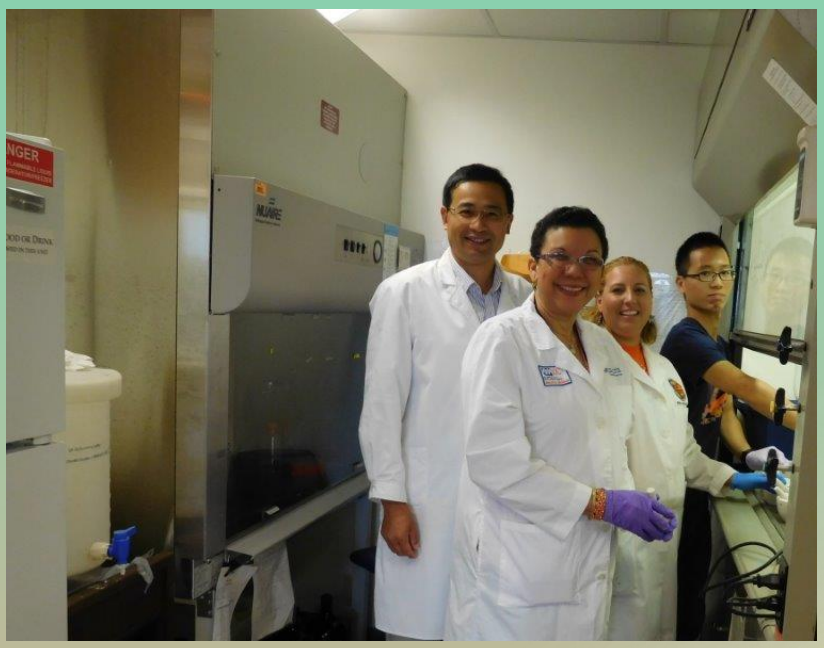


Proteomics: Twenty-First Century Skills in Biotechnology

Mrs. Donely Santiago

PROTEOMICS: TWENTY FIRST CENTURY SKILLS IN BIOTECHNOLOGY

UF | Center for Precollegiate Education and Training
UNIVERSITY of FLORIDA

Author: Mrs. Donely Santiago

Contributing Author for Lessons: Curriculum Team

Curriculum Team: Dr. Sixue Chen, Dr. Tong Zhang, Dr. Li, Dr. Iris Payan, and cpet

Lessons Adapted from Ellyn Daugherty Text and Lab Manual.

Thank you to for offering excellent review and suggestions: Curriculum Team

This curriculum was developed as part of *Biomedical Explorations: Bench to Bedside*, which is supported by the Office Of The Director, National Institutes Of Health of the National Institutes of Health under Award Number R25 OD016551. The content is solely the responsibility of the authors and does not necessarily represent the official views of the National Institutes of Health..

Additional information regarding the Bench to Bedside project is available at http://www.cpet.ufl.edu/bench.

Please direct inquiries to Julie Bokor at Julie@cpet.ufl.edu or 352.392.2310.

Last updated: 7/24/2012

Center for Precollegiate Education and Training

PO Box 112010 • Yon Hall, Room 331

Gainesville, FL 32611

Phone 352.392-2310• Fax 352.392-2311

This curriculum was developed in the laboratory of:

Sixue Chen, PhD
Associate Professor
Department of Biology
College of Liberal Arts and Sciences
Director, Proteomics and Mass Spectrometry Core
Interdisciplinary Center for Biotechnology Research

My research is focused on the signaling and metabolic mechanisms underlying plant interaction with the environment. My lab research has been particularly focused on three topics: glucosinolate metabolism, guard cell signal transduction, and plant pathogen interaction.

Project 1. Glucosinolate metabolism. Glucosinolates are a group of naturally occurring thioglucosides, present in Brassica plants (e.g., canola and cabbage). Glucosinolate degradation products display diverse biological activities, including defense against insects and herbivores, N/S nutrition and growth regulation. From a human perspective, glucosinolate metabolites account for the distinctive flavors of cabbage and condiments. Some of the metabolites such as isothiocyanates exhibit anticarcinogenic properties. The core glucosinolate pathway has been well studied in Arabidopsis. However, we know little about how the components in different pathways interact to produce plant phenotypes and traits. Nor do we know how different layers of molecular control work together. The lack of such fundamental knowledge is a major reason why plant genetic engineering has been largely unsuccessful. It poses a chronic problem for rational engineering of crops for better quality and defense. Research in this project is focused on characterizing the regulatory and metabolic networks involving glucosinolate metabolism using multidisciplinary approaches. We aim to identify protein and metabolite changes in response to perturbation of glucosinolate metabolism and to integrate the data into glucosinolate networks. The process of networking will generate new testable hypotheses concerning glucosinolate metabolic pathways and related pathways. The ultimate objective is to use the immense biosynthetic potential of plants as an efficient, environmentally friendly and renewable source of fine chemicals and pharmaceuticals.

Project 2. Guard cell signaling networks. Guard cells are highly specialized plant epidermal cells that enclose tiny pores called stomata. Stomatal movements control both uptake of carbon dioxide and loss of water, and thus play important roles in plant growth and acclimation to environmental stresses. The plant hormone abscisic acid (ABA) is a key indicator of drought stress. ABA induces stomatal closure via an intricate intracellular signaling network in guard cells, thereby promoting plant water conservation. It is our central hypothesis that protein redox modification and dynamic changes in key metabolites are critical regulatory mechanisms in ABA signaling. We are testing the hypothesis by pursuing: identification of guard cell proteins whose redox status is altered in response to ABA and determination of their specific redox-sensitive amino acid residues, quantification of ABA-induced changes in

metabolites implicated in guard cell signaling, and integration of the new information into a dynamic model of ABA-induced stomatal closure. Accomplishing these objectives is significant because it will reveal novel components of ABA signaling networks and provide knowledge of regulatory mechanisms underlying stomatal movements that will help to develop crops with enhanced stress tolerance and productivity.

Project 3. Plant pathogen interaction. The study of pathogen response and defense in crop species is of essential importance as the applications are directly related to agricultural production. *Pseudomonas syringae* pv tomato (Pst DC3000) causes speck disease in tomato (*Solanum Lycopersicum*), a crop growing in large quantities in Florida and having both nutritional and economical value. The goal of this project is to take what is known about pathogen host interactions and observe in greater detail mechanisms that plants utilize in response to pathogen infection at the posttranscriptional levels, including protein expression, redox and phosphorylation/dephosphorylation switches. Understanding changes in protein expression as well as redox and phospho-switches will provide important insights into how plant response and resistance to pathogens are occurring. Further investigation into unique/novel proteins and regulations will advance our knowledge of plant defense against pathogens, and allow researchers to use biotechnology to prevent future bacterial speck disease outbreaks.

Interestingly, as we gain more and more knowledge, the above projects have become interconnected with each other. Glucosinolate metabolism plays a role in pathogen defense and affects stomatal movement, which serves as the first line of defense against pathogen invasion. In addition to hypothesis generation projects, another major part of my research program has been hypothesis driven, i.e., characterizing molecular, biochemical and physiological functions of specific genes and proteins identified by proteomics and metabolomics approaches. One of the projects has been focused on understanding the key steps in the methionine chain-elongation pathway, which directly connects methionine (primary) metabolism to glucosinolate (spealized) metabolism. Our integration of hypothesis generation and hypothesis driven research will ultimately lead to a holistic view of cellular networks and processes in plants and will create important stepping stones towards potential biotechnological applications in enhanced yield, bioenergy and defense.

TABLE OF CONTENTS

AUTHOR'S NOTE: SUMMER RESEARCH EXPERIENCE AT UF CPET 2016

The introduction of Proteomics began during the 2016 Summer Research Experience (SRE) at the University of Florida (UF) in Gainesville. As two Florida Certified Teachers, Dr. Iris Payan and Mrs. Donely Santiago walked into the laboratory of C.V. Sixue Chen, Ph.D. in hopes of exploration of current biotechnology applications in a working laboratory. Mrs. Santiago reflects, "a fascinating thought, teachers wish to experience science just as the students do while walking across the science classroom threshold." Upon entering the room students (SRE Teacher Interns) begin to think about, "What new techniques, ideas, and equipment will the students (SRE Teacher Interns) get to play with?" In utilizing the word play, Mrs. Santiago is referencing to the enjoyment of science discovery. The wish of every science teacher is for previous students to walk away with a passion for learning, as student move forward in life to implement the internal desire for success in all of life's personal or educational events. Why Proteomics?

- Students will be exposed to higher learning content of cells, cell culturing/harvesting, transcription, translation, product pipeline, plant propagation, lab techniques and equipment use, and employability skills.
- Higher educated citizens will be able to make consciences decisions regarding health care, treatment, or research in regards to family or societal concerns.
- Designing a simple across the curriculum platform for science teachers to implement will be an ongoing task; the curriculum needs to be both teacher and student friendly while allowing students to think as research scientists producing quality student work.

Throughout the three weeks teachers worked with a diverse group of scientist. Dr. Zhang was our lead teacher, as the mentor was patient with the mentee's lab errors and mistakes. Again the certified teachers take on the role of student and not of teacher. The experience allowed for Mrs. Santiago to reflect on real world applications in research biotechnology, as the lab protocols were verbal, fast paced, and required accurate measurements. In addition to, teacher identified lab techniques that needed varied instruction (international techniques) or improvements allowing current student populations to be adequately prepared for college and work force opportunities in the world of science.

INTRODUCTION

How can teachers introduce twenty-first century applications of protein Analysis into the classroom? By introducing peptide mass fingerprinting (PMF), students will be introduced to real world scenarios that everyday scientist work with day to day in a Proteomics Facility.

What is Proteomics? Why would teachers and students want to learn about the current applications in protein identification of cellular material, plant or animal? What is the purpose of protein identification? How would understanding the content help me become a better student or person within society? Can an across curriculum be designed for any science teacher to implement as a true lesson while still targeting the standardized testing learning goals? Throughout the three weeks, the SRE Interns asked the above questions while being exposed to a variety of cutting edge research. In the discovery process the below are some answers that the SRE Interns found out while working within Dr. Chen's Lab: Genetics Institute: Plant Molecular and Cellular Biology.

- Proteomics- the study of proteomes, large-scale study of protein structure and function.
- Teachers keeping up with current science applications maintain an exciting student-learning environment this is accomplished by teaching trendy content, look at science trends. Yes, science has trends.
- Students will transfer into critical thinking students allowing for college and the work force biotechnology applications to be carried in developing an educational portfolio.
- Protein Identification allows for scientist to pinpoint genetic responses due to favorable or unfavorable environmental stresses placed on an organism. Then the identified proteins may lead the pathway to desirable treatment or cure for societal and environmental diseases.

In addressing the above, the curriculum designed will incorporate: Pre-Lab Activities, Pre/Post Testing, Computer Research, Work force/College preparation Alternative Assessments, Teacher Links, Biotechnology Tips, and Extensions for Re-teaching or Technology Incorpation.

TIPS ABOUT THIS CURRICULUM

Lesson Plan Format: All lessons in this curriculum unit are formatted in the same manner. In each lesson you will find the following components: Biotechnology Teacher Tips Noted: Biotech Tip (BT)

ESSENTIAL QUESTION (S): Identifies lesson goals students will be assessed on based on standards.
OVERALL TIME ESTIMATE: Indicates total amount of time needed for the lesson, including advanced preparation, BT: *biotechnology teachers need to create pre-labs for equipment preparation and material measurements in preparation for the certification lab practical, B.A.C.E. Therefore, a week lab requires a week of pre-labs for effective time management and student learning.* BT: Teachers that love lab!!! *If teachers rush, teachers will find out that grades will reflect along with your lack of having fun, now your exhausted and not a fun teacher.*
LEARNING STYLES: Visual, auditory, and/or kinesthetic.
VOCABULARY: Lists key vocabulary terms used and defined in the lesson. Also collected in master vocabulary list. BT: *Print the Biotechnology Vocabulary Worksheets provided by Ellyn Daugherty links and have students' laminate, cut out, package according to chapters, then use as bell ringers, Matching Game.*
ABBREVAIATIONS: List key abbreviations used within the biotechnology laboratory in preparing students for both college and work force. BT: *Assessed on B.A.C.E. computer and lab assessment.*
BT: *Have students do the same, as they did with the vocabulary worksheets. Teachers can assess based on Abbreviation Letters or correlate with chapters. A great introductory activity to biotechnology text book first two weeks of class.*
LESSON SUMMARY: Provides a 1-2 sentence summary of what the lesson will cover and how this content will be covered. Also collected in one list.
STUDENT LEARNING OBJECTIVES/GOALS: Focuses on what students will be able to do on assessments, projects, pre-labs, and labs. BT: *Use the Florida DOE Curriculum from Website, easy way to develop lesson plans, do not remake the wheel. You will not have time! Use 2 AKS and 2CTE standards to begin, as you become more proficient in the standards expand use of both AKS and CTE for each lesson.*
STANDARDS: Specific state benchmarks addressed in the lesson. BT : List and Link provided
MATERIALS: Items needed to complete the lesson. Number required for different types of grouping formats BT: *Students need to be in small lab groups for individual proficiency. Therefore allowing for teacher-student skill development of lab applications. Allows for personal assessment of student achievement and ability.*
BACKGROUND INFORMATION: Provides accurate, up-to-date information from reliable sources about the lesson topic. BT: *Allow students to investigate concepts as an introduction before rushing into lesson, Computer Research with Guided Q+A, Virtual labs, and Simulated Websites. Remember your audience has the ability to self teach introductory ideas. The allotted time allows teacher to perform data chats (portfolio reviews) with students or prepare lab materials.*
ADVANCE PREPARATION: How to prepare for Activity or Lab? Items to be done before hand. BT: *Develop a process that removes total responsibility from teacher to student; remember students need to be able to walk into any laboratory to perform make solutions and media for cell culturing.*
PROCEDURE WITH TIME ESTIMATES: The procedure details the steps of implementation with suggested time estimates. The times will likely vary depending on the class. BT: *Time interval lesson plans will keep you from running out of time to review student data, put lab away fro day two, and S.L.O.P. Refer to your CTE standards for daily grading of students, so students are responsible for Lab Safety.*
ASSESSMENT SUGGESTIONS: Formative assessment suggestions have been given. Additionally, there is a brief summative assessment (pre/post test) that can be given. Teachers will need to create a formative and summative assessment that meets both the curriculum and classroom Syllabus. BT: *Quick,*

pre-lab Quizzes will establish student ownership of learning. Tasking at first, but soon you will have a databank to develop section folders.
EXTENSIONS: (ACTIVITIES/LITERATURE) Many activities and reading sources available to augment and enhance the curriculum are included. If you find additional ones that should be added, please let us know.
RESOURCES/REFERENCES: This curriculum is based heavily on primary sources. As resources and references have been used in a lesson, their complete citation is included as well as a web link if available. All references and resources are also collected in one list.
STUDENT PAGES: Worksheets and handouts to be copied and distributed to the students.
TEACHER MASTERS: Versions of the student pages with answers or the activity materials for preparation.

Collaborative Learning: The lessons in this curriculum have been developed to include many collaborative learning opportunities. Rather than presenting information in lecture format and teacher driven, the activities involve the students in a more engaged manner. For classrooms not accustomed to using collaborative learning strategies, have patience. At first, communication may be difficult to convey instructions, particularly for students who are visual learners. For these students, use of visual clues such as flowcharts and graphics can help them understand how they are to move to different groups.

Groups: Most of the lessons are carried out in individual or two group parties. BT: *Each student will need to perform on the lab practical with no assistance. The less individual lab time per a student the less prepared the students will be for the B.A.C.E.* While not necessary for students to remain in the same groups the entire unit. Students working well together may foster students to think deeper while becoming comfortable with their teammates and willing to ask questions of each other.

Inquiry-based: The lessons in the curriculum invite students to be engaged and ask questions. Students will work through background information in a guided fashion, but are challenged to think beyond covered material. Once students have read or done. The teacher serves as the facilitator in these activities, not the deliverer of information. BT: *Set some time aside to acquire guest speakers, on site training industry, or university. Teachers are not limited to classroom experiences due to technical content standards and expected mastery of state certification. Come up with a good marketing plan, and educational opportunities will be available to students.*

Technology: Lessons have been written to be mindful of varying availability of technology in schools and homes. Some lessons are well suited to online environments. If students are able, you might wish to engage in some of the technology modifications. BT: *If you have no equipment your first year, then look into summer training that will allow you to borrow equipment, cpet. Also, your local community college will become your mentor build bridges with the lab manager, and plan two field trips that will offer student exposure to advanced lab applications.*

Content: Often people teach in a manner that is very content heavy. With high-stakes testing the norm, students are pushed to memorize and regurgitate numerous isolated facts. This unit provides a simplistic exploratory learning experience for all science students integrating industrial biotechnology. The lesson can be modified for any across the curriculum science class, but modifications need to be based on pre-assessed of student ability, what students already know. BT: *Pre-assessing will allow teachers to keep high*

student engagement. First year takes some time to develop, but increased student learning gains will become more apparent.

Implementation notes: This curriculum should be modified and adapted to suit the needs of the teacher and students. To help make implementation easier in this first draft, Biotechnology Tips, BT are included in lessons as needed with extensions based on cutting edge industrial biotechnology applications incorporating the following: scientific research, biotechnology career fields, virtual labs, and equipment.

Extensions: For those teaching an AP Biology curriculum, bacterial transformation is a required laboratory. While bacterial transformation can be very useful in the research lab and certainly it helps students understand how bacteria gain new traits, it is also somewhat abstract from their daily lives. Other than the concept of antibiotic resistance (which is extremely important for students to understand), Likewise, in this unit, students may have difficulty conceptualizing how a hamster ovary cell can produce an enzyme for human use. Bacterial transformation can be used to model this process: transfection and cell culture in a pharmaceutical manufacturing facility is analogous to transformation and overnight bacterial cultures in an academic laboratory. For example, students can complete the BioRad pGLO bacterial transformation, pick and grow a transformed colony, purify the protein using column chromatography, and even perform a SDS PAGE to confirm the protein of interest is present and test for purity, much like quality assurance in a pharmaceutical company.

AP Chemistry curriculum may utilize the Solutions Labs, Spectrophotometer, and Mass Spectrometry in meeting standards based on the following: Chemical Changes, Molarity, %Mass/Volume Calculations, Properties of electron and light interaction, and analysis of protein structures.

AP Physics curriculum may extend from Properties of electrons, light, and wavelength with either spectrophotometer or mass spectrometry.

Additional activities including Mascot, Protein assay, protein digestion, SDS PAGE, Spectrophotometer, 3D protein modeling, and Mass Spectrometry will be developed and included in Proteomics: Twenty-First Century Skills in Biotechnology.

