

## Statewide Dual Credit Learning Objectives

### Introduction to Plant Science

Topic 1: Plant Anatomy and Physiology		Sub-Objectives
<b>1a</b>	<p><b>Describe the characteristic features of a plant cell.</b></p> <p><b>Keywords/Key concepts:</b> cell wall, chloroplast, central vacuole, plasmodesmata</p>	<ul style="list-style-type: none"> <li>• List the cellular components of a eukaryotic cell</li> <li>• Identify the unique cellular components of a plant cell</li> <li>• Describe basic structure and function of a plant cell wall, chloroplast, central vacuole and plasmodesmata</li> </ul>
<b>1b</b>	<p><b>Describe plant cell types and tissues.</b></p> <p><b>Keywords/Key concepts:</b> dermal tissue, ground tissue, vascular tissues: xylem &amp; phloem, parenchyma cells, collenchyma cells, sclerenchyma cells</p>	<ul style="list-style-type: none"> <li>• List three tissue types in plants</li> <li>• Describe identifying features of dermal tissue</li> <li>• List the most common modifications of dermal tissue</li> <li>• List two types of vascular tissues.</li> <li>• Explain the structure of xylem tracheids and xylem vessels</li> <li>• Explain the structure of a sieve tube member and companion cell</li> <li>• Differentiate between xylem &amp; phloem</li> <li>• List the three types of plant cells</li> <li>• List the identifying features of parenchyma, collenchyma, and sclerenchyma cells and their modifications</li> </ul>
<b>1c</b>	<p>Describe the features of vegetative plant parts.</p> <p><b>Keywords/Key concepts:</b> roots (fibrous &amp; tap), stem and leaf; monocot vs. dicot crops</p>	<ul style="list-style-type: none"> <li>• Identify the shoot &amp; root system of a plant</li> <li>• Differentiate between a monocot and a dicot plant</li> <li>• List types of root, stem, and leaf modifications</li> </ul>
<b>1d</b>	<p><b>Explain the stages of plant growth.</b></p> <p><b>Keywords/Key concepts:</b> phase changes in plants from vegetative to reproductive, meristem, primary and secondary growth, annual, biennial, &amp; perennial plants</p>	<ul style="list-style-type: none"> <li>• Identify factors that influence the transition of a plant from the vegetative to reproductive phase</li> <li>• List the differences between two kinds of meristem</li> <li>• Differentiate between annual, biennial, &amp; perennial plants</li> </ul>
<b>1e</b>	<p><b>Describe the reproductive parts of the plant.</b></p> <p><b>Keywords/Key concepts:</b> the structure of a flower, complete vs. incomplete flowers, perfect vs. imperfect flowers, monoecious vs. dioecious plants</p>	<ul style="list-style-type: none"> <li>• List the parts of a typical angiosperm flower</li> <li>• Differentiate between complete and incomplete flowers</li> <li>• Differentiate between perfect and imperfect flowers</li> <li>• Differentiate between monoecious and dioecious plants</li> </ul>
Topic 2: Plant Function		Sub-Objectives
<b>2a</b>	<p><b>Describe the stages of cellular respiration.</b></p> <p><b>Keywords/Key concepts:</b> glycolysis, Krebs cycle, Electron transport chain, oxidative phosphorylation, fermentation</p>	<ul style="list-style-type: none"> <li>• Explain the process of glycolysis</li> <li>• Distinguish between aerobic respiration &amp; fermentation</li> <li>• Explain how the Krebs cycle oxidizes pyruvate</li> <li>• Explain the fate of the electrons in the ETC</li> <li>• Explain how production of ATP is called oxidative phosphorylation</li> </ul>
<b>2b</b>	<p><b>Illustrate the two stages of photosynthesis.</b></p>	<ul style="list-style-type: none"> <li>• Explain the structure of a chloroplast</li> </ul>

	<p><b>Keywords/Key concepts:</b> light dependent phase, light independent phase</p>	<ul style="list-style-type: none"> <li>• Describe steps in the light dependent reaction of photosynthesis</li> <li>• Describe steps in the light independent reaction of photosynthesis</li> <li>• Differentiate between C3, C4, and CAM plants</li> </ul>
2c	<p><b>Explain cohesion-tension theory of water movement in xylem.</b></p> <p><b>Keywords/Key concepts:</b> xylem water transport, turgor pressure, transpiration, water potential, apoplastic, symplastic, and trans-membrane transport, mineral transport</p>	<ul style="list-style-type: none"> <li>• Identify the components of water potential</li> <li>• Define transpiration</li> <li>• Explain cohesion tension theory of xylem transport</li> </ul>
2d	<p><b>Discuss how environmental factors (solar radiations, water availability, temperature, and air movement) effect plant growth.</b></p> <p><b>Keywords/Key concepts:</b> solar intensity, phytochromes and photoperiod, soil water saturation levels (flooding to drought), fluctuation in temperatures, air movement (slight breeze to gusty winds)</p>	<ul style="list-style-type: none"> <li>• List the effects of high intensity and low intensity light on photosynthesis</li> <li>• Explain how plants adapt to changes in solar intensity</li> <li>• List drought and flood adaptations</li> </ul>
2e	<p><b>Explain phloem translocation process.</b></p> <p><b>Keywords/Key Concepts:</b> source-sink relationship, bulk flow of photosynthates in phloem, nutrient transport</p>	<ul style="list-style-type: none"> <li>• Explain how phloem transport is driven by osmotically generated pressure flow</li> </ul>
2f	<p><b>Discuss the role of plant hormones.</b></p> <p><b>Keywords/Key Concepts:</b> five classic plant hormones: auxin, gibberellins, cytokinin, abscisic acid, ethylene, commercial use of plant hormones in pest and weed control and other horticultural practices</p>	<ul style="list-style-type: none"> <li>• List the six major plant hormones</li> <li>• Describe some of the effects caused by each of the plant hormones</li> </ul>
<b>Topic 3: Plant Reproduction and Propagation</b>		<b>Sub-Objectives</b>
3a	<p><b>Explain the stages of sexual reproduction in plants.</b></p> <p><b>Keywords/Key Concepts:</b> alternation of generations, ploidy (haploid, diploid, and polyploid), male and female gametophytes, formation of pollen grain and embryo sac; meiosis, mitosis, and homologous/genetic recombination; self and cross pollination; fertilization, double fertilization</p>	<ul style="list-style-type: none"> <li>• Introduce the alternation of generations in a plant's life cycle and discuss ploidy</li> <li>• Describe the development of male and female gametophytes (reproductive structures)</li> <li>• Contrast mitosis and meiosis and explain the significance in the development of reproductive structures</li> <li>• Define pollination and the process of self-pollination and cross-pollination</li> <li>• Define double fertilization and the process that leads to seed/embryo/zygote and endosperm development</li> </ul>
3b	<p><b>Evaluate the vegetative plant propagation techniques utilized in agriculture and horticulture.</b></p> <p><b>Keywords/Key Concepts:</b> layering, grafting, bulbs, stolons, runners, cuttings, tissue culture</p>	<ul style="list-style-type: none"> <li>• Describe the characteristics of plants that reproduce asexually</li> <li>• Discuss natural and artificial methods of asexual reproduction</li> <li>• Describe the advantages and disadvantages of asexual reproduction</li> </ul>
3c	<p><b>Explain how basis for inheritance of traits.</b></p>	<ul style="list-style-type: none"> <li>• Introduce heredity and Mendel's laws</li> </ul>

	<b>Keywords/Key Concepts:</b> heredity, Mendel's laws, phenotype, genotype, alleles, dominant, recessive; laws of inheritance; plant breeding, artificial selection; homozygous, and heterozygous	<ul style="list-style-type: none"> <li>• Discuss the relationship between phenotype and genotype</li> <li>• Introduce plant breeding, hybridization, artificial selection and domestication</li> </ul>
<b>3d</b>	<b>Explain, with at least two examples, the influence of genetic engineering on agriculture.</b>  <b>Keywords/Key Concepts:</b> IR=insect resistant, HT=herbicide tolerant, DT=drought tolerant, VR=virus resistant. Examples: Bt Corn/Bt cotton	<ul style="list-style-type: none"> <li>• Describe the basics of plant biotechnology/genetic engineering</li> <li>• Compare conventional breeding and genetic engineering</li> <li>• Explain the significance of agricultural biotechnology</li> </ul>
<b>3e</b>	<b>Discuss the significance of germplasm conservation.</b>  <b>Keywords/Key Concepts:</b> germplasm, gene banks, seed banks	<ul style="list-style-type: none"> <li>• Explain the need for germplasm conservation</li> <li>• Discuss the common conservation activities and resources</li> </ul>

#### Topic 4: Soil, Mediums, and Plant Nutrition

#### Sub-Objectives

<b>4a</b>	<b>Examine the physical and hydrological features of the soil.</b>  <b>Keywords/Key Concepts:</b> soil formation, soil profile, properties of soil; types of soil (clay, silt, loam, sandy); permanent wilting point, field capacity, saturation water content	<ul style="list-style-type: none"> <li>• Explain a vertical section of soil</li> <li>• Describe the three horizons of soil</li> <li>• Distinguish among various soil types: clay, silt, loam &amp; sandy</li> <li>• Explain how pore size dictates field capacity, PWP, and SWC</li> </ul>
<b>4b</b>	<b>Illustrate the hydrological cycle and discuss its significance to plant growth and development.</b>  <b>Keywords/Key Concepts:</b> precipitation, condensation, transpiration, evaporation, runoff, ground water	<ul style="list-style-type: none"> <li>• Explain the role of precipitation &amp; condensation in the water cycle</li> <li>• Describe how transpiration from plants affects the water cycle</li> <li>• Distinguish between runoff and ground water</li> </ul>
<b>4c</b>	<b>Explain the chemical properties of the soil and soil/medium pH on nutrient availability.</b>  <b>Keywords/Key Concepts:</b> acidic soil, alkaline soil, how the pH of soil affects cation exchange of minerals with root hair, leaching of anionic minerals and soil treatments to enhance nutrient availability for plants, electrical conductivity	<ul style="list-style-type: none"> <li>• Explain how soil pH affect nutrient availability for plants</li> <li>• Describe the process of cation exchange</li> <li>• Explain how negatively charged mineral ions are more likely to be leached</li> </ul>
<b>4d</b>	<b>Explain the types and utility for soilless substrata for plant growth.</b>  <b>Keywords/Key Concepts:</b> hydroponics, synthetic substrates, tissue culture medium	<ul style="list-style-type: none"> <li>• Identify the different types of soilless cultures</li> <li>• Discuss the advantages of alternate growth medium</li> </ul>
<b>4e</b>	<b>Distinguish between the major and minor plant nutrients and deficiency symptoms.</b>  <b>Keywords/Key Concepts:</b> NPK as well as other major and minor nutrients, how these nutrients are identified as major or minor based on dry weight of the plant, nitrogen fixation by symbiotic bacteria, phosphorus absorption by mycorrhizae	<ul style="list-style-type: none"> <li>• Identify the major and minor plant nutrients</li> <li>• List the most common symptoms of nutrient deficiency in plants</li> <li>• Explain the process of nitrogen fixation by bacteria</li> <li>• Describe phosphorus absorption</li> </ul>
<b>4f</b>	<b>Discuss the importance of soil organic matter (SOM) and the biological community of soil.</b>	<ul style="list-style-type: none"> <li>• Explain the process of primary and secondary ecological succession</li> </ul>

	<p><b>Keywords/Key Concepts:</b> how organic matter slowly accumulates in newly formed soil and how diversity of bacteria and fungi in soil decompose the organic matter that is reabsorbed into plants.</p>	<ul style="list-style-type: none"> <li>• Explain the significance of soil biodiversity and organic matter</li> </ul>
4g	<p><b>Describe different fertilizer application techniques.</b></p> <p><b>Keywords/Key Concepts:</b> fertigation, sidedress, broadcast, injection, foliar, topdress</p>	<ul style="list-style-type: none"> <li>• Describe the advantages and limitations of various fertilizer application methods</li> </ul>
<b>Topic 5: Plant Classifications and Use</b>		<b>Sub-Objectives</b>
5a	<p><b>Identify examples of field crops, forage crops, vegetable crops, and fruit crops.</b></p> <p><b>Keywords/Key Concepts:</b> corn, cotton, cereals, oil crops, vegetable crops, fruit crops, pulses</p>	<ul style="list-style-type: none"> <li>• Select examples of common field crops from the list provided</li> <li>• Select examples of common forage crops from the list provided</li> <li>• Select examples of common vegetable crops from the list provided</li> <li>• Select examples of common fruit crops from the list provided</li> </ul>
5b	<p><b>Identify common uses of field crops, forage crops, vegetable crops, and fruit crops.</b></p> <p><b>Keywords/Key Concepts:</b> animal feed, sweeteners, oil, silage</p>	<ul style="list-style-type: none"> <li>• Select common uses of field crops from the list provided</li> <li>• Select common uses of forage crops from the list provided</li> <li>• Select common uses of vegetable crops from the list provided</li> <li>• Select common uses of fruit crops from the list provide</li> </ul>
5c	<p><b>Explain common production practices for field crops, forage crops, vegetable crops, and fruit crops.</b></p> <p><b>Keywords/Key Concepts:</b> row crops, intercropping, crop rotation, sequential cropping, ratooning, mixed cropping, conservation tillage, no-till agriculture</p>	<ul style="list-style-type: none"> <li>• Describe common field crop production practices</li> <li>• Describe common forage crop production practices</li> <li>• Describe common vegetable crop production practices</li> <li>• Describe common fruit crop production practices</li> </ul>
5d	<p><b>Evaluate the economic impact of field crops, forage crops, vegetable crops and fruit crops.</b></p> <p><b>Keywords/Key Concepts:</b> bushels per acre calculation, land cost, return on investment (ROI), depreciation</p>	<ul style="list-style-type: none"> <li>• Explain the significance of ROI to investment decision making</li> <li>• Evaluate the role of depreciation in evaluating production of crops</li> </ul>
5e	<p><b>Defend the need for genetic diversity in cropping systems.</b></p> <p><b>Keywords/Key Concepts:</b> monoculture, polyculture, vulnerability, crop rotation</p>	<ul style="list-style-type: none"> <li>• Identify various cropping systems that promote genetic diversity</li> <li>• Recognize the advantages and disadvantages related to genetic diversity</li> </ul>
<b>Topic 6: Nursery Production</b>		<b>Sub-Objectives</b>
6a	<p><b>Evaluate the factors that influence site selection of a production nursery.</b></p> <p><b>Keywords/Key Concepts:</b> soil, water supply, climate, drainage, location, distance to market, supply chain</p>	<ul style="list-style-type: none"> <li>• Identify factors that influence nursery site selection</li> <li>• Explain the influence of climate, soil, water, topography, previous land use, site potential, and location to nursery site selection</li> </ul>
6b	<p><b>Compare various growing methods for nursery production.</b></p>	<ul style="list-style-type: none"> <li>• Describe B&amp;B, pot-in-pot, in-ground fabric containers, and bare root growing methods</li> </ul>

	<b>Keywords/Key Concepts:</b> B&B, containerized, bare root	<ul style="list-style-type: none"> <li>Identify advantages and disadvantages of the various growing methods for nursery production</li> <li>Explain the impact of growing method on transplant success</li> </ul>
<b>6c</b>	<b>Identify various environmental factors that influence landscape plant selection.</b>  <b>Keywords/Key Concepts:</b> photoperiod, hardiness, nativity, availability, durability	<ul style="list-style-type: none"> <li>Describe the influence of photoperiod, hardiness, nativity, availability, and durability on landscape plant selection</li> </ul>
<b>6d</b>	<b>Evaluate the sustainable use of irrigation systems for a variety of plant production systems.</b>  <b>Keywords/Key Concepts:</b> water balance, surface evaporation, crop coefficient, drip emitters, drip lines, spray, micro spray, grey water	<ul style="list-style-type: none"> <li>Determine the role of water balance, surface evaporation, and crop coefficient in determining irrigation needs</li> <li>Explain the use of drip emitters, drip line, spray, micro spray, and grey water in sustainable irrigation design</li> </ul>

**Topic 7: Controlled Environment Production**

**Sub-Objectives**

<b>7a</b>	<b>Create a controlled environment growing schedule.</b>  <b>Keywords/Key Concepts:</b> days to maturity, warm season, cool season	<ul style="list-style-type: none"> <li>Explain the use of days to maturity in creating a controlled environment growing schedule</li> <li>Differentiate the needs of warm season and cool season crops in creating a controlled environment growing schedule</li> </ul>
<b>7b</b>	<b>Match specific crops with appropriate controlled environment production systems.</b>  <b>Keywords/Key Concepts:</b> crop selection, controlled environment systems evaluation	<ul style="list-style-type: none"> <li>Identify common crops grown in a variety of controlled environment systems</li> </ul>
<b>7c</b>	<b>Explain a variety of different controlled environment systems.</b>  <b>Keywords/Key Concepts:</b> Greenhouse, high tunnel, cold frame, vertical farming, hydroponics, aquaponics, aeroponics	<ul style="list-style-type: none"> <li>Define greenhouse, high tunnel, cold frame, vertical farming, hydroponics, aquaponics, and aeroponics</li> <li>Evaluate the use of greenhouse, high tunnel, cold frame, vertical farming, hydroponics, aquaponics, and aeroponics</li> </ul>
<b>7d</b>	<b>Defend the benefits of hydroponic production in comparison to soil-based production.</b>  <b>Keywords/Key Concepts:</b> water efficiency, production efficiency, nutrient management, climate control, disease management	<ul style="list-style-type: none"> <li>Compare hydroponic growth to soil-based production</li> <li>Explain the advantages and disadvantages of hydroponic production</li> </ul>

**Topic 8: Plant Injuries and Their Control/Integrated Pest Management**

**Sub-Objectives**

<b>8a</b>	<b>Discuss the effects of pesticides on the environment and human health.</b>  <b>Keywords/Key Concepts:</b> leeching, runoff, acute toxicity, chronic toxicity	<ul style="list-style-type: none"> <li>Discuss how agriculture would be different with or without pesticide use</li> </ul>
<b>8b</b>	<b>Develop an understanding of Integrated Pest Management and how it is employed.</b>  <b>Keywords/Key Concepts:</b> multiple methods, threshold	<ul style="list-style-type: none"> <li>Devise a IPM management plan for multiple crops within different systems</li> </ul>

<b>8c</b>	<b>Identify common weeds, insects, mites, and plant diseases.</b>  <b>Keywords/Key Concepts:</b> Weed ID, Insect ID, Plant Injury ID	<ul style="list-style-type: none"> <li>• Recognize plant distress and possible causes</li> <li>• Expand on the differences between beneficial and non-beneficial insects</li> <li>• List different parasitoids, predators, and/or pathogens that can be used to manage insect and mite pest populations in crops</li> </ul>
<b>8d</b>	<b>Compare plant and disease management practices to limit plant injury.</b>  <b>Keywords/Key Concepts:</b> cultural controls, mechanical controls, biological controls, genetic selection, government regulation	<ul style="list-style-type: none"> <li>• Understand selective vs. non-selective insect control</li> <li>• List insects that can be released as biological controls to manage insect pests</li> </ul>
<b>8e</b>	<b>List the stages of the disease cycle.</b>  <b>Keywords/Key Concepts:</b> inoculation, penetration, establishment, growth/reproduction, overwintering, spread	<ul style="list-style-type: none"> <li>• Illustrate the Disease Triangle</li> <li>• Explain the difference between biotic vs. abiotic diseases</li> </ul>
<b>8f</b>	<b>Demonstrate proper use of Personal Protective Equipment (PPE).</b>  <b>Keywords/Key Concepts:</b> gloves, apron, mask, respirator, goggles, boots	<ul style="list-style-type: none"> <li>• Match a pesticide label with proper PPE</li> </ul>
<b>8g</b>	<b>Describe how product label directions are used in proper application of chemicals.</b>  <b>Keywords/Key Concepts:</b> signal words, Restricted Entry Interval, PPE	<ul style="list-style-type: none"> <li>• Define: active ingredient, inert ingredient, MSDS, LD50</li> </ul>

**Topic 9: Impact of Plants and Horticulture on People**

**Sub-Objectives**

<b>9a</b>	<b>Explain the domestication of plants for agriculture.</b>  <b>Keywords/Key Concepts:</b> artificial selection, early hybridization	<ul style="list-style-type: none"> <li>• Explain the transition to agrarian lifestyle</li> </ul>
<b>9b</b>	<b>Demonstrate understanding of origin, evolution, and diversity of plant life.</b>  <b>Keywords/Key Concepts:</b> field crops, forage crops, vegetable, and fruit crops	<ul style="list-style-type: none"> <li>• Match major crops with original regions of domestication and wild progenitor</li> </ul>
<b>9c</b>	<b>Describe the various ways plants impact human well-being.</b>  <b>Keywords/Key Concepts:</b> psychological, restorative, physical, medicinal, physiological	<ul style="list-style-type: none"> <li>• Distinguish between the terms psychological and physiological</li> <li>• List research based psychological and physiological benefits of plants</li> </ul>
<b>9d</b>	<b>Describe and assess the influence of plants and their management on environmental sustainability and restoration.</b>  <b>Keywords/Key Concepts:</b> built environment, ecosystem services, functional plant material, water shed	<ul style="list-style-type: none"> <li>• Explain several guiding principles of sustainable site design</li> </ul>

<p><b>9e</b></p>	<p><b>Quantify the economic importance of plants in managed ecosystems and the impact of horticultural crops in food systems.</b></p> <p><b>Keywords/Key Concepts:</b> property value, social and economic value, food-scaping, production horticulture</p>	<ul style="list-style-type: none"> <li>• Give examples of how growing plants benefits people at the home-owner scale</li> <li>• Explain the economic impact of the larger green industry from an economical and environmental context</li> </ul>
<p><b>9f</b></p>	<p><b>Describe the social, spiritual, and cultural importance of plants to historical and contemporary communities of people.</b></p> <p><b>Keywords/Key Concepts:</b> cultural use of plants, weddings, funerals, religions ceremonies. Use and preservation of ecosystems</p>	<ul style="list-style-type: none"> <li>• Give specifics of how different cultures incorporate plants into their lives</li> </ul>
<p><b>9g</b></p>	<p><b>Communicate a variety of career choices available in the green industry.</b></p> <p><b>Keywords/Key Concepts:</b> green industry, jobs in horticulture and agriculture, definition of career related terms</p>	<ul style="list-style-type: none"> <li>• Explain why jobs in the green industry are important</li> <li>• List jobs examples in several categories within the green industry</li> </ul>