Maryland
STATE DEPARTMENT OF EDUCATION

Program of Study Guide: Horticulture Science - DRAFT

Comprehensive guidelines and course standards for the Plant Systems pathway

Office of College and Career Pathways

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MARYLAND STATE DEPARTMENT OF EDUCATION

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Purpose

The purpose of this document is to communicate the required Career and Technical Education (CTE) academic standards for the Horticulture Science Program of Study. The academic standards in this document are theoretical and performance based. The academic standards in this document are theoretical and performance based. The standards contain content from multiple state departments of education, the College Board, the Maryland Nursery, Landscaping, and Greenhouse Association, and the Maryland Department of Agriculture. They have been reviewed and vetted by members of the Maryland business and industry community.

In addition to academic standards, the Maryland State Department of Education (MSDE) has incorporated into this document Labor Market Information (LMI) definitions and explanations for the Program of Study; program aligned Industry Recognized Credentials; and Work-Based Learning resources and requirements by course level.

This document is intended for use by educational administrators and practitioners. A similar document is available for each state-approved CTE Program of Study.

Sources of Standards

The development of the Horticulture Science I-III course standards is informed by several authoritative sources that provide comprehensive guidelines and frameworks for horticulture science education. These sources collectively provide a robust foundation for developing comprehensive and industry-aligned standards for the Horticulture Science courses, ensuring that students acquire the necessary skills and knowledge to succeed in the field of horticulture sciences.

Below is a list of these sources, along with descriptions, their applications in course development, and corresponding web links:

1. **Advance CTE's Agriculture, Food & Natural Resources (AFNR) Career Cluster**
   A. **Description:** The AFNR Career Cluster, developed by Advance CTE, outlines essential knowledge and skills for students pursuing careers in agriculture-related fields, including horticulture, agronomy, soil science, and integrated pest management. It serves as a national framework that guides educators in aligning curriculum with industry standards.
   B. **Usage:** The AFNR framework informs the development of horticulture course standards, ensuring that instruction meets industry-recognized competencies and prepares students for a wide range of careers within the agricultural sector.
   C. **Source:** Advance CTE Agriculture, Food & Natural Resources Career Cluster

2. **Maryland Nursery, Landscape, and Greenhouse Association (MNLGA) Certified Professional Horticulturist (CPH) Program**
   A. **Description:** The MNLGA CPH program provides a recognized professional certification demonstrating mastery of horticultural knowledge, plant production, landscape management, and sustainable agricultural practices.
   B. **Usage:** Standards for the upper-level horticulture courses align with the knowledge and competencies outlined in the CPH certification criteria, setting students on a path toward eventual professional certification after acquiring required work experience.
   C. **Source:** MNLGA Certified Professional Horticulturist

3. **Maryland Department of Agriculture (MDA) Pesticide Applicator Certification Guidelines**
   A. **Description:** The MDA provides regulatory guidance, training materials, and exam requirements for Private and Commercial Pesticide Applicator Certifications, ensuring that pesticide usage is safe, effective, and environmentally compliant.
   B. **Usage:** Course standards incorporate pesticide safety, legal requirements, and calculation methods drawn from MDA guidelines to prepare students for the Private and Commercial Pesticide Applicator Certifications.
   C. **Source:** Maryland Department of Agriculture - Pesticide Regulation

4. **Occupational Safety and Health Administration (OSHA) – 10-Hour General Industry (Agriculture) Safety Training**
   A. **Description:** OSHA's 10-hour training provides foundational knowledge of workplace hazards, safety regulations, and prevention strategies specific to agriculture and related industries.
   B. **Usage:** Standards in early horticulture courses integrate OSHA safety principles to ensure students understand essential workplace safety practices, providing them with a recognized safety credential and establishing a solid safety culture.
   C. **Source:** OSHA Training

5. **National Association of Landscape Professionals (NALP) Credentials**
   A. **Description:** NALP credentials offer industry-recognized certifications and guidelines in landscaping and horticulture, reflecting current best practices in plant maintenance, installation, and management.
   B. **Usage:** Standards in advanced horticulture courses reference competencies from NALP certifications, guiding instruction in advanced technical skills and professional practices.
   C. **Source:** NALP Certifications

6. **USDA Cooperative Extension Service Resources**
   A. **Description:** The USDA Cooperative Extension Service, often administered through state universities, provides research-based information on horticulture best practices, integrated pest management (IPM), soil health, and sustainable production.
   B. **Usage:** Educators use extension materials to reinforce science-based horticultural concepts and techniques within the curriculum, ensuring that students learn from current, research-driven information.
   C. **Source:** USDA National Institute of Food and Agriculture – Extension

7. **U.S. Environmental Protection Agency (EPA) Pesticide Safety and Regulations**
   A. **Description:** The EPA offers national standards and guidance on pesticide registration, labeling, and usage to protect human health and the environment.
   B. **Usage:** Standards integrate EPA guidelines to ensure students understand the regulatory context, environmental considerations, and safety protocols required for responsible pesticide use, complementing state-level certification requirements.
   C. **Source:** EPA Pesticide Safety

8. **U.S. Green Building Council (USGBC) / SITES & LEED Certification**
   A. **Description:** The USGBC administers the LEED rating system, and SITES (Sustainable SITES Initiative) is a collaborative framework created by the Lady Bird Johnson Wildflower Center, the American Society of Landscape Architects, and USGBC. Both SITES and LEED emphasize sustainable site development, environmental stewardship, resource conservation, and green infrastructure.
   B. **Usage:** In advanced horticulture standards, students learn how SITES and LEED principles influence sustainable landscape design, construction, and management. By referencing these frameworks, the curriculum addresses site-specific practices that reduce environmental impact and meet evolving market demands for green-certified projects.
   C. **Source:** U.S. Green Building Council – SITES and LEED

9. **Pollinator Protection Programs (e.g., Xerces Society, Pollinator Partnership)**
   A. **Description:** Various organizations and coalitions (such as the Xerces Society for Invertebrate Conservation and Pollinator Partnership) offer research-based guidelines, certification programs (e.g., Bee Better Certified), and best practices to protect and enhance pollinator habitats.
   B. **Usage:** Newly added standards reference pollinator protection strategies within advanced sustainable horticultural production and IPM. By incorporating these programs, the curriculum aligns with cutting-edge ecological stewardship methods and fosters industry-relevant skills for pollinator habitat design, pesticide impact reduction, and habitat certification.
   C. **Source:** Xerces Society for Invertebrate Conservation – xerces.org and Pollinator Partnership – pollinator.org

10. Maryland Department of Agriculture (MDA) Nutrient Management Program

A. **Description:** The MDA Nutrient Management Program provides regulations, guidelines, and training for agricultural and urban nutrient management to protect water quality and promote responsible fertilizer usage. These requirements help ensure compliance with Maryland Fertilizer Laws, safeguard the Chesapeake Bay, and maintain sustainable land stewardship.
B. **Usage:** In the updated Course III standards (particularly Standard F.5), students delve deeper into Maryland Fertilizer Laws and advanced nutrient management practices. By referencing the MDA Nutrient Management Program, the curriculum ensures that learners understand state-specific regulations, record-keeping requirements, and science-based strategies for applying fertilizers responsibly – core competencies needed for the MNLGA CPH exam and professional horticultural practice.
C. **Source:** Maryland Department of Agriculture – Nutrient Management Program

