

## ENVIRONMENTAL HORTICULTURE CURRICULUM

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A Project

Presented

to the Faculty of

California State University, Chico

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In Partial Fulfillment

of the Requirements for the Degree

Master of Science

in

Agricultural Education

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by

Stephanie Marie Serna

Summer 2016

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## ABSTRACT

### ENVIRONMENTAL HORTICULTURE CURRICULUM

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The Monterey county economy is built around the agriculture sector. Top crops produced require knowledge and skill in the horticulture industry. This particular industry provides job opportunities, making it essential for the Everett Alvarez FFA program to retain students in the plant science pathway and more specifically, the environmental horticulture class. This project creates a resource to aid horticulture teachers with an updated curriculum and recommendations procedures to build a shade house and garden/planter boxes to allow students hands on experience in the horticulture industry.

Research revealed limited resources for horticulture curriculum. Most resources included very traditional lesson plans with lectures and focus questions. Lesson plans needed to be updated and a laboratory component added to be used in the multiple facets of horticulture industry. This will also align with the current trends in American education, including next generation education, which emphasizes true

learning and inquiry. The areas of study for the curriculum were identified along with targeted research on students and the learning process. Next, materials were gathered and collected from former classes, online resources and other horticulture teachers.

Materials were compiled and placed into one document divided into subdivisions/ units. The shade house and planter/garden boxes were built by the horticulture class. The shade house was purchased as a do it yourself kit. Students constructed the shade house by leveling the ground, cementing, and leveling the poles into the ground and attaching the shade cloth. Students also constructed 10' X 12' planter boxes by leveling the ground, using power drills and construction screws.

In conclusion, recommendations should be the inclusion of technology or web based learning into the curriculum. Recommendations for the shade house included adding pea gravel to for drainage as well as an automatic watering system.

## CHAPTER I

### INTRODUCTION

Agriculture, known as the domestication of plants and animals, was developed over 10,000 years ago ("History of Agriculture," n.d.) and has undergone significant developments in technology since the time of the earliest cultivation. The word agriculture is the English adaptation of the Latin word agricultura ("Agriculture," n.d.). The literal break down of the word agriculture, ager means, "a field" and cultura means, "cultivation", a literal reading of the word means "tillage of a field" ("Agriculture," n.d.). This literal reading of the word will later play a huge role in the shaping of agriculture education

Civilization began with agriculture, as far back as nomadic ancestors that settled in a permanent spot and eventually grew their own food ("History of Agriculture," n.d.). Human society would forever be changed with this settlement. All human communities could not ignore the importance of agriculture despite their developing sophistication. Without these dependable sources of food, all early communities would risk malnutrition and starvation. However, in modern times, many urban populations may have forgotten this fundamental connection with agriculture and the land. The abundance of food generated from new technologies may cause humanity to overlook the fundamental importance and the dependence upon agriculture more specifically horticulture and the cultivating of plants on a mass scale.

The apparent lack of an understanding of a community's dependence increases the need for agriculture education. Agriculture education is the teaching of agriculture through hands-on experience that prepares students for future employment or education and more advanced jobs in the agricultural field (National FFA Organization, 2015). Common curriculum for agriculture education can include, but is not limited to horticulture, turf grass management, agricultural science (earth science, biology, and chemistry), small animal care, shop classes, health and nutrition of livestock, livestock management and many more.

Agricultural education began to flourish during the late 19th century when the United States Congress created the Department of Agriculture in 1862 (National Institute of Food and Agriculture, and United States Department of Agriculture. 2014). The Department of Agriculture was established to gather and distribute agricultural information and was the foundation of agriculture education. In 1862, The Merrill Act was established and provided the land-grant for schools (National Institute of Food and Agriculture, and United States Department of Agriculture. 2014). In 1887, The Hatch Act funded agricultural experiment stations (National Institute of Food and Agriculture, and United States Department of Agriculture). Then finally in 1890, the first school with agriculture majors in the United States was established at University of Wisconsin-Madison.

The 20<sup>th</sup> century continued with increased government support for agricultural education. Examples include the Smith- Lever Act of 1914 and the Smith-Hughes Act of 1917, which created the now Cooperative Extension System and financed high- school instruction in farming (Mercier, 2015). Also helping to finance high- school instruction

was the George-Barden Act of 1946 (Mercier, 2015). The importance of vocational training in schools brought more funding to agriculture education in a vast variety of fields with the Vocational Education Act of 1963(Mercier, 2015). Government support led agricultural science and education to expand due to the need for additional technical knowledge. The knowledge and skills developed led to the use of modern farming methods and technologies that require less farm laborers and higher yielding crops. All of these advances demanded the need for further expansion in agriculture science and education field.

Currently, students have the opportunity to choose to enroll in an agriculture class at the high school level, which allows them to experience components of the agriculture industry through FFA's (Future Farmers of America) three ring model. The three rings includes:1) classroom instructions- classroom/laboratory instruction (contextual learning), 2) SAE-supervised agricultural experience (work-based learning) and 3) FFA- a student leadership organizations (National FFA Organization, 2015).

SAE's learn by doing model allows students real world experience in the field of agriculture (Wilson, & Curry, 2011). Students can choose to participate in any of the following categories: 1) Entrepreneurship-students own and operate an agricultural business (e.g. a lawn care service or a fair animal project.) 2) Placement- student's get a job or internship at an agriculture-based business. 3) Research and Experimentation- students plan and conduct a scientific experiment. (e.g. test different fertilizers on greenhouse plants.) 4) Exploratory- students explore careers in agriculture (National FFA Organization, 2015).

After a student decides on a class in agriculture, they can choose a pathway to help build upon those particular knowledge and skills that they may want to pursue after high school (National FFA Organization, 2015). Career pathways are also an essential component to agriculture education and to all of the career technical education (CTE) programs (CTE Online, 2015). Career and technical education (CTE) is an educational strategy to provide young people with the academic, technical, and employability skills and knowledge to pursue postsecondary training or higher education and enter a career field prepared for ongoing learning. Eliminating a stigma that vocational education consisted of low-level courses, job training, and single electives and replacing it with academically rigorous, integrated, and sequenced programs of study that align with and lead to postsecondary education. These programs provide students with opportunities to acquire the competencies required to enter the workplace; such skills include: critical thinking, collaboration, problem solving, innovation, teamwork, and communication. Career technical education is no longer just about teaching students a narrow set of skills sufficient for entry-level jobs; it is about preparing students for careers.

The intention of the career pathway is to provide marketable and valuable skills that will help students secure a job or move onto further post-secondary education (McGhee, 1974). Students are not required to choose a specific pathway, but the courses are designed to scaffold or build upon each other (CTE Online, 2015). This allows students the opportunity to gain specific experience in a specific pathway. For example, the Salinas Union High School Districts understands the benefit and need for career technical education and currently works with the Mission Trails Regional Occupation Program (ROP) to provide academic, technical, and employability skills and knowledge

to pursue postsecondary training or higher education and enter a career field prepared for ongoing learning to the students of Salinas. Since the city of Salinas and its surrounding communities are built around a \$4.38 billion dollar agricultural sector (Monterey Farm Bureau, n.d.), it was beneficially to include career pathways in agriculture at three of the high schools in the Salinas Union High School District. Some of the largest agriculture businesses in the area include horticulture and greenhouse production. Thus, Everett Alvarez High School has chosen to establish a plant science pathway and is the only high school in the county currently offering a horticulture class.

Below is a description of the plant science pathway that is offered, as well as foundation course descriptions for areas within the pathway. Horticulture and greenhouse production are some of the largest agriculture businesses in Monterey County and the surrounding counties. This pathway is ideal for students who enjoy being outside and learning hands-on while beautifying their surroundings. Students completing the Plant Science Pathway will have a solid understanding of plant reproduction and propagation, plant nutrition, principles of color and design, landscape installation, irrigation, and much more. The two foundation courses in the Plant Science Pathway include the following:

#### Environmental Horticulture

Environmental horticulture is the study of growing, arranging and tending decorative plants and flowers. Studies in environmental horticulture explore methods for designing plant and flower displays that can be used by golf courses, greenhouses and public or private businesses. In this class, students acquire landscaping and ornamental nursery skills, develop home landscaping skills, and practice landscape design and layout. Emphasis is placed on landscaping and nursery management principles (plant growth and production). Projects and experiments will be directed at the use of the use of the greenhouse and garden area. Students will create their own horticulture project and design their own business through the use of an on campus produce store and greenhouse facility. Additional

emphasis will be placed on record keeping and FFA. (Salinas Union High School District, 2015-2016, p. 13)

### Floral Design

This course provides students a review of the floriculture industry in California. The emphasis will be on learning skills for cut flowers, potted plant selection, and care. Floral design principles will be used to teach art concepts in elements of color, texture, balance, design principles, balance of shape and form. Shop management and job seeking procedures are also covered. Each student will have a supervised agriculture experience project through the on campus produce store and emphasis will be on record keeping and FFA. (Salinas Union High School District, 2015-2016, p. 1)

The Monterey County economy is built around a \$4.38 billion dollar agricultural sector and a \$2.2 billion dollar tourism sector (Monterey Farm Bureau, n.d.). The farm, food manufacturing and leisure/hospitality industries account for almost half of all jobs in Monterey County (Monterey Farm Bureau, n.d.). The top crops produced, in gross values, are Strawberries, Leaf and Head Lettuce, Broccoli, Nursery Stock, Wine Grapes, Celery, Cauliflower, and Spinach (Monterey Farm Bureau, n.d.). According to the Monterey Farm Bureau (n.d.), Monterey County supplies the following percentages of total national pounds produced each year: 61% of leaf lettuce, 57% of celery, 56% of head lettuce, 48% of broccoli, 38% of spinach, 30% of cauliflower, 28% of strawberries, and 3.6% of wine grapes Thus, there is a significant need for the development of skilled and knowledgeable students in the horticulture industry. The horticulture industry provides value to the local community and creates jobs opportunities. It also provides food and aesthetic pleasure to everyone in the community. This is why it is essential for the Everett Alvarez High School to retain students in the plant science pathway.

The first objective of this project is to create a resource to aid horticulture teachers with an updated curriculum that can benefit a diversity of learners. The second objective was to build a shade house and garden boxes to allow students additional aspects of the horticulture industry beyond working in the greenhouse.

## CHAPTER II

### LITERATURE REVIEW

#### Agricultural Education in the United States

For the United States to compete with other countries and sustain the growing population, the food and agricultural education system must be expanded and strengthened to address the challenges and opportunities facing the global food system (Mercier, 2015). Currently, agricultural education can be viewed through numerous forms in all grade levels, including secondary and post- secondary education (Mercier, 2015). For example, children in grade school classrooms benefit from programs such as “Ag in the Classroom,” middle and high school programs can include programs like Career Technical Education and Future Farmers of America and undergraduate and graduate students can enroll in colleges of agriculture at universities and other schools with agricultural programs (Mercier, 2015). This also includes professional agricultural leadership programs available for adults in farming and agribusiness.

This literature review focuses on agricultural education provided to students in high school (National FFA Organization, 2015). Programs such as Future Farmers of America are a means not only of exposing young people to careers in agriculture, but also to help educate the general population about agriculture. The subjects have broadened to include health and nutrition and natural resource issues (National FFA Organization, 2015).

Increased knowledge in the general public allows consumers to be more conscious of the impacts on the food they eat and the natural resource constraints such as water. The agricultural program can include, but is not limited to the following: courses in animal science; agricultural mechanics; food sciences; horticultural and landscape design; and agricultural finance (National FFA Organization, 2015).

Many high schools are also involved in programs and activities associated with Future Farmers of America which provide opportunities to expand knowledge and experience related to agriculture (Mercier, 2015). Future Farmers of America was established in 1928 and has been viewed as a contributor to formal, in-school learning (Mercier, 2015). Future Farmers of America chapters and agricultural education programs operate within a three ring model with activities conducted both within and outside of school hours. It also seeks to develop leadership skills among young people (National FFA Organization, 2015). Since California depends highly on the agriculture industry to maintain its economy. Schools saw fit to add agricultural education programs. This program allows for a more agriculture educated workforce with basic leadership skills.

Agriculture is fundamentally important to the California economy. According to the California Department of Food and Agriculture (CDFA), agriculture is a major industry a \$46.4 billion dollar industry with 80,500 farms and ranches. California Department of Food and Agriculture (2015) stated, “The state produces nearly half of US-grown fruits, nuts and vegetables. Across the nation, US consumers regularly purchase several crops produced solely in California” (p. 1). The demand for an educated

workforce will continue to grow as the population continues to grow and so will the need for horticulture services.

### Horticulture Curriculum: Why Laboratory Activities are Beneficial

Horticulture is the art or science of growing flowers, fruits and vegetables (“Horticulture,” n.d.). In the early history of this country, agriculture was a broad term to describe everything, but specialization in the study and use of plants has resulted in the field of horticulture being divided into several sub-divisions, including pomology, olericulture, floriculture, ornamental horticulture and viticulture (“Horticulture,” n.d.) Horticulture is a large part of the agriculture industry and should be one of the many topics addressed in a high school agriculture program. Unfortunately, limited curriculum resources exist for plant/horticulture teachers. Thus, one objectives of this project was to create and compile a curriculum for a horticulture class. The curriculum will include unit topics and lesson plans. Some of these units will include labs and lesson activates that will help to supplement the lectures and allow students to have hands on learning by experimenting and make their own decisions based on the concepts presented to them by the instructor.

Adoption of the common core or next gen standards clearly identifies a deeper need for students to learn a concept or skill, not just memorize it for a test or a grade. The emphasis is moving away from lecture, which may only benefit students who can recall information quickly and connect previous concepts to current ones because of what they have seen or heard during a lesson (Martinez, 1999). Public education creates a classroom of students with different ways of learning combined with personal experience

which influence students' emotional presence in the classroom. This environment suggests teachers can no longer rely on the status quo (Kovalik & Olsen, 1998). Students with different methods of learning need alternative learning environments, thus laboratory activates are important as they provide a challenging alternative to lectures and allow students with different learning styles the chance to succeed (Taraban, Box, Myers, Pollard, & Bowen, 2006).

According to Kruse (1998), laboratory instruction encourages students to learn differently by having them discover the key concepts for themselves instead of a lecture that simply discusses the background information or principles of a concept. Investigation and inquiry are skills common in labs. This allows students to apply critical thinking to a problem and use those skills to answer the problem, thus supplementing the information they learned from a lecture or other background information (Overbaugh & Lin, 2006). Lab and other hands on activates allow students to claim ownership, by the students making their own conclusions to the problem instead of the teacher (Splan, Shea Porr, & Broyles, 2011). Students demonstrate improved retention of concepts and ownership in what they discover themselves, which is why this strong laboratory based curriculum will help students achieve.

Effective laboratory activities heavily depend upon the facilitator. In order for inquiry to occur, the facilitator must guide the students with instruction without answering or giving away too much information to allow students the sense of discovery (Taraban et al., 2006).

## Learning Theories: Benefits of Agriculture Education

Sensory perception and interaction are paramount to learning. Sensory perception and interaction both involve the body and the mind (Kruse, 1998). Perception based learning is divided into four main styles, including auditory, visual, kinesthetic, and tactile (Kruse, 1998). Auditory learning is focused on hearing what is being taught or said and able to recall the information that was given. (Kruse, 1998). Visual learning is based upon visual representation and can connect to the concepts being taught in class (Kruse, 1998). Kinesthetic learners are based on actual performance of a task. Additionally, it can be something as simple as reenacting a process while being taught the content class (Kruse, 1998). Tactile learners need tangible items to touch, manipulate or a physical representation of a concept being discussed (hands-on-learning) (Kruse, 1998). Labs assist all styles of learning, but especially tactile or kinesthetic learning styles. Students should be able to benefit from learning by this “experiential” learning which promotes a more in depth understanding of the key concepts. Experiential learning is having students themselves interact and sort through the problems facing them in their classroom environment. This is also tied closely into a theory of learning called “constructivism” (Splan et al., 2011).

Constructivism is a theory of knowledge that humans generate knowledge and meaning from an interaction between their experiences and their ideas. It has influenced a number of disciplines, including psychology, sociology, education and the history of science. (Splan et al., 2011, p. 3)

Learning Orientation Model (LOM) is another theory about learning styles in which students can be classified into four categories: transforming, performing, conforming, or resistant (Martinez, 1999). Laboratory experiences allow transforming learners to succeed because these students are dedicated and motivated in whatever they undertake (Martinez, 1999). Performing learners are self-motivated when a particular subject interests them, but hopefully with a variety of activities this would spark more of an interest than the usual lecture (Martinez, 1999). Conforming learners accept that they must learn a particular set of information and store it away to recall later (Martinez, 1999). Conforming learners are often challenged by more open-ended forms of learning environments which pairs nicely with the nature of inquiry based labs (Martinez, 1999). The final learner is the resistant learners who believe academic education does not benefit them at all, yet the practicality of the technical skills learned in lab classes will be more valuable to the student than the lecture based on pure theory (Martinez, 1999).

Based on the Learning Orientation Model, only a percentage of students can succeed with the traditional classroom (Martinez, 1999). Those percentage of students which were referred to as conforming learners (Martinez, 1999), learn at a lower level due to the lack of diversity in the teaching methods (Dunn, 1995). Diversity can be created when labs are incorporated, allowing students to make real-world connections and applications between theories taught in the classroom. Taraban et al., (2006), described this phenomenon of labs as “Active Learning” in which students process the underlying lesson and important concepts that coincide while actively doing something that directly correlates to the lesson. Taraban et al. (2006), determined audience attention in lectures begins to wane every 10-20 minutes. Incorporating active learning during a

class increases student engagement. According to Taraban et al. (2006), active learning benefits students by reinforcing important material, concepts and skills. This is the premise of Common Core. Active learning can also provide the teacher with frequent and immediate feedback that addresses different student learning styles (Taraban et al., 2006). As students prepare for their post-secondary future, it is important to prepare them for the rigorous curriculum ahead of them. Furthermore, as future members of the work force, learning by doing empowers students with an opportunity to think, discuss, process information, practice important skills such as collaboration, and build self-esteem through conversations with other students (Splan et al., 2011). Agricultural science programs already encourage student participation in hands-on learning through Supervised Agricultural Experience Projects (SAE), class workdays, and class projects. Agricultural science curriculum specifically outlines laboratory learning as a key component of course objectives.

Agriculture science classes focus on key areas in the agriculture industry, broadening the scope so students view agriculture as more than production agriculture, and provide a foundation for hands-on learning and technical education. Laboratory components allow students to work together in a “learning community” where students must work together towards a common goal, contribute their ideas respectfully, and synthesize their thoughts into one collective answer (Overbaugh & Lin, 2006). There are numerous courses offered in high school, yet few programs offer a hands-on type of learning experience like agriculture programs. Animal science courses allow students the opportunity to work with live animals. Students study topics such as physiology, breeds, nutrition, breeding and behavior; something that any other class would lack. Mechanics

classes allow students to explore both design and fabrication of a project by creating their own projects and to harness practical skills by operating power tools, taking apart machinery, and learning construction methods. Other classes such as agriculture leadership or agribusiness allow students to coordinate, interact with local government or community members in relation to agriculture issues, or something as simple as developing a budget and keeping monthly records of expenses and income on their supervised agricultural experience projects. Last but not least, horticulture classes are a source of many jobs in the Monterey County area. Students have the opportunity to see the many facets including landscape design, nursery production, plant protection sciences, botany, turf grass management, floriculture, olericulture and much more. Horticulture offers students the opportunity to work with plants nearly every day with a production schedule, class projects and any number of laboratory scenarios for students to actively learn.

### Horticulture's Importance in the Classroom

Horticulture classes in the state of California have curriculum resources that are outdated (McGhee & Max, 1974). Research for this project, revealed a limited amount of resources. A large majority of the resources had very traditional lesson plans, outline of a lecture and focus questions for students to answer. A few of the resources had very detailed lesson plans, tests, quizzes, and even lab plans (CTE Online, 2015). One of the objectives of this project was to better equip future horticulture teachers with a set of teaching aids and materials to use in a high school level horticulture class. In particular, laboratory activities should be available to use for the multiple facets of Horticulture

classes. Research labs are where students stand to benefit the most from an experiential education standpoint. Current trends in American education, such as common core or next gen, strive for better science instruction with an emphasis on true learning and inquiry. It is believed that the entering an era of “scientific agriculture,” where a strong emphasis is being placed on research and discovery in this long-lived field of interest agriculture (Wilson & Curry, 2011).

Horticulture classes can be engaging and informative even if a student lacks interest in pursuing an education or career dealing with plants because we interact with plants on a daily basis. Horticulture classes involve activities such as buying floral arrangements, front and back yards, gardens, house plants, and even something as simple as grocery shopping (Overstreet & Straquadine, 2011).

According to Overstreet and Straquadine (2011), plants are proven to be therapeutic for those recovering from illness or injury, and relieve both stress and rid the air around us of toxins. As students learn more about plants and the horticulture industry, the more they can take away from agriculture classes. Well-structured horticulture classes with clear objectives, standards and interactive hands-on labs activities provide teacher’s opportunities to reach even those students who struggle to learn in a typical classroom. A well-designed curriculum provides students tools necessary to become actively learning for the rest of their lives (Overstreet & Straquadine, 2011). According to Overstreet & Straquidine (2011), personal experiences where we learn an idea, concept, or item, stay with us longer. Horticulture classes provide students with personal experiences to learn by using strong lab component. Lab based curriculum caters to all different learning styles making for a very effective class for which any student could be enrolled in it.

Student would be discovering things for themselves with the help of the learning community (Overstreet & Straqudine, 2011).

Schools are always looking for resources to introduce high school students to science labs and other similar hands-on activities. Instead schools could use agriculture classes like horticulture which allows students to explore the physical and chemical nature of topics such as soil. Students are taught to examine the properties of soil by using knowledge of scientific protocols and other information they have attained through their course contents. Students can then use the information learned to conduct simple experiments such as how to increase production or determine which seed variety to use. Students would learn how to formulate a question related to horticulture, formulate a hypothesis, conduct an experiment, collect data, and form a conclusion based on analysis of the data. All while demonstrating their knowledge of the soil chemistry content learned throughout the horticulture class.

Agriculture classes allow students to develop in many areas. Agriculture classes follow the three ring model which include: 1) classroom instructions-classroom/laboratory instruction (contextual learning), 2) SAE-supervised agricultural experience (work-based learning) and 3) FFA- a student leadership organizations (National FFA Organization, 2015). This class structure not only promotes hands on scientific learning, but also promotes skills students can use later in life. There is a need for additional agriculture classes, and more specifically horticulture classes. Thus, leading to the first objective, creating a resource to aid for horticulture teachers with an updated curriculum that can benefit a diversity of learners. The second objective is to update Everett Alvarez High School greenhouse area by building a shade house and

garden boxes. Allowing students to experience additional aspects used in the horticulture industry.