Science Subject: Biotechnology I, II, and III, AP/H Biology, AP/H Chemistry, Honors Physics.

Grade and ability level: 9-12 students in advanced Sciences: Biology, Chemistry, and Physics

Science concepts: Proteomics, Biotechnology, Micropipetting Skills, Solution Preparation, Environmental Stimuli and Responses, Genetics, Protein Structure and Function, Protein Synthesis, Lab Protocols, S.L.O.P., Technical Writing, Scientific Data Reporting, REE, PE, PA, Spectrophotometer (Protein Assay), Mass Spectrometry, Mascot for computer analysis of protein identification.

LESSON SUMMARIES: HIGH SCHOOL SCIENCE INCORPORATING INDUSTRIAL BIOTECHNOLOGY

Pre-Testing: Introduction and Pre/Post Assessment.
In measuring student mastery of the biotechnology contents for standards I, II, and III. Students will begin with a pre-test to indicate current knowledge of concepts and applications within the Ellyn Daugherty Text of Chapters 1, 2,3, and 5. The test will be taken in the ninety-minute time frame. Students will be permitted to use calculators only, since phones are not permitted on the B.A.C.E. The teacher will provide a graphic organizer outlining the semester activities involved with Protein Identification of day-to-day student expectations.

LESSON ONE: How Can Plants Be Fingerprinted With No Fingers?

Students will be introduced to cutting edge concepts of Peptide Mass Fingerprinting (PMF) by utilizing a guided inquiry activity based on Dr. Chen's website: moleculardectives.org. Students will begin seed cultivation of Iceplant. Teacher may plan an UF Tour to create student interest and excited of what to come.

LESSON TWO: What are the building blocks (monomers) of living organisms?
Review Macromolecules, Peptide bonds, and Protein Synthesis with teacher demo: Lab 2a: "Dissecting " a "Cell" and Examining Its Components from Ellyn Daugherty Lab Manual, pgs. 14-17.
Flipped: Student will need to have written the following in Legal Science NB:
Title, Purpose, Materials, Table 2.1, 2.2, and Thinking Like a Biotechnician Q's 1-7 with skipped line for answers. Students will review properties of acids and bases, macromolecules, and qualitative data observations, and peptide bond formation of condensation reactions using atom models, Learn genetics web tutorial, and simple plant extraction exercises to develop and practice lab skills before using Iceplant.

LESSON THREE: Do Peptide Bonds Matter for Protein Function?
Student will perform the following lab and create a Standard Operating Procedure (SOP) to be utilized for Biotechnology I students based on teacher created rubric. Laboratory 2f: How Molecular Structure is Affected by Environmental Change, Ellyn Daugherty pg. 29-30.
Flipped: Student will need to have written the following in Legal Science NB:
Title, Purpose, Materials, Table 2.5, and Thinking Like a Biotechnician (TLB) Q's 1-2 with skipped line for answers. May need to give two class periods to complete SOP.

LESSON FOUR: Presentation, Presentation, and Presentation! A Student Skill or Burden?
Students will complete SOP on the Laboratory 2f: How Molecular Structure is Affected by Environmental Change, Ellyn Daugherty pg. 29-30. Students will assess presented SOP, as

presented by overhead projectors. Students will grade and announce the winner of the SOP Competition

LESSON FIVE: What technical skills will Biotechnology Students learn, thus giving students an advantage in the work force or college preparation? Micropipetting skills.

Students will be running teacher created micropipetting races of labs Ellyn Daugherty labs (3a and 3b). Students will be pre-tested using the making solutions review sheet No. 1. Afterwards, students will begin making solutions to begin plant extraction lab.

LESSON SIX: Proteome not Genome! Protein ID.

Day 1: Plant Extraction.

LESSON SEVEN: Protein Assay using the Spectrophotometer.

LESSON SEQUENCING GUIDE: AN ACROSS SCIENCE CURRICULUM, BIOTECHNOLOGY COURSES, H BIOLOGY, AND H CHEMISTRY.

Modified for Biotechnology Courses, Biology, and Chemistry. 45 min.
****May be modified for AP Biology or Chemistry.**
****Technology Extensions will apply across science curriculums to increase student engagement and background knowledge for college or work force preparation.**

***Iceplant Observations will be conducted for 12 weeks or till flowering.
Extension concepts: DNA, Plant Structure/Function, Germination, Photosynthesis, Cellular Respiration (C3 –CAM Plants), Molarity, Properties of Light, Wavelength, Beers Law.

	Day 1	Day 2	Day 3	Day 4	Day 5
Week 1	Lesson 1 **Rotation 1: (20 min**) Teacher Demo: How Can Plants be Fingerprinted without Fingers? **Rotation 2:(20 min:)** Website (PMF) investigation Flipped: Proteins and Proteomics Video Next class **(15 min:)** Class discussion, cool, what do you want to learn	Lesson 2 **(First10 min:)** Class discussion, cool, what do you want to learn? **(15 min:)** PMF Quiz. **25 min**. Cultivate Iceplant seeds Flipped: Introduced to plant extraction protocols for Biotechnicians	Lesson 3 Day 1: Seed observation, as students enter class. **First (15 min)** Quiz: plant extraction protocols performed in biological facilities. **30 min.** Plant Extraction Protocol Flipped: Spectrophoto meter Protocols for Plant Analysis	Lesson 4 Day 2: Seed observation, as students enter class. **First (15 min**)Quiz Spectrophoto meter Protocols (**20 minutes**). Teacher Demo Using Spectrophoto meter to analyze concentration of protein (**10 min**) Graph paper: set up x-axis and y-axis to	Lesson 3 Day 3: Seed observation, as students enter class. **(45 min)** Students run plant extraction using the spectrophotom eter to conduct a colorimetric analysis of protein concentration. Student closest to teacher's most accurate

				collect data	

VOCABULARY

Agricultural Biotechnology: biotechnologists develop products to protect animals and crops from disease and help farmers identify the best animals and seeds to use in selective breeding programs.

Amino Acids: The basic building block of proteins. There are 20 different amino acids that link together to in various orders to form proteins.

Arabidopsis - A genus of flowering plants found in north temperate regions. The species *A. thaliana* is used for experiments in classical plant genetics as well as molecular genetic studies in plant physiology, biochemistry, and development.

Aseptic - free of or using methods to keep free of contaminant microorganisms; "a sterile operating area"

Assay – A test to perform a specific function**.**

Autoclave: A vessel, usually of steel, able to withstand high temperatures and pressure.

Bioinformatics - the application of computer & statistical techniques to the management of biological information

Centrifuges – Machine used to separate a mixture based on mass.

Concentration - (in a solution) a measure of the amount of dissolved substance contained per unit of volume.

Colorimetric Assay- An assay where a spectrophotometer is used to measure the amount of protein that is present in a sample by detecting a colored complex.

Cotyledon: The primary or rudimentary leaf of the embryo of seed plants.

Electric Charge - A component of atoms having a positive or negative electric current.

Denature - To induce structural alterations that disrupt the biological activity of a molecule. Often refers to breaking hydrogen bonds between base pairs in double-stranded nucleic acid molecules to produce single-stranded polynucleotides or altering the secondary and tertiary structure of a protein, destroying its activity

Endosperm: Tissue that surrounds and nourishes the embryo in the angiosperm seed.

VOCABULARY: CONTINUED

Embryo (plant): The earliest stage of development in an animal or plant. An embryo begins to form following the fusion of egg and sperm (a zygote).

Genomics: the comprehensive study of whole sets of genes & their interactions (DNA Microarrays).

Germination: The process by which a seedling emerges and develops from a seed, or by which a sporeling emerges and develops from a spore.

Greenhouse Technician: care for plants that have been created through genetic engineering and have to understand how to plant seeds, pollinate flowers, water and weed plant beds, plant rooted plants, nurture root cuttings, treat plants for disease and pest infestation, and be able to use a computer for documentation purposes.

Mesembryanthemum crystallium L: The ice plant is a little-known vegetable of the southern hemisphere. Ice plant is named after the shimmering silvery dots that cover the leaves. All green parts of the plant are covered with small, transparent, membranous bladders.

Metabolomics: the comprehensive study of the small molecules or metabolite

Molarity- the number of moles of solute dissolved in one liter of solution.

Peptide bond – formed between the carbon of a carboxyl group of one amino acid with the nitrogen of the amino group of an adjacent amino acid.

Peptide Mass Fingerprinting- an analytical technique for protein identification.

Perlite: a variety of obsidian consisting of masses of small pearly globules: used as a filler, insulator, and soil conditioner.

Protease inhibitors - compounds that interfere with the ability of certain enzymes to break down proteins. Some protease inhibitors can keep a virus from making copies of itself.

Proteomics: the study of proteomes, large-scale study of protein structure and function.

Radicle: The end of a plant embryo which gives rise to the first root.

Seed: A structure produced by seed plants that encapsulates the embryo. The seed often provides nourishment during germination, but may lie dormant for many years first.

System Biology- the study of the interactions and behavior of the components of biological entities, including molecules, cells, organs, and organisms.

VOCABULARY: CONTINUED

Transgenic - This term describes an organism that has had genes from another organism put into its genome through recombinant DNA techniques.

Vermiculite: Any group of micaceous minerals consisting mainly of hydrated silicate of magnesium, aluminum, and iron: as a bedding medium for young plant.

Wild Type: the typical form of a species of organism resulting from breeding under natural conditions

NEXT GENERATION SUNSHINE STATE STANDARDS – SCIENCE: BIOLOGY, BIOTECHNOLOGY I, II, III, HONORS CHEMISTRY, AND I.

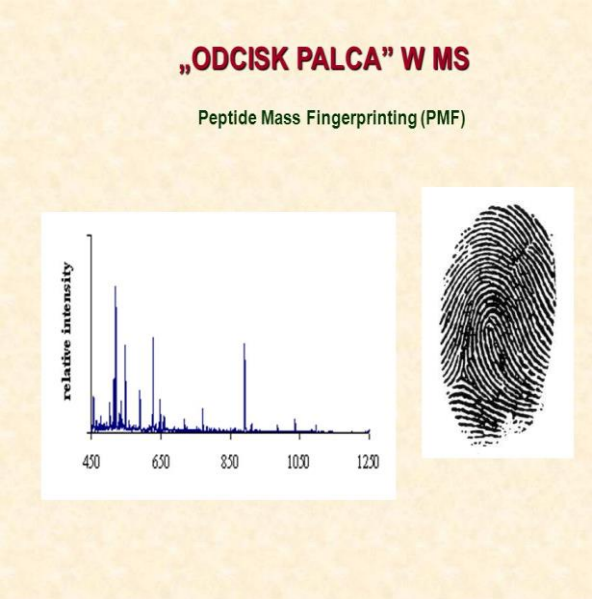
Benchmark	Lesson						
	1	2	3	4	5	6	7
SC.912.N.1.1 Define a problem based on a specific body of knowledge, for example: biology, chemistry, physics, and earth/space science, and do the following: 1. pose questions about the natural world, 2. conduct systematic observations, 3. examine books and other sources of information to see what is already known, 4. review what is known in light of empirical evidence, 5. plan investigations, 6. use tools to gather, analyze, and interpret data, 7. pose answers, explanations, or descriptions of events, 8. generate explanations that explicate or describe natural phenomena (inferences), 9. use appropriate evidence and reasoning to justify these explanations to others, 10. communicate results of scientific investigations, and evaluate the merits of the explanations produced by others.	X	X	X	X	X		
SC.912.N.1.5 Describe and provide examples of how similar investigations conducted in many parts of the world result in the same outcome.							
SC.912.N.1.6 Describe how scientific inferences are drawn from scientific observations and provide examples from the content being studied.		X					
SC.912.N.3.5 Describe the function of models in science, and identify the wide range of models used in science.			X				
.							

Benchmark	**Lesson**						
	1	**2**	**3**	**4**	**5**	**6**	**7**
.							

BACKGROUND INFORMATION: PROTEOMICS AND PLANT PROTEINS

General background information is given here. More detail is provided in the individual lessons as needed as well in the student information in lesson one.

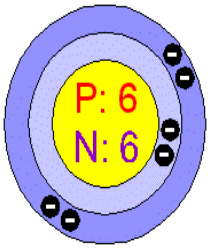
How Can Plants Be Fingerprinted With No Fingers?



Since proteins are covered in the Florida Standards across the science curriculum, how can teachers introduce twenty-first century applications of protein Analysis into the classroom? By introducing peptide mass fingerprinting (PMF), students will be introduced to real world scenarios that everyday scientist work with day to day in a Proteomics Facility.

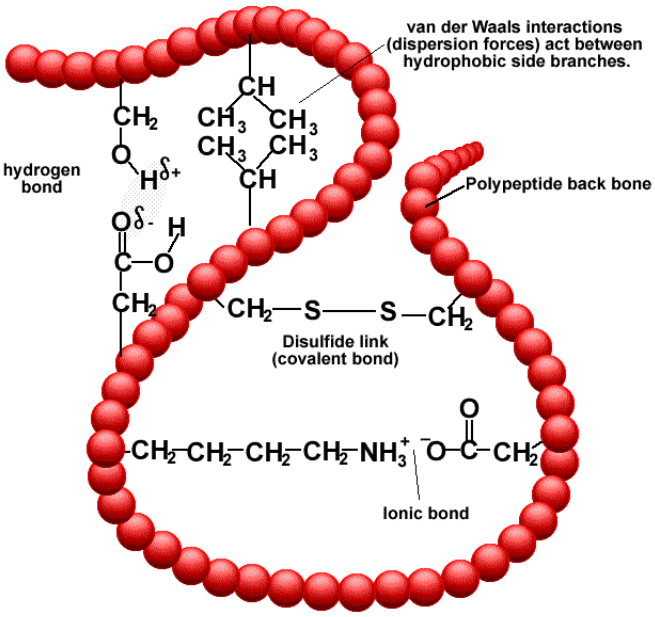
What are the building blocks (monomers) of living organisms?

Proteins are a type of organic compound called, macromolecules. Macromolecules are organic compounds consisting of a main backbone element, Carbon. Since, carbon has the ability to bond with up to four atoms. Carbon will be in either a straight chain or branched, thus allowing the element to create a diverse variation of molecules. Proteins are the molecules from which living things are constructed. Proteins help us digest our food, fight infections, control body chemistry, and in general, keep our bodies running smoothly.



Do Peptide Bonds Matter for Protein Function?

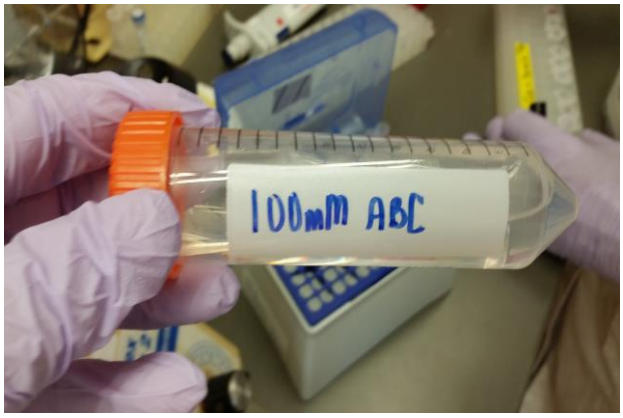
Teachers will be able to use previous material from biotechnology 1 course of Ellyn Daugherty, "Biotechnology Laboratory Manual", pgs. 29-30. Laboratory 2f, "*How Molecular Structure Is Affected by Environmental Change.*" During protein extraction, solutions of varying pH are used during the purification process. In obtaining pure peptide material, students will need to understand the importance of accurate measurements and calculations. Since acidic or basic solutions will influence the protein sample



environment from the globular protein structure into a chain of amino acids with peptide bonds. Students will explore the changes that occur in milk protein (casein) due to environmental changes of added acidic and basic solutions to the milk. Therefore, students will be able to observe protein changes (denaturing) in a milk plant protein identification protocol. Afterwards, the biotechnology teacher will be able to implement writing technical skills by designing a Standard Operating Procedure (SOP) rubric. The teacher created rubric will need to be based on industrial examples for work force connection. Along with the rubric development, SOP will need to continue throughout the biotechnology I, II, and III progression of course work to ensure student mastery.

What technical skills will Biotechnology Students learn, thus giving you an advantage in the work force or college preparation?

As indicated on about careers, "Technical skills are abilities and knowledge needed to perform specific tasks. They are practical, and often relate to mechanical, IT, mathematical, or scientific tasks. Some examples include knowledge of programming language mechanical equipment, or tools (Doyle, Alison)." In preparing for the sequence of labs in protein identification Progression, students will need to be proficient in both micropipetting and solution calculations. In review of Chapter 3, the teacher will create alternative extensions of the original conducted labs during biotechnology 1 for both review and mastery of %Mass/Volume, Dilutions, and Molarity based on the lab manual. The Ellyn Daugherty, "Biotechnology Laboratory Manual," Chapter 3 pgs.



ABC solution, pH buffer. Taken by Santiago, D.

31-62, *Basic Chemistry for the Biotechnician.*

Proteome not Genome! Protein ID.

DNA of each organism is unique in composition. Therefore the protein made from the unique DNA temple must also be unique in nature. The proteome found in living organisms consists of the entire complement of proteins. As defined in MolecularDectives.org, "*cellular proteome* is all the proteins found in a specific cell type under a particular set of environmental conditions." Since proteins are manufactured as an environmental stimuli placed on cells, then proteins within a cell will also change as a response mechanism. What if protein changes do reveal a cell story to society? Therefore opening the words for protein formation that control metabolic, bacterial, viral, or cancer diseases in regards to transmission or suppression? Thus scientists initiated experimentation with plant extraction and analysis, as a small-scale scientific model. In lesson two, students will be exploring lab protocols developed in biotechnology laboratories for protein identification, as students emulate biotechnology technicians.

Plant cell extraction with liquid Nitrogen. Taken by: Santiago, D.

Why Legal Science Notebooks in the Biotechnology Classroom?

The biotechnology curriculum is categorized, as a level three course.

Therefore, teachers need to develop assessment aligned with work force or college expected tasks, as outlined in Purpose and Characteristics of the document, "Career and Technical Education Courses Level III Criteria." Teachers mentoring with local higher education institutions are encouraged to develop a grading rubric consistent within all biotechnology progression courses, so students will master writing a valid lab report incorporating REE, PE, PA method indicated by Ellyn Daugherty.

Presentation, Presentation, Presentation! A Student Skill or Burden?