11. National Phenology Network (NPN)

A. **Description:** The National Phenology Network (NPN) is a collaboration among citizen scientists, government agencies, nonprofits, and researchers that collects, analyzes, and shares data on the timing of seasonal events in plants and animals (phenology). The NPN's database and tools allow users to track degree-day accumulations and predict pest emergence more accurately.
B. **Usage:** In Course III (see Standard G.7), students learn how to apply degree-day modeling to anticipate pest and disease outbreaks. The NPN's real-time and historical data on temperature and phenological stages enables more precise scheduling of scouting and treatment, aligning with the advanced IPM strategies emphasized in the curriculum.
C. **Source:** USA National Phenology Network

12. American Society for Horticultural Science (ASHS)

A. **Description:** ASHS is a leading professional society for educators, researchers, and industry practitioners in horticulture, offering peer-reviewed journals, conferences, and a community dedicated to advancing horticultural science.
B. **Usage:** Course III introduces specialized grow lights and how varying light wavelengths affect plant growth (Standard E.2). Educators may draw on ASHS publications and resources for up-to-date research findings on controlled environment horticulture (CEH), lighting technologies, and their practical applications in advanced propagation and production.
C. **Source:** American Society for Horticultural Science

Course Descriptions

Course Level	Course Information	Description
Required Core: Course 1	Horticulture Science I SCED: <XX> Grades: 9-12 Prerequisite: None Credit: 1	Horticulture Science I introduces students to the foundational principles of plant growth, basic plant anatomy, soil health, and sustainable crop production practices. Students gain an understanding of integrated pest management (IPM) fundamentals, the importance of environmental stewardship, and industry-standard safety practices.
Required Core: Course 2	Horticulture Science II SCED: <XX> Grades: 10-12 Prerequisite: Horticulture Science I Credit: 1	Building on the foundational knowledge gained in Horticulture Science I, Horticulture Science II focuses on intermediate plant physiology, propagation techniques, soil fertility management, and more sophisticated integrated pest management strategies.
Optional Flex: Course 1	Horticulture Science III SCED: <XX> Grades: 11-12 Prerequisite: Horticulture Science I and II Credit: 1	Horticulture Science III challenges students to deepen their understanding of advanced plant breeding, biotechnology, and integrated production methods. They refine soil and nutrient management strategies, analyze complex IPM plans, and explore specialized production systems such as hydroponics and vertical farming.
Optional Flex: Course 2	Career Connected Learning I SCED: <XX> Grades: 11-12 Prerequisite: Horticulture Science I and II Credit: 1	This flexible, work-based learning course introduces students to real-world applications of classroom knowledge and technical skills through on-the-job experiences and reflective practice. Students engage in career exploration, skill development, and professional networking by participating in youth apprenticeships, registered apprenticeships, pre-apprenticeships, internships, capstone projects, or other approved career-connected opportunities. Variable credit (1–3) accommodates the required on-the-job training hours and related instruction. By integrating industry standards, employability skills, and personalized learning goals, Career Connected Learning I equips students to make informed career decisions, develop a professional portfolio, and build a strong foundation for success in postsecondary education, training, or the workforce.

Course Level	Course Information	Description
Optional Flex: Course 3	Career Connected Learning II SCED: <XX> Grades: 11-12 Prerequisite: Career Connected Learning I Credit: 1	Building on the foundational experiences of Career Connected Learning I, this advanced work-based learning course provides students with deeper on-the-job practice, leadership opportunities, and refined career exploration. Students continue to enhance their technical and professional skills, expanding their industry networks and aligning personal goals with evolving career interests. Variable credit (1–3) remains aligned with the required training hours and related instruction. Through elevated responsibilities and skill application, Career Connected Learning II prepares students to confidently transition into higher-level postsecondary programs, apprenticeships, or the workforce.

Dual Enrollment and Career Connected Learning Experiences Must be Aligned to the CTE Core.

Industry-Recognized Credentials and Work-Based Learning

Industry-Recognized Credentials – The standards in this document are aligned to the following certifications:
By the end of Horticulture Science I: OSHA 10-Hour General Industry (Agriculture) Safety Certification (Not on the IRC list) **By the end of Horticulture Science II:** OSHA-30 **Optional Credentials (via the Flex Course options):** The Maryland Nursery, Landscape, and Greenhouse Association Certified Professional Horticulturist certifications

Work-Based Learning Examples and Resources		
Horticulture Science I: Career Awareness	**Horticulture Science II: Career Preparation**	**Flex Courses: Career Preparation**
• Industry Visits • Guest Speakers • Participation in Career and Technical Student Organizations • Postsecondary Visits – Program Specific Site Tours • Mock Interviews	• All of Career Awareness plus the following: • Job Shadow • Paid and Unpaid Internships	• Paid and Unpaid Internships • Apprenticeships

*If the Commercial Pesticide Applicator certification meets with industry approval, a request will be made to have it added to the IRC list. If it does not, then the program guide will be updated to exclude its content.

Labor Market Information: Definitions and Data

Labor market information (LMI) plays a crucial role in shaping Career and Technical Education (CTE) programs by providing insights into industry demands, employment trends, and skills gaps. This data helps education leaders assess the viability of existing programs and identify opportunities for new offerings. By aligning CTE programs with real-time labor market needs, schools can better prepare students for in-demand careers and ensure that resources are effectively used to support pathways that lead to high-quality, sustainable employment.

Standard Occupational Code (SOC) and Aligned Industry:

Indicator	Definition	Pathway Labor Market Data
High Wage[1]	Those occupations that have a 25th percentile wage equal to or greater than the most recent MIT Living Wage Index for one adult in the state of Maryland, and/or leads to a position that pays at least the median hourly or annual wage for the DC-VA-MD-WV Metropolitan Statistical Area (MSA). *Note: A 25th percentile hourly wage of $24.74 or greater is required to meet this definition.*	**Standard Occupational Code:** 19-1012 Food Scientists and Technologists 19-1013 Soil and Plant Scientist **Hourly Wage/Annual Salary:**
High Skill	Those occupations located within the DC-VA-MD-WV Metropolitan Statistical Area (MSA) with the following education or training requirements: completion of an apprenticeship program; completion of an industry-recognized certification or credential; associate's degree, bachelor's degree, or higher.	**Typical Entry-Level Education:** Agricultural and food scientists need at least a bachelor's degree from an accredited postsecondary institution, although many earn advanced degrees.
In-Demand	Annual growth plus replacement, across all Maryland occupations, is 405 openings between 2024-2029.	**Annual Openings**

[1] Living Wage Calculator: https://livingwage.mit.edu/states/24

Labor Market Information Data Source

Lightcast Q4 2024 Data Set. Lightcast occupation employment data are based on final Lightcast industry data and final Lightcast staffing patterns. Wage estimates are based on Occupational Employment Statistics (QCEW and Non-QCEW Employees classes of worker) and the American Community Survey (Self-Employed and Extended Proprietors). Occupational wage estimates are also affected by county-level Lightcast earnings by industry. Foundational data for the state of Maryland is collected and reported by the Maryland Department of Labor.