## CHAPTER III

### METHOD

#### Objective One

The first objective was to create a resource for those teaching horticulture.

First it was determined in which areas of study (subdivisions) would be included in the curriculum. Strategic, targeted research allowed for the discovery of existing high school horticulture curricula. Additional research was conducted on students and how they learn to determine how to design beneficially curriculum. Next, gathered materials from previous online curriculum and materials from the Salinas Unified High School District was sought through to focus on horticulture and laboratory-centered classes. Methods of research involved finding, analyzing, and synthesizing the information by using scholarly journals and search engines like Google Scholar. Other resources included personal knowledge from notes, books and handouts from the greenhouse management class and teaching horticulture classes that were obtained at California State University, Chico, which helped supplement the curriculum.

#### Objective Two

The second objective was to build a shade house and garden boxes to allow students additional aspects of the horticulture industry beyond working in the greenhouse. Shade houses are used to help prevent damage to plants during the bright days of summer

in Salinas in the months of August and September. This allows the Everett Alvarez FFA program to grow specialty crops with this addition to greenhouse area. The primary material used to construct a shade house is shade cloth. Each type of shade cloth is rated by the percentage of light it blocks. For this project, it has been determined that a 30% shade cloth will be most beneficial to the program. Next, is to determine the type of shade house structure that best matched the needs of Everett Alvarez High School. Factors can include space at the facility and the amount of plant material that will be sold or utilized in a schools program. After consideration, it was determined the school required a 10'x20' shade house structure.

Shade structures are fairly simple to build and make a great horticulture class project. This class project provides the opportunity to dive into other aspects of the industry such as basic layout and surveying skills. Students need to learn simple pacing to estimate the size of the greenhouse and later survey for elevations to level-out the ground. Budget constrictions determined that pea gravel would be placed on the ground to help with the drainage.

The final step before construction was the approval of any type of construction project required prior to construction. This project only required approval from the district office. It was proposed to the district office that the environmental horticulture class was going to be building the structure over the period of several weeks.

Ensuring student safety is paramount. Thus, PG & E was contacted to assess the area prior to ground breaking, for underground lines and to release any personal liability should an electrical, water, gas, or sewage line is hit while digging the footings.

Once confirmation was received from PG&E, footings for poles were secured. Holes were dug and checked for any debris. Sand was then placed in the bottom of the holes to help level the poles. To set the poles students used wheel barrels to mix up the concrete based on the directions given and placed cement in the holes. Students made sure to level the tops with a line and a line level. This ensures that walls are square making the installation of bracing later on an easier task.

Students installed the bracing in groups of four. Two members of the team held each side of the bracing while one member drilled and the last member checked if it was square and level. Once secured, students stretched the cables to attach the shade cloth by stretching the cables tight enough to hold the shade cloth from sagging.

Students also built additional planter boxes. The planter boxes were built with 1.5"x12"x20' redwood boards. The dimensions of the planter boxes were 10'x12'. Students then prepared the ground by leveling it and constructed the planter boxes by using power drills and 3" construction screws. Students then placed chicken wire in the bottom of the planter box help and lined the boxes with a thick black plastic plant liner. Last, students then filled the planter box with soil.

## CHAPTER IV

### FINDINGS AND RESULTS

#### Objective One

The first objective was created to address the state of California's standards of learning in the fields of Ornamental Horticulture and Plant Sciences. Ten units were developed in topics that included the following: Introduction and Safety; Careers in Horticulture; Plant Parts and Function; Plant physiology; Environmental Factors; Plant Nutrition and Fertilizer; Soils; Landscape Design; Integrated Pest management system; and Turf Grass. Lesson plans are structured as a rough outline of the topics and concepts that should be taught during a specific unit. Unit topics were identified and ranged in length from a week to two weeks, depending on the subject matter. Laboratory activities are listed in the lesson plans, to emphasize concepts discussed and to reach students with diverse learning needs. Particularly, the laboratory activities rely on students using inquiry to discover the concepts for themselves. The final components to the units are supplemental materials such as worksheets and handouts that allow students to use as a reference during school year.

The units of curriculum developed provide students with many different opportunities to express their creativity and inquiry skills. The curriculum addresses a variety of topics related to the horticulture industry and can be easily adopted at a high school agriculture program that lack a horticulture class. Based on the research, the

curriculum was developed with a strong emphasis on laboratory-based activities in order to be more effective with the variety of learners in a classroom setting. The compilation of materials will help with inquiry teaching that California is embracing with the common core or next gen standards.

### Objective Two

The second objective was accomplished by building a shade house and planter boxes to allow students additional aspects of the horticulture industry. Students will start to utilize the shade house and planter boxes in the spring.

## CHAPTER V

### THE CONCLUSION AND RECOMMENDATIONS

#### Objective One Recommendations

Recommendations for this curriculum can be the addition of technology and other web-based resources. Technology in the classroom helps to advance students understanding of materials. A further topic of study could include the applications of computer-based learning to the units of study. Teachers could benefit from technology when addressing units that are technical or very detailed, such as anatomy or plant identification. With this curriculum and additional funding, laboratory plans could be advanced to copy the same techniques used in the industry. This would provide students real life applications to scientific equipment and testing methods that are being used today in agriculture careers. Although this curriculum is suitable for a horticulture class, it is vital that curriculum like this continue to be modified and adjusted to suit future course objectives.

#### Objective Two Recommendations

Horticulture teachers it is recommend that a programs agriculture advisory board should assist with any permits needed with the county office or help with connecting career objectives outside the classroom with administration. It is also

recommended to have industry personnel talk to students in class about the building process.

Objective two required three adjustments to the shade house portion of the project. First, after three weeks of high winds, the grommets pulled out of the shade cloth and did not hold up the shade cloth for any length of time. It is recommended to purchase Shark Bite clips to remedy the problem. The clips are available from any supply house and work with a greater efficiency in terms of efficiency and longevity.

Next, it was stated above to purchase and place pea gravel on the ground of the shade house. This led to the need of a curb to help keep the gravel in the structure and not scattered as students walked in and out of the area. Cement edging is highly recommended to secure gravel and gives the structure a clean look. This process should take the horticulture class less than one day to set forms and level them and an additional day to pour and finish the concrete.

Finally, students have to water by hand daily according to plant material needs. Next steps include developing a watering system in the house in the spring. An automatic watering system will improve efficiency and promote uniform plant growth.

Agriculture classes allow students to develop in many areas as explained in the methods section. This class not only promotes hands on scientific learning about complex subjects such as soil chemistry, but also promotes skills such as masonry and public speaking that could potential benefit them in careers and in life. Promoting a need for additional agriculture classes, and more specifically horticulture classes.

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## **APPENDIX A**

## BUDGETS FOR PLANTER BOXES / PICTURES OF PLANTER BOXES

Materials	Price Per Single Unit	# of Materials Needed	Total for materials used
Pressure Treated Lumber 12'	\$13	6	78
Pressure Treated Lumber 8'	\$ 20	6	120
3' Construction Screws	\$8	1 box	8
Chicken Wire	\$73	1 roll	73
Plant Liner	\$65	1 roll	65
Soil	\$20	20	400
Total			744





## **APPENDIX B**

## PLANS FOR CONSTRUCTING A SHADE HOUSE / BUDGET

Materials	Price Per Single Unit	# of Materials Needed	Total for materials used
Shade house Structure	\$520	1	520
Cement	\$ 4	6	24
Pea Gravel	\$4	30	120
Clips for cloth	\$2	30	60
Total			724





## **APPENDIX C**

## HORTICULTURE STANDARDS

F. Ornamental Horticulture Pathway: The Ornamental Horticulture Pathway prepares students for careers in the nursery, landscaping, and floral industries. Topics include plant identification, plant physiology, soil science, plant reproduction, nursery production, and floriculture as well as landscaping design, installation, and maintenance.

F1.0 Students understand plant classification and use principles:

F1.1 Understand how to classify and identify plants by order, family, genus, and species.

F1.2 Understand how to identify plants by using a dichotomous key.

F1.3 Understand how common plant parts are used to classify the plants.

F1.4 Understand how to classify and identify plants by using botanical growth habits, landscape uses, and cultural requirements.

F1.5 Understand plant selection and identification for local landscape applications.

F2.0 Students understand plant physiology and growth principles:

F2.1 Understand plant systems, nutrient transportation, structure, and energy storage.

F2.2 Understand the seed's essential parts and functions.

F2.3 Understand how primary, secondary, and trace elements are used in plant growth.

- F2.4 Understand the factors that influence plant growth, including water, nutrients, light, soil, air, and climate.
  - F2.5 Understand the tissues seen in a cross section of woody and herbaceous plants.
  - F2.6 Understand the factors that affect plant growth.
- F3.0 Students understand sexual and asexual plant reproduction:
- F3.1 Understand the different forms of sexual and asexual plant reproduction.
  - F3.2 Understand the various techniques for successful plant propagation (e.g., budding, grafting, cuttings, seeds).
  - F3.3 Understand how to monitor plant reproduction for the development of a saleable product.
- F4.0 Students understand basic integrated pest management principles:
- F4.1 Read and interpret pesticide labels and understand safe pesticide management practices.
  - F4.2 Understand how pesticide regulations and government agencies affect agriculture.
  - F4.3 Understand common horticultural pests and diseases and methods of controlling them.
  - F4.4 Understand the systematic approach to solving plant problems.
- F5.0 Students understand water and soil (media) management practices:
- F5.1 Understand how basic soil science and water principles affect plant growth.

- F5.2 Know basic irrigation design and installation methods.
- F5.3 Prepare and amend soils, implement soil conservation methods, and compare results.

F5.4 Understand major issues related to water sources and water quality.

- F5.5 Know the components of soilless media and the use of those media in various types of containers.

F6.0 Students understand ornamental plant nutrition practices:

- F6.1 Analyze how primary and secondary nutrients and trace elements affect ornamental plants.

F6.2 Understand basic nutrient testing procedures on soil and plant tissue.

- F6.3 Analyze organic and inorganic fertilizers to understand their appropriate uses.

F6.4 Understand how to read and interpret labels to properly apply fertilizers.

F7.0 Students understand the selection, installation, and maintenance of turf:

- F7.1 Understand the selection and management of landscape and sports field turf.

F7.2 Understand how to select, install, and maintain a designated turfgrass area.

F7.3 Understand how the use of turf benefits the environment.

F8.0 Students understand nursery production principles:

- F8.1 Understand how to properly use production facilities and common nursery equipment.

F8.2 Understand common nursery production practices.

- F8.3 Understand how to propagate and maintain a horticultural crop to the point of sale.

F8.4 Understand marketing and merchandising principles used in nursery production.

F9.0 Students understand the use of containers and horticultural tools, equipment, and facilities:

F9.1 Understand the use of different types of containers and demonstrate how to maintain growing containers in controlled environments.

F9.2 Operate and maintain selected hand and power equipment safely and appropriately.

F9.3 Select proper tools for specific horticultural jobs.

F9.4 Understand how to install landscape components and electrical land and water features.

#### AGRICULTURE AND NATURAL RESOURCES INDUSTRY SECTOR

F10.0 Students understand basic landscape planning, design, construction, and maintenance:

F10.1 Know the terms associated with landscape and design and their appropriate use.

F10.2 Understand the principles of residential design, including how to render design to scale.

F10.3 Understand proper landscape planting and maintenance practices.

F10.4 Prune ornamental shrubs, trees, and fruit trees.

F10.5 Develop clear and concise landscape business contracts.

F11.0 Students understand basic floral design principles:

F11.1 Understand the use of plant materials and tools.

F11.2 Apply basic design principles to products and designs.

F11.3 Handle, prepare, and arrange cut flowers appropriately.

F11.4 Understand marketing and merchandising principles used in the floral industry.

## **APPENDIX D**

## UNITS OF TOPIC OUTLINE

Units	Standards Covered	# of Weeks to complete
Introduction and Safety	F9.0- F9.4	2 weeks
Careers in Horticulture	NA	1 week
Plant Parts and Functions	F2.0 –F2.6	4 weeks
Plant Physiology	F3.0-F3.3	3 weeks
Environmental Factors	F5.0-F5.5	4 weeks
Plant Nutrition and Fertilizer	F6.0-F6.4	3 weeks
Soils	F5.0-F5.5	2 weeks
Integrated Pest Management System	F4.0-F4.4	3 weeks
Landscape Design	F10.0-F10.5	3 weeks
Turf grass	F7.0-F7.3	2 weeks

## **APPENDIX E**

## CURRICULUM

# Introduction and Safety Unit

### Lesson History of Horticulture:

Hook: NA

Brainstorm- Where does food come from?

Objective: Students will be able to explain and describe the history of horticulture.

PowerPoint:

History of Horticulture

- Garden of Eden"
  - Romanticized garden of paradise.
  - Ultimate goal throughout history.
- Prehistoric people were primarily....
  - Hunters and gatherers.
  - Collected seeds, fruits, and nuts.
- Primitive people began to study plants.
  - Is it edible?
  - Does eating it modify well-being?
  - Does it taste good?
  - Can it used to keep me warm? As fuel? As clothing?
  - Is it useful to combat pain? Disease?
- When were plants first cultivated?
  - Neolithic Age (7000 – 10000 years ago)
  - First farmers were women!!!!
- By 3000 B.C. in Egypt
  - Land preparation
  - Irrigation
  - Pruning

- Meanwhile in Mesopotamia, Babylonia, and Assyria.....
  - Irrigation canals lined with burnt brick and sealed with asphalt joints.
- This system kept 10,000 square miles under cultivation.....
  - Which fed 15,000,000 people
- Cultivated roses, figs, dates, grapes, and olives.
- Meanwhile, back in America.....
  - The Pre-Incas were cultivating maize (corn)
  - Potatoes
  - Sweet potatoes
  - Peppers
  - Squash
  - Tomatoes
  - Cocoa
- The use of plant products eventually led to physicians, pharmacists, and scientists.
- Theophrastus
  - 1<sup>st</sup> scientific horticulturist
  - Student of Plato and Aristotle
  - Wrote the books *History of Plants* and *The Causes of Plants*.
- *History of Plants*
  - Morphology of roots, flowers, and leaves.
  - Anatomical features such as bark, pith, fibers, and vessels.
- *The Causes of Plants*
  - Relationship of weather, soils, and agricultural practices.
  - Importance of seeds
  - Value of grafting
  - Tastes and flagrances of plants
  - Death of plants
- Middle Ages
  - Little advancement in horticulture
  - Arabs (established botanical gardens)
  - Scientific advances of Greeks and Romans were preserved in monasteries.
- Renaissance
  - Rebirth of energetic attention to scientific discovery.
  - Taxonomy, morphology, and anatomy branches of botany began to grow.

- More and more plants were discovered due to exploration which required a system of classification.
- Linnaeus (1707-1778)
  - Swedish botanist.
  - Developed binomial classification scheme for plants.
  - Based on their sexual or flowering parts.
  - Basis for all classification systems today.
  - Built upon the work of the Greeks, especially Dioscorides.
- As the Renaissance evolved.....
  - Creation of formal Gardens
    - Versailles
    - Belvedere in Vienna

### Horticulture in America

- When the Europeans arrived they brought seeds, cuttings, and plants.
  - Orchards were established
  - Crops brought to America
    - Oranges
    - Wheat
    - Cabbage
- Early horticulturists in America
  - John Bartram
  - George Washington
  - Thomas Jefferson
  - John Chapman
    - aka. Johnny Appleseed
- New life in horticulture
  - Morrill Act of 1862.
  - Established land-grant universities.
  - Encouraged the growth of agricultural knowledge.
- Liberty Hyde Bailey (1858-1954)
  - “Father of American Horticulture”
  - Educated at Michigan Agricultural College
  - Present Day Michigan State University
  - Then was a professor at Michigan Agricultural College and at Cornell University.
  - Established the 1<sup>st</sup> horticulture department

- Prodigious Writer
  - *Hortus*
    - Taxonomic index of horticultural plants.
- *Cyclopedia of Horticulture*
  - Cultural and taxonomic information of plants.
- Established the Bailey Hortorium.
  - “things of the garden”
- Established the (ASHS) American Society of Horticulture Science in 1903.

Student Activity: Students will create a timeline of horticulture in America.

### **Lesson Introduction to Horticulture:**

Hook:

Define the word horticulture

Using ONLY the pictures that you have been given, work together to tape them to the board under each branch of horticulture.

Objective: Students will be able to explain and describe the branches of horticulture.

PowerPoint: Horticulture

- Word first used in 1600's
- Comes from two Latin words
- *Hortus* "Garden"
- *Cultura* "Cultivation"
- Horticulture means "cultivated garden" or "culture of garden plants"
- The culture of plants for food, comfort and beautification purposes

Horticulture Science

- Biology is the branch of science that deals with both plant and animal organisms and life processes.
  - Zoology is the part of biology that deals with animals.
  - Botany is the part of biology that deals with plants.

## Horticulture Technology

- The application of science to horticulture
- More than just daily watering
- Time, patience, & understanding of the processes of plants
- Science + technology + production = the horticulture industry

## Branches of Horticulture

- Olericulture
  - The growing and study of vegetables.
- Pomology
  - The growing and study of fruits and nuts.
- Viticulture
  - The growing and study of grapes or vines.
- Floriculture
  - The growing and study of flowers.
- Greenhouse Management
  - The growing and study of plants in greenhouses.
- Turfgrass Management
  - The growing and study of turfgrasses. This includes home, municipal, and commercial lawns; sports turf maintenance; highway rights-of-way; and seed and sod production.
- Nursery Management
  - The growing and study of trees and shrubs that are produced primarily for landscape purposes.
- Arboriculture
  - The growing and study of trees.
  - Known as silviculture in forestry.

- Synonymous with urban forestry.
- Landscape Horticulture
  - The application of design and horticultural principles to placement and care of plants in the landscape.
- Interiorscaping
  - The application of design and horticultural principles to placement and care of plants in indoor environments.
- Horticultural Therapy
  - The use of horticultural plants and methods as therapeutic tools with disabled and disadvantaged people.

**Student Activity:**

Students will be assigned a branch of horticulture and will conduct research to make an informational flyer.

**Lesson why is horticulture important**

Hook:

Using the grocery store advertisements, find 2 examples of a vegetable, fruit and a nut. Once you have found two examples identify which branch of horticulture these advertisements would fall under.

Objective: Students will be able to explain and describe the importance of the horticulture industry.

PowerPoint:

**Popularity of Horticulture**

- People like plants
- Small vegetable gardens
- “green revolution” (60s-70s)

## Advantages of Horticulture

- Increase in jobs
- Increase in enrollment at colleges
- Increase in aesthetic pleasure

## Horticulture Industry segments

- Floriculture
  - \$5.4 billion market
  - California & Florida are top producers
- Landscape Horticulture
  - Homeowners spent \$50.9 billion on landscaping & gardening in 1999.
  - Nursery production in 2000 \$3.3 billion nationally
- Olericulture
  - Worth over \$10 billion of US Farm receipts
  - California leads in fresh & processed
  - Grown on 1% of US Cropland
  - Increased production a result of technology & efficient production
- Pomology
  - No citrus fruit \$9.01 billion in 2004
  - Citrus production \$2.39 billion in 2005
  - US Nut production \$3.25 billion in 2004

Student Activity: Students will use the advertisements chosen in the beginning of the class. To create their own advertisement about one segment of the horticulture industry. Make sure students use information they have learned all week including branches, history and its importance.

### **Lesson Safety in Horticulture:**

#### **Hook:**

Show the students the video on accidents

<https://www.youtube.com/watch?v=ZzmraESLueA>

After the video explain to the students that agricultural and agribusiness occupations are among the nation's most hazardous occupations. Many of the same hazards that occur in the workplace are found in the school's greenhouse.

**Objective:** In this lesson you will learn about general safety practices in the Horticulture laboratory. You will be given very specific safety instructions for the equipment and chemicals will be used in the laboratory or greenhouse for hazardous situations in later lessons.

#### **PowerPoint**

#### **What makes Horticulture so dangerous?**

- A. Dangerous equipment like tractors and chainsaws (some say chainsaws are the most dangerous device ever created by humans)
- B. Many times people work alone
- C. Water is used a lot in conjunction with electricity
- D. Sometime the noise level is too high to hear warnings or high enough cause permanent hearing loss.
- E. Chemicals splashes (like pesticides)
- F. Sometimes there is a lot of heavy work (lifting causing back and muscle problems)
- G. A lot of eye hazards (ricocheting nails, grinding, dust, etc.)
- H. Respiratory exposure to dusts, chemicals

#### **Definition of "accident."**

*"An unfortunate event causing loss or injury resulting from carelessness, unawareness, ignorance, or a combination of causes."* Webster's Dictionary

A common quote is "Ah, it's not going to happen to me." To which a logical reply is, "That is why they call it an accident; nobody thinks it's going to happen to them."

### **The Steps of Accidents**

The factors that may cause an accident and possibly injury: - 80% of accidents are caused by unsafe acts

- 20% are caused by unsafe conditions

Three factors that lead to accidents:

1. Background of a person

A. Personal habits

B. Inexperience

2. Defects of Person

A. Lack of knowledge or skill

B. Improper attitude (not willing)

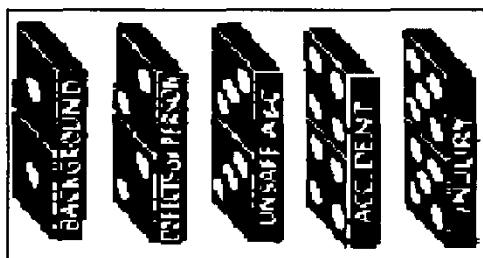
C. Physical deficiency (not able)

3. Unsafe Acts and Conditions (Unlimited list)

### **DOMINO SAFETY DEMONSTRATION**

A visual representation of how accidental injuries occur and what must be done to control them.

1. In this illustration the 5 dominos show the steps leading to an accident and possible injury. Topple the domino to illustrate injury.



### **What injury is the leading cause of lost work time?**

Back problems. Eight out of 10 people in the U.S. will consult a physician for back problems sometime in their lives. What can be done to avoid back injury?

#### **Basic Principles to Prevent Back Pain Injury**

Here are some basic principles to prevent back pain injury:

- Avoid lifting when possible and by pushing, pulling, rolling or sliding the object.
- Use mechanical aids (hand trucks, carts, winches, forklifts, etc.)
- Request help from others when necessary.
- Lift only loads you can safely handle.
- Establish good footing.
- Keep the loads close to body.
- Bend at the knees as you grasp it.
- Get a full hand grip and keep your body erect.
- Lift smoothly by straightening the legs (avoid jerky or snatching lifts.)
- Avoid the lift and twist action.
- When turning, move your feet rather than twisting your body at the waist.
- Reverse the procedure to set the object down.

#### **Safety Rules and Policies**

In Horticulture class you will carry out many lab activities. While no human activity is completely risk free, if you use common sense and a bit of knowledge or the situation, you will encounter few problems. Sensible lab conduct won't happen by memorizing a list of rules -- although they are important and do help. A perfect score on a written driver's test does not ensure you will not have an accident. The safety rules given below apply to most agriculture lab activities. For your personal safety and that of your classmates, make following these guidelines second nature in the laboratory. If you understand the reasons behind them, these safety rules will be easy to remember and to follow.

Show the students safety video made by students  
<https://www.youtube.com/watch?v=VoJk1KwPCls>

**Student Activity:**

Students will perform a skit to demonstrate the factors that lead to accidents.

**General Rules of Conduct and Safety Contract**

*The following rules must be observed to insure your safety and the safety of others in the Horticulture classroom and laboratory.*

- 1.Your concern for safety should begin even before the first lab or shop activity. Always read and think about safety before starting an activity.
- 2.Perform laboratory work only when your teacher is present. Unauthorized or unsupervised laboratory experimenting is not allowed.
- 3.Know the location and use of all safety equipment in your laboratory. These should include the eye wash station, first-aid kit, fire extinguisher, and safety shower (if available).
- 4.Gum, food, or drinks should not be brought into the laboratory.
- 5.Any laboratory accident, however small, should be reported immediately to your teacher.
- 6.No horseplay, running, etc. is allowed at anytime in lab/shop or classroom. Scuffling and "horseplay" will not be permitted in Horticulture class. 85% of school accidents are caused by "horseplay."
- 7.Never throw tools, soil, plants, pots or other objects around the work area or classroom.
- 8.Do not use equipment unless you have been instructed on its use and safety precautions, and given permission to do so.
- 9.Keep all tools stored in their correct location while not in use.
- 10.Make sure all safety devices, guards and other items of protective equipment are in place and working at all times.
- 11.Before making adjustments on any piece of equipment, make sure it is turned off and unplugged.
- 12.The greenhouse is loaded with electrical wiring. Water is a very good conductor. When watering plants, put the water on the plants - nowhere else. Never spray water around any electrical control equipment.
- 13.Keep your work area clean and clear of hazards.
- 14.If water has been spilled on the floor, clean it up immediately
- 15.Always use the proper tool for the job.

- 16.Lift heavy objects safely, using proper lifting techniques. Never try to show your strength by lifting excessive weights. Get help if the object is too heavy.
- 17.Students are not to work with any equipment or controls other than that assigned to him by the instructor.
- 18.Never consume water from greenhouse faucets.
- 19.Take responsibility for the safety of yourself and others. Follow tool and equipment safety manuals. Obey rules and guidelines as well as the instructions of your teacher. Use good judgment for safety sake. *If in doubt ask!!*

Student Signature: \_\_\_\_\_ Parent Signature: \_\_\_\_\_  
Instructors Signature: \_\_\_\_\_ Date: \_\_\_\_\_

# Unit Two Careers in Agriculture

## Lesson Careers in Horticulture

Hook:

Teacher: Someday, you will be done with school, all of your schooling, and college. Every day that alarm clock is going to go off and you will be going to work. What would make an ideal job for you? What traits or characteristics of a job best suit your personality? On a separate piece of paper list 5 traits or characteristics that you have. After turn to your elbow partner to develop 10 more characteristics that are important to you.

After 5 minutes has passed, bring students' attention back to the teacher. Ask each set of partners to share 2 traits from their new list. They cannot duplicate what another student has already said. As the class is listening to the sharing, direct them to write down on their paper any of the characteristics that they hear that may also apply to them.

Objective: Students will be able to explain and describe What is needed in order to obtain a career in the horticulture field and what job opportunities are there.

PowerPoint:

### Skills

- Science & business understanding
- Understand plant needs & growth
- Mechanical needs (irrigation systems, tools, equipment)
- Marketing skills
- Administrative skills
- Legal skills

### How to prepare for a career in horticulture

- Must be productive & have necessary personal skills (ability to relate to others)
- Setting & Achieving goals
- Education & Training

- Education related to plant and soil science, etc.
- National FFA Organization

### Horticulture Industries

- Landscape Horticulture
- Floriculture
- Pomology & olericulture
- Turfgrass

What are examples of jobs and careers in the horticulture field?

- Nursery production involves growing plants in containers or fields.
  - Plants can be grown from seeds, cuttings, or grafts.
  - Jobs and occupations in nursery production supervisor include propagator, inventory manager, field supervisor, manager, salesperson, sales manager, and shipping.
- landscape nursery industry prepares sites for landscaping and purchases the items needed for a landscape design.
  - Jobs and occupations in the landscape nursery industry include construction supervisor, designer, and salesperson
- Landscape maintenance work involves caring for already established landscapes.
  - Mowing, pruning, weed control, and fertilization are all examples of landscape maintenance work.
  - Jobs and occupations in the landscape maintenance industry include crew supervisor, superintendent of operations, salesperson, and manager.
- The plants and seeds used by commercial growers come from large operations.
  - These large operations are able to mass produce seeds and plants.
  - Examples of jobs and occupations related to this industry include plant breeder, propagator, independent grower, sales manager, and salesperson
- A garden center offers consumers plant materials and supplies needed to maintain a garden or landscape
  - Jobs and occupations related to the retail nursery industry include buyer, landscape designer, plant technician, and manager.

- Arborets and botanical gardens offer both job and educational opportunities for people interested in horticulture
- Floriculture
  - Grower
  - production superintendent
  - marketing manager
  - inventory controller
  - Wholesale florists sell both floral products and materials used in floral designs.
  - Jobs and occupations related to the wholesale floral industry include manager, buyer, and salesperson.
  - A retail florist shop is a business in which people can find floral products
  - Jobs and occupations related to the retail floral industry include store manager, sales clerk, and designer.
- *Pomology and olericulture*
  - Production varies according to the crop being raised and where it is being raised.
  - Examples of jobs and occupations in food crop production include manager and field technician.
  - Marketing is also important in the food crop production industry.
  - Examples of jobs and occupations in the food crop marketing industry include sales agent and broker
- Turf grass
  - Sod production is the mass production of turfgrass.
  - Jobs and occupations related to the sod production industry include farm manager, assistant farm manager, spray technician, and staff leader
  - Turfgrass establishment involves a site where turfgrass has already been installed and requires maintenance.
  - Examples of jobs and occupations in the turfgrass establishment industry include construction superintendent and planting superintendent.
- Golf course design and maintenance involves workers designing and caring for golf course landscapes.
  - golf course architect
  - superintendent
  - assistant superintendent
  - irrigation technician
  - spray technician

- landscape technician
- equipment operator
- Other career areas
  - horticulture therapist
  - cooperative extension agent
  - horticultural specialist
  - consultant, teacher
  - research scientist.

### Student Activity

#### **Exploring Horticulture – Career Brochure Project**

This project will consist of a tri-fold brochure highlighting key factors of the specific career chosen. Use Rubric attached for specific criteria and points for each section.

<b><u>Requirements:</u></b>
<b>Job Description</b>
<b>Working Conditions</b>
<b>Education &amp; Training Requirements</b>
<b>Salary &amp; Earnings Information – MN and US</b>
<b>Job Outlook</b>
<b>Cover</b>

#### **CAREER IDEAS:**

**www.iseek.org**

Floral Designer

Foresters

Greenhouse Workers  
Landscape Architect  
Landscapers & Groundskeepers  
Nursery Workers  
Park Naturalists  
Pest Control Workers

**www.bls.gov/oco**

Grounds Maintenance & Landscaping Workers  
Horticultural Specialty Farmers  
Landscape Designer  
Soil and Plant Scientist

**Unit 1 and 2 Quiz**

The science and practice of growing and harvesting tree fruits, small fruits, and tree nuts is called?

- a) ornamental and landscape horticulture
- b) floriculture
- c) olericulture
- d) pomology**

The science and practice of growing vegetable crops is called?

- a) ornamental and landscape horticulture
- b) floriculture
- c) olericulture**
- d) pomology

The science and practice of growing and harvesting flowering plants is called?

- a) ornamental and landscape horticulture
- b) floriculture**
- c) olericulture
- d) pomology

The science and practice of propagating, growing, maintaining, and using grasses, annual plants, shrubs, and trees in the landscape is called?

- a) ornamental and landscape horticulture
- b) floriculture
- c) olericulture
- d) pomology

A greenhouse employee works?

- a) mostly outdoors
- b) mostly indoors
- c) with nursery stock only
- d) alone

The greenhouse worker has a job that consists of?

- a) very irregular and seasonal work
- b) very strenuous manual labor
- c) regular hours that are steady throughout the year
- d) constant outside work

Nursery workers?

- a) spend a great deal of time outdoor
- b) spend most working hours in the greenhouse
- c) can always depend on steady work
- d) do not need to be able to identify plants.

To find out what jobs are available locally, the student should?

- a) make a survey of local horticultural businesses.
- b) check with the Department of Labor
- c) check with a local employment agency
- d) all of the above

A garden center employee should?

- a) enjoy meeting people.
- b) enjoy a job that is mostly paper work
- c) enjoy working alone
- d) not be concerned about finishing high school

A grounds maintenance employee should?

- a) enjoy working outdoors and working alone
- b) enjoy mowing grass as part of the job

- c) enjoy repairing equipment and walks
- d) all of the above**

Which one of the positions listed below is never related to horticulture?

- a) researcher
- b) teacher
- c) an ability to meet people
- d) a person who enjoys being alone**

Most of the jobs in horticulture require?

- a) a high school diploma**
- b) excellent physical condition
- c) marketing specialist
- d) a person who enjoys being alone

Horticultural salespeople should have a background in horticulture because?

- a) it helps them to know the product they are selling
- b) it help them to talk to grower
- c) it helps them to know which items to offer for sale
- d) all of the above**

The word "HORTICULTURE", a Latin word, means?

- a) "grower of crops"
- b) "plant cultivator"
- c) "lover of plants"
- d) "garden cultivation"**

When selecting a job?

- a) be sure you like the work involved**
- b) take the highest paying job
- c) don't consider how well you may get along with the boss
- d) don't worry about possible promotion

# Unit Three/ Four Plant Parts and Function/ Plant Physiology

## Lesson Functions of plant parts

Hook: How do you know something is living? Give me 5 characteristics of a living organism.

Ask students questions to move them through the concepts

- All living things have needs.
- Needs must be met in order for living things to survive, grow, and be healthy.
- Needs can be met in different ways.
- Living things are built so that their needs can be met.
- Plants and animals (including people) have some similar needs

Objective: Students will be able to explain the importance and function of the following plant parts:

- stem
- roots
- leaf
- fruit
- flower

PowerPoint:

Roots

- Take up oxygen during respiration
- Absorb and translocate water and nutrients to the stem that are taken up through the root hairs
- Store food in the form of starch
- Anchor the plant and keep it in a stable position
- Give off carbon dioxide during respiration

- In some plants, roots have nodules which contain nitrogen fixing bacteria (like legumes)

### Leaves

- Photosynthesis is the process by which plants produce their food....and photosynthesis takes place in the leaves.
- Carries out transpiration and cools the plant.
- Can store some food, which can be transferred to other areas of the plant
- In some cases, the leaf can be used in asexual or vegetative propagation

### Stems

- Serves to translocate nutrients from the roots to the leaves in the vessels of the XYLEM and PHLOEM
- Supports the leaves of a plant and also the fruit and flowers
- Provides growth in the ‘MERISTEM’ of the terminal bud
  - The meristem is where cell division occurs
  - Often can be used for vegetative propagation
  - The CAMBIUM layer provides diameter growth in the stem

### Fruit

- The fruit is a ripened ovule together with its associated parts, and often protects the seed.
- Some plants have a dry dehiscent fruit which, when split open helps disseminate seeds
  - some actually hurl the seeds out as the seed surface explode
  - others have wings, or other ways to float or be carried by air
- Can provide nutrients to the soil and to a newly germinating seedling
- Some fruits help disseminate seed by providing food for animals:
  - animals eat the fruit and seeds. The fruit is digested and the seeds pass out in the animals' feces at (presumably) another location

### Flower

- The flower is of utmost importance in reproduction and continuance of the species.
- Pollination of the flower serves to instigate the fertilization of the ovules
  - this produces a ‘zygote’ which becomes the seed

- » Because flowers are often colorful and fragrant, it attracts insects and birds for pollination
  - It can be said that the flower is often a biotic partner with the animals which obtain food from the flowers and in exchange help fertilize it (by bringing in pollen).
- The flower can also be an animal trap, such as the Venus Fly Trap and the pitcher plant. Once the insect is trapped, it is digested (dissolved by the plant for food.)

### Student Activity

Rotating lab stations.

Station 1. Remove the top two inches of the carrot, which is the cell foliage, and put it in a cup of water in the back of the classroom. We will check the carrot cuttings periodically and record what happens.

Station 2. Place a piece of opaque paper over a part of a leaf surface and a paper clip it to the leaf given to you. What happens to the color of that portion of leaf surface? Why?

Station 3. Cut out the eye of a potato with some potato meat attached. Plant in our sterile growing media in the back of the classroom with the eye pointing up. We will observe and record what happens with these eyes in the next couple weeks.

Station 4. Please take out a piece of paper and write down 5 new things you learned from today's lesson on the functions of basic plant parts

### **Lesson Plan Roots and Stems**

Hook:

You have probably pulled a plant out of the ground by its stalk (stem) to reveal the jumbled mess of roots below, but do you know how roots and stems help a plant stay alive?

Objective: Students will be able to explain and describe plant systems, nutrient transportation, structure, and energy storage.

PowerPoint

Functions of a Root

- Anchor the plant
- Absorb water and nutrients from the soil and transports them to the stems and leaves
- Store food for the plant
- Help prevent soil erosion

### Parts of the Root System

- Primary Roots
  - Grow from the hypocotyl part of the seed embryo
- Secondary Roots
  - Branch off of the primary root
- Root Hairs
  - Hair-like extensions that make their way through the openings between soil particles
  - Water and nutrients enter the root hairs and then travel up the secondary and primary roots to the stems and leaves

### Taproot

- One large root with smaller secondary roots attached to it
- They penetrate deep into the soil
- Examples: carrot, dandelion, oak trees

### Fleshy Taproot

- Acts as a food storage area of the plant
- Examples: carrots, turnips, beets

### Fibrous Root

- No recognizable primary root
- Lots of fine, thread-like roots of the same size
- Originate at the base of the stem
- Spread near the surface of the soil
- Examples: grasses, shrubs

### A Balance is needed between roots and stems

- Roots supply water and minerals to shoots, while shoots supply food to roots.
- Hormones normally balance the growth of roots and shoots
  - Roots make cytokinin, which travels to shoots and promotes bud growth
  - Shoots make auxin, which travels to roots and promotes root growth

## Functions of Stems

- Transport materials up and down the plant through the vascular system
  - Consists of xylem and phloem tissue
  - Young stems have vascular bundles, which consist of both xylem and phloem
  - Woody stems have a vascular cylinder in which the outer portion is the phloem and the inner portion is the xylem
    - Xylem Tissue- Moves water and nutrients Upward from the roots to the stems and leaves
    - Phloem Tissue- Moves water and nutrients DOWNward from the stems and leaves to the roots

## Other Functions of Stems

- Provide physical support for leaves, fruit and flowers
- Store food (ex: onions, garlic, potatoes)
- Green stems have chlorophyll in them and conduct minor photosynthesis
- Capable of reproduction
- Help establish tendrils which aid climbing plants

## Types of Stems

- Herbaceous – soft tissue that bends (ex: houseplants)
- Woody – brittle, non-bendable, bark-like tissue (ex: trees, shrubs)

## Student Activity: Stem Lab

### Materials

1 celery stalk

2 beakers

2 different colors of food coloring

### Procedure

- Fill both beakers half full of water.
- Place 5 drops of one color food coloring into one beaker and the other color into the other beaker.
- Cut off the base of the celery stalk, making sure to leave approximately 8 inches of stem.

- Make a cut (lengthwise) through the stem, 2-3 inches upwards from the base
- Place one half of the celery stalk in one beaker and the other half in the second beaker.
- Cut flower with stem and place it in either beaker.
- Allow your celery stalk and flower stem to sit in the colored water until next class period.
- Make sure that your work area is clean and all trash is disposed of.

#### Analysis Questions

1. What is the conductive tissue that allows the food coloring to move up the plant?
2. Why is this tissue important to the survival of the plant?
3. Why didn't the two colors of food coloring mix inside the celery stalk? And, what is the significance of this?
4. Where are most of the nutrients produced in the plant and where are they stored? How does this experiment demonstrate the importance of conductive tissues?

#### Roots and Stems Quiz

1. List 3 functions of roots:
2. Draw a plant in the space below. Label the primary root, a secondary root,
3. Explain the difference between a primary root and a secondary root.
4. Give one example of a plant with a tap root system.

5. Name a type of plant that has a fibrous root system.
6. What is the name of the hormone produced by plant roots that helps stimulate bud growth?
7. What are 2 functions of stems?
8. Describe the difference between xylem and phloem tissue in stems.
9. Explain the difference between a herbaceous stem and a woody stem.

### **Lesson Plan Leaves**

Hook: Why do leaves change color?

Objective: Students will be able to explain and describe plant systems, nutrient transportation, structure, and energy storage.

PowerPoint:

Functions of leaves

- Manufacture food for the plant – through process of photosynthesis
  - Equation for Photosynthesis:  $\text{CO}_2 + \text{H}_2\text{O} \rightarrow \text{C}_6\text{H}_{12}\text{O}_6 + \text{O}_2$
  - Photosynthesis only occurs when light is present

Leaf Terms

- Epidermis: outside layer of the leaf (leaf surface)
- Stomata: openings in the leaves where carbon dioxide comes in from the atmosphere (needed for photosynthesis)
- Transpiration: the loss of water vapor from the plant; most water is lost from the stomata, some through the cuticle layer

### Types of leaves

- Simple
- Compound

### Leaf Arrangement

- Alternative
- Opposite
- Whorled

### Leaf Venation

- Parallel
- Pinnate
- Palmate

### Leaf Types

- Palmately Compound
- Odd Pinnate
- Even Pinnate

### Why do leaves change color?

- Chlorophyll is a chemical that helps photosynthesis happen
  - Gives plants their green color
  - What happens in winter?
  - Days get shorter.
  - Not enough light for photosynthesis.
  - Trees rest and live off the food they stored.
  - As the food factories shut down, the chlorophyll disappears from the leaves.
  - As the green fades away, we see yellow and orange.
  - Bright reds and purples is from glucose trapped in leaves after photosynthesis stops.
  - The brown is made by wastes left in the leaves.

### Did you know

- The green color in unripe bananas comes from chlorophyll, the same pigment that gives green leaves their color. As bananas ripen, the chlorophyll breaks down and disappears, revealing the yellow color which has been there all along

Student Activity:

Name \_\_\_\_\_

Date \_\_\_\_\_

## PAPER CHROMATOGRAPHY OF LEAF PIGMENTS

Do green leaves also contain other pigments?

### Hypothesis

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### Materials

Isopropyl alcohol

Green leaf

Coffee filter or chromatography paper

Coin

Beaker

Ruler

Scissors

Pencil

Tape

Colored pencils or crayon

### Define

❖ Chromatography

❖ Chlorophyll

❖ Carotenoids

### **Procedure**

1. Obtain a strip of chromatography paper or cut a 2 ½ cm strip from a coffee filter.
2. Use a ruler to measure and draw a light pencil line 2 cm above the bottom of the paper strip.
3. Wrap a leaf around a coin with the waxy side of the leaf facing outward. Now rub the leaf along the pencil line on the paper strip until you make a dark green line. DO NOT RUB THE LEAF ABOVE OR BELOW THE LINE. RUB THE LEAF ON THE LINE ONLY.
4. Tape the top of the paper strip to a pencil so that the end of the strip with the green line hangs down. The pencil should be able to sit across the top of the beaker with the bottom of the paper strip just touching the bottom of the beaker. Cut off any excess paper from the top of the strip if it is too long. DO NOT CUT THE BOTTOM OF THE STRIP WITH THE GREEN LINE.
5. Remove the pencil/paper strip from the beaker for now.
6. Carefully add isopropyl alcohol to the beaker until it reaches a depth of 1 cm in the beaker.
7. Lay the pencil across the top of the beaker with the paper strip extending into the alcohol. MAKE SURE THAT THE LEVEL OF THE ALCOHOL IS BELOW THE GREEN LINE ON YOUR PAPER STRIP. IF THE ALCOHOL IS GOING TO COVER THE GREEN LINE, POUR OUT SOME ALCOHOL BEFORE YOU GET THE GREEN LINE WET.
8. Observe as the alcohol gets absorbed and travels up the paper. This may take up to 20 minutes. Do not touch your experiment during this time.
9. Using colored pencils or crayons, draw your results.

### **Results**

<b>Filter paper</b>	<b>Use colored pencils or crayons to draw your observations</b>
<b>Before paper chromatography</b>	
<b>After paper chromatography</b>	

## Conclusions

1. Did the leaf you tested contain different pigments? Use your results to support your answer.
  2. Based on what you have learned, explain why leaves tend to change color in the fall.

## **Lesson Plan Parts of a Flower**

## Hook: Why are flowers so pretty?

Objective: Students will be able to explain and describe different forms of sexual and asexual plant reproduction

PowerPoint

## About Flowers

- Flowers differ in such features as size, shape, and color, but all flowers contain the same basic parts.
  - These parts are necessary for the production of seeds.
  - Seeds are produced by a sexual process called fertilization, with a male and female parent involved.
  - A complete flower has both male and female parts, and only one parent flower is needed. There are also incomplete flowers, which have either male or female parts on the flower but not both.
  - Plants that have incomplete flowers require two parent flowers, one of each sex.
  - The complete flower, that we will be working with today, has 5 main parts.

## Main Parts

- The sepals are small green leaf-like parts of a flower that cover and protect the flower bud before it opens. They also cover the calyx, which contains the receptacle.
- The receptacle is the base of the flower where all the other sexual parts of the flower attach and join together.
- The petals are actually leaves but are generally known as the most colorful and striking part of the flower. The bright colors of the petals are present to attract pollinators to the flower.

## Sexual Parts of the Flower

- The stamen is the male reproductive part of the flower.
- Each stamen consists of a short stalk called a filament and a saclike structure on top of the filament called the anther.
- The anther contains pollen, which is the male sex cell
- The pistil, located in the exact center of the flower, is the female reproductive part. It produces the female sex cells, the eggs (ovules). These eggs, if fertilized, become seeds.
- The pistil has three main parts: a sticky stigma on top to catch pollen and a style, a tube that leads to the third part, the ovary.
- The egg cells develop in the ovary. After fertilization, the ovary grows to become a fruit or a seed coat depending on the type of plant.

## Why is a flower pretty?

- A flower is constructed so that insects are attracted to it for nectar they must first climb over the anther and brush the pollen on the hairy surface of their bodies.
- As they climb onto the center of the flower for nectar, part of the pollen is brushed onto the stigma of the pistil. This allows the fertilization process to begin.
- The pollen grain sprouts like a seed and sends a long stalk down the style to the ovary and egg cells. The pollen sperm cell then fertilizes the egg cells and seeds begin to develop.
- The ovary enlarges into a fruit or seed coat

## Plants

- Monoecious Plants

- Plants that bear both male and female flowers (capable of self-pollination)
- Dioecious Plants
  - Plants that carry only male OR female flowers (not capable of self-pollination)

Student Activity:

## Reproductive Parts of a Flower

For each reproductive part of the flower, please label with proper name, place the example from your dissection on the lab sheet, and fill in any terms.

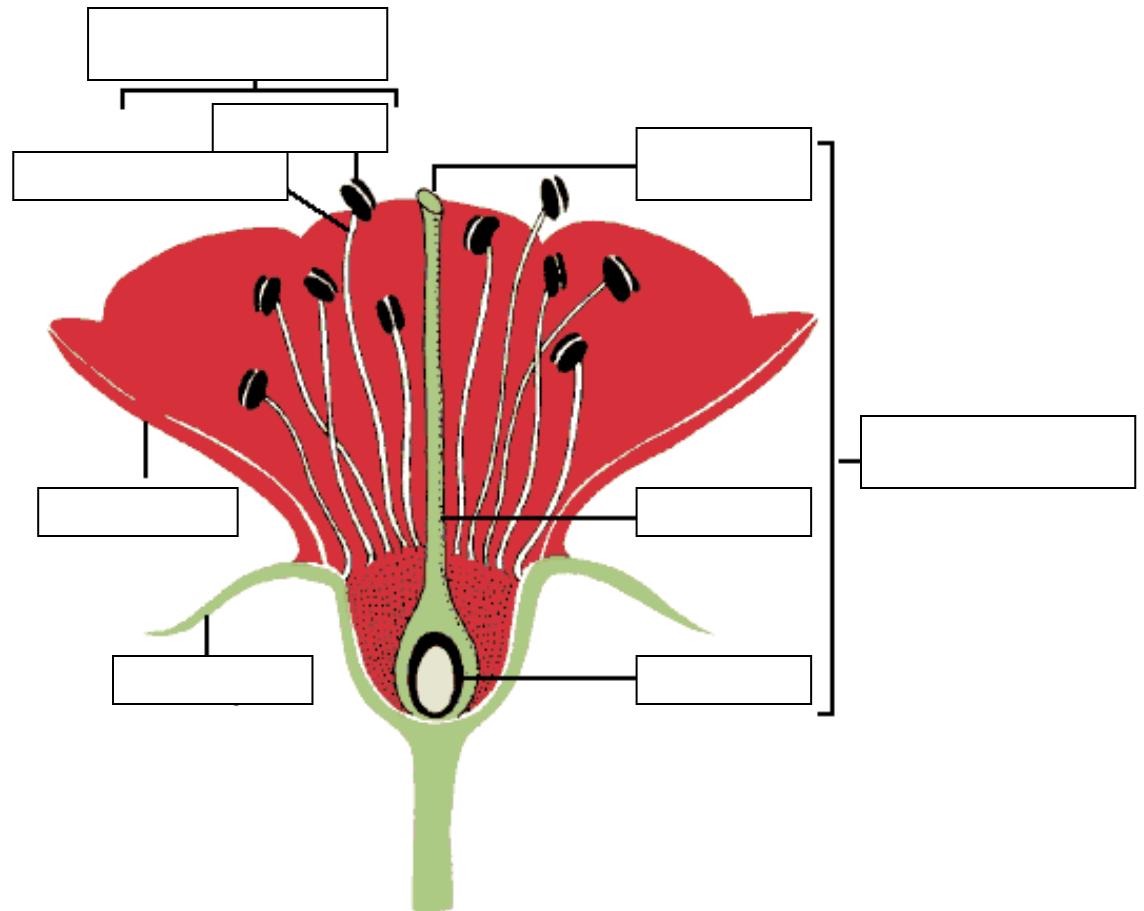
\_\_\_\_\_ Large and showy – attracts pollinators

\_\_\_\_\_ Male portion of the flower – releases pollen  
\_\_\_\_\_ releases pollen from sacs  
\_\_\_\_\_ – connects pollen sac to the receptacle, thin stalk

\_\_\_\_\_ Female portion of the flower – contains ovary and ovules  
\_\_\_\_\_ – surface for pollen to stick to  
\_\_\_\_\_ – connects sticky top to the ovary, long tube  
\_\_\_\_\_ – contains ovules

\_\_\_\_\_ Inside the ovary  
\_\_\_\_\_ these are developing eggs

Please fill on the labels missing for the flower parts.



Lab Questions:

What is a complete flower?

What is an incomplete flower?

Explain what happens in fertilization?

Student Activity #2

## **Flower Parts Activity**

Using two flowers from the samples provided:

- Diagram, label, and color the parts of each flower
  - Determine if the flower is COMPLETE or INCOMPLETE
  - Determine if the flower is PERFECT or IMPERFECT
- 
- 

Define the 5 major parts of the complete flower :

- 
- 
- 
- 
-

## Lesson Plan Seeds and germination

Hook: What do you need to grow?

Objective: Students will be able to use techniques for successful plant propagation.

PowerPoint:

### Seeds- General Information

- Mature, fertilized eggs contained inside fruit
- Range in size from a few millimeters to a few inches
- Can be flat round or cylinder
- Distributed by wind water or animal

### Basic Parts of a Seed

- Seed embryo- complete miniature plant in a resting stage
  - Divided into the epicotyl and hypocotyl
- Endosperm- stored food that contain sugars and proteins and fats; used during the first stage of development
- Seed coat- tissue that surrounds the embryo and the stored food; protects seed from water loss and injury

### Germination

- The process of a seed developing into a plant
- Requirements
  - Adequate moisture
  - Oxygen
  - Proper Temperature
  - Light
- Steps in germination
  - Seed absorbs water
  - Water cracks the seed coat, activating growth
  - Root shoot (hypocotyl) begins to grow downward
  - Stem Shoot (epicotyl) begins to grow upward
  - Normal growth continues. Green leaves begin to develop

### Student Activity

## Seed Dissection Activity

### Directions

With one partner, you will carefully dissect corn and pinto bean seeds. Once sliced open, you need to examine and identify the parts located inside.

### Materials

- |   |                                      |
|---|--------------------------------------|
| <input type="checkbox"/> Pinto bean seeds | <input type="checkbox"/> Paper towel |
| <input type="checkbox"/> Corn seeds       | <input type="checkbox"/> Pen/pencil  |
| <input type="checkbox"/> Scalpel          |                                      |

### Procedure

1. You and your partner need to set-up a work area, making sure to leave enough room between you and the group next to you. Obtain all materials needed for this activity.
2. Spread your paper towel out on the table. Place your seeds on top of the paper towel.
3. Before you split your seeds in half, identify the external parts of the seed (seed coat, hilum, and micropyle). Draw and label these parts in the space provided.
4. Using extreme caution, make a lateral incision on the seeds with the scalpel. Your seeds should now be in two separate pieces.
5. Raise your hand and have your teacher collect your scalpel.
6. Once your bean seed is split in half, examine it closely for the following internal parts: seed embryo, epicotyl, hypocotyls, endosperm, cotyledons
7. Use the space provided to diagram the dissected seeds and label the parts.

8. Once you are done with the lab, throw the seeds and the paper towels in the trash. Make sure that your work area is clean.
9. Make sure that this handout is completed and then turn it in to the box at the front of the room.

Data

<b>Monocot Seed – External Parts</b>	<b>Dicot Seed – External Parts</b>
<b>Monocot Seed – Internal Parts</b>	<b>Dicot Seed – Internal Parts</b>

Analysis & Conclusion Questions

1. Where does the seed store its food?
2. Explain why it is important for a seed to contain its own food source.

3. What part of the embryo plant develops into the roots?

4. What is the purpose of the seed coat?

5. List the requirements for seed germination.

### Quiz Seed Germination

1. List 3 ways that seeds are distributed in nature.
2. The seed embryo is divided into two parts . . . the \_\_\_\_\_ which forms the plant's root system and the \_\_\_\_\_ which forms the plant's stems and leaves.
3. Explain the importance of having the endosperm inside the seed.
4. What is the purpose of the seed coat?
5. Define "germination"
6. List the 4 requirements for germination.
7. In detail, explain the germination process . . . from the seed to the growing plant.

### Lesson Plan Cuttings: Asexual Propagation

Hook: Today we're going to make clones

Objective: Students will be able to explain techniques for successful plant propagation.

PowerPoint:

#### Asexual Propagation

- A= without
- Therefore asexual= Without sex
- Without sex = No pollination

How?

- Clones the parent plant to create identical replicas of the plant.
- Uses plant parts such as leaves, roots, and stems to start new plants.

## Woody & Semi Woody Cuttings

- When to take cuttings:
- After current or present seasons growth has partially hardened.
- Cuttings should still be able to bend

### Stem Cuttings

- Collecting cuttings:
- Early morning is the best time to take cuttings

### Making Cuttings

- Make cutting 2-4 inches long.
- $\frac{1}{4}$  Inch below a leaf, bud, or side shoot.
- Remove any blooms on cutting.

### Caring for Cuttings

- Place cutting in a sanitizing water/bleach solution immediately after taking cutting.
- Be sure to remember which is the top of the cutting.
  - If you bury the top of the cutting, the cutting won't root
- Cut bottom at a 45° angle.
  - allows more surface area to contact media for water absorption.

### Treating Cuttings

- Strip cuttings lower leaves.
  - will prevent the cutting from rooting.
- Dip cutting in rooting hormone #3.
  - chemicals which help cuttings grow more quickly and grow a larger number of roots.

### Inserting Cuttings

- Place dipped cutting in
- dibbled hole.
- Gently press media around cutting.
- Label cutting with name and variety, include name of rooting hormone used

### Rooting of Cutting

- Check for roots by pulling out cutting.
  - Immature root system= roots don't hold soil, so soil crumbles in hand.
  - Root bound= roots coiled tightly around soil.
  - \*Mature root system= roots hold soil, so soil doesn't crumble in hand.
  - \*Ideal and ready to transplant.
- Growth on the tips or sides is normal, but does not indicate root growth.

### Student Activity

## ***Stem Cutting Propagation Lab***

- We will be taking cuttings of Mexican Sage.
- We want a cutting that is approximately 1-2 inches in length.
- Cutting needs to be from the top portion of the plant.
- Each group needs to get 20 cuttings from the bush.
- Once all cuttings are collected, we will go to the greenhouses.
- Each group needs to get a flat and fill it up with perlite and peat moss mixture.
- Then follow the chart below to see what needs to be done with each group of your cuttings, to determine which is best.
- We will check and record data.

	Bleach	Rooting Hormone	Number of Cutting	Number that rooted	Percentage that rooted
Control	No	No	5		
Group A	No	Yes	5		
Group B	Yes	No	5		
Group C	Yes	Yes	5		

- Upon the conclusion of the lesson students will write out 1/2 a page on this sheet with why they think certain groups rooted best than others (in the space provided below)
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### **Study Guide**

1. How are seeds distributed?
2. What are the 3 basic parts of a seed?
3. Be able to label the monocot & dicot seed diagrams.
4. What are the 4 requirements for germination?
5. Explain the steps in the germination process.
6. Define the following terms:  
Seed embryo, Seed coat, Endosperm, Hypocotyl, Epicotyl, Germination, Monocot and Dicot
7. What are the functions of roots?
8. Explain the difference between primary roots, secondary roots, and root hairs.
9. Give an example of a plant with a tap root system.
10. Give an example of a plant with a fibrous root system.
11. What is a “fleshy taproot”?
12. Explain how cytokinin & auxin help create a balance between root & shoot growth.
13. What are the functions of stems?
14. Describe the difference between xylem & phloem vascular tissue.
15. Be able to identify woody & herbaceous stem specimens.
16. Know how to identify the following external stem parts: Terminal bud, Axillary bud, Leaf scar, Internode, Node

17. Understand and be able to explain what bulbs, runners, and tubers are.
18. What was the purpose of the stem lab activity that we did in class (with the celery, flowers, & food coloring)?
19. List the functions of leaves.
20. What is the equation for photosynthesis
21. Explain how photosynthesis benefits the plant.
22. What are the 3 types of leaf venations?
23. Be able to identify the node, leaf blade, & petiole on a leaf specimen.
24. What is the outside layer of the leaf called?
25. What occurs during transpiration?
26. Explain the difference between a simple & compound leaf.
27. Be able to identify the following leaf specimens: Parallel venation, Palmate venation, Pinnate venation, Palmately compound leaf, Odd pinnate compound leaf, Even pinnate compound leaf, Opposite leaf arrangement, Alternate leaf arrangement
28. What are the functions of flowers?
29. List the 5 parts that make up a complete flower.
30. Be able to label/identify the flower parts listed in #29.
31. These are made up of anthers & filaments.
32. True or False? The anther holds the pollen in a flower.
33. These are made up of a stigma, style, & ovary.
34. Why is the stigma sticky?
35. What does the ovary hold?
36. What makes a flower incomplete?
37. Describe the difference between perfect & imperfect flowers.
38. Can a flower be complete & imperfect?
39. Can a flower be incomplete & perfect?
40. Which plants are able to self-fertilize . . . monecious or dioecious?

## Semester Final

**TRUE OR FALSE -- Please write your answer (either "T" or "F") in the blank provided.**

1. A carrot is an example of a fleshy taproot.
2. Seeds may be distributed by wind or by animals.
3. Plants with two cotyledons are called monocots.
4. The bean is an example of a dicot.
5. One function of roots is to store food for the plant.
6. Ornamental Horticulture is defined as the growing, harvesting, storing, processing and marketing of vegetable crops.
7. One example of a modified stem is a potato.
8. Oak trees have fibrous roots just like grass.
9. Seeds will germinate without access to water or air.
10. Growth rings occur as trees grow in diameter.
11. Perfect flowers have both male & female reproductive structures.
12. Annual plants take nearly 3 years to complete their life cycles.
13. The purpose of the seed coat is to protect the seed from water loss & injury.
14. Endosperm is the name given to the male reproductive parts in plants.
15. Cytokinin is a hormone produced by the stems to control root growth.
16. The pistil is the female reproductive structure inside a flower.
17. Xylem tissue carries nutrients produced by the leaves down to the roots.
18. Root hairs are tiny little extensions of the secondary roots that help absorb water for the plant.
19. A woody stem is brittle and will snap when bent in two.
20. Runners and bulbs are types of roots.
21. Bark is the protective covering of woody stems.
22. Fibrous root systems spread out near the surface of the soil.

- \_\_\_\_\_ 23. Transpiration is the process by which plants manufacture food for themselves.
- \_\_\_\_\_ 24. A simple leaf contains many small leaflets that make-up the leaf blade.
- \_\_\_\_\_ 25. Epidermis is the outside layer on the leaf (skin).
- \_\_\_\_\_ 26. A complete flower can also be considered imperfect.
- \_\_\_\_\_ 27. The pistil is the female part of the flower – made up of the anthers and filaments.
- \_\_\_\_\_ 28. Leaf venation refers to the way that the leaves are attached to the stem.
- \_\_\_\_\_ 29. Pollinators, such as bees and butterflies, are important for reproduction in the plant kingdom.
- \_\_\_\_\_ 30. The node is the area of the stem where leaves, fruit & flowers are attached.

**MATCHING** --Write the letter of the definition on the line in front of the term that it matches.

- |                         |  |
|-------------------------|--|
| _____ 31. Fruit         | a. attract insects for pollination               |
| _____ 32. Roots         | b. manufacture food for the plant                |
| _____ 33. Transpiration | c. contain seeds                                 |
| _____ 34. Seed          | d. support leaves, fruit, flowers                |
| _____ 35. Flowers       | e. absorb and store nutrients and water          |
| _____ 36. Leaves        | f. first leaves to appear on a plant             |
| _____ 37. Stems         | g. aid in sexual propagation of a plant          |
| _____ 38. Cotyledon     | h. forms all plant parts below the cotyledon     |
| _____ 39. Hypocotyl     | i. loss of water (as water vapor) from the plant |

**Fill in the Blank** -- Complete the following questions by filling in the appropriate words

**40. List 4 benefits that plants provide to humans:**

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**41. What are the 4 major steps in the germination process?**

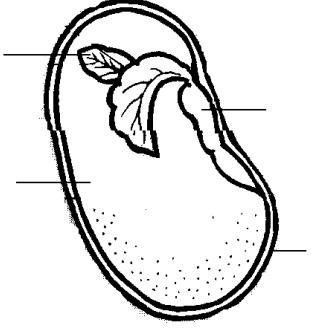
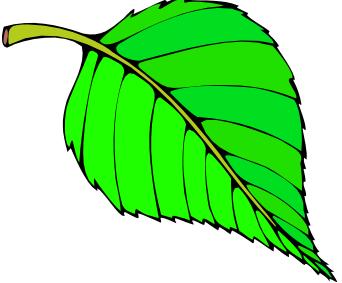
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**Labeling** -- Please identify each numbered part on the diagrams below.

<b>Parts of the Seed:</b> 42. _____ 43. _____ 44. _____ 45. _____	
<b>Parts of the Leaf:</b> 46. _____ 47. _____ 48. _____	

**Parts of the Flower:**

49. \_\_\_\_\_

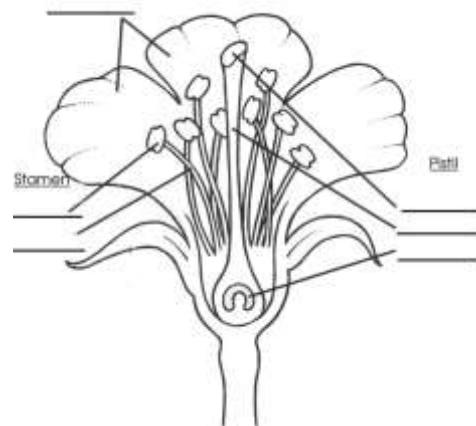
50. \_\_\_\_\_

51. \_\_\_\_\_

52. \_\_\_\_\_

53. \_\_\_\_\_

54. \_\_\_\_\_



55. \_\_\_\_\_

Palmate venation

56. \_\_\_\_\_

Pinnate venation

57. \_\_\_\_\_

Opposite arrangement

58. \_\_\_\_\_

Alternate arrangement

59. \_\_\_\_\_

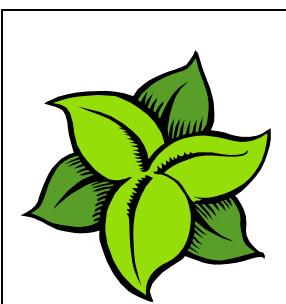
Whorled arrangement

60. \_\_\_\_\_

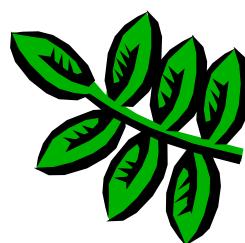
Odd pinnate

61. \_\_\_\_\_

62. \_\_\_\_\_



55



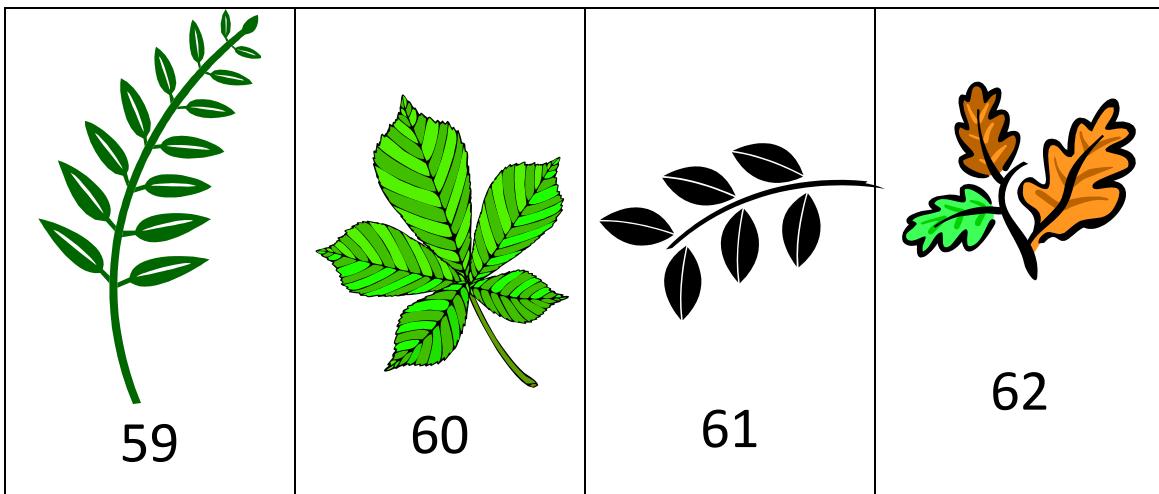
56



57



58



## Unit Five/Six/Seven- Environmental Factors/ Plant Nutrition and Fertilizer /Soils

### Lesson Environmental Horticulture

Hook:

Take 3 minutes to brainstorm How horticulture related to the environment?

Objective: Students will be able to explain and describe how horticulture impacts the environment.

PowerPoint:

Environment

- The environment is the nonliving (abiotic) aspect of an organism's immediate habitat.
  - Rocks, minerals, air and water
- Horticultural plants, animals and microorganisms are living (biotic) aspects of an environment
- The study of living things in relation to their environment is called ecology
- Ecosystem is a community of organisms and its nonliving environment
- Horticultural practices influence an ecosystem

- Public demand for high-quality causes growers concern for how to produce this at a low cost

#### Environmental Issues

- Intensive land use – large fields
- Integrated Pest Management- a combination of measures to reduce pest damage with the least disruption to environment
- Biotechnology & genetic engineering – new plant varieties
- Invasive species- disrupting ecological balance by out-competing native species
  - Purple Loosestrife, multiflora rose, etc.

#### Benefits to the Environment

- Personal
  - Recreational & aesthetic value
  - Increase value of real estate
- Biological
  - Roots help prevent soil erosion
  - Plant slow water runoff
  - Plant control dust & absorb pollutants
  - Plants provide wildlife habitat

#### Dangers to the Environment

- Pollution- harm caused by improperly applied chemicals
  - Point source pollution- easily identified sources
  - Nonpoint source pollution- from few to many sources that is not easily identified

#### Natural Resource Affect

- Water resources
- wetlands
- wildlife

## Water Resources

- Hydrologic cycle
  - The way water flows through an environment (oceans, lakes, rivers, streams, groundwater, and reservoirs)
  - Precipitation- water in form of rain or snow
  - Evaporation- water from a liquid to a vapor when passing through air
  - Transpiration- movement of water in vapor form
  - Condensation- water from a vapor to a liquid
- Infiltration
  - Movement of water through the soil
  - Proper land management needed to ensure proper infiltration

## Wetland Resources

- Swamps, bogs, marshes, ponds, etc protected by law
  - Essential as flood control, wildlife habitat, and erosion control
- Enhance environment
  - Fishing, hunting, beauty and comfort for people

## Chemicals

- Fertilizers
- Pesticides
- Cause damage when used inappropriately

## Fertilizers

- Used to increase plant growth
- Eutrophication- overabundance of nutrients in a body of water that depletes oxygen supply
  - Caused by excessive fertilizer running off fields & into ponds, rivers & lakes
- High nitrogen causes excess nitrates in groundwater (drinking water)

- Phosphorus loss through runoff

- Turfgrass & ground covers help

Pesticides

- Kill plant & animal pests
- Excess causes water contamination, resistant pest populations, & decline in bird populations (DDT)
- To reduce need keep plants healthy
- USE SPECIFICALLY AS DIRECTED!!

Student Activity Worksheet:

**Point versus Non-Point Source Pollution**

**Essential Question: How do humans affect the quality of water with point and non-point sources of water pollution?**

**Pollutants**

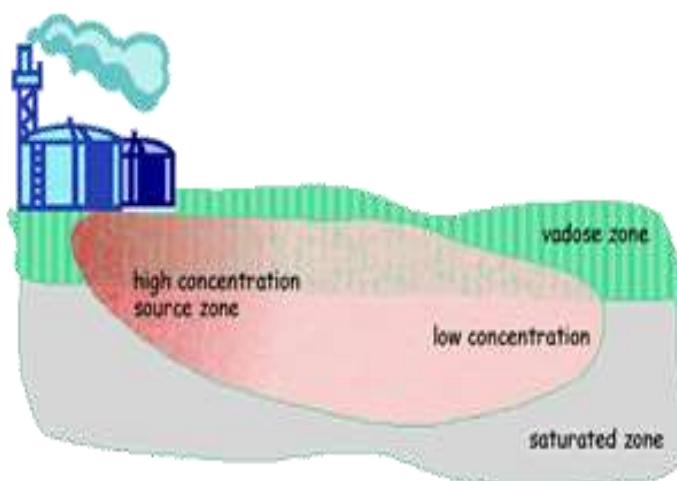
- A **pollutant** is a substance or energy, like heat, that can cause **harm** to the environment and the organisms in it.
  - **Water** pollutants have a **negative** effect on the water **system** or **living** things that depend on the water.

**Point versus Non-Point Source Pollution**

- Sources of pollution in water are identified by **how** they **enter** the water system.
  - A pipe gushing orange water or a tanker oil spill into a river would be from a single source, which is called a **point source**.



- Sometimes it is hard to **locate** the source of pollution.
- **Runoff** from a farm field, or street is a **widespread** source of pollution called **non-point** source pollution.



#### Contamination Plumes

- An **underground** area where pollutants have been **spread** by **groundwater** is called a **contamination plume**.
- These plumes can also be from **point** or **non-point** sources.
- Picture of site in Minnesota after **underground** oil pipeline break.
- The NC Triad has many oil pipelines running across it underground. What would happen if one of them broke?



**Activity:**

1. Cut out each source of pollution.
2. Glue the Category Heading “Point Source” to the left and “Non-Point Source” to the right on the top of a piece of paper.
3. Cut out each of the other types of pollution and sort them into one of the categories.
4. Glue them down after the class checks the answers.

<b>Damaged wastewater pipe</b>	<b>Acid rain</b>
<b>Leaking underground storage tank</b>	<b>dish water release from homes</b>
<b>soil and silt from farms</b>	<b>Fertilizer runoff from golf courses</b>
<b>Waste runoff from hog farms</b>	<b>heated water release from Duke Power Plant into Belews Creek</b>
<b>Point Source Pollution</b>	<b>salts from irrigation of farms</b>
<b>release of chemicals from paper mill</b>	<b>Non-Point Source Pollution</b>
	<b>Raw sewage release from wastewater treatment plants</b>

**Student Activity**

Your task is to investigate any environmental issue, and identify what sources of information are available to thoroughly investigate the topic.

The assignment has two parts. Both parts will be submitted together in the same document.

1. In the first part, you will make a list of APA citations for 10 types of information resources that are available that could be used to write a paper on your selected environmental issue.
2. In the second part, you will compare how your selected environmental issue is treated in popular media and the academic literature by answering a series of questions.

Your assignment should be prepared and submitted in .DOC or .PDF format.

Create a title page showing:

- a. the title of the assignment (Assignment: Understanding Environmental Issues and Information Sources);
- b. the topic or subject area you have chosen;
- c. the course name;
- d. your name and student number.

The rest of your assignment will consist of two parts:

1. Part I: A list of 10 citations for relevant information sources, in APA style; and

Part II: Answers five questions comparing and contrasting popular media and scholarly sources.

- A. How balanced was the treatment given to the issue by the popular versus the scholarly media? Were any biases or specific viewpoints evident?
- B. Who were the intended target audiences of the articles? Did this influence the way they were written or presented? Did the use of language differ in popular versus scholarly articles?
- C. How were you able to judge the accuracy of the reported facts in the two types of articles? Observe the presentation of data and / or statistics. Were authorities or sources cited or quoted? What further sources of information were provided in the articles, if any? Did you notice any inconsistencies between the articles?
- D. Did either the popular or the scholarly articles discuss the policy implications of the subject (i.e., explicit or implicit recommendations for

changes in thought, action or deed that emerged from the discussion in the articles)? Are there any implications of this issue for tourism?

- E. What are the advantages and disadvantages of learning about environmental issues using popular versus scholarly sources of information? What roles do these different information sources play in the environmental education of the general public?

### **Lesson Plan Environmental Factors- Part 1 Soil**

**Hook:** Prepare a head of time popcorn (1 cup), peanuts (1/4 cup) and m&m's (1/4 cup) - (1) of each kind for each student or a group of students. Also give each student or group of students a clear plastic cup (16 oz). Have students keep the items separate. Have students pour the popcorn into the clear cup, add in the peanuts, put their hand over the top of the cup and shake it up for five seconds. On a sheet of paper have students record their findings. What do they see? Why do they think it is happening? Give them only thirty seconds to write their thoughts. Next add in the m&m's, cover and shake for five more seconds. Once again give students thirty seconds to record their findings and opinions about what is happening. Students should be able to identify that the materials mix based on size and texture.

**Objective:** Students will be able to explain and describe the factors that influence plant growth, including water, nutrients, light, soil, air, and climate.

**PowerPoint:**

**What is Soil?**

- composed of sand, silt, and clay, organic matter, living organisms, and pore spaces
- classified according to percentage of sand, silt, and clay they contain.

**Soil Particles**

- vary greatly in size
- sand is the largest
- silt - medium
- clay – smallest

### Sand

- Sand is small, coarse-grained pieces of rock.
- We can see and feel the individual pieces
- It feels gritty. It doesn't stick together or form clods.
- It can be really fine or not so fine
- Not much surface area is exposed
- Sand increases space between particles, which means air and water can move more freely, which means Sand is needed in soil to provide good drainage!

### Silt

- Silt is really soft and powdery
- Silt particles are so small that we can only see them with a microscope
- Water soaks well into silt
- Silt forms clods that crumble when wet so they are not good for mudballs!
- Silt particles don't stick together well
- Soils with a good water holding capacity are high in silt

### Clay

- particles hold moisture and plant food elements more effectively than larger particles
- Clay is even finer than silt
- Clay particles are platy and thin in shape, they fit closely together with little space
- Clay sticks together well and forms hard clods
- A soil that contains lots of clay is considered "heavy"
- Clay has a large surface area because they are so small
- The amount of clay in a soil has a great impact on the soils water holding capacity

### Soil Profile

- consists of 3 basic layers
- topsoil- Horizon A
- subsoil- Horizon B
- soil bedrock -Horizon C

### Topsoil

- represents depth normally plowed
- Can be a few inches to a foot deep
- Is usually a pretty dark color
- Lighter texture than the B or C horizon
- More likely to be a granular structure

### SubSoil

- Low in organic matter
- Red or yellow in color
- Less desirable structure than the A horizon
- Blocky or prismatic structure
- Roots may extend into this horizon looking for moisture and nutrients
- deep rooting plants send roots down into subsoil

### Soil Bedrock

- Deepest of the 3 major horizons
- Low in organic matter
- Coarse or rocky texture
- Undesirable structure
- Lighter in color than A and B horizon
- Rarely has roots or biological activity

### Texture, Structure, Depth and Color

- Texture- How much sand, silt and clay is found in soil, is it fine or coarse
- Structure- The mixture of the soil, how the particles are arranged to make up the soil, the structure is not permanent! Think of it as...wet soil, or disk the soil
- Depth- Important to plants, depends on rooting zone
- Color- Soil color can tell us a lot...It can tell us about drainage and water and organic matter

### Sandy Soil

- silt and clay make up less than 20% by weight
- drain well
- little water holding capacity

### Clayey Soil

- must contain at least 30% clay
- holds more moisture than is good for plants
- poor drainage

### Loamy Soil

- most desirable soil
- equal parts sand, silt and clay

### Soil Improvements

- Drainage
  - change soil structure
  - add organic matter to encourage earth worms
    - their tunnels and castings result in better soil structure - aggregation - clinging together
- Moisture Retention
  - adding organic matter (o.m.)
  - sources of o.m.
    - peat moss
    - sawdust
    - mulches - compost or wood chips
      - placed on the surface to help retain moisture
      - reduce runoff and evaporation
      - reduce weeds
  - animal manure
  - green manure - crop grown and plowed under to improve the soil

### Student Activity: #1

#### Soil Erosion Lab

Background The ratio of sand, silt, and clay in soil determines its ability to hold moisture and nutrients. To determine the ratio of sand, silt, and clay, a small amount of solid soil will be mixed with water and given a chance to settle out. The sand is the densest layer and will settle to the bottom of the jar. The silt is the next densest and will settle in the middle of the three layers. The clay, the least dense layer, will settle at the top of the layers.

## Materials

Mason jar

Soil

Water

Salt

### Directions Day 1:

1. Place one inch of dry, crushed soil in a tall quart (Mason) jar.
2. Fill the jar 2/3 full with water and add one teaspoon of table salt (dispersing agent).
3. Shake the jar thoroughly and then let the contents settle overnight.

### Day 2:

4. Measure the entire depth of sand, silt, and clay together. Record the total depth below.
5. Sand will settle to the bottom of the jar. Measure the depth of that layer and record below.
6. Silt will be the next to settle. You should see a color and size difference between the sand and silt layers. If not, measure the depth of both layers and subtract the sand depth from the total to determine the silt depth. Record below.
7. The clay takes days to settle. Determine its depth in the same way as for the silt. Some of the smallest clay particles may remain permanently in suspension and will not settle out. Record below.
8. Determine the percentage of sand, silt, and clay in your soil by dividing the depth of each individual layer by the total depth and multiple by 100%.
9. Use the SDA International Soil Textural Triangle to determine the type of soil.

**Data**

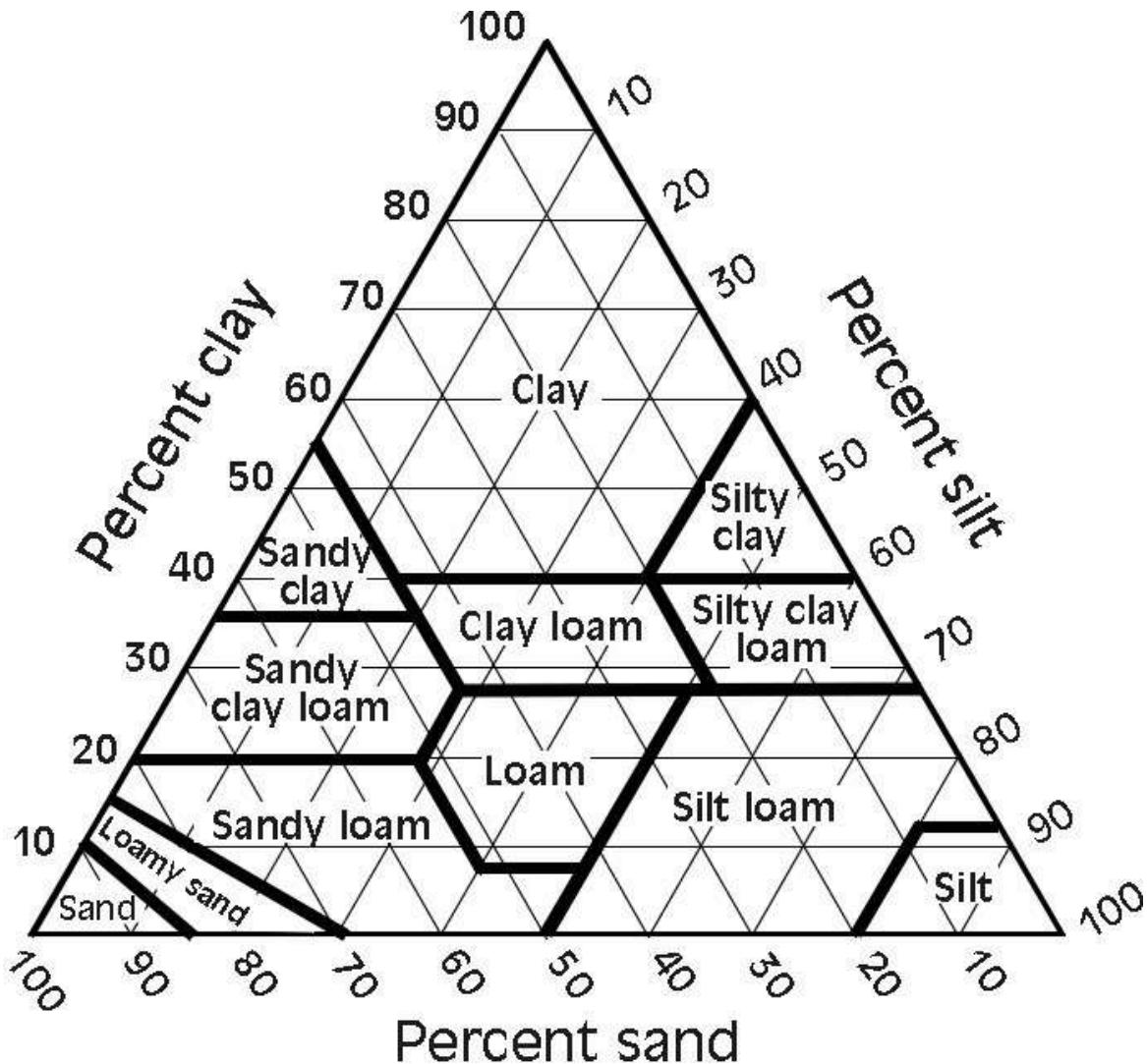
Total Depth of all Layers = \_\_\_\_\_ cm

Layers	Observations about layers	Depth of Layer (cm)	Percentage of layer (depth/total depth X 100)
Sand			
Silt			
Clay			

**SDA International Soil Textural Triangle**

How to use the triangle to determine type of soil:

1. Start with layer with the largest percentage. Clay is on the left of the triangle and is read by the lines going straight across the page (horizontal). Silt is on the right of the triangle and the lines are read on a downwards (to the left) angle. Sand is on the bottom of the triangle and the lines are read going up on an angle (to the left). Follow the arrows on the triangle.
2. Highlight the line that represents the correct percentage for the largest layer percentage. Highlight the next largest percentage line. Highlight the last percentage line.
3. Circle or locate where all three lines intersect. The area in which all lines intersect is the type of soil you have. Read it and record below



#### Questions

1. Why did it take more than one day to do this lab?
2. Why does it matter what type of material (silt, sand, or clay) is in your soil?
3. Why might sand be the densest layer (think particle size) while clay the least dense layer?
4. A) If you have 55% silt, 30% clay, and 15% sand, what type of soil do you have?  
B) If you want more clay loam rather than what soil you have in A, how should your amounts of silt, sand, and clay change?

5. Do you think the depth to which you dug up your soil matters? Why or why not?

Student Activity: # 2

### Soil Texture Triangle Activity

Using the soil texture triangle, scientists have created classes which break the distribution of particle sizes (soil textures) into 12 categories: clay, sandy clay, silty clay, sandy clay loam, clay loam, silty clay loam, sand, loamy sand, sandy loam, loam, silt loam, silt. The soil texture triangle is one of the tools that soil scientists use to visualize and understand the meaning of soil texture names. The textural triangle is a diagram which shows how each of these 12 textures is classified based on the percent of sand, silt, and clay in each. Note: these percentages are based on the USDA definition of sand and silt only.

Follow these steps to determine the textural class name of your soil sample:

- 1) Determine the percent sand of your sample and find that number on the bottom of the triangle. Note that the numbers read from right to left, not left to right. For example, if your sample is 65% sand, then you need to pick a point to the LEFT of the 60 mark
- 2) Draw another line to correspond to the percent clay. Let's say you had 27% clay.
- 3) Where the lines intersect should also indicate percent silt. On the graph above, you can see that it is about 8% silt.
- 4) Wherever your lines intersect indicates the soil type you have. In this situation, with 65% sand, 27% clay, and 8% silt, it is sandy clay loam

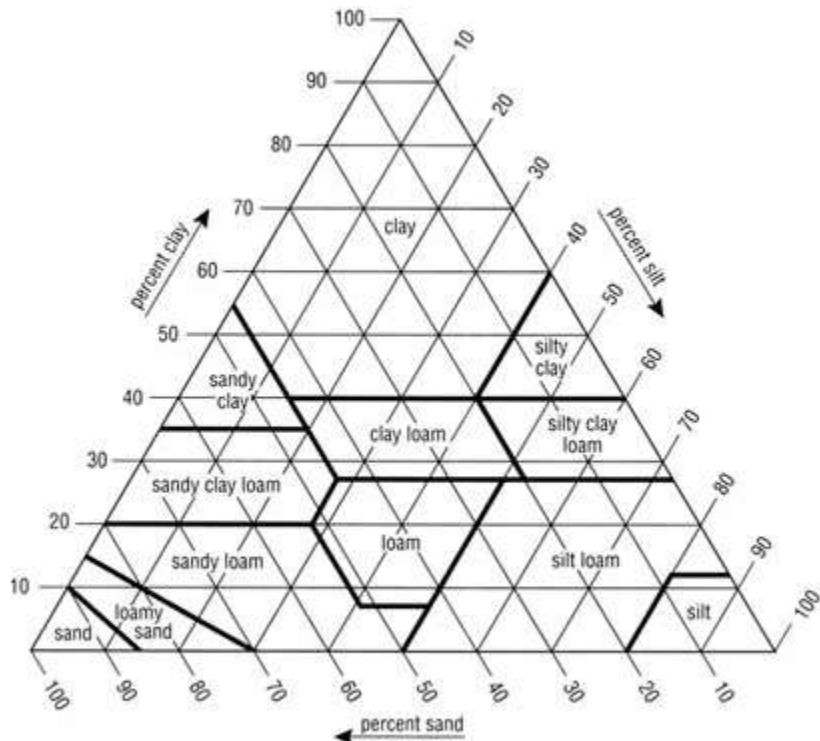


Chart showing the percentages of clay, silt, and sand in the basic textural classes.

**Soil Texture Practice Part 1:** Use the following numbers to determine the soil texture name using the textural triangle. When a number is missing, fill in the blanks. Note: the sum of percent's and, silt and clay should always add up to 100 percent

	% sand	% silt	% clay	Texture Name	Properties
a.	75	10	15	Sandy Loam	Water infiltration, aeration, workability
b.	10	83	7		
c.	42		37		
d.		52	27		
		35	50		
f.	30		21		
g.	5	70			
h.	55		40		
i.		45	10		

## Part 2: Soil texture properties

Using the table below, determine the properties of each of the soil samples analyzed above.

Soil Texture	Nutrient-holding Capacity	Water-Infiltration Capacity	Water-Holding Capacity	Aeration	Workability
Clay	Good	Poor	Good	Poor	Poor
Silt	Medium	Medium	Medium	Medium	Medium
Sand	Poor	Good	Poor	Good	Good
Loam	Medium	Medium	Medium	Medium	Medium

### Student Activity: #3

#### Soil Texture

What are my goals for today's laboratory?

1. To define soil texture
2. To determine soil texture qualitatively by the ribbon method

**Introduction** Soil texture is one of the most important physical properties of soils. Soil texture is related to a number of important soil characteristics such as water holding capacity, soil drainage, and soil fertility. As we discussed in lecture, soil texture is simply the relative proportion of sand, silt, and clay in a given soil. The U.S. Department of Agriculture (USDA) has defined 12 standard texture classes. These classes are typically displayed in what is known as the USDA texture triangle. Each of the texture classes is associated with a specific composition of sand, silt, and clay.

How do we determine soil texture? Soil texture may be determined in a qualitative fashion or a quantitative fashion. A qualitative determination of texture gives us an estimate of texture. A quantitative determination of texture gives us a precise measurement of the % sand, % silt, and % clay in a sample. This allows us to use the USDA texture triangle to assign the soil to one of the twelve official classes of soil texture. In today's laboratory, you will begin by determining the soil texture of your sample in a qualitative fashion using a test known popularly as the ribbon test.

#### Determining Soil Texture by the Ribbon Method

#### Materials

1. Soil sample(s)
2. Tap water

### Method

1. Follow the steps listed below to determine soil texture by the ribbon method.

Step 1 Collect a small amount of dry soil in your palm, approximately enough to make a small ball of soil about 3/4 inch in diameter when wetted.

Step 2 Add water drop wise to the dry soil until it takes on the consistency of modeling clay.

Step 3 Form the soil sample into a ball, about  $\frac{1}{2}$  -  $\frac{3}{4}$  inch in diameter. If you are unable to form a ball, that is if the soil is not 'sticky' enough to form a ball, the texture of your sample is sand. Record this in the data table at the end of lab and stop the procedure. If you can form a ball, continue the procedure.

Step 4 Place the ball of soil between your thumb and forefinger, and begin to gently knead the ball into a relatively flat ribbon shape. As the ribbon develops, let it extend over your forefinger until it breaks from its own weight. If the soil sample does not form any ribbon, the texture of your sample is loamy sand texture. Record this in the data table at the end of lab and stop the procedure. If it does form a ribbon, continue the procedure.

Step 5 If you are able to form a ribbon that is less than 1 inch and the soil has a gritty feel to it, you have a sandy loam texture. Record this in the data table at the end of lab and stop the procedure. Otherwise continue the procedure.

Step 6 If you are able to form a ribbon that is less than 1 inch and the soil has a smooth feel to it, you have a silty loam texture. Record this in the data table at the end of lab and stop the procedure. Otherwise continue the procedure.

Step 7 If you are able to form a ribbon that is less than 1 inch and there is not either a noticeable gritty or smooth feel you have a loam texture. Record this in the data table at the end of lab and stop the procedure. Otherwise continue the procedure.

Step 8 If you are able to form a ribbon that is between 1-2 inches long and the soil has a noticeable gritty feel to it, you have a sandy clay loam texture. Record this in the data table at the end of lab and stop the procedure. Otherwise continue the procedure.

Step 9 If you are able to form a ribbon that is between 1-2 inches long and the soil has a noticeable smooth feel to it, you have a silty clay loam texture. Record this in the data table at the end of lab and stop the procedure. Otherwise continue the procedure.

Step 10 If you are able to form a ribbon that is between 1-2 inches long and the soil does not have either a noticeable gritty or smooth feel to it, you have a clay loam texture. Record this in the data table at the end of lab and stop the procedure. Otherwise continue the procedure.

Step 11 If you are able to form a ribbon that is more than 2 inches long and the soil has a noticeable gritty feel to it, you have a sandy clay texture. Record this in the data table at the end of lab and stop the procedure. Otherwise continue the procedure.

Step 12 If you are able to form a ribbon that is more than 2 inches long and the soil has a noticeable smooth feel to it, you have a silty clay texture. Record this in the data table at the end of lab and stop the procedure. Otherwise continue the procedure.

Step 13 If you are able to form a ribbon that is more than 2 inches long and the soil does not have either a noticeable gritty or smooth feel to it, you have a clay texture. Record this in the data table at the end of lab and stop the procedure.

#### Lab Analysis

1. What is soil texture?
2. What is the importance of soil texture?
3. What is the rationale behind the ribbon test for soil texture?

Results	
Ribbon Test Texture Class	
% sand (best guess)	
% silt (best guess)	
% clay (best guess)	

Student Activity: #4

Name \_\_\_\_\_ Date \_\_\_\_\_

### Edible Soils Lab

**Purpose:** What is the makeup of a soil horizon (profile)?

**Hypothesis:** If I use the appropriate ingredients in the correct order, then I will construct an accurate representation of the soil horizon (profile).

**Experiment:** Construct an edible soil profile as follows.

**Step 1 Horizon R:** In a plastic cup, place Oreo cookie in the bottom of the cup. Answer the following questions.

**1A. Why do you think we are using an Oreo to represent horizon R?**

Bedrock is solid rock. Parent material is formed from the bedrock after a long weathering process. There are two basic ways that weathering can happen.

**1B. What are the two main types of weathering? \_\_\_\_\_ and \_\_\_\_\_.**

**Step 2 Horizon C:** Place a small layer of M&M's on top of the Oreo cookie. Answer the following questions.

This is the C horizon in a soil profile. It is called the parent material because it is the weathered rock and partly weathered soil from which the soil layers above are formed.

**2A. How do the crumbled Oreos represent horizon C?****2B. What influences does the parent material have on the other horizons?**

**Step 3 Horizon B:** Place a layer of shredded coconut on top of the M&M's

**3A. Horizon B is also known as \_\_\_\_\_.**

**Step 4 Horizon A:** Place a layer of chocolate pudding on top of the coconut.

**4A.** Horizon A is also known as \_\_\_\_\_.

This is the top layer of soil. Nutrients, bacteria, fungi, and small animals are abundant. Plants thrive in it because of the nutrients in it.

**Step 5 Horizon O:** Place a layer of sprinkles.

The sprinkles represent the organic matter. This layer is usually less than an inch thick. Litter decomposes into nutrients that enrich the soil. In areas where the temperature is lower, the composition of organic matter is slower.

**5A.** The decomposed litter will become \_\_\_\_\_.

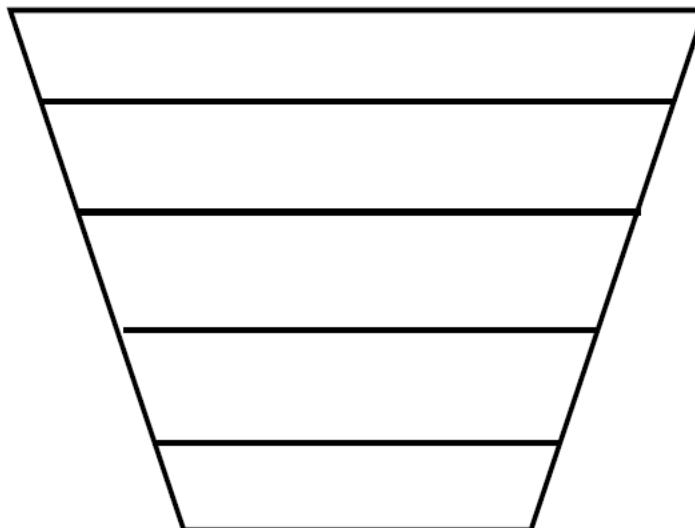
**Step 6: DO NOT EAT UNTIL GIVEN PERMISSION TO. You MUST draw your diagram and answer ALL questions above first!**

**Analysis and Conclusion:**

1. Draw, color, and label the horizons of your “edible soil”.

Soil layer or part

Edible representation



2. Discuss the use of ..... (Why did we use these materials to represent each layer?)

Material	Horizon	Why?
Chocolate Pudding		

Coconut

Oreo

Sprinkles

M&M's

3. What would cause the horizons to become mixed?

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Student Activity: # 5

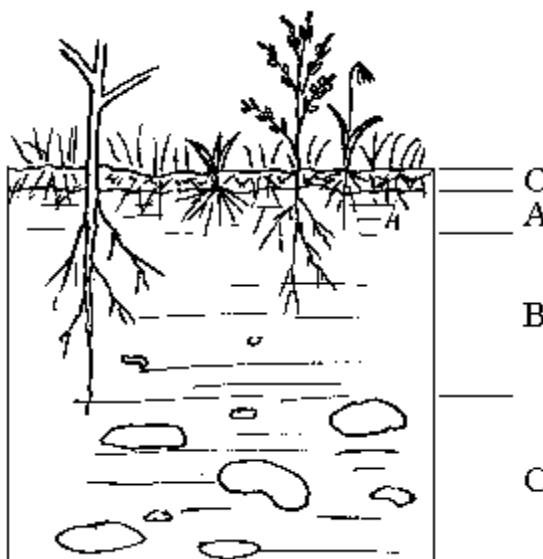
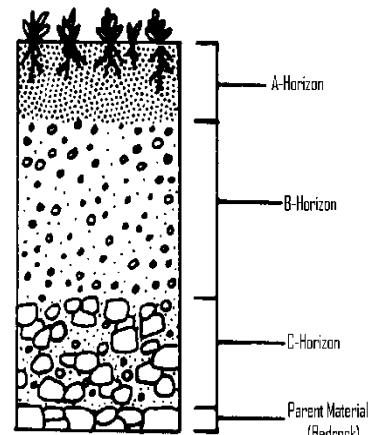
### Soil Worksheet

**Soil** is a mixture of weathered rock & organic matter that usually covers **bedrock** (solid rock that underlies all soil). Both chemical & mechanical processes are involved in the development of soils.

- Chemical weathering turns hard minerals into soft ones
- Mechanical weathering breaks solid rock into smaller pieces
- Plant & animals add organic materials in the form of waste products & dead organisms
- The decay of organic matter produces acids which accelerate chemical weathering
- Burrowing Animals, such as earthworms, insects, & rodents, help circulate air and water through the soil & mix mineral & organic remains

The material from which soil forms is called its **parent material**. Soil that has weathered directly from the bedrock beneath it and therefore matches its parent material is called **residual soil**.

Soil that does not match the bedrock it is over is called **transported soil**. It did not weather from the bedrock beneath it but was brought there by agents of erosion such as winds, rivers, or glaciers. Much of New England & the Midwest are covered by soil that was deposited by the movement of glaciers after the last Ice Age.

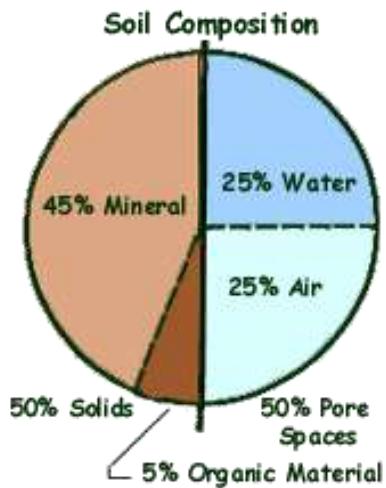


A cross section of soil exposed by digging is called the **soil profile**. The weathering of soil produces layers known as **soil horizons**. The topsoil or **A horizon** is usually rich in dark-colored organic remains called **humus (labeled O horizon below)**. The subsoil or **B horizon** contains minerals that have been transported deeper by groundwater. Most of the clay in soil has also been washed

down to this layer. The partially weathered bedrock or **C horizon** is composed of broken up bedrock on top of the solid bedrock (parent material).

**Soil erosion** is the removal of topsoil by the action of running water or wind. It takes between 100 & 400 years for one centimeter of topsoil to form.

Loss of topsoil can be caused when plants root are no longer present to hold down soil. Salting roads can raise the salinity of the soil and kill the plants. Over grazing can kill plants. Winds, construction, & mining can all effect plant cover.



Means of soil conservation include the following:

- **Windbreaks** – belts of trees along the edge of fields
- **Contour farming** – crops are planted in rows parallel to land contours p143
- **Terraces** - flattening hill slopes to slow the flow of water & erosion
- **Strip Cropping** – a crop that leaves bare ground between rows is alternated with a crop that completely covers the ground, ex. Corn & Alfalfa
- **No-till method**- plowing, planting and fertilizing are all done at the same time so there is less chance of wind removing topsoil

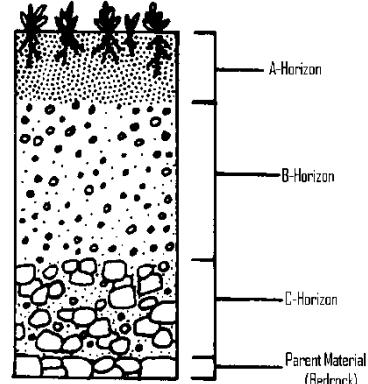
**Use the worksheet above to answer the following questions.**

- \_\_\_\_\_ 1. Which layer in the diagram below contains the most organic material?

A. A      B.B      C.C      D. the bedrock

- \_\_\_\_\_ 2. How is soil created from rock?

A. physical weathering without chemical weathering  
 B. chemical weathering without physical weathering  
 C. erosion without weathering  
 D. weathering without erosion



- \_\_\_\_\_ 3. What causes soil erosion?

A. Wind      C. Human activity  
 B. Water      D. All of the above

- \_\_\_\_\_ 4. Approximately how many years does one centimeter of topsoil take to form?

A. 100 – 400 years      C. 1000 – 4000 years  
 B. 10 – 40 years      D. 10,000 – 40,000 years

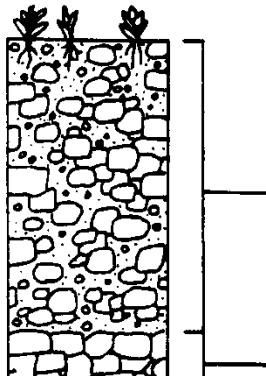
- \_\_\_\_\_ 5. Which of the following is found in the greatest % in soil?

A. Mineral matter      B. Organic matter      C. Water      D. Air

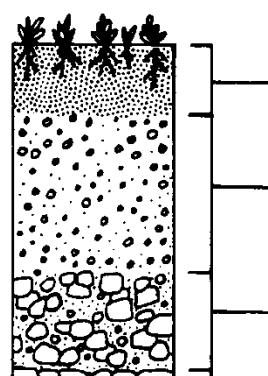
- \_\_\_\_\_ 6. Which layer of a soil profile forms first from the bedrock?

A. A horizon      B. B horizon      C. C horizon      D. humus

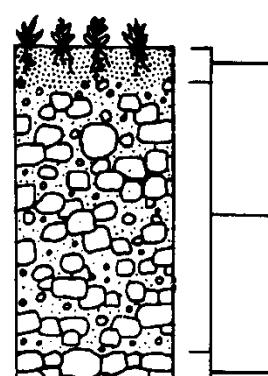
7. For the soil profiles below, label the horizons (A, B, or C) and the parent material in each of the soil profiles using the spaces provided next to each image.



Profile A



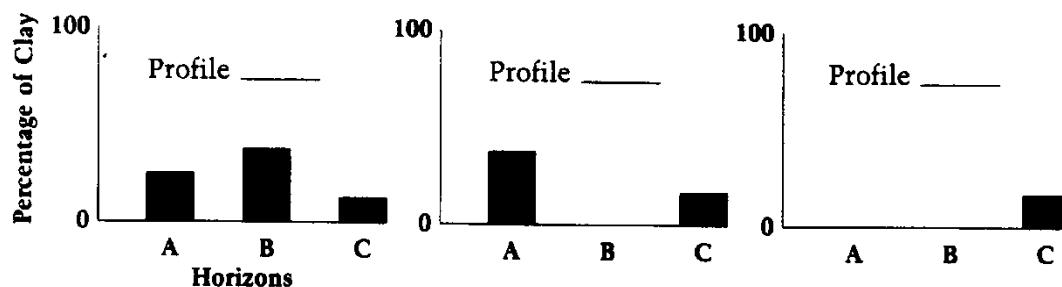
Profile B



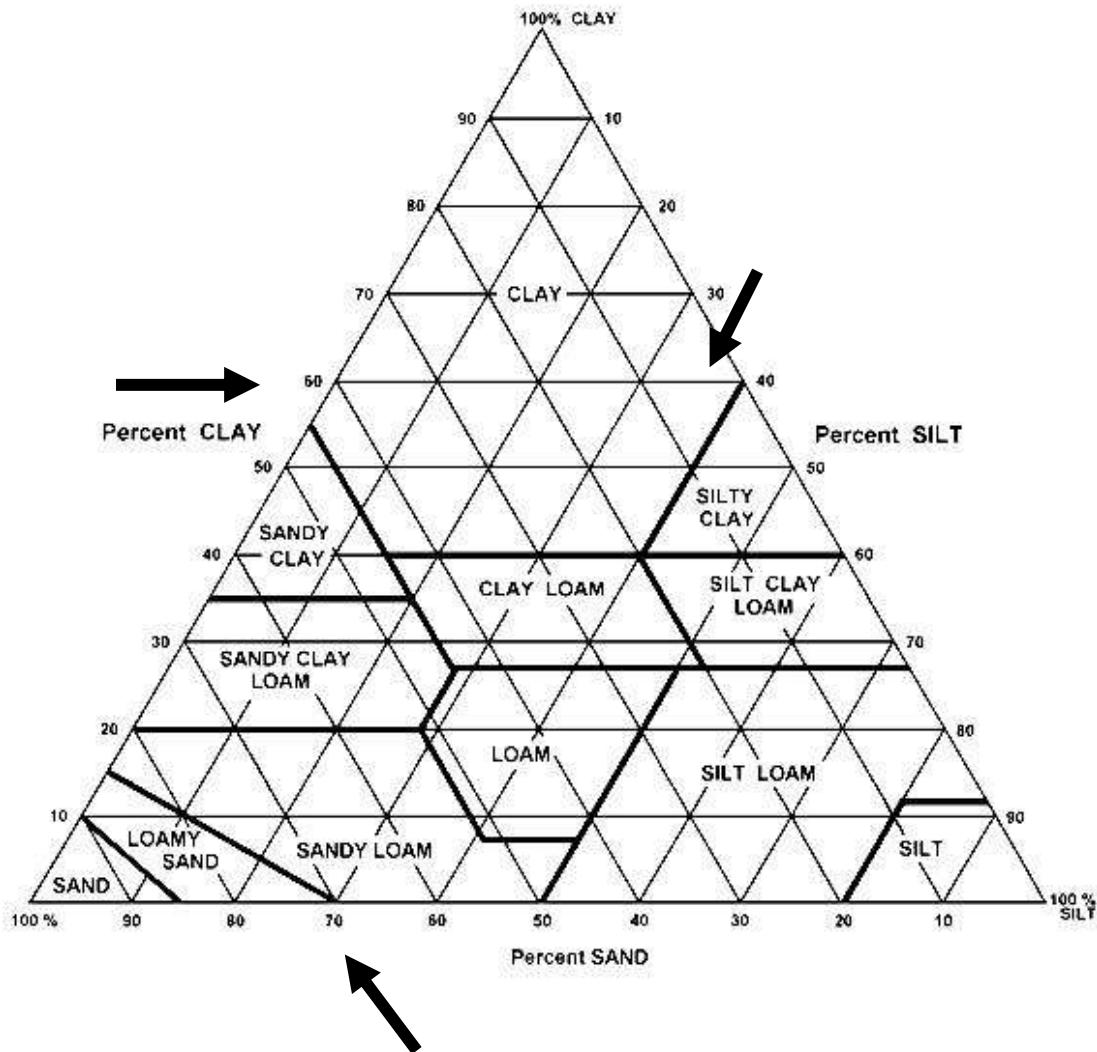
Profile C

8. At the base of each profile above, number the profiles according to the proper sequence of development.

9. Match each soil profile above to the graph below that would most likely represent that profile. Write the letter of the matching profile in the space provided below each graph.



### THE SOIL TEXTURAL TRIANGLE



### Soil Textural Triangle Practice Exercises

	% Sand	% Silt	% Clay	Texture Name
a)	75	10	15	sandy loam
b)	10	83	7	_____

### Soil Texture Worksheet

Directions: Using your soil texture chart and example, determine the following soil textures using the percentages given.

	% sand	% silt	% clay	Soil Texture
example	75	10	15	sandy loam
a)	42	_____	37	_____
b)	_____	52	21	_____
c)	_____	35	50	_____
d)	64	30	_____	_____
e)	50	_____	40	_____

Now for a challenge!:

f)	36	_____	_____	Clay Loam
g)	_____	_____	42	Silty Clay
h)	_____	_____	_____	Loamy sand
i)	_____	_____	_____	silt loam

Make your own!!

_____	_____	_____	_____
_____	_____	_____	_____

### Soil Texture Worksheet

Directions: Using your soil texture chart and example, determine the following soil textures using the percentages given.

	% sand	% silt	% clay	Soil Texture
example	75	10	15	sandy loam
j)	42	<b>21</b>	37	<b>clay loam</b>
k)	<b>27</b>	52	21	<b>silt loam</b>
l)	<b>15</b>	35	50	<b>clay</b>
m)	64	30	<b>6</b>	<b>sandy loam</b>
n)	50	<b>10</b>	40	<b>sandy clay</b>

Make your own!!

_____	_____	_____	_____
_____	_____	_____	_____

For anyone who is up for a challenge:

- o)    36                \_\_\_\_\_                \_\_\_\_\_                Clay Loam
- p)    \_\_\_\_\_            \_\_\_\_\_                42                Silty Clay
- q)    \_\_\_\_\_            \_\_\_\_\_                \_\_\_\_\_                Loamy sand
- r)    \_\_\_\_\_            \_\_\_\_\_                \_\_\_\_\_                silt loam

**Use your textbook to answer the following question:**

Discuss the negative effects of soil erosion. List and define 3 types of soil erosion.

**Use your textbook to define the following terms:**

porosity

permeability

infiltration

desertification

salinization

waterlogging

## Soil Texture Quiz

---

date

( 38 pts)

---

name

1. Define the following terms.

2pts ea

**Soil Texture**

**Clay**

**Sand**

**Silt**

**Light soil**

**Heavy soil**

**Infiltration rate**

**Percolation rate**

2. What would the texture of each of the following soils be if you did the lab and got the following  
12pts. results.

**Sample A- 22 % sand, 38 % silt, and 40 % clay**

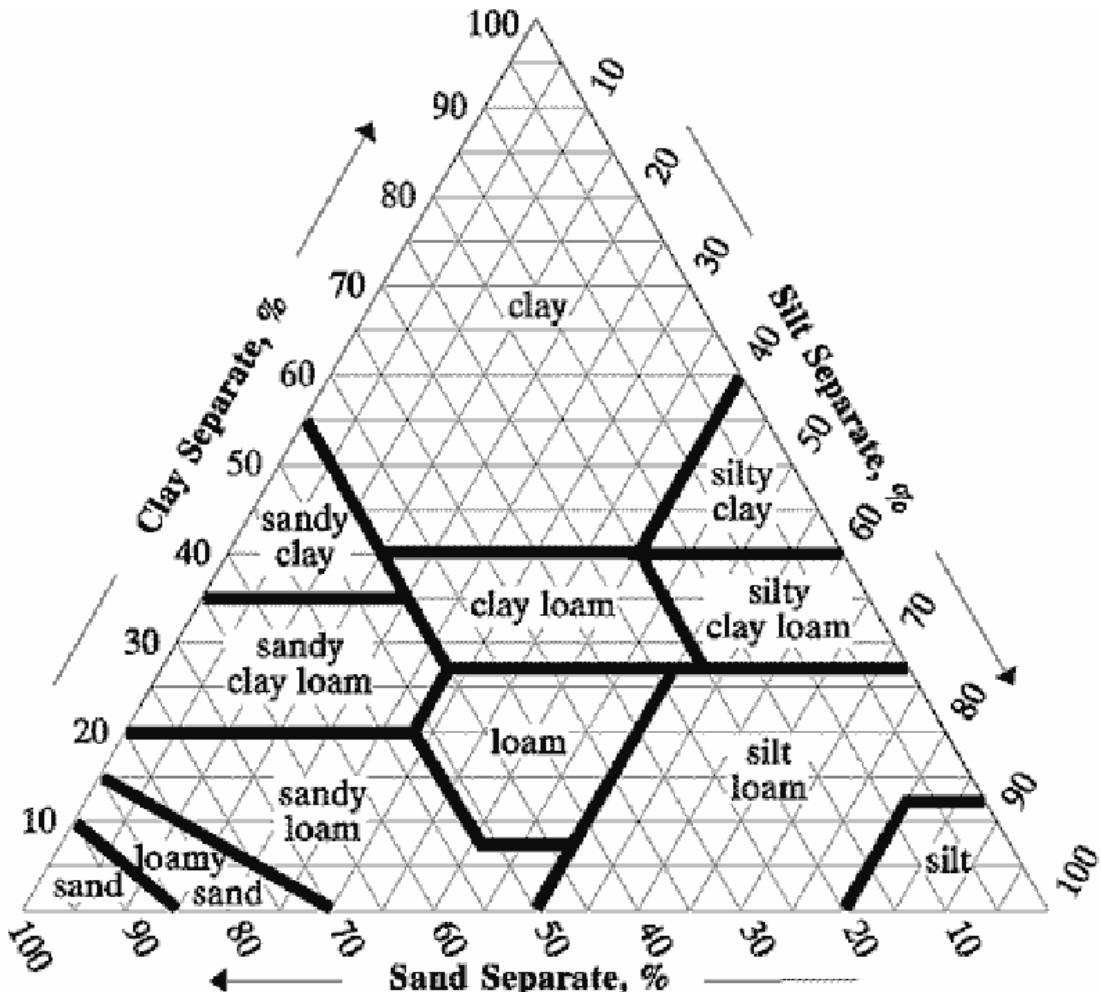
**Sample B- 24mm of Sand, 12mm of silt, and 10mm of clay.**

\_\_\_\_\_ %sand, \_\_\_\_\_ %silt, \_\_\_\_\_ %clay

Show the % of each component and determine what the correct soil texture is using colored pencils and the soil texture triangle on the back of this page. Be sure and label your answers.

3.     **Describe the relative size and shape of each of soil particles found in our soil samples.**

**6pts.**



4. Explain what the advantages and limitations would be for both a clay soil and a sandy soil.

4pts

Texture Sample A \_\_\_\_\_

Texture Sample B \_\_\_\_\_

### **Lesson Plan: Environmental Factors Plant Nutrition/ Growth Part 2**

**Hook:** As students enter the room, have several versions of the same plant at the front of the room (number the pots). The plants should be the same age and will have needed some time in order to change their habits. Do not water one for a couple days to force it to begin wilting. Place another in the dark to alter its color and make it stretch. Place one in the light and water it regularly and lastly have one that has received plant food, been in the light, in good temperature and watered regularly. You may use more or less plants and change them accordingly.

When class begins ask the students to take one minute and write down the differences about the plants in their notebook as a warm up. At the close of the minute, allow the students to share their information with a partner and then allow the partner to share. Request that students share the thoughts of their partner out loud. After, give them another minute to add in their notebook why they think each plant looks the way it does or is growing the way it is. Again, allow for the pair share. The discussion aloud should lead to not enough water, light etc. This begins a discussion that you can lead into the fact that plants need a variety of things in order grow and be healthy. I compare it to a recipe. If you alter a recipe, the results are different than expected, and if you leave things out, the end product isn't right.

**Objective:** Students will be able to explain and describe how primary, secondary, and trace elements are used in plant growth.

**PowerPoint:**

#### **Plant Growth Requirements**

- There are 5 basic items that all plants need/require to conduct regular life processes.
- They are:
  - Temperature
  - Light
  - Water
  - Air (CO<sub>2</sub> & O<sub>2</sub>)
  - Nutrients

- Temperature
  - Most seeds need a certain degree of warmth to germinate (sprout).
  - Most plants have an optimal (best) range of temperature for growth.
    - Higher: Plants have smaller leaves, thicker cuticles, and wilt is more likely to occur.
    - Lower: Grow lower to the ground, have shorter life cycles, and dish-shaped leaves.
  - Temperature affects moisture and nutrient uptake for the plant
- Light
  - Plants need light to produce their own food through the process of photosynthesis.
  - Plants use sunlight as their energy source.
    - **Type:** Red and blue light (visible light spectrum)
    - **Intensity:** Amount of light given off.
    - **Exposure:** Length of time in light (photo period)
      - Short day plants flower when nights are over 12 hours long.
      - Long day plants flower when nights are under 12 hours long.
      - Day neutral –flowering is unaffected by photo period
- Water
  - Water enters through the root system and carries nutrients throughout the plant.
  - Water cools the plant.
  - Water helps give structure to the plant.
  - Keys to successful watering:
    - Water all the way through the root zone for even growth.
    - Pots need drainage holes to allow oxygen into the root zone.
- Air- Oxygen and Carbon Dioxide
  - Air contains O<sub>2</sub> and CO<sub>2</sub> which are both necessary for plant growth.
  - CO<sub>2</sub> is a gas that is taken in by the leaves (stomata) of the plant and is used for photosynthesis.
  - Together with sunlight, the plant makes food from CO<sub>2</sub>.

- O<sub>2</sub> is necessary for normal respiration. It enters through the roots of the plant.
- Nutrients
  - Plants need 16 essential nutrients to grow and produce.
  - The primary nutrients (macronutrients) that plants need most are:
    - Nitrogen (N)
    - Phosphorus (P)
    - Potassium (K)
    - (most fertilizers have a balance of these 3 nutrients)
- Micronutrients
  - The other 14 nutrients are called secondary nutrients (micronutrients).
  - They are needed in smaller amounts.
  - They include:
    - (C) Carbon
    - (H) Hydrogen
    - (O) Oxygen
    - (S) Sulfur
    - (Ca) Calcium
    - (Fe) Iron
    - (Mg) Magnesium
    - (B) Boron
    - (Mn) Manganese
    - (Cu) Copper
    - (Zn) Zinc
    - (Mo) Molybdenum
    - (Cl) Chlorine
    - (Ni) Nickel

Student Activity: #1

Virtual Lab

**Which colors of the light spectrum are most important for plant growth?"**

Site: [bit.ly/pholab](http://bit.ly/pholab)

(you can type "glencoe photosynthesis" into a google search to find this resource)

- Read the summary in the side bar which explains how colors of light affect plant growth.
  - Read the procedure. Many of your tasks will be recorded in the journal
  - There are 5 questions to answer in the journal, use complete, thoughtful sentences for each of these questions.
  - You will also record your measurements in the table

Name: \_\_\_\_\_ Date: \_\_\_\_\_

## **Journal Questions**

1. Make a hypothesis about which color in the visible spectrum causes the most plant growth and which color in the visible spectrum causes the least plant growth?
  2. How did you test your hypothesis? Which variables did you control in your experiment and which variable did you change in order to compare your growth results?
  3. Analyze the results of your experiment. Did your data support your hypothesis? Explain. If you conducted tests with more than one type of seed, explain any differences or similarities you found among types of seeds.

4. What conclusions can you draw about which color in the visible spectrum causes the most plant growth?

5. Given that white light contains all colors of the spectrum, what growth results would you expect under white light?

### **Data Table**

#### **Measurement**

**Which colors of the light spectrum are most important for plant growth?**

<b>Filter Color</b>	Spinach Avg. Height (cm)	Raddish Avg. Height (cm)	Lettuce Avg. Height (cm)
<b>Red</b>			
<b>Orange</b>			
<b>Green</b>			
<b>Blue</b>			
<b>Violet</b>			

### **Student Activity #2**

#### **Virtual Lab**

<http://www.kscience.co.uk/animations/photolab.swf> (search for "kscience photolab")

This simulation allows you to manipulate many variables. You already observed how light colors will affect the growth of a plant, in this simulation you can directly measure the rate of photosynthesis by counting the number of bubbles of oxygen that are released.

There are 3 other potential variables you could test with this simulation: **amount of carbon dioxide, light intensity, and temperature.** Keep the light settings at white light (you already tested colored light in the last experiment.)

Choose one variable and design an experiment that would test how this factor affects the rate of photosynthesis. Remember, that when designing an experiment, you need to keep all variables constant except the one you are testing. Collect data and write a summary of your findings that includes:

- Hypothesis or Experimental Question
- Data table
- Conclusions

**\*Type this document on a google doc and share it with your teacher**

### **Lesson Plan Environmental Factors Fertilizers Part 3**

**Hook:** As students enter the classroom, they are asked to create an acronym or mnemonic device with the nutrient symbols on the board. Allow students 5 minutes to complete this task, be sure to remind students every minute of the time remaining. Once they have created their acronym or mnemonic device they are to share with the other students. The students will select their favorite and add it to the poster paper under the teacher's sample. After five minutes students are to be back in their seats ready to share the selected example with the class.

**Objective:** Students will be able to explain and describe importance of plant nutrition in ornamental plants.

PowerPoint:

#### Fertilizing

- fertilize according to soil test results
  - Soil tests determine the amount of elements needed for various plants

#### Planting Media Mixes

- Soil less mixes
  - advantages include : uniformity - doesn't vary in pH, fertility or texture
- Soil Mixes
  - Advantages
    - sterile

- lightweight
- good moisture retention and drainage
- free of weed seeds
- Disadvantages
  - light weight - pots tip in strong wind
  - minor elements are missing
  - transplants may not adjust well to new media
- Contents of mixes
  - perlite
  - improve aeration
  - volcanic origin
  - vermiculite
    - exploded Mica
    - improves aeration

### Plant Food and Fertilizers

- divided into two groups
  - Major elements (macro)
    - Nitrogen - N
    - Phosphorus - P
    - Potassium - K
  - Minor Elements (Micro)
    - (C) Carbon
    - (H) Hydrogen
    - (O) Oxygen
    - (S) Sulfur
    - (Ca) Calcium
    - (Fe) Iron
    - (Mg) Magnesium
    - (B) Boron
    - (Mn) Manganese
    - (Cu) Copper
    - (Zn) Zinc
    - (Mo) Molybdenum
    - (Cl) Chlorine
    - (Ni) Nickel

### Plant Requirements

- large amounts of major elements
- relatively small amounts of minor elements

### Commercial Fertilizer

- shows % or pounds per cwt. (100#) of the three major elements in large numbers on the container or bag
- 5-10-5
- 5% N, 10% P, 5% K
- remaining 80% is filler
- NP&K are always listed in that order.

### Nitrogen

- generally purchased in one of four forms
  - Nitrate of soda
  - ammonium nitrate
  - ammonium sulfate
  - urea formaldehyde
- has most noticeable effect on plants
- encourages above ground vegetative growth
- regulates use of other elements
- Too Much Nitrogen
  - lower disease resistance
  - weaken stem because of long soft growth
  - lower fruit quality
  - delay maturity
  - increase winter damage to plants
- Not Enough Nitrogen
  - yellow or light green color
  - stunted root and top growth
- Nitrogen is easily lost from soil
  - leaching - being filtered down through soil with water
  - not held by soil particles, dissolved in water
  - O.M. holds insoluble N for slow release

### Phosphorous

- held tightly by soil particles

- not easily leached
- effects plants in several ways
  - encourage cell division
  - flowers and seeds don't form without it
  - hastens maturity, offsetting quick growth caused by N
  - encourage root growth
  - makes K more available
  - increase disease resistance
  - improves quality of grain, root and fruit crops
  - container plants can be damaged by excess P
  - increases soluble salt content of medium
  - causes dehydration of roots
- Insufficient P
  - purple color on underside of leaf
  - reduced flower fruit and seed production
  - susceptibility to cold injury
  - susceptibility to plant diseases

### Potassium

- modifies both fast soft growth of N and early maturity of P
- is essential
  - increase disease resistance
  - encourages healthy root systems
  - essential for starch formation
  - development of chlorophyll
  - efficient use of CO<sub>2</sub>
- Insufficient Potassium
  - leaves appear dry and scorched with irregular yellow areas on the surface

### Lime

- CaCO<sub>3</sub>- Calcium Carbonate
- acts as a plant food
- affects soil acidity
- soil acidity affects availability of plant food elements
- furnishes calcium

### pH

- measure of acidity or alkalinity

- pH scale - runs from 0 - 14
- most plants grow best from 5.6-7.0
- 7.0 is neutral
- pH of 7 or above is alkaline or basic
- pH below 7 is acidic
- As numbers decrease, solution becomes more acidic.
- As numbers increase, solution becomes more basic or alkaline
- if soil is too acidic, lime is added to raise the pH
- if soil is too alkaline, sulfur is added

Student Activity: #1

Name \_\_\_\_\_ Per \_\_\_\_\_ Date \_\_\_\_\_

### Reading a Fertilizer Label and Application Calculations

1. List two things that are required to be printed on a fertilizer label.
2. What does N-P-K represent on a fertilizer label (be specific)?
3. Name one secondary nutrient you found today on a sample fertilizer label.
4. Name one micronutrient you found today on a sample fertilizer label.
5. Mrs. Smith has a lawn that needs to be fertilized; she has found a bag of 10-3-3 in her garage. If she needs to put 1 pound of nitrogen per 1,000 sq ft of her 1,000 sq ft lawn, how much fertilizer does she need to apply?
6. How much Phosphorous will she be applying?
7. How much Potassium will she be applying?

**Semester Final*****Science Fair Assignment Worksheet***

This worksheet will help you determine when each assignment should be due. Some teachers may want to add due dates for rough drafts of key assignments.

## Assignment Worksheet

Assignment	Assignment Description (Note: Students should have at least 8 weeks to do their projects)	Suggested Time to Complete this Step	In Class Due Date (where applicable)
Topic Selection Wizard	Please have your students log in to complete the Topic Selection Wizard ("Wizard") to help them narrow down an area of interest for their project.	5 days	
Question	The specific question the student will be investigating in the project.	5 days	
Research Plan & Bibliography	The Research Plan is a roadmap of the research questions that need to be answered. The Bibliography is a list of the sources that will be used to answer the research questions. <b>Source Requirement: at least 3 offline sources including one encyclopedia.</b>	5 days	
Research Paper	<p>The purpose of the Research Paper is to provide information to help understand why the experiment turns out the way it does. It should include:</p> <ul style="list-style-type: none"> <li>• The <b>history</b> of similar experiments or inventions.</li> <li>• <b>Definitions</b> of all important words and concepts that describe the experiment.</li> <li>• <b>Answers</b> to all the background research plan questions.</li> <li>• <b>Mathematical formulas</b>, if any, that are needed to describe the results of the experiment.</li> </ul>	10 days	
Variables and Hypothesis	An explanation of which factors will be changed while conducting the experiment and a hypothesis on the resulting impact of the change.	5 days	

Assignment Worksheet (continued)

Assignment	Assignment Description (Note: Students should have at least 8 weeks to do their projects)	Suggested Time to Complete this Step	In Class Due Date (where applicable)
Materials and Procedures	A detailed list of the materials that will be used to conduct the experiment and the detailed steps that will be followed while conduct the experiment	5 days	
Conducting the Experiment	There should be a minimum of two weeks here to allow the students to do multiple runs of their experiments. <b>Minimum Trials: 3 runs of experiment.</b> If students are working with plants, they should have 3 plants for each variable tested.	10 days	
Data Analysis and Graphs	The analysis of the experimental data. A summary of the findings of the experiment.	5 days	
Conclusions	An explanation of the results of the experiment.	3 days	
Final Report	A report that collects all the above written assignments in one place plus a short abstract of the project..	5 days	
Display Board	The final project board that will be displayed at the science fair.	3 days	
School Science Fair	The date the students must turn in their projects to the teacher <b>or</b> to the school science fair.		

## Topic Worksheet

Name \_\_\_\_\_

Date \_\_\_\_\_

The title of my project is: \_\_\_\_\_

What is the scientific question that will guide your project?

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My science fair experiment will test \_\_\_\_\_

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My hypothesis (prediction) is that the following will happen. \_\_\_\_\_

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The materials and resources I will be using are \_\_\_\_\_

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I need help with

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**Teacher Conference – Date** \_\_\_\_\_

**Assignment Overview:**

Students will design and perform science experiments, which they will present at the East Palo Alto Charter School Science Fair. Students will be responsible for selecting their own topic, writing a 3-page research paper, conducting their experiment, and creating a poster presentation to display their results/work. Students will be evaluated on their work at all stages of the project and will receive a science test grade for their ongoing work, as well as a test grade for their final poster.

**Assignment Details:**

This science fair project asks students to demonstrate their understanding of scientific inquiry by conducting an experiment. The following set of guidelines and instructions will help students in completing their project.

- 1) The science fair project must be an experiment (not a demonstration). An experiment begins with a prediction or hypothesis, which is then tested through the collection of data. More simply, an experiment tests to find out if something is true or if a predicted outcome will happen, rather than simply demonstrating a science concept. Below are two examples that illustrate the difference between an experiment and a demonstration

**Demonstration:** A student creates a volcano using vinegar and baking soda.

**Experiment:** A student tests to see how changing the amount of baking soda added to 30ml of vinegar affects the amount of gas produced.

**Demonstration:** A student creates a simple circuit using wire, a battery, and a light bulb.

**Experiment:** A student compares how different substances conduct electricity through the use of a simple circuit. (student places objects in circuit to see if bulb lights and calculates each item's resistance).

- 2) All projects must be presented on science fair display boards. Science fair boards are made of cardboard and have three panels. These boards are available at the dollar store. Boards must be typed.

- 3) Students are expected to use a notebook or science log to keep track of their experiment. Students will periodically turn in these notebooks/logs as well as brief report on their progress.
- 4) Students will present their project to the class during the week of Finals. Presentations should last between 5-7 minutes.
- 5) Students will have a plenty of class time to work on their projects.
- 6) There will be afternoon work sessions available Monday – Thursday from 3:25pm – 4:25pm. During these work sessions, students may use classroom supplies, computers, and receive extra assistance with their projects. Students can either be picked up by family members, or may ride the late bus at 4:30 after school bus.

***Grading:***

This project will count as a semester final. As each student's project will represent our class in the school science fair, quality work is expected from each student. Students earning a final grade of less than 70% (a grade lower than a C) will be required to rework and make improvements on their project.

# Unit 8 Integrated Pest Management System

## Lesson Plan Basic Integrated Pest Management System

Hook: Cue the YouTube video clip of It's a Bug's Life as your students walk in the room. Play the video clip and after its completion, reiterate, "It's a bug eat bug world out there."

Objective: Students will be able to explain and describe four categories of IPM

PowerPoint:

A healthy garden is full of insects and wildlife

They perform vital tasks

- Pollinating Plants
- Feeding on Threatening Insects
- Breaking down Plant Matter
- Recycling Plant Matter
- However some
  - Injure plants
  - Cause damages
  - We call these pests

How can we solve pest problems?

- IPM ( Integrated Pest Management)
  - Primary aim is prevention
- How does it work?
  - Prevents or reduces the occurrence of pest diseases or other problems

Four Components of IPM

- Cultural Practices
  - Choose plants that are adapted to your climate and garden conditions
  - Amend Soil, Water, Fertilize & Prune
    - A vigorously growing plant can outgrow injuries caused by pests
- Physical Control
  - Killing or capturing pests
  - Examples
    - Handpick
      - (*Snails, Caterpillars, Eggs*)
    - Prune & Destroy
      - (*Borers, Scales and Fire Blight*)

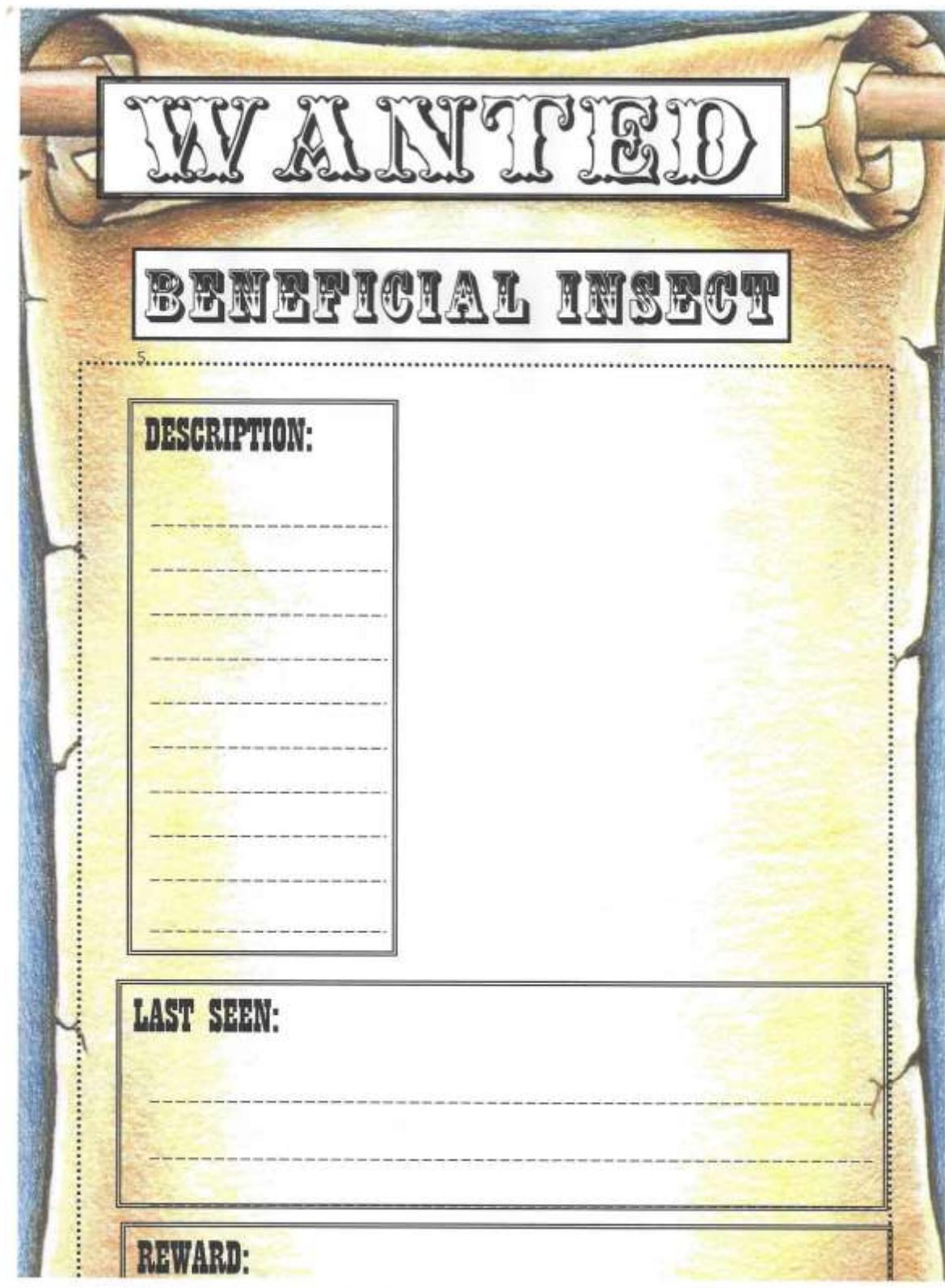
- Spray Water
  - (*Aphids, Thrips & Spider Mites*)
- Erect barriers
  - Fences and chicken wire
- Use Traps
  - Sticky cards
- Rotate Plants
  - Romaine Lettuce with a row of Alyssum, a natural repellent.
- Biological Controls
  - Predators and Parasites that feed on Garden pests ( Beneficial Insects)
    - Beneficial Insects
      - Birds, Toads, Garter Snakes
      - Lady Beetles & Mantids
      - Lacewings
      - Ground Beetles
      - Syrphid Flies
      - Hunting Wasps
      - Spiders
- Chemical Controls
  - Use pesticides as a last resort

Student Activity:

Wanted Poster

Directions:

1. Cut out the picture of your beneficial insect and glue or tape it on the right side of your Wanted Poste
2. Find your beneficial insect on page 705 in your Sunset Western Garden Book and research the information needed to complete the Wanted Poster.
3. Fill in the information on your poster.
4. Color your Beneficial Insect Wanted Poster



# Unit 9 Landscape Design

## Lesson Plan Landscape Design

**Hook:** As students enter the classroom, present two pictures of landscape that are different from one another. Students will write the differences down and share their differences with a neighbor. Once they have shared their answers, have a whole class discussion. With this discussion we can go into the value of landscaping a home. How has landscaped design contributed to the benefit of agriculture, our economy and jobs? What is the relation to agriculture? Why is this important?

**Objective:** Students will be able to explain and describe factors and aspects involved in landscape design.

**PowerPoint:**

### What is Landscape Design?

- Landscape design is the art of developing property for its greatest use and enjoyment.
- Effective landscape design is also a science because it involves understanding the environment around your home and selecting plants that perform well in that environment.
- A well-conceived landscape design, properly installed and well maintained, adds value to your property and enhances the quality of your life.

### Aspects of Landscape Design

- Involves the planting of:
  - Ornamental trees
  - Shrubs
  - Vines
  - Ground Covers ( including grasses)
  - Flowers ( annuals and perennials)
  - Bulbs
- Also involves physical features or hardscapes.
- Hardscapes include :
  - Fences
  - Terraces
  - Retaining Walls ]
  - Patios
  - Walks
  - Any non plant features

## Factors of Landscape Design

- Factors that influence
  - Terrain
  - Climate
  - Homes
  - Buildings
  - Other Physical Structures
  - Intended Use of the Property
  - Client Needs

## Benefits of Landscape Design

- Four ways
  - Aesthetically
  - Economically
  - Functionally
  - Environmentally
- Aesthetically
  - An attractive landscape that adds beauty or is pleasing to your senses.
  - The visual beauty of your home and property can be enhanced through creative landscaping while undesirable features can be downplayed.
  - The sounds that a landscape offers, like a breeze rustling the leaves in the trees or the sounds of birds or of water splashing in a fountain, enhance the aesthetic qualities of your home environment.
  - The aroma of flowers or the smell of a freshly mowed lawn and even the taste of fruit from plants that you might have in the landscape are soothing
- Economic Value
  - The well-done landscape adds economic value to your home and property.
  - The value of your home can be increased by as much as 6 to 15 percent as a result of a good landscape.
    - It is not the most valuable feature of your property; the house is.
  - The function of the landscape is to enhance the beauty and therefore the economic value of your house.
  - Can also reduce energy bills by buffering seasonal temperatures.
  - Trees and shrubs can be used to reduce wind speed, making your outdoor living area more comfortable.
- Functional Value
  - Well-placed trees, shrubs, turf, and construction features increase your use of the property.
  - A little shade in the right place, a little sun in another, a place for the kids to play, a private patio, pool, or deck—all add to the enjoyment of being outside.

- Landscaping helps you solve landscape problems and cut down on maintenance.
  - Groundcover used on a steep hill in the yard can help you avoid lawn maintenance headaches and, on a very steep slope.
  - Groundcover may be essential to prevent erosion.
- Environmental Value
  - Temperatures can be buffered in the summer and winter.
  - Glare and wind can be reduced and water can be used more efficiently.
  - Plants in the landscape help clean the air of dust and some pollutants.
- Your landscape also provides a habitat for all kinds of wildlife

## PowerPoint# 2

### Principles and Elements of Landscape Design

- Design Process
  - Site Analysis
  - General Use of Space
  - Principles of Design
  - Putting Ideas on Paper
- Site Analysis
  - Site analysis (Step 1) begins with a base plan or base map and an inventory of what already exists on the property
  - A Sketch of the house, existing structural features of the property, and plants are included and are done in plan view,( looking down on the property).
  - Measure the dimensions of the house and draw and label existing features and plants on the base map.
  - Draw to scale, such as 1" = 8' (1 inch on the ruler represents 8 feet on the plan). Or, draw on graph paper where each square on the paper represents 1 foot.
- General Use of Space
  - Second Step in landscape design is to organize the outdoor living area to meet needs and desires
  - There are three major areas in the landscape: the public area, the private area, and the service area.
    - Public Area
      - The public area is usually in front of the house that is visible to the public.
      - The house is the central focus of this part of the landscape. The public area design should be kept simple and uncluttered.

- Allow space for guests to park. If the lot is small they may have to park in the street. Otherwise, you could design a double driveway, a circular one, or one with parking areas near the house.
- Through the use of plantings and walks, it could direct guests to the public entrance to the home. If you want them to notice and use the front door, focus their attention on it. A few bright flowers and specimen or unusual plants may do this.
- Design the walk wide enough for two people to walk comfortably side by side.
- Private Area
  - The private area is traditionally located near the family portions of the home, usually the back yard.
  - Its main purpose is privacy for your family. This may be obtained by an attractive border or screen plantings and walls or fences made from wood, stone, or metal.
  - It should also serve as a place to entertain guests and a place for rest, relaxation, and recreation.
  - To do this include a patio, terrace, pool, lawn, shade trees, greenhouse, play area for small children or sports' areas for older children.
  - The private area is also the place for your favorite flowers, flowering shrubs, and roses.
- Service Area
  - The service area does not have to be attractive or large; its size and use depends on the family needs.
  - It should be located nearest the kitchen or garage.
  - The service area is the place for the garbage cans, air conditioning condenser, a utility building, firewood pile, compost bin, or a vegetable garden.
  - Usually, this area is screened from the view of the other areas
- Principles Of Design
  - Unity
  - Simplicity
  - Variety
  - Balance
  - Sequence
  - Scale and Proportion
  - Form

- Texture
- Line
- Focal Point
- Color
- Selecting & Arranging Plants
- Unity
  - Describes the idea of tying the landscape together into an orderly design.
  - Some repetition is good, but it should not be carried to the point of monotony.
  - Unity in the landscape can be achieved through a theme of colors, forms, or textures without using exactly the same plants.
    - For example, a red color may be used as a theme, but you could use plants with reddish foliage as well as other plants with similar colored flowers or foliage. The plants would be in different areas of the landscape, but the color theme unites the overall landscape.
    - Other themes, such as kinds of plants, curves or straight lines, and construction materials, can be used to create unity in the design.
- Simplicity
  - It is an important principle of design, but it is a hard one to achieve.
  - Too many design themes can be confusing, and unity of design lost, so the design should be kept simple.
  - Too many different colors, textures, and forms result in visual confusion, and any sense of design can be ruined.
  - One way to achieve simplicity is by using a limited range of plant species.
- Variety
  - Oversimplification is boring; some variety must be sprinkled in for interest and to focus attention on the desirable aspects of your property.
  - Don't use the same kind of plant everywhere.
  - A long hedge of the same kind of plant can be very monotonous.
    - For example: break plants up into groupings, maintaining some of the same plants in the groupings but adding other plants for variety.
- Balance
  - In landscape design the idea is to balance the visual weight of objects in the landscape. Balance can be symmetrical—one side of an area looks just like another and gives a sense of stability, creating a **formal balance**.
  - Balance can be asymmetrical creating an **informal balance**.

- Asymmetrical balance can be achieved with a mass planting of shrubs or a tree on one side of the house visually balancing a chimney on the other side.
  - Asymmetrical balance is dynamic and tends to suggest movement.
- Sequence
  - **Sequence** is used to direct the eye smoothly to a desired focal point like the front door or a specimen shrub. Sudden changes in appearance break the visual flow around the landscape.
  - Includes a gradual change in the form, color, texture, or size of the landscape.
- Proportion or Scale
  - **Proportion** or **scale** refers to the way in which objects, like plants, people, or structures, relate to each other in size.
  - Proportion can be used to evoke emotion.
  - Large scale causes a humbling of the observer.
    - Example: A large tree or massive screen can seem imposing.
  - Small scale gives a sense of dominance or perhaps a desire to care for the smaller objects;
    - Example: dwarf plants, such as miniature roses.
- Form
  - **Form** refers to the silhouette or outline of the plant
  - A plant can be selected for the way its form can be used in the landscape to complement the house or achieve the principles of design.
    - Example: Rounded trees or shrubs can be used with oval, spreading, or weeping plants in a pleasing border.
- Texture
  - Refers to a plant's feel, but generally in the landscape visual texture is the main consideration.
  - Large leaves cast distinctive shadows in the plant canopy, offering a coarse appearance.
  - Finer-textured foliage offers a more uniform shade pattern.
  - Texture can be used to affect the sense of scale.
    - A fine-textured plant used near the viewer with a coarse-textured plant farther away gives a subtle sense of decreased distance. It makes your property or structure seem smaller
- Line
  - In curvilinear design, lines should be dramatic, done with a sense of flamboyancy and be very expressive in their shape.
  - Curvilinear lines that have weak, scallopy edges will not be visually interesting or pleasing to the eye.

- Curvilinear, meandering lines suggest a naturalistic look that invites the user to casually stroll through and experience the landscape.
- Focal Point
  - It is the use of emphasis.
  - Eye movement is directed towards a center of interest that takes a position of prominence in the landscape.
  - This could be a single tree, a beautifully designed water feature, a piece of sculpture, or a collection of ericaceous plants that automatically draw the eye to this point of interest.
- Color
  - Color has a strong effect and should be used with discretion.
  - Don't plan the landscape only with use of flowering plants in mind.
  - Use 80 to 90 percent of the plants for foliage effect.
    - Some variety in foliage color is needed, but green provides the continuity as well as the backdrop for carefully used color.
  - Color should be used to focus attention on an area of the landscape and to complement the house.
  - Colors should complement each other and use similar hues together.
  - Mass colors, don't alternate colors. Alternating breaks up visual sequence and is distracting.

### Selecting Plants

- Plants are living things and have basic environmental and maintenance requirements.
- Give careful attention to the growing conditions and unique needs of certain plants before using them in the landscape design.
- Can reduce pesticide use, reduce maintenance efforts, like pruning; and encourage longer-living, better-looking plants. In other words you can save a lot of effort and money.
- Factors to consider:
  - Cold hardiness or heat tolerance.
  - Light requirement.
  - Moisture requirement.
  - Soil drainage needs.
  - Soil pH requirement.
  - Pest susceptibility.
  - Rate of growth and mature size.
- Many plant reference books provide a USDA hardiness map of the United States broken down into zones of average minimum temperatures

### Arranging Plants

- Keep your landscape simple.
- Use a small number of plants with different characteristics; and repeat these. Use even fewer unusual plants. Use simple lines for edges of borders, walks, and drives. And, use simple arrangements for groupings of plants.
- Simplicity is the key to both lower maintenance and effective landscapes. Simplicity, combined with creativity, is the key to a landscape.
- Plants are arranged in seven basic ways
  - Specimen Plant
    - The center of attention. It deserves a prominent place in the landscape.
  - Accent
    - Like a specimen but more subtle as a featured plant in a grouping of other plants.
  - Corner Plantings
    - Groups of plants used to “tie down” the corners of the house. Corner plantings blend the vertical line of the wall with the horizontal plane of the ground
  - Foundation Plants
    - Help anchor the house to the ground and should direct the eye of the viewer to the entrance.
    - Taller plants are placed on, or beyond, the corners with height of plants descending toward the entrance
  - Entrance Plantings
    - Plants used to identify an entryway like the driveway, a garden gate, or an entry to the house.
  - Borders
    - Groupings of plants used to divide and define spaces in the yard.
  - Screens
    - Groupings of plants used to hide or cover unwanted views or objects.
    - Evergreen plants are an important part of screens, but they should not be the only plants used. Add deciduous plants for variety in color and texture.
    - The screen needs to be at least 6 feet high to be effective.

#### Putting Ideas on Paper

- Standard symbols are used to depict the kinds of plants and structures to be used in the landscape.
  - For example, a broadleaf deciduous tree, like a dogwood, may be depicted with a rounded canopy line or as leafless branches.
  - Broadleaf evergreen shrubs, like azaleas, might be illustrated as circles with rounded edges.

- Pines and other needle evergreens are often pictured with sharp edges.
- The use of fancy symbols in your landscape plan is not essential; simply using circles drawn to scale with a circle template is all right as long as you are consistent.
- It is helpful to be familiar with the symbols that are typically used so you can recognize the general kinds of plants used as you look at the plan of a professional landscape design.
- Circles used to represent the plants should be drawn to scale so the plants are illustrated at their mature size.
- Plants need to be identified on the plan.
  - For example: After all, you may put your plan away until you can afford to install another portion of your landscape. You may forget what plants were selected; without the key, you are lost.
  - On the key, be sure to include the number and size of plants that need to be purchased. Also include the scientific names of plants to avoid confusion when you purchase them.

### Student Activity: #1 Group

Students will get into groups of 2 or 3 and complete the landscape design webquest at  
<http://landscapingwebquest.weebly.com/task.html>

#### **Step One:**

##### **Pick your yard size**

These are your different yard sizes:

- 70 yards x 80 yards
- 50 yards x 100 yards
- 60 yards x 90 yards
- 130 yards x 70 yards

#### **Step Two:**

##### **Pick what you want to go in the yard**

Here are some features you could use: pool, patio, fire pit, table set, garden, deck, outdoor bar, swingset, trampoline, hot tub, gazebo, treehouse, trees, shed, bushes, grill, flowerbeds, fencing, pond, and more!

#### **Step Three:**

##### **Create the blueprint**

Draw, from an aerial view what the yard could look like. Be exact in your sizes. This blueprint is a smaller scale of what you will see in your client's yard.

**Step Four:****Find the area and perimeter of anything you add to the landscape**

You are responsible for finding all the dimensions and area using any resource you want.  
For example: a hot tub can be 3 yards x 3 yards

**Step Five:****Determine the area of the grass left open**

Wherever you leave room for grass you need to calculate the area because you need to purchase sod to put down on the ground.

Hint: Total yard area minus sum of the area of the elements added.

**Step Six:****Figure out the cost**

Use prices from stores that you could possibly buy your materials from as estimates for the cost of this landscape.

Student Activity: #2 (Individual)

**Landscape Design Project Requirements**

**Objective:** The student will design the landscaping for the yard of a house, either a front yard or a back yard.

**Materials:**

- Graph Paper – 2 sheets (1 for rough draft and 1 for final draft)
- Samples of a landscape design
- Ruler
- Pencil
- Colored Pencils

**Options:**

- You may choose to use your own yard as your project
  - Redesign your current yard
- You may propose your own landscaping project
  - Start fresh

**Procedure:**

1. Make a scale drawing of the size of the lot on the graph paper

2. Draw the footprints of the house on the graph paper to assess site analysis and the general use of space.
3. Apply the principles of design to your project.
4. Consider what landscaping materials to use in your project.
5. Draw the landscaping plan on the graph paper, be sure to use the landscape design symbols, you can make up your own if the samples do not list the plants you want to use.
6. Make a legend that identifies the type of plants in the landscape on a separate page.
7. Be sure to use the correct writing
8. Submit the rough draft for approval
9. Make your final landscape design on graph paper
10. Present your project to the class when completed.

# Unit 10 Turfgrass

## Lesson Plan: Introduction to turfgrass

**Hook:** Take your students out to the football field and have them lay down on the turf and kick a soccer ball. Then take students to baseball field to lay down on grass and kick a soccer ball. Have them take mental notes about the different experiences. Once students are back in the classroom give them 2 minutes to write down all the differences they noticed in a t-chart.

**Objective:** Students will be able to explain and describe the purposes and functions of turfgrass.

**PowerPoint:**

### Turfgrass Functions

- People enjoy its beauty
- Conservationist appreciate its positive effects on the environment.
- Athletes like the surface it provides on playing fields.
- Turf appreciates property value when maintained.
- The three purposes and functions of turf:
  - Utility
  - Ornamental
  - Sports
- Utility
  - The utility functions of turf are how it helps the environment.
  - Utility turf has many functions.
  - Stabilizes the soil and reduces erosion.
  - Cooling effect on the environment in hot weather.
  - Helps clean the air by removing toxic emissions.
- Ornamental
  - Enhances areas around homes, businesses and in parks.
  - Form of decoration.
  - Brings beauty to areas that might otherwise be unattractive
- Sports Turf
  - All types of playing fields.
  - Surface reduces injuries to players
  - Surface can be specially groomed to provide the area needed for different sports.
  - A lot of research has been done to improve turfgrass for sports fields.
  - Technology has been established to help maintain turf for sports fields.

### Turgrass Quality

- Turf quality is the excellence of the turf
- It is closely related to the function of turf
- Turf quality is based on utility, appearance and playability.

### Visual Quality

- Visual turf inspection is often used to assess quality.
- There are six common visual factors used to assess quality.
  - Density, texture, uniformity, color, growth habit, and smoothness.
- Density
  - The number of aerial shoots per unit area.
  - How many blades (leaves) are present
- Texture
  - The width of the leaf blades.
  - Wide blades form turf with a coarse texture.
  - Narrow blades produce a fine texture
- Uniformity
  - The evenness and distribution of the turf on site.
  - Involves the mass of aerial shoots that form the visible surface.
  - Gives the surface a smooth, even appearance
- Color
  - Measure of light reflected by the turf.
  - Most turf should be a rich green color.
  - Different species are different colors.
- Growth Habit
  - The type of shoot growth
  - Bunch, rhizomatous and stoloniferous are types of shoot growth.
  - Horizontal growth patterns are a problem in stoloniferous turfgrasses.
- Smoothness
  - Surface feature that affects visual quality and playability.
  - Preparation of the soil prior to planting turf is important in smoothness.

### Functional Quality

- Functional turf quality is how well a turf achieves its purpose.
- There are nine functional factors in turf quality.
  - Rigidity, elasticity, resiliency, ball roll, traction, yield, verdure, rooting and recuperative potential.
- Rigidity
  - Involves the resistance of turf leaves to compression.
  - Related to wear resistance.

- Influenced by plant tissue, water content, temperature, plant size and density.
- Elasticity
  - The tendency of leaves to bounce back once a compressing force is removed
- Resiliency
  - The capacity of a turf to absorb shock without altering surface characteristics.
  - Growth medium is a factor.
- Ball Roll
  - The average distance a ball travels upon being released on a turf surface.
  - Mechanical devices are used may be used to release a ball at a consistence speed to obtain measurements.
- Traction
  - Indicates the positive planting of feet and positive movement which is unhindered by the turf or soil surface.
  - The better the traction the more the turf and soil hold firm to this movement.
  - This is important in sports activities on athletic fields.
- Yield
  - Measure of clippings removed with mowing.
  - Indication of turfgrass growth as influenced by fertilization, irrigation and other cultural and natural environmental factors
- Verdure
  - The measure of aerial shoots remaining after mowing.
  - Increasing verdure can correlate with increasing resiliency and rigidity
- Rooting
  - The amount of root growth evident at any one time in the growing season.
  - Estimated visually by extracting a turf core with a soil probe or knife.
  - Soil is worked free or washed away to expose the roots
- Recuperative Potential
  - The capacity of the turfgrass to recover from damage caused by:
    - Disease organisms, insects, vehicular and pedestrian traffic, flooding, spills and scalping.

## Selection

- A good turf begins with selecting the right turfgrass.
- Climate, use, maintenance needs and characteristics of southern and northern turfgrasses are important in selecting the kind to grow
- Climate and turfgrass life cycle
  - Turfgrasses are place in two groups.

- These groups are based on the ability of a species to grow and serve a useful purpose in the climate.
  - Southern- Warm Season Turfgrass grows best at 80 to 95 degrees F.
  - Northern- Cool Season Turfgrass grows best at 60 to 75 degrees F.
  - Both Warm and Cool season turfgrasses can go into dormancy when exposed to extreme weather conditions
- Regions
  - It is important to grow the correct type of turfgrass for your region.
  - Those in a transition zone (area between climate zones) need be cautious when selecting a turf grass.
  - Tall fescue and ryegrasses are popular turf for the transition zone

Student Activity: The grass is always greener Webquest @

<http://zunal.com/webquest.php?w=123834>

Determine how much profit you want to make from this job upon completion. Don't sacrifice quality of materials and workmanship in order to make more money! This number will be your budget for overhead (materials, labor, and other miscellaneous expenses).

1. Determine how big of an area you are working with. Use basic formulas for area to get the square footage. This will give you the amount of grass you need to purchase and will go along way in helping you to determine the installation method to use.

These formulas will help you out:

- Square/rectangle = Base x Height
- Triangle =  $1/2 \times \text{Base} \times \text{Height}$
- Circle =  $3.14 \times (\text{Radius} \times \text{Radius})$
- Semicircle =  $\{3.14 \times (\text{Radius} \times \text{Radius})\} / 2$

2. Use the internet to research what species of grasses grow well in your climate. Which types grow well in what conditions. What are the conditions of your site? Use this information to select a species for installation. Include a link to the website with your findings in your final document.

3. Use the internet to research different turf retailers in your area. What are their prices for sod? for seed? for sprigs? for delivery? This will help you determine who to buy from and what to buy, which will be the decisive factor in what type of installation to perform, (sod, seed, or sprigs) and will help keep you within your budget. Include a link to the website with your findings in your final document.

4. Determine how much you expect to earn per hour and how much you will pay your hired help (if you have hired help). Then determine how many hours you can devote to this project in order to keep in your budget.
5. Once all of these decisions have been made, create a document that lists each detail and its cost individually. This information can be used as an invoice for your client, or used in your records for future business transactions and other business related purposes.