, .03, .04, .05, .06; NRS.01, .02, .04, and .05 at the conclusion of the course.
- P21: Partnership for 21st Century Skills Framework for 21st Century Learning
    - Note: While not all standards are specifically aligned, teachers will find the framework helpful for setting expectations for student behavior in their classroom and practicing specific career readiness skills.

Organizational Leadership and Communications

Primary Career Cluster:	Agriculture, Food and Natural Resources
Consultant:	Steven Gass, (615) 532-2847, Steven.Gass@tn.gov
Course Code(s):	5956
Prerequisite(s):	Agriscience (5957) and Principles of Agribusiness (TBD)
Credit:	1
Grade Level:	11
Graduation Requirements:	This course satisfies one of three credits required for an elective focus when taken in conjunction with other Agriculture courses.
Programs of Study and Sequence:	This is the third course in the *Agribusiness* program of study.
Necessary Equipment:	Refer to the Teacher Resource page below.
Aligned Student Organization(s):	FFA: www.tnffa.org Allie Ellis, (615) 253-5207, Allie.Ellis@tn.gov
Coordinating Work-Based Learning:	All Agriculture students are encouraged to participate in a Supervised Agricultural Experience (SAE) program. In addition, if a teacher has completed work-based learning (WBL) training, he or she can offer appropriate student WBL opportunities. To learn more, please visit http://tennessee.gov/education/cte/wb/.
Available Student Industry Certifications:	None
Dual Credit or Dual Enrollment Opportunities:	Dual Credit opportunities exist through Middle Tennessee State University.
Teacher Endorsement(s):	048, 448
Required Teacher Certifications/Training:	None
Teacher Resources:	www.tn.gov/education/cte/AgricultureFoodNaturalResources.shtml

Course Description

Organizational Leadership and Communications is an applied-knowledge course for students interested in learning more about the attributes and skills of successful leaders in the Agriculture industry. This course covers organizational behavior, communication, management, and leadership topics. Students in this course participate in activities that will assist them in the development of communication and interpersonal skills transferrable to any agribusiness application. Standards in this course are aligned

with Tennessee Common Core State Standards for English Language Arts & Literacy in Technical Subjects as well as National Agriculture, Food and Natural Resources Career Cluster Content Standards.*

Program of Study Application

This course is the third course in the *Agribusiness* program of study. For more information on the benefits and requirements of implementing this program in full, please visit the Agriculture, Food and Natural Resources website at www.tn.gov/education/cte/AgricultureFoodNaturalResources.shtml.

Course Standards

Career Awareness

1) Use local news media, organizational websites, and real-time labor market information to investigate occupations in plant and soil sciences. Compare and contrast the knowledge, skills, and abilities necessary for employment, as well as the typical level of education required. (TN CCSS Reading 2, 9; TN CCSS Writing 4, 7, 9)

2) Demonstrate the ability to prepare basic personal and business records to complete taxes, employment, and SAE related applications, including resume, budgets, income statements, balance sheets, cash flow statements, profit and loss statements, and equity statements. (TN CCSS Reading 3; TN CCSS Writing 4)

Organizational Structure and Performance

1) Consult case studies, business journals, and news articles to determine the relationships between organizational performance and human capital, social capital, organizational learning, total quality management, and customer satisfaction. Analyze case studies to identify the elements supporting high-performing organizations and describe how successful agribusinesses incorporate them. (TN CCSS Reading 2, 4, 5; TN CCSS Writing 2, 9)

2) Define organizational behavior, citing examples from agricultural businesses currently in operation. Produce a narrative or annotated timeline analyzing the major developments and features of the agriculture industry that have influenced changes in organizational behavior over the past century. These features include but are not limited to: scientific advancements, transportation of goods, labor market shifts, labor organization, the rise of large corporations, subsidies, automation, information technology, and globalization. (TN CCSS Reading 4; TN CCSS Writing 2, 8, 9)

3) Compare and contrast characteristics of models of organizational change. Analyze a case study in which an organization faced an unplanned change and develop a written argument supporting transformational change as a preventive measure. (TN CCSS Reading 9; TN CCSS Writing 1, 9)

4) Differentiate between extrinsic and intrinsic motivation and summarize how each influences employee productivity. Develop a list of strategies for motivating individuals or groups and write business scenarios in which the strategies apply. (TN CCSS Reading 1, 2; TN CCSS Writing 4, 9)

5) Create an annotated graphic (such as a flowchart, table, or mind map) illustrating the stages of team development. Draw conclusions about the advantages and disadvantages of group decision-making and evaluate the potential effectiveness of group decision-making at each stage. (TN CCSS Reading 5, 7; TN CCSS Writing 1, 4)

Communication

6) Practice effective verbal and nonverbal communication for use in business environments via role-plays. Contrast communication appropriate for an agribusiness environment versus an informal setting.

7) Recognize the consequences of poor communication skills and describe the importance of effective communication among team members. Apply concepts of giving and receiving oral and written instructions to accomplish a complex task. (TN CCSS Reading 3)

8) Define constructive criticism; analyze potential conflicts involved in giving and receiving feedback; and create a plan for engaging in productive dialogue. Role-play work-related feedback as an employer and as an employee. Demonstrate active listening and appropriate response skills.

9) Cite evidence to support the idea that conflict is a normal part of work relationships. Compare and contrast assertive and aggressive communication in conflicts. Apply concepts pertaining to different methods for handling conflicts by participating in role-play exercises and constructively critiquing the practices of others. (TN CCSS Reading 1, 9)

10) Analyze the potential customer impact of sample verbal, print, and electronic communications in agribusiness. Examine case studies in which various forms of communication have facilitated or hampered effective business operations. (TN CCSS Reading 9)

Management and Leadership

11) Develop a hypothesis surrounding the character traits and interpersonal skills needed by effective agribusiness managers. Determine which individual traits and skills can be developed and create a plan for personal growth. Example traits and skills include but are not limited to: enthusiasm, effective communication, decision making, risk evaluation, self-discipline, integrity, lifelong learning, and teamwork. (TN CCSS Writing 4)

12) Analyze the outcomes of case studies or current events and critique how organizational leaders managed people and made decisions. Write a narrative advocating alternative management strategies that would benefit the organization and which lead to either a better financial outcome or improved employee motivation. (TN CCSS Reading 2, 6, 8; TN CCSS Writing 1, 9)

13) Define organizational culture and evaluate the role of business leaders in establishing and maintaining a workplace in which employees work cooperatively with others from diverse backgrounds. (TN CCSS Reading 6)

14) Research a variety of project management models and create a visual representation to show important connections and distinctions between the essential phases of each model. Select one

model and modify it to meet the needs of a sample organization; justify its application in an agribusiness setting. (TN CCSS Reading 7, 8, 9; TN CCSS Writing 1, 8, 9)

15) Research professional ethical standards from recognized national organizations (such as the United States Department of Agriculture – Rural Business Cooperative Service). Synthesize principles from the standards to create a personal code of agribusiness ethics designed to address professional, ethical, and legal issues such as:
    a. Conducting business with friends, relatives, or competitors
    b. Sales incentives
    c. Pricing policies
    d. Illegal practices
    e. Behavior toward customers, employees, and shareholders

    (TN CCSS Reading 1, 2; TN CCSS Writing 4, 7, 9)

16) Demonstrate knowledge of basic parliamentary procedures by planning and conducting a simulated annual stockholders meeting for a small agricultural corporation or cooperative. Develop an agenda and take official minutes. Identify meeting materials to be used, including data and reports, and outline the responsibilities of organizational leadership in facilitating the meeting. (TN CCSS Reading 3; TN CCSS Writing 4)

Innovation and Influence

17) Formulate a hypothesis about the relationship between the stages of innovation adoption (knowledge, persuasion, decision, implementation, confirmation) and the rate of innovation adoption (innovator, early adopter, early majority, late majority, laggard). Analyze the role that opinion leaders play in the adoption process. Write coherent arguments based on evidence from real-world examples to support the hypothesis. (TN CCSS Reading 1, 2, 6, 9; TN CCSS Writing 1, 4, 9)

18) Analyze case studies of stakeholder resistance to change, identify the causes, and propose measures for overcoming resistance. (TN CCSS Reading 2, 6, 8; TN CCSS Writing 1, 9)

19) Compare and contrast theories of persuasion and influence (reciprocity, commitment, social proof, liking, authority, scarcity) and apply these theories to agricultural sales and marketing communications. (TN CCSS Reading 5)

20) Synthesize the understanding of stakeholder resistance, adoption models, and persuasion theories. Develop a sales plan for a new agricultural product or service (such as commodity trading to farmers). Deliver a focused, coherent presentation on the plan. (TN CCSS Reading 1, 2, 7; TN CCSS Writing 2, 4, 8, 9)

Standards Alignment Notes

*References to other standards include:

- TN CCSS Reading: Tennessee Common Core State Standards for English Language Arts & Literacy in History/Social Studies, Science, and Technical Subjects; Reading Standards for Literacy in Science and Technical Subjects 6-12; Grades 9-10 Students (page 62).

    - Note: While not directly aligned to one specific standard, students that are engaging in activities outlined above should be able to also demonstrate fluency in Standard 10 at the conclusion of the course.
- TN CCSS Writing: Tennessee Common Core State Standards for English Language Arts & Literacy in History/Social Studies, Science, and Technical Subjects; Writing Standards for Literacy in History/Social Studies, Science, and Technical Subjects 6-12; Grades 11-12 Students (pages 64-66).
    - Note: While not directly aligned to one specific standard, students that are engaging in activities outlined above should be able to also demonstrate fluency in Standards 3, 5, 6, and 10 at the conclusion of the course.
- AFNR: National Agriculture, Food and Natural Resources (AFNR) Career Cluster Content Standards: Students engaged in activities outlined above should be able to demonstrate fluency in Standard CS at the conclusion of the course.
- P21: Partnership for 21st Century Skills Framework for 21st Century Learning
    - Note: While not all standards are specifically aligned, teachers will find the framework helpful for setting expectations for student behavior in their classroom and practicing specific career readiness skills.

TENNESSEE DEPARTMENT OF EDUCATION
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Plant and Soil Science

Primary Career Cluster:	Agriculture, Food and Natural Resources
Consultant:	Steven Gass, (615) 532-2847, Steven.Gass@tn.gov
Course Code(s):	TBD
Prerequisite(s):	Agriscience (5957)
Credit:	1
Grade Level:	11
Graduation Requirements:	This course satisfies one of three credits required for an elective focus when taken in conjunction with other Agriculture courses.
Programs of Study and Sequence:	This is the third course in the *Environmental and Natural Resources* program of study.
Necessary Equipment:	Please see Teacher Resources link below.
Aligned Student Organization(s):	FFA: www.tnffa.org Allie Ellis, (615) 253-5207, Allie.Ellis@tn.gov
Coordinating Work-Based Learning:	All Agriculture students are encouraged to participate in a Supervisied Agricultural Experience (SAE) program. In addition, if a teacher has completed work-based learning training, they can offer apporpriate student WBL opportunitieis. To learn more, please visit http://tennessee.gov/education/cte/wb/.
Available Student Industry Certifications:	None
Dual Credit or Dual Enrollment Opportunities:	Currently, this course is available for dual enrollment at the Univerity of Tennessee at Martin.
Teacher Endorsement(s):	048, 448
Required Teacher Certifications/Training:	None
Teacher Resources:	www.tn.gov/education/cte/AgricultureFoodNaturalResources.shtml

Course Description

Plant and Soil Science is an applied-knowledge course focusing on the science and management of plants and soils with special attention given to current agricultural practices that support the healthy and sustainable cultivation of major crops. Students in this course will be exposed to a range of careers associated with the science and management of plants and soils and will develop the essential skills and knowledge to be successful in science- or agriculture-related occupations. Standards in this course are aligned with Tennessee Common Core State Standards for English Language Arts & Literacy in Technical Subjects, Tennessee Biology I, Biology II, Ecology, and Environmental Science, as well as National Agriculture, Food and Natural Resources Career Cluster Content Standards.*

Program of Study Application

This course is the third course in the *Environmental and Natural Resources* program of study. For more information on the benefits and requirements of implementing this program in full, please visit the Agriculture, Food, & Natural resources website at www.tn.gov/education/cte/AgricultureFoodNaturalResources.shtml.