Methodology for High Wage Calculations

To combine labor market data across multiple Standard Occupational Classifications (SOCs), a weighted average approach was used to ensure accurate representation of the marketplace. Median wages for each SOC were weighted based on their respective employment levels, reflecting the relative demand for each occupation. This method ensures that occupations with higher employment contribute proportionately to the overall wage calculation. Additionally, job openings from all relevant SOCs were summed to determine the total projected demand. For example, if Mechanical Engineers account for 67% of total employment and Electrical Engineers for 33%, their respective wages are weighted accordingly, and job openings are aggregated to provide a comprehensive view of labor market opportunities. This approach delivers a balanced and accurate representation of both wages and employment demand for the program.

Methodology for In-Demand Calculations

The baseline for annual job openings, taking into account new positions and replacement positions, was determined by taking the average of all annual job openings between 2024 and 2029 across all 797 career sectors at the 5-digit SOC code level. For the 2024-2029 period, average job openings (growth + replacement) is 405.

Course Standards: Horticulture Science I

1. **GENERAL REQUIREMENTS.** This course is recommended for students in Grades 9-12, and there are no prerequisites.

2. **INTRODUCTION**
   A. Career and Technical Education (CTE) instruction provides content aligned with challenging academic standards and relevant technical knowledge and skills for students to further their education and succeed in current or emerging professions.
   B. The Agriculture Career Cluster is dedicated to careers involving the study and management of plant growth, soil health, and pest management, focusing on sustainable crop production for both food and goods. This Sub-Cluster includes careers in agronomy, horticulture, timber and plant fiber harvesting, and soil science that are aimed at enhancing crop yields, preserving soil resources, and developing advanced production practices.
   C. The Horticulture Science CTE Program of Study is designed to prepare students for successful careers in agriculture, specifically within the fields of horticulture, agronomy, soil science, integrated pest management, and sustainable crop production. Aligned with the Advance CTE Agriculture Career Cluster Framework, these courses provide a progressive learning experience that equips students with the foundational knowledge, practical skills, and technical competencies needed to excel in a rapidly evolving green industry.
   D. Horticulture Science I develops essential communication, critical thinking, and teamwork skills that support future success in horticulture careers. Upon completion, students are prepared to earn the OSHA 10-Hour General Industry (Agriculture) Safety Certification, ensuring a strong emphasis on workplace safety as they begin their horticulture studies and start building the foundation for advanced certifications, including the Commercial Pesticide Applicator Certification (CPAC).
   E. Students will participate in at least two Career-Connected Education and Work-Based Learning experiences in this course, which might include informational interviews or job shadowing relevant to the program of study.
   F. Students are encouraged to participate in extended learning experiences through aligned Career and Technical Student Organizations (CTSOs). CTSOs are a cocurricular requirement in the Carl D. Perkins Act, and alignment to CTSO activities is an expectation for CTE programs in the state of Maryland.

3. **KNOWLEDGE AND SKILLS**
   A. **The student demonstrates the necessary skills for career development, maintenance of employability, and successful completion of course outcomes. The student is expected to:**
      1. Identify and demonstrate positive work behaviors that enhance employability and job advancement, such as regular attendance, promptness, proper attire, maintenance of a clean and safe work environment, and pride in work.
      2. Demonstrate positive personal qualities such as flexibility, open-mindedness, initiative, active listening, and a willingness to learn.
      3. Employ effective reading, writing, and technical documentation skills.
      4. Solve problems using critical thinking techniques and structured troubleshooting methodologies.
      5. Demonstrate leadership skills and collaborate effectively as a team member.

6. Implement safety procedures, including proper use of software and following privacy guidelines.
7. Exhibit an understanding of legal and ethical responsibilities in the horticulture science field, following copyright laws and regulations.
8. Demonstrate time-management skills and the ability to prioritize tasks in a technical setting.

B. **The student identifies various career pathways in the horticulture science field. The student is expected to:**
   1. Develop a career plan that includes the necessary education, certifications, job skills, and experience for specific roles in horticulture science.
   2. Create a professional resume and portfolio that reflect skills, projects, certifications, and recommendations.
   3. Demonstrate effective interview skills for roles in horticulture science fields.

C. **The student develops technology and digital literacy skills. The student is expected to:**
   1. Students should learn to navigate online resources, use search engines effectively, and critically evaluate digital content related to plant science and horticulture.
   2. Students should develop foundational skills in word processing to write simple reports and use spreadsheets to record basic plant growth data and field observations.
   3. Students should learn to use email and shared documents for collaboration, maintain clear digital correspondence, and adhere to appropriate digital etiquette when communicating with peers and instructors.

D. **The student integrates core academic skills into horticulture science practices. The student is expected to:**
   1. Demonstrate basic scientific reading comprehension, identifying main ideas and key details in texts on plant anatomy, soil properties, and sustainable practices.
   2. Write clear, concise summaries and observations related to greenhouse activities, lab results, and safety protocols.
   3. Apply basic measurement and unit conversions to tasks such as mixing soil media, measuring greenhouse temperature, and tracking plant growth rates.
   4. Use foundational biological and chemical concepts (e.g., photosynthesis, nutrient elements) to understand plant growth and soil health.
   5. Engage in class discussions and small group work, practicing active listening and asking clarifying questions to better understand horticultural concepts.

E. **The student demonstrates foundational knowledge of plant anatomy, physiology, and the environmental factors influencing plant growth. The student is expected to:**
   1. Identify basic plant structures (roots, stems, leaves, flowers, fruits, and seeds) and describe their functions, and understand how plants respond to stress.
   2. Differentiate among common plant growth habits, life cycles, and classifications (annuals, perennials, woody, herbaceous), incorporating an entry-level understanding of scientific nomenclature, the distinction between scientific and common names, and the concept of cultivars.
   3. Explain the fundamental processes of photosynthesis, respiration, and transpiration, and their importance to plant health and productivity.

4. Investigate how environmental factors—including light, temperature, water, nutrient availability, and soil pH (which directly influences nutrient solubility and uptake)—as well as diseases and insects, affect plant growth and development.
5. Recognize how an understanding of plant structure and function underpins both proper cultural practices and safe handling procedures (e.g., pruning, transplanting) to ensure worker safety and minimize injury or stress to plants and workers.
6. Identify commonly cultivated plants (including vegetables, fruits, landscape perennials, trees, and cut flowers), describing how physiology (e.g., transpiration rate, ethylene sensitivity) affects their post-harvest care and design suitability.