Lesson	Alternative Assessment: Computer/Technical Writing
4Ci	Technical Writing: Cell Extraction SOP (Standard Operating Procedure) https://734f453fbd643b2bcf4d-0381c0a61c2ead190e88e7cdc282ed5a.ssl.cf1.rackcdn.com/2014/09/good-standard-operating-procedure-template-sop.jpg
4Cii	Employability Skill: Biological Waste Protocol Flyer

Biotechnology teachers will discover why students enroll in the courses. One student indicator revealed over the last five years, students want the opportunity to create and develop higher-level projects based on student interest. The teacher has the opportunity to allow students a selection of assessments based on creativity and innovation. In addition, the student selection will allow for more student ownership of learning; as the student has a personal investment in the outcome of the project. Since the student selected alternative assessment of Florida standards are based on personal interest.

ExpressTrain
www.expresstrain-ti.com

For Internal Use Only

Name of this Standard Operating Procedure	Document No.	SOP-####-####
	Version No.	001

1. **BACKGROUND**

   Description and reference of the source of the requirement and the standard that defines the requirement.

2. **PURPOSE**

   This procedure is being standardized and implemented to achieve the following purposes:

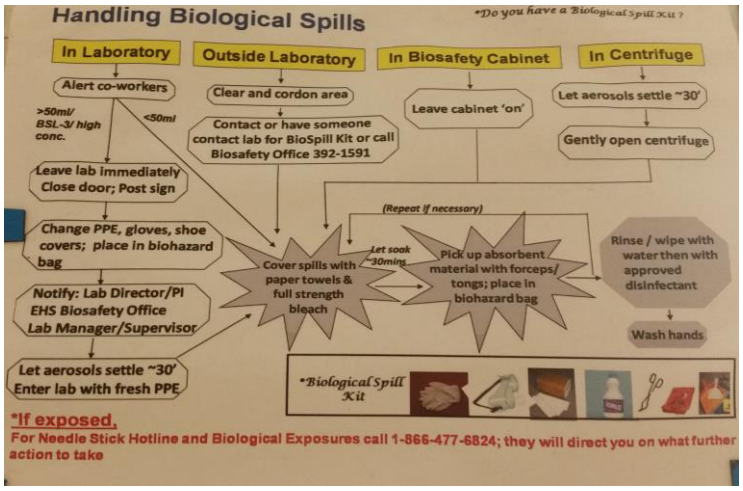
   - bullet item
   - bullet item

3. **APPLICABILITY**

   This procedure is applicable to...

4. **RESPONSIBILITIES**

   - The process owner for this SOP is the [Title or Function].
     Enter description text here...
   - The [Title or Function]. will be responsible for;
     Enter description text here...
   - The [Title or Function]. will be responsible for;
     Enter description text here...
   - The [Title or Function]. will be responsible for;
     Enter description text here...
   - The [Title or Function]. will be responsible for;
     Enter description text here...



LESSON ONE: PROTEOMICS AND PLANT PROTEINS

ESSENTIAL QUESTION (S): HOW CAN PLANTS BE FINGERPRINTED WITHOUT FINGERS?

OVERALL TIME ESTIMATE:

- Advanced Preparation: 45 (15 minutes for copies + 30 minutes to assemble DNA fingerprinting materials
- Student Procedure: 40 minutes

LEARNING STYLES: Visual, auditory, and kinesthetic

VOCABULARY:

Amino Acids: The basic building block of proteins. There are 20 different amino acids that link together to in various orders to form proteins.

DNA Fingerprinting - Thirteen DNA locations, called loci are selected to scan for DNA Sequences that vary from person to person. Data from these regions compromises the DNA profile of that individual.

Proteomics: the study of proteomes, large-scale study of protein structure and function.

Proteins: A molecule composed of amino acids linked together in a particular order specified by a gene's DNA sequence.

Peptide Mass Fingerprinting:

ABBREVIATIONS:
a.a. - Amino acid
D.N.A.- Deoxyribonucleic acid
P.M.F- Peptide Mass Fingerprinting

LESSON SUMMARY: Students will be introduced to related applications of DNA and Protein Analysis by the following:

1. Conduct a human DNA fingerprinting technique.
2. Compare and contrast the two fingerprinting techniques used to identify a human or plant.
3. Ask the Essential Question: HOW CAN PLANTS BE FINGERPRINTED WITHOUT FINGERS?
4. Discover Peptide Mass Fingerprinting (PMF) is no longer leading the way for protein identification, as gene sequencing is emerging into the realm of "System Biology".
5. Inquire about the introduction of protein identification process based on Proteomics.
6. Utilizing a guided inquiry activity based on Dr. Chen's website: moleculardectives.org. Students will begin seed cultivation of Iceplant. Teacher will plan an UF Tour to create student interest and excited of what to come.

7. Prepare for next class using flipped concept: Watch the assigned video for connection to classroom activities in preparation for next class, Quiz,.

STUDENT LEARNING OBJECTIVES:
The student will be able to...
1. Identify subunits of proteins, amino acids.
2. Describe DNA Fingerprinting
3. Utilize the Internet to find information about the structure and function of specific proteins in the development of Proteomics.
4. Explore current biotechnology applications used in "System Biology"

STANDARDS: 01.02.3, 01.03.3, 02.02.3, 03.05, 42.06, 42.07, 42.08

MATERIALS:

- (5-6) Classroom Computers (assign 2 students /computer to ensure academic integrity)
- (2) Pack of 4 * 6 #100 Notecards
- (1) Color of paint
- (20-30) Pickle Jars with Lids, ask kids to bring in for extra credit or assign for HW.
- (30) Leaves from any tree, go outside with kids go outside for 10 min to collect leaves. Teacher extension to discuss why leaves maybe changing color, parts of a leaf, or location and function of stomata.
- Gloves
- Iodine Crystals, look in chemistry storage or ask department head.
- Fume Hood (optional)

BACKGROUND INFORMATION: Since proteins are covered in the Florida Standards across the science curriculum, how can teachers introduce twenty-first century applications of protein Analysis into the classroom? By introducing peptide mass fingerprinting (PMF), students will be introduced to real world scenarios that everyday scientist work with day to day in a Proteomics Facility in discovering products useful to society.

ADVANCE PREPARATION:

1. Print Copies of Lab, Guided Inquiry, and Quiz for next day.
2. Lab Preparation:
   A. (2) Notecards given to student as they enter class.
   B. Students will bring in jars.
   C. Prepare a leaf print section with color paint.
   When Time to Begin Lab:
   C. Teacher will place into jar Iodine Crystals Only, will sublime + Toxic, wear

gloves

PROCEDURE AND DISCUSSION QUESTIONS WITH TIME ESTIMATES:

1. As you hold open the door greeting students hand them the Activity Sheet
2. Ask another student to hand out two 4 * 6 Notecards to each student.
3. Ask students to read over Rotation 1,Rotation 2, and Flipped Assignments while you take attendance.
4. After attendance, have students read aloud rotations and ask for clarity.
5. Ask students, "When do you have a Quiz?" "On what?"
6. Teacher will indicate: Do you have the following materials on your desk?

   A. Pickle Jar w/lid

   B. (2) 4 * 6 Notecards

   C. Collect leaves.

   7. Teacher will indicate: Before we go outside to collect the leaves we will follow Safety Procedures: BT

   A. Set a parameter to collect leaves

   B. No one is to damage trees, just pick one leaf. Do not touch other people's leaves.

   C. If you do not see me then you are not in the right place.

   D. Do not ask to go to the bathroom.

   E. ID's on, please line up at door. Indicate how you want students to move from your classroom to desire location. Assign a leader and an end person in the line with you following.

   F. Quick 10 min. BT: good time to discuss why leaves changing color? Parts of a leaf, locate stomata or stomata function.

8. Back into class then divide students into Rotation 1 and Rotation 2.
9. Rotation 2 is Independent Learning, so no teacher guidance just ensure from time to time students are working and not meandering from computer to computer.
11. Set the classroom timer to 20 min. and select students to give you a 10 and 5 minute cue to complete
10. Teacher Lead, Rotation 1: HOW CAN PLANTS BE FINGERPRINTED WITHOUT FINGERS?
12. Teacher will indicate the objective and discuss DNA Fingerprinting.

    Conduct fingerprints then reflect on the Inquiry Questions, time for prints to develop.

    13. Inquiry Questions: What do you know about DNA?

    Have you seen a DNA Fingerprint? Where? When?

Why is DNA Fingerprinting useful to society?

How is DNA Fingerprinting conducted on humans?

(focus on hands/fingers) How are plants and humans alike? Different?

14. Ask the Essential Question: HOW CAN PLANTS BE FINGERPRINTED WITHOUT FINGERS?

15. Ask students to think about the question then form a hypothesis on how to test plant fingerprinting based on what they just did except no jar is needed.

16. Use the following: (1) Notecard, (1) paint, and (1) leaf.

17. Ask do you know that plant fingerprinting is a real biotechnology technique? Show ppt. with pictures

18. Ask guess what the special abbreviation for plant fingerprinting is? PMF, peptide mass fingerprinting.

20. Rotation 2, Do not forget your flipped assignment for tomorrow's Quiz.

ASSESSMENT SUGGESTIONS:

- Student Lab Conclusion checked for completion and/or accuracy.
- Lab Reflection, Question and Answers.
- Flipped Assignment
- Quiz assigned to begin next class.

EXTENSIONS:

Biology Junction Color Activities: http://biologyjunction.com/biology_coloring_worksheets.htm

Find Out Why Leaves Change Color:
http://www.education.com/activity/article/Leaves_Change_fifth/

NOVA, Create a DNA Fingerprint:
http://www.pbs.org/wgbh/nova/education/body/create-dna-fingerprint.html

RESOURCES/REFERENCES:

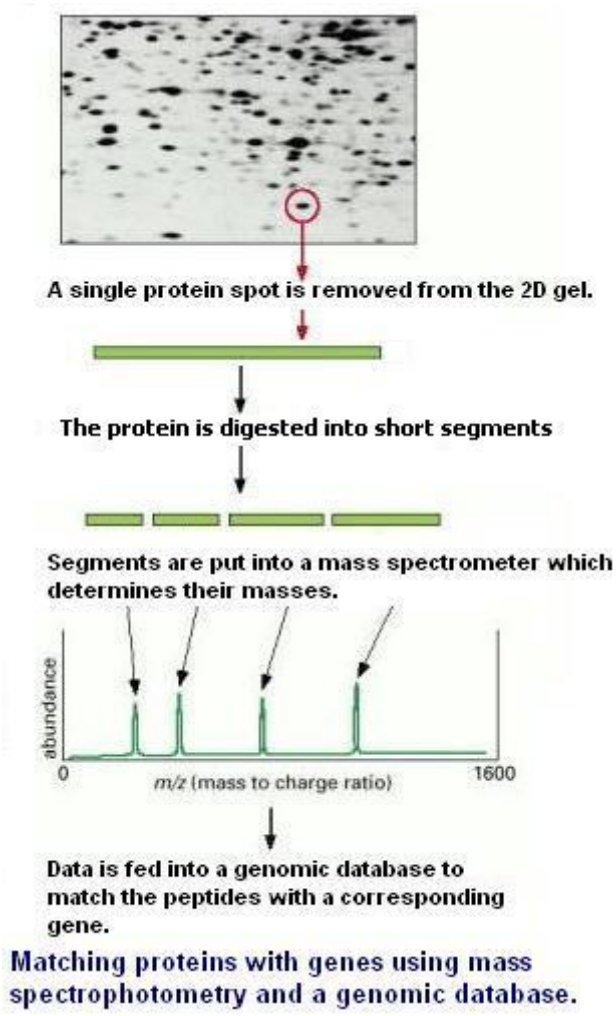
- Background information: Molecular Detectives http://www.moleculardetective.org

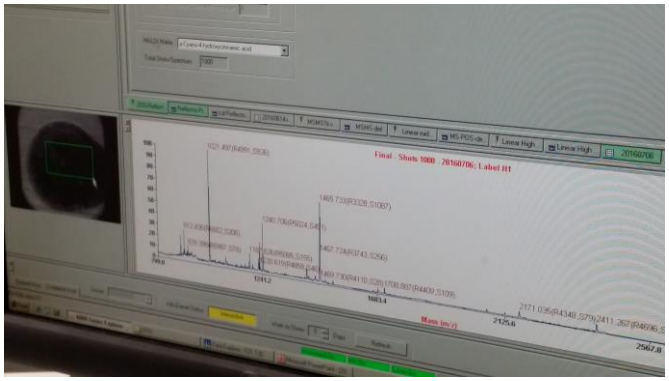
- Background information: Proteomics, System Biology
http://www.learner.org/courses/biology/textbook/proteo/index.html

TEACHER PAGES: PROTEIN IDENTIFICATION

Teachers will want to visit the indicated websites to grasp some background information on the introduction of Protein Identification.

Protein Identification Diagram: After Plant Material is extracted and a Colorimetric Assay (Spectrophotometer) is performed.





The above image taken by Mrs. Santiago from Summer Research Experience 2016 is a real world example of a peptide mass fingerprinting (PMF) data collected from extracted plants in Dr. Chen Lab. Each peak is an isolated peptide that gives specific numerical readings. Values over 1200 are favorable the wide peaks on either side are the average mass isotopes.

Introduction to Protein Identification
Quiz-Proteomics and Proteins-Santiago

Student Name: _____Date: _____

1. Proteins are made up of subunits called?
   _____
2. Amino Acids are bonded by the removal of water (condensation reaction) and form a bond called a _____ bond.
3. Why are proteins essential to life? _____
   _____
4. What does Dr. Chen study? _____ a scientific field called: _____.
5. Name one technology application used in protein identification:
   _____
6. What do you know or remember about the operations of the machine or procedure?
   _____

Introduction to Protein Identification
Quiz-Proteomics and Proteins-Santiago

Student Name: _____Date: _____

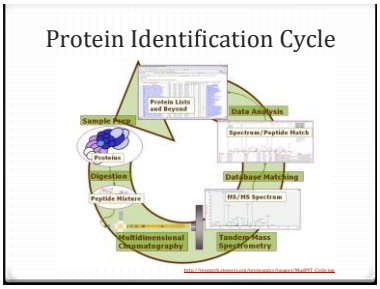
1. Proteins are made up of subunits called?
   _____
2. Amino Acids are bonded by the removal of water (condensation reaction) and form a bond called a _____ bond.
3. Why are proteins essential to life? _____
   _____
4. What does Dr. Chen study? _____ a scientific field called: _____.
5. Name one technology application used in protein identification:
   _____
6. What do you know or remember about the operations of the machine or procedure_____

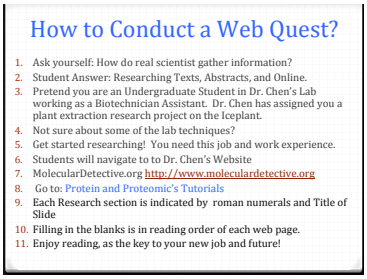
TEACHER PAGES - QUIZ ANSWER KEY: PROTEIN IDENTIFICATION

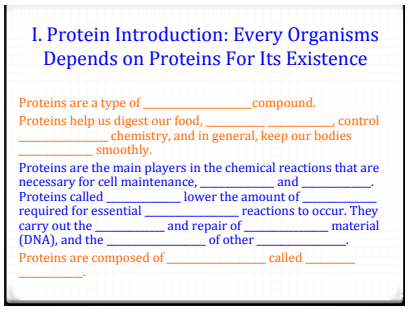
Proteomics and Proteins:

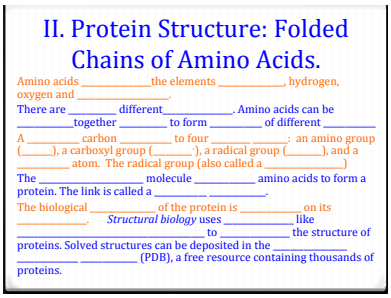
1. Amino Acids
2. Peptide bond
3. Proteins are essential to life because they are: (Any one of the below are correct)
   The building blocks of bones, cartilage, ligaments, skin, blood, and hair.
   Regulate growth, development, and immunity.
   Body's response to environmental stimuli.
4. Proteomes, Proteomics.
5. Mass spectrometer, SDS PAGE, MALDI TOP, PMF.
6. Mass spectrometer (concentration by light absorption), SDS PAGE (protein fragmentation), MALDI (Separate peptides by charge) TOP (separates peptides by size), PMF.

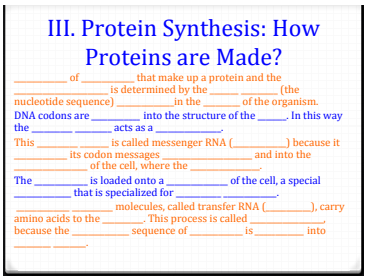
Web Quest: MolecularDetective.org











IV. Proteomics: What is Proteome? What is Proteomics?

The _____ is the entire _____ of _____, including the _____ made to some of them, _____ by an _____ at _____.

_____ _____ is all the proteins found in a _____ cell type under a _____.

_____ is the _____ study of _____, particularly their _____ _____ _____.

Proteome _____ from _____ __ _____, over _____ and with _____ conditions.

GeneBio has molecular scanners to _____ the process of _____ and _____ of thousands of ____ _____, uses automation to remove protein spots, cut proteins into _____ with _____, and then _____ the _____ in a _____ _____, which plots the pieces by their _____ (_____).

V. Isolating Proteins: The First Step Toward Identification.

In order to _____ proteins _____ of a living _____, _____ or _____, first be _____ away from _____ cell _____.

_____ of proteins from plant _____ begins by gently _____the _____ and _____ so that their contents are _____ into a specific _____.

_____ who study _____ usually do this with a _____ technique called _____ _____ _____ _____.

The _____ step is _____ _____. A special _____is added to _____ the _____. _____ on the basis of their _____ _____ (their *isoelectric point*). An _____ _____ is applied. Over time, _____with the current but _____ at _____ in the_____.

_____ step the proteins are _____ on the _____, by using a technique called *sodium dodecyl sulfate polyacrylamide-gel electrophoresis* (_____).

VI. Identifying Proteins: Mass Spectrometer

_____ protein _____ and _____, proteins are _____(their internal bonds are cut) by a _____enzyme. The _____ is a solution of _____ _____ derived from a _____protein.

_____ _____of the _____ peptides can be determined by a _____ _____.

One _____ of mass spectrometer, _____, can produce _____ _____ _____. (MALDI-TOF stands for _____).

The _____ of the _____ in the _____ is usually _____ to the _____, just like our _____ fingerprints are _____ to each _____ person.

The protein _____ can be used to _____ a protein _____ that contains all the _____.

_____, developed in the early _____, is called **peptide mass fingerprinting** (_____ _____).

VII. PMF Technology: How Does a Mass Spectrometer Determine The Mass of a Molecule?

In a _____ mass spectrometer, _____ from a laser _____ proteins (_____) that are _____ onto a _____. An _____ field _____ the molecules toward the _____. The _____ it takes for each molecule to reach the detector is _____ to the _____ (m/z) of the _____. In this type of _____, each molecule usually only takes one charge, therefore the _____ to the _____ is _____ to the _____ of the _____.

