Agricultural Biology Lab Manual

A resource for connecting STANDARDS and LABS in California Agricultural Education.

Developed by:
The Agricultural Education Curriculum Project
California State University, Fresno
Fresno, California
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Agricultural Biology Lab Manual

Major Concepts

- Cell Biology
- Genetics
- Ecology
- Evolution
- Physiology

Other Concepts Included

- Investigation

Resources Referenced

Biology/Life Sciences - Grades Nine through Twelve Science Content Standards
www.cde.ca.gov/be/st/ss/scbiology.asp

Agriculture Content Standards Grades 9-12
http://www.cde.ca.gov/ci/ct/sf/documents/ctestandards.pdf

How to use this Manual

A suggested year plan provides an outline to start planning your agricultural biology class for the year. Online and text resources are provided to enhance your program. The agricultural biology course has been broken into 5 major concepts, according to the Biology/Life Sciences standards. A concept of investigation is also included for a total of 6 concepts included in the manual. Under each concept you will find the standards as well as several labs which can be used to help students master the standards. It is the intent of this manual to provide labs that require minimal resources and practical set up time, which support the goals of the agricultural education program.

Contributing Teachers

This compilation of labs has been produced under a special grant through California State University, Fresno Agricultural Education under the direction of Dr. Rosco Vaughn. Labs were submitted by agriculture teachers throughout California. The sacrifice made by teachers who took the time to share labs they have acquired and/or developed is greatly appreciated and integral in continuing to improve agricultural education in California. Thank you to the following individuals for contributions to this project:

Aaron Albisu, Spring Creek High School, Spring Creek, NV
Amber Madlem & Science Staff at Central Valley High School, Ceres
Amy Schulte, Davis High School
Atwater High School Agriculture Department
Brian Combes, Hanford High School
Christine Dickson, North High School, Bakersfield
Claire Gebers, Merced High School
Daniel Galan, Calexico High School
Diane Prescott, Atwater High School
Elizabeth Knapp, Atwater High School
Heather Opfergelt, Firebaugh High School
Izaskun Zallo, Pleasant Grove High School, Elk Grove
Jamie Sakugawa, Mt. San Antonio College
JessaLee Goehring, Lodi High School
Jill Sperling, Kingsburg High School
Jim Looper, Sheldon High School
John Kohntopp, Elko High School, Elko, NV
Katy Parson, Golden Valley High School, Bakersfield
Krista Vannest, John H. Pitman High School, Turlock
Kristen Machado, East Union High School, Manteca
Laura Mendes, St. Helena High School
Lorilee Niesen, Maxwell High School
Markie Severtson, Calexico High School
Mandi Bottoms, California Agriculture In The Classroom
Maria Rangel, Holtville High School
Ron Sa, Reedley High School
Steven Rocca, California State University, Fresno
Susan Young, Sutter High School
Theresa Noga, Arcata High School

Other Contributing Agricultural Educators

Formatting and Compilation:
A. Mayfield Curriculum Development
http://amayfieldcurriculum.vpweb.com/

Review and Documentation of Standards:
Karen Dalton-Wemp

Labs Submitted by California Polytechnic State University, San Luis Obispo Students:
Dr. Wendy Warner

Editing and Formatting:
Dr. Steven Rocca

Project Director:
Dr. Rosco Vaughn

Ag Biology Year Plan

(37 weeks)* Biology/Life Sciences Standards denoted (BLS). Agriculture Content Standards denoted (AG). Foundation Standards denoted (FDN)

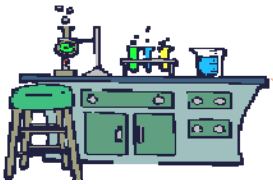
Use this as a template for planning your year. Take the opportunity to write in YOUR CHAPTERS from your selected text book, and make a note of labs you would like to use from the selections provided.

Weeks	Unit	My Chapters	Topic	Standards	Labs
2	Science of Biology & Class Overview		Establish Procedures FFA Involvement Biology Overview	(FDN) 1.2, (AG) C 13.0	
3	Ecology		Biosphere Populations	(BLS) 6 a-g (FDN) 1.1,1.2 5.0, 5.3, 9.0, 9.3 (AG) C 2.0, 3.0, 10.0, 11.0, 11.12, 12.0; D 3.2; E 2.0, 5.2, 5.3, 6.0; F 2.0	
6	Cell Biology		Structure and Function Photosynthesis Cellular Respiration Growth & Division	(BLS) 1 a-j (FDN) 1.2, 4.0, 5.0, 5.3, 10.0 (AG) C 2.6, 3.1, 3.2, 5.0-5.4, 8.1, 9.2, 9.3, 10.2, 11.1-11.6, 13.1, 13.3; G 2.0,	
6	Genetics		Intro to Genetics Mutation & Sexual Reproduction Human Genome & Heredity DNA & RNA	(BLS) 2 a-g, 3 a-d, 4 a-f, 5 a-e(FDN) 1.1, 1.2, 2.2, 2.4 (AG) C 3.3, 4.2, 7.1, 7.3, 7.4, 7.5, 11.1, 11.4,13.3; D 4.0, 4.4, 5.1, 5.2, 5.4; F 3.0, G 2.4, 2.5, 4.0, 11.0	

Second Semester

1	Semester Pre-view	FFA Update and Semester Preview		
4	Evolution	Allele Frequency Darwin's Theory Evolution of Populations History of Life	(BLS) 7 a-f, 8 a-g (FDN) 1.1, 1.2, 5.0 (AG) C 4.1, 4.2, 5.4, 7.1, 7.2, 132.3	
4	Physiology	Internal Stability Structures & Functions Organ Systems Disease Defense	(BLS) 9 a-I, 10 a-f (FDN) 1.1, 1.2, 5.0 (AG) C 6.1, 6.28.1,8.3,9.1-9.4, 13.3; D3.0; F 2.0; G 3.0	
2	Review for Standardized Testing	Review 5 Major Concepts	All	Gallery Learn-Book Be the Teacher
1	Standardized Testing			
4	Controversial Issues/ Mobile Labs	Exploration of controversial issues or areas of student interest. Field Trips/Mobile Labs can effectively be implemented as well.	(AG) D 9.0, E 2.0, E 13.0, G 11.0	
3	Record Keeping & Management	Record Book s Updated and Proficiency Award Applications Completed	(AG) A 4.0,	
1	Finals Schedule			

Online Resources



MUST SEE!!! Biology Junction: Fabulous teacher friendly site! Created by a teacher for teachers, the site has quick links to biology activities, openers, puzzles and handouts correlated with the national science standards. There is even an interactive pacing calendar posted to plan your year. Here is the link: http://www.biologyjunction.com/curriculm_map.htm. (*Note that curriculum is spelled curriculm). Check the main site (www.biologyjunction.com) as well for additional information.

The Science Inquirer newsletter has several links to free resources for science teachers. To access the list, visit *http://scienceinquirer.wikispaces.com/freestuff*.

Reeko's Mad Scientist Lab Welcome to Reeko's Mad Scientist Lab! Your source for free science experiments for parents, teachers, and children of all ages. Be sure to check out the "Real Time World Stats" http://www.spartechsoftware.com/reeko/

Annenberg Media Learner.org

Learner.org is a great resource of information and interactive labs. www.learner.org

MARKETPLACE FOR THE MIND.COM AN AGRICULTURAL EDUCATION RESOURCE

Marketplace for the Mind is a unique, educational resource created by The Pennsylvania Department of Agriculture in cooperation with The Pennsylvania Department of Education. Here you'll find a bounty of current agricultural educational materials aligned to Pennsylvania's Academic Standards, as well as, a wide variety of useful information on Agriculture and Agribusiness! www.marketplaceforthemind.com

MINERAL INFORMATION INSTITUTE

Mineral Information Institute provides free materials, including rock and mineral posters and class activity ideas great for Earth Science. www.mii.org

This link from San Benito High School supports agricultural biology with labs and worksheets. It was made for the CATA skills conference in 2008.
http://www.sbhsd.k12.ca.us/~gbecerra/CATA/onlinehandouts.html

Agripedia.com
What you need, when you need it

This is a great website for agriculture searches, games, livestock breeds, and judging practice.

www.cellsalive.com A great site illustrating the parts of the cell, mitosis, and meiosis. This site can be an interactive opportunity for students to learn and/or review concepts.

www.insectlore.com This site is managed by a local company out of Shafter and provides interactive activities, books, and live kits including ants, butterflies, ladybugs and silkworms.

www.thesciencespot.net Check out the "Science Classroom" for activities and lessons. The site also includes daily trivia, puzzles and an "Idea Factory". This is also a great resource for useful worksheets.

www.classzone.com This site is intended for use with the McDougal Little Biology text, however access to online resources is not restricted. Follow the prompts to select the biology text for California, and then select from Activities, Animated Biology, Labs or any of the other great resources.

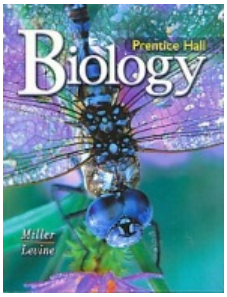
www.microbeworld.com This site is a great resource for biology teachers looking for current news related to biology, career profiles, experiments, and great resources for teachers.

www.brainpop.com This is a fun site with short animated clips (3-5 minutes) on nearly every subject you could think of! Great to use for class warm-ups or reviews. Each cartoon clip is followed by an interactive quiz. There is a subscription fee, but your district might want to do this for all teachers. It is worth checking into!

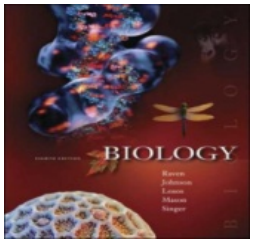
Text Resources

Agricultural Biology:

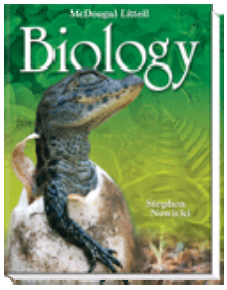
Modern Biology
Holt, Rinehart and Winston



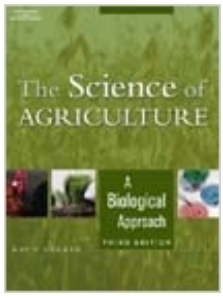
Biology
Prentice Hall



Biology
McGraw-Hill

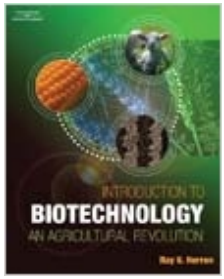


Biology
McDougal Littell

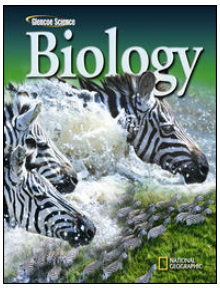


The Science of Agriculture, A Biological Approach

Thomson Delmar Learning

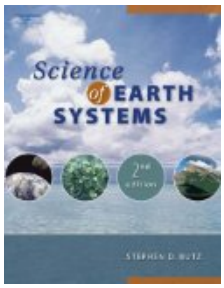


Introduction to Biotechnology, An Agricultural Revolution
Thomson Delmar Learning



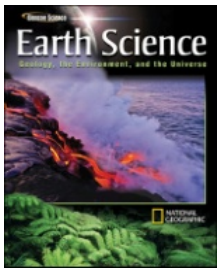
Biology
Glencoe Science

Agricultural Earth Science:

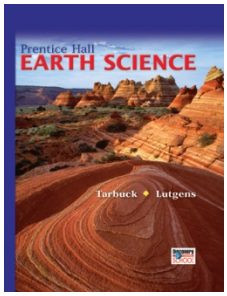


Science of Earth Systems

Delmar

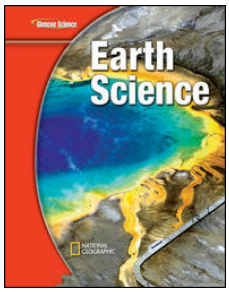


Earth Science: Geology, the Environment, and the Universe Student Edition©2008
McGraw-Hill



Earth Science
Prentice Hall

Earth Science
Holt, Rinehart, Winston



Earth Science
Glencoe Science

Biology/Life Sciences Standards

1. The fundamental life processes of plants and animals depend on a variety of chemical reactions that occur in specialized areas of the organism's cells. As a basis for understanding this concept:
    a. Students know cells are enclosed within semi permeable membranes that regulate their interaction with their surroundings.
    b. Students know enzymes are proteins that catalyze biochemical reactions without altering the reaction equilibrium and the activities of enzymes depend on the temperature, ionic conditions, and the pH of the surroundings.
    c. Students know how prokaryotic cells, eukaryotic cells (including those from plants and animals), and viruses differ in complexity and general structure.
    d. Students know the central dogma of molecular biology outlines the flow of information from transcription of ribonucleic acid (RNA) in the nucleus to translation of proteins on ribosomes in the cytoplasm.
    e. Students know the role of the endoplasmic reticulum and Golgi apparatus in the secretion of proteins.
    f. Students know usable energy is captured from sunlight by chloroplasts and is stored through the synthesis of sugar from carbon dioxide.
    g. Students know the role of the mitochondria in making stored chemical-bond energy available to cells by completing the breakdown of glucose to carbon dioxide.
    h. Students know most macromolecules (polysaccharides, nucleic acids, proteins, lipids) in cells and organisms are synthesized from a small collection of simple precursors.
    i. *Students know how chemiosmotic gradients in the mitochondria and chloroplast store energy for ATP production.
    j. *Students know how eukaryotic cells are given shape and internal organization by a cytoskeleton or cell wall or both.

Lab Reference: Cell Biology

Standards: 1a-j

STANDARD CONCEPT	LAB NAME	LAB NUMBER
Cells	Blood Typing	A-1
Cells	Cell Model Project	A-2
Cells	Fun with Fomites	A-3
Cells	Leaf Anatomy	A-4
Cells	Press Exerted by Germinating Seeds	A-5
Cells	Root Anatomy	A-6
Cells	Stem Anatomy	A-7
Cells	The Cell	A-8
Enzymes	Apple Browning	A-9
Enzymes	Enzymes: Gelatin Lab	A-10
Enzymes	Enzymes: Meat Tenderizer	A-11
Fermentation	Pickle Fermentation	A-12
Fermentation	Root Beer	A-13
Macromolecules	Fat Cells: Raw vs. Homogenized Milk	A-14
Macromolecules	Identifying Organic Compounds in Food	A-15
Macromolecules	Macromolecule – Urinalysis	A-16
Macromolecules	Sweet Talk	A-17
Microscope	Using the Microscope	A-18
Mitosis	Mitosis	A-19
pH	Curds and Whey	A-20
pH	Environmental pH	A-21
Photosynthesis	A Scientific Play Starring…	A-22
Photosynthesis	Photosynthesis Graphic Organizer	A-23
Photosynthesis	Photosynthesis Products	A-24
Photosynthesis	Plant & Animal Relationships/Snail Lab	A-25
Plant Growth	Ag Sudoku	A-26
Transpiration	Transpiration	A-27
Transport	Osmosis	A-28
Transport	Passive Transport	A-29

Biology/Life Sciences Standards	• (BLS) 1.c.
Agriculture Standards	• (AG) C 5.1, C 5.2, and C 5.3. • (Foundation) 1.2 Science, Specific Applications of Investigation and Experimentation: (1.a) and (1.d).

Name_____

Date_____

Blood Typing: Crime Scene Investigation

Purpose

The purpose of this exercise is to demonstrate knowledge of specialized blood cells and the blood typing process.[i ii]

Procedure:

Materials

1. Blood Samples
   **See Teacher's Page*
2. 6 labeled bottles of Anti-A Serum
3. 6 labeled bottles of Anti – B Serum
4. 6 labeled bottles of Rh Serum
5. Biology Text book, with reference to the chapter on blood/blood typing

Sequence of Steps

1. Complete "Pre-lab" questions
2. Read the scenario below. Then, follow the instructions given by your teacher to complete the observation table and solve the crime.

Crime Scenario: You are a criminologist working for the Department of Justice crime lab for your county. You are called to the scene of a murder in town. The victim, John Doe, had apparently walked in on a burglary in progress. It is believed that the criminal, startled by the presence of the victim, attacked Mr. Doe. In his haste, the criminal cut his arm on the broken window that he had used to enter the apartment.

A small piece of clothing stained with the criminal's blood was taken from the scene of the crime. A weapon with a blood sample was also found at the scene. Three suspects have been identified who either knew the victim or were seen in the area before the body was discovered. Your task is to identify the blood type found on the weapon, to see if it indeed was used to kill Mr. Doe, and match the crime scene sample to one of the three suspects. Good luck Detective.

I. Pre-lab Questions:

1. What does a person's blood type tell you? Be specific.

2. Complete the table below. Use your biology text for reference. Find the section on blood typing, and investigate the information relating to antigens and genotypes. Record this information below. Hypothesize the reactions with anti-serums. Clumping will indicate a (+) reaction. *For example, if a blood sample clumps when anti-serum A is added, and does not clump with anti-serum B, it is type A blood.*

Clumping = + (Positive)
No Clumping = - (Negative)

Blood Type	Antigens Present	Genotypes Possible	Reaction w/ Anti-A Serum	Reaction w/ Anti-B Serum
A				
B				
AB				
O				

Rh Serum = Clumping = Rh+ Blood

II. Lab Observations:

Wait for directions from your instructor to proceed to a lab station and begin testing your sample.

Table 1. Blood Agglutination (clumping) results

If the blood sticks together (agglutinates) after an anti-serum is added, then the suspect has that blood type.

	Observations			
Source	Anti-A Serum	Anti-B Serum	Rh Serum	Blood Type
Crime Scene Sample				
Weapon Sample				
Victim – John Doe				
Suspect #1 – John "The Boss" McLittle				
Suspect #2 – Miss Demeanor				
Suspect #3 – J.R. Fitts				

III. Analysis of results

1. Which blood types will clump with the addition of Anti-A serum? Why?

2. Why can't people with Type-O blood receive blood from any other type (A, B, or AB)?

3. Was the weapon found used to kill Mr. Doe? How do you know?

4. Based on the blood typing results, which of the four suspects most likely committed the burglary? Why?

5. Why was it necessary to type the victim's blood?

6. Can you think of some limitations to using blood typing in a criminal investigation?

Teacher's Notes

Materials for 6 kits:

- 2 cups milk
- 2 bottles of food coloring – red and green
- 2 cups water (+ additional water for the serum bottles)
- 18 small cups (Dixie cup size)
- 6 permanent markers
- 6 boxes of toothpicks
- Vinegar
- 18 small dropper bottles
- 6 small plastic storage containers
- Labels for bottles and containers

Preparation

1. Mix 2 cups of milk with 2 cups of water. Add enough red food coloring to get a bright red color and then add a few drops of green to make it a deeper red color which looks more realistic.
2. Label 6 dropper bottles to correspond with the three suspects, the victim, the weapon sample and the crime scene sample. Take time to label each of the 6 storage containers to correspond to the bottles of fake blood. Fill each bottle with the fake blood mixture. Save the extra "blood" in case a group spills their sample.
3. Label 6 dropper bottles with "Anti-A Serum", label six others with "Anti-B Serum", and label the final six "Anti-Rh". Use the information in the chart below to fill the bottles with either vinegar or water. (Note that the contents differ depending on the suspect or sample!) You may want to code the bottles in a way that you can tell the contents easily, but it will not be obvious to the student.

Kit	Anti A	Anti B	Anti-Rh	Blood Type
Crime Scene Sample	Vinegar	Water	Vinegar	A+
Weapon Sample	Water	Water	Vinegar	0+
Victim – John Doe	Water	Water	Vinegar	0+
Suspect #1 – John "The Boss" McLittle	Vinegar	Water	Vinegar	A+
Suspect #2 – Miss Demeanor	Water	Vinegar	Water	B-
Suspect #3 – J.R. Fitts	Vinegar	Vinegar	Water	AB-

4. Create the testing kits by placing the correct bottle of fake blood in each kit along with the correct serums, a permanent marker, 3 small cups, and a box of toothpicks in a small plastic storage container.

Directions:

1. Pass out copies of the student worksheet. Discuss the Crime Summary from the worksheet and go over the directions for the lab.
2. Provide one testing kit for each group of students and have then label the cups in the kit as directed. *NOTE: If you have time, you may want to set up six stations in your classroom and have the groups rotate to the stations to test each blood sample. If you don't have the time to do this, have each group test one of the samples and share their results with the class.*
3. Allow time for the groups to complete the testing of their blood sample as outlined in the directions.

Conclusion:

Through this investigation, students should conclude that the crime scene sample matched suspect #1 (John "The Boss" McLittle) and the weapon sample matched the victim, John Doe.

---

[i] Niesen, Lorilee (2008).Blood Typing, Lab. *Maxwell High School Agriculture Department*.

[ii] Trimpe, T (2006). Ernie's Exit. Retrieved July 24, 2009, from Science Spot Web site: http://sciencespot.net/Media/FrnsScience/bloodtypinglab2wkst.pdf

Biology/Life Sciences Standards	• (BLS) 1.a, 1.b, 1.c, 1.d, 1.e, 1.f, and 1.g.
Agriculture Standards	• (AG) C 5.1, C 5.2, C 5.3, and C 5.4. • (Foundation) 1.2 Science, Specific Applications of Investigation and Experimentation: (1.a).

Name_____

Date_____

Cell Model Project

Purpose

The purpose of this exercise is to evaluate the cell structure of plants and animals, and create a three dimensional model of the cell.[i] In your group design a model that will represent either a plant or animal cell. This project is due on _____.

Procedure:

Materials

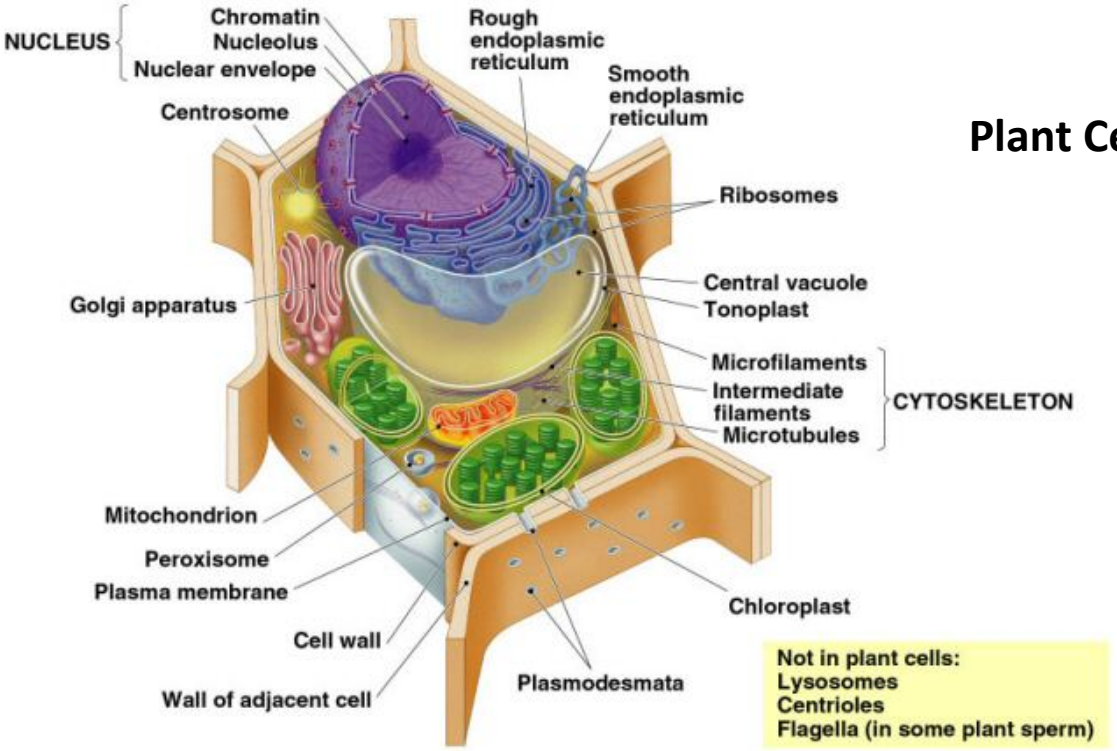
1. Play dough (see recipe)
2. Cardboard base
3. Materials of your choice (No food items)

Sequence of Steps

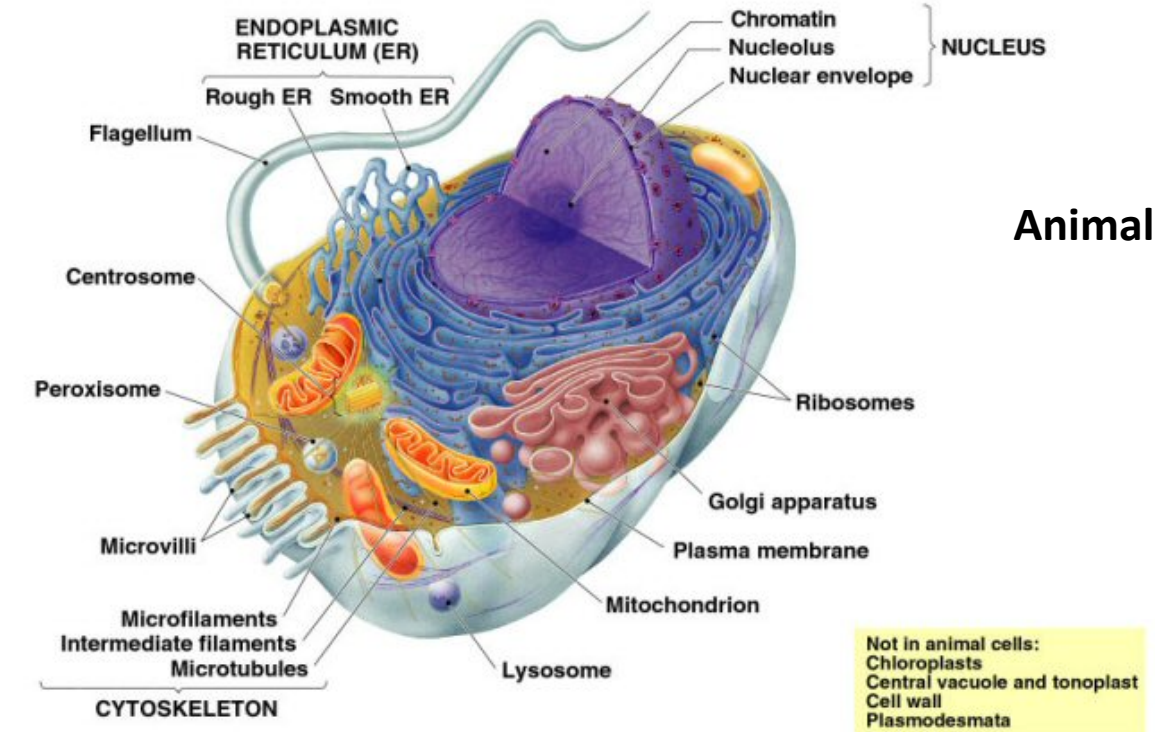
1. For your project construct a 3-dimensional eukaryotic plant or animal cell that includes the organelles listed in the table below. Your cell must show all of the cellular organelles listed on the table. These organelles should be labeled. NO FOOD ITEMS MAY BE USED IN THE CONSTRUCTION OF YOUR CELL MODEL!
2. You must include a short paper with a sketch of your model and a brief explanation of the function of each of the cellular organelles that you constructed.
3. In the construction of your model you will create the various organelles of your cell using play dough (recipe is attached). The type of cell you create (animal or plant) determines which organelles you need to create.
4. Each group member must bring in the necessary colors of play dough to create your model. You will create your model on pieces of cardboard.

Cellular Organelles		
Cell Membrane	Nucleus	Nucleolus
Cell Wall (plants)	Chromatin	Rough ER
Smooth ER	Attached Ribosomes	Mitochondria
Chloroplasts (plant)	Lysosomes	Golgi Apparatus
Cytoplasm	Free Ribosomes	Centrioles (animal)
Vacuoles	Nucleolus	Nuclear Envelope

Plant Cell



Animal Cell



Play dough Recipe

1/4 cup salt
1 cup flour
1/4 cup water
Food coloring

Mix the flour and salt in a bowl then add water. Knead and squeeze the dough to make a clay consistency. You may need to add more water.

[i] Opfergelt, H (2008).Ag Biology Cell Model Project. *Firebaugh High School Agriculture Department*.

Biology/Life Sciences Standards	• (BLS) 1.a, 1.b, 1.c, 1.d, 1.e, 1.f, 1.g, and 10.a.
Agriculture Standards	• (AG) C 9.2 and C 13.3. • (Foundation) 1.2 Science, Specific Applications of Investigation and Experimentation: (1.a), (1.c), and (1.d).

Name_____

Date_____

Fun with Fomites

Purpose

The purpose of this exercise is to test a chosen fomite for the presence of microbes and the effects of a disinfectant by growing colonies of bacteria in a medium on petri plates.

Background

"Fomites? What are fomites? This is a term for any inanimate object that can carry disease-causing organisms. Your cutting board, kitchen sink, the change in your pocket and even that pen you keep putting in your mouth are all fomites. Very few things we encounter in our everyday activities are sterile, or microbe-free, including us. At birth, microbes immediately begin colonizing our bodies as they do most every object in the world. They float around until they come in contact with a surface that offers food and shelter. You are most likely to find microbes in and on dark, moist objects that frequently come into contact with food, dirt or vegetation. Bathroom surfaces, hairbrushes, refrigerators, kitchen sinks and cutting boards often have lots of microbes on them. But doorknobs and walls have fewer because they are nutrient-poor and dry.

Most of the microbes on our bodies and other surfaces are harmless, but some are pathogenic or disease-causing. For this reason, we want to control the number of microbes around us. The odds of becoming infected increase with the number of microbes on surrounding objects. But what can we do to affect the number of microbes on surfaces around us?

In this activity, you will test a chosen fomite for the presence of microbes and the effects of a disinfectant by growing colonies of bacteria in a medium on petri plates. A medium has food, vitamins and salts that help microbes grow. You usually don't see bacterial colonies like those that form on petri plates on everyday surfaces. That's because there is rarely such a perfect concentration of nutrients on fomites in nature."[i]

Procedure:

Materials

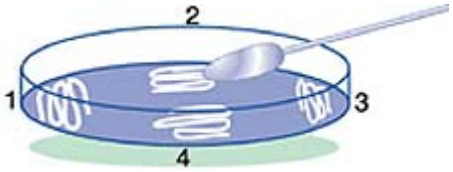
1. 3 sterile petri plates prepared with nutrient agar (can be ordered from Carolina Biological Supply Co. by calling 800-334-5551)
2. unopened box of sterile cotton swabs
3. paper towels
4. cellophane tape
5. permanent marker or grease pencil
6. a disinfectant such as 70% alcohol solution (mix 7 parts alcohol to 3 parts water), 10% bleach solution (mix 1 part bleach to 9 parts water), liquid soap, Lysol® or other household cleanser

Sequence of Steps

1. Clean your work area by dabbing, not pouring, disinfectant solution onto a paper towel and swabbing your area. Set out your petri plates but DO NOT OPEN THE PLATES UNTIL YOU'RE TOLD.

2. Choose an object in the room (doorknob, picture frame, toy, kitchen counter, TV remote control, coin, etc.). Take one unopened petri plate and using your grease pencil or marker, divide the bottom of the plate into four equal sections. Write the object's name across the top and label the sections 1 through 4. Open the box of cotton swabs and select one being careful not to touch the tip. Swab your chosen object with all sides of the swab tip by turning and twisting the swab as you move it across the object's surface.

3. Now open the lid of the plate and GENTLY make four streaks on the plate's surface as shown in the illustration, starting in the section labeled "1" and continuing streaking in order of the sections, making your last streak in section 4. Use firm, but GENTLE pressure and do not retrace your previous streaks. Your streaks should make only very slight impressions in the agar—don't gouge. Close the plate and seal it shut with two pieces of tape placed along the side—don't cover over the top with tape or you won't be able to see the inside of it well.



4. Divide a second unopened petri plate into 4 sections numbered 1 through 4 and label it "Control." Clean half of the object you swabbed with a paper towel dampened with plain water—just wipe a couple of times; don't scrub. Using a new cotton swab, swab the cleaned area for microbes. Open the lid of the second plate and GENTLY make 4 streaks on the plate's surface, following the order of the numbered sections as you did previously. Close the plate and seal it.

5. Divide your third petri plate into 4 numbered sections and label it with the name of the disinfectant you've chosen (e.g. "Bleach"). Use your chosen disinfectant to clean the other half of the object you swabbed. Using another new cotton swab, swab the area for microbes. Repeat the process of streaking the plate. Close and seal the plate.

6. Soak the used cotton swabs in disinfectant and throw them away. Place your plates in an out of the way spot and let them incubate at room temperature for two days. Clean your work area with disinfectant solution. Wash your hands.

7. After two days have passed, look at your initial petri plate. Do not open it. Examine your other petri plates in turn without opening them. Create a table that compares the plates made before and after cleaning the object. Be sure to indicate whether microbes grew in each streak.

8. Very carefully open the petri plates in a sink and flood them with undiluted bleach or alcohol. Let stand for an hour and then rinse them out thoroughly, tie them in a plastic bag and throw them away. Be sure not to touch the plate surfaces when you open them and wash your hands thoroughly after handling the plates. Clean your work area with disinfectant solution.

9. Answer the questions under "observations".

Observations

Table 1

Place an "x" in the growth row under each streak number that showed growth.

	Plate 1				Plate 2				Plate 3			
Streak	1	2	3	4	1	2	3	4	1	2	3	4
Growth												

1. Which plate grew the most and biggest colonies? Why do you think that is?

2. Do you see a pattern in the size and amount of colonies in each plate?

3. How can we control microbial contamination?

4. If you tested more than one fomite, which one grew more microbes? Why is that?

5. Agriculture application: Complete the table below, identifying fomites which can carry disease causing organisms in a production environment.

Scenario: Hog production facility		
	Fomites	Ways to control or sanitize
Housing Facilities		
General Sanitation		
Other		

[i] (2006). Fun with Fomites. Retrieved January 19, 2009, from American Society for Microbiology Web site: http://www.microbeworld.org/resources/experiment/experiment_%20fun_with_fomites.aspx

Biology/Life Sciences Standards	•(BLS) 1.a and 1.j.
Agriculture Standards	•(AG) C 5.2, C 11.1, C 13.3, G 3.1, G 3.4, G 3.5, and G 10.1. •(Foundation) 1.2 Science, Specific Applications of Investigation and Experimentation:(1.a) and (1.d).

Name_____

Date_____

Leaf Anatomy

Purpose

The purpose of this exercise is to study the structure of a typical plant leaf and to learn the function of each part. [i]

Procedure:

Materials

1. Microscope
2. Prepared slides of leaf cross section
3. Colored pencils
4. Models/charts of leaf structure

Sequence of Steps

Microscope examination of a leaf

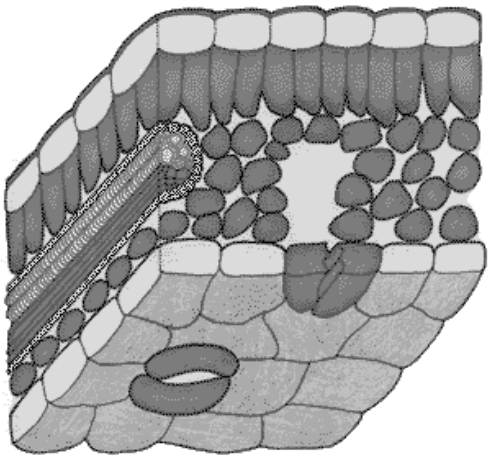
1. Obtain a prepared slide of a cross section of a leaf.
2. Place the slide on the microscope stage centered over the light opening.
3. Focus with the low power objective lens.
4. Using class examples and your textbook, examine the slide carefully. Check the *italicized* items off below as you identify them with the microscope.
5. You should see a top and bottom layer of protective cells. The top layer is *Upper Epidermis*, a continuous layer. The bottom layer is the *Lower Epidermis*. The lower epidermis has small openings called *Stomata*, with specialized cells around the openings called *Guard Cells*.
6. Usually, a very thin layer of waxy material called the *Cuticle* can be seen above the upper epidermis and below the lower epidermis. The cuticle may be seen better under high power.
7. Just below the upper epidermis is the layer of tightly packed columnar shaped cells. This is the *Palisade Layer*. It is usually only one or two cell layers thick.
8. Below the palisade layer are several layers of irregularly shaped cells called *Spongy Layer*. Between the cells of the spongy layer are many *Air Spaces*.
9. Search the slide to find an area of the leaf where there is a compact bundle of cells. This is a *Vein*.
10. Examine the vein under high power. Several different types of cells can be seen. The ring of cells around the vein is he *Bundle Sheath*. Inside the bundle sheath look for thick walled cells of *Xylem*. Cells with relatively thin walls are *Phloem*.

Label and color the drawing of the leaf cross section as follows

1. Upper and lower epidermis – light green
2. Cuticle – Yellow
3. Palisade and spongy layers – dark green
4. Air spaces and stomata – blue
5. Guard cells – orange
6. Bundle sheath – brown
7. Xylem – red
8. Phloem – purple

Observations

1. Diagram of a leaf cross section – Identify parts as directed above.



ii

Conclusions

1. Briefly describe the function of each of the following structures:
    a. Cuticle: _____
    b. Upper epidermis: _____
    c. Lower epidermis: _____
    d. Stomata: _____
    e. Guard Cells: _____
    f. Palisade layer: _____
    g. Spongy layer: _____
    h. Vein: _____
    i. Bundle sheath: _____
    j. Xylem: _____
    k. Phloem: _____

2. What is the function of the leaf?

3. How does the shape and internal organization of a plant cell help the leaf carry out important functions?

4. List and explain how 2 specific cells/groups of cells in the leaf help regulate interactions with their surroundings.

5. Examining the leaf structure, determine the role leaves play in helping a plant absorb water. How does this impact irrigation practices?

[i] Agricultural Biology Curriculum Lesson Plans. Sacramento: California State Department of Education, Agriculture Education Unit, 1990.
[ii] "The World of Plants." Making Food. Bitesize Biology. 3 Oct 2008 <www.bbc.co.uk/.../making_food_rev5.shtml>.

Biology/Life Sciences Standards	• (BLS) 1.a.
Agriculture Standards	• (AG) C 5.3, C 11.1, C 11.2, and C 11.3. • (Foundation) 1.2 Science, Specific Applications of Investigation and Experimentation: (1.a), (1.c), and (1.d).

Name_____

Date_____

Pressure Exerted by Germinating Seeds

Purpose

The purpose of this exercise is to observe the pressure exerted by germinating seeds.[i]

Procedure:

Materials

1. Lima bean seeds
1. Dry sand
2. Glass jar with lid
3. Cloth towel or heavy duty zip-lock bag

Sequence of Steps

1. Place an equal amount of beans and sand in a jar. Shake the jar to mix the beans and sand completely. Push the sand in tightly. Fill the jar to the top with sand.
2. Wet the sand, but do not put enough water into the jar to flood it.
3. Screw the lid on tightly (it does not have to be airtight). Place a cloth towel over the jar(s) or place the jar(s) in a zip-lock bag and place the jar(s) in a large pan in an area away from students. (Note: the jar(s) will not explode, but will crack and sometimes crumble).
4. Record your observations.

Observations

1. Describe your observations.

Analysis:

1. Why did you use sand in the experiment?

2. Could this experiment have worked with any kind of seed?

3. Can this experiment work with glassware of any thickness?

4. What do you think happens inside the seed, at the cellular level, that creates enough pressure to crack a glass jar?

5. Identify one way that cells regulate their interaction with their surroundings.

Teacher's Notes

Pressure Exerted by Germinating Seeds
Purpose of Lab

The purpose of these experiments is to observe the pressure exerted by germinating seeds.

Background

Many times, as teachers, we gloss over the impact seed germination has on the formation of soil. This little experiment will illustrate just how tough the germination of seeds can be. It is not to say that seeds can be thrown out into any soil and 100% germination will occur, this lab is simply showing that the water absorbed by the seed is powerful.

Safety precautions must be taken. Although the glass jars should only crack, there is the outside chance that the glass may fracture in a way that someone handling the jar could be injured.

It only takes a few hours for the seeds to absorb the water. The instructor may want to have the class set up the experiment, but not add the water. The instructor may want to add the water and seal the jars the next morning so that the class can observe the actual exertion of the germinating seeds during their class period.

Materials needed

Lima bean seeds
Dry sand
Glass jar with lid
Cloth towel or heavy duty zip-lock bag

Procedure

1. Place an equal amount of beans and sand in a jar. Shake the jar to mix the beans and sand completely. Push the sand in tightly. Fill the jar to the top with sand.
2. Wet the sand, but do not put enough water into the jar to flood it.
3. Screw the lid on tightly (it does not have to be airtight). Place a cloth towel over the jar(s) or place the jar(s) in a zip-lock bag and place the jar(s) in a large pan in an area away from students. (Note: the jar(s) will not explode, but will crack and sometimes crumble).
4. Record your observations.

<u>THE JAR CRACK, AND WATER OOZED FROM THE CRACK or THE JAR CRACK, AND</u>

<u>NOTHING HAPPENED UNTIL THE NEXT DAY WHEN THE JAR FELL APART or THE JAR DID</u>

<u>NOT CRACK OR CRUMBLE, IT COULD BE THAT THE LID WASN'T SEALED</u>.

Analysis:

1. Why did you use sand in the experiment? SAND IS INERT AND ANY WATER WILL BE ABSORBED BY THE SEEDS; ALSO SAND IS LARGE ENOUGH TO ALLOW FOR WATER TO BE ADDED TO THE SEED/SAND MIX SO THAT THE SEEDS WILL ABSORB THE WATER.
2. Could this experiment have worked with any kind of seed? YES, LET'S TRY . . . .
3. Can this experiment work with glassware of any thickness? GOOD QUESTION, LET'S TRY . . . .
4. What do you think happens inside the seed, at the cellular level, that creates enough pressure to crack a glass jar? The seed absorbs water for its metabolic processes, embryo expansion, and radicle and hypocotyl growth (at this point in the plant's life the plant is considered to be heterotrophic (receiving food from another source; not until photosynthesis begins does it become autotrophic.) The embryo absorbs the water and swells (the embryo was almost completely dry, almost dehydrated, prior to absorbing water. With the absorption of oxygen by the seed, (that's why we don't want the jar to be water-logged), energy is made available for growth in the embryo. Food has been stored in the endosperm or in the cotyledons and is broken down by enzymes. The radicle, (the root), is the first part of the embryo to break through the seed coat. The hypocotyls lengthen bringing the cotyledon (monocotyledons; grasses) or cotyledon**s** (legumes or dicotyledons) above the surface of the soil.

[i] Dickson, Chris (2008).Pressure Exerted by Germinating Seeds, Lab. *North High School, Bakersfield Agriculture Department*.

Biology/Life Sciences Standards	• (BLS) 2.b.
Agriculture Standards	• (AG) C 5.1, C 5.2, C 5.3, C 11.1, and C 13.3. • (Foundation) 1.2 Science, Specific Applications of Investigation and Experimentation: (1.a) and (1.d).

Name_____

Date_____

Root Anatomy

Purpose

The purpose of this exercise is to examine the cells and tissues of a mature root and identify the regions of the root after secondary thickening.[i]

Procedure:

Materials

1. Prepared slides of a cross section of root and carrot
2. Knife
3. Hand lens/ Magnifying glass

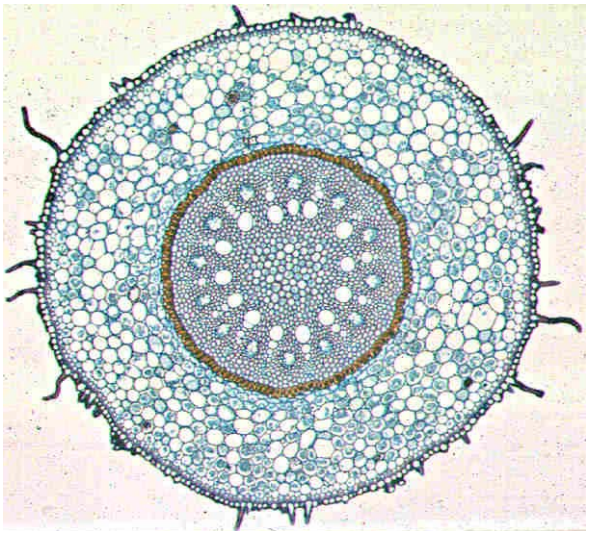
Sequence of Steps

1. Examine a cross section of a mature root under low power and high power. Compare your sample with the picture in "observations".
   a. In "observations", label the following parts on the mature root: epidermis, cortex, endodermis, and pericycle.

2. Using an ordinary carrot, take a sharp knife and carefully slice the root lengthwise. Be careful to make the cut through the center of the root, since that region contains one of the important tissues of this organ.
   a. Before examining the inner tissues, look on the outside of your root and find the secondary roots.
   b. Find the crown, which is the point where the stem joined the top of the root and from which leaves arose.
   c. In "observations", complete an external, longitudinal and cross section illustration of the carrot.

Observations

1. Label the parts of the cross section of mature root.[ii]



2. Illustrations of carrot sample

External Outline Longitudinal Section Cross Section

Conclusions:

1. In the slide, how many cells thick is the epidermis?

2. Count the number of cortex cells from the epidermis to the central cylinder on 2 opposite sides of the root. What is the average cell thickness of the cortex?

3. Are intercellular spaces present in the cortex of your section?

4. How many cells thick are the endodermis and the pericycle?

5. What are the 2 conduction tissues that lie in the central cylinder?

6. What are the most important functions of roots?

7. How are more root cells made? (Mitosis or Meiosis) Explain

8. Agriculture Application: Why are roots important for plant growth?

9. How do production agriculturists (farmers) help roots grow? Brainstorm at least 2 ideas.

[i] Agricultural Biology Curriculum Lesson Plans. Sacramento: California State Department of Education, Agriculture Education Unit, 1990.
[ii] Grech, Josephine Ebejer. "Transport in Plants." 3 Oct 2008 <www.nsci.plu.edu/.../images/mono_root.jpg>.

Biology/Life Sciences Standards	• (BLS) 2.b.
Agriculture Standards	• (AG) C 5.3 and C 11.1. • (Foundation) 1.2 Science, Specific Applications of Investigation and Experimentation: (1.a).

Name_____

Date_____

Stem Anatomy

Purpose

The purpose of this exercise is to use a diagram to identify the parts of an herbaceous stem (dicot). You will color and label the parts of the diagram. You will also identify the many different cells of the stem by examining prepare slides.[i]

Procedure:

Materials

1. Diagrams & models of stems
2. Microscope
3. Prepared stem slides
4. Colored pencils

Sequence of Steps

Examining the Herbaceous Stem