F. **The student demonstrates an understanding of soil science principles and the importance of soil health to sustainable plant production. The student is expected to:**
   1. Identify soil components (minerals, organic matter, water, and air) and their roles in supporting plant growth.
   2. Describe soil texture, structure, pH, and horizons (e.g., O, A, B, C), explaining how these properties influence nutrient availability, water retention, and plant root development.
   3. Interpret basic soil-test results—including pH and fertility levels—and propose amendments or fertilizers appropriate for vegetables, ornamentals, and both warm-season (e.g., bermudagrass, zoysiagrass) and cool-season (e.g., tall fescue, Kentucky bluegrass) turfgrasses.
   4. Understand sustainable soil management practices, including crop rotation, cover cropping, and proper composting techniques, and recognize actions to avoid (e.g., over-tilling, working soil when too wet) that can damage soil structure.
   5. Connect soil science knowledge to workplace safety (e.g., proper lifting techniques for soil bags, safe equipment operation when tilling or moving soil) to reinforce OSHA-10 awareness.
   6. Explore how soil-based and soilless media (e.g., floral foam, hydroponic substrates) are selected for floral design and specialty crop production, emphasizing proper handling and disposal to maintain sustainability.
   7. Demonstrate an introductory awareness of Maryland Department of Agriculture (MDA) fertilizer regulations—including application-rate limits, seasonal blackout dates, and required setbacks near waterways—and explain how these laws guide responsible nutrient management for turf, landscape, and production settings.
   8. Practice basic pesticide safety measures (e.g., proper handling, storage, and use of personal protective equipment) in relation to soil health, recognizing the importance of minimizing chemical inputs where feasible to protect environmental quality and support sustainable horticulture.

G. **The student demonstrates knowledge of integrated pest management (IPM) principles and common pest issues in horticulture. The student is expected to:**
   1. Recognize common insect pests, weeds, and diseases that impact horticultural crops, including invasive species currently prevalent in Maryland and their regional variations.
   2. Describe the principles of IPM, incorporating diagnostic skills (e.g., observing plant symptoms, assessing site conditions) to determine causes of plant decline, and addressing prevention, monitoring, economic thresholds, and control strategies.
   3. Differentiate between chemical, biological, cultural, and mechanical pest management methods and evaluate their advantages and limitations as part of a comprehensive IPM approach.

4. Understand the importance of environmentally responsible practices when implementing chemical controls, recognizing that safe handling, storage, and application procedures align with broader IPM goals.
5. Recognize common pests and diseases affecting cut flowers and floral arrangements (e.g., Botrytis on roses), applying IPM strategies to maintain product quality and extend vase life.
6. Recognize common pests and diseases affecting not only cut flowers and floral arrangements (e.g., Botrytis on roses) but also woody ornamentals—including landscape trees, shrubs, and nursery stock (e.g., emerald ash borer on ash trees, boxwood blight on boxwood, scale insects on hollies)—and apply appropriate IPM strategies to maintain product quality, plant health, and long-term aesthetic, or market value.

H. **The student demonstrates an awareness of sustainable crop production practices and their significance in horticulture. The student is expected to:**
   1. Identify sustainable horticultural practices that conserve resources, reduce inputs, and protect the environment (e.g., implementing rain gardens to manage stormwater, rotating crops to maintain soil health, composting to recycle organic waste, and companion planting to enhance biodiversity and pest control).
   2. Discuss the role of plant selection, biodiversity, and habitat enhancement in promoting ecological balance.
   3. Explore introductory greenhouse and nursery production methods that emphasize efficient resource use and waste reduction.
   4. Explain how sustainable horticulture contributes to long-term soil health, crop quality, and responsible land stewardship.
   5. Recognize how sustainability initiatives integrate with workplace safety (e.g., proper chemical storage, waste handling, water conservation) to protect worker health, environmental resources, and align with OSHA-10 standards.
   6. Describe eco-friendly floral design practices (e.g., using reusable containers, reducing single-use plastics, sourcing locally grown flowers) that support sustainable crop production and responsible resource management.

I. **The student demonstrates the foundational skills and habits of mind necessary for future professional growth in horticulture. The student is expected to:**
   1. Use proper horticultural terminology in both oral and written communications, including correct botanical and scientific names, plant morphology terms (e.g., “petiole,” “inflorescence”), and industry-specific vocabulary (e.g., “transplant shock,” “pruning cuts,” “germination rate”) to convey information accurately and professionally.
   2. Employ basic mathematical and scientific concepts (e.g., measurement, data collection, observation) to inform horticultural decisions.
   3. Practice workplace safety standards, including personal protective equipment (PPE) use and tool handling, to maintain a safe learning environment.
   4. Engage in collaborative learning experiences, problem-solving activities, and critical thinking exercises related to horticultural scenarios, building toward readiness for more advanced study and eventual professional certification.
   5. Outline pathways for professional advancement within the horticulture industry (e.g., exploring the MNLGA CPH process, continuing education programs, and networking opportunities).

6. Reflect on how foundational horticultural knowledge, combined with core OSHA-10 safety competencies, prepares students for entry-level roles and sets the stage for further certification pursuits.
7. Practice essential floral design mechanics (e.g., wiring, taping, bow-making) and safe tool usage (e.g., floral knives, shears), integrating horticultural knowledge to create basic arrangements.

J. **The student demonstrates foundational knowledge of pesticide use, safety, and regulation to support eventual readiness for the Commercial Pesticide Applicator Certification. The student is expected to:**
1. Identify basic pesticide categories (e.g., insecticides, herbicides, fungicides) and understand their general modes of action and target pests.
2. Understand the significance of pesticide labeling, including key terminology, signal words, and required safety measures, as well as the importance of following label instructions.
3. Recognize federal and state regulations governing pesticide use (e.g., the Federal Insecticide, Fungicide, and Rodenticide Act [FIFRA], Maryland Department of Agriculture regulations) and discuss their implications for professional practice.
4. Discuss appropriate pesticide storage, handling, and disposal practices to minimize environmental impact and ensure worker and consumer safety.
5. Explore personal protective equipment (PPE) requirements, focusing on the proper selection, use, and maintenance of PPE to reduce exposure risks.
6. Demonstrate how to read and interpret Safety Data Sheets (SDS) for horticultural chemicals and pesticides, ensuring alignment with both FIFRA and OSHA's Hazard Communication Standard.
7. Recognize pesticide concerns in floriculture (e.g., flower residues, pollinator impacts) and apply prudent pesticide practices, building on IPM principles to protect product quality and promote environmental stewardship

K. **The student demonstrates foundational knowledge of turfgrass species, establishment, and cultural practices. The student is expected to:**
1. Differentiate between warm-season and cool-season turfgrasses commonly used in Maryland landscapes (e.g., bermudagrass vs. tall fescue), identifying key growth characteristics and seasonal performance traits.
2. Explain how soil-test data (pH, nitrogen, phosphorus, potassium) drive fertilizer-selection and application schedules for each turfgrass group, emphasizing compliance with MDA fertilizer-law limits.
3. Describe best-practice cultural techniques—seeding, sodding, mowing, irrigation, aeration, and thatch management—that promote healthy, environmentally responsible turfgrass systems.
4. Identify common turfgrass pests, diseases, and weeds, and outline introductory IPM strategies that integrate cultural, mechanical, biological, and (when necessary) chemical controls.
5. Relate turfgrass-maintenance tasks to workplace safety (e.g., PPE for mowing, safe fertilizer-spreader operation), reinforcing OSHA-10 concepts and the importance of equipment calibration to prevent over-application of nutrients or pesticides.