Course Standards

History and Importance

1) Determine the role of plants and soil in maintaining environmental quality. Trace the history of soil conservation in the United States by developing an informational essay or graphic, citing specific historical events that promoted the development of soil conservation methodologies found in academic journals and news media. (TN CCSS Reading 1, 2; TN CCSS Writing 4, 7, 9)

2) Describe current land management practices for rural, suburban, and urban settings to protect and ensure the quality and quantity of freshwater supply. Conduct a review of a specific municipality to identify existing practices governed by local laws and agency policy. Create a narrative to describe the use of a specific practice, citing specific textual evidence from research. (TN CCSS Reading 2; TN CCSS Writing 2, 4, 7, 9; TN Biology I 2; TN Biology II 2; TN Environmental Science 4)

3) Use local news media, organizational websites, and real-time labor market information to investigate occupations in plant and soil sciences. Compare and contrast the knowledge, skills, and abilities necessary for employment, as well as the typical level of education required. (TN CCSS Reading 2, 9; TN CCSS Writing 4, 7, 9)

4) Review common laboratory safety procedures for tool and equipment operation in plant and soil science laboratories, including but not limited to accident prevention and control procedures. Demonstrate the ability to follow safety and operational procedures in a lab setting and complete a safety test with 100 percent accuracy. (TN CCSS Reading 3)

Soil Science

5) Create a model or illustration that depicts the formation of soil. Differentiate between the biological, geological, chemical, and physical factors and processes involved in soil formation. (TN CCSS Reading 2, 7; TN CCSS Writing 4, 9; TN Environmental Science 1)

6) Communicate understanding of methods for classifying soils by preparing a guide that accurately describes the procedures for each method using domain specific language. Demonstrate the ability to follow methods for sampling and analyzing the following: soil pH, texture, permeability, water holding capacity, slope, chemical analyses, and soil organisms. (TN CCSS Reading 1, 2, 3, 4; TN CCSS Writing 4, 7, 9; TN Environmental Science 1)

7) Conduct soil profiles, soil analysis, and water availability analysis. Synthesize findings in an argumentative essay. Develop a claim justifying appropriate agricultural, recreational,

conservational, and/or aesthetic uses of specific land areas using valid reasoning and citing specific evidence gathered in analyses. (TN CCSS Reading 3; TN CCSS Writing 1, 4, 7, 9)

Plant Science and Nutrition

8) Compare and contrast the anatomy and physiology of monocot and dicot plants used for crop production. (TN CCSS Reading 2, 5)

9) Create a model depicting the parts and functions of plant cells. Label the structures and describe the functions of plant cell organelles. (TN CCSS Reading 2, 4, 7; TN CCSS Writing 4; TN Biology I 1; TN Biology II 1, 7)

10) Assess the importance of the 16 (sixteen) nutrients essential to plant growth and development. Identify nutritional deficiencies and disorders, distinguish among signs of nutrient deficiency in plants, make recommendations for appropriate treatments, and prescribe preventative control measures for major agricultural crops, including corn, soybean, cotton, tobacco, hay, pasture, and forest. (TN CCSS Reading 2, 5; TN CCSS Writing 2, 4, 9; TN Biology II 7)

11) Investigate the use of fertilizers as a source of essential plant nutrients. Compare and contrast the use of organic and chemical fertilizers, assessing claims made by producers and consumers of fertilizer products found in promotional materials, news articles, and academic journals. Calculate fertilizer formulations and perform various methods of fertilizer application for crops, such as erosion controlling crops. (TN CCSS Reading 1, 3, 6, 8; TN CCSS Mathematics HS Math Modeling)

Agricultural Practices and Environmental Issues

12) Research, compare and contrast traditional, sustainable, and organic agriculture methods and practices. Describe how each method aligns to a specific goal, including but not limited to the following: soil fertility and texture maintenance, adequate soil moisture maintenance, erosion prevention, pollution prevention, and weed, insect, and disease management. Assess the costs and benefits of specific methods and practices. (TN CCSS Reading 2, 4, 5, 9; TN Environmental Science 2, 4, 6)

13) Identify major agriculture-related pollutants and isolate practices that contribute to the spread of pollution in both urban and traditional agricultural production environments. Develop a list of best practices, citing technical texts to make recommendations for watering procedures, runoff containment, pest control, and chemical use and disposal in both domestic (home) and agricultural production settings. Prepare informational materials emphasizing the importance of using recommended best practices to reduce pollution. (TN CCSS Reading 2, 5; TN CCSS Writing 4, 7, 9; TN Environmental Science 4, 6, 7)

14) Compare and contrast alternative methods for maintaining home landscapes using sustainable and/or organic products that will reduce pollution and soil erosion and conserve water and energy. Develop an argumentative essay that develops a claim about the need for a specific practice to maintain a healthy home landscape, developing claim(s) and counterclaim(s) with reasoning and evidence. (TN CCSS Reading 5, 9; TN CCSS Writing 1, 4, 7, 9; TN Environmental Science 2, 4, 6, 7)

15) Research the use of compost and mulch in improving and rebuilding soils. Create a presentation or resource guide describing various compost methods, including field crop composting, commercial composting, backyard compost piles, vermicomposting, and bokashi. Create a chart that compares the inputs, time investment, quality, and quantity of compost prepared by each method. (TN CCSS Reading 2, 4, 7; TN CCSS Writing 4, 7, 9; TN Ecology 4, 6; TN Environmental Science 4, 6)

16) Determine characteristics important in selecting a site for optimal growth of plants and crops in rural, suburban, and urban settings. Describe the factors that influence the economics of crop production in each setting. (TN CCSS Reading 2; TN CCSS Writing 4, 9; TN Environmental Science 2, 4)

Standards Alignment Notes

*References to other standards include:

- TN CCSS Reading: Tennessee Common Core State Standards for English Language Arts & Literacy in History/Social Studies, Science, and Technical Subjects; Reading Standards for Literacy in Science and Technical Subjects 6-12; Grades 11-12 Students (page 62).
    - Note: While not directly aligned to one specific standard, students that are engaging in activities outlined above should be able to demonstrate fluency in Standard 10 at the conclusion of the course.
- TN CCSS Writing: Tennessee Common Core State Standards for English Language Arts & Literacy in History/Social Studies, Science, and Technical Subjects; Writing Standards for Literacy in History/Social Studies, Science, and Technical Subjects 6-12; Grades 11-12 Students (pages 64-66).
    - Note: While not directly aligned to one specific standard, students that are engaging in activities outlined above should be able to demonstrate fluency in Standards 3, 5, 6, and 10 at the conclusion of the course.
- TN Biology I: Tennessee Science: Biology I, standards 1 and 2.
- TN Biology II: Tennessee Science: Biology II, standards 1, 2, and 7.
- TN Ecology: Tennessee Science: Ecology, standards 4 and 6.
- TN Environmental Science: Tennessee Science: Environmental Science, standards 1, 2, 4, 6, and 7.
- AFNR: National Agriculture, Food and Natural Resources (AFNR) Career Cluster Content Standards: Students engaged in activities outlined above should be able to demonstrate fluency in Standard PS at the conclusion of the course.
- P21: Partnership for 21st Century Skills Framework for 21st Century Learning
    - Note: While not all standards are specifically aligned, teachers will find the framework helpful for setting expectations for student behavior in their classroom and practicing specific career readiness skills.

TENNESSEE DEPARTMENT OF EDUCATION
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Principles of Agribusiness

Primary Career Cluster:	Agriculture, Food and Natural Resources
Consultant:	Steven Gass, (615) 532-2847, Steven.Gass@tn.gov
Course Code(s):	TBD
Prerequisite(s):	Agriscience (5957)
Credit:	1
Grade Level:	10
Graduation Requirements:	This course satisfies one of three credits required for an elective focus when taken in conjunction with other Agriculture courses.
Programs of Study and Sequence:	This is the second course in the *Agribusiness* program of study.
Necessary Equipment:	
Aligned Student Organization(s):	FFA: www.tnffa.org Allie Ellis, (615) 253-5207, Allie.Ellis@tn.gov
Coordinating Work-Based Learning:	All Agriculture students are encouraged to participate in a Supervisied Agricultural Experience (SAE) program. In addition, if a teacher has completed work-based learning training, they can offer apporpriate student WBL opportunitieis. To learn more, please visit http://tennessee.gov/education/cte/wb/.
Available Student Industry Certifications:	None
Dual Credit or Dual Enrollment Opportunities:	There are no known dual credit/dual enrollment opportunities for this course. If interested in developing, reach out to a local postsecondary institution to establish an articulation agreement.
Teacher Endorsement(s):	048, 448
Required Teacher Certifications/Training:	None
Teacher Resources:	www.tn.gov/education/cte/AgricultureFoodNaturalResources.shtml

Course Description

Principles of Agribusiness teaches students to apply the economic and business principles involved in the sale and supply of agricultural products to a wide range of careers across the industry and builds foundational knowledge of finance and marketing principles. Standards in this course are aligned with Tennessee Common Core English Language Arts & Literacy in Technical Subjects as well as National Agriculture, Food and Natural Resources Career Cluster Content Standards.*

Program of Study Application

This course is the second course in the *Agribusiness* program of study. For more information on the benefits and requirements of implementing this program in full, please visist the Agriculture, Food, and Natural Resources website at www.tn.gov/education/cte/AgricultureFoodNaturalResources.shtml.

Course Standards

Introduction to Agribusiness

1) Explore and compare local, regional, state, national, and global career opportunities in the agribusiness industry. Drawing evidence from multiple sources, such as but not limited to the United States Bureau of Labor Statistics, Organisation for Economic Co-operation and Development and Tennessee Department of Labor and Workforce Development, to evaluate labor data on viable career pathways in an agribusiness-related field. Describe in a written or visual representation the knowledge, skills, and abilities necessary for a range of careers in agribusiness. (TN CCSS Reading 1, 9; TN CCSS Writing 4, 7, 9)

2) Examine specific business practices, laws, regulations, and technologies that have evolved within the agribusiness sector, and evaluate the economic and societal implications of each. Explain in an informative essay how these advances have influenced the agriculture industry, citing specific textual evidence from case studies or legislation. (TN CCSS Reading 1, 2; TN CCSS Writing 2, 4, 7, 9)

3) Create a graphic illustration comparing and contrasting regulations in the United States with those in countries from which the U.S. imports agricultural products, citing evidence from governmental agencies and news organizations. Analysis should address governing agencies, subsidies, and trade agreements. (TN CCSS Reading 1, 7, 9; TN CCSS Writing 7, 9)

Business Concepts and Structures

4) Compare and contrast types of business ownership models including at minimum the following: sole proprietorship, partnerships, small businesses, cooperatives, limited liability corporations, and corporations. In a narrative referencing agribusiness examples, explain the organizational structure of each model and describe its advantages and disadvantages to both owner and customer. (TN CCSS Reading 4, 5, 9; TN CCSS Writing 2, 4, 7, 9)

5) Write a business plan for an agricultural entrepreneurial enterprise that includes basic business and entrepreneurship principles such as budget, target customer, and product information. As an extension, apply principles of the business plan for use as a Supervised Agricultural Experience (SAE) program. (TN CCSS Writing 4, 9)

6) Define and analyze the relationships among basic business concepts used in agribusiness, including the business cycle, profit, loss, competition, equilibrium price, ethics, social responsibility, and supply and demand. Develop a visual representation (i.e., chart, table, graph, mind map) to illustrate situations that would affect supply and demand of an agricultural product nationally and globally. (TN CCSS Reading 4, 5, 7; TN CCSS Writing 9)

Accounting Practices

7) Using case studies and instructional materials, explain how components of financial recordkeeping affect operations and management decisions for an agricultural enterprise. Components include the general journal, balance sheet, cash flow statements, financial statements, reconciliation of accounts, depreciation, net worth, income statements, and profit and loss statements. (TN CCSS Reading 2, 5; TN CCSS Writing 9)

Markets and Futures

8) Compare the costs affecting the production of agricultural products (such as basic logistics, input costs) with the costs of producing and marketing non-agricultural products.

