Module 4: Plant Growth, Management & Pest Control
Overview and Standards Alignment

Plant Growth, Management & Pest Control
This module explores how plant biology connects to **sustainable pest management systems**. Across three lessons, students investigate how plants allocate resources for growth and defense, how Integrated Pest Management (IPM) integrates multiple control strategies, and how rapid diagnostic tools prevent crop losses. By the end of Module 4, students will understand the trade-offs plants face between growth and defense, evaluate the sustainability of different pest management approaches, and recognize how innovation in diagnostics can improve **agricultural resilience**. The module emphasizes systems thinking, applied problem-solving, and hands-on design of sustainable agricultural practices.

Standards Alignment:
Next Generation Science Standards (NGSS) – Performance Expectations:
Disciplinary Core Ideas (DCIs) – This module ties into several DCIs by integrating key biology and ecology concepts into the applied context of crop health and pest management:

- **ESS3.C:** Human Impacts on Earth Systems. Students consider how sustainable plant health management (e.g., diagnostics, IPM) reduces chemical inputs and environmental impacts of farming.
- **LS2.A:** Interdependent Relationships in Ecosystems. Lesson C highlights plant–microbe–pathogen interactions and the role of beneficial microbes in supporting resilience, competition, and nutrient cycling in the rhizosphere.
- **LS1.C:** Organization for Matter and Energy Flow in Organisms. Lessons A and B emphasize how photosynthesis, source–sink relationships, and hormonal signaling drive plant growth and defense. Students examine how matter and energy allocation shift under stress (e.g., drought, pruning, herbivory).
- **LS2.C:** Ecosystem Dynamics, Functioning, and Resilience. Case studies of IPM show how ecological understanding of pests and pathogens leads to more resilient agricultural systems that reduce pesticide reliance.

Science and Engineering Practices (SEPs):
- **Asking Questions and Defining Problems:** Guiding questions such as “How do plants balance growth with defense?” and “How can diagnostics close the loop in IPM?” frame student inquiry.
- **Analyzing and Interpreting Data:** Students interpret graphs of hormone signaling pathways, diagnostic comparisons (PCR vs. LAMP/CRISPR), and microbial exchange networks.
- **Constructing Explanations and Designing Solutions:** In the IPM and microbial consortia activities, students design applied solutions to agricultural challenges using biological principles.
- **Engaging in Argument from Evidence:** Learners debate trade-offs in plant sugar allocation, or defend the use of rapid diagnostics based on cost, speed, and practicality evidence.
- **Using Mathematics and Computational Thinking:** Cost-of-delay math exercises, metabolic modeling thresholds (fungal density), and quantifying yield loss link mathematical reasoning to applied outcomes.

Crosscutting Concepts (CCCs):
- **Systems and System Models:** Plant health is taught as a system involving metabolic loops, source–sink sugar allocation, and IPM strategies that integrate diagnostics and ecology.
- **Energy and Matter:** Students examine how energy from photosynthesis is partitioned into growth vs. defense, and how microbial consortia cycle nutrients at the root interface.
- **Cause and Effect:** Lessons emphasize how stressors (pruning, pathogens, drought) trigger hormonal pathways, altering growth and defense outcomes.
- **Stability and Change:** Hormone trade-offs (jasmonic acid vs. salicylic acid) and pathogen dynamics illustrate system stability under pressure and the shifts needed to restore balance.

- **Influence of Science, Engineering, and Technology on Society and the Natural World:** Rapid diagnostics, IPM, and microbial engineering show how innovations improve sustainability and reduce chemical dependence.

California CTE Standards (Agriculture & Natural Resources Pathway):

Module 4 reinforces Foundation Standards from the Agriculture & Natural Resources (ANR) sector framework by embedding sustainable plant management practices into real-world agricultural contexts:

- **Foundation Standard 5:** Problem Solving and Critical Thinking. Students evaluate pest management options, analyze diagnostic tools, and model microbial interactions to solve complex agricultural challenges.
- **Foundation Standard 9:** Leadership and Teamwork. Group activities (designing IPM protocols, microbial consortia mapping) foster collaboration and applied teamwork.
- **Foundation Standard 11:** Demonstration and Application. Learners apply plant physiology and ecological knowledge to practical scenarios: source–sink stress responses, cost-of-delay math, and pathogen diagnostics.
- **Sustainable Agriculture Pathway Standard:** Students demonstrate the ability to "apply the principles of integrated pest management (IPM) and sustainable practices to improve crop production and reduce environmental impacts," directly through case studies, IPM design, and diagnostics integration.
- **Plant and Soil Science Pathway Standard:** Activities reinforce understanding of "plant growth, physiology, and environmental interactions," especially how hormones, source–sink dynamics, and microbial symbioses shape resilience.

UC A–G "D" Lab Science Alignment:

This module is designed to meet UC/CSU A–G "D" Laboratory Science requirements as part of an approved science course.

- **Inquiry & Hands-On Activities:** At least 20% of instructional time involves teacher-supervised lab-style work, including hormone pathway mapping, source–sink loop modeling, IPM design, and microbial consortia simulations.
- **Scientific Practices:** Students pose scientific questions, design pest management protocols, collect and analyze diagnostic comparisons, and construct evidence-based conclusions.
- **Interdisciplinary Science:** Module 4 integrates biology (plant physiology, hormones), microbiology (pathogens and beneficial microbes), and applied agricultural science (IPM and diagnostics).
- **Rigor & Depth:** Exit tickets, reflection prompts, and case study evaluations emphasize higher-order thinking and science communication skills, consistent with UC's expectations for laboratory science rigor.

Content supports NGSS disciplinary core ideas ESS3 (Human Impacts on Earth Systems) and LS2 (Ecosystem Dynamics, Interactions, and Biodiversity), while also engaging students in cross-cutting science and engineering practices such as modeling, data analysis, and designing solutions.