Course Standards: Horticulture Science II

1. **GENERAL REQUIREMENTS.** This course is recommended for students in Grades 10-12, and Horticulture Science I is the prerequisite.

2. **INTRODUCTION**
   A. Career and Technical Education (CTE) instruction provides content aligned with challenging academic standards and relevant technical knowledge and skills for students to further their education and succeed in current or emerging professions.
   B. The Agriculture Career Cluster is dedicated to careers involving the study and management of plant growth, soil health, and pest management, focusing on sustainable crop production for both food and goods. This Sub-Cluster includes careers in agronomy, horticulture, timber and plant fiber harvesting, and soil science that are aimed at enhancing crop yields, preserving soil resources, and developing advanced production practices.
   C. The Horticulture Science CTE Program of Study is designed to prepare students for successful careers in agriculture, specifically within the fields of horticulture, agronomy, soil science, integrated pest management, and sustainable crop production. Aligned with the Advance CTE Agriculture Career Cluster Framework, these courses provide a progressive learning experience that equips students with the foundational knowledge, practical skills, and technical competencies needed to excel in a rapidly evolving green industry.
   D. In Horticulture Science II, students evaluate nutrient requirements, soil amendments, and greenhouse production methods, honing their analytical and problem-solving skills to make informed crop management decisions.
   E. Students will participate in at least two Career-Connected Education and Work-Based Learning experiences in this course, which might include informational interviews or job shadowing relevant to the program of study.
   F. Students are encouraged to participate in extended learning experiences through aligned Career and Technical Student Organizations (CTSOs). CTSOs are a cocurricular requirement in the Carl D. Perkins Act, and alignment to CTSO activities is an expectation for CTE programs in the state of Maryland.

3. **KNOWLEDGE AND SKILLS**
   A. **The student demonstrates an advanced understanding of plant growth, physiology, and propagation methods, building on foundational concepts from Horticulture Science I. The student is expected to:**
      1. Identify and demonstrate positive work behaviors that enhance employability and job advancement, such as regular attendance, promptness, proper attire, maintenance of a clean and safe work environment, and pride in work.
      2. Demonstrate positive personal qualities such as flexibility, open-mindedness, initiative, active listening, and a willingness to learn.
      3. Employ effective reading, writing, and technical documentation skills.
      4. Solve problems using critical thinking techniques and structured troubleshooting methodologies.
      5. Demonstrate leadership skills and collaborate effectively as a team member.
      6. Implement safety procedures, including proper use of software and following privacy guidelines.

7. Exhibit an understanding of legal and ethical responsibilities in the horticulture science field, following copyright laws and regulations.
8. Demonstrate time-management skills and the ability to prioritize tasks in a technical setting.

B. **The student identifies various career pathways in the horticulture science field. The student is expected to:**
   1. Develop a career plan that includes the necessary education, certifications, job skills, and experience for specific roles in horticulture science.
   2. Create a professional resume and portfolio that reflect skills, projects, certifications, and recommendations.
   3. Demonstrate effective interview skills for roles in horticulture science.

C. **The student develops technology and digital literacy skills. The student is expected to:**
   1. Build on spreadsheet skills by learning to input, organize, and perform basic calculations on horticulture-related data, such as soil test results, fertilizer usage, and irrigation records.
   2. Be introduced to industry-relevant applications, such as digital plant identification tools, online pest databases, and nutrient management software, to inform decision-making.
   3. Practice maintaining digital records of experiments, greenhouse logs, and field activities, learning version control and basic file organization.

D. **The student integrates core academic skills into horticulture science practices. The student is expected to:**
   1. Interpret more complex technical texts, such as plant propagation guides and integrated pest management protocols.
   2. Develop short research briefs or compare different nutrient management strategies, citing reliable sources.
   3. Perform ratio, proportion, and basic algebraic calculations for fertilizer application rates, irrigation scheduling, and cost estimations.
   4. Analyze cause-and-effect relationships in plant physiology and growth conditions, applying scientific principles to solve production challenges.
   5. Deliver short presentations on plant health observations, integrating evidence and data to support conclusions.

E. **The student demonstrates an advanced understanding of plant growth, physiology, and propagation methods, building on foundational concepts from Horticulture Science I. The student is expected to:**
   1. Analyze plant metabolic pathways (e.g., photosynthesis, respiration) and their interactions with external factors such as nutrition and light quality.
   2. Evaluate different plant propagation techniques (seed propagation, cuttings, grafting, and tissue culture) for various horticultural crops.
   3. Assess how plant hormones and growth regulators (natural and synthetic) influence plant growth, plant development, crop quality, and stress responses.
   4. Interpret plant growth data to guide decision-making related to cultivar selection, production scheduling, and crop improvement.
   5. Demonstrate safe handling of propagation tools and equipment, emphasizing best practices for disease prevention (e.g., sanitation) and advanced hazard recognition in propagation facilities, aligning with OSHA-30 guidelines for tool use and chemical safety.

6. Explore advanced propagation methods specific to high-value floral crops (e.g., specialty cut flowers, greenhouse ornamentals), highlighting timing, rooting media, and environmental controls needed to optimize floral design materials.
7. Expand advanced plant identification skills by distinguishing morphological and physiological traits among specialized horticultural species (e.g., niche ornamental plants, greenhouse crops, or regional natives), building on the foundational identification competencies developed in Course I.
8. Assess the impact of light-quality (wavelength) and intensity delivered by modern grow-light technologies (e.g., LED spectra) on seedling morphology, flowering response, and secondary-metabolite production, using data logs to adjust lighting strategies for greenhouse crops.

F. **The student applies intermediate soil science and nutrient management principles to support sustainable and efficient plant production, expanding upon concepts introduced in Horticulture Science I. The student is expected to:**
1. Differentiate between macronutrients and micronutrients, explaining their roles in plant health and productivity.
2. Evaluate soil amendments, fertilizers, and soil conditioners for their suitability in addressing specific nutrient deficiencies and improving soil structure.
3. Implement soil testing protocols and interpret results to develop targeted nutrient management plans.
4. Integrate principles of soil conservation, crop rotation, and cover cropping to enhance long-term soil fertility and resilience.
5. Apply advanced safety protocols when handling and storing large quantities of fertilizers and soil amendments (e.g., bulk totes, storage bins) by recognizing potential chemical and physical hazards, in accordance with OSHA-30 hazard prevention strategies.
6. Analyze nutrient management practices tailored to cut flower and potted florals, comparing soil-based and soilless media to achieve optimal bloom quality, vase life, and color vibrancy in floral design.
7. Apply precision-agriculture technologies (e.g., variable-rate applicators, GIS-based soil maps) to refine nutrient applications for field and container production, comparing economic and environmental benefits to the uniform-rate methods introduced in Course I.
8. Formulate intermediate fertility and irrigation schedules for athletic-field and landscape turfgrasses, interpreting mid-season soil-test data and clipping-yield growth to adjust nitrogen-release rates while maintaining compliance with Maryland Department of Agriculture fertilizer regulations.

