



Program of Study Guide:

Horticulture Science

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

Carey M. Wright, Ed.D.

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Office of Teaching and Leading

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Division of College and Career Pathways

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Samir Paul, Esq.

Table of Contents

Document Control Information.....	3
Purpose.....	4
Sources of Standards.....	5
Course Descriptions.....	8
Industry-Recognized Credentials and Career-Connected Learning	10
Labor Market Information: Definitions and Data	12
Course Standards: Horticulture Science I.....	14
Course Standards: Horticulture Science II	17
Course Standards: Horticulture Science III	21

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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 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: Pending 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: Pending 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: Pending 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: Pending Grades: 11-12 Prerequisite: See Course Description Credits: 1-3	Prerequisites: 1. Alignment to the student's 6-Year Plan 2. Completion of: a. Minimum two sequential courses in a CTE pathway, OR b. Minimum two years of the same world language; OR c. Minimum two sequential courses in a comprehensive arts program; OR d. Inclusion in the IEP/504 transition plan with supporting documentation (as required) 3. Endorsement from an educator, mentor, employer, or career coach

Course Level	Course Information	Description
		4. No more than one course recovery credit in core subjects is needed by the student. 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 practices. 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.
Optional Flex: Course 3	Career Connected Learning II SCED: Pending Grades: 11-12 Prerequisite: Career Connected Learning I Credits: 1-3	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 Career-Connected Learning

The *Blueprint for Maryland's Future* and the High School Level of a Registered Apprenticeship

The Maryland State Department of Education recognizes the high-school level of a Registered Apprenticeship (RA), defined as a State-approved Registered Apprenticeship begun during high school in which students complete at least 144 hours of related technical instruction and 250 hours of paid on-the-job training before graduation, with the remaining required apprenticeship hours completed post-graduation, as the gold standard of Career Connected Learning.

The CTE Committee of the Governor's Workforce Development Board, in alignment with federal apprenticeship standards, requires 144 hours of RTI for all high school RA participants, and the Apprenticeship Maryland Program (AMP) defines the minimum RTI as **one course credit equivalent**. This high-school-level Registered Apprenticeship is the preferred career-connected learning option for students to meet the Blueprint's goal that 45% of public high school graduates complete either the high-school level of a Registered Apprenticeship or another industry-recognized credential.

To the extent practicable, the greatest number of students should achieve this goal through participation in a high-school level Registered Apprenticeship, with schools ensuring these requirements are scheduled, completed, and documented for transcript and reporting purposes.

To the extent practicable, the greatest number of students should achieve this goal through the high-school level of a Registered Apprenticeship.

Career-Connected Learning Resources		
Course 1: Career Awareness	Course 2: Career Preparation	Flex Courses: Career-Connected Learning
- 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 - Employer Mentoring	- Registered Apprenticeship - Internship - School-Based Enterprise - Employer-Directed Capstone

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 and the American Institute of Floral Designers Certified Floral Designer certifications

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 Wage¹	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). <i>Note: A 25th percentile hourly wage of \$24.74 or greater is required to meet this definition.</i>	Standard Occupational Code: 17-1012 Landscape Architects 19-1012 Food Scientists and Technologists 19-1013 Soil and Plant Scientist Hourly Wage/Annual Salary: 25 th Percentile: \$32.11 / \$66,791.00 50 th Percentile: \$40.03 / \$83,264.00 75 th Percentile: \$51.48 / \$107,087.00
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 <u>405</u> openings between 2024-2029.	Annual Openings 99

Lightcast Data Updated August 2025

¹ Living Wage Calculator: <https://livingwage.mit.edu/states/24>

Labor Market Information Data Source

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 model the MNLGA CPH Code of Ethics (e.g., honesty in record-keeping, respect for IP rights), explain scenarios illustrating each ethical principle, and reflect on their own professional conduct.
 - 2. Demonstrate positive work behaviors—recording attendance/punctuality, maintaining clean workspaces, wearing proper PPE—and evaluate how each behavior contributes to workplace safety.
 - 3. Apply OSHA-10 safety standards by performing hazard assessments in greenhouse and field labs, correctly using lockout/tagout procedures on electrical equipment, and leading a safety briefing.

4. Produce technical lab reports that include a clear hypothesis, step-by-step methods, quantified results (with units), safety annotations, and a concise conclusion.
5. Diagnose at least three plant-health issues (e.g., iron chlorosis, powdery mildew, overwatering stress) by observing symptoms, comparing to diagnostic guides, and recommending corrective actions.
6. Demonstrate fundamental AIFD floral mechanics—wire poultry wire cage, tape wired roses, set kenzan in shallow dish—and apply basic design principles (line, form, color balance) to construct a hand-tied bouquet that meets professional staging guidelines (e.g., no exposed mechanics, even distribution of mass).

B. The student identifies various career pathways in the horticulture science field. The student is expected to:

1. Research at least three horticulture and floral-design occupations (e.g., greenhouse technician, retail florist, landscape designer); prepare a one-page summary of education, certifications (OSHA-10, CPH, CFD), salary ranges, and career ladders.
2. Create a professional portfolio including copies of safety certificates, photos of propagation projects, and scanned images of floral designs; annotate each with context and outcomes.
3. Conduct a mock interview for an entry-level position, demonstrating clear descriptions of technical skills and portfolio highlights; receive peer feedback and revise responses.

C. The student develops technology and digital literacy skills. The student is expected to:

1. Navigate and extract data from horticultural databases (e.g., USDA Plant Hardiness, cultivar trial results); import into a spreadsheet and create a chart showing zone suitability.
2. Record greenhouse climate data (temperature, humidity, PAR light) over a week, calculate daily averages, and graph trends to identify correlations with plant growth rates.
3. Collaborate on a shared digital workspace (e.g., Google Docs or MS Teams); upload photos of floral designs, comment constructively on peers' work, and track revisions.

D. The student integrates core academic skills into horticulture science practices. The student is expected to:

1. Write a summary of plant anatomical structures (roots, stems, leaves, flowers, fruits, seeds) and physiological processes (photosynthesis, respiration) using proper scientific terminology.
2. Convert soil mix ratios (e.g., 2:1:1 peat:sand:perlite) to percentages and calculate the mass of each component needed for a 20-liter batch.
3. Explain how photosynthesis and transpiration rates change under different light intensities by designing and interpreting a simple classroom experiment.

E. The student investigates plant form and function by dissecting specimens, measuring physiological responses, and relating structures to environmental adaptations and stress responses.. The student is expected to:

1. Identify basic plant structures (roots, stems, leaves, flowers, fruits, seeds) and describe each function (e.g., roots for water/nutrient uptake, leaves for gas exchange), then explain plant responses to abiotic stresses (drought, salinity, temperature extremes).
2. Dissect monocot and dicot flowers; label parts (sepals, petals, stamens, pistils), photograph differences, and submit a comparative report.
3. Conduct a stomatal-density experiment: peel leaf epidermis, count stomata per mm² under a microscope, record data, and graph density vs. humidity.

- F. The student analyzes soil properties, interprets test data, and selects optimal growing media—including soilless options—for horticultural and floral applications based on water-holding, aeration, and structural needs. The student is expected to:**
1. Describe soil texture triangle components (sand, silt, clay), perform a hand texturing test, classify a soil sample, and relate texture to drainage and aeration.
 2. Interpret a full soil-test report (pH, N, P, K), calculate amendment rates (e.g., pounds of lime per 1,000 ft²), and justify recommendations in writing.
 3. Compare soilless media (peat moss, perlite, floral foam) for cut-flower support: measure water retention and structural integrity; defend your selection for a vase arrangement.
- G. The student implements an IPM program by identifying pests and diseases, monitoring populations, and applying cultural, biological, and mechanical controls in compliance with safety and label-reading protocols. The student is expected to:**
1. Identify common greenhouse pests (aphids, whiteflies), diseases (botrytis, powdery mildew), and weeds; document life cycles with diagrams.
 2. Develop and implement a weekly scouting plan—use yellow sticky cards, quadrat sampling; record pest counts and determine if thresholds are met.
 3. Select and apply cultural (sanitation, resistant cultivars), biological (predatory mites), and mechanical (hand-removal) controls; read and interpret pesticide labels, calculate application rates, and demonstrate safe handling.
- H. The student plans and evaluates sustainable horticultural systems—such as composting, crop rotations, and local sourcing—to minimize environmental impact and promote long-term resource stewardship. The student is expected to:**
1. Design and build a three-bin compost system; monitor temperature, moisture, and C:N ratio weekly; present findings in a lab journal.
 2. Plan a four-year crop rotation schedule to minimize soilborne disease and nutrient depletion; simulate it in a plot map.
 3. Incorporate locally sourced, seasonal cut flowers into three different floral designs; calculate each design's carbon footprint and propose ways to reduce it.
- I. The student masters essential post-harvest handling and mechanics to create professional-quality floral designs that meet industry standards for aesthetics, durability, and vase life. The student is expected to:**
1. Condition fresh stems: recut at 45°, remove foliage below waterline, hydrate in preservative solutions; document changes in turgidity.
 2. Construct a hand-tied bouquet using proper mechanics: hold stems at correct angle, wrap tape with uniform tension, and finish with decorative ribbon.
 3. Evaluate vase-life: store designs at 4 °C, record daily freshness indicators (stem firmness, petal turgidity), and adjust hydration techniques as needed.

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 the necessary skills for career development, maintenance of employability, and successful completion of course outcomes. The student is expected to:**
 1. Draft and maintain a professional development portfolio, including updated résumé, certificates (OSHA-30, CPH exam prep), and reflective journal entries on project outcomes.
 2. Exhibit leadership and teamwork by coordinating a propagation or design project, assigning roles, managing time, and conducting a post-project debrief.
 3. Prepare and deliver a client-style presentation summarizing a greenhouse or floral installation project, incorporating visual aids and responding to stakeholder questions.
 4. Conduct self- and peer-assessments using industry rubrics (e.g., AIFD criteria) to identify strengths, set SMART goals for skill growth, and demonstrate progress.
 5. Apply professional ethics and workplace standards—dress code, punctuality, safety compliance—in daily lab activities and record adherence in a workplace log.

B. The student identifies various career pathways in the horticulture science field. The student is expected to:

1. Research and compare at least five horticulture-related careers (e.g., greenhouse manager, floriculturist, turfgrass specialist, landscape designer, nursery sales consultant), detailing required credentials, daily duties, and salary ranges.
2. Interview or shadow a professional in one chosen pathway; summarize insights on education, certifications (CPH, CFD), and career progression in a reflective report.
3. Map local and regional employment opportunities—public gardens, nurseries, landscapers, event-floral businesses—using online job boards and industry directories.
4. Evaluate emerging niche pathways (urban farming, vertical-farm technician, botanical-garden curator) for alignment with personal interests and regional labor trends.

C. The student develops technology and digital literacy skills. The student is expected to:

1. Collect and log environmental data (temperature, humidity, light intensity) using digital sensors and export to spreadsheet software; create charts tracking trends over a two-week period.
2. Build and query a simple relational database of plant cultivars, propagation methods, and performance metrics; generate filtered reports for decision making.
3. Use GIS or mapping software to plot on-site trial plots or client landscapes, layering soil-test results and sunlight-exposure data to guide planting plans.
4. Create and manage a digital portfolio website or blog showcasing propagation experiments, design projects, and safety documentation, with embedded photos and captions.
5. Use technology tools—digital sensors, mobile apps, geographic-information systems (GIS), and cloud-based dashboards—to collect, visualize, and analyze horticultural production data.

D. The student integrates core academic skills into horticulture science practices. The student is expected to:

1. Write a technical report on an IPM trial—including hypothesis, materials and methods (with units), results (tables/graphs), and a discussion that references scientific literature.
2. Solve quantitative problems: calculate fertilizer injection rates (PPM), soil-amendment weights for given area, and irrigation volumes needed per planting schedule.
3. Apply biological concepts by explaining photosynthesis and nutrient uptake in propagation exercises; relate pH and EC measurements to plant physiology.
4. Interpret financial data: develop a basic budget for a small-scale greenhouse project, compute cost per plant, and project return-on-investment scenarios.
5. Apply mathematical and scientific principles (e.g., unit conversions, statistical analysis) to solve horticultural production and management problems.

E. The student designs, evaluates, and manages production systems—such as hydroponics, aquaponics, and organic rotations—that optimize resource use and environmental stewardship. The student is expected to:

1. Assemble a nutrient-film technique (NFT) bench: calculate flow rates, monitor nutrient solution composition, and troubleshoot pump or clogging issues.
2. Plan a six-crop rotation for greenhouse microgreens to prevent disease carryover and maintain substrate fertility; simulate yields and nutrient drawdown.

3. Conduct a life-cycle assessment (LCA) for a cut-flower crop: quantify water, energy, and carbon inputs; propose improvements to reduce footprint by $\geq 15\%$.

F. The student hones industry-level communication—written, oral, and visual—and practices leadership skills to coordinate teams and liaise with clients or stakeholders. The student is expected to:

1. Write a grant proposal summary for a school greenhouse upgrade: articulate objectives, budget breakdown, timeline, and expected student learning outcomes.
2. Deliver client presentations for a landscape-floral project: employ professional visuals (CAD renderings, mood boards), handle Q&A, and document feedback.
3. Mentor Horticulture I students through biweekly design critiques and propagation workshops; maintain a reflective journal of mentorship strategies and outcomes.

G. The student demonstrates knowledge of the regulatory frameworks, professional standards, and documentation practices required for the MNLGA Certified Professional Horticulturist credential and maintains accurate, exam-ready records. The student is expected to:

1. Identify each of the MNLGA CPH content areas (e.g., plant biology, soils & media, production systems, IPM, business management, codes & regulations), summarize key competencies, and map them to course activities.
2. Create and follow a personalized CPH study timeline, compile authoritative resources (manual chapters, journal articles, practice quizzes), and conduct biweekly self-assessments to track readiness.
3. Produce and organize standard operating procedures (SOPs) for greenhouse or propagation labs, detailed IPM scouting logs, and business-management worksheets (budgets, inventory records) in a consolidated digital portfolio.
4. Locate and interpret Safety Data Sheets (SDS) for at least five common horticultural inputs, extract hazard statements and recommended PPE, and practice recording this information in a lab-safety register.
5. Describe Maryland Department of Agriculture nursery/greenhouse registration procedures, local zoning or water-use regulations, and continuing-education obligations for CPH recertification; draft a compliance checklist.
6. Participate in a simulated CPH oral panel or written case study: present solutions to a real-world scenario (e.g., disease outbreak response, business-plan critique), justify decisions using CPH standards, and incorporate peer/instructor feedback.

H. The student develops turf in production settings by practicing seeding, mowing, fertilizing, and diagnosing turf issues common to lawns, athletic fields, and ornamentals. The student is expected to:

1. Select appropriate grass species based on USDA hardiness zone and intended use; prepare a seedbed, sow seed at recommended rates, and monitor germination and establishment over four weeks.
2. Compare cutting heights (e.g., 1.5" vs. 2.5") on turf density, color, and wear tolerance; record observations weekly and recommend best mowing practices.
3. Identify drought stress, thatch buildup, nutrient deficiencies, and common fungal pathogens; prescribe integrated cultural (aeration, topdressing) and corrective treatments.

I. The student refines design proficiency by creating complex arrangements, critiquing peers, and adhering to industry presentation and durability standards. The student is expected to:

1. Construct advanced pieces (e.g., geodesic spheres, wall installations) using foam, cages, wiring, and fresh materials; document each step with annotated photographs for portfolio inclusion.
2. Apply the AIFD evaluation rubric to peer work—assessing proportion, unity, scale, and technical workmanship—and provide written, actionable feedback.
3. Package and protect mechanical elements, verify structural stability in transport, and draft client care instructions to ensure post-installation longevity.

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. Produce a professional certification portfolio for CPH submission: SOPs, continuing-education log, ethics reflections, and project case studies.
 2. Lead and evaluate a capstone team project—such as a themed botanical installation—managing budget, timeline, and quality control, then present lessons learned in a formal report.
 3. Author and peer-review a journal-style article on an advanced horticulture topic; adhere to AHS formatting and reference guidelines.
 4. Design and deliver a client pitch for a commercial floral or landscape contract, including cost estimates, design renderings, and maintenance plans.
 5. Maintain professional standards in an internship or externship setting—attendance, communication, safety compliance—and document performance evaluations.

B. The student identifies various career pathways in the horticulture science field. The student is expected to:

1. Analyze advanced career roles (e.g., greenhouse operations manager, research horticulturist, master florist, turfgrass researcher), detailing required graduate credentials, research competencies, and leadership responsibilities.
2. Network with professionals via virtual conferences or industry associations (MNLGA, AIFD); summarize key takeaways and how they inform personal career planning.
3. Research entrepreneurial opportunities—boutique floral studio, specialty nursery, design consultancy—and draft a basic business model canvas for one chosen venture.
4. Evaluate certification maintenance and continuing-ed requirements (CEU credits for CPH, CFD) and integrate them into a five-year professional development plan.

C. The student develops technology and digital literacy skills. The student is expected to:

1. Configure and analyze data from a network of IoT sensors (moisture probes, pH/EC loggers) feeding into an online dashboard; interpret alerts to optimize irrigation and feeding.
2. Employ image-analysis software or drone-based NDVI mapping to assess plant health across a trial block; generate and present a georeferenced stress map.
3. Develop an automated fertigation algorithm using spreadsheet macros or lightweight scripting (e.g., Python), simulating input/output relationships based on sensor data.
4. Design and maintain a professional social-media campaign for a horticultural project—scheduling posts, documenting engagement metrics, and reflecting on digital outreach effectiveness.

D. The student integrates core academic skills into horticulture science practices. The student is expected to:

1. Conduct advanced data analysis: perform statistical tests (t-tests, ANOVA) on experimental growth trials and interpret p-values in the context of horticultural research.
2. Apply chemistry principles by calculating buffer solutions for nutrient injectors, adjusting pH of irrigation water, and explaining dissociation equilibria.
3. Use geometric and spatial reasoning to design efficient greenhouse layouts or vertical-farm racks, calculating area, volume, and light-distribution ratios.
4. Integrate business math by modeling cash-flow projections for a startup nursery or floral enterprise and evaluating break-even points.

E. The student designs and troubleshoots advanced production modules—such as vertical farms, controlled-environment agriculture (CEA), or integrated aquaponics—to meet commercial and sustainability objectives. The student is expected to:

1. Engineer a vertical-farm prototype: calculate light distribution for LED arrays, model airflow for humidity control, and program PLCs for automated nutrient dosing.
2. Compare plant performance in aquaponic vs. hydroponic setups: measure growth rate, nutrient uptake, and fish health metrics; summarize in a comprehensive report.
3. Integrate renewable-energy solutions (solar panels, rainwater harvesting) into a CEA design; perform payback-period calculations and ROI projections.

F. The student readies for MNLGA CPH certification by compiling professional documentation, authoring technical articles, and demonstrating ethical business leadership. The student is expected to:

1. Assemble a CPH submission portfolio: include detailed SOPs, continuing-education logs, project case studies, and ethics-scenario reflections.
2. Author a peer-reviewed style technical article on a horticultural topic of choice; follow AHS journal formatting guidelines and submit for mock review.
3. Facilitate quarterly team workshops on safety, quality assurance, and ethics; document agendas, attendance, and post-workshop evaluations.

G. The student orchestrates an enterprise-level IPM program—integrating monitoring data, predictive models, and professional standards—to maintain plant health and meet CPH regulatory requirements. The student is expected to:

1. Create a decision-tree protocol that integrates pest scouting data (trap counts, visual inspections), environmental conditions (degree-day models), and economic thresholds to trigger precise cultural or biological controls.
2. Configure and maintain a network of digital traps and sensor-linked cameras; upload data to a central dashboard, generate weekly trend analyses, and recommend interventions.
3. Author a facility-level IPM & pesticide-use compliance manual—including record-keeping templates, inspection schedules, emergency response plans, and Maryland Department of Agriculture reporting procedures.
4. Design and conduct replicated greenhouse trials comparing two biological control agents; collect quantitative data on pest suppression and non-target impacts, then present a cost-benefit analysis.
5. Track and document ≥ 10 hours of CPH-approved continuing-education activities (workshops, webinars, field days), summarizing key learnings and their application to your IPM program.

H. The student leads turfgrass research projects—developing and validating best practices for elite sports turf, specialty lawns, and ornamental groundcovers. The student is expected to:

1. Plan and execute randomized complete-block trials on sports-field grasses testing irrigation regimes and mowing frequencies; use proper blocking and replication, then analyze results via ANOVA.
2. Operate a drone to capture NDVI imagery over trial plots; process data to identify turf stress zones and draft targeted management recommendations.
3. Compile a comprehensive guide for high-use turf (athletic fields, event lawns) covering aeration schedules, topdressing protocols, pest and disease monitoring, and renovation strategies.
4. Establish demonstration plots for two experimental turfgrass cultivars; record establishment rates, wear tolerance, and color retention over a season; present findings in a poster session.

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 conceives and executes large-scale, client-driven floral projects—demonstrating advanced creativity, technical mastery, and professional business practices aligned with AIFD CFD criteria. The student is expected to:

1. Manage the full scope of a wedding or corporate-event floral installation—from client consultation and budget development through design, build-out, and teardown—while supervising a team of peers.
2. Create three marketable floral-design product lines (e.g., subscription bouquets, event collection packages); include cost analyses, production workflows, and marketing strategies.
3. Use the AIFD CFD evaluation rubric to assess your own portfolio designs on creativity, conceptualization, technical skill, workmanship, and marketability; document actionable improvement plans.
4. Plan and execute a public “portfolio review” event—inviting real or mock clients—presenting your top 10 designs, gathering feedback via structured surveys, and generating post-event reflections.