HIGH SCHOOL HORTICULTURE CURRICULUM

A Senior Project

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Bachelor of Science of Environmental Horticulture Science

by

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Abstract

Horticulture is just one of the many topics covered in a high school agriculture curriculum, and yet, there are very few lesson plans or resources available to teachers for these classes specifically. The objectives of this project were to compile a set of lesson plans, lab plans, and tests that would emphasize interactive and investigative learning. The lesson plans were written in such a way that they reflected a certain set of standards, set down by the state of California, and were meant to serve as a bare outline of topics that would be discussed within a week’s worth of lectures. The labs (as well as the in-class activities mentioned in the lesson plans) are supplemental to the lectures, emphasizing concepts learned in class, while allowing students to experiment and make determinations on these concepts for themselves. The tests were designed to test students’ abilities to recall and explain, in their own words, key concepts, processes, and terms that they learned during a couple weeks’ worth of classes. Tests consisted of multiple choice, essay, and short response questions. Overall, the resources created in this project covers all of the standards required by the state of California for both Ornamental Horticulture and Plant Sciences education, with particular stress on lab-based interactive learning.
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# TABLE OF CONTENTS

<table>
<thead>
<tr>
<th>Section</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>I. Introduction</td>
<td>1</td>
</tr>
<tr>
<td>II. Literature Review</td>
<td>2</td>
</tr>
<tr>
<td>III. Materials and Methods</td>
<td>7</td>
</tr>
<tr>
<td>IV. Results</td>
<td>8</td>
</tr>
<tr>
<td>a. Lesson Plans</td>
<td>8</td>
</tr>
<tr>
<td>b. Lab Plans</td>
<td>36</td>
</tr>
<tr>
<td>c. Exams</td>
<td>49</td>
</tr>
<tr>
<td>V. Discussion</td>
<td>69</td>
</tr>
<tr>
<td>VI. References</td>
<td>71</td>
</tr>
<tr>
<td>VII. Supplemental Materials</td>
<td>73</td>
</tr>
<tr>
<td>VIII. Supplemental Materials References</td>
<td>123</td>
</tr>
</tbody>
</table>
Introduction

Across the nation, “non-essential classes,” like the arts and vocational education, are being placed farther and farther down in the ranks of classes that all American students must enroll in, and consequently, many students whose interests don’t lie solely in academically-based fields are losing out on incredible opportunities to broaden their horizons. With the support of a strong high school program, like agriculture, students can learn about things they would never learn about in another class. In a time in our nation’s history when education is suffering greatly under many budget cuts and program reductions, it behooves educators to be as prepared as possible for the inevitable. This is why I decided to create a curriculum (including quizzes, tests, and full lesson plans) for a high school horticulture class—to make myself more marketable as an educator at schools that have scarce enough resources to develop to the curriculum-developing process for a program that is not as essential as a mathematics or English class.

There have been many studies done on the beneficial aspects of having plants in one’s life. In addition, I feel that a basic understanding of plants, how to grow them and how to care for them, and how plants interact with the environment around us is something everyone should know. It is my goal that this curriculum will cover a variety of topics related to plants, like anatomy, pest and disease management, growing basics, plant-soil interactions, and plant identification. With this introduction to the wide world of horticulture, I hope to instill in my students a curiosity to learn more about plants and agriculture in general. My goal is to make this curriculum something that could be easily integrated into a high school agriculture program that currently has no horticulture classes offered. I hope that this curriculum, with its strong emphasis on laboratory-based active learning, will help the students who receive instruction based on it into more well-rounded and more effective learners in a classroom setting, and that they will understand the concepts being taught more clearly because of the diversity of teaching methods presented to them in this course.
Literature Review

In a society so focused on student success and achievement, which is judged by the completion or attainment of set standards of learning, it is easy to overlook the fact that there are more permanent and deeper ways of learning a concept or skill rather than just memorizing and repeating information for a test, and consequently, a grade. The product of this type of emphasis on student performance is the lecture, catered almost exclusively to those who are quick at recalling information, have longer attention spans, and can make connections to earlier concepts learned just based on what they see or hear during lecture. However, in this day and age, when public education means that there are around 40 students in every classroom, each one with a different background and way of learning, teachers cannot afford to rely on one way of getting a message across to their pupils. (7) Enter the laboratory, a challenging and effective alternative to the lecture-based class, which, on the opposite side of the spectrum, can result in low-level rote practice and may ultimately lead to the failure of some children who have the potential to succeed through alternate learning environments. (7)

The point of laboratory instruction is to encourage student learning in a different manner where those learning are actively engaged in discovering key concepts for themselves, rather than listening to a lecture on the principles behind those concepts. Labs stimulate investigative and applied thinking, where the student is presented with a problem at the outset of the class period, and they must, through scientific method or some other methodical means of discovery, determine the answer to said problem and apply what they learn in the lab to supplement or even substitute for what they learned or would have learned in a lecture. (8) Labs encourage student interaction with each other and give them a push to take ownership of the concepts being taught to them by having them make the conclusions, not the teacher. (9) The effect of labs on student performance in class is clear: those being taught have a better retention of ideas and notions discussed in class, as well as a personal investment and pride in what they have discovered for themselves. Very effective labs are those in which the teacher acts as a facilitator of sorts, answering any questions students may have, but not giving away too much of the answer or giving such specific instructions to complete the lab that the sense of discovery is left out of the educational process. (9) Labs also stimulate learning on a deeper level, as students use more of their perceptual senses as opposed to just watching and listening in a regular lecture. In a lab,
students have the opportunity to actually do something with their hands, to take something apart to see how something works, to touch something to see how it feels, as well as the chance to watch something or listen for certain sounds, depending on the subject matter being covered.

Many students in today’s public school system fall through the cracks because teachers simply do not have time to address their learning styles on a more individual basis. Learning styles are the ways in which we, as people, can best intake and process information being presented to our senses. Learning is an activity that actively involves both the mind and body through sensory perception and interaction. There are four main perception-based learning styles: auditory, visual, kinesthetic, and tactile. Auditory learning is based on retention of what one hears and can recall. Visual learning is based on what one sees and connects to the concepts being taught. Kinesthetic learners perform best when they can actually perform an action or go through a process being taught about in class. Tactile learners prefer hands-on learning, where they can make physical contact with an item or a physical representation of a concept being discussed. Those with the last two types of learning styles could strongly benefit from learning by experiencing what is being discussed in class; this type of “experiential” learning promotes a stronger grasp of ideas by having the students themselves interact and sort through issues facing them in their surrounding environment (a theory of learning also referred to as “constructivism”).

Another prominent theory of learning styles is the Learning Orientation Model (LOM) in which there are also four categories students fall into: transforming, performing, conforming, or resistant. Transforming learners are very dedicated and motivated to succeed in whatever they undertake. Performing learners are self-motivated when they are interested in a particular subject, but only perform well in the hope of reward on topics they are less passionate about. Conforming learners are those that are willing to accept, point-blank, that they must learn a particular set of information and store it away to reproduce later, and are often challenged by more open-ended forms of learning environments. Finally, resistant learners are those who believe academic education does not benefit them at all. While enrolled in a class with a lab, however, there is an opportunity for each type of student to succeed: the transformer would intake the information and the opportunities presented to them in the lecture and lab with open arms; the performer would be able to experience the class in a variety of ways (both in lecture and in lab), and would therefore possibly find a more interesting perspective on the topic if it
initially bored them; the conformer would intake the information they gleaned from lecture and observe and make mental connections in the lab, and will hopefully be positively challenged by the open-ended structure of a lab; and finally, the resistant learners would find the practicality of the technical skills learned in lab classes to be more valuable than anything they would learn in an academic lecture based on pure theory.

While children who can learn in a variety of the above manners are succeeding, children who can only use one or two styles of learning very effectively are performing at a lower level because of a lack of diversity in teaching methods. (1) This is where labs can help those students struggling to make connections and real-world applications between theories. “Active learning” is the process of comprehending the underlying lesson and important concepts that go along with it while actively doing something that directly correlates to the lesson, like a lab. (9) In labs, students actively learn by getting hands-on experience and exposure to the ideas being discussed in class. As students preparing for a four or more year tenure at a university, this helps children further develop the way they learn and perceive incoming information, and will make them more ways to sharpen their skill of learning. As future members of the work force, learning by experience also empowers students to work together to solve common problems, develop critical thinking skills, and apply what they learn from hands-on experiences to devise answers to questions facing them. (8) While any type of class, from a liberal arts course to a mathematics course, could have a lab component in which students delve deeper into what they’re learning through interactive activities, no other type of class lends itself easier to lab components than the sciences. In particular, Agricultural Science programs encourage student participation in hands-on learning through multiple venues (like supervised agricultural experience projects, class workdays, class projects, and more) through curriculum that specifically outlines laboratory learning as a key component of their classes’ structure.

Agriculture Science classes, in a high school education setting, are those that center around key areas in the agriculture industry, and that have a foundation in hands-on learning and technical education. Agriculture classes in general broaden the scope of an average high school student’s concept of agriculture, showing them that it is a much more diverse field of interest than just farming. These classes permit exclusive occasions for students to learn about a huge, important industry through the medium of labs and active learning experiences. The lab components of the classes also allow them to work together in a kind of “learning community”
where all those learning have to work together towards a common goal, contribute their ideas respectfully, and synthesize their thoughts into one collective answer. (6) There are many different courses offered in high school agriculture programs across the nation; however, there are a few mainstays of each program that all lend themselves to a hands-on type of learning experience. Courses in animal science would give the students the opportunity to work with live animals to study physiology, breeds, and behavior, something that any other similarly themed non-agricultural class would lack. An agricultural mechanics class allows students to be both creative in creating their own projects and to harness practical skills by operating power tools, taking apart machinery, and learning construction methods. Classes like agriculture leadership, agriculture government, or agribusiness let students to take on projects like coordinating events by themselves, learning about and sometimes interacting with local government in relation to agriculture issues, or developing a budget and keeping monthly records of expenses and income on their supervised agricultural experience projects, a valuable real-world skill. Finally, classes in horticulture give students a chance to see the many facets of the “green industry,” including landscape design, nursery production, plant protection sciences, botany, turf grass management, and much more. These classes offer students the opportunity to work with plants possibly even on a daily basis with class projects and they especially lend themselves easily to any number of laboratory scenarios for students to actively learn.

Current resources for high school Horticulture classes in the state of California are either very outdated (5) or not as specific as it could be. While the state of California sets down a range of standards in learning that every student in horticulture should apparently meet (11), and organizations like the California Association of Nurserymen and Garden Centers (12) have specific stipulations for high school Horticulture programs to become industry-certified and accredited, there are very few detailed curricula in existence for these kinds of classes. Of the few found during research for this project, only a handful of them had very detailed lesson plans, tests, quizzes, or even lab plans for the most part, the curriculum just outlined focus questions for students to be able to answer by the end of each unit. (13) It is the goal of this project to fill in the gaps and create a better set of teaching aids and materials for those interested in instructing a high school level horticulture class. In particular, there should be more sample labs available for the multiple facets of Horticulture classes, as labs are where students stand to benefit the most from an experiential education standpoint. There is a current trend in American education to
strive for better science instruction, and it is believed that we are entering an era of “scientific agriculture,” where a strong emphasis is being placed on research and discovery in this long-lived field of interest. (10)

Horticulture classes can be engaging and informative even if a student has no interest in pursuing and education or career dealing with plants. We interact with plants on a daily basis, grow them in our yards, and buy them at the store. They are proven to be therapeutic for those recovering from illness or injury, and relieve both stress and rid the air around us of toxins. The more students understand and appreciate what plants and the horticulture industry does for our daily lives, the more they can take away from similar agriculture classes. Having well-structured Horticulture classes with clear aims and standards, as well as interactive, hands-on labs and opportunities for student learning will be able to reach even those students who have the hardest time learning in the classroom, and these classes will give students the tools they need to keep actively learning for the rest of their lives. (7) When we learn from our own experiences with an idea, concept, or item, those lessons tend to stay with us the most; a horticulture class with a strong lab component and carefully structured curriculum to cater to all different learning styles could, therefore, be a very effective and educational class for any student enrolled in it, because the student, in part, would be discovering things for themselves with the help of the teacher.
Materials and Methods

Materials used for this project consisted of a number of past curricula for California high school horticulture or agriculture classes, like the Career Preparation in Ornamental Horticulture: A Curriculum Guide for High School Vocational Agriculture by Max McGhee, as well as a variety of educational handouts acquired from Dr. Ann DeLay of the Agricultural Education and Communication Department at Cal Poly, San Luis Obispo. This project also referred frequently to the California Career Technical Education Model Curriculum Standards for grades seven through twelve on the California Department of Education website. Finally, the project drew on notes and handouts from horticulture classes I took over my four years at Cal Poly that I knew would supplement the curriculum I was developing.

This project utilized strategic, targeted research to discover what had already been completed in terms of high school horticulture curricula, and, in addition, what was known already about student performance in laboratory-centered classes. These methods of research involved finding, analyzing, and synthesizing the information found. This project made frequent use of databases such as ERIC Documentation Reproduction Service and those available to Cal Poly students through the Robert E. Kennedy Library website, scholarly journals like the Journal of Agricultural Education, and search engines like Google Scholar.
Lesson Title: Classifying Plants

Materials:
Large plant samples to pass around
Sample dichotomous key handout (1/student)
Small worksheet on naming plants (1/student)

Resources:

Standards: classify and identify plants by order, family, genus, species. Use common plant parts used to classify plants. Use a dichotomous key. Differences between monocots/dicots. Understand how to classify and id plants by using botanical growth habits, landscape uses, cultural requirements.

Objectives:
Write plants’ botanical names correctly.
   -Distribute handouts after explaining. Students work individually for five minutes.
Understand the hierarchy of nomenclature.
Describe the differences between monocots and dicots.
Use a dichotomous key to classify plants.
   -Students create their own dichotomous key for five different plants (given at the end of lecture).

Key Terms:
Nomenclature
Genus
Species
Dichotomous key
Monocot
Dicot

Homework: Dichotomous key
Ticket out the door: nomenclature handout
Lesson Title: Different Uses and Functions of Plants

Materials:
Map of California regions
Sunset Zone map (1/student)
Sunset Book (1/student)
Large plant examples for the class to look at and touch
Slides of plants

Resources:

Standards: Understand how to classify and id plants by using botanical growth habits, landscape uses, cultural requirements. Understand plant selection and id for local landscape applications. Learn about natives/nonnatives. Learn about plants under production and weeds.

Objectives:
Describe how different climate zones/geographic areas/cultural requirements can affect which plants grow there.

Explain how plants can be used in different landscape settings based on the way they grow.
Explain the differences between native and nonnative species.
Define the term ‘weed’, and describe what makes them undesirable.

Key Terms:
Native
Invasive
Noxious
Weed

Homework: Using the Sunset book, pick three different regions of the state. Then choose seven different plants that would do well together in those specific regions, based on their individual growing requirements.

Ticket out the door: Write the definition of a weed, and give an example of what makes it bad for growers.
Lesson Title: Plant Physiology

Materials:
Microscopes (1/3 students)
Pumpkin seeds (1/student)
Woody and herbaceous cross-section slides (1/sample/microscope)
Handouts on organelles, cell structure

Resources:

Standards:
Understand seed’s essential parts and functions. Understand the tissues seen in a cross section of woody and herbaceous plants. Understand different cell types. Understand which organelles in plant cells carry out photosynthesis. Understand what part of the cell is responsible for genetic information

Objectives:
Identify plant cell structures.
- Distribute handouts on cell structure. Have students label them during the lecture.
- Students observe cross sections under microscopes and draw what they see.
Explain the functions of certain organelles.
Understand the difference between prokaryotic and eukaryotic cells.
Explain the basics of photosynthesis.
- Have students draw a diagram of both parts of photosynthesis.

Key Terms:
Cotyledon
Embryo
Radicle
Seed coat
Epicotyl
Hypocotyl
Endosperm
Eukaryotic
Prokaryotic
Chloroplasts
Chlorophyll
Cytoplasm
Cell Wall
Nucleus
Mitochondria
DNA
Protein
Photosynthesis
Light Reactions
Calvin Cycle
Homework:
Finish drawings and diagrams. See textbook and notes for help.

Ticket out the door:
Name three organelles and their functions.
**Lesson Title:** Inheritance and Other Factors Affecting Plant Growth

**Materials:**
Blank Punnett Square handout (1/student)

**Resources:**

**Standards:**
Understand plant inheritance principles, including structure and role of DNA. Understand cellular function reactions when plants grown under different conditions. Understand the factors that affect plant growth. Understand plant systems, nutrient transportation, structure, and energy storage. Understand how primary, secondary, and trace elements are used in plant growth.

**Objectives:**
- Explain how inheritance and gene expression works using a Punnett Square.
- Distribute handouts (1/student)
- Describe the effects of drought, temperature, and other stresses.
- Have students observe effects of experiments—have them record their results in a table.
- List the essential plant nutrients, and one thing they are useful for in plants.

**Key Terms:**
Genotype
Phenotype
Gene
Major Nutrient
Minor Nutrient
Xylem
Phloem
Stress
Tolerance

**Homework:**
Pick three distinct physical traits about yourself and determine which parent they came from using a Punnett Square.

**Ticket out the door:**
Pick a plant stress and describe its symptoms.
Lesson Title: Plant Reproduction

Materials:
Examples of plant reproductive parts (dissected flowers), seeds, plugs, tissue culture specimens, grafts, and root cuttings.
(Lab component will show proper procedures for tissue propagation.)

Resources:

Standards:
Understand the different forms of sexual and asexual plant reproduction. Understand various techniques used in plant propagation. Understand how to monitor plant reproduction for development of saleable product. Understand proper sterile technique used in tissue culture.

Objectives:
Identify plant reproductive organs.
-Show students examples of each structure with a dissected flower.
Analyze the differences, strengths, and weaknesses of different types of propagative methods versus normal plant reproductive methods.
-Propagative methods include tissue culture, sewing seeds, air layering, grafting, root cuttings, and plugs.
List ways to monitor plant reproduction to ensure a quality product, and understand their importance.
Identify proper procedures for keeping tissue culture specimens in a sterile environment.

Key Terms:
Stamen
Pistil
Anther
Filament
Ovary
Pollen
Style
Stigma
Propagation
Tissue culture
Air layering
T-graft
Whip graft
Cleft graft

Homework:
Answer the following questions:
Amy wants to ensure that her crop of nursery plants has all of the desirable traits of a plant that she carefully bred. Which method of propagation would best ensure that its progeny have these traits and why?

What does natural plant reproduction offer that assisted propagation not offer?

Why is keeping a propagule in a sterile environment so crucial to growth?

Ticket out the door:
Describe one method of propagation in detail.

Lesson Title: Pest Management
Materials:
Insect anatomy handout
Insect families handout
Microscopes
Slides with microscopic plant pests
Plants with fungi, nematodes on them
Some common weed pest samples

Resources:

Standards:
Understand common horticultural pests and diseases and methods of controlling them.
Understand how to categorize insects as pests, beneficial, or neutral and their roles. Understand
the role of other pests, such as nematodes, molds, mildews, and weeds.

Objectives:
Identify different parts of basic insect anatomy.
Identify symptoms and signs of insect damage on plants.
Identify symptoms and signs of fungi, nematode, virus, or weed damage.
Differentiate between pests and beneficials.
-Describe the roles that beneficials play in a typical ecosystem.
Understand a typical disease cycle of reproduction and infestation/emergence.
Develop effective control strategies for different types of pests.

Key Terms:
Pest
Symptom
Sign
Disease
Pathogen
Virus
Bacteria
Fungi
Nematode
Weed
Beneficial
Vector
IPM
Pesticide/Herbicide/Fungicide

Homework:
Find a picture of an insect and a fungi. Do as best as you can to identify each pest, draw out their
life cycle, and label their different parts.
Ticket out the door: Describe three major agricultural pests, why they are so hard to control, and describe what can be done to keep their populations down.

Lesson Title: Integrated Pest Management and Basic Pesticide Use

Materials:
Example pesticide label
Resources:
http://www.ipm.ucdavis.edu/
IPM handout with “IPM house”

Standards:
Read and interpret pesticide labels and understand safe pesticide management practices. Understand how pesticide regulations and government agencies affect agriculture. Understand integrated pest management to prevent, treat, and control plant disease symptoms.

Objectives:
Understand the crucial components of a basic pesticide label and their importance. Identify essential items of PPE that must be worn while applying pesticides. List proper application procedures. Understand the laws that govern pesticide applications and their importance. Develop a plan to treat pest problems using IPM methods, using chemical treatment as a last resort. Observe application equipment in action and perform proper application procedures (lab component).

Key Terms:
IPM - Five pillars of the “house”
PPE
PCA, QA
State laws, federal laws
EPA
REI
Active ingredient
Inert ingredient
Liquid pesticide
Granular pesticide
Spray pesticide

Homework:
Find a plant at your house that looks like it is suffering from some type of disorder or insect damage, and diagnose the problem. Using your deductions, create a plan of attack to control the problem using the IPM approach.

Ticket out the door:
List all five “pillars” of IPM, and describe one method of pest control that falls under each of the five categories.
Lesson Title: Introduction to Sustainable Agriculture

Materials:
Ag. Alert magazine
Computer lab or library—for research purposes
Handouts on organic and conventional agriculture
Resources:
Ag. Alert Magazine
Other reliable sources of agricultural news

Standards: Understand the systematic approach to solving plant problems. Know conventional, sustainable, and organic management methods to prevent or treat plant disease symptoms. Understand how biotechnology can be used to manage pests

Objectives:
Organize a plan of attack in diagnosing plant problems.
  - Have students make a map or timeline of a plant problem based on what they know about how the problem manifests itself and how long selected treatment methods will take, including reapplications.
Understand the differences between organic and conventional agricultural practices.
  - Distribute articles on both methods for students to read and compare/contrast.
Explain the advantages and disadvantages of both methods.
List emerging biotechnological advancements in the area of plant production, and identify the ways in which they help control pests.

Key Terms:
Sustainable
Genetically modified
Organic
Conventional

Homework: Find an interesting article on plant biotechnology, and write a two page paper on it; the first page should provide a summary of the article, and the second page should consist of your thoughts on whether the ideas posed in the article are feasible or viable.

Ticket out the door:
Define organic and conventional agriculture, and give three points about each method that makes it different from the other.

Lesson Title: Introductory Soil Science

Materials:
Soil triangle handout
Handout on assessing soil texture (feel, continuity, etc.)
Soil samples for students to feel
Pictures of soil profiles

Resources:
http://websoilsurvey.nrcs.usda.gov/app/HomePage.htm

Standards: Understand how basic soil science and water principles affect plant growth. Understand soil types, soil texture, structure, and bulk density and explain the USDA soil-quality rating procedure. Understand soil properties necessary for successful plant production, including pH, EC, and essential nutrients.

Objectives:
Identify clay, silt, loam, and sand soils by appearance and feel.
Identify several different types of common soil profiles based on specific characteristics.
-Tie-in: have students identify specific types of plants and geographical regions of California that would relate best to these soil profiles.
List the plant essential nutrients, and understand what each nutrient helps the plant do.
Perform a soil-quality test. (lab component)
Analyze pH, EC, and nutrient contents of soil; determine how well these results would help a plant grow.

Key Terms:
Soil profile
Epipedon
Soil horizon
Soil type
Soil texture
Structure
Bulk density
pH
EC
Nutrients
Pore

Homework:
Analyze the soil in your yard; using the soil triangle, make a determination about what type of soil it is.

Ticket out the door:
What types of soils do we have here around the school? What specific characteristics let you come to that conclusion?

Lesson Title: Fertilizers and Introductory Irrigation

Materials:
Example fertilizer label
Soil samples and pots for students
Fertilizer samples
Seeds

Resources:

Standards: Prepare and amend soils, implement soil conservation methods, and compare results. Know components of soilless media and the use of those media in various types of containers. Know basic irrigation design and installation methods.

Objectives:
Understand the differences in composition, and affects on plant performance, of different types of fertilizers. (lab component)
- Give students handout on fertilizer label.
Analyze different methods of erosion control.
Understand the components of, and create, an irrigation system for a small landscape. (lab component)

Key Terms:
Granular fertilizer
Fertigation
Soilless media
Erosion
Sprinkler head
Riser
Drip system
Valve
Irrigation symbols

Homework:
Draw a small landscape, including a lawn area, a small bedding plant area, and a shrub border. Using the irrigation symbols you know and lines showing where your system would be, design an irrigation plan for your landscape. Include any erosion prevention methods necessary.

Ticket out the door:
Name three different types of fertilizers, what they are used for mainly, how they are applied, and what they offer plants.

Lesson Title: Water Relations

Materials:
Cadillac Desert video and handout
Handout on water rights and laws
Resources:
http://www.water.ca.gov/

Standards: Understand major issues related to water sources and water quality. Prepare and amend soils, implement soil conservation methods, and compare results. Understand CA water history, current issues, water rights, water law, and water transfer through different distribution projects throughout the state.

Objectives:
Analyze data from soil amendment experiments from last lab component.
- Determine which treatments were most effective.
Understand the situation California finds itself in right now with regards to water shortages and public water quality concerns.
- Distribute handouts on water rights and laws.
- Watch video on the history and current status of water issues in California.

Key Terms:
Pueblo laws
Riparian rights
Appropriation rights
“Reasonable and beneficial use”
Public trust doctrine
Sacramento Delta
California Aquaduct
Drought

Homework:
Find an article on the California water situation and write a one page summary and one-page opinion paper on what you think about the opinions presented in the article. This counts as half of a normal test grade.

Ticket out the door:
What do you think is the best way to help the California water situation?

Lesson Title: Plant Nutrients

Materials:
Handout on essential plant nutrients

Resources:
Standards: Analyze how primary and secondary nutrients and trace elements affect ornamental plants. Understand basic nutrient testing procedures on soil and plant tissue.

Objectives:
List all of the primary and secondary nutrients essential for plant growth.
- Distribute handout to students.
Understand what sources each of the nutrients came from naturally, and in what concentration they are found naturally.
Discuss methods of nutrient testing procedures on soil and plant tissue.

Key Terms:
Nutrient
Major nutrient
Minor nutrient

Homework:
Draw a diagram of a plant, and using arrows, draw lines to where each of the essential plant nutrients effect the plant.

Ticket out the door:
Name three nutrients and the parts of the plant they affect.

Lesson Title: Fertilizers, Part II

Materials:
Sample fertilizer label (already distributed to students in previous lecture)
Resources:

Standards: Analyze organic and inorganic fertilizers to understand their appropriate uses. Understand how to read and interpret labels to properly apply fertilizers.

Objectives:
Differentiate between types of fertilizers and their advantages and disadvantages. Calculate how much fertilizer to apply in a basic dimensional analysis problem.

Key Terms:
“Potash”
Broadcast fertilizer
Banding
Injecting
Foliar fertilizer
Filler

Homework: Solve the following problem: How many pounds of 11-48-0, 46-0-0, 15-15-15, and filler are needed to make a ton of 22-12-8 fertilizer?

Ticket out the door: What are the advantages and disadvantages of urea as a fertilizer?

Lesson Title: Growing and Harvesting Methods

Materials:
Permission slips for field trip
Resources:
Nearby farm or nursery to give students a tour of facilities and operations

Standards: Understand local cultural techniques, including monitoring, pruning, fertilization, planting, irrigation, harvest treatments, processing, and packaging practices. Understand general maturity and harvest-time guidelines for specific local plant products.

Objectives:
Observe firsthand, and understand, the proper way to take a crop from planting to production.

Key Terms:
Pruning
Processing

Homework:
Write a summary of what you observed and learned about the production process from our field trip. This will be worth a quarter of a test score for this component of the class.

Ticket out the door:
What is the most interesting part of the process of getting crops ready for harvest to you and why?
Is there anything in particular that you learned that we do locally that isn’t done anywhere else near us?

Lesson Title: Technology and Plant Science

Materials:
Several articles from scholarly journals for students to read
Standards: Understand how changing technology—such as micropropagation, biological pest controls, and genetic engineering (including DNA extraction, and gel electrophoresis)—affects plant production, yields, and management. Understand the various technology advancements that affect plant and soil science.

Objectives:
Identify several different emerging methods of plant production, and list their advantages and disadvantages.
Identify several methods of production management with new technology.
Utilize scholarly journals as a means of learning about the most current advances in the field of horticulture.
Research the effectiveness of new methods of production in plant and soil science.

Key Terms:
DNA extraction
Micropropagation
Gel electrophoresis
Vertical greenhouses

Homework: Research one of the new technologies we discussed, and, in a two-page paper, describe the technology and your thoughts on whether it is a viable means of production in the future or not. This will be worth half of a test score for this component of the class.

Ticket out the door: Do you think that biotechnology will play a large part in the future of plant sciences?

Lesson Title: Emerging Technology in Plant Sciences, Part II

Materials:
A few packets of genetically modified seed
A few packets of naturally bred seed
Resources:

Standards: Know how herbicide-resistant plant genes can affect the environment. Understand how genetic engineering techniques have been used to improve crop yields. Understand the effects of agricultural biotechnology, including genetically modified organisms, on the agriculture industry and the larger society and the pros and cons of such use.

Objectives:
Observe any differences between genetically modified crops and natural seed as they grow. (lab component)
Discuss, as a class, the importance of genetically modified organisms on the agriculture industry.
Discuss public opinion on genetically modified organisms.

Key Terms:
Genetically modified organisms

Homework: Find an article online about plant genetic technology, bring it to class, and give the class a summary of what you learned. This will be worth one quarter of your test grade for this component of the class.

Ticket out the door: What do you think about genetic technology?

Lesson Title: Horticultural Equipment and Tools

Materials:
Various horticultural tools

Resources:
Standards: Understand the use of different types of containers and demonstrate how to maintain growing containers in controlled environments. Select proper tools for horticultural jobs. Operate and maintain selected hand and power equipment safely and appropriately. Understand how to install landscape components and electrical land and water features.

Objectives:
Understand the differences between similar pieces of equipment.
Demonstrate a proper use and safe use of horticultural tools.
Plant a landscape using proper planting techniques and the correct tools for the job. (lab component)

Key Terms:
#1, 5, 10, 15 containers
Hand trowel
Shovel (round point and square point)
Lawn rake
Landscape rake
Mattock
Dibble
Hand cultivator
Broadcast spreader
Drop spreader
Weed whacker
Hand saw
Pruning shears
Hand shears
Soil probe

Homework: Prune a plant at home (after asking your parents’ permission), and take before and after pictures of your work. Show and tell with the class, explaining why you made the cuts you did.

Ticket out the door: What five tools do you always think you should have when planting a job site?

Lesson Title: Basic Turfgrass Management

Materials:
Samples of different warm season and cool season turfgrass species
Sample turfgrass seed packet
Resources:

Standards: Understand the selection and management of landscape and sports field turf. Understand how to select, install, and maintain a designated turfgrass area. Understand how the use of turf benefits the environment.

Objectives:
Determine which grasses are best to use during a particular season, based on their characteristics of growth.
- Have students examine example specimens.
Identify parts of grass plants.
Compare and contrast which species are best to help conserve water or which species will perform best under certain environmental conditions.
Understand the pros and cons of having a turf area in a landscape.
Install and maintain a small turf plot. (lab component)

Key Terms:
Auricle
Blade
Collar
Sheath
Ligule
Rhizome
Stolon
Seedhead
Cool season grass
Warm season grass
Plug
Sod
Overseed

Homework:
Look at the grass at your house or a nearby park. Can you identify it, or at least describe it? Is it warm season or cool season?

Ticket out the door: Why is water conservation such a huge consideration when planting a turf area?

Lesson Title: Basic Nursery Production

Materials:
Plugs
#1 containers
Resources:

Standards: Understand how to properly use production facilities and common nursery equipment. Understand common nursery production practices.

Objectives:
Identify and understand different growing processes and requirements for certain economically important ornamental crops.
Grow a crop from plug to market as a class, while managing and marketing the crop at the same time. (lab component)
Understand how to cool or heat a greenhouse using technology available.
Understand what signs of stress to look for if a crop is taking a turn for the worse.
Schedule a crop from plug to harvest.

Key Terms:
Photoperiodism
Salt stress
Sun burn
Thigmomorphogenesis
Long day plants
Short day plants
Day neutral plants
Phytochrome

Homework:
In partners, care for a portion of the crop we’re growing as a class. Once the crop is fully grown, devise a marketing strategy.

Ticket out the door: Briefly outline the process of growing one particular crop of your choosing.

Lesson Title: Basics of Landscape Design

Materials:
Drafting vellum
Drafting pencils
Colored pencils
Engineer’s scale
Architect’s scale
Triangles
Lettering tools

Resources:

Standards: Understand the principles of residential design, including how to render design to scale. Know the terms associated with landscape and design and their appropriate use.

Objectives:
Write a sentence using lettering tools.
Draw basic shapes and landscape symbols using design tools.
Draw shapes properly to scale.

Key Terms:
Line
Form
Weight
Proportion
Repetition
Unity
Color
Texture
Balance
Harmony
Contrast
Bubble plan
Base plan
Elevation view
Color rendering
Plan view

Homework: Come up with a simple design for your backyard or a family member’s backyard. Measure out the area first, and make sure your drawing is to scale. Label the plants you decide to use with general terms (i.e. WBLET=woody broadleaf evergreen tree).

Ticket out the door:
Draw a 30-foot diameter tree, using one of the landscape symbols we’ve learned about, at a 1/8”=1 foot scale. Then, write a sentence underneath the symbol, describing the tree (is it deciduous, evergreen, broadleaf, etc.?), using lettering.
Lesson Title: Basic Landscape Maintenance

Materials:
Various horticultural tools
Diagram of proper fruit tree pruning cuts
Sample business contract—tie-in with FFA record books
Resources:

Standards: Understand proper landscape planting and maintenance practices. Prune ornamental shrubs, trees, and fruit trees. Develop clear and concise landscape business contracts.

Objectives:
Identify steps of the decision-making process when pruning a plant.
Identify the correct sequence of steps when planting a plant. (lab component)
Perform proper cuts on plants, and be able explain why each cut was made. (lab component)
- Distribute handouts on fruit tree pruning.
Understand the important components of a landscape basic contract.
- Distribute handouts of sample contract.

Key Terms:
Structural pruning
Sucker
Hanger
Flush cut
Stub
Included bark
Branch bark ridge
Branch collar
Bud swell
Compartmentalization
Spur
Thinning out
Pinching
Deadheading
Topping off
Heading back
Pollarding
Lion’s tailing

Homework:
Work on group lab of pruning trees.

Ticket out the door:
Name the three steps you take when you cut a branch with a saw.

Lesson Title: Basic Floral Design

Materials:
Ribbon
Wire
Wire cutters
Floral tape
Cut flowers
Sample arrangements

Resources:

Standards: Understand the use of plant materials and tools in floral design. Apply basic design principles to products and designs.

Objectives:
Identify the different types of tools used when creating floral arrangements.
Recall terms from landscape design lectures and apply knowledge about that to floral designs.
- Have students take a look at sample arrangements, show them the different parts and elements of the designs.
- Demonstrate how to make a corsage and have students follow, step-by-step.

Key Terms:
Focal flowers
Intermediate flowers
Filler flowers

Homework:
Go online and find a floral arrangement you like. State which elements of design it uses, and why they are particularly effective in catching your attention. If there are any problems, critique the arrangement.

Ticket out the door: Pick three elements of design, and give possibilities as to how they can be achieved in a flower arrangement.

Lesson Title: Floriculture

Materials:
Various floriculture tools
Cut flowers
Oasis
Ribbon
Floral design magazines (for students to get inspiration from)

**Resources:**

**Standards:** Handle, prepare, and arrange cut flowers appropriately. Understand marketing and merchandising principles used in the floral industry.

**Objectives:**
Make a floral arrangement using the elements of design covered in the last lecture series.
- Have students look at magazines for inspiration.
Evaluate cut flower quality.
Discuss marketing in the floral industry as a class, with emphasis on seasonal marketing.

**Key Terms:**
(Same as last lesson’s)

**Homework:**
Continue to work on your designs during class.

**Ticket out the door:**
What do you think you did really well in your designs? What’s something you could improve upon?

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**Lab Title:** Dichotomous Key.

**Goes with Classifying Plants Lesson**

**Materials:**
10 different plant specimens for students to use
Western Garden Book

Resources:
http://webworldwonders.firm.edu/cameras/keys/sa/tree.html

Objectives:
Students learn new terms regarding plant anatomy. Using this knowledge, the students create a dichotomous key for ten separate and identify plants. Give a list of all ten plant names to the students before they start, so they know what to choose from. Characteristics identified can include leaf pubescence, leaf shape, leaf size, color, and any other reasonable characteristics students identify. A key with the correct answers should be ready before the students begin the exercise. Students may work in pairs if they wish. To double-check their answers, they may reference the Western Garden Book.

Lab Title: Seed Physiology

Goes with Plant Physiology Lesson

Materials:
Microscopes
Pumpkin seeds
Woody and herbaceous cross-section slides

Resources:

Objectives:
Students learn about parts of the cell, seed, and plant in this series of lectures. In this lab, they will be able to examine the structure of a seed under a microscope, as well as cross-sections of fully-grown plants. Students will draw and label what they see under the microscope. Under each drawing, the students will describe what the part they’ve observed does and what its function is in the plant, seed, or cell.

Lab Title: Plant Propagation

Goes with Plant Reproduction Lesson

Materials:
Petri dishes with agar solution in them
Plant tissue specimens
Plants that can be air layered
Plastic wrap
Seeds

Resources:

Objectives:
After learning about different methods of propagating plants, students will be able to try out some of these techniques for themselves.
In the first part of the lab, students will be able to scarify tough-skinned seeds for themselves and plant them in a small container, and care for them for the next two weeks. There should be two groups of seeds: one scarified, and one control group that has had no scarification. Students compare how well each set grows.
In the next portion of the lab, students will air layer *Fatsia japonica*, using proper techniques. Over the next two weeks, students will monitor the progress of the propagules.
In the last component of the lab, students will utilize proper procedures (including complete sterilization of the workspace) to make tissue culture specimens. Students will watch the growth of the specimens in petri dishes over a two-week period.

Lab Title: Pest Identification

Goes with Pest Management Lesson

Materials:
Cricket specimens to dissect
Tweazers
Small knives/razor blades
Magnifying glass
Microscope
Samples of fungi to observe under microscopes

Resources:

Objectives:
Students will apply the terms they have learned in lecture to identifying body parts of a basic insect while dissecting one. Students will be informed of proper dissection techniques before beginning the lab. Students will collect important body parts of the insect and paste them on a 3x5 card to use for studying.
After dissection is complete, students may move to the microscopes to observe and draw fungal structures that they see. Students must identify what stage of life the fungi is in, what family it belongs to, and which structures they see.

Lab Title: Pesticide Application and PPE

Goes with Integrated Pest Management and Basic Pesticide Use Lesson

Materials:
Gloves
Goggles  
Tyvex suits  
Backpack sprayers  
Rubber boots  
Roundup

Resources:

Objectives:
Students will learn how to wear personal protective equipment, and become aware of possible injuries if they do not wear it. After putting on gear, they will watch a demonstration on how to spray a pesticide (like Roundup) from a backpack sprayer. Next, students will learn how to evenly mix pesticide mixtures. They will learn how to pace themselves as they spray as well, so they spray evenly. This can be done on a weed patch at the school agriculture department. Students can take turns with the sprayer, and then observe the results of their sprays over the next couple of days as the weeds die.

Lab Title: Soil Texture and Quality

Goes with Introductory Soil Science Lesson

Materials:
Samples of different types of soil
Resources:

Objectives:
Students will apply what they’ve learned about soil textures to this lab as they feel samples of different soils to determine their textures. Students will roll the soil into a small ball in their hands, feel how easily it crumbles with a bit of water on it, how long of a “rope” they can make when they roll it out long-ways in their hands, and make a determination on how sticky it feels. Using all of this, they should be able to determine which type of soil they have. Students can be separated into groups, with one group per soil sample, and a key can be made up beforehand of which sample is what texture.
In the second part of the lab, students add soil to water, and using an EC machine to measure salt concentration and a litmus test, will be able to identify key soil characteristics based on the pH and EC outputs.

Lab Title: Fertilizer Testing and Irrigation Assembly

Goes with Fertilizers and Introductory Irrigation

Materials:
Several different types of common fertilizers
Soil
#1 containers
Plants with abiotic stresses
PVC pipe and connectors
Miscellaneous irrigation tools and pieces

Resources:

Objectives:
Using plants already planted that are suffering from abiotic stresses, students amend the soil of the plants with different types of fertilizers. Students will first strategize as a class as to which deficiencies the plants are suffering from. As the plants grow, students will watch the different fertilizers’ effectiveness in increasing the plants’ health.
In the second portion of the lab, students will construct a basic loop of irrigation pipe using an easy-to-read plan and all the necessary tools.

Lab Title: Organic vs. Inorganic Fertilizers

Goes with Fertilizers Part II Lesson

Materials:
Plants from last fertilizer test
Organic fertilizer
Soil
Plants with nutrient deficiency symptoms

Resources:

Objectives:
Students will compare the effects of organic fertilizer versus a manmade fertilizer on plants with nutrient deficiencies over the period of a couple of weeks. Use the plants from the last fertilizer experiments as test subjects for the manmade fertilizer group.

Lab Title: Genetically Modified Seed vs. Natural Seed

Goes with Emerging Technology in Plant Sciences, Part II Lesson

Materials:
Packets of genetically modified seed
Packets of natural seed

**Resources:**

**Objectives:**
Students will plant, and observed any differences between, genetically modified seed and natural seed. For viable data, there will be three species tested, each with genetically modified and natural versions of the seeds, bringing the total amount of test groups to six overall. Students will record growth progress and make general comments on overall vigor as the seedlings grow.

**Lab Title:** Landscape Installation

**Goes with Horticultural Equipment and Tools Lesson**

**Materials:**
Shovels
Rakes
Hand cultivators
Hoes
Plants
Dibbles
Hand pruners

Resources:

Objectives:
Using what they’ve learned about the proper way to prepare the ground and install a landscape, students will plant a landscape using a basic plan. They will be responsible as a class for its upkeep, including watering, weeding, and pruning.

Lab Title: Turfgrass Installation and Maintenance

Goes with Basic Turfgrass Management Lecture

Materials:
Turf seed
Rakes

Resources:

Objectives:
Students will seed a plot with grass seed. Students will first prepare and level the area, and make sure there are no weeds protruding from the soil. Then, students will spread the seed as evenly as possible over the plot. As the plot grows, students will be responsible for its upkeep, including weeding, watering, and mowing the area.

Lab Title: Nursery Crop Production

Goes with Basic Nursery Production

Materials:
Plugs
4-inch, 6-inch, #1 containers

**Media**

**Resources:**

**Objectives:**
Students will be responsible for a small enterprise of nursery crops over the course of the year. They will be grown from plugs until at least a #1 container size, depending on the plant species selected. Students will be responsible for the care of the plants in the greenhouse as well as outside when they are moved to harden off. Care includes watering, monitoring for pests, making sure the plants are receiving the correct amount of light, making sure the temperature and environment in the greenhouse is correct, etc. Once the plants are at a marketable size, students will be responsible, as a class, for developing a marketing plan for the crop, to be sold at a nursery sale towards the end of the school year. Several students may be chosen as designated class leaders.

**Lab Title:** Fruit Tree Planting and Pruning

**Goes with Basic Landscape Maintenance Lesson**

**Materials:**
Hand pruners
Resources:

Objectives:
Now that students know how to correctly plant a tree or plant in a specific sequence of steps, they will perform the step-by-step process of planting trees (either at the agriculture department or in contingency with some community service organization). Students will also have the opportunity to work in groups of 3 or 4 to determine the best pruning cuts to make on a fruit tree that needs some clearing. After cuts are all made, each group of students will explain what ailed the tree before, which cuts they decided to make, and their reasons behind the cuts.

Part I: Taxonomy and Plant Identification.

Match the parts of the following name:

1. *Leptospermum*  a. Variety
2. New Zealand Tea Tree  b. Genus name
3. ‘Ruby Glow’  c. Species name
4. *scoparium*  
   d. Common name

5. Which of the following choices is written in the correct taxonomical form?  
   a. ‘Confetti’ *Lantana camara*  
   b. ‘Confetti’ *Lantana camarad.*  
   c. lantana Camara ‘Confetti’  
   d. *Lantana camara* ‘Confetti’

Match each leaf shape with its name (specimens are at the front of the room):
   6. Palmately compound
   7. Pinnately compound, ovate
   8. Lanceolate
   9. Reniform
   10. Elliptic

Match each leaf arrangement with its name:
   11. Basal
   12. Alternate
   13. Opposite
   14. Whorled

Match each leaf tip shape with its name:
   15. Acuminate
   16. Obtuse
   17. Mucronate
   18. Emarginate

19. The specimen on the table (numbered 19) has which type of veination?  
   a. Palmate  
   b. Pinnate  
   c. Parallel  
   d. Perpendicular

20. Because of its veination, the leaf from the above question is a:  
   a. Dicot  
   b. Fungi  
   c. Monocot  
   d. Angiosperm

Part II: Plant Anatomy.

21. The nutritive tissue found inside a growing seed is called:  
   a. Perisperm  
   b. Endosperm  
   c. Cotyledon  
   d. Embryo

22. Some of the first structures to emerge from the seed, precursors to leaves, are called:  
   a. Cotyledons  
   b. Hypocotyls  
   c. Radicles  
   d. Plumules

23. The young seed’s precursor to roots are called:  
   a. Hypocotyls  
   b. Radicles  
   c. Epicotyls  
   d. Cotyledons
24. Label this cross-section of a typical root:

![Root cross-section](image)


25. Label this cross-section of a typical leaf:

![Leaf cross-section](image)

26. The organelle that holds all of the plant’s genetic information is the:
   a. Mitochondria  c. Chloroplast
   b. Cytoplasm       d. Nucleus

27. The plant’s center for photosynthesis is the:
   a. Chloroplasts    c. Mitochondrion
   b. Cell wall       d. Endoplasmic reticulum

28. Some of the pigments that absorb light energy needed for the Light Reactions are called:
   a. Thylakoids     c. Chromoplasts
   b. Grana          d. Chlorophyll

29. The Light Reactions produce which forms of chemical energy for the Calvin Cycle?
   ___________________ and ___________________

30. The main product of the Calvin Cycle is ________________.

Part III: Plant Genetics and Growth

31. Fill out the following Punnett Square for a F2 generation of a dihybrid cross of a pea plant.

traits GG
the F1
Tt and Gg

The parent generation had the TT and gg tt, and generation had the characteristics Gg Tt.
32. Explain, briefly, what happens in plants when they undergo water stress.

33. Explain how xylem and phloem move nutrients throughout a plant.

34. Pick three elements (one primary, one secondary, and one trace) and describe, in as much detail as possible, how they affect plant growth.

Part IV: Landscape Applications.

35. You are in charge of designing the backyard landscape for a small home. The house is in a dry, sunny area that does not get a lot of water. The east side of the house gets some afternoon shade. See the drawing on the board if you need a visual representation of the property. Using some of the specific plants we’ve learned about in class, state which plants you would use and where you would place them because of their specific growing characteristics and requirements (including drought tolerance, mature size, aesthetic qualities, etc.). You must use at least: three different shrubs, two different trees, one groundcover, and one vine.

1. Identify the parts of the flower on this chart.
2. Name four separate methods of seed dispersal.

_________________________________________________________________
_________________________________________________________________

3. A plant that has both male and female flowers on it is referred to as:
   a. Diecious  
   b. Monocot  
   c. Dicot  
   b. Monoecious

4. Name three methods which can help break seed dormancy:

_________________________________________________________________
_________________________________________________________________

5. Compare and contrast the benefits of sexual and asexual propagation.
6. Pick two methods of plant asexual reproduction and describe them thoroughly.

Part II: Insect and Pest Management.
7. Label the parts of the insect on the diagram below.

![Grasshopper diagram](http://www.biologyjunction.com/grasshopper_dissection.htm)

8. You have a vineyard. Unfortunately, you found traces of both powdery mildew and glassy-winged sharpshooter damage the other day in small, concentrated locations in the vineyard. There is a large weed population covering the aisles between vine
rows. Explain the conditions that are making this environment favorable for these pests, and outline a plan, using integrated pest management techniques, that would help control these pests, based on their life cycles, overwintering habits, and physiology. Explain what would happen if the pests were allowed to continue thriving unabated.

9. Fill in the names of the components the pesticide label below.
Match the following insect order descriptions with their Latin names.

10. Largest order of insects; holometabolous metamorphosis; sexual reproduction; chewing mouthparts; sclerotized wings (elytra).
11. One pair of wings; small and soft-bodied; sexual reproduction with complex mating rituals; either sponging/lapping or piercing-sucking mouthparts; holometabolous metamorphosis.
12. Either knobbed or pointed antennae, sometimes plumose; two pairs of wings covered in scales, often brightly colored; sexual reproduction; holometabolous metamorphosis; chewing mouthparts when larvae, siphoning when adults.
13. Adults have chewing mouthparts, but some species can also have siphoning in addition to that; holometabolous metamorphosis; sex of offspring determined if the egg is fertilized or not; some species may have a modified ovipositor with a sting; families in the order either have two pairs of wings or none at all.

   a. Diptera
   b. Lepidoptera
   c. Hymenoptera
   d. Coleoptera

14. Show a lifecycle diagram of the following diseases:
   a. Powdery mildew
   b. Rust

Part I: Soil Science and Fertilizers.
1. A pedon is:
a. The smallest unit of volume in soils that manifests all the characteristics of a specific soil.
b. The highest possible category of soil type classification.
c. A horizon in the soil profile characterized by a dark color from high organic matter concentration.
d. A soil with a heavy content of clay.

2. Using the soil triangle, answer the following question: What type of soil texture results from a mix of 23% clay and 37% silt?
   a. Sandy clay loam
   b. Silt loam
   c. Sandy loam
   d. Silty clay loam

3. Label the missing components of the Nitrogen Cycle.
4. Which of these soils textures can hold the least amount of water, has the largest pore space, and has the smallest surface area?
   a. Silt  
   b. Clay  
   c. Loam  
   d. Sand

5. __________ soil structures are found commonly in soils with high concentrations of clay with strong shrink-swell capacities.
   a. Blocky  
   b. Granular  
   c. Prismatic  
   d. Platy

6. An E horizon:
   a. is dominated by organic material. 
   b. Is comprised of solid bedrock.
c. Is a layer of concentrated silicate clay, iron, humus, silica, or other similar materials.
d. Usually has a lighter color than the layers around it.

7. A soil horizon with a lowercase letter after the master horizon letter denotes:

8. Give three examples of soil horizon suffix symbols and briefly state their meanings.

9. Acidic soils have pHs ranging from ____________, and alkaline soils have pHs ranging from _______________. ________ is considered neutral.
   a. 1-5, 7-14, 6.
   b. 1-3, 5-14, 4.
   c. 1-6, 8-14, 7.
   d. 1-7, 9-14, 8.

10. A fertilizer has a grade of 8-4-3. This fertilizer has:
   a. 8% available nitrogen
   b. 4% available P as P₂O₅
   c. 3% available as K₂O
   d. 4% total K
   e. More than one of the above is correct

Part II: Plant Nutrients.

11. Which of these lists of nutrients contains only essential micronutrients?
   a. Ca, Fe, Mn, N
   b. CL, P, S, Zn
   c. Cl, Mn, Mo, Zn
   d. Mg, K, P, S

12. A nutrient in the soil that is moving away from a plant root could be moving by:
   a. contact exchange
   b. diffusion
13. When you have problem soils, the method of fertilizer application that is most efficient for nutrient use by plants is:
   a. banding
   b. broadcast
   c. foliar
   d. sidedress
   e. topdress

14. A non-mobile nutrient expresses its first visual deficiency symptoms in:
   a. flowers
   b. newer tissue
   c. older tissue
   d. roots
   e. root hairs

15. Look at the photos at the front of the room; identify the deficiency symptoms and the probable nutrient that’s deficient. (For #15-20)
   15.
   16.
   17.
   18.
   19.
   20.

16. How many pounds of 15-8-7 fertilizer are needed to supply 222 pounds of $P_2O_5$ to a soil? Show your calculations.

Part I: Horticultural Tool Identification.

Name the horticultural tools placed around the room.
1. _______________________
2. _______________________
3. _______________________
4. _______________________
5. _______________________
6. _______________________
7. _______________________
8. _______________________
9. _______________________
10. ______________________

Part II: Turf Grass Management.

11. Label the parts of the grass specimen:

![Parts of a grass plant](http://commodities.caes.uga.edu/turfgrass/georgiaturf/Turfgras/1130_DiagramParts.htm)


12. A healthy lawn should be watered:
   a. Frequently and shallowly
   b. Frequently and deeply
c. Occasionally and deeply

13. Before planting any landscape or lawn area, the first thing that should be done is ________________________________.

14. After mowing, it is recommended that you not spread the cuttings back over the lawn. True or False

15. It is recommended that, when mowing, no more than ________ of the grass blades should be removed.

16. Over-applications of nitrogen fertilizers to lawns can hurt the plant’s overall growth, especially going into long, hot summer periods, because:

17. Maintaining a dense turf canopy is an effective way of preventing weed emergence in lawns. True or False

18. Most turf pest problems are caused by:
   a. Insects
   b. Bacteria
   c. Nematodes
   d. Fungi

19. Turf grass species are effective at reducing air pollution, filtering runoff water, and keeping temperatures on lawns much cooler in hot environments. True or False

Part III: Greenhouse Management.

20. Some of the considerations that go into placing a greenhouse in a specific location include: (list five)

21. When considering glazing materials for a greenhouse, ________________ is generally considered to be the material that transmits the most light for the longest amount of time, but ________________ is more cost-effective and loses much less heat during the day.
22. Calculate how much BTUs are required to power the heating system of the following greenhouse: a glass, standard-pitch greenhouse (U-value of 1); an inside temperature of 70 degrees Fahrenheit; an outdoor environment temperature of 28 degrees Fahrenheit; no curtain wall; 40 feet wide, 100 feet long. Show your work.

23. What are some advantages of benches over beds in greenhouses?

24. What are some advantages and disadvantages of growing plants hydroponically?

25. Fill in the blanks: as the temperature in a greenhouse goes _______, the relative humidity goes _________ if humidity _________________.
   Goes up               Goes down               Stays the same

26. When planning out a short-day crop’s growth, it is best to start planting:
   During the summer       During the winter
Part IV: Landscape Design and Maintenance.

27. List five different principles of design, and state how they can be accomplished in either a floral or a landscape design.
   -
   -
   -
   -
   -

28. What are five key components of a typical landscape contract?

29. List the three steps you would take (in order) to prune a branch of a tree using a hand saw, and briefly explain why the procedure is in that order.

30. What are five important questions to ask any client when designing a landscape?
Discussion
The materials compiled and created in this project were catered to fit the state of California’s standards of learning in the fields of Ornamental Horticulture and Plant Sciences.

Lesson plans were structured so as to not outline one day’s lesson in particular; rather, they were written as a rough outline of the topics and concepts that should be taught during a specific unit or module of the class, which could last anywhere from a week to two weeks, depending on the subject matter.

Labs were written as supplements to the lectures and in-class activities listed in the lesson plans, to help emphasize concepts discussed and to cover topics that might pose more of a challenge in which to test student understanding. These labs also relied heavily on students using critical thinking skills and active learning, where they discover the truth behind concepts for themselves.

The four exams written for this project represent four midterms that would be given throughout the year, and are comprised of multiple choice, calculation, true or false, short answer, and essay questions, as well as some identification questions that depend on students’ recollection of names and recognition of what they see in front of them. Any of the tests could be shortened or modified to be made into a quiz, to check on student progress. In addition to tests, some homework assignments listed in the lesson plans actually count towards a students’ overall test grade, and challenge them to research topics on an independent basis, so they may form their own opinions outside of the classroom discussion. Examples include a short research paper on emerging biotechnology in plant science, writing summaries of field trips, and a short, educated opinion paper on the water shortage situation in California.

Finally, the supplemental materials are comprised of useful worksheets and handouts that students will have to reference as the school year progresses.

Overall, this project has been able to achieve what it aimed to accomplish: to create a sizeable collection of teaching materials for a typical high school Horticulture class. The materials have the potential to stimulate multiple learning types and provide students with many different opportunities to express their creativity and critical thinking skills. As technology in the classroom advances, more applications of computer-based learning may be a path to consider when teaching units that deal with very technical or small details, like plant or insect anatomy or plant identification. Online flashcards are a great tool to help students learn to recognize specific characteristics after repetition. If these materials were to be implemented in a Horticulture
program with enough funding, the lab plans could be enhanced with access to more advanced technology, so students can get a firsthand look at scientific equipment and testing methods. California’s state standards are bound to change as the Horticulture industry does. While these materials may be suitable for a Horticulture classroom of today, it is vital that, as time goes on, materials like these continue to be modified and adjusted to suit future classrooms’ purposes.


curriculum standards: grades seven through twelve. Abbott, D. and Contreras, J.
certification program. California Association of Nurseries and Garden Centers, CA.
March 2012.
* Symptoms refer to deficiency unless otherwise stated.

** Symptoms of sulfur deficiency usually occur on upper leaves first, but a general yellowing of the entire plant may occur under prolonged deficiency conditions.

Diagrammatic illustration showing the supporting nature of the four basic elements to insect pest management and its six components.

Supplemental Materials References