9) Research and explain the economic impact of agriculture futures and commodities on the local, state, national and the global economy. Identify the top ten agricultural commodities and describe the factors that impact their values and trading patterns. Predict the value of each commodity at a specified point in time. (TN CCSS Reading 5; TN CCSS Writing 4, 7, 9)

10) Compare and contrast the sale of agricultural products through local marketing (such as farmers markets, buyers, and marketing cooperatives) to the sale of products in futures markets, supporting analysis with graphic illustrations (such as charts, tables, graphs) and explanatory narratives. (TN CCSS Reading 1, 5, 7, 9; Writing 2, 4, 7, 9)

Sales and Marketing

11) Describe basic marketing principles fundamental to the sale of agriculture products, including but not limited to benefit and cost analysis, impact and application of online mediums, value-added, and niche marketing.

12) Research an agricultural product or service to determine its features and consumer benefits. Identify appropriate marketing strategies and target audiences; develop and present materials designed to market the product or service. (TN CCSS Reading 2; TN CCSS Writing 4, 7, 9)

13) Demonstrate understanding of basic sales principles by writing scripts for a role play between an agricultural product salesperson and a customer. Include customer follow up conversations after the sale. (TN CCSS Writing 4)

14) Develop and present an agricultural marketing or sales plan on a specific product or service. The plan should include at least the following: a mission statement, long- and short-term smart goals, target markets, profit and loss projections, industry trends, and product samples. (TN CCSS Writing 4, 7, 9)

Standards Alignment Notes

*References to other standards include:

- TN CCSS Reading: Tennessee Common Core State Standards for English Language Arts & Literacy in History/Social Studies, Science, and Technical Subjects; Reading Standards for Literacy in Science and Technical Subjects 6-12; Grades 9-10 Students (page 62).
    - Note: While not directly aligned to one specific standard, students that are engaging in activities outlined above should be able to also demonstrate fluency in Standards 6, 8 and 10 at the conclusion of the course.
- TN CCSS Writing: Tennessee Common Core State Standards for English Language Arts & Literacy in History/Social Studies, Science, and Technical Subjects; Writing Standards for Literacy in History/Social Studies, Science, and Technical Subjects 6-12; Grades 9-10 Students (pages 64-66).
    - Note: While not directly aligned to one specific standard, students that are engaging in activities outlined above should be able to also demonstrate fluency in Standards 1, 5, 6, 8 and 10 at the conclusion of the course.
- AFNR: National Agriculture, Food and Natural Resources (AFNR) Career Cluster Content Standards: Students engaged in activities outlined above should be able to demonstrate fluency in Standards ABS at the conclusion of the course.
- P21: Partnership for 21st Century Skills Framework for 21st Century Learning
    - Note: While not all standards are specifically aligned, teachers will find the framework helpful for setting expectations for student behavior in their classroom and practicing specific career readiness skills.

TENNESSEE DEPARTMENT OF EDUCATION
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Principles of Agricultural Mechanics

Primary Career Cluster:	Agriculture, Food and Natural Resources
Consultant:	Steven Gass, (615) 532-2847, Steven.Gass@tn.gov
Course Code(s):	TBD
Prerequisite(s):	Agriscience
Credit:	1
Grade Level:	10
Graduation Requirements:	This course satisfies one of three credits required for an elective focus when taken in conjunction with other Agriculture courses.
Programs of Study and Sequence:	This is the second course in the *Agricultural Engineering and Applied Technologies* program of study.
Necessary Equipment:	
Aligned Student Organization(s):	FFA: www.tnffa.org Allie Ellis, (615) 253-5207, Allie.Ellis@tn.gov
Coordinating Work-Based Learning:	All Agriculture students are encouraged to participate in a Supervisied Agricultural Experience (SAE) program. In addition, if a teacher has completed work-based learning training, they can offer apporpriate student WBL opportunitieis. To learn more, please visit http://tennessee.gov/education/cte/wb/.
Available Student Industry Certifications:	None
Dual Credit or Dual Enrollment Opportunities:	There are no known dual credit/dual enrollment opportunities for this course. If interested in developing, reach out to alocal postsecondary institution to establish an articulation agreement.
Teacher Endorsement(s):	048, 448
Required Teacher Certifications/Training:	No
Teacher Resources:	www.tn.gov/education/cte/AgricultureFoodNaturalResources.shtml

Course Description

Principles of Agricultural Mechanics is a course introducing students to basic skills and knowledge in construction and land management for both rural and urban environments. This course covers topics including project management, basic engine and motor mechanics, land surveying, irrigation and drainage, agricultural structures, and basic metalworking techniques. Standards in this course are aligned with Tennessee Common Core State Standards for English Language Arts & Literacy in Technical Subjects, Tennessee Common Core State Standards for Mathematics and National Agriculture, Food, and Natural Resources Career Cluster Content Standards.*

Program of Study Application

This course is the second course in the *Agricultural Engineering and Applied Technologies* program of study. For more information on the benefits and requirements of implementing this program in full, please visit the Agriculture, Food, and Natural Resources website at www.tn.gov/education/cte/AgricultureFoodNaturalResources.shtml.

Course Standards

Safety

1) Identify the benefits of knowing and applying basic safety procedures in both an agricultural laboratory and workplace. Interpret current Occupational Safety and Health Administration (OSHA) guidelines to conduct a compliance review of the agricultural laboratory, including a written summary justifying the findings with recommendations for improving the safety of working conditions. (TN CCSS Reading 1, 2; TN CCSS Writing 1, 4, 7, 9; AFNR CS.06, CS.07)

2) Review common laboratory safety procedures for tool and equipment operation in the agricultural mechanics laboratories, including but not limited to accident prevention and control procedures. Demonstrate the ability to follow safety and operational procedures in a lab setting and complete a safety test with 100 percent accuracy. (TN CCSS Reading 3; ARNR CS)

Project Management

3) Outline the basic principles and procedures of effective project planning. Create and present a project plan for an agricultural mechanics project or a supervised agricultural experience program related to agriculture mechanics. (TN CCSS Reading 2; TN CCSS Writing 4; AFNR CS.02, CS.04, CS.07, CS.08, ABS.01, ABS.02, ABS.07)

4) Using industry-specific terminology, identify components for preparing a budget and cost estimate. Develop a budget using a scaled drawing or blueprint to construct or repair an agriculture mechanics project. (TN CCSS Reading 1, 7; TN CCSS Writing 8; TN CCSS Math N, Q, SSE; AFNR CS.02, CS.04, ABS.01, ABS.02, ABS.04, ABS.05, ABS.07, PST.04)

Engine and Motor Mechanics

5) Compare and contrast the chief features, functions, and applications of two-cycle engines, four-cycle engines, and electric motors. Citing technical references, recommend a maintenance schedule specific to the working environment (such as indoor/outdoor conditions, exposure to heat or cold) of the engine and/or motor. Conduct the appropriate maintenance with adherence to specifications outlined in the schedule. (TN CCSS Reading 1, 2; TN CCSS Writing 2, 4, 7, 8, 9; AFNR CS.02, CS.04, ABS.01, ABS.02, ABS.04, ABS.05, ABS.07, PST.02, PST.03)

6) Identify and differentiate between the different types of fuel and power sources used in conjunction with engines and motors. Recommend the types and sizes of engines/motors best suited for a range of applications. Provide a written justification, citing specific textual evidence, to support the recommendation. (TN CCSS Writing 1, 7, 9; AFNR PST.01, PST.02)

Surveying

7) Using topographical maps and appropriate mathematical equations, determine the acreage of a specific plot of land. Document and defend the methods used to arrive at the result, annotating calculations and field notes in a manner easily retrieved by other readers. (TN CCSS Reading 3, 4; TN CCSS Writing 4, 7; TN CCSS Math N-Q, G-CO, G-MG)

8) Apply precision surveying processes and geographic information system (GIS) technology to calculate the acreage of a specific plot of property. Using field notes and digital data (such as GIS overlays), develop a written survey report of the designated plot to include, at minimum, measurements, degrees, markers, and other notable geographic parameters. (TN CCSS Reading 3, 7; TN CCSS Writing 2, 7, 9; TN CCSS Math N-Q, G-CO, G-MG; AFNR CS.07, CS.08)

Irrigation and Drainage

9) Analyze the interrelationships among plants, water, air, and soil to maximize the health and productivity of agricultural crops. Calculate the permeability rate, available water holding capacity, pH levels, and nutrient levels for a specific soil type. (TN CCSS Reading 4; TN CCSS Math N-Q, F-BF; AFNR CS.09, NRS.01, NRS.02, NRS.03, NRS.04, PS.01, PS.02)

10) Apply physics concepts governing various pumping systems and delivery options to achieve the optimum irrigation and drainage required for row crop, greenhouse, and nursery operations in various soil-plant-climate combinations. Develop irrigation schedules to satisfy the design daily irrigation requirements (DDIR) for specific crops, citing specific textual evidence. (TN CCSS Reading 1; TN CCSS Writing 4; TN CCSS Math N-Q, A-CED, F-BF; AFNR CS.09, CS.11, ABS.01, ABS.03, ABS.07, ESS.02, NRS.02, NRS.04, PS.01, PS.02, PST.01, PST.02)

11) Compare and contrast irrigation methods for row crops, attending to such factors as water conservation, efficiency, and cost. Investigate and document findings on the effectiveness and efficiency of a surface irrigation versus a drip irrigation method, developing claim(s) and counterclaim(s) for scenarios in which each method would be most applicable. (TN CCSS Reading 1; Writing 1, 7, 9; TN CCSS Math N-Q, F-IF; AFNR CS.09, CS.11, ABS.01, ABS.02, ABS.03, ABS.04, ABS.05, ABS.06, ESS.02, ESS.03, NRS.02, NRS.04, PS.01, PS.02, PST.01, PST.02)

Agricultural Structures

12) Interpret plans and working drawings to select appropriate building materials for a given agricultural structure. Using correct units and measurements, draft a written bill of materials enumerating the quantities of each selection, including but not limited to concrete, masonry, wood, metal, and composite materials. (TN CCSS Reading 3, 4, 5; TN CCSS Writing 2, 4, 9; TN CCSS Math N-Q, A-REI, G-MG; AFNR CS.06, CS.07, CS.09, PST.04)

13) Applying construction principles pertaining to wood, concrete, metal, masonry, plumbing and electricity construct or repair an agricultural structure according to prescribed working plans. (TN CCSS Reading 3, 7; TN CCSS Math N-Q, G-MG; AFNR CS.06, CS.07, CS.08, CS.09, ABS.04, ABS.05, PST.01, PST.04)