I. Answers: Protein Intro.

Proteins are a type of **organic** compound - large and complex collections of molecules. Proteins help us digest our food, fight infections, control body chemistry, and in general, keep our bodies functioning smoothly.

Proteins are the main players in the chemical reactions that are necessary for cell maintenance, growth and development. Those proteins called enzymes lower the amount of energy that is required for essential chemical reactions to occur. They also carry out the replication and repair of genetic material (DNA), and the synthesis of other proteins.

Proteins are composed of units called amino acids.

II. Answers: Protein Structure

Amino acids contain the elements carbon, hydrogen, oxygen and nitrogen.

There are 20 different amino acids. Amino acids can be linked together differently to form thousands of different proteins.

A central carbon bonded to four main groups: an amino group (-NH_3^+), a carboxyl group (-COO^-), a radical group (-R), and a hydrogen atom. The radical group (also called a side chain)

The removal of a water molecule links amino acids to form a protein. The link is called a peptide bond.

The biological function of the protein is dependent on its shape.

Structural biology uses techniques like X-ray crystallography or NMR spectroscopy to determine the structure of proteins. Solved structures can be deposited in the Protein Data Bank (PDB), a free resource containing thousands of proteins.

III. Answers: Protein Synthesis

Sequence of amino acids that make up a protein and the number that is linked together is determined by the genetic code (the nucleotide sequence) contained in the DNA of the organism.

DNA codons are *transcribed* into the structure of the RNA. In this way the genetic code acts as a blueprint.

This special RNA is called messenger RNA (mRNA) because it carries its codon messages out of the nucleus and into the cytoplasm of the cell, where the protein is made.

The mRNA is loaded onto a ribosome of the cell, a special organelle that is specialized for protein production. Other RNA molecules, called transfer RNA (tRNA), carry amino acids to the site. This process is called translation, because the mRNA sequence of codons is *translated* into amino acids.

IV. Answers: Proteomics

The *proteome* is the **entire** complement of proteins, including the modifications made to some of them, produced by an organism at any particular time.

cellular proteome is all the proteins found in a specific cell type under a particular set of environmental conditions.

Proteomics is the large-scale study of proteins, particularly their structure and functions.

proteome differs - from cell to cell, over time and with environmental conditions.

GeneBio has molecular scanners to automate the process of separation and identification of thousands of cell proteins, uses automation to remove protein spots, cut proteins into fragments with enzymes, and then maps the fragments in a mass spectrometer, which plots the pieces by their mass (a protein fingerprint).

V. Answers: Isolating Proteins

In order to analyze proteins outside of a living plant, animal or microbe, they must first be purified away from other cell contents.

Extraction of proteins from plant tissue begins by gently grinding the tissue and breaking the cell membranes so that their contents are released into a specific solution.

Scientists who study proteomics usually do this with a two-step technique called *two dimensional gel electrophoresis.*

The first step is *isoelectric focusing*. A special detergent is added to release the tangle of protein chains. Separated on the basis of their natural charge (their *isoelectric point*). An electric current is applied. Over time, proteins move with the current but stop at different places in the gel. Second step the proteins are separated on the basis of size, by using a technique called *sodium dodecyl sulfate polyacrylamide-gel electrophoresis* (SDS-PAGE).

VI. Answers: Protein Isolation

After protein separation and fractionation, proteins are digested (their internal bonds are cut) by a specific enzyme. The result is a solution of many peptides derived from a single protein.

The molecular weight of the individual peptides can be determined by a **mass spectrometer**.

One type of mass spectrometer, MALDI-TOF, can produce peptide mass fingerprints. (MALDI-TOF stands for "matrix-assisted-laser-desorption/ionization-time-of-flight).

The pattern of the peptides in the fingerprint is usually unique to the protein, just like our human fingerprints are unique to each individual person.

The protein fingerprint can be used to search a protein database that contains all the protein sequences in a particular organism.

Technology, developed in the early 1990s, is called **peptide mass fingerprinting** (abbreviated **PMF**).

VII. Answers: PMF Technology

In a laser-desorption mass spectrometer, pulses of light from a laser ionize proteins (or peptides) that are absorbed onto a metal target. An electric field accelerates the molecules toward the detector. The time it takes for each molecule to reach the detector is inversely proportional to the mass-to-charge ratio (m/z) of the molecule. In this type of ionization, each molecule usually only takes one charge, therefore the time to the detector is inversely proportional to the mass of the molecule.

STUDENT PAGES-LAB: EXPLORING DNA FINGERPRINTING, HOW ARE PLANTS FINGERPRINTED WITH NO FINGERS?

Student Name: _____ Date: _____

Lab Partner: _____

Student Directions: Students will conduct two Rotations with an aligned Flipped Activity that students will be quizzed on beginning of next class, so STUDY! STAY ON TASK! THEN LEARNING IS FUN!

Rotation 1: Teacher Guided Lab - Exploring DNA Fingerprinting, HOW CAN PLANTS BE FINGERPRINTED WITH NO FINGERS?

Rotation 2: Computer Station 2 students per computer, Molecular Detectives, WebQuest Q+A. http://www.moleculardetective.org

What Do I Do NOW?
1. Upon Completion of Rotations Students will complete student reflection Q+A (1-5)
2. Begin Flipped Activity with out the teacher telling students to move forward.

What DO I NEED TO STUDY? Quiz beginning of next class.
Flipped Activity: Completion of Student Reflection for beginning next class, Proteins and Proteomics Video:
http://www.learner.org/courses/biology/textbook/proteo/index.html

Rotation 1: Exploratory Activity

Essential Question (EQ): HOW CAN PLANTS BE FINGERPRINTED WITHOUT FINGERS?

Background Investigation: What is Peptide Mass Fingerprinting (PMF)?
ZooMS: Species identification of parchment using peptide mass finger printing:
https://www.youtube.com/watch?v=xBAXaLvGe5I

Objectives: What does the student need to be able to do?

- Identify subunits of proteins, amino acids.
- Describe DNA Fingerprinting.
- Conduct a human DNA fingerprinting technique.
- Compare and contrast the two fingerprinting techniques used to identify a human or plant.
- Explore the Essential Question: HOW CAN PLANTS BE FINGERPRINTED WITH NO FINGERS?
- Analyze energy transfer based on state phase changes of energy gain, sublimation of a solid to a gas.

How to write a hypothesis?

(Teacher Example): If milk is left out then milk will spoil because the proteins will denature)

Create a hypothesis after performing human DNA Fingerprinting and teacher led inquiry questions based on EQ, before trying

Hypothesis for Plant Fingerprinting:

_____

_____

SAFETY: Please wear goggles, apron, and gloves

****TEACHER WILL PLACE IODINE IN JARS (Fume Hood), NO EXCEPTION.

VOCABULARY:

Amino Acids:

DNA Fingerprinting:

Proteomics:
Proteins:
Peptide Mass Fingerprinting:

ABBREVIATIONS:
a.a. -
D.N.A.-
P.M.F-
(s):
(g):

Materials:

* (1) 6 * 4 Index card
* (1) Hand lens or microscope.

* Iodine crystals in a closed jar
* Fume hood
* Gloves
* (1) Pickle jar with lid
* Paint, any color may want washable.
* Collected leaf

Procedure:

1. Place several latent prints an index card.
2. One card per group.
3. While under the fume hood and wearing gloves.
4. Place the strip into a small jar containing iodine crystals.
5. Do not breathe the vapors! Quickly close the lid, why?
6. Ask yourself, what state phase change goes from (s) to (g)?
7. Google: sublimation _____
   _____.
8. Allow the print to develop for 5 – 10 minutes.
9. Begin Teacher Inquiry Notes.
10. Discuss the EQ with teacher with Inquiry Questions
11. To remove student fingerprints.
12. Use forceps to remove the paper from the jar.
13. Iodine sublimes and will quickly leave the paper. (Starch spray can be used to help save the print.)
14. Using the hand lens or microscope, analyze your DNA Fingerprint, wearing gloves.

    _____
15. Analyze your lab partner prints, what did you discover?

    _____
16. Review your teacher discussion notes.
17. Now create a hypothesis for fingerprinting your leaf.

18. Write in the hypothesis section.
19. Now create a protocol to fingerprint the leaf with paint.
20. Perform your protocol.
21. Using the hand lens or microscope, analyze your DNA Fingerprint, wearing gloves.

    _____

22. Analyze your lab partner prints, what did you discover?
23. _____
24. Reflect on what you observed or discovered in the conclusion section.

Conclusion: Students will need to collaborate with lab partner in writing out complete sentences to answers for full credit.

Student Reflection Questions and Answers:

1. During your investigation in comparing your DNA Fingerprint and the plant Fingerprint with paint. Even though both processes apply the word fingerprint how are the outcomes different in comparing both samples, as a class? Can a plant be fingerprinted with a leaf print? Why or Why not?

   _____

   _____

   _____

   _____

   _____

   _____

2. Define DNA Fingerprinting:

   _____

   _____

3. Define Peptide Mass Fingerprint (PMF):

   _____

   _____

4. How did you apply your previous knowledge of DNA to both rotations?

   _____

5. What did you learn new about proteins during the rotations?

STUDY AND COMPLETE FLIPPED ACTIVITY FOR
QUIZ PREPARATION NEXT CLASS.

HAVE A GREAT DAY!

LESSON TWO: BIOTECHNOLOGY PROTOCOLS WORKING WITH SEEDS

2A: Seed Morphology and Dissection from Ellyn Daugherty, Lab 10b, pgs. 190-191

Essential Question, (EQ): What Do Scientist Need to Know About Seeds to Conduct Plant Cell Model Research?

Inquiry Extensions:
A. What carbohydrate structures in seeds ensure survival?
B. What Inferences can be made as to the function or seed structures, as you become a plant specialist?

OVERALL TIME ESTIMATE:

- Advanced Preparation: 30 minutes
- Student Procedure: 30 minutes

LEARNING STYLES: Visual, auditory, and kinesthetic.

VOCABULARY:

Arabidopsis - A genus of flowering plants found in north temperate regions. The species *A. thaliana* is used for experiments in classical plant genetics as well as molecular genetic studies in plant physiology, biochemistry, and development.

***Aptenia cordifolia*:** a perennial evergreen herb with small, simple, heart-shaped, dark green succulent leaves. The moderately thick, succulent stems are flexible and easily snapped. They appear to crawl along the soil and hug the ground forming a tight, almost clipped appearance. Plants grow no taller than about 3 to 4 inches.

Cotyledon: The primary or rudimentary leaf of the embryo of seed plants.

Endosperm: Tissue that surrounds and nourishes the embryo in the angiosperm seed.

Embryo (plant): The earliest stage of development in an animal or plant. An embryo begins to form following the fusion of egg and sperm (a zygote).

Germination: The process by which a seedling emerges and develops from a seed, or by which a sporeling emerges and develops from a spore.

Radicle: The end of a plant embryo which gives rise to the first root.

Seed: A structure produced by seed plants that encapsulates the embryo. The seed often provides nourishment during germination, but may lie dormant for many years first.

LESSON SUMMARY: Since proteins are manufactured as an environmental stimuli placed on cells, then proteins within a cell will also change as a response mechanism. What if the protein changes could tell society something about metabolic, bacterial, viral, or cancer diseases transmission or suppression? Thus scientists began experimenting with plant extraction and analysis, as a small-scale scientific model. In lesson two, students will be exploring lab protocols developed in biotechnology laboratories for germinating seeds for the purpose of plant protein identification, as students emulate biotechnology technicians

STUDENT LEARNING OBJECTIVES:

The student will be able to...

1. Describe how scientists to explain observations of nature use models.

2. Maintain thorough documentation of tasks and procedures

3. Utilize appropriate tools strategically.

4. Conduct short as well as more sustained research projects to answer a question (including a self-generated question) or solve a problem; narrow or broaden the inquiry when appropriate; synthesize multiple sources on the subject, demonstrating understanding of the subject under investigation.

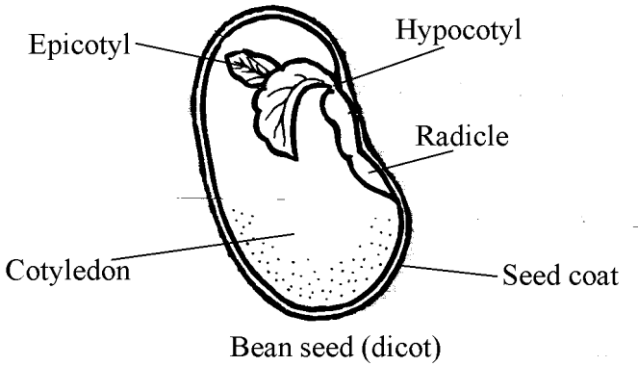
STANDARDS: SC.912.N.3.5, 03.05, 02.03.1, (H Chem. I /C.C.) 40.03 (Biotech II)

MATERIALS:

- Magnifying hand lens or Microscope
- Forceps-fine tip preferred
- Scalpel handle with blade
- Metric ruler, clear
- Tabletop balance (mg)
- Weigh paper
- Various seeds: peanut, bean, (dicots preferred, since studied plants are dicots)

BACKGROUND INFORMATION:

Seeds are the result of reproduction passing down genetic information from parent to offspring. The seed is essential for the plant to



Bean seed (dicot)

germinate, grow, and develop into a plant. Because the seed carries a "baby" plant called an embryo. Just, as your Mother carried you in her uterus during early development, as an embryo. Your mother's role was to protected and nourished you. The role of the seed is the same in plants to protect and nourish the embryo until established as a seedling. Anatomically, the seed is constructed for the purpose of ensuring that the embryo survives until growth occurs above ground and photosynthesize. Surrounding the embryo is a food source called the endosperm. The endosperm is packed in a leaf-like structure called the cotyledon. The plants we are studying will have two cotyledons. Therefore the plants will both be classified as dicots.

The endosperm in each cotyledon contains protein, sugar, starch, and fat molecules, macromolecules. One main reason why other organisms eat seeds,

since each plant grows in a unique environment, a seed size, shape, and structure are a consequence of evolution. Plant species with seeds that function best in their environment survive until reproductive age and pass on "good-seed genes" to the next generation. The large diversity of seed types is due to the "selection pressure" from each unique environment. As a model organism in the realm of biotechnology lab applications, scientists will expose plants to various "selective pressures". Over a period of time, technicians will record observations of the plant responses to the environmental changes. How do the environmental changes affect both genetics and protein production, thus possibly influencing genotypic changes seen in the plant shape, color, or metabolic pathway, (photosynthesis). As you become a plant specialist, what special seed characteristics are revealed to you, "the life of seeds".

ADVANCE PREPARATION:

1. Copy Student Labs and Quiz
2. Obtain lab materials

3. Purchase beans (dicot) and corn (monocot)

PROCEDURE AND DISCUSSION QUESTIONS WITH TIME ESTIMATES:

1. Set out Materials at student lab stations or selected area for dispersal
2. Create student interest by posing the Essential Question and then reviewing the Video:
3. Ask the students to refer to the Inquiry Questions while conducting the lab.
4. Have student read aloud the Background, Materials, and Procedure.
5. Discuss Safety with blades.
6. Discuss clean up, 10 minutes before bell rings allows you and student time for next class.
7. During the lab walk around to assist with tools and ask to identify the cotyledon.

ASSESSMENT SUGGESTIONS:

- Use the diagrams on background to verbal assess if students can identify seeds parts on bean.
- Relate Endosperm to macromolecules.
- Compare/Contrast Monocot and Dicot seeds.
- Completion of table: Anatomical Differences in Seeds.
- Teacher created Quiz.

EXTENSIONS:

- Seed Dissection can be converted into a teacher demo if time is an issue.
- Biodiesel Energy 101 | Biofuels https://search.yahoo.com/search;_ylc=X3oDMTFiN25laTRvBF9TAzIwMjM1MzgwNzUEaXRjAzEEc2VjA3NyY2hfcWEEc2xrA3NyY2h3ZWI-?p=Biodiesel+video&fr=yfp-t-728%2CE829075%2C332&fp=1&toggle=1&cop=mss&ei=UTF-8
- Plant Biology: Root hairs, surface area, water, and transpiration (water transport from roots to leaves, Capillary Action)
- Properties of Water: cohesion, adhesion, hydrogen bonding, polarity, and capillary action
- Compound Light Microscopes, animated biology, Ch. 1 Cells Through Different Microscopes.
- Biotechnology applications and careers

ACTIVITIES:

- Teacher Demo: Lab 2A
- Parts of Microscope or Flowering Plants ColorActivity:**http://biologyjunction.com/biology_coloring_worksheets.htm**
- **Transpiration: How Much Water Does a Tree Transpire in One Day? https://www.ucar.edu/learn/1_4_2_18t.htm**
- Agricultural biotechnology **http://www.biotech-careers.org/job-areas/agricultural-biotechnology**

RESOURCES/REFERENCES:

- "Biotechnology Laboratory Manual", Ellyn Daugherty. 2012.
- Energy 101 | Biofuels https://search.yahoo.com/search;_ylc=X3oDMTFiN25laTRvBF9TAzIwMjM1MzgwNzUEaXRjAzEEc2VjA3NyY2hfcWEEc2xrA3NyY2h3ZWI-?p=Biodiesel+video&fr=yfp-t-728%2CE829075%2C332&fp=1&toggle=1&cop=mss&ei=UTF-8
- Parts of Microscope or Flowering Plants Color Activity:**http://biologyjunction.com/biology_coloring_worksheets.htm**
- Bean picture: http://garden.org/onlinecourse/Diagrams/c1/c1-1seed.gif

- Biology Terms: http://www.ucmp.berkeley.edu/glossary/glossary_S.html
- Seed Germination picture: http://study.com/cimages/multimages/16/photoseedgerminationhighquality.png
-

TEACHER PAGES - BIOTECHNOLOGY PROTOCOLS: WORKING WITH SEEDS, SEED MORPHOLOGY AND DISSECTION

Teacher will be able to implement "Seed Morphology and Dissection", as a teacher demo to assist with time management of curriculum schedule. The lesson activities aligned will be used to ensure NGSSS are addressed while agricultural biotechnology techniques are utilized in lab protocol.

BT: Teachers will be able to teach across the science curriculum by incorporating both science standards of Biology and Chemistry properties of water (chemical properties) to plant structure and function. Biology will teach properties of water in the beginning of the year then plants at the end, why not teach application not just content. Chemistry teachers will be able to have a real way for students to see properties of water in action, not just an abstract thought.

Chemistry teachers: great way to bring the chemical properties of water into real application to understand why water is the "Universal Solvent" by the application of transpiration leading into your standards: SC.912.P.10.2 Conservation of Energy Cyclic process: (photosynthesis forward rx. As Cellular Respiration is the reverse rx.)

Then mesh content with real world application of how society uses plants and why would student be interested in pursuing a job in Agricultural Biotechnology.

Teacher will be able to use the below teaching strategies to increase content learning for students while maintaining high student engagement. Activities will be best used if stretched out through lessons 2-4 based on teacher's learning goals.

1. Student Quiz: Teacher created.

2. Vocabulary Matching Game:

A. Table 1: SEED STRUCTURE AND FUNCTION

B. Table 2: PROPERTIES OF WATER

2. Video Cloze passage: Energy 101 | Biofuels

3. Connected lab web page contains information: Transpiration: How Much Water Does a Tree Transpire in One Day? https://www.ucar.edu/learn/1_4_2_18t.htm

4. Biotechnology Career Poster: Rubric included.
Agricultural biotechnology

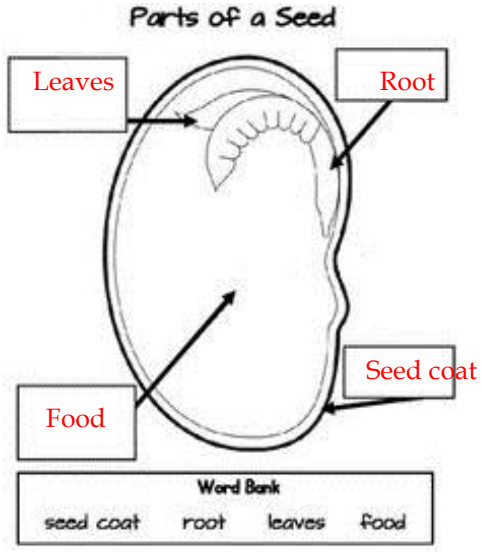
http://www.biotech-careers.org/job-areas/agricultural-biotechnology

TEACHER PAGES - QUIZ ANSWERS: BIOTECHNOLOGY PROTOCOLS WORKING WITH SEEDS, SEED MORPHOLOGY AND DISSECTION

Biotechnology Protocols Working With Seeds
Quiz-Seed Morphology and Dissection-Santiago

Student Name: _____Date: _____

A. Using the given terms, label the seed's parts. (4pts)



B. Complete the below sentence by *filling in* the correct term, *Not all words will be used*.

Arabidopsis thaliana	***Seed***	***Germination***
Radicle	***Embryo***	***Cotyledon***
Endosperm		

1. At the end of the embryo stage, the Radicle gives rise to the first root.

2. ***Arabidopsis thaliana*** is used for experiments in classical plant genetics as well as molecular genetic studies in plant physiology, biochemistry, and development.

3. The earliest stage of development in an animal or plant. An ***Embryo*** begins to form following the fusion of egg and sperm (a zygote).

4. The angiosperm seed will be protected and nourished by the Endosperm.

5. A process called ***Germination*** by which a seedling emerges and develops from a seed.

6. Primary structure encapsulating the embryo. A Seed may lie dormant for many years.

TEACHER PAGES-VOCABULARY MATCHING GAME: BIOTECHNOLOGY PROTOCOLS WORKING WITH SEEDS, SEED MORPHOLOGY AND DISSECTION

Objective: Students to use word manipulative in matching vocabulary terms to definitions to assist in content vocabulary, as a bell-ringer or quiz review.

1. Print out table (1) per 2 students.
2. Laminate to preserve.
3. Cut out.
4. Insert into envelope or sandwich zip lock bag to be used over and over again

TABLE 1: SEED STRUCTURE AND FUNCTION

Term	Definition
Arabidopsis	Used for experiments in classical plant genetics as well as molecular genetic studies in plant physiology, biochemistry, and development.
Mesembryanthemum crystallium L	The ice plant is a little-known vegetable of the southern hemisphere. Ice plant is named after the shimmering silvery dots that cover the leaves. All green parts of the plant are covered with small, transparent, membranous bladders.
Cotyledon	The primary or rudimentary leaf of the embryo of seed plants.
Endosperm	Tissue that surrounds and nourishes the embryo in the angiosperm seed.
Radicle	The end of a plant embryo which gives rise to the first root.
Seed	A structure produced by seed plants that encapsulates the embryo. The seed often provides nourishment during

	germination, but may lie dormant for many years first.
Germination	The process by which a seedling emerges and develops from a seed, or by which a sporeling emerges and develops from a spore.
Embryo	The earliest stage of development in an animal or plant. An embryo begins to form following the fusion of egg and sperm (a zygote).

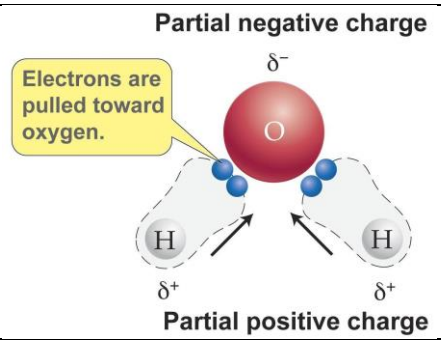
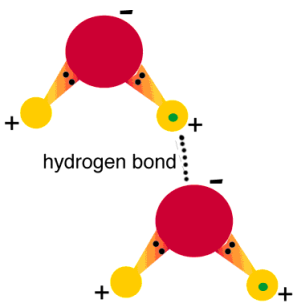
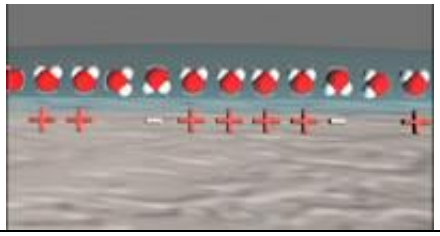
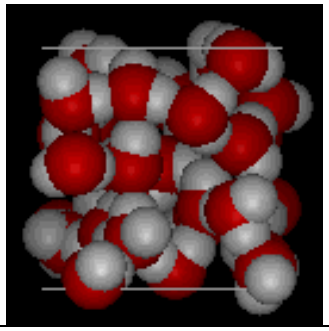
TEACHER PAGES-VOCABULARY MATCHING GAME: BIOTECHNOLOGY PROTOCOLS WORKING WITH SEEDS, PROPERTIES OF WATER.

Objective: Students to use word manipulative in matching vocabulary terms to definitions to assist in content vocabulary, as a bell-ringer or quiz review.

1. Print out table (1) per 2 students.
2. Laminate to preserve.
3. Cut out.
4. Insert into envelope or sandwich zip lock bag to be used over and over again

TABLE 2: PROPERTIES OF WATER

Term	**Definition**
Chemical Structure	
Molecular Formula	H_2O

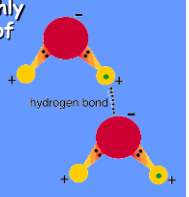
Polarity	
Hydrogen Bonding	
Adhesion	
Cohesion	

Capillary Action	
Surface Tension	

TEACHER PAGES-PPT NOTES: PROPERTIES OF WATER.

Hydrogen Bonds Exist Between Water Molecules

- Formed between a highly **Electronegative atom** of a polar molecule and a **Hydrogen**
- **One** hydrogen bond is **weak** , but **many** hydrogen bonds are **strong**

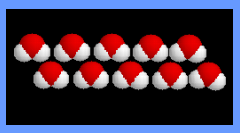


Adhesion

- **Attraction between two different substances**.
- Water will make **hydrogen bonds with other surfaces** such as glass, soil, plant tissues, and cotton.
- **Capillary action**-water molecules will "tow" each other along when in a thin glass tube.
- Example: **transpiration** process which plants and trees remove water from the soil, and paper towels soak up water.

Water

- A water molecule (H_2O), is made up of three atoms --- one oxygen and two hydrogen.



Water is Polar

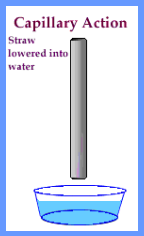
- In each water molecule, the oxygen atom attracts more than its "fair share" of electrons
- The oxygen end "acts" negative
- The hydrogen end "acts" positive
- Causes the water to be POLAR
- However, Water is neutral (equal number of e- and p+) --- Zero Net Charge

Cohesion …

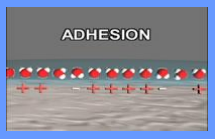
Helps insects walk across water

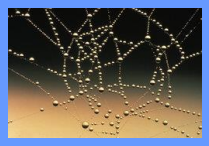
Adhesion Causes Capillary Action

Which gives water the ability to "climb" structures



Adhesion Also Causes Water to …





Form spheres & hold onto plant leaves

Attach to a silken spider web

TEACHER PAGES- ENERGY 101,

VIDEO CLOZE PASSAGE: BIODIESEL.

Cloze Answers:

The original diesel engine named after inventor Rudolf Diesel actually ran on vegetable oil changes in the design of diesel engines over the years required a different fuel with more energy output and lest jelling in colder weather than vegetable oil hence petroleum based diesel gained popularity over oil. The number one environmental concern about diesel fuel is it emits harmful pollutants into the air. Biodiesel is a replacement fuel for diesel engines made out of animal fats or vegetable oil. The advantage is biodiesel fuel is not derived from fossil fuels, as they can be made from local crops. Biodiesel lowers greenhouse gas emissions and the production is safe and of biodiesel generates a domestic fuel economy. The University of Idaho was one of the pioneers of biodiesel research having over thirty years experience working with biodiesel fuel. At the University of Idaho biodiesel education program farm scale production facility we make biodiesel from a variety of feedstock. Most of the time biodiesel is made from waste vegetable oil gathered from the kitchens of the University or extract the oil ourselves with their seed oil press.

List the "small" batch recipe narrated by: Production Specialist, Mr. Joe Thompson.

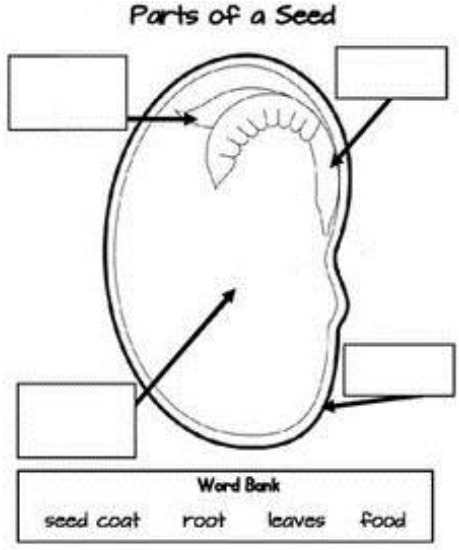
1. Remove impurities from fat or oil.
2. Change Viscosity to decrease clogging fuel line.
3. Chemical rx. Transesterification.
4. Oil + Alcohol+ Catalyst
5. Add certain amount of alcohol to catalyst
6. Add alcohol+catalyst solution to feed stock
7. Heat and Agitate for short time
8. Heterogeneous solution: Glycerin (cloudy)+ Biodiesel (clear).
9. Remove Glycerin by draining from bottom of seperatory funnel.
10. Wash process to remove contaminants.
11. Glycerin, coproduct may be used for other products like soap.
12. Two step process, repeat
13. Use fats or oils with low free fatty acid content, FFA.
14. Methanol + Sodium Methylate (catalyst).
15. Dry wash Method: Ion Exchange Wash.

STUDENT PAGES - QUIZ: BIOTECHNOLOGY PROTOCOLS WORKING WITH SEEDS, SEED MORPHOLOGY AND DISSECTION

Biotechnology Protocols Working With Seeds
Quiz-Seed Morphology and Dissection-Santiago

Student Name: _____Date: _____

A. Using the given terms, please label the seed. (4pts)



B. Complete the below sentence by *filling in* the correct term, *Not all words will be used*.

Arabidopsis thaliana	***Seed***	***Germination***
Radicle	***Embryo***	***Cotyledon***
Endosperm		

1. At the end of the embryo stage, the _____ gives rise to the first root.
2. _____ is used for experiments in classical plant genetics as well as molecular genetic studies in plant physiology, biochemistry, and development.
3. The earliest stage of development in an animal or plant. An _____ begins to form following the fusion of egg and sperm (a zygote).
4. The angiosperm seed will be protected and nourished by the _____.
5. A process called _____ by which a seedling emerges and develops from a seed.
6. Primary structure encapsulating the embryo. A _____ may lie dormant for many years.

STUDENT PAGES - CLOZE PASSAGE: ENERGY 101, BIODIESEL

Student Name: _____ Date: _____

Classwork: Video Cloze passage: Energy 101 | Biofuels

Objective(s): What do I need to know?
1. Identify plant material and chemicals used in making biodiesel
2. Discuss why biodiesel will be cost beneficial for both domestic and environmental economics for the United States.
3. Explain how Universities assist with new applications in perfecting biodiesel production.
4. Synthesize the process of biodiesel from feedstock to production.

Student Directions:
1. Watch Video "How We Make Biodiesel"

2. As you watch video complete sentences.
3. Try to practice listening and writing a college preparatory skill.

The original _____engine named after inventor Rudolf Diesel. Actually ran on _____ oil changes in the design of diesel engines over the years required a _____ fuel with _____ energy _____and lest jelling in _____weather than vegetable oil. Hence _____ based diesel _____ popularity over oil. The number one _____concern about diesel fuel is it _____ harmful _____ into the _____. Biodiesel is a _____ fuel for _____ engines made out of _____ fats or _____ oil. The _____ is biodiesel fuel is _____ derived from _____ fuels, as they can be _____ from local _____. Biodiesel _____ greenhouse gas _____ and the production and safe of biodiesel _____ a domestic fuel _____. The University of _____ was one of the _____ of biodiesel _____ having over _____ years experience working with biodiesel fuel. At the University of Idaho biodiesel education program farm scale _____ facility we make biodiesel _____ a variety of _____. Most of the time biodiesel is made from _____ vegetable oil gathered from the _____ of the University or _____ the oil ourselves with their _____ _____ _____.

Fill in the blanks to the "small" batch recipe narrated by: Production Specialist, Mr. Joe Thompson.

1. Remove _____ from fat or oil.
2. Change _____ to _____ clogging fuel line.
3. Chemical rx. _____.
4. Oil + Alcohol+ _____
5. Add certain amount of alcohol to catalyst
6. Add _____+catalyst solution to feed stock
7. Heat and _____ for short time
8. _____ solution: Glycerin (cloudy)+ Biodiesel (clear).
9. _____ Glycerin by draining from bottom of separatory funnel.
10. Wash process to remove _____.
11. Glycerin, _____ may be used for other products like _____.
12. _____ step process, repeat
13. Use fats or oils with low _____ _____ _____ content, FFA.
14. Methanol + _____ _____(catalyst).
15. Dry wash Method: _____ Exchange Wash.

STUDENT PAGES - BIOTECHNOLOGY CAREER RUBRIC: AGRICULTURE BIOTECHNOLOGY.

Student Name: _____ Date Given: _____ Date Due: _____

Quarterly Alternative Assessment: 50 pts.

Topic: Agricultural biotechnology
Website: http://www.biotech-careers.org/job-areas/agricultural-biotechnology
Format, Technology Implementation: Student may choose to use Publisher, ppt, or Word. No Hand Created Formats (-10pts.)
Images or Graphics: Non-copyrighted, reference website, and hand drawn only for the artistically inclined student. Please do not attempt to draw if you have no art schooling.
Academic Integrity: All Assessments are individual projects, NO GROUP PROJECTS = Zero.
Late Projects: Grading will start at 90%. Employees that grow with a company are punctual.

Students will be assessed based on the Rubric

Areas of Assessment	What should students illustrate?	Possible Points	Points Earned
Title	Large, Visible, Neat, and Creative. How will you attract	**8**	

	your audience?		
What is Agricultural Biotechnology?	How is biotechnology used in agriculture? (images) What does agricultural biotechnology produce for society? (Images) Name three ways the products will benefit society. (Images)	**7**	
Related Job Areas	What other job related area did you find interesting? Tell you audience about the job (Images) Why would you be interested in pursuing a career in this field (Images)	**7**	
Related Videos	Select one video of your choice to discuss new ideas and jobs in the biotechnology career fields (Images). What did you find cool or interesting.	**7**	
Site Search by High School Education	Do you have to work for McDonalds? What other career choices require a High School Diploma? List two to three with images.	**7**	
Site Search by Job Area	What other related job positions are possible? Discuss briefly with images.	**7**	
Site Search Explore Careers: by Salary	In the future, what gross annual salary would you like to earn? What careers will meet your future income expectations? List two-three with salary level and images.	**7**	

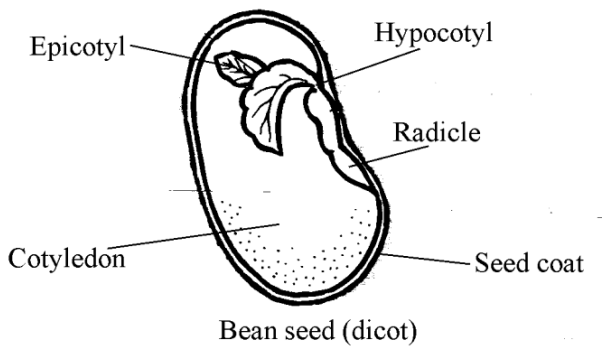
STUDENT PAGES - LAB: BIOTECHNOLOGY PROTOCOLS WORKING WITH SEEDS, SEED MORPHOLOGY AND DISSECTION

Student Name: _____ **Date:** _____

Lab Partner Name:_____

BACKGROUND INFORMATION:

Seeds are the result of reproduction passing down genetic information from parent to offspring. The seed is essential for the plant to germinate, grow, and develop into a plant. Because the seed carries a "baby" plant called an embryo. Just, as your Mother carried you in her



Bean seed (dicot)

uterus during early development, as an embryo. Your mother's role was to protected and nourished you. The role of the seed is the same in plants to protect and nourish the embryo until established as a seedling. Anatomically, the seed is constructed for the purpose of ensuring that the embryo survives until growth occurs above ground and photosynthesize. Surrounding the embryo is a food source called the endosperm. The endosperm is packed in a leaf-like structure called the cotyledon. The plants we are studying will have two cotyledons. Therefore the plants will both be classified as dicots.

The endosperm in each cotyledon contains protein, sugar, starch, and fat molecules another reason why other organisms eat seeds.

Since each plant grows in a unique environment, a seed size, shape, and structure are a consequence of evolution. Plant species with seeds that function best in their environment survive until reproductive age and pass on "good-seed genes" to the next generation. The large diversity of seed types is due to the "selection pressure" from each unique environment. As a model organism in the realm of biotechnology lab applications, scientists will expose plants to various "selective pressures". Over a period of time, technicians will record observations of the plant's response to the environmental changes. How do the environmental changes affect both genetics and protein production, thus possibly influencing genotypic changes seen in the plant shape, color, or metabolic pathway, (photosynthesis). As you become a plant specialist, what special seed characteristics reveals to you, "the life of seeds".

Objective: What do I need to learn?

1. Describe how scientists to explain observations of nature use models.
2. Maintain thorough documentation of tasks and procedures
3. Utilize appropriate tools strategically.

4. Conduct short as well as more sustained research projects to answer a question (including a self-generated question) or solve a problem.

Hypothesis: Write as an if...then…because…statement

_____

VOCABULARY:
Cotyledon:

Endosperm:

Embryo:

Radicle:

Seed:

Abbreviations:
GP:

MATERIALS:

- (1) Magnifying hand lens or microscopes.
- (1) Forceps-fine tip preferred
- (1) Scalpel handle with blade
- (1) Metric ruler, clear
- (1) Tabletop balance (mg)
- (1) Weigh paper
- (1) Various seeds: corn, bean

Procedure:
1. Gather seeds to be observed.
2. Dissect the bean seed by carefully separating the two cotyledons.
3. Observe the size, shape, color, and structures on the lab activity sheet table.
4. Analyze seed structures to compare between monocots and dicots.
5. Synthesize comparisons of other seed structures and repeat.

Data Table: Anatomical Differences in Seeds

Seed	Seed Dimensions (mm)	Seed Mass (g)	Seed Coat Color/Characteristics	Endosperm Color/Characteristics	Embryo Dimensions (mm)	Other Characteristics

Conclusion: Summarize the similarities and differences you have observed in the seeds that you dissected. Suggest evolutionary reasons why a plant might produce seeds that exhibit their specific characteristics.

_____

_____

_____

1. Summarize the advantages and disadvantages of larger seeds versus smaller seeds:

_____

_____

2. Dicots have two cotyledons (seed sections) and monocots have only one. Can you tell which of the seeds that you dissected are monocots that are dicots**?**

_____

_____

LESSON THREE: BIOTECHNOLOGY PLANT CELL PROTOCOLS, SEED GERMINATION.

Adapted from: Seed Germination from Ellyn Daugherty, Lab 10b, pgs. 191-194

Essential Question: What is the Germination Process in the Biotechnology Laboratory for *Arabidopsis thaliana and Mesembryanthemum crystallium L,* as a Research Model for a Plants' Response to Environmental Stress?

OVERALL TIME ESTIMATE:

- Advanced Preparation: 30 minutes
- Student Procedure: 45 minutes

LEARNING STYLES: Visual, auditory, and kinesthetic.

VOCABULARY:

Aseptic: Free from living pathogenic organisms; sterile.

Angiosperm: A group of plants that produce seeds enclosed within an ovary, which may mature into a fruit; flowering plants**.**

Dicot: An angiosperm that is not a monocotyledon, having two cotyledons in the see
Dormancy: A period of suspended growth and metabolic activity. Many plants, seeds, spores, and some invertebrates become dormant during unfavorable conditions.
Germination: The process by which a seedling emerges and develops from a seed, or by which a sporeling emerges and develops from a spore.
Moncot: Any of a class of angiosperm plants having a single cotyledon in the seed. Monocotyledons have leaves with parallel veins, flower parts in multiples of three, and fibrous root systems.

Abbreviations:
GP: Generation Percent

LESSON SUMMARY: Since proteins are manufactured as an environmental stimuli placed on cells, then proteins within a cell will also change as a response mechanism. What if the protein changes could tell society something about metabolic, bacterial, viral, or cancer diseases transmission or suppression? Thus scientists began experimenting with plant extraction and analysis, as a small-scale scientific model. In lesson two through three, students will be exploring lab protocols developed in biotechnology laboratories for germinating seeds for the purpose of plant protein identification, as students emulate biotechnology technicians

STUDENT LEARNING OBJECTIVES:

The student will be able to...

1. Describe how models are used by scientists to explain observations of nature.
2. Maintain thorough documentation of tasks and procedures
3. Utilize appropriate tools strategically.
4. Conduct short as well as more sustained research projects to answer a question (including a self-generated question) or solve a problem; narrow or broaden the inquiry when appropriate; synthesize multiple sources on the subject, demonstrating understanding of the subject under investigation.

STANDARDS: SC.912.N.3.5, 03.05, 02.03.1, (H. Chem. I /C.C.) 40.03 (Biotech II)

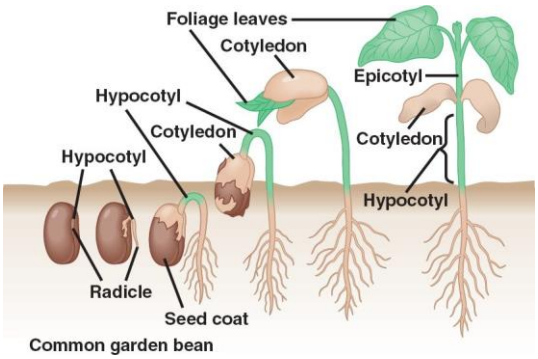
MATERIALS:

- Filter paper or Thick paper towels
- Containers: Zip lock baggies or Square/Round Petri Dishes
- Seeds
- Tap water will be left out the night before to remove Cl.
- Forceps
- Transfer pipet
- Ruler

BACKGROUND INFORMATION:

Germination or seed sprouting occurs when a seed's dormancy (resting state) is broken, and the embryo inside the seed starts to grow and become visible. An

appropriate temperature, an appropriate amount of water, and oxygen trigger germination. Depending on the seed, germination may take a few days or weeks.



ADVANCE PREPARATION:

4. Copy Student Labs and Quiz
5. Obtain lab materials
6. Purchase seeds.

PROCEDURE AND DISCUSSION QUESTIONS WITH TIME ESTIMATES:

1. Set out Materials at student lab stations or selected area for dispersal

2. Create student interest by posing the Essential Question and then reviewing the Video:

3. Ask the students to refer to the Inquiry Questions while conducting the lab.

4. Have student read aloud the Background, Materials, and Procedure.

5. Discuss Safety Rule and Procedures, student need to maintain Aseptic lab station.

6. Discuss clean up, 10 minutes before bell rings allows you and student time for next class.

7. During the lab walk around to assist with tools and ask to identify the cotyledon.

ASSESSMENT SUGGESTIONS:

- Quiz next class
- Student's will take observe and record daily seed changes
- Students will measure and record daily root growth
- Students will measure germination percentage and rate.
- Teacher will be able to assess student's learning by Quiz, Science NB and Lab Data.

EXTENSIONS:

- Lab can be converted into a teacher demo if time is an issue.
- Biodiesel, Renewable Energy
- Agriculture, Alternative Farming: Vertical growth facilities
- Pharmaceutical Plant Biology
- Biotechnology applications and careers

ACTIVITIES:

Hydroponic gardening**:** **http://homebiology.blogspot.com/2008/12/hydroponics.html**

Virtual Lab: Seed Germination and Pollution, scroll down:
http://teachingcommons.cdl.edu/virtuallabs/biology/index.html#blol

Part of Flowering Plants Color Activity:**http://biologyjunction.com/biology_coloring_worksheets.htm**

Literature:

The Private Life of Plants (1995) - NOVA series by David Attenborough - includes awesome time-lapse.

Teacher can use various teacher resources to create rotation activity, Biodiesel FAQs
Biodiesel http://biodiesel.org

AeroFarms: http://aerofarms.com/

RESOURCES/REFERENCES:

"Biotechnology Laboratory Manual", Ellyn Daugherty. 2012.

Seed Germination Inquiry Lab
http://employees.csbsju.edu/SSAUPE/biol106/Labs/seed_germination.htm

Biofuel and Ethanol:
https://search.yahoo.com/search;_ylc=X3oDMTFiN25laTRvBF9TAzIwMjM1MzgwNzUEaXRjAzEEc2VjA3NyY2hfcWEEc2xrA3NyY2h3ZWI-?p=Biodiesel+video&fr=yfp-t-728%2CE829075%2C332&fp=1&toggle=1&cop=mss&ei=UTF-8

Biodiesel http://biodiesel.org

Expo Milano 2015: http://www.expo2015.org/en/

TEACHER PAGES- VIDEO CLOZE PASSGE, VERTICAL PLANTING

Cloze Answers:

Is Vertical Farming the Answer?
http://www.bing.com/videos/search?q=vertical+crops&&view=detail&mid=08828A130C063C0FC2E508828A130C063C0FC2E5&rvsmid=08828A130C063C0FC2E508828A130C063C0FC2E5&fsscr=0&FORM=VDFSRV

By the year 2050, it is estimated that eighty percent of the world's population will be living in cities by then there will be more than nine billion people on the planet. A problem on how to feed them all is one of the key themes to this year's world expo in Milan. Of some of the one hundred and forty-five countries here many believe that vertical farming may be the answer. Israel is using sustainable methods from the very first day of this establishment because Israel has faced severe lack of water and soil. We had to develop methods, waste, and technologies in order to use less resource to

produce more. The Israeli pavilion was highlighting a problem they experience at home. How to grow crops in the desert with virtually no water? There hoping this instillation growing wheat may help to solve the problem. Many agriculture's cultivators who use this method when they cultivate product which are not connected to the crown, but grow vertically and do not spread on the ground. The American pavilion was also displaying a vertical vegetable garden. This spanning the length of the entire building. There hoping to harvest over six different patches over the next six months.

Farm to Table the Urban Route: https://www.youtube.com/watch?v=GoPwIAzpd-Y

Well when you think a farming you probably don't think I've Newark, New Jersey, but that's exactly where green leafy vegetables are being grown and it's not just Newark, but also other cities across the country that are using new technologies to create what could be the next big thing in food production Morgan Brennan is a Newark with more. This is the research lab AeroFarms a 10-year-old startup developing the world's largest vertical farm in a former steel mill in Newark New Jersey the 39 million dollar project backed by the state Goldman Sachs a potential financial company expects to see 2 million pounds of Kayla rule and other salad greens per year without soil or natural sunlight the concept converting urban buildings into high-tech grow houses that use artificial lighting hydroponics and climate control to increase crop productivity to seventy times greater in a field farmers. On average were growing in 16 days would otherwise takes 30 days in the field using ninety-five percent less water about fifty percent less fertilizers With zero pesticides, herbicides, and fungicides, and there are other benefits as well it cuts down on transportation costs and spoilage. Since these companies supply local stores and restaurants. Take green sense farms a two-year-old vertical farm that supplies for food and other retailers in the Chicago area by being able to get your food to your customers quicker it's more nutritious and more importantly we can grow year round, but there are drawbacks vertical farms are limited in what they can grow since space constraint. The concept has been around for years but because it's capital intensive energy costs can be very high. It was never economically viable. Two things are now changing that shifting taste as consumers increasingly seek out locally sourced all natural foods and new technology that's lowering costs dramatically. LED lighting were the largest expenses has become more efficient green sense for example works with Philips Lighting which created a division just dedicated to this concept. Green sense and other farms use lots of blue and red diodes two colors that optimize photosynthesis and require less energy than standard yellow light. The energy used as well they have a very long lifetime. Here their farms has also been collecting big data 10,000 data points hardest cycle that information that allows it to grow mustard greens according to color, texture and taste products case for nightly Business Report I'm more than ready Newark New Jersey

TEACHER PAGES- QUIZ ANSWERS: PRE-LAB

Student Name: _____ **Date:** _____

Directions: Based on student's preparedness for today's lab, the below questions need to be answered with a mastery of 75% to begin lab.

1. Fill in the genus or species scientific names of the organism's students will be working with over the next twelve to thirteen weeks.

2. In your own words, explain why a seed experiences dormancy?

A seed's dormancy (resting state) is broken, and the embryo inside the seed starts to grow and become visible. An appropriate temperature, an appropriate amount of water, and oxygen trigger germination.

3. According to your research on the USDA Website, what factors will affect germination?

Water and/or humidity levels.

4. List one of the four learning goals that students will need to learn:

Measure seed germination percentage and rate

1. Learn the requirements for seed germination in a biotechnology career field
2. Study the effect of various treatments on seed germination to stimulate an environmental response, experimental data.
3. Grow a plant to maturity
4. Explore about two particular species of plant used for various applications in the biotechnology lab.

5. What type of angiosperms are your seeds monocot or dicot? Circle one. Both species are dicots.

STUDENT PAGES – QUIZ: PRE-LAB

Seed Germination Pre-Lab Quiz

Student Name: _____ **Date:** _____

Directions: Based on student's preparedness for today's lab, the below questions need to be answered with a mastery of 75% to begin lab.

1. Fill in the genus or species scientific names of the organism's students will be working with over the next twelve to thirteen weeks.

2. In your own words, explain why a seed experiences dormancy?

_____

_____

3. According to your research on the USDA Website, what factors will affect germination?

_____

_____

4. List one of the four learning goals that students will need to learn:

_____

5. What type of angiosperms are your seeds monocot or dicot? Circle one.

Seed Germination Pre-Lab Quiz
Student Name: _____ **Date:** _____
Directions: Based on student's preparedness for today's lab, the below questions need to be answered with a mastery of 75% to begin lab.

1. Fill in the genus or species scientific names of the organism's students will be working with over the next twelve to thirteen weeks.

2. In your own words, explain why a seed experiences dormancy?

_____

_____

3. According to your research on the USDA Website, what factors will affect germination?

_____

_____

4. List one of the four learning goals that students will need to learn:

_____

5. What type of angiosperms are your seeds monocot or dicot? Circle one.

STUDENT PAGES – CLOZE PASSAGE: VERTICAL PLANTING

Student Name: _____ Date: _____

Classwork: Video Cloze passage - **Is Vertical Farming the Answer**?
http://www.bing.com/videos/search?q=vertical+crops&&view=detail&mid=08828A130C063C0FC2E508828A130C063C0FC2E5&rvsmid=08828A130C063C0FC2E508828A130C063C0FC2E5&fsscr=0&FORM=VDFSRV

Related Literature: **Expo Milano 2015- http://www.expo2015.org/en/**

Objective(s): What do I need to know?
1. Identify problems with population growth on the planet.
2. Relate Density Dependent Factors to problems associated with natural resources, water and soil.
3. Explain how applications of Vertical Farming plan to improve agriculture practices.
4. Compare and Contrast world farming issues shared in the, *Expo Milano 2015.*

Student Directions:
1. Watch Video "How We Make Biodiesel"
2. As you watch video complete sentences.
3. Try to practice listening and writing, as a college and work force preparatory skill.

By the year _____, it is estimated that _____percent of the world's population will be living in cities by then there will be more than _____ _____ people on the planet. A _____ on how to _____ them all is one of the key _____ to this year's_____ _____ in Milan. Of some of the one hundred and forty-five countries here many believe that _____ _____ may be the answer. _____ is using _____ _____from the very first day of this establishment because Israel has _____ severe _____ of water and _____. We had to develop methods, _____, and _____ in order to use _____resource to produce _____. The Israeli pavilion was highlighting a problem they experience at home. How to _____ crops in the _____with virtually _____water? There hoping this instillation growing _____ may help to solve the problem. Many agriculture's _____who use this _____ when they cultivate _____ which are not connected to the crown, but _____ _____and do _____ spread on the _____. The _____ pavilion was also displaying a vertical _____ garden. This _____ the _____ of the entire building. There hoping to _____ over _____ different patches over the next six _____.

STUDENT PAGES – CLOZE PASSAGE: FARM TO TABLE THE URBAN ROUTE

Student Name: _____ Date: _____
Classwork: Video Cloze passage - Farm to Table The Urban Route
https://www.youtube.com/watch?v=GoPwIAzpd-Y

Related Literature: AeroFarms: http://aerofarms.com/

Objective(s): What do I need to know?

1. Identify biotechnology-farming techniques that will assist with sustainable farming.
2. Relate the economics of investment farming to the economics of capital growth for any city.
3. Explain how vertical farming has benefited society.
4. Discuss the drawbacks to vertical farming, and then discuss how using new technologies based on physics, chemistry, and biology can improve vertical farming.

Student Directions:

1. Watch Video "Farm to Table The Urban Route"
2. As you watch video complete sentences.
3. Try to practice listening and writing, as a college and work force preparatory skill.

Well when you think a _____ you probably don't think I've Newark, _____ _____, but that's exactly where green leafy _____ are being _____ and it's not just Newark, but also _____ cities _____ the _____ that are using new _____to create what could be the next big thing in _____ _____ Morgan Brennan is a Newark with more. This is the research lab _____ a 10-year-old _____ developing the _____ largest _____ _____ in a _____ steel mill in Newark New Jersey the 39 _____ dollar project backed by the state _____ _____ a potential _____ company expects to see 2 _____ pounds of Kale rule and other salad greens per year _____ the concept _____ urban buildings into high-tech grow houses that use artificial lighting _____ and _____ control to increase crop _____ to _____ _____ greater in a field farmers. On average were growing in _____ _____ would otherwise takes _____ _____ in the _____ using _____ percent _____ water about _____ less _____ with _____ pesticides, _____, and _____, and there are other _____ as well it cuts _____ on _____ costs and _____. Since these companies supply _____ stores and restaurants. Take green sense farms a two-year-old vertical farm that supplies for food and other retailers in the _____ area by being able to get your _____ to your customers _____ it's more _____ and more importantly we can grow _____ round, but there are _____ vertical farms are limited in _____ they can grow since _____ constraint. The concept has been around for years but because it's _____ intensive energy costs can be very high. It was never economically _____. Two things are now _____ that shifting taste as _____ increasingly seek out locally sourced all _____ foods and _____ technology that's _____ costs dramatically. _____ _____ Were the largest expenses has become more _____ green sense for example works with Philips Lighting, which created a division just dedicated to this concept. Green sense and other farms use lots of _____ and _____ diodes two _____ that _____ photosynthesis and require _____ energy than

standard _____ light. The energy used as well they have a very long lifetime. Here their farms has also been collecting big data 10,000 data points hardest cycle that information that allows it to grow mustard greens according to color, texture and taste products case for nightly Business Report I'm more than ready Newark New Jersey.

STUDENT PAGES – LAB: PLANT PRPEPARATION IN THE BIOTECHNOLOGY LAB, *Arabidopsis thaliana* AND *Mesembryanthemum crystallium L*

Student Name: _____ **Date:** _____
Lab Partner Name:_____

BACKGROUND INFORMATION:

Germination or seed sprouting occurs when a seed's dormancy (resting state) is broken, and the embryo inside the seed starts to grow and become visible. An appropriate temperature, an appropriate amount of water, and oxygen trigger germination.

Depending on the seed, germination may take a few days or weeks. Many different factors can affect the germination percentage of plants. Think about what conditions are needed for seeds of the type you selected to germinate. Do seeds need light to germinate? Do seeds need water to germinate? Students may need to use the USDA Website to research characteristics of selected plants before beginning any part of the lab. The germination percentage tells you what fraction of seeds germinates out of a total population of seeds. The equation to calculate germination percentage is: below

GP = seeds germinated/total seeds x 100

Objective: Learning goals, what do I need to know?

1. Measure seed germination percentage and rate
5. Learn the requirements for seed germination in a biotechnology career field
6. Study the effect of various treatments on seed germination to stimulate an environmental response, experimental data.
7. Grow a plant to maturity
8. Explore about two particular species of plant used for various applications in the biotechnology lab.

Hypothesis: (Write as an If…then…because statement)

_____

_____

VOCABULARY:

Aseptic:

Angiosperm:

Dicot:

Dormancy:

Germination:

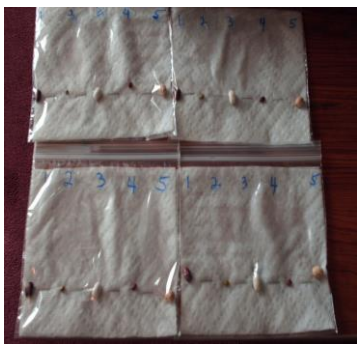
Moncot:

Abbreviations:

GP:

MATERIALS:

- Magnifying hand lens
- Forceps-fine tip preferred
- Filter paper or thick paper towels or absorbent cotton



- Containers: Zip lock baggies or Square/Round Petri Dishes
- Seeds
- Water, tap water left out the night before to remove Cl.
- Transfer pipet
- Ruler
- %5 Bleach solution.

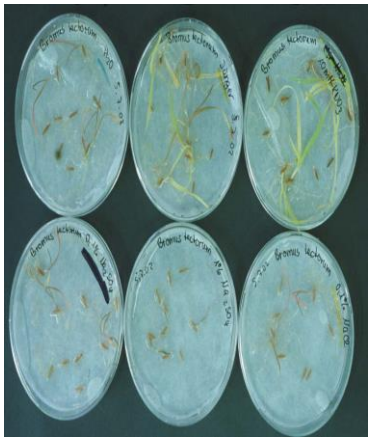
Procedures: Brainstorming and Recording in the Industrial Work Force, how to begin design and collect ideas. Adapted from Ellyn Daugherty "Lab Manual" laboratory 10c, pgs. 191-193.

1. Students will need to decide on one of the two plants to grow, circle selected species.
   Plant A: *Arabidopsis thaliana seeds* wild type (Columbia)
   Plant B: *Aptenia cordifolia*:

2. Complete Species Selection/Research using the USDA Website: http://plants.usda.gov/java/
3. **Read Germination Percentage section to develop ideas for the following steps.**
4. Decide on an independent variable that you think will affect germination
5. Record independent variable in data section.
6. Identify the dependent variable of your experiment.
7. Record Dependent variable in data section.
8. Create a hypothesis about the effect of the independent variable on Germination Percentage,
9. Design an experiment to test your hypothesis.
10. Students will be making daily observations for a period of time, if your plant dies then you will not be able to move forward with the protein identification process, so no grade! Just as in a lab no data = an unhappy employer.

Procedures: Implementing a Scientific Design Like a Laboratory Biotechnician
**** Teacher will run the control while student run the experimental labs.**

1. Wearing Gloves and wipe down station with alcohol.
2. Obtain one Petri dishes.
3. Obtain one filter paper.
4. Obtain 5% bleach solution.
5. Cut filter paper same width of petri dish.
6. Draw a pencil line 1 cm from top, place seeds will be placed.
7. Soak seeds and filter paper in 5% bleach solution to prevent fungal growth.
8. Soak for 5 minutes.
9. Rinse with tap water.



Set up Petri dish germination chamber:
***Procedure with absorbent cotton will be the same for thick paper towels.

10. Label top edge of petri dish as picture, name, date, and species
11. Add absorbent cotton that has been soaked in aged tap water, remove Cl.
12. Squeeze out excess aged water
13. Place absorbent cotton into dish.
14. Place filter paper on top of absorbent cotton or paper towel.
15. Using sterile forceps.
16. Place the seeds on the filter paper equally spaced on pencil line.
17. Using transfer pipette.
18. Add 4 mL of water under the absorbent cotton, water will rise up due to capillary action
19. Close the germination lid with tape or pararfilm.
20. Keeps the seeds in dark (label this dish control). Until seeds germinate.
21. Then move to indirect light.
22. Keep germination chamber vertical, so seeds grow in response to gravity.
23. Put one Petri dish under experimental conditions. (Label this "Experimental")
24. Record in **Date section C**: Tables 1 and 2 numbers of seeds that germinate daily.
25. Record, the length of each seedling root over time (growth rate), as the embryonic root (radicle) emerges
26. Continue gathering data for 7 consecutive school days (168 hrs.)

Data Section:

A. Data Table: <u>Species Selection/Research.</u>

Select a seed by: (1) examining the seeds available in the lab; (2) recovering your seeds from a commercially available fruit; or (3) from a wild plant. Record as much data about the seeds as possible.

Common name:	
Scientific name:	
Family name:	
Origin:	

B. <u>Germination Percentage and Rate.</u>

Many different factors can affect the germination percentage of plants. Think about what conditions are needed for seeds of the type you selected to germinate. Germination percentage tells you what fraction of seeds germinates out of a population of seeds. The equation to calculate germination percentage is: **GP = seeds germinated/total seeds x 10**

Show Calculations:

What to Look for? Length of each seedling root over time (growth rate), as the embryonic root (radicle) emerges, as shown in the image below.

C. Daily Germination Observations:

Table 1. Germination data for seeds in **Control** Group, every 12 hrs for 7 days.

Date Started	Days since start	Total Seeds in Treatment	# Seeds Germinated During Time Interval	Total Seeds Germinated Since T_o	Percent Germination during time interval (per day)	Cumulative Percent Germination/ **Root Length in (cm)**
	0					

Student Notes:

Table 2. Germination data for seeds in **Experimental** Group, every 12 hrs/ 7 days

Date Started	Days since start	Total Seeds in Treatment	# Seeds Germinated During Time Interval	Total Seeds Germinated Since T_o	Percent Germination during time interval (per day)	Cumulative Percent Germination/ **Root Length in (cm)**
	0					

Student Notes:

Conclusion: Reflecting and Technical Writing in the Biotechnology Lab

Please use content vocabulary and complete sentences in completing student reflection.

1. What was the final germination percent of your seeds for the Control and Experimental groups? Were either/both of them what you expected? Explain.

2. Using Excel graph, plot Percent Germination per Day for both the Experimental and Control groups on the same graph. Be sure to include a key.

3. What did the graph you created in #2 above tell you about seed germination?

4. Write a summary of the experiment that explains what you did. In your summary, address questions you had during the experiment, conclusions you made, and opportunities for further research. Use additional paper if necessary.

Extra Credit: Monitor your plants during the next few weeks. Prepare a growth curve by measuring the height of your plants at weekly intervals and describe what you learned from the activity.

LESSON FOUR: BIOTECHNOLOGY TECHNIQUES IN GROWING, *Aribidopsis thaliana* AND *Mesembryanthemum crystallium L*

Essential Question: What is the Planting Process in the Biotechnology Laboratory for *Arabidopsis thaliana and*

Mesembryanthemum crystallium L, as Research Models for a Plants' Response to Environmental Stress?

OVERALL TIME ESTIMATE:

- Advanced Preparation: 45 minutes
- Student Procedure: 45 minutes

LEARNING STYLES: Visual, auditory, and kinesthetic.

VOCABULARY:

Autoclave: A vessel, usually of steel, able to withstand high temperatures and pressure.

Aribidopsis thaliana

Agricultural Biotechnology: biotechnologists develop products to protect animals and crops from disease and help farmers identify the best animals and seeds to use in selective breeding programs.

Greenhouse Technician: care for plants that have been created through genetic engineering and have to understand how to plant seeds, pollinate flowers, water and weed plant beds, plant rooted plants, nurture root cuttings, treat plants for disease and pest infestation, and be able to use a computer for documentation purposes.

Perlite: a variety of obsidian consisting of masses of small pearly globules: used as a filler, insulator, and soil conditioner.

Vermiculite: Any group of micaceous minerals consisting mainly of hydrated silicate of magnesium, aluminum, and iron: as a bedding medium for young plants

Wild Type: the typical form of a species of organism resulting from breeding under natural conditions

LESSON SUMMARY: Agricultural biotechnology is generating new products and having a significant impact on the food industry and horticulture industry. Plant biotechnologies in particular are creating new breeds, cloning new traits into crops, and improving the processes for growing and processing plants. Student will utilize plant biology and biotechnology applications in using plant models in becoming Greenhouse Technicians within Agricultural Biotechnology Career Field.

STUDENT LEARNING OBJECTIVES:

The student will be able to...

1. Describe how models are used by scientists to explain observations of nature.
2. Maintain thorough documentation of tasks and procedures
3. Utilize appropriate tools strategically.
4. Conduct short as well as more sustained research projects to answer a question (including a self-generated question) or solve a problem; narrow or broaden the inquiry when appropriate; synthesize multiple sources on the subject, demonstrating understanding of the subject under investigation.

STANDARDS: SC.912.N.3.5, 03.05, 02.03.1, (H. Chem. I /C.C.) 40.03 (Biotech II)

MATERIALS:

- Several plastic buckets
- Potting soil
- Vermiculite
- Perlite
- Lab scoops
- Tri-pour beakers, 1L →

- Aluminum foil
- Forceps
- Six-cell planting trays (alternative to start egg crated)

- Germinated seedlings, root length 3 to 4 cm or up to 4-5 wks.
- Plastic wrap

BACKGROUND INFORMATION:

Agricultural biotechnology is generating new products and having a significant impact on the food industry and horticulture industry. Plant biotechnologies in particular are creating new breeds, cloning new traits into crops, and improving the processes for growing and processing plants.

Arabidopsis thaliana and *Mesembryanthemum crystallium L* are both good models in agriculture biotechnology, as readily used for genetic studies based on the plant's genome and protein identification. *Arabidopsis thaliana* is more readily used, since growth and development of this species is more understood by plant biologist.

In this activity, you will become a *Greenhouse Technician* within the career field of *Agricultural Biotechnology*. What do theses positions do? Greenhouse technicians are people who like to work with plants, enjoy being more outdoors, but also like to understand science. They care for plants that have been created through genetic engineering and have to understand how to plant seeds, pollinate flowers, water and weed plant beds, plant rooted plants, nurture root cuttings, treat plants for disease and pest infestation, and be able to use a computer for documentation purposes. They can work in a greenhouse and or out in the fields and may need experience with farm equipment. Employers hire people with two-year degrees in plant science, crop science or botany, or four-year people with degrees in agriculture, agronomy, plant science, biology or botany.

ADVANCE PREPARATION:

1. Copy Student Labs
2. Obtain lab materials

3. Purchase materials needed

PROCEDURE AND DISCUSSION QUESTIONS WITH TIME ESTIMATES:

1. Set out Materials at student lab stations or selected area for dispersal

2. Create student interest by posing the Essential Question and then reviewing the Videos and Activities.

3. Ask the students to refer to the Inquiry Questions while conducting the lab.

4. Have student read aloud the Background, Materials, and Procedure.

5. Discuss Safety Rule and Procedures, student need to maintain Aseptic lab station.

6. Discuss clean up, 10 minutes before bell rings allows you and student time for next class.

7. During the lab walk around to assist with tools
Ask students " what procedures they are conducting?"
Ask student, "what is the purpose of the specified procedure?"
Assist with working and mixing soil; try to show them how to keep the lab station "tidy"

BT: Good work outside day, but need to prepare by the following "Safety"
1. Set date, so students, and yourself will be able to dress appropriate.
2. Time correctly: set up materials? Get outside, mix/plant in soil, clean up, bring materials /student's back, and some students will want to change.
3. Send home a type of out of classroom permission slip, protect yourself from administration and forgetful parents.

ASSESSMENT SUGGESTIONS:

- Quiz next class
- Students will collect, observe, and record daily plant changes.
- Students will measure and record daily plant growth, leaflets.
- Students will conduct two experimental variables: A. Drought, B. .5 M salt soln.
- Teacher will be able to assess student's learning by Quiz, Science NB, Lab Data, Science Journal, and Standard Operating Procedure.
- Previous activities and extensions may be utilized through out lessons 2-4.

EXTENSIONS:

- Lab can be converted into a teacher demo if time is an issue.
- Biofuel and Ethanol: How its Made: Bio Diesel
- Agriculture, Alternative Farming: Vertical growth facilities
- Pharmaceutical Plant Biology: Biology Lesson Ideas Plants as Medicine, Aspirin
- Biotechnology Careers, Cell Culture: Using Tissue Culture with Plants

ACTIVITIES:

- Hydroponic gardening**: http://homebiology.blogspot.com/2008/12/hydroponics.html**
- Virtual Lab: Which Colors of The Light Spectrum are more Important For Plant Growth?
- Chemical Laboratory Technology: What equipment do CLTs Work with?

Literature:

Teacher can use various teacher resources to create rotation activity, Biodiesel FAQs
Biodiesel http://biodiesel.org

RESOURCES/REFERENCES:

"Biotechnology Laboratory Manual", Ellyn Daugherty. 2012.

Tips To Sterilize Potting Soil, Garden Soil And Soil For Seeds
http://www.gardeningknowhow.com/garden-how-to/soil-fertilizers/sterilizing-soil.htm

TEACHER PAGES-LESSON FOUR: BIOTECHNOLOGY TECHNIQUES IN GROWING, *Aribidopsis thaliana* AND *Mesembryanthemum crystallium L*

Student Name: _____ **Date:** _____
Lab Partner Name: _____

EQ: What is the Planting Process in the Biotechnology Laboratory for *Arabidopsis thaliana and Mesembryanthemum crystallium L,* as Research Models for a Plants' Response to Environmental Stress?

BACKGROUND INFORMATION:

Agricultural biotechnology is generating new products and having a significant impact on the food industry and horticulture industry. Plant biotechnologies in particular are creating new breeds, cloning new traits into crops, and improving the processes for growing and processing plants.

Arabidopsis thaliana and *Mesembryanthemum crystallium L* are both good cell models in agriculture biotechnology, as readily used for genetic studies based on the plant's genome and protein identification. *Arabidopsis thaliana* is more readily used, since growth and development of this species is more understood by plant biologist.

In this activity, you will become a *Greenhouse Technician* within the career field of *Agricultural Biotechnology*. What do theses positions do? Greenhouse technicians are people who like to work with plants, enjoy being more outdoors, but also like to understand science. They care for plants that have been created through genetic engineering and have to understand how to plant seeds, pollinate flowers, water and weed plant beds, plant rooted plants, nurture root cuttings, treat plants for disease and pest infestation, and be able to use a computer for documentation purposes. They can work in a greenhouse and or out in the fields and may need experience with farm equipment. Employers hire people with two-year degrees in plant science, crop science or botany, or four-year people with degrees in agriculture, agronomy, plant science, biology or botany.

STUDENT LEARNING OBJECTIVES: What do I need to know?

The student will be able to...

1. Describe how models are used by scientists to explain observations of nature.
2. Maintain thorough documentation of tasks and procedures
3. Utilize appropriate tools strategically.
4. Conduct short as well as more sustained research projects to answer a question (including a self-generated question) or solve a problem; narrow or broaden the inquiry when appropriate; synthesize multiple sources on the subject, demonstrating understanding of the subject under investigation

HYPOTHESIS: written as an If…then…because statement

VOCABULARY:

Autoclave: A vessel, usually of steel, able to withstand high temperatures and pressure.

Agricultural Biotechnology: biotechnologists develop products to protect animals and crops from disease and help farmers identify the best animals and seeds to use in selective breeding programs.

Greenhouse Technician: care for plants that have been created through genetic engineering and have to understand how to plant seeds, pollinate flowers, water and weed plant beds, plant rooted plants, nurture root cuttings, treat plants for disease and pest infestation, and be able to use a computer for documentation purposes.

Perlite: a variety of obsidian consisting of masses of small pearly globules: used as a filler, insulator, and soil conditioner.

Vermiculite: Any group of micaceous minerals consisting mainly of hydrated silicate of magnesium, aluminum, and iron: as a bedding medium for young plants

Wild Type: the typical form of a species of organism resulting from breeding under natural conditions

STUDENT LEARNING OBJECTIVES:

The student will be able to...

1. Describe how models are used by scientists to explain observations of nature.
2. Maintain thorough documentation of tasks and procedures
3. Utilize appropriate tools strategically.
4. Conduct short as well as more sustained research projects to answer a question (including a self-generated question) or solve a problem; narrow or broaden the inquiry when appropriate; synthesize multiple sources on the subject, demonstrating understanding of the subject under investigation

MATERIALS:

- Several plastic buckets
- Potting soil
- Vermiculite
- Perlite
- Lab scoops
- Tri-pour beakers, 1L

- Aluminum foil
- Forceps
- Six-cell planting trays (alternative to start egg crated)

- Germinated seedlings, root length 3 to 4 cm to transport to soil.
- Plastic wrap

- Tub reservoir (square plastic containers trays fit in)
- Microwave for soil sterilization.
-

PROCEDURES: Part A, Growing Seedlings

1. Obtain large plastic bucket.
2. Add 2L of potting soil, if 2L ~2000mL ~ 2000g.
3. Add 1L of vermiculite.
4. Add 1L of perlite.
5. Mix with scoop.
6. Mixture will fill 5 planting trays = 30 seedlings.
7. Sterilize soil: http://www.gardeningknowhow.com/garden-how-to/soil-fertilizers/sterilizing-soil.htm BT: Microwave or Oven based on your equipment.
8. Sterilized soil must be used within one week to decrease algae growth.
9. After a week, re-sterilize.
10. Obtain clean planting tray.
11. Do the trays have drainage holes?
12. Label trays with date, name, and species.
13. Fill trays to top with sterilized soil.
14. Use clean forceps to make small hole in soil.
15. Gently insert seedling into hole.
16. Gently even out soil without covering seedling.
17. Use transfer pipette to water.
18. Tray wells will be dripping to indicate enough water.
19. Obtain a tub reservoir that fits planting trays.
20. Lay trays in tub reservoir.
21. Fill tub reservoir with enough eater that covers tray holes.
22. Cover the whole growing chamber (tray+tub reservoir) with plastic.
23. Secure the plastic to give a "greenhouse" environment.
24. Keep the trays under light.
25. Ensure soil stays moist.

Sprout Appears:

26. Once first sprout appears (1 wk.).
27. Open plastic wrap, seedlings adjust to open environment.
28. Keep water level the same by covering tray holes.
29. Next day remove plastic completely.
30. Count the number of seedlings that survived transplantation.
31. Start plant structure data

Plant Structure Data:

32. Each week record number of flowers, number of flower buds per seedling.

Part B: Experimental Testing of Environmental Stresses, Drought and Salinity.
After 5 weeks from germination week begin up to 12 weeks or flowering

1. Induce to stress environments:

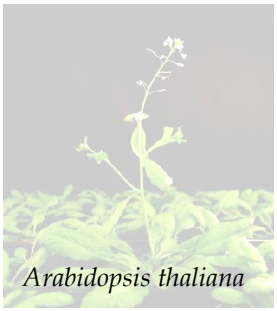
A. Control, 50 mL tap water (left out to remove Cl) /day/plant.
B. Drought-no water, at all from this point.
C. 0.5 Molar Salt Solution, 50 mL/day/plant.

2. Light is constant every 8 hours/day.
3. Harvest seeds by sifting from plant material into a dry paper bag to reduce mold.

STUDENT PAGES – LAB: BIOTECHNOLOGY TECHNIQUES IN GROWING, *Aribidopsis thaliana* AND *Mesembryanthemum crystallium L*

Student Name: _____ **Date:** _____
Lab Partner Name: _____

EQ: What is the Planting Process in the Biotechnology Laboratory for *Arabidopsis thaliana and Mesembryanthemum crystallium L,* as Research Models for a Plants' Response to Environmental Stress?


Arabidopsis thaliana

BACKGROUND INFORMATION:

Agricultural biotechnology is generating new products and having a significant impact on the food industry and horticulture industry. Plant biotechnologies in particular are creating new breeds, cloning new traits into crops, and improving the processes for growing and processing plants.

Arabidopsis thaliana and *Mesembryanthemum crystallium L* are both good models in agriculture biotechnology, as readily used for genetic studies based on the plant's genome and protein identification. *Arabidopsis thaliana* is more readily used, since growth and development of this species is more understood by plant biologist.

In this activity, you will become a *Greenhouse Technician* within the career field of *Agricultural Biotechnology*. What do theses positions do? Greenhouse technicians are people who like to work with plants, enjoy being more outdoors, but also like to understand science. They care for plants that have been created through genetic engineering and have to understand how to plant seeds, pollinate flowers, water and weed plant beds, plant rooted plants, nurture root cuttings, treat plants for disease and pest infestation, and be able to use a computer for documentation purposes. They can work in a greenhouse and or out in the fields and may need experience with farm equipment. Employers hire people with two-year degrees in plant science, crop science or botany, or four-year people with degrees in agriculture, agronomy, plant science, biology or botany.

STUDENT LEARNING OBJECTIVES: What do I need to know?

The student will be able to...

1. Describe how models are used by scientists to explain observations of nature.
2. Maintain thorough documentation of tasks and procedures

3. Utilize appropriate tools strategically.
4. Conduct short as well as more sustained research projects to answer a question (including a self-generated question) or solve a problem; narrow or broaden the inquiry when appropriate; synthesize multiple sources on the subject, demonstrating understanding of the subject under investigation.

HYPOTHESIS: written as an If…then…because statement

_____

_____

VOCABULARY:
Autoclave:
Agricultural Biotechnology:
Greenhouse Technician:
Perlite:
Sterilize:
Vermiculite:
Wild Type:

MATERIALS:

- Several plastic buckets
- Potting soil
- Vermiculite
- Perlite
- Lab scoops
- Tri-pour beakers, 1L

- Aluminum foil
- Forceps
- Six-cell planting trays (alternative to start egg crated)

- Germinated seedlings, root length 3 to 4 cm to transport to soil.
- Plastic wrap
- Tub reservoir (square plastic containers trays fit in)
- Microwave or oven to sterilize soil, Tips To Sterilize Potting Soil, Garden Soil And Soil For Seeds http://www.gardeningknowhow.com/garden-how-to/soil-fertilizers/sterilizing-soil.htm

PROCEDURES: Part A, Growing Seedlings
Adapted from Ellyn Daugherty "Lab Manual" lab 11k pgs. 238-240.
1. Obtain large plastic bucket.
2. Add 2L of potting soil, if 2L ~2000mL ~ 2000g.
3. Add 1L of vermiculite.
4. Add 1L of perlite.
5. Mix with scoop.
6. Mixture will fill 5 planting trays = 30 seedlings.

7. Sterilize soil: http://www.gardeningknowhow.com/garden-how-to/soil-fertilizers/sterilizing-soil.htm
8. Sterilized soil must be used within one week to decrease algae growth.
9. After a week, re-sterilize.
10. Obtain clean planting tray.
11. Do the trays have drainage holes?
12. Label trays with date, name, and species.
13. Fill trays to top with sterilized soil.
14. Use clean forceps to make small hole in soil.
15. Gently insert seedling into hole.
16. Gently even out soil without covering seedling.
17. Use transfer pipette to water.
18. Tray wells will be dripping to indicate enough water.
19. Obtain a tub reservoir that fits planting trays.
20. Lay trays in tub reservoir.
21. Fill tub reservoir with enough eater that covers tray holes.
22. Cover the whole growing chamber (tray+tub reservoir) with plastic.
23. Secure the plastic to give a "greenhouse" environment.
24. Keep the trays under light.
25. Ensure soil stays moist.

Sprout Appears:
26. Once first sprout appears (1 wk.).
27. Open plastic wrap, seedlings adjust to open environment.
28. Keep water level the same by covering tray holes.
29. Next day remove plastic completely.
30. Count the number of seedlings that survived transplantation.
31. Start plant structure data

Plant Structure Data:
32. Each week record number of flowers, number of flower buds per seedling.

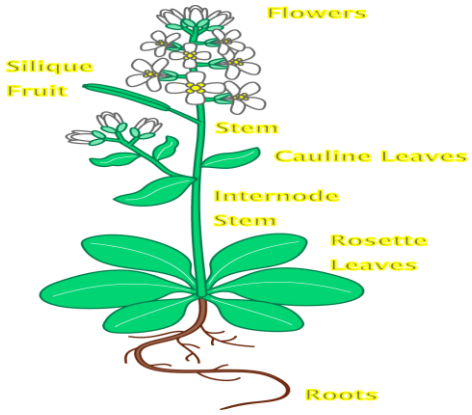
Part B: Experimental Testing of Environmental Stresses, Drought and Salinity. After 5 weeks from germination week begin experimental testing up to 12 weeks or flowering

1. Induce to stress environments:
   A. Control, 50 mL tap water (left out to remove Cl) /day/plant.
   B. Drought-no water, at all from this point.
   C. 0.5 Molar Salt Solution, 50 mL/day/plant.

2. Light is constant every 8 hours/day.

3. Harvest seeds by sifting from plant material into a dry paper bag to reduce mold.

Data: *Arabidopsis thaliana*



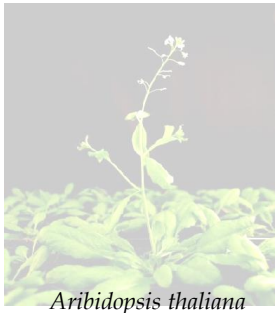
Date	# Rosette Leaves	# Cauline Leaves	Length of Stem	# Silique Fruit	# Flowers

Data: *Mesembryanthemum crystallium L*

Date	**# Leaves**	**# bladder cells**	**Length of Stem**	**# Fruit**	**# Flowers**

LESSON FIVE: DISCUSSING A SCIENCE JOURNAL ARTICLE

Essential Question: What is the Planting Process in the Biotechnology Laboratory for *Arabidopsis thaliana and Mesembryanthemum crystallium L,* as Research Models for a Plants' Response to Environmental Stress?



Aribidopsis thaliana

OVERALL TIME ESTIMATE:

- Advanced Preparation: 45 minutes
- Student Procedure: 45 minutes

LEARNING STYLES: Visual, auditory, and kinesthetic.

VOCABULARY:

LESSON SUMMARY: Agricultural biotechnology is generating new products and having a significant impact on the food industry and horticulture industry. Plant biotechnologies in particular are creating new breeds, cloning new traits into crops, and improving the processes for growing and processing plants. Student will utilize plant biology and biotechnology applications in using plant models in becoming Greenhouse Technicians within Agricultural Biotechnology Career Field.

STUDENT LEARNING OBJECTIVES:

The student will be able to...

1. Describe how models are used by scientists to explain observations of nature.
2. Maintain thorough documentation of tasks and procedures
3. Utilize appropriate tools strategically.
4. Conduct short as well as more sustained research projects to answer a question (including a self-generated question) or solve a problem; narrow or broaden the inquiry when appropriate; synthesize multiple sources on the subject, demonstrating understanding of the subject under investigation

STANDARDS:

MATERIALS:

- Copies of *Guide to Reading Scientific Papers*, one per student
- Copies of *Guide to Reading Scientific Papers Worksheet*, one per student
- Copies of introductory journal article, one per student or student pair.
- Copies of journal articles (choose three to five articles for the class and make multiple copies of each, allowing one per student)

BACKGROUND INFORMATION: Little was known about Pompe disease until the latter part of the 20th century. There have been several reviews of literature and reported cases published, but most attention from the research and clinical community is focused on treatment and cure. Therefore many of the papers published are related to a treatment and heavy on academic jargon.

Students need to be scientifically literate, and part of that effort includes their use and familiarity with primary sources of information, namely articles peer-reviewed and published in scientific journals. Many high school and undergraduate students are intimidated by these articles because they approach them in the wrong manner. They are not novels to be consumed at one time. They are jargon-filled texts that are often presented in a dry and painful manner. Students are bogged down by the vocabulary and the methods, so they can't focus on the bigger, important ideas of the paper, the "take-home message". Small, manageable doses of primary literature in a guided manner will allow students to gain comfort using and understanding original research articles.

ADVANCE PREPARATION:
PROCEDURE AND DISCUSSION QUESTIONS WITH TIME ESTIMATES:
Day One (45 minutes)

1.

ASSESSMENT SUGGESTIONS:

EXTENSION:

ACTIVITY:

RESOURCES/REFERENCES:

TEACHER PAGE: DISCUSSING A SCIENCE JOURNAL ARTICLE

Disease severity in children and adults with Pompe disease related to age and disease duration
http://amdapompe.ehclients.com/downloads/publications/Hagemans_Neurology_280605.pdf

Feel free to use any article. This one was selected to model because it is short and not very complicated, which will allow students to focus on the main parts and how to read an article rather than be burdened with jargon and methods during the introduction.

Things to point out:

1. Read the title: Disease severity in children and adults with Pompe disease related to age and disease duration.
2. Note the journal: Neurology. This is a peer-reviewed and highly respected journal.
3. Multiple authors contributed, indicating collaboration among many individuals. In this case, the funding for the project and the main research lab is indicated by the last name listed, Van der Ploeg.
4. In the bottom left, note the institutions represented, who funded the project, and potential conflict of interest. This information is telling regarding any bias that might be apparent or inadvertent.
5. Also, note the date the paper was originally received: Dec. 21, 2004. This is the date it was submitted to the journal. After going through peer review, suggested modifications are sent to the authors for the chance to revise. The revision is then either approved or denied publishing. In this case, it was accepted on March 23, 2005 and appeared in print in June, 2005.
6. The layout of papers differ. Each journal has its own way of arranging the text on the page, as well as specific sections they do or don't want included.

Use the reading guide with the students, calling attention to each section and highlighting key points.

The **Abstract** provides a nice summary of the paper.

- This one is particularly short, reflective of a short paper. 255 individuals with Pompe completed a survey to gather information about the natural course of the disease.

The **Introduction** gives a history of the topic and discusses what others have found. It also poses the research question(s).

- The author devotes the first paragraph to a description of Pompe. This provides background. They then discuss what the current treatment available is – ERT is just in clinical trials (this is why it is important to note the date). The authors want to help determine the ideal time to administer the treatment, so they need to understand the natural course of the disease, particularly for individuals with late-onset.

Methods and Materials are most meaningful to those in the field who might want to repeat the research or to help clarify results. Skip this section, but note that as you become more experienced with reading primary sources, it can be helpful to return to this section to better understand some of the results and discussion.

- Interesting how tiny the font is for the methods section in this journal, indicating this section is really for those that need to know all the details of carrying out the experiment. Not necessary for our students to understand the paper.

Results are just that. There is no discussion or explanation. They are worth a glance, particularly if any tables are included that summarize the findings neatly. Just a skim of this section will suffice.

- Font size is increased a bit, but not as large as the introduction or conclusions. There are a lot of percentages given, and description of the figures. It does give some nice descriptions of the symptoms and pathologies affected individuals reported, and the age of onset.

The **Discussion/Conclusion** is where the author explains what happened. In this section, the questions should be answered. This is usually where the author reflects on the work and its meaning in relation to other findings and to the field in general.

- General findings are discussed such as disease severity increases with duration. This is a progressive disease, so not unexpected. It wasn't correlated with age however, supporting the diverse set of symptoms that present at all ages. Other than the classic infantile form, all other forms are heterogeneous. They do point out the subset of children who were affected very young, as presenting more severe symptoms earlier and consistently: those who are respirator dependent, are likely to be wheelchair dependent. There concluding remarks suggest ERT should be started as early as possible, before "irreversible damage has occurred" such as muscle weakness requiring a wheelchair or respiratory assistance.

Add your own interpretations to these:

- What was the purpose of the study? Compile and analyze data about the natural course of Pompe disease (how does it progress in individuals not on enzyme replacement therapy?)
- What questions were asked? Is there a relation between age of onset, duration, and symptom severity?
- What were the final answers? Only in those presenting symptoms very young is there an expected course; all others present a mix of symptoms.
- What was unique about the study? Surveyed 255 patients, quite a large sample size for a disease so rare, to record the natural history of the disease with one standard questionnaire. Rather than piecing bits of case reports together for the literature, they were able to standardize the questions and therefore the results.
- What is the next step? Compare to the next generation who receives ERT. Does ERT make a difference in severity and duration? Can those who present symptoms early, be treated with enzyme replacement therapy and delay serious symptoms? For how long?

STUDENT PAGE: GUIDE TO READING SCIENTIFIC PAPERS

Scientific papers can be daunting, full of details and language that is unfamiliar. Scientific papers are best read and considered in small, manageable pieces. Unless you plan to repeat the experiment, you really just need to get the general idea of the questions and answers along with the big idea of the paper. As you become more comfortable with reading journal articles, you will naturally read for more depth and content. When starting out however, the key is knowing what to read, what to skim, and what to skip. Yes. There are parts of a paper that you can skip.

The paper is divided into sections, based generally on the scientific method. Most research papers contain the following sections: Abstract, Introduction, Methods/Materials, Results, Discussion, sometimes Conclusions, and References.

The **Abstract** provides a nice summary of the paper. It might have some unknown words or numbers, but it gives the overall flavor of the paper. It should be read and then re-read at the end.

The **Introduction** gives a history of the topic and discusses what others have found. It also poses the research question(s).

Methods and Materials are most meaningful to those in the field who might want to repeat the research or to help clarify results. Skip this section, but note that as you become more experienced with reading primary sources, it can be helpful to return to this section to better understand some of the results and discussion.

Results are just that. There is no discussion or explanation. They are worth a glance, particularly if any tables are included that summarize the findings neatly. Just a skim of this section will suffice.

The **Discussion/Conclusion** is where the author explains what happened. In this section, the questions should be answered. This is usually where the author reflects on the work and its meaning in relation to other findings and to the field in general.

Re-read the Abstract. Does it make more sense now? It should tie everything together.

Vocabulary. You may need to look words up if you can't figure them out using context clues. You can miss a really important point of the paper if you don't understand the language.

In summary:

- Absolutely read the Abstract, Introduction, Discussion, and then the Abstract again.
- Skim the results.
- Skip the methods/materials.

In the end, you want to be able to answer the following questions with some confidence:

- What was the purpose of the study?
- What questions were asked?
- What were the final answers?
- What was unique about the study?

- What is the next step?

STUDENT PAGE: GUIDE TO READING SCIENTIFIC PAPERS WORKSHEET

Name: _____

Paper name: _____

1. What was the purpose of the study?

2. What questions were asked?

3. What were the final answers?

4. What was unique about the study?

5. What is the next step?

LESSON SIX: PROTEOME NOT GENOME, PROTEIN EXTRACTION OF PLANT CELLS IN BIOTETECHNOLOGY

ESSENTIAL QUESTION (S) EQ: How are proteins purified and tested? How can you determine the identity of a protein? What industrial biotechnology analysis equipment is used to develop societal health products?

OVERALL TIME ESTIMATE:

- Advanced Preparation: 45 minutes
- Student Procedure: 100 minutes or two 50-minutes sessions

LEARNING STYLES: Visual, Auditory, kinesthetic

VOCABULARY: (adapted from http://www.dictionary.com)
Trypsin - a proteolytic enzyme of the pancreatic juice, capable of converting proteins into peptides

Denature - to treat (a protein or the like) by chemical or physical means so as to alter its original state

Digestion – the process by which larger molecules are broken down into smaller ones by the action of enzymes

Surfactant - A substance that, when dissolved in water, lowers the surface tension of the water and increases the solubility of organic compounds

LESSON SUMMARY:

STUDENT LEARNING OBJECTIVES:

The student will be able to..

1. Analyze separate proteins with gel electrophoresis, using a simulation program.
2. Explain SDS PAGE separates protein molecules present in a mixture.
3. Describe the relationship between fragment size and migration rate in a gel.
4. Describe the use of mass spectrometers in Proteomics studies.
5. Use bioinformatics by accessing a web-based programs (MASCOT and UniProt) to determine the protein identity from data of protein extracted and purified from plants and processed in a real laboratory setting.

STANDARDS: SC.912.N.1.1, SC.912.N.1.2
AP CHEM LO 5.10, SC.912.N.3.5, SC.912.L.16.10, SC.912.L.18.4, SC.912.N.2.4

LESSON SEVEN: PLANT EXTRACTION IN THE BIOTECHNOLOGY LAB

KEY QUESTION (S):
Advanced Preparation: 30 minutes

- Student Procedure: 45 minutes

LEARNING STYLES: Visual and kinesthetic.

VOCABULARY:

LESSON SUMMARY:

STUDENT LEARNING OBJECTIVES:
The student will be able to...
STANDARDS:
MATERIALS:
BACKGROUND INFORMATION:
IMPLEMENTATION NOTE:

.

ADVANCE PREPARATION:

PROCEDURE:

ASSESSMENT SUGGESTIONS:

EXTENSIONS:
ACTIVITIES:

LITERATURE:

RESOURCES/REFERENCES: