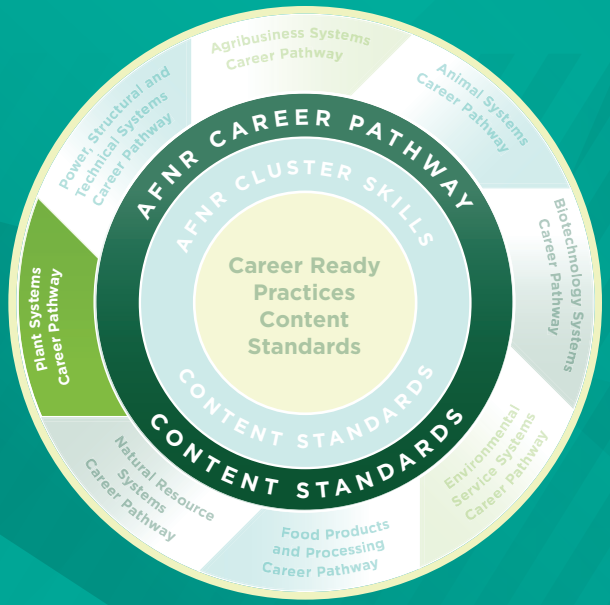


PLANT SYSTEMS CAREER PATHWAY

Agriculture, Food and Natural Resources Content Standards

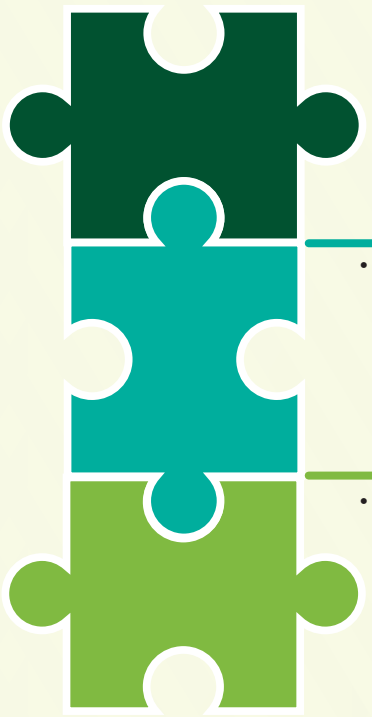
Plant Science Systems Career Pathway Content Standards

PURPOSE: The career pathway content standards outline technical knowledge and skills required for future success within this discipline. The content standards are intended to provide state agricultural education leaders and educators with a forward-thinking guide for what students should know and be able to do after completing a program of study in this career pathway. State leaders and local educators are encouraged to use the standards as a basis for the development of well-planned curriculum and assessments for Agriculture, Food and Natural Resource (AFNR)-related Career and Technical Education (CTE) programs. Adoption and use of these standards is voluntary; states and local entities are encouraged to adapt the standards to meet local needs.

SCOPE: The Plant Systems (PS) Career Pathway encompasses the study of plant life cycles, classifications, functions, structures, reproduction, media and nutrients, as wells as growth and cultural practices through the study of crops, turf grass, trees, shrubs and/or ornamental plants. Students completing a program of study in this pathway will demonstrate competence in the application of principles and techniques for the development, application and management of plant systems in AFNR settings.

SAMPLE CAREERS: Plant Breeder, Soil & Water Specialist, Plant Pathologist, Botanist, Forest Geneticists, Greenhouse Managers, Crop Farm Managers, Floriculturist, Agronomist

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



- **Common Career Technical Core (CCTC) Standards** – These are the standards for Plant Systems (AG-PS) from the 2012 version of the Common Career and Technical Core Standards, which are owned by the National Association of State Directors of Career and Technical Education/National Career Technical Education Foundation and are used here with permission. These statements define what students should know and be able to do after completing instruction in a program of study for this pathway.
- **Performance Indicators** – These statements distill each CCTC Standard into more discrete indicators of the knowledge and skills students should attain through a program of study in this pathway. Attainment of the knowledge and skills outlined in the performance indicators is intended to demonstrate an acceptable level of proficiency with the related CCTC Standard at the conclusion of a program of study in this area.
- **Sample Measurements** – The statements are ***sample*** measureable activities that students might carry out to indicate attainment of each performance indicator at three levels of proficiency – awareness (a), intermediate (b), and advanced (c). This is not intended to be an all-encompassing list; the sample measurements are provided as examples to demonstrate a logical progression of knowledge and skill development pertaining to one or more content areas related to the performance indicator. State and local entities may determine the most appropriate timing for attainment of each level of proficiency based upon local CTE program structures.

CONNECTIONS TO OTHER PATHWAYS:
For additional content standards on the topic of plant breeding, see Biotechnology Systems BS.02.
For additional content standards on the topic of plant productivity and quality, see Biotechnology Systems BS.03.
For additional content standards on the topic of precision technologies, see Power, Structural and Technical Systems PST.05.

PS.01. Develop and implement a crop management plan for a given production goal that accounts for environmental factors.

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

Sample Measurement: The following sample measurement strands are provided to guide the development of measurable activities (at different levels of proficiency) to assess students' attainment of knowledge and skills related to the above performance indicator. The topics represented by each strand are not all-encompassing.

PS.01.01.01.a. Identify and summarize the three measurements of light – color, intensity and duration – that affect plant growth.	**PS.01.01.01.b.** Analyze and describe plant responses to light color, intensity and duration.	**PS.01.01.01.c.** Analyze plant responses to varied light color, intensity and duration and recommend modifications to light for desired plant growth.
PS.01.01.02.a. Identify and summarize the effects of air and temperature on plant metabolism and growth.	**PS.01.01.02.b.** Determine the optimal air and temperature conditions for plant growth.	**PS.01.01.02.c.** Design, implement and evaluate a plan to maintain optimal air and temperature conditions for plant growth.
PS.01.01.03.a. Identify and summarize the effects of water quality on plant growth, (e.g., pH, dissolved solids, etc.).	**PS.01.01.03.b.** Analyze and describe plant responses to water conditions.	**PS.01.01.03.c.** Analyze plant responses to water conditions and recommend modifications to water for desired plant growth.

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

Sample Measurement: The following sample measurement strands are provided to guide the development of measurable activities (at different levels of proficiency) to assess students' attainment of knowledge and skills related to the above performance indicator. The topics represented by each strand are not all-encompassing.

PS.01.02.01.a. Identify the major components of growing media and describe how growing media support plant growth.	**PS.01.02.01.b.** Describe the physical and chemical characteristics of growing media and explain the influence they have on plant growth.	**PS.01.02.01.c.** Formulate and prepare growing media for specific plants or crops.
PS.01.02.02.a. Identify the categories of soil water.	**PS.01.02.02.b.** Discuss how soil drainage and water-holding capacity can be improved.	**PS.01.02.02.c.** Determine the hydraulic conductivity for soil and how the results influence irrigation practices.

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

Sample Measurement: The following sample measurement strands are provided to guide the development of measurable activities (at different levels of proficiency) to assess students' attainment of knowledge and skills related to the above performance indicator. The topics represented by each strand are not all-encompassing.

PS.01.03.01.a. Identify the essential nutrients for plant growth and development and their major functions (e.g., nitrogen, phosphorous, potassium, etc.).	**PS.01.03.01.b.** Analyze the effects of nutrient deficiencies and symptoms and recognize environmental causes of nutrient deficiencies.	**PS.01.03.01.c.** Monitor plants for signs of nutrient deficiencies and prepare a scouting report to correct elements negatively affecting plant growth in a field or greenhouse.
PS.01.03.02.a. Discuss the influence of pH and cation exchange capacity on the availability of nutrients.	**PS.01.03.02.b.** Contrast pH and cation exchange capacity between mineral soil and soilless growing media.	**PS.01.03.02.c.** Adjust the pH of growing media for specific plants or crops.
PS.01.03.03.a. Collect soil and plant tissue samples using generally accepted procedures and explain how incorrect sample collection will affect the results of a laboratory analysis.	**PS.01.03.03.b.** Interpret laboratory analyses of soil and tissue samples.	**PS.01.03.03.c.** Prescribe fertilizer applications based on the results of a laboratory analysis of soil and plant tissue samples.
PS.01.03.04.a. Identify fertilizer sources of essential plant nutrients; explain fertilizer formulations, including organic and inorganic; and describe different methods of fertilizer application.	**PS.01.03.04.b.** Calculate the amount of fertilizer to be applied based on nutrient recommendation and fertilizer analysis.	**PS.01.03.04.c.** Calibrate application equipment to meet plant nutrient needs.
PS.01.03.05.a. Research and summarize production methods focused on soil management (e.g., crop rotation, companion planting, cover crops, etc.).	**PS.01.03.05.b.** Assess and describe the short- and long-term effects production methods have on soil.	**PS.01.03.05.c.** Devise a plan for soil management for a selected production method.
PS.01.03.06.a. Summarize the impact of environmental factors on nutrient availability (e.g., moisture, temperature, pH, etc.).	**PS.01.03.06.b.** Assess and describe the impact environmental factors have on a crop.	**PS.01.03.06.c.** Devise a plan to meet plant nutrient needs based on environmental factors present.