Agricultural Metalworking

14) Compare and contrast the physical and chemical properties of arc welding, metal inert gas (MIG) welding, gas welding, soldering, and brazing. Demonstrate the ability to precisely follow operational and safety procedures for each fusion process across various applications. (TN CCSS Reading 3; AFNR CS.06, CS.07, CS.08, CS.09, PST.02, PST.05)

15) Classify the physical and chemical properties associated with various metal-cutting methods. Demonstrate adherence to operational and safety procedures for using oxy-fuel or plasma in applications involving mild steel, copper, sheet metal, and cast iron. (TN CCSS Reading 3; AFNR CS.06, CS.07, CS.08, CS.09, PST.02, PST.05)

16) Select and demonstrate the best method to construct, connect, or repair metallic and non-metallic materials for a variety of agricultural applications, including but not limited to plumbing, sheeting, and equipment. (AFNR CS.07, CS.08, PST.01, PST.02, PST.03, PST.04, PST.05)

Standards Alignment Notes

*References to other standards include:

- TN CCSS Reading: Tennessee Common Core State Standards for English Language Arts & Literacy in History/Social Studies, Science, and Technical Subjects; Reading Standards for Literacy in Science and Technical Subjects 6-12; Grades 9-10 Students (page 62).
    - Note: While not directly aligned to one specific standard, students that are engaging in activities outlined above should be able to demonstrate fluency in Standards 10 at the conclusion of the course.
- TN CCSS Writing: Tennessee Common Core State Standards for English Language Arts & Literacy in History/Social Studies, Science, and Technical Subjects; Writing Standards for Literacy in History/Social Studies, Science, and Technical Subjects 6-12; Grades 9-10 Students (pages 64-66).
    - Note: While not directly aligned to one specific standard, students that are engaging in activities outlined above should be able to demonstrate fluency in Standards 3, 5, and10 at the conclusion of the course.
- TN CCSS Math: Tennessee Common Core State Standards for Mathematics; Math Standards for High School: Number and Quantity, Algebra, Functions, Modeling, Geometry, Statistics and Probability (pages 58-83).
    - Note: The standards in this course are not meant to teach mathematical concepts. However, the concepts referenced above may provide teachers with opportunities to collaborate with mathematics educators to design project-based activities or collaborate on lesson planning. Students that are engaging in activities listed above should be able to demonstrate quantitative, algebraic, and functional reasoning as applied to specific technical concepts. In addition, students will have the opportunity to practice the habits of mind as described in the eight Standards for Mathematical Practice.
- AFNR: National Agriculture, Food and Natural Resources (AFNR) Career Cluster Content Standards. Students engaged in activities outlined above should be able to demonstrate fluency in Standards in CS, PST, ABS, NRS, ESS, and PS systems at the conclusion of the course.

- P21: Partnership for 21st Century Skills Framework for 21st Century Learning
    - Note: While not all standards are specifically aligned, teachers will find the framework helpful for setting expectations for student behavior in their classroom and practicing specific career readiness skills.

TENNESSEE DEPARTMENT OF EDUCATION
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Principles of Food Production

Primary Career Cluster:	Agriculture, Food and Natural Resources
Consultant:	Steven Gass, (615) 532-2847, Steven.Gass@tn.gov
Course Code(s):	TBD
Prerequisite(s):	Agriscience (5957)
Credit:	1
Grade Level:	10
Graduation Requirements:	This course satisfies one of three credits required for an elective focus when taken in conjunction with other Agriculture courses.
Programs of Study and Sequence:	This is the second course in the *Food Science* program of study.
Necessary Equipment:	Please see Teacher Resources link below.
Aligned Student Organization(s):	FFA: www.tnffa.org Allie Ellis, (615) 253-5207, Allie.Ellis@tn.gov
Coordinating Work-Based Learning:	All Agriculture students are encouraged to participate in a Supervisied Agricultural Experience (SAE) program. In addition, if a teacher has completed work-based learning (WBL) training, he or she can offer appropriate student WBL opportunities. To learn more, please visit http://tennessee.gov/education/cte/wb/.
Available Student Industry Certifications:	None
Dual Credit or Dual Enrollment Opportunities:	There are no known dual credit/dual enrollment opportunities for this course. If interested in developing, reach out to a local postsecondary institution to establish an articulation agreement.
Teacher Endorsement(s):	048, 448
Required Teacher Certifications/Training:	None
Teacher Resources:	www.tn.gov/education/cte/AgricultureFoodNaturalResources.shtml

Course Description

Principles of Food Production is an applied course in plant and animal agriculture for students interested in pursuing careers in production agriculture or food science. Students will study principles related to plant and animal structural anatomy, systems physiology, economics of production, genetics and biotechnology, and other management approaches associated with plant and animal production. Standards in this course are aligned with Tennessee Common Core State Standards for English Language Arts & Literacy in Technical Subjects, Tennessee Common Core State Standards for Mathematics, and Tennessee state standards for Biology I, Biology II, Ecology, and Environmental Science, as well as National Agriculture, Food and Natural Resourses Career Cluster Content Standards.*

Program of Study Application

This course is the second course in the *Food Science* program of study. For more information on the benefits and requirements of implementing this program in full, please visit the Agriculture, Food and Natural Resources website at www.tn.gov/education/cte/AgricultureFoodNaturalResources.shtml.

Course Standards

Introduction to Plant and Animal Agriculture and Safety

1) Research the roles and contributions of plants and animals in meeting the food and fiber needs of society using government agency data, news articles, and instructional resources. Identify and describe in an informative text the different aspects of plant and livestock production (such as product selection, site selection, optimal development, harvesting, and marketing), and examine characteristics of occupations in the field. (TN CCSS Reading 1; TN CCSS Writing 2)

2) Describe the scope and economic importance of plant and animal agriculture in the United States and the world, using quantitative data compiled by government agencies and news media. Summarize trends in crop and livestock production in Tennessee, citing information from the Tennessee Department of Agriculture. (TN CCSS Reading 1, 2; TN CCSS Writing 4, 9)

3) Review common laboratory safety procedures for tool and equipment operation in the food science laboratories, including but not limited to accident prevention and control procedures. Demonstrate the ability to follow safety and operational procedures in a lab setting and complete a safety test with 100 percent accuracy. (TN CCSS Reading 3)

Principles of Plant Science for Agricultural Production

4) Differentiate between major plant species used for vegetable, forage, fruit, and agronomic crop production. Describe basic principles of plant science needed to produce healthy crops for high quality food products. (TN Biology II 7)

5) Identify and describe the general growth and development processes of crops used for food production. Synthesize information from a range of sources to analyze plant anatomy, physiology, genetics, and reproduction in the context of plant growth and productivity, including the following:
    a. Describe different plant types based on their anatomy and physiology
    b. Investigate the relationship between form and function for the major plant structures
    c. Examine the components of the plant reproduction system and identify specific anatomical features on different species and varieties of plants
    d. Demonstrate cross-breeding techniques to enhance identified traits and characteristics

    (TN CCSS Reading 7, 9; TN CCSS Writing 8; TN Biology II 7)

6) Relate principles of disease and parasite control to the health, growth, and maintenance of food crops. Compare and contrast methods for disease and parasite controls, distinguishing between prevention and treatment methods. (TN Biology II 7)

7) Document, using either a chart, table, graph or graphic organizer, the optimum levels of specific nutritional factors that influence plant health (such as pH, nitrogen, potassium, etc.). Identify nutritional deficiencies and disorders and make recommendations for the safe production of major food crops. (TN CCSS Reading 7; TN Biology II 7)

Principles of Soil Science for Plant and Animal Production

8) Evaluate the physical and chemical properties of soils needed for optimum food crop production. Perform technical procedures to classify soils for agricultural production by evaluating factors such as soil pH, texture, permeability, drainage class, soil depth, and water holding capacity. Interpret test results and formulate conclusions regarding production use suitability. (TN CCSS Reading 3)

9) Research the factors that influence soil erosion rates, and compare soil conservation practices used for maintaining a healthy growing environment for plant and animal production. (TN CCSS Writing 7; TN Env. Science 4)

10) Analyze practices for land selection and conservation that ensure optimal productivity in crop development and livestock operations. Using information from government agencies (such as Tennessee Extension Service, Natural Resources Conservation Service), cite examples of best management practices that ensure the appropriate use of land resources and maximize crop yields and determine the extent to which evidence provided supports them. (TN CCSS Reading 8; TN CCSS Writing 9; TN Env. Science 4, 7)

11) Identify environmental factors (such as climate and topography) considered in site selection to ensure optimal production and economic return for plant and animal production, depending on intended use and location (rural, suburban, and urban). (TN Env. Science 4)

Principles of Environmental Science for Plant and Animal Production

12) Research sustainable practices and principles applicable to food crop and animal production. Craft an argumentative essay recommending management practices for a specific setting (rural, suburban, urban) by developing a claim with reasoning and evidence that incorporate soil and water conservation principles. (TN CCSS Writing 1, 4, 7; TN Ecology 6; TN Env. Science 4, 7)

13) Debate water, air, and noise pollution issues associated with agricultural production, and recommend control measures for rural, suburban, and urban areas, citing evidence from specific case studies. Demonstrate adherence to procedures for handling, storing, and disposing of production waste in compliance with relevant laws and regulations in a variety of plant and animal settings. (TN CCSS Reading 3; TN CCSS Writing 1; TN Env. Science 6, 7)

Principles of Animal Science for Agricultural Production

14) Identify the major breeds of production animals (such as cattle, sheep, goats, poultry, swine, and specialty animals) and their associated food and fiber products, citing specific textual evidence of characteristics. Explore the basic principles of animal science needed to produce healthy livestock for high quality food and fiber products (such as nutrition, reproduction, and breed selection). (TN CCSS Reading 1; TN CCSS Writing 9)

15) Identify and describe the general growth and development processes of production animals used for food and fiber production. Analyze animal anatomy, physiology, genetics, and reproduction in the context of animal growth and productivity, including the following:
    a. Describe different animal types based on their anatomy and physiology
    b. Examine the components of the animal reproduction system and identify specific anatomical features on different species and varieties of production animals
    c. Demonstrate understanding of cross-breeding techniques to enhance identified traits and characteristics

    (TN CCSS Reading 9; TN CCSS Writing 8)

16) Research principles of disease and parasite control and relate them to livestock health, growth, and maintenance. Recommend safe methods for disease and parasite prevention and treatment, citing established scientific and industry guidelines. (TN CCSS Reading 2, 8; TN CCSS Writing 7, 9)

17) Use professional and academic journals and/or publications from Tennessee Extension Service to research and document connections between proper nutrition and animal health. Apply principles of proper nutrition to maximize livestock gains and cost efficiency, by:
    a. Making specific diet recommendations, based on animal breed, available resources, costs, and nutritional requirements and justifying recommendations with specific textual evidence
    b. Differentiating between various diet alternatives to determine which ration is most cost effective to obtain maximum production

    (TN CCSS Reading 1, 4, 5; TN CCSS Writing 1, 7, 9)

18) Summarize how heritability, selection intensity, and generation interval are important to genetic change in production animals, including:
    a. Explaining how each concept impacts genetic change
    b. Comparing and contrasting characteristics of each as a tool for animal producers
    c. Determining how long it will take to get specific traits, using each method

    (TN CCSS Reading 1, 2; TN CCSS Writing 8, 9; TN Biology I 4, TN Biology II 4)

Principles of Agribusiness for Plant and Animal Production

19) Identify and critique factors that influence the economics of crop and livestock production in the United States and the world. Using informational texts and graphic illustrations published by government agencies, interpret production costs for various types of plant and animal operations that impact the wholesale cost of food. (TN CCSS Reading 4; TN CCSS Writing 2, 9)

20) Using local news media, advertisements, and information from production companies, explore and compare marketing methods and strategies to develop opportunities for specialty plant and animal products in niche markets. (TN CCSS Reading 1, 6, 8)

21) Identify and describe the American factors impacting global commodity markets. Compare and contrast, through debate, different factors that impact food prices in specific scenarios (such as the impact of a war, economic sanctions, or weather on local food prices). (TN CCSS Reading 2, 4)

Plant and Animal Biotechnology

22) Examine the role and importance of genetic principles in improving plant and animal production. Summarize the important historical achievements in plant and animal biotechnology. Research current and emerging plant and animal biotechnologies and craft an argumentative essay to debate the use of biotechnology in production agriculture. Justify claims surrounding the ethical, legal, practical, and economic issues related to food production and biotechnology with evidence drawn from scientific and professional resources. (TN CCSS Reading 2, 8; TN CCSS Writing 1, 7)

Standards Alignment Notes

*References to other standards include:

- TN CCSS Reading: Tennessee Common Core State Standards for English Language Arts & Literacy in History/Social Studies, Science, and Technical Subjects; Reading Standards for Literacy in Science and Technical Subjects 6-12; Grades 9-10 Students (page 62).
    - Note: While not directly aligned to one specific standard, students that are engaging in activities outlined above should be able to also demonstrate fluency in Standards 4, 5, 6 and 10 at the conclusion of the course.
- TN CCSS Writing: Tennessee Common Core State Standards for English Language Arts & Literacy in History/Social Studies, Science, and Technical Subjects; Writing Standards for Literacy in History/Social Studies, Science, and Technical Subjects 6-12; Grades 9-10 Students (pages 64-66).
    - Note: While not directly aligned to one specific standard, students that are engaging in activities outlined above should be able to also demonstrate fluency in Standards 3, 5, 6 and 10 at the conclusion of the course.
- TN Biology I: Tennessee Science: Biology I, Standard 4
- TN Biology II: Tennessee Science: Biology II, Standards 4, 6, and 7
- TN Ecology: Tennessee Ecology, Standard 6
- TN Env. Science: Tennessee Science: Environmental Science, standards 4, 6, and 7
- AFNR: National Agriculture, Food and Natural Resources (AFNR) Career Cluster Content Standards: Students engaged in activities outlined above should be able to demonstrate fluency in Standards AS, BS and PS at the conclusion of the course.
- P21: Partnership for 21st Century Skills Framework for 21st Century Learning
    - Note: While not all standards are specifically aligned, teachers will find the framework helpful for setting expectations for student behavior in their classroom and practicing specific career readiness skills.

Principles of Plant Science and Hydroculture

Primary Career Cluster:	Agriculture, Food and Natural Resources
Consultant:	Steven Gass, (615) 532-2847, Steven.Gass@tn.gov
Course Code(s):	TBD
Prerequisite(s):	Agriscience (5957)
Credit:	1
Grade Level:	10
Graduation Requirements:	This course satisfies one of three credits required for an elective focus when taken in conjunction with other Agriculture courses.
Programs of Study and Sequence:	This is the second course in the *Horticulture Science* program of study.
Necessary Equipment:	Please see Teacher Resources link below.
Aligned Student Organization(s):	FFA: www.tnffa.org Allie Ellis, (615) 253-5207, Allie.Ellis@tn.gov
Coordinating Work-Based Learning:	All Agriculture students are encouraged to participate in a Supervisied Agricultural Experience (SAE) program. In addition, if a teacher has completed work-based learning (WBL) training, he or she can offer appropriate student WBL opportunities. To learn more, please visit http://tennessee.gov/education/cte/wb/.
Available Student Industry Certifications:	Worker Protection Standard (WPS) for Agricultural Pesticides
Dual Credit or Dual Enrollment Opportunities:	There are no known dual credit/dual enrollment opportunities for this course. If interested in developing, reach out to a local postsecondary institution to establish an articulation agreement.
Teacher Endorsement(s):	048, 448
Required Teacher Certifications/Training:	Teachers are required to receive a Commerical Pesticide Applicators License C10 and C15 prior to teaching this course.
Teacher Resources:	www.tn.gov/education/cte/AgricultureFoodNaturalResources.shtml

Course Description

Principles of Plant Science and Hydroculture focuses on essential knowledge and skills related to the science of plant growth. This course covers principles of plant health, growth, reproduction, and biotechnology, as well as fundamental principles of hydroponics and aquaponics. Standards in this course are aligned with Tennessee Common Core State Standards for English Language Arts & Literacy in Technical Subjects, Tennessee Biology I standards, Tennessee Biology II standards, Tennessee Ecology

standards, and Tennessee Environmental Science standards, and National Agriculture, Food and Natural Resources Career Cluster Content Standards.*

Program of Study Application

This course is the second course in the *Horticulture Science* program of study. For more information on the benefits and requirements of implementing this program in full, please visist the Agriculture, Food, and Natural Resources website at www.tn.gov/education/cte/AgricultureFoodNaturalResources.shtml.

Course Standards

Safety

1) Differentiate general occupational safety prevention and control standards as related to the plant science and hydroculture industry. Apply concepts of safety procedures to complete safety test with 100 percent accuracy. Obtain the worker protection standards student industry certification. (TN CCSS Reading 3)

Plants, Society, and the Environment

2) Investigate the roles of cultivated plants in meeting the food, fiber, fuel, medicinal, aesthetic, and occupational needs of society. Identify and describe, in an informative text, the different domains of the horticulture industry, and examine current issues and trends affecting professionals in the field. Cite specific textual evidence from government publications and news media. (TN CCSS Reading 1; TN CCSS Writing 2, 7, 8)

3) Summarize the impact and patterns of environmental factors on plant biodiversity by examining research from academic journals, news articles, and government publications. Describe important characteristics of the relationships between plants and other organisms, including basic plant-human interactions, plant-animal interactions, and plant adaptation. (TN CCSS Reading 2; TN CCSS Writing 4; TN Biology I 2, 5; TN Biology II 2, 5; TN Ecology 6; TN Env. Science 2)

Principles of Soil Science

4) Evaluate, citing specific textual evidence, the physical and chemical properties of soils in an informative text. Perform technical procedures to classify soils by evaluating biotic and abiotic factors such as soil pH, texture, permeability, and water holding capacity. Interpret test results to identity deficiencies and formulate appropriate corrective actions. (TN CCSS Reading 3)

5) Describing factors that influence soil quality and erosion. Assess the extent to which reasoning and evidence presented in news articles or case studies support the use of a specific soil conservation practice for maintaining healthy growing media for plants. (TN CCSS Reading 8; TN CCSS Writing 2, 7)

6) Cite specific textual evidence for the analysis of land selection and conservation practices that ensure optimal productivity and stewardship. Identify factors that affect site selection for plant

growth and draw evidence from multiple authoritative sources to appraise and justify management practices that ensure appropriate use of land resources. (TN CCSS Reading 1, 8; TN CCSS Writing 9; TN Ecology 6; TN Env. Science 4)

Plant Structure and Function

7) Integrate print and digital sources to create a model depicting the parts of plant cells. Examine the structure and outline the functions of plant cell organelles. (TN CCSS Reading 2, 7; TN Biology I 1; TN Biology II 1, 7)

8) Analyze plant anatomy and physiology and relate key concepts to the processes and requirements involved in plant growth and productivity. (TN Biology II 6, 7)

Plant Nutrition

9) Analyze the nutrient requirements of plants and assess the importance of essential plant nutrients to plant growth and development. Use visual representations to illustrate the chemical and biological processes, including photosynthesis, that make nutrients available to plants for growth and maintenance. (TN CCSS Writing 4, 9; TN Biology II 7)

10) Justify the use of fertilizers as a source of essential plant nutrients. Calculate fertilizer formulations perform different methods of fertilizer application. (TN CCSS Reading 1, 3))

11) Research the nutritional factors that influence plant health to identify nutritional deficiencies and disorders. Compile observations to distinguish between the signs of nutrient deficiency in plants and defend recommendations for appropriate treatments. (TN Biology II 7)

Plant Diseases and Pests

12) Research the principles of disease and pest control to plant health, growth, and maintenance. Analyze the effects of different types of plant pests and diseases; prescribe methods for pest and disease prevention and treatment. (TN CCSS Reading 2)

13) Demonstrate understanding of common classes of chemicals used for pest management. Gather and evaluate information regarding PPE (Personal Protective Equipment) for chemical application and demonstrate appropriate use of PPE. Create a checklist for safe storage and handling of pesticides. (TN CCSS Reading 3; TN CCSS Writing 4)

Plant Breeding and Genetics

14) Analyze the reproductive structures in plants and describe how they function in both sexual and asexual plant reproduction. (TN Biology II 7)

15) Investigate the role of DNA, heritability, and genetic applications in plant breeding and compose an informative essay that describes how mutation, gene flow, and adaption influence plant populations. Identify desirable traits in various plant species and predict the probable outcome of genetic crosses based on Mendel's laws. (TN CCSS Reading 3; TN CCSS Writing 2, 7; TN Biology I 4; TN Biology II 4)

Plant Biotechnology

16) Distinguish the branches of science that influence plant biotechnology and summarize important historical achievements. Examine the role and importance of genetic principles to improving plant characteristics and perform basic plant DNA extraction procedures. (TN CCSS Reading 2, 3; TN CCSS Writing 4; TN Biology I 4; TN Biology II 4)

17) Research current and emerging plant biotechnologies and construct an argumentative essay to support a claim supporting or opposing the use of a specific biotechnology in horticulture. Justify and debate ethical, legal, and economic issues surrounding plant biotechnology. (TN CCSS Reading 2, 8; TN CCSS Writing 1, 7)

Fundamentals of Hydroponics and Aquaponics

18) Evaluate the significance of hydroponics and aquaponics technology as related to sustainable practices and principles. Compare and contrast production systems and techniques utilized in the hydroponics and aquaponics fields, including structures and equipment, production methods, and common crops. (TN Ecology 6; TN Env. Science 7)

19) Assess the functions, attributes, and desirable properties of soilless growing media. Write an informative essay to describe the major components of soilless media, identifying basic physical and chemical characteristics. (TN CCSS Reading 9; TN CCSS Writing 2)

20) Apply concepts learned in this course to visually identify common plant and animal species used for hydroponic and aquaponic production, and distinguish between their structural and physiological differences, as well as their specific production applications. (TN CCSS Reading 3; TN Biology II 6)

21) Examine the role that water chemistry plays in the development of water quality for plant production. Demonstrate the ability to perform common tests to evaluate water quality factors including pH, hardness, ammonium, nitrate, nitrite, dissolved oxygen, and ammonia levels. (TN CCSS Reading 3)

22) Analyze the effects of environmental conditions on aquatic plant and animal life. Adjust water quality factors by using quantitative reasoning and appropriate units to calculate proper formulations of chemicals based upon label directions. (TN CCSS Reading 3; TN Biology I 2, TN Biology II 2)

Standards Alignment Notes

*References to other standards include:

- TN CCSS Reading: Tennessee Common Core State Standards for English Language Arts & Literacy in History/Social Studies, Science, and Technical Subjects; Reading Standards for Literacy in Science and Technical Subjects 6-12; Grades 9-10 Students (page 62).

    - Note: While not directly aligned to one specific standard, students that are engaging in activities outlined above should be able to also demonstrate fluency in Standard s 5, 6, and 10 at the conclusion of the course.
- TN CCSS Writing: Tennessee Common Core State Standards for English Language Arts & Literacy in History/Social Studies, Science, and Technical Subjects; Writing Standards for Literacy in History/Social Studies, Science, and Technical Subjects 6-12; Grades 9-10 Students (pages 64-66).
    - Note: While not directly aligned to one specific standard, students that are engaging in activities outlined above should be able to also demonstrate fluency in Standards 5, 6, and 10 at the conclusion of the course.
- TN Biology I: Tennessee Science: Biology I, standards 1, 2, 3, 4.
- TN Biology II: Tennessee Science: Biology II, standards 1, 2, 4, 5, 6, 7.
- TN Ecology: Tennessee Science: Ecology, standard 6.
- TN Env. Science: Tennessee Science: Environmental Science, standards 2, 4, 7.
- AFNR: National Agriculture, Food and Natural Resources (AFNR) Career Cluster Content Standards: Students engaged in activities outlined above should be able to demonstrate fluency in Standards BS and PS at the conclusion of the course.
- P21: Partnership for 21st Century Skills Framework for 21st Century Learning
    - Note: While not all standards are specifically aligned, teachers will find the framework helpful for setting expectations for student behavior in their classroom and practicing specific career readiness skills.

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Small Animal Science

Primary Career Cluster:	Agriculture, Food and Natural Resources
Consultant:	Steven Gass, (615) 532-2847, Steven.Gass@tn.gov
Course Code(s):	TBD
Prerequisite(s):	Agriscience(5957)
Credit:	1
Grade Level:	10
Graduation Requirements:	This course satisfies one of three credits required for an elective focus when taken in conjunction with other Agriculture courses.
Programs of Study and Sequence:	This is the second course in the *Veterinary and Animal Sciences* program of study.
Necessary Equipment:	
Aligned Student Organization(s):	FFA: www.tnffa.org Allie Ellis, (615) 253-5207, Allie.Ellis@tn.gov
Coordinating Work-Based Learning:	All Agriculture students are encouraged to participate in a Supervisied Agricultural Experience (SAE) program. In addition, if a teacher has completed work-based learning (WBL) training, he or she can offer appropriate student WBL opportunities. To learn more, please visit http://tennessee.gov/education/cte/wb/.
Available Student Industry Certifications:	None
Dual Credit or Dual Enrollment Opportunities:	There are no known dual credit/dual enrollment opportunities for this course. If interested in developing, reach out to a local postsecondary institution to establish an articulation agreement.
Teacher Endorsement(s):	048, 448
Required Teacher Certifications/Training:	None
Teacher Resources:	www.tn.gov/education/cte/AgricultureFoodNaturalResources.shtml

Course Description

Small Animal Science is an applied course in animal science and care for students interested in learning more about becoming a veterinarian, vet tech, vet assistant, or pursuing a variety of scientific, health, or agriculture professions. This course covers anatomy and physiological systems of different groups of small animals, as well as careers, leadership, and history of the industry. Standards in this course are aligned with Tennessee Common Core State Standards for English Language Arts & Literacy in Technical Subjects, Tennessee Biology I standards, Tennessee Biology II standards, Tennessee Anatomy and Physiology standards, as well as National Agriculture, Food and Natural Resources Career Cluster Content Standards.*

Program of Study Application

This course is the second course in the *Veterinary and Animal Sciences* programs of study. For more information on the benefits and requirements of implementing this program in full, visist the Agriculture, Food, and Natural Resoruces website at: www.tn.gov/education/cte/AgricultureFoodNaturalResources.shtml.

Course Standards

History of Domestication

1. Synthesize research on the history of small animal domestication to produce an informative essay, including defining and applying industry-specific terminology to classify animals in the correct taxonomy. Justify the historical uses and roles of domesticated animals, and compare historical processes of small animal domestication. (TN CCSS Reading 1, 2, 4; TN CCSS Writing 2, 4, 9)

Economic, Occupational, and Technological Implications

2. Determine the general economic impact of the small animal industry by investigating both home and business implications of small animal domestication through governmental and news publications. (TN CCSS Reading 1; TN CCSS Writing 7)

3. Explore and compare local and regional career opportunities in the small animal industry. Describe in a written or visual representation the knowledge, skills, and abilities necessary for a diverse range of careers in small animal sciences, citing specific textual evidence from local job postings and Tennessee labor data. (TN CCSS Reading 1; TN CCSS Writing 2, 9)

4. Examine specific technologies that have evolved within the small animal industry (such as, but not limited to, equipment, procedures, and healthcare) and evaluate the economic and societal implications of each. (TN CCSS Reading 1, 2, 4)

Personal and Occupational Health and Safety

5. Identify, research, and determine the significance of zoonotic diseases associated with small animals. Compare and contrast findings from multiple sources relating to a specific disease (including student's own experience, laboratory experiment, case studies, and scholarly journals). Justify the use of different methods of infection control in the prevention or management of a zoonotic disease and evaluate the efficacy of existing small animal biosecurity measures. (TN CCSS Reading 1, 5, 9)

6. Correctly identify and summarize laws and regulations that pertain to small animal health and safety in an explanatory text, citing specific textual evidence from state and national legislation. Describe health requirements and necessary documentation for small animal transportation and change of ownership. (TN CCSS Reading 1, 9; TN CCSS Writing 2, 4)

7. Review common laboratory safety procedures for tool and equipment operation in the small animal science laboratories, including but not limited to accident prevention and control procedures. Demonstrate the ability to follow safety and operational procedures in a lab setting and complete a safety test with 100 percent accuracy. (TN CCSS Reading 3)

8. Demonstrate in a live setting or in a presentation the ability to follow procedures precisely, attending to special cases or exceptions noted in appropriate materials, and apply them to the following areas:
    a. Animal restraint and handling
    b. Techniques for transportation
    c. Appropriate use of chemicals (such as pesticide, fungicide, disinfectants)

    Differentiate between effective methods for handling small animals and methods proven to be less effective. (TN CCSS Reading 3)

Responsible Pet Ownership

9. Research and prepare informational resources for potential pet owners (such as fact sheets, brochures, posters, or presentations) that present the benefits and responsibilities of pet ownership, including listing important factors to consider when choosing a pet, comparing and contrasting available sources for obtaining a pet, identifying and summarizing common laws governing pet ownership, and investigating the societal and economic issues that may impact pet owners. (TN CCSS Reading 1, 7, 9; TN CCSS Writing 4, 6, 8, 9)

10. Drawing from multiple sources on small animal management practices, craft an argumentative essay that contrasts the characteristics of responsible pet ownership with ownership practices that have been shown to be negligent or inappropriate. Using supporting evidence from the research to develop claim(s) and counterclaim(s), argue why certain practices fail and others succeed. Topics may include:
    a. Training and behavior management
    b. Housing, boarding, and transporting
    c. Breeding
    d. Feeding and nurturing
    e. Management of health conditions
    f. Matching of animal type/breed and owner lifestyle (including living conditions, geographic location, and number and age of family members)

    (TN CCSS Reading 1, 9; TN CCSS Writing 1, 4, 8, 9)

Animal Ethics

11. Identify the fundamental philosophies related to animal rights and animal welfare. Compare the impact of specific persons, organizations, and legislation related to animal rights and welfare of small animals, citing specific textual evidence. (TN CCSS Reading 1, 9; TN CCSS Writing 9)

12. Investigate current small animal issues by analyzing an author's purpose and assessing the extent to which the reasoning and evidence in a specific text support the author's claim. Debate specific issues by forming and supporting claims and counterclaims with specific data and evidence. Issues related to animal rights and animal welfare may include, but are not limited to:
    a. Abuse and/or neglect

b. Illegal capture and/or trade
c. Overpopulation
d. Control of populations
e. Euthanasia
f. Exhibiting and showing
g. Global issues in small animal ethics and their relation to local problems.

(TN CCSS Reading 6, 7, 8, TN CCSS Writing 1, 9)

Nutrition and Digestive Systems

13. Create a visual representation to differentiate between ruminant and non-ruminant animals, comparing and contrasting their anatomical and physiological differences. (TN CCSS Reading 7, TN A&P 5)

14. Using information from scholarly journals or Tennessee Extension Service, research nutrient requirements of the diets of small animals and organize these into various nutrient groups. Interpret feed labeling and evaluate factors such as life stage and activity level to determine the nutritional needs and then recommend balance rations for small animals, justifying recommendations with evidence from the text. (TN CCSS Reading 1, 7; TN CCSS Writing 2, 4; TN A&P 6)

15. Distinguish among the symptoms of nutritional diseases relevant to small animals and recommend the appropriate control procedures, expressed in writing. (TN CCSS Reading 7, 9; TN CCSS Writing 2)

Genetics and Reproduction

16. Research and develop illustrative models of the major components of male and female reproductive systems in small animals and prepare a short narrative to distinguish the function of reproductive organs, endocrine glands, and hormones. Produce an explanatory essay summarizing the physiological changes that occur during reproductive phases, including the estrus cycle, fertilization, gestation, parturition and lactation. (TN CCSS Reading 7; TN CCSS Writing 2, 4; TN A&P 6)

17. Using graphic representations and descriptive text, explain how the fundamental principles of genetics, such as but not limited to concepts of inheritance and gene transfer, apply to the study of small animals. (TN Biology I 4, TN Biology II 4)

Fundamental Care and Health of Dogs and Cats

18. Synthesize research on the historical importance of dogs and cats, noting major economic, social, and medical advances impacting domestication. Produce an informational essay or model (such as a timeline, graphical illustration, or presentation) that differentiates between the defining characteristics of common dog and common cat breeds. Demonstrate conceptual understanding and technical skill in current practices of comprehensive health care and management for the following:
    a. Precisely follow effective grooming procedures and techniques to maintain healthy skin, coat, nails, eyes, and ears

b. Design appropriate facilities based on assessment of needs and present plans in a visual format
c. Identify appropriate owner/handler responses to behaviors and instincts to ensure safety of both individual and small animal in a variety of situations
d. Distinguish between clinical signs of proper health and poor health, justifying explanations with data and evidence
e. Using quantitative reasoning and appropriate units, calculate appropriate rations based on animal characteristics (age, weight, breed, activity level) and nutritional needs by creating systems of equations that describe numerical relationships
f. Illustrate the reproductive cycle graphically, and summarize available breeding methods and current reproductive technologies
g. Research common diseases and parasites and their effects on the health of dogs and cats, and draw evidence from relevant medical literature to recommend the best prevention or control measures.

(TN CCSS Reading 1, 2, 3, 7, 8, 9; TN CCSS Writing 2, 7, 8, 9)

Fundamental Care and Health of Rabbits, Guinea Pigs, Chinchillas, and Rodents

19. Synthesize research on the historical importance of rabbits, guinea pigs, chinchillas, and rodents, noting major economic, social, and medical advances impacting domestication. Produce an informational essay or model (such as a timeline, graphical illustration, or presentation) that differentiates between their defining characteristics. Demonstrate conceptual understanding and technical skill in current practices of comprehensive health care and management for the following:
    a. Precisely follow effective grooming procedures and techniques to maintain healthy skin, coat, nails, eyes, and ears
    b. Design appropriate facilities based on assessment of needs and present plans in a visual format
    c. Identify appropriate owner/handler responses to behaviors and instincts to ensure safety of both individual and small animal in a variety of situations
    d. Distinguish between clinical signs of proper health and poor health, justifying explanations with data and evidence
    e. Using quantitative reasoning and appropriate units, calculate appropriate rations based on animal characteristics (age, weight, breed, activity level) and nutritional needs by creating systems of equations that describe numerical relationships
    f. Illustrate the reproductive cycle graphically, and summarize available breeding methods and current reproductive technologies
    g. Research common diseases and parasites and their effects on the health of rabbits, guinea pigs, chinchillas, and rodents, and draw evidence from the most recent medical literature to recommend the best prevention or control measures.

    (TN CCSS Reading 1, 2, 3, 7, 8, 9; TN CCSS Writing 2, 7, 8, 9)

Fundamental Care and Health of Avians, Fish, Amphibians, and Reptiles

20. Synthesize research on the historical importance of avians, fish, amphibians, and reptiles, noting major economic, social, and medical advances impacting domestication. Produce an informational essay or model (such as a timeline, graphical illustration, or presentation) that differentiates between their defining characteristics. Demonstrate conceptual understanding

and technical skill in current practices of comprehensive health care and management for the following:

a. Precisely follow effective grooming procedures and techniques for applicable species
b. Design appropriate facilities based on assessment of needs and present plans in a visual format
c. Identify appropriate owner/handler responses to behaviors and instincts to ensure safety of both individual and small animal in a variety of situations
d. Distinguish between clinical signs of proper health and poor health, justifying explanations with data and evidence
e. Using quantitative reasoning and appropriate units, calculate appropriate rations based on animal characteristics (age, weight, breed, activity level) and nutritional needs by creating systems of equations that describe numerical relationships.
f. Illustrate the reproductive cycle graphically, and summarize available breeding methods and current reproductive technologies
g. Research common diseases and parasites and their effects on the health of birds, fish, amphibians, and reptiles, and draw evidence from the most recent medical literature to recommend the best prevention or control measures.

(TN CCSS Reading 1, 2, 3, 7, 8, 9; TN CCSS Writing 2, 7, 8, 9)

Standards Alignment Notes

*References to other standards include:

- TN CCSS Reading: Tennessee Common Core State Standards for English Language Arts & Literacy in History/Social Studies, Science, and Technical Subjects; Reading Standards for Literacy in Science and Technical Subjects 6-12; Grades 9-10 Students (page 62).
    - Note: While not directly aligned to one specific standard, students that are engaging in activities outlined above should be able to also demonstrate fluency in Standard 10 at the conclusion of the course.
- TN CCSS Writing: Tennessee Common Core State Standards for English Language Arts & Literacy in History/Social Studies, Science, and Technical Subjects; Writing Standards for Literacy in History/Social Studies, Science, and Technical Subjects 6-12; Grades 9-10 Students (pages 64-66).
    - Note: While not directly aligned to one specific standard, students that are engaging in activities outlined above should be able to also demonstrate fluency in Standards 5 and 10 at the conclusion of the course.
- TN Biology I: Tennessee Science: Biology I, standard 4.
- TN Biology II: Tennessee Science: Biology II, standard 4
- TN A&P: Tennessee Science: Anatomy and Physiology, standards 5 and 6.
- AFNR: National Agriculture, Food and Natural Resources (AFNR) Career Cluster Content Standards: Students engaged in activities outlined above should be able to demonstrate fluency in Standards AS at the conclusion of the course.
- P21: Partnership for 21st Century Skills Framework for 21st Century Learning
    - Note: While not all standards are specifically aligned, teachers will find the framework helpful for setting expectations for student behavior in their classroom and practicing specific career readiness skills.

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Supervised Agricultural Experience (SAE)

Primary Career Cluster:	Agriculture, Food and Natural Resources
Consultant:	Steven Gass, (615) 532-2847, Steven.Gass@tn.gov
Course Code(s):	5964
Prerequisite(s):	None
Credit:	½ credit each year, up to a maximum of 2 credits
Grade Level:	9-12
Graduation Requirements:	This course satisfies ½ credit of three credits required for an elective focus when taken in conjunction with other agriculture courses.
Programs of Study and Sequence:	This course can be used to supplement all Agriculture, Food and Natural Resources programs of study and is designed to evolve with a student through high school.
Necessary Equipment:	Dependent on student project
Aligned Student Organization(s):	FFA: www.tnffa.org Allie Ellis, (615) 253-5207, Allie.Ellis@tn.gov
Coordinating Work-Based Learning:	All AFNR students are encouraged to participate in a Supervisied Agricultural Experience (SAE) program.
Available Student Industry Certifications:	None
Dual Credit or Dual Enrollment Opportunities:	There are no dual credit/dual enrollment opportunities for this course.
Teacher Endorsement(s):	048, 448
Required Teacher Certifications/Training:	None
Teacher Resources:	www.tn.gov/education/cte/AgricultureFoodNaturalResources.shtml

Course Description

A *Supervised Agricultural Experience* (SAE) is a structured experiential learning opportunity that takes place in a setting outside of regular school hours. Individual LEAs can choose whether or not to offer credit, provided participating students demonstrate mastery of the standards outlined below. SAEs allow students to experience the diversity of agriculture and natural resources industries and to gain exposure to agricultural-related career pathways. SAEs require a documented formal project scope, accurate recordkeeping, and student advisor supervision. The following SAE standards align to the overarching framework of the Tennessee Common Core State Standards for English Language Arts & Literacy in Technical Subjects, the National Agriculture, Food, and Natural Resources (AFNR) Career

Cluster Content Standards, and the Partnership for 21st Century Skills Framework for 21st Century Learning.*

Program of Study Application

This course can be used to supplement all AFNR programs of study. For more information on the benefits and requirements of implementing these programs in full, please visit the Agriculture, Food, and Natural Resources website at www.tn.gov/education/cte/AgricultureFoodNaturalResources.shtml.

Course Standards

Principles of Supervised Agricultural Experience (SAE) Programs

1) Examine the general philosophy and objectives of SAE programs. Identify and describe the types of SAEs, their applications, and benefits. Types of offerings include:
    a. **Exploratory**: Learn about the big picture of agriculture and its many related careers
    b. **Research/Experimentation and Analysis**: Conduct research and analyze information to discover new knowledge
    c. **Ownership/Entrepreneurship:** Plan and operate an agriculture-related business
    d. **Work-Based Learning (WBL) Placement**: Work (paid or unpaid) for a business or individual

2) Choose a specific project or WBL placement to build knowledge and skills in a particular agriculture area. Articulate how the knowledge and skills learned in a specific SAE program will benefit preparation for agriculture- and natural resources-related careers. Conduct at least 180 hours of research, work, or activities related to the chosen SAE project.

Project Management and Recordkeeping Skills

3) Formulate annual SMART goals for the SAE project or placement and apply the concepts of project planning to monitor and evaluate SAE progress.

4) Accurately maintain a prescribed recordkeeping system and apply proper financial recordkeeping skills as required by the specific project.

Personal and Career Growth

5) Develop personal SMART goals and conduct activities (such as updating a professional resume or joining a professional organization) to work toward individual and career development.

6) Explore and compare local and regional career opportunities from multiple sources such as the United States Bureau for Labor Statistics and the Tennessee Department of Labor and Workforce Development. Identify and develop knowledge and technical skills necessary for selected careers by linking specific attributes to development activities outlined in SAE SMART goals.

Leadership Skills

7) Examine the leadership skills needed for careers in agriculture and natural resources industries and engage youth leadership opportunities to practice and develop effective leadership skills, such as teamwork, decision making, problem solving, critical thinking, and time management.

8) Demonstrate a working knowledge of parliamentary procedure. When appropriate, conduct meetings and facilitate discussions in accordance with Robert's Rules of Order.

Interpersonal and Communication Skills

9) Demonstrate positive interpersonal skills to work effectively with others and maintain successful professional relationships.

10) Demonstrate the ability to communicate effectively with diverse groups and individuals. Compare and contrast elements of formal and informal communication, and demonstrate appropriate written, verbal, and nonverbal communication skills.

11) Develop public speaking skills by planning, preparing, revising, and delivering public presentations about the results and overall impact of the SAE project at local science/agricultural fairs, school activities, and/or participation in career development events.

Occupational Safety

12) Interpret general occupational health and safety standards. Demonstrate appropriate health and safety procedures for agriculture and natural resources activities aligned with SAE project.

Occupational Ethics

13) Identify and discuss occupational ethics, legal responsibilities, and regulatory compliance issues in relation to specific activities and/or careers aligned with SAE project.

Information Literacy

14) Use a variety of methods to assemble and evaluate information for the purposes of technical research, scientific inquiry, and investigation.

Standards Alignment Notes

*References to other standards include:

- TN CCSS Reading: Tennessee Common Core State Standards for English Language Arts & Literacy in History/Social Studies, Science, and Technical Subjects; Reading Standards for Literacy in Science and Technical Subjects 6-12; as appropriate to grade level (page 62).
    - Note: While not directly aligned to specific standards, students that are engaging in activities outlined above should be encouraged by their agriculture instructor to follow expectations for their grade level for reading and comprehending informational texts.
- TN CCSS Writing: Tennessee Common Core State Standards for English Language Arts & Literacy in History/Social Studies, Science, and Technical Subjects; Writing Standards for Literacy in History/Social Studies, Science, and Technical Subjects 6-12; as appropriate to grade level (pages 64-66).
    - Note: While not directly aligned to the specific standards, students that are engaging in activities outlined above should be encouraged by their agriculture instructor to follow expectations for their grade level for research and production of discipline-specific formal writing products.
- AFNR: National Agriculture, Food and Natural Resources (AFNR) Career Cluster Content Standards: Students engaged in activities outlined above should be able to demonstrate fluency in Standards CS.01, CS.02, CS.03, CS.07, CS.09, CS.10, and CS.11 at the grade appropriate level.
- P21: Partnership for 21st Century Skills Framework for 21st Century Learning: Students engaged in activities outlined above should be able to demonstrate fluency in 21st Century Themes, Learning and Innovation Skills, Information and Media Technology Skills, and Life and Career Skills.

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Veterinary Science

Primary Career Cluster:	Agriculture, Food and Natural Resources
Consultant:	Steven Gass, (615) 532-2847, Steven.Gass@tn.gov
Course Code(s):	TBD
Prerequisite(s):	Agriscience (5957)
Credit:	1
Grade Level:	12
Graduation Requirements:	This course satisfies one of three credits required for an elective focus when taken in conjunction with other Agriculture courses.
Programs of Study and Sequence:	This is the fourth, and final, course in the *Veterinary and Animal Science* program of study.
Necessary Equipment:	
Aligned Student Organization(s):	FFA: www.tnffa.org Allie Ellis, (615) 253-5207, Allie.Ellis@tn.gov
Coordinating Work-Based Learning:	All Agriculture students are encouraged to participate in a Supervisied Agricultural Experience (SAE) program. In addition, if a teacher has completed work-based learning (WBL) training, he or she can offer appropriate student WBL opportunities. To learn more, please visit http://tennessee.gov/education/cte/wb/.
Available Student Industry Certifications:	None
Dual Credit or Dual Enrollment Opportunities:	Dual Credit/Dual Enrollment options currently exist at University of Tennessee Martin, Tennessee Tech University, and Volunteer State Community College.
Teacher Endorsement(s):	048, 448
Required Teacher Certifications/Training:	None
Teacher Resources:	www.tn.gov/education/cte/AgricultureFoodNaturalResources.shtml

Course Description

Veterinary Science is an advanced course in animal science and care for students interested in learning more about becoming a veterinarian, vet tech, vet assistant, or pursuing a variety of scientific, health, or agriculture professions. This course covers principles of health and disease, basic animal care and nursing, clinical and laboratory procedures, and additional industry-related career and leadership knowledge and skills. Standards in this course are aligned with Tennessee Common Core State Standards for English Language Arts & Literacy in Technical Subjects, Tennessee Anatomy and Physiology, Tennessee Biology I, and Tennessee Biology II standards, as well as National Agriculture, Food and Natural Resourses Career Cluster Content Standards.*

Program of Study Application

This course is the fourth, and final, course in *Veterinary and Animal Sciences* program of study. For more information on the benefits and requirements of implementing this program in full, please visit the Agriculture, Food, and Natural Resources website at www.tn.gov/education/cte/AgricultureFoodNaturalResources.shtml.

Course Standards

Economic, Occupational, and Technological Implications

1. Explore and compare local and regional career opportunities in the veterinary science industry using information from local job postings and Tennessee labor data. Describe in a written or visual representation the knowledge, skills, and abilities necessary for a selected occupation in veterinary science. (TN CCSS Reading 1, 2; TN CCSS Writing 4)

2. Examine specific technologies that have evolved within the veterinary science industry including but not limited to advances in equipment, procedures, and healthcare, and evaluate the economic and societal implications of each. Explain in an informative essay how these advances have impacted the veterinary science industry. (TN CCSS Writing 2, 4, 7, 8, 9)

Personal and Occupational Health and Safety

3. Compare and contrast the safety hazards associated with clinical and field settings. Review safety hazard case studies and recommend research-based practices to prevent the safety hazard in the future. (TN CCSS Reading 1, 9)

4. Review common laboratory safety procedures for tool and equipment operation in the veterinary science laboratories, including but not limited to accident prevention and control procedures. Demonstrate the ability to follow safety and operational procedures in a lab setting and complete a safety test with 100 percent accuracy. (TN CCSS Reading 3)

5. Demonstrate in a live setting or in a presentation the ability to follow procedures precisely for the following areas:
    a. Animal restraint and handling in clinical or field settings
    b. Sanitation, disinfection, and sterilization procedures to prevent transfer of zoonotic diseases
    a. Material safety data sheets (MSDS) interpretation

    (TN CCSS Reading 3)

Veterinary Law and Ethics

6. Gather and compare information from a variety of authoritative sources (such as professional associations or non-profit organizations) on the philosophical, social, moral, and ethical issues encountered in the veterinary profession. Debate their implications for practitioners of veterinary science by developing claim(s) and counterclaim(s) supported by reasoning and evidence from research. (TN CCSS Reading 1; TN CCSS Writing 1, 4, 7, 8, 9)

7. Citing specific textual evidence from legislation and news media, summarize local, state, and federal laws that regulate policies and procedures in veterinary medicine pertaining to:
    a. Animal rights and welfare
    b. Professional licensing
    c. Liability of veterinary staff
    d. U.S. Food and Drug Administration (FDA), U.S. Department of Agriculture (USDA), and U.S. Environmental Protection Agency (EPA) regulations for veterinary drugs and biologicals
    e. Occupational Safety and Health Administration (OSHA) regulations for workplace safety

    (TN CCSS Reading 1, 2; TN CCSS Writing 7, 9)

Clinical Anatomy and Physiology

8. Identify common clinical terminology, abbreviations, and symbols relating to the diagnosis, pathology, and treatment of animals. (TN CCSS Reading 4)

9. Recognize various states of cellular homeostasis to identify infections, diseases, and mutations. (TN Biology I 1; TN Biology II 1)

10. Review fundamental concepts pertaining to tissue and organ systems by comparing and contrasting the structure and function of different tissue types, including epithelial, connective, muscle, and nervous tissues. Summarize in written or presentation format how cellular differentiation allows for specialized tissue development. (TN CCSS Writing 2, 4; TN Biology I 1; TN Biology II 1)

11. Identify and research the major body systems, including skeletal, muscular, respiratory, digestive, nervous, integumentary, urinary, and reproductive system. Develop models to compare and contrast between different species of small and large domesticated animals.(TN CCSS Reading 7; TN A&P 1, 2, 5, 6)

Clinical Nutrition

12. Perform nutritional assessment techniques, including body condition scoring and life stage to determine the nutritional status of animals. Apply this information to recommend balanced rations, providing written and oral justification to support recommendations. (TN CCSS Reading 1, 3, 9; TN CCSS Writing 2)

13. Research the relationships of diseases and disorders to digestion, absorption, and metabolic processes using case studies, instructional materials, and scholarly journals. Assess the impact of various diseases and disorders on the maintenance of optimum nutrition levels in the body. (TN CCSS Reading 1, 2, 5, 9)

Clinical Procedures

14. Correctly identify and describe the function of common equipment used in the clinical area of a veterinary practice, including but not limited to examination tools, radiology equipment, ultrasound equipment, surgical equipment and testing equipment. Develop a checklist including

safe use and maintenance for specific equipment. (TN CCSS Reading 2, 9; TN CCSS Writing 4, 8, 9)

15. Demonstrate, in a live setting or in a presentation, physical examination procedures in the following areas:
    a. Identification of exam purpose, importance, and routine tasks
    b. Completion of new client health history report
    c. Identification and evaluation of factors affecting the physiological state of animals
    d. Identification of characteristics and signs of healthy animals
    e. Demonstration of procedures to accurately obtain and record vital signs
    f. Identification and evaluation of effects of age, stress, and environmental factors on vital signs

    (TN CCSS Reading 3)

16. Identify and recommend the optimum timeline for administering different types of vaccines suitable for different species. Demonstrate, in a live setting or in a presentation, the ability to:
    a. Identify injection methods
    b. Identify appropriate anatomical injection sites
    c. Administer the injection, including the selection of appropriate equipment
    (TN CCSS Reading 3, 7, 9; TN CCSS Writing 2)

17. Explain the importance of contamination prevention as related to the veterinary industry. Demonstrate, in a live setting or in a presentation, the ability to explain and follow contamination control procedures relating to the following areas:
    a. Principles of sanitation, disinfection, antiseptics, and sterilization
    b. Exam room care and sanitation procedures
    c. Classification of sterilants, antiseptics, disinfectants, and their appropriate applications
    d. Hazardous waste management
    e. Proper techniques to fill a syringe for a prescribed dosage

    (TN CCSS Reading 1, 3, 7, 9)

Animal Nursing

18. Design a plan of care by interpreting patient records and treatment plans, and perform basic nursing and patient monitoring tasks. (TN CCSS Writing 2, 4, 9)

19. Outline basic first aid, wound care, and bandaging procedures and compare the different procedures in relation to small and large animals. Demonstrate, in a live setting or in a presentation, the ability to follow these procedures precisely, while distinguishing between small and large animals for the following areas:
    a. Canine cardiopulmonary resuscitation (CPR) procedures
    b. Assessment and care of common physical injuries such as cuts, abrasions, and contusions
    c. Wound therapies at different phases of healing
    d. Types and purposes of bandages, splints, slings, and casts, and indications for use
    e. Techniques for application and removal of bandages

    (TN CCSS Reading 3)

20. Research and explain laws and regulations related to the administration of prescription and over-the-counter medication within the veterinary industry to develop a customer fact sheet for common medicines, citing specific text from legislation. Demonstrate, in a live setting or in a presentation, the ability to follow medication administration procedures precisely, including:
    a. Identification of common medications and their required storage, handling, and disposal
    b. Demonstration of administration techniques for topical and oral medications
    c. Interpretation of medication label and packaging information
    d. Calculate proper dosages of medications based upon label directions

    (TN CCSS Reading 2, 3; TN CCSS Writing 2, 4, 7, 9)

Laboratory Procedures

21. Compare and contrast appropriate laboratory quality control procedures such as the proper collection, preparation, handling, and storage of biological samples, and describe their effects on obtaining accurate data from laboratory procedures. (TN CCSS Reading 8, 9; Writing 2, 7, 9)

22. Develop a procedural check sheet to aid in conducting veterinary clinical hematology procedures such as complete blood count (CBC). Using the check sheet, demonstrate, in a live setting or in a presentation, the ability to follow clinical hematology procedures precisely in relation to the following areas:
    a. Sample collection, preparation, and storage
    b. Microscopic examination to identify blood cells
    c. Interpretation of normal and abnormal results

    (TN CCSS Reading 3, 7, 8)

23. Explain and justify the need for conducting urinalysis and fecal analysis as related to animal health. Outline procedures for conducting clinical urinalysis to include the following:
    a. Sample collection, preparation, and storage
    b. Physical, chemical, and microscopic examination procedures
    c. Interpretation of normal and abnormal results

    (TN CCSS Reading 3)

Principles of Disease

24. Compare and contrast the role of the USDA, state veterinarians, state animal disease laws, and diagnostic labs in disease prevention and control. Explain the classification of diseases and disease processes, and identify causative factors and agents of disease in a graphical illustration or written analysis. (TN CCSS Reading 7, 9; TN CCSS Writing 2, 9)

25. Explain how diseases affect the body and differentiate between clinical signs and symptoms of disease. Identify and describe the differences between clinical signs and symptoms of proper health and poor health. (TN CCSS Writing 2, 7, 9; TN CCSS Writing 2, 4, 7, 9)

26. Identify symptoms of common animal diseases and their causative agents, and summarize methods of prevention, treatment, and control by drawing evidence from informational texts or recent medical literature. (TN CCSS Reading 2, 7, 8, 9; TN CCSS Writing 2, 7, 9)

27. Describe the clinical signs of an animal with a parasite infection. Compare and contrast the symptoms of common internal and external parasite infections and summarize methods of prevention, treatment, and control between small and large animals. (TN CCSS Writing 2, 9)

Clinic Management

28. Demonstrate effective oral and written communication skills needed in clinical settings, including but not limited to client greeting, telephone answering, appointment scheduling and management, and admission and discharge procedures. Outline the procedures for euthanasia and post mortem customer care and role-play appropriate grief counseling services for clients. (TN CCSS Reading 2, 7, 9; Writing 2, 4)

29. Identify the types of medical records required in veterinary practices. Explain, justify, and demonstrate correct procedures for the completion and filing of veterinary records and related documentation in a professional and legal manner. (TN CCSS Reading 1, 7, 9; TN CCSS Writing 2, 9)

Standards Alignment Notes

*References to other standards include:

- TN CCSS Reading: Tennessee Common Core State Standards for English Language Arts & Literacy in History/Social Studies, Science, and Technical Subjects; Reading Standards for Literacy in Science and Technical Subjects 6-12; Grades 9-10 Students (page 62).
    - Note: While not directly aligned to one specific standard, students that are engaging in activities outlined above should be able to also demonstrate fluency in Standards 6 and 10 at the conclusion of the course.
- TN CCSS Writing: Tennessee Common Core State Standards for English Language Arts & Literacy in History/Social Studies, Science, and Technical Subjects; Writing Standards for Literacy in History/Social Studies, Science, and Technical Subjects 6-12; Grades 9-10 Students (pages 64-66).
    - Note: While not directly aligned to one specific standard, students that are engaging in activities outlined above should be able to also demonstrate fluency in Standards 5, 6, and 10 at the conclusion of the course.
- TN A&P: Tennessee Science: Anatomy and Physiology standards 1, 2, 5, 6.
- TN Biology I: Tennessee Science: Biology I, standard 1.
- TN Biology II: Tennessee Science: Biology II: standard 1.
- AFNR: National Agriculture, Food and Natural Resources (AFNR) Career Cluster Content Standards: Students engaged in activities outlined above should be able to demonstrate fluency in Standards AS.01, AS.02, AS.03, AS.04, AS.06 at the conclusion of the course.
- P21: Partnership for 21st Century Skills Framework for 21st Century Learning
    - Note: While not all standards are specifically aligned, teachers will find the framework helpful for setting expectations for student behavior in their classroom and practicing specific career readiness skills.