G. **The student refines integrated pest management (IPM) strategies, utilizing critical thinking and diagnostic skills developed in Horticulture Science I. The student is expected to:**
1. Identify signs and symptoms of complex or emerging pests and diseases and determine effective, sustainable management responses.
2. Compare the efficacy and environmental impact of advanced chemical, biological, and cultural pest control methods.
3. Develop basic scouting and monitoring plans, using field data and record-keeping techniques to inform treatment decisions.
4. Use weather-based degree-day calculations and pest-development models to predict optimal scouting windows and treatment timings for regional pests, documenting the process in a digital IPM logbook.

5. Conduct jobsite hazard assessments in pest management settings (e.g., locked storage areas, ventilation requirements, restricted entry intervals), addressing advanced OSHA-30 topics like hazard communication, emergency action plans, and safe work practices for supervised crews.
6. Investigate common pests and post-harvest diseases prevalent in floral crops (e.g., Botrytis on roses, thrips on chrysanthemums), applying refined IPM tactics to maintain flower quality during production, storage, and transport.
7. Develop invasive management strategies in response to the presence of an invasive pest or plant, integrating risk assessment, monitoring strategies, and coordinated control measures that comply with local and state regulations.

H. **The student explores advanced sustainable horticultural practices and production systems, building on the foundational sustainability concepts from Horticulture Science I. The student is expected to:**
   1. Investigate greenhouse and controlled environment agriculture techniques, including substrate selection, fertigation, and lighting systems, to optimize plant growth.
   2. Examine water conservation strategies such as drip irrigation, hydroponics, and water recycling to improve resource efficiency.
   3. Compare conventional vs. organic production methods, focusing on their respective environmental, economic, and social impacts.
   4. Evaluate emerging sustainable technologies, such as precision agriculture tools, that improve decision-making and reduce inputs.
   5. Incorporate advanced workplace safety measures in sustainable horticultural operations, including confined-space entry (e.g., tanks or enclosed areas), lockout/tagout procedures for equipment, and safe maintenance of water or electrical systems, aligning with OSHA-30 requirements for complex work environments.
   6. Apply sustainable floriculture practices (e.g., locally sourced inputs, reuse or reduction of floral foam, organic production approaches) to reduce waste and chemical use in the floral design supply chain.

I. **The student enhances professional communication, technical competence, and foundational leadership skills necessary to progress toward industry certifications, including the MNLGA CPH. The student is expected to:**
   1. Demonstrate technical writing and presentation skills through developing crop production reports, documenting field observations, and sharing research findings.
   2. Apply mathematical and scientific principles (e.g., unit conversions, statistical analysis) to solve horticultural production and management problems.
   3. Use technology tools—digital sensors, mobile apps, geographic-information systems (GIS), and cloud-based dashboards—to collect, visualize, and analyze horticultural production data, building proficiency for advanced analytics in Course III.
   4. Collaborate in teams to design, implement, and evaluate small-scale horticultural projects, reflecting on business management, budgeting, leadership, communication, and project management practices.
   5. Evaluate advanced leadership and supervisory responsibilities for safety in horticulture operations, discussing OSHA-30 topics such as safety training for co-workers, record-keeping requirements, and effective communication of workplace hazards.

6. Identify how advanced horticultural knowledge and supervisory safety skills connect to the broader horticulture industry (e.g., MNLGA CPH exam content), reinforcing the professional standards expected for certification-level competence.
7. Critique floral design projects (e.g., event displays, special occasions) by analyzing cost analysis, logistics, and workflow to demonstrate project management skills aligned with industry best practices.

J. **The student demonstrates the knowledge and skills necessary to prepare for the Commercial Pesticide Applicator Certification (CPAC), building on advanced IPM and pesticide safety concepts introduced in previous courses. The student is expected to:**
1. Interpret and apply pesticide label information, Safety Data Sheets (SDS), and state/federal regulatory guidelines to ensure legal, effective, and safe pesticide use.
2. Calculate and verify accurate pesticide application rates, dilution ratios, and equipment calibration settings, demonstrating precision in mixing and measuring procedures.
3. Employ best management practices for personal protective equipment (PPE) use, equipment maintenance, spill prevention, and emergency response related to pesticide applications.
4. Integrate CPAC preparation into overall pest management strategies by prioritizing environmental stewardship, minimizing off-target effects, and adhering to worker protection standards.
5. Demonstrate advanced understanding of licensing and certification requirements (e.g., MDA regulations for specialized pest categories), incorporating supervisory-level safety protocols, record-keeping, and application logs—key areas tested in CPAC and relevant to OSHA-30 hazard communication.
6. Assess pesticide selection and application techniques specifically for ornamental and cut-flower crops, ensuring precise timing and minimal residue on blooms destined for consumer use or design projects.
7. Practice thorough pesticide record keeping and reporting, demonstrating compliance with local, state, and federal regulations, and reinforcing the importance of documentation in tracking usage, evaluating effectiveness, and maintaining safety standards.

K. **The student applies intermediate turfgrass-science principles and management techniques to deliver resilient, high-quality turf systems in athletic-field, golf-course, and landscape settings. The student is expected to:**
1. Differentiate cultivar groups within warm-season and cool-season turfgrasses (e.g., hybrid bermudagrass vs. seeded bermudagrass; elite tall fescue blends vs. Kentucky bluegrass mixes) and select cultivars based on site conditions, traffic intensity, and performance goals.
2. Interpret seasonal soil-test data and clipping-yield reports to adjust nitrogen source, timing, and rate—using variable-rate applicators where feasible—while meeting Maryland Fertilizer Law limits for urban and sports-turf settings.
3. Design and carry out renovation and overseeding programs (e.g., core aeration + slit-seeding, fraise mowing) that improve turf density, wear tolerance, and rooting depth, documenting costs and labor requirements.
4. Implement precision irrigation and moisture-monitoring strategies (e.g., soil-moisture sensors, evapotranspiration models) to maximize water-use efficiency and prevent localized dry spots or disease outbreaks.
5. Diagnose and manage turfgrass pests and abiotic disorders using weather-based degree-day models (e.g., white-grub emergence, dollar-spot pressure indices) and

integrate cultural, biological, and reduced-risk chemical controls into a site-specific IPM program.

6. Operate and maintain specialized turf-care equipment (walk-behind reel mowers, sprayers, topdressers, aerators) following OSHA-30 safety protocols, including lockout/tag-out and PPE for high-noise or chemical-application tasks.
7. Develop a mid-season turf-health report that synthesizes soil and tissue analyses, irrigation audits, pest-scouting data, and budget considerations; recommend evidence-based adjustments to fertility, mowing, and pest-management plans to meet client or facility performance standards.

Course Standards: Horticulture Science III

1. **GENERAL REQUIREMENTS.** This course is recommended for students in Grades 11-12, and Horticulture Science I and II are the prerequisites.
2. **INTRODUCTION**
   A. Career and Technical Education (CTE) instruction provides content aligned with challenging academic standards and relevant technical knowledge and skills for students to further their education and succeed in current or emerging professions.
   B. The Agriculture Career Cluster is dedicated to careers involving the study and management of plant growth, soil health, and pest management, focusing on sustainable crop production for both food and goods. This Sub-Cluster includes careers in agronomy, horticulture, timber and plant fiber harvesting, and soil science that are aimed at enhancing crop yields, preserving soil resources, and developing advanced production practices.
   C. The Horticulture Science CTE Program of Study is designed to prepare students for successful careers in agriculture, specifically within the fields of horticulture, agronomy, soil science, integrated pest management, and sustainable crop production. Aligned with the Advance CTE Agriculture Career Cluster Framework, these courses provide a progressive learning experience that equips students with the foundational knowledge, practical skills, and technical competencies needed to excel in a rapidly evolving green industry.
   D. Horticulture Science III enhances students' efficiency, productivity, and sustainability in horticultural operations through the use of technology—such as environmental sensors, data analytics, and controlled environment agriculture systems.
   E. Students will participate in at least two Career-Connected Education and Work-Based Learning experiences in this course, which might include informational interviews or job shadowing relevant to the program of study.
   F. Students are encouraged to participate in extended learning experiences through aligned Career and Technical Student Organizations (CTSOs). CTSOs are a cocurricular requirement in the Carl D. Perkins Act, and alignment to CTSO activities is an expectation for CTE programs in the state of Maryland.

3. **KNOWLEDGE AND SKILLS**
   A. **The student demonstrates the necessary skills for career development, maintenance of employability, and successful completion of course outcomes. The student is expected to:**
      1. Identify and demonstrate positive work behaviors that enhance employability and job advancement, such as regular attendance, promptness, proper attire, maintenance of a clean and safe work environment, and pride in work.
      2. Demonstrate positive personal qualities such as flexibility, open-mindedness, initiative, active listening, and a willingness to learn.
      3. Employ effective reading, writing, and technical documentation skills.
      4. Solve problems using critical thinking techniques and structured troubleshooting methodologies.
      5. Demonstrate leadership skills and collaborate effectively as a team member.
      6. Implement safety procedures, including proper use of software and following privacy guidelines.
      7. Exhibit an understanding of legal and ethical responsibilities in the horticulture science field, following copyright laws and regulations.

8. Demonstrate time-management skills and the ability to prioritize tasks in a technical setting.

B. **The student identifies various career pathways in the horticulture science field. The student is expected to:**
   1. Develop a career plan that includes the necessary education, certifications, job skills, and experience for specific roles in horticulture science.
   2. Create a professional resume and portfolio that reflect skills, projects, certifications, and recommendations.
   3. Demonstrate effective interview skills for roles in horticulture science fields.

C. **The student develops technology and digital literacy skills. The student is expected to:**
   1. Learn to operate and interpret data from digital sensors (e.g., temperature, humidity, soil moisture), automated irrigation controllers, and environmental monitors, integrating this data into crop management strategies.
   2. Gain experience with GIS or mapping software to visualize field layouts, track pest outbreaks, plan crop rotations, and analyze spatial data for decision-making.
   3. Refine their ability to analyze data sets, use charts and graphs to interpret trends, and leverage data-driven insights for more informed horticultural planning and problem-solving.

D. **The student integrates core academic skills into horticulture science practices. The student is expected to:**
   1. Evaluate peer-reviewed journal articles, industry reports, and extension publications to inform decisions in advanced horticultural practices.
   2. Write detailed analytical reports on experimental results, including data interpretation and recommendations.
   3. Employ statistical methods (averages, variances, basic probability) to interpret yield data, pest monitoring results, and nutrient analyses.
   4. Apply advanced biological, chemical, and environmental concepts (e.g., plant breeding principles, soil microbiology) to optimize production systems.
   5. Participate in debates or structured discussions on sustainability methods, defend positions using scientific evidence, and synthesize multiple viewpoints.

E. **The student demonstrates advanced knowledge of plant physiology, breeding, and cultivar improvement, building on the concepts learned in Horticulture Science II. The student is expected to:**
   1. Differentiate between traditional and modern plant breeding techniques, including selection, hybridization, and molecular breeding, and assess their impact on crop improvement.
   2. Analyze the genetic, physiological, and environmental factors influencing crop yield, quality, and resilience under various growing conditions, including how specialized grow lights and varying light wavelengths can affect plant growth and development.
   3. Investigate advanced propagation methods (e.g., micropropagation, grafting of specialized cultivars) for specific horticultural crops.
   4. Evaluate plant stress responses (e.g., drought, salinity, extreme temperatures) and propose management strategies to optimize crop performance.

5. Demonstrate comprehensive plant identification and nomenclature skills, emphasizing ornamental, native, and invasive species relevant to regional horticulture and the MNLGA CPH exam.
6. Examine how advanced breeding and selection techniques are applied to floral crops (e.g., new rose cultivars, long-stemmed varieties, enhanced color traits), evaluating the market and design implications of emerging cultivars in the floral industry.
7. Integrate high-throughput phenotyping and basic genomic-selection data to evaluate breeding lines, interpreting digital imaging or molecular-marker results to expedite cultivar improvement.

F. **The student applies advanced soil science, nutrient management, and environmental stewardship principles, expanding upon foundational and intermediate concepts introduced in Horticulture Science II. The student is expected to:**
   1. Develop integrated soil fertility plans that incorporate precision agriculture techniques, soil testing, and site-specific amendments.
   2. Use knowledge of soil microbiology and beneficial organisms to enhance nutrient cycling, soil structure, and plant health.
   3. Compare long-term soil management strategies that balance productivity with environmental sustainability, including the use of renewable soil amendments and biodynamic practices.
   4. Interpret complex soil and substrate test data to refine management decisions and improve overall crop quality and efficiency.
   5. Integrate advanced nutrient management regulations and industry standards (including the Maryland Fertilizer Laws and Maryland Nutrient Management Program guidelines) to ensure legal compliance and stewardship required for MNLGA CPH preparation.
   6. Develop specialized nutrient and substrate management plans for commercial floriculture production (e.g., high-value cut flowers, potted ornamentals), highlighting how advanced fertility strategies can enhance bloom color, size, and post-harvest longevity.
   7. Quantify soil-health metrics (e.g., aggregate stability, soil organic-carbon indices) and model long-term carbon sequestration benefits arising from different fertility and cover-cropping strategies, preparing reports that meet MNLGA CPH evidence-based expectations.