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

PS.02.01. Classify plants according to taxonomic systems.

Sample Measurement: The following sample measurement strands are provided to guide the development of measurable activities (at different levels of proficiency) to assess students' attainment of knowledge and skills related to the above performance indicator. The topics represented by each strand are not all-encompassing.

PS.02.01.01.a. Identify and summarize systems used to classify plants based on specific characteristics.	**PS.02.01.01.b.** Compare and contrast the hierarchical classification of agricultural and ornamental plants.	**PS.02.01.01.c.** Classify agricultural and ornamental plants according to the hierarchical classification system
PS.02.01.02.a. Describe the morphological characteristics used to identify agricultural and herbaceous plants (e.g., life cycles, growth habit, plant use and as monocotyledons or dicotyledons, woody, herbaceous, etc.).	**PS.02.01.02.b.** Identify and describe important plants to agricultural and ornamental plant systems by common names.	**PS.02.01.02.c.** Identify and describe important plants to agricultural and ornamental plant systems by scientific names.

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

Sample Measurement: The following sample measurement strands are provided to guide the development of measurable activities (at different levels of proficiency) to assess students' attainment of knowledge and skills related to the above performance indicator. The topics represented by each strand are not all-encompassing.

PS.02.02.01.a. Identify structures in a typical plant cell and summarize the function of plant cell organelles.	**PS.02.02.01.b.** Compare and contrast mitosis and meiosis.	**PS.02.02.01.c.** Apply the knowledge of cell differentiation and the functions of the major types of cells to plant systems.
PS.02.02.02.a. Identify and summarize the components, the types and the functions of plant roots.	**PS.02.02.02.b.** Analyze root tissues and explain the pathway of water and nutrients into and through root tissues.	**PS.02.02.02.c.** Correlate the active and passive transport of minerals into and through the root system to plant nutrition.
PS.02.02.03.a. Identify and summarize the components and the functions of plant stems.	**PS.02.02.03.b.** Analyze and describe the difference in arrangement of vascular tissue between monocot and dicot plant stems.	**PS.02.02.03.c.** Evaluate the function of the xylem, phloem and cambium tissues and the impact on plant systems.
PS.02.02.04.a. Research and summarize leaf morphology and the functions of leaves.	**PS.02.02.04.b.** Analyze how leaves capture light energy and summarize the exchange of gases.	**PS.02.02.04.c.** Devise a plan for plant management practices that takes into account leaf structure and functions.

PS.02.02.05.a. Identify and summarize the components of a flower, the functions of a flower and the functions of flower components.	**PS.02.02.05.b.** Apply knowledge of flower structure to differentiate between the types of flowers and flower inflorescence (e.g., complete, incomplete, perfect, imperfect).	**PS.02.02.05.c.** Evaluate flower structures and analyze the impact of plant structure on plant breeding, production and use.
PS.02.02.06.a. Identify and summarize the functions and components of seeds and fruit.	**PS.02.02.06.b.** Analyze and categorize the major types of seeds and fruit.	**PS.02.02.06.c.** Evaluate the impact of different seed and fruit structures to plant culture and use.
PS.02.03. Apply knowledge of plant physiology and energy conversion to plant systems.		
Sample Measurement: The following sample measurement strands are provided to guide the development of measurable activities (at different levels of proficiency) to assess students' attainment of knowledge and skills related to the above performance indicator. The topics represented by each strand are not all-encompassing.		
PS.02.03.01.a. Summarize the importance of photosynthesis to plant life on earth and the process of photosynthesis, including the types (c3, c4, Cam), its stages (e.g., light-dependent and light independent reactions), and its products and byproducts.	**PS.02.03.01.b.** Apply knowledge of photosynthesis to analyze how various environmental factors will affect the rate of photosynthesis.	**PS.02.03.01.c.** Evaluate the impact of photosynthesis and the factors that affect it on plant management, culture and production problems.
PS.02.03.02.a. Summarize the stages of cellular respiration including their products and byproducts.	**PS.02.03.02.b.** Analyze the factors that affect cellular respiration processes and rate in a crop production setting.	**PS.02.03.02.c.** Evaluate the impact of plant respiration on plant growth, crop management and post-harvest handling decisions.
PS.02.03.03.a. Summarize primary growth and the role of the apical meristem.	**PS.02.03.03.b.** Analyze plant growth and assess the process of secondary plant growth.	**PS.02.03.03.c.** Relate the principles of primary and secondary growth to plant systems.
PS.02.03.04.a. Identify and categorize the five groups of naturally occurring plant hormones and synthetic plant growth regulators.	**PS.02.03.04.b.** Analyze and identify the plant responses to plant growth regulators and different forms of tropism.	**PS.02.03.04.c.** Select and defend the use of specific plant growth regulators to produce desired responses from plants.
PS.02.03.05.a. Compare and contrast the effects of transpiration, translocation and assimilation on plants.	**PS.02.03.05.b.** Identify and analyze the factors affecting transpiration, translocation and assimilation rate and products.	**PS.02.03.05.c.** Devise plans for plant management that applies knowledge of transpiration, translocation and assimilation on plant growth.

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

PS.03.01. Demonstrate plant propagation techniques in plant system activities.

Sample Measurement: The following sample measurement strands are provided to guide the development of measurable activities (at different levels of proficiency) to assess students' attainment of knowledge and skills related to the above performance indicator. The topics represented by each strand are not all-encompassing.

PS.03.01.01.a. Identify examples of and summarize pollination, cross-pollination and self-pollination of flowering plants.	**PS.03.01.01.b.** Examine and apply the process of plant pollination and/or fertilization.	**PS.03.01.01.c.** Select and defend the use of pollination methods and practices used to maximize crop pollination.
PS.03.01.02.a. Demonstrate sowing techniques for providing favorable conditions to meet the factors of seed germination.	**PS.03.01.02.b.** Handle seed to overcome seed dormancy mechanisms and to maintain seed viability and vigor.	**PS.03.01.02.c.** Conduct tests associated with seed germination rates, viability and vigor.
PS.03.01.03.a. Summarize optimal conditions for asexual propagation and demonstrate techniques used to propagate plants by cuttings, division, separation, layering, budding and grafting.	**PS.03.01.03.b.** Manage the plant environment to support asexual reproduction.	**PS.03.01.03.c.** Evaluate asexual propagation practices based on productivity and efficiency.
PS.03.01.04.a. Define micropropagation, discuss advantages associated with the practice and summarize the main stages of the process.	**PS.03.01.04.b.** Demonstrate aseptic micropropagation techniques.	**PS.03.01.04.c.** Propagate plants by micropropagation.
PS.03.01.05.a. Summarize the principles of recombinant DNA technology and the basic steps in the process.	**PS.03.01.05.b.** Compare and contrast the potential risks and advantages associated with genetically modified plants.	**PS.03.01.05.c.** Evaluate the impact of using genetically modified crops on other production practices.

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

Sample Measurement: The following sample measurement strands are provided to guide the development of measurable activities (at different levels of proficiency) to assess students' attainment of knowledge and skills related to the above performance indicator. The topics represented by each strand are not all-encompassing.

PS.03.02.01.a. Research and summarize the importance of starting with pest- and disease-free propagation material.	**PS.03.02.01.b.** Inspect propagation material for evidence of pests or disease.	**PS.03.02.01.c.** Produce pest- and disease-free propagation material.

PS.03.02.02.a. List and summarize the reasons for preparing growing media before planting.	**PS.03.02.02.b.** Prepare soil and growing media for planting with the addition of amendments.	**PS.03.02.02.c.** Analyze how mechanical planting equipment performs soil preparation and seed placement.
PS.03.02.03.a. Determine seeding rate need for specified plant population or desired quantity of finished plants.	**PS.03.02.03.b.** Apply pre-plant treatments required of seeds and plants and evaluate the results.	**PS.03.02.03.c.** Adjust and calibrate mechanized seeding and/or planting equipment for desired seed application rate.
PS.03.02.04.a. Observe and record environmental conditions during the germination, growth and development of a crop.	**PS.03.02.04.b.** Monitor the progress of plantings and determine the need to adjust environmental conditions.	**PS.03.02.04.c.** Prepare and implement a plant production schedule based on predicted environmental conditions and desired market target (e.g., having plants ready to market on a specific day such as Mother's Day, organic production, low maintenance landscape plants, etc.).
PS.03.02.05.a. Summarize the stages of plant growth and the reasons for controlling plant growth.	**PS.03.02.05.b.** Demonstrate proper techniques to control and manage plant growth through mechanical, cultural or chemical means.	**PS.03.02.05.c.** Prepare plant production schedules utilizing plant growth knowledge to get plants to their optimal growth stage at a given time.
PS.03.02.06.a. Identify and categorize structures and technologies used for controlled atmosphere production of plants.	**PS.03.02.06.b.** Compare and contrast the types of technologies used for controlled atmosphere production.	**PS.03.02.06.c.** Research, select and defend technology for use in controlled atmosphere production.
PS.03.02.07.a. Summarize the use of hydroponic and aquaponic systems for plant production.	**PS.03.02.07.b.** Compare and contrast the types of systems used in hydroponic and aquaponic plant production.	**PS.03.02.07.c.** Research, select and defend the use of a hydroponic or aquaponic plant system.
 **PS.03.03. Develop and implement a plan for integrated pest management for plant production.**		
 Sample Measurement: The following sample measurement strands are provided to guide the development of measurable activities (at different levels of proficiency) to assess students' attainment of knowledge and skills related to the above performance indicator. The topics represented by each strand are not all-encompassing.		
PS.03.03.01.a. Identify and categorize plant pests, diseases and disorders.	**PS.03.03.01.b.** Identify and analyze major local weeds, insect pests and infectious and noninfectious plant diseases.	**PS.03.03.01.c.** Devise solutions for plant pests, diseases and disorders.
PS.03.03.02.a. Diagram the life cycle of major plant pests and diseases.	**PS.03.03.02.b.** Predict pest and disease problems based on environmental conditions and life cycles.	**PS.03.03.02.c.** Design and implement a crop scouting program.

PS.03.03.03.a. Identify and summarize pest control strategies associated with integrated pest management and the importance of determining economic threshold.	**PS.03.03.03.b.** Demonstrate pesticide formulations including organic and synthetic active ingredients and selection of pesticide to control specific pest.	**PS.03.03.03.c.** Employ pest management strategies to manage pest populations, assess the effectiveness of the plan and adjust the plan as needed.
PS.03.03.04.a. Distinguish between risks and benefits associated with the materials and methods used in plant pest management.	**PS.03.03.04.b.** Examine and apply procedures for the safe handling, use and storage of pesticides including personal protective equipment and reentry interval.	**PS.03.03.04.c.** Evaluate environmental and consumer concerns regarding pest management strategies.
PS.03.04. Apply principles and practices of sustainable agriculture to plant production.		
Sample Measurement: The following sample measurement strands are provided to guide the development of measurable activities (at different levels of proficiency) to assess students' attainment of knowledge and skills related to the above performance indicator. The topics represented by each strand are not all-encompassing.		
PS.03.04.01.a. Compare and contrast the alignment of different production systems (conventional and organic) with USDA sustainable practices criteria.	**PS.03.04.01.b.** Analyze the alignment of modern technologies used in production systems (e.g., precision agriculture, GE crops, etc.) with USDA sustainable practices criteria.	**PS.03.04.01.c.** Research, prepare and defend plans for a plant systems enterprise that aligns with USDA sustainable practices criteria.
PS.03.04.02.a. Summarize national/international and local/regional food production systems.	**PS.03.04.02.b.** Compare and contrast the impact on greenhouse gas, carbon footprint of the national/international production system with local/regional production system markets.	**PS.03.04.02.c.** Select and defend the use of nationally/internationally grown or locally/regionally grown for a production operation system.
PS.03.04.03.a. Identify and summarize impacts of environmental conditions on plants.	**PS.03.04.03.b.** Compare and contrast differing research conclusions related to environmental factors and their effect on plants.	**PS.03.04.03.c.** Evaluate evidence supporting claims on how environmental conditions effect plants.
PS.03.05. Harvest, handle and store crops according to current industry standards.		
Sample Measurement: The following sample measurement strands are provided to guide the development of measurable activities (at different levels of proficiency) to assess students' attainment of knowledge and skills related to the above performance indicator. The topics represented by each strand are not all-encompassing.		
PS.03.05.01.a. Identify and summarize harvesting methods and equipment.	**PS.03.05.01.b.** Assess the stage of growth to determine crop maturity or marketability and demonstrate proper harvesting techniques.	**PS.03.05.01.c.** Analyze the processed used by mechanical harvesting equipment.

PS.03.05.02.a. Research and summarize reasons for calculating crop loss and or damage.	**PS.03.05.02.b.** Evaluate crop yield and loss data and make recommendations to reduce crop loss.	**PS.03.05.02.c.** Implement and evaluate the effectiveness of plans to reduce crop loss.
PS.03.05.03.a. Research and summarize how safety is ensured at each stage of the following processes: harvesting, processing and storing.	**PS.03.05.03.b.** Research and analyze practices used to maintain a safe product through harvest, processing, storage and shipment (e.g., Food Safety Modernization Act, Good Agricultural Practices, etc.).	**PS.03.05.03.c.** Research laws and apply regulations to ensure the production of plants and plant products that are safe for distribution and use.
PS.03.05.04.a. Identify and categorize plant preparation methods for storing and shipping plants and plant products.	**PS.03.05.04.b.** Analyze the proper conditions required to maintain the quality of plants and plant products held in storage and during shipping.	**PS.03.05.04.c.** Monitor and evaluate environmental conditions in storage facilities for plants and plant products.
PS.03.05.05.a. Summarize the reasons for preparing plants and plant products for distribution.	**PS.03.05.05.b.** Demonstrate techniques for grading, handling and packaging plants and plant products for distribution.	**PS.03.05.05.c.** Evaluate techniques for grading, handling and packaging plants and plant products.
PS.04. Apply principles of design in plant systems to enhance an environment (e.g. floral, forest landscape, and farm).		
PS.04.01. Evaluating, identifying and preparing plants to enhance an environment.		
Sample Measurement: The following sample measurement strands are provided to guide the development of measurable activities (at different levels of proficiency) to assess students' attainment of knowledge and skills related to the above performance indicator. The topics represented by each strand are not all-encompassing.		
PS.04.01.01.a. Identify and categorize plants by their purpose (e.g., floral plants, landscape plants, house plants, etc.).	**PS.04.01.01.b.** Demonstrate proper use of plants in their environment (e.g., focal and filler plants in floriculture, heat tolerant and shade plants in a landscape design, etc.).	**PS.04.01.01.c.** Install plants according to a design plan that uses the proper plants based on the situation and environment.
PS.04.01.02.a. Summarize the applications of design in agriculture and ornamental plant systems.	**PS.04.01.02.b.** Create a design utilizing plants in their proper environments.	**PS.04.01.02.c.** Evaluate a design and provide feedback and suggestions for improvement (e.g., a floral arrangement, a landscape or a landscape plan, etc.).

PS.04.02. Create designs using plants.		
Sample Measurement: The following sample measurement strands are provided to guide the development of measurable activities (at different levels of proficiency) to assess students' attainment of knowledge and skills related to the above performance indicator. The topics represented by each strand are not all-encompassing.		
PS.04.02.01.a. Research and summarize the principles and elements of design for use in plant systems.	**PS.04.02.01.b.** Apply principles and elements of design that form the basis of artistic impression.	**PS.04.02.01.c.** Analyze designs to identify use of design principles and elements.
PS.04.02.02.a. Identify and categorize tools used for design (e.g., computer landscape software, drawing tools, florist tools, etc.).	**PS.04.02.02.b.** Demonstrate the use of tools used for creating designs.	**PS.04.02.02.c.** Choose and properly use appropriate tools to create a desired design..
PS.04.02.03.a. Explain the concept of landscape ecology and summarize factors that shape the ecology of a landscape (e.g., composition, structure, function, etc.).	**PS.04.02.03.b.** Research and provide examples of ecological factors incorporated into landscape designs.	**PS.04.02.03.c.** Utilize green technologies and sustainable practices that prevent or limit negative environmental impacts.