G. **The student refines integrated pest management (IPM) strategies through advanced diagnostic, planning, and evaluation techniques, building on skills acquired in Horticulture Science II. The student is expected to:**
   1. Diagnose complex pest, disease, and weed problems by evaluating host-pathogen-environment interactions and field data.
   2. Develop comprehensive IPM plans that integrate biological control agents, habitat manipulation, resistant cultivars, and reduced-risk pesticides.
   3. Apply decision-support tools and technology (e.g., scouting apps, remote sensing, environmental monitors) to optimize timing and effectiveness of control measures.
   4. Assess long-term impacts of pest management decisions on environmental health, economic sustainability, and crop marketability.
   5. Demonstrate mastery of advanced IPM record-keeping and compliance with Maryland Department of Agriculture (MDA) guidelines, ensuring readiness for the CPAC exam in subsequent coursework.

6. Evaluate targeted IPM strategies for premium floral crops (e.g., lilies, hydrangeas, Gerbera daisies), focusing on pests/diseases that affect aesthetic value, post-harvest quality, and consumer satisfaction in the floral marketplace.
7. Apply degree-day modeling to predict pest emergence and refine the timing of management interventions, enhancing precision in diagnosing and controlling invasive insects or pathogens.
8. Coordinate area-wide IPM programs by synthesizing regional pest-forecast data, stakeholder communications, and environmental-impact assessments to design collaborative intervention plans.

H. **The student explores advanced sustainable horticultural production systems, expanding on the intermediate methods introduced in Horticulture Science II. The student is expected to:**
1. Investigate specialized production systems (e.g., hydroponics, aquaponics, vertical farming) and evaluate their economic, environmental, and resource-use implications.
2. Analyze various certification standards (e.g., organic, eco-labels, sustainable sourcing) and their market impacts on horticultural products.
3. Integrate technologies such as climate-controlled environments, automation, and data analytics to enhance productivity and reduce input costs.
4. Examine strategies to adapt horticultural production to climate change, resource limitations, and evolving consumer demands.
5. Evaluate advanced certification frameworks (e.g., SITES, LEED for green building) and collaborative initiatives (e.g., pollinator protection programs) that intersect with sustainable horticulture, aligning with MNLGA CPH guidelines and industry best practices.
6. Incorporate sustainable floriculture methods (e.g., responsible water use, eco-friendly floral foam alternatives, integrated pollinator habitats) to optimize environmental stewardship in the commercial floral design supply chain.
7. Conduct life-cycle assessments (LCA) of selected production systems to quantify greenhouse-gas emissions, energy inputs, and waste streams, recommending design changes that meet third-party sustainability benchmarks.

I. **The student enhances leadership, communication, and professional skills necessary for eventual attainment of the MNLGA CPH certification, building from prior courses. The student is expected to:**
1. Prepare detailed technical reports, case studies, and presentations using industry-standard terminology and best practices.
2. Employ advanced quantitative methods (e.g., statistical analysis, economic modeling) to evaluate production strategies and outcomes.
3. Demonstrate the ability to manage horticultural projects, oversee team operations, and maintain compliance with relevant laws, regulations, and industry standards.
4. Engage in advanced problem-solving and critical thinking exercises, reflecting on decisions, evaluating risks, and proposing evidence-based improvements in horticultural systems.
5. Develop a professional portfolio showcasing horticultural competencies (e.g., documented field experiences, continuing education activities, and professional references), demonstrating readiness for the MNLGA CPH exam.
6. Coordinate and lead advanced floral design projects or installations (e.g., large-scale events, high-end retail displays), practicing resource management, quality control, and team supervision as aligned with MNLGA CPH leadership standards.

7. Develop a comprehensive business or enterprise plan—including market analysis, financial projections, and risk-management strategies—for a horticultural venture, demonstrating mastery of supervisory-level decision-making and communication skills.

J. **The student demonstrates advanced knowledge and competencies required to prepare for the Commercial Pesticide Applicator Certification (CPAC), building on previously developed IPM and pesticide safety skills. The student is expected to:**
   1. Interpret and apply federal, state, and local pesticide regulations, including proper licensing, record-keeping, and reporting requirements.
   2. Analyze pesticide labels, Safety Data Sheets (SDS), and application guidelines to ensure precise, legal, and effective use of chemical controls.
   3. Perform accurate pesticide application rate calculations, equipment calibration, and maintenance protocols to achieve targeted, efficient treatments with minimal waste.
   4. Integrate pesticide use as a strategic component of a broader IPM plan, evaluating the environmental impact, resistance management considerations, and safety practices to protect applicators, non-target organisms, and surrounding ecosystems.
   5. Implement drift management and buffer zone strategies, incorporating advanced application technologies and local regulatory protocols to minimize environmental impact and support CPAC readiness.
   6. Demonstrate best practices for pesticide selection and application specific to ornamental and floral operations, addressing consumer safety, residue tolerance, and market quality expectations in line with CPAC standards.
   7. Practice comprehensive pesticide record keeping and reporting to ensure compliance with all relevant regulations, enhancing accountability and supporting effective IPM strategies.

K. **The student integrates advanced turfgrass-science research and management techniques to design, evaluate, and troubleshoot elite turf systems, building on intermediate skills from Course II. The student is expected to:**
   1. Design experimental trials (e.g., N-rate strips, cultivar performance plots, wetting-agent comparisons) on sports-turf or golf-course sites, analyze data statistically, and present findings to stakeholders.
   2. Engineer USGA-spec root-zone or sand-based athletic-field constructions, calculating drainage coefficients, amendment ratios, and surface hardness standards for player safety.
   3. Develop advanced, year-round turf-health programs that integrate growth-potential models, clipping-yield forecasting, and real-time sensor data to fine-tune fertility, mowing frequency, and plant-growth-regulator schedules.
   4. Implement precision-sprayer or robotic-mower technologies, evaluating labor, fuel, and environmental benefits relative to traditional equipment; document OSHA best-practice compliance for autonomous or semi-autonomous machinery.
   5. Formulate site-specific water-management plans using salinity mapping, soil-moisture telemetry, and deficit-irrigation algorithms to conserve resources while maintaining surface performance.
   6. Create an annual turf-operations report synthesizing agronomic, environmental-impact, and budgeting data—demonstrating supervisory-level communication aligned with MNLGA CPH and industry executive-manager competencies.

Course Standards: Career Connected Learning I and II

Career connected learning is an educational approach that integrates classroom instruction with real-world experiences, enabling high school students to explore potential careers and develop relevant skills before graduation. By participating in work-based learning opportunities—such as apprenticeships, internships, capstone projects, and school-based enterprises—students apply academic concepts in authentic settings, gain practical industry knowledge, and build professional networks. This hands-on engagement helps students connect their studies to future career paths, strengthens their problem-solving and communication skills, and supports a smoother transition into college, vocational programs, or the workforce.

All Career and Technical Education Programs of Study include aspects of work-based learning, and almost all of the programs include two Career Connected Learning (CCL) courses. The CCL standards can be found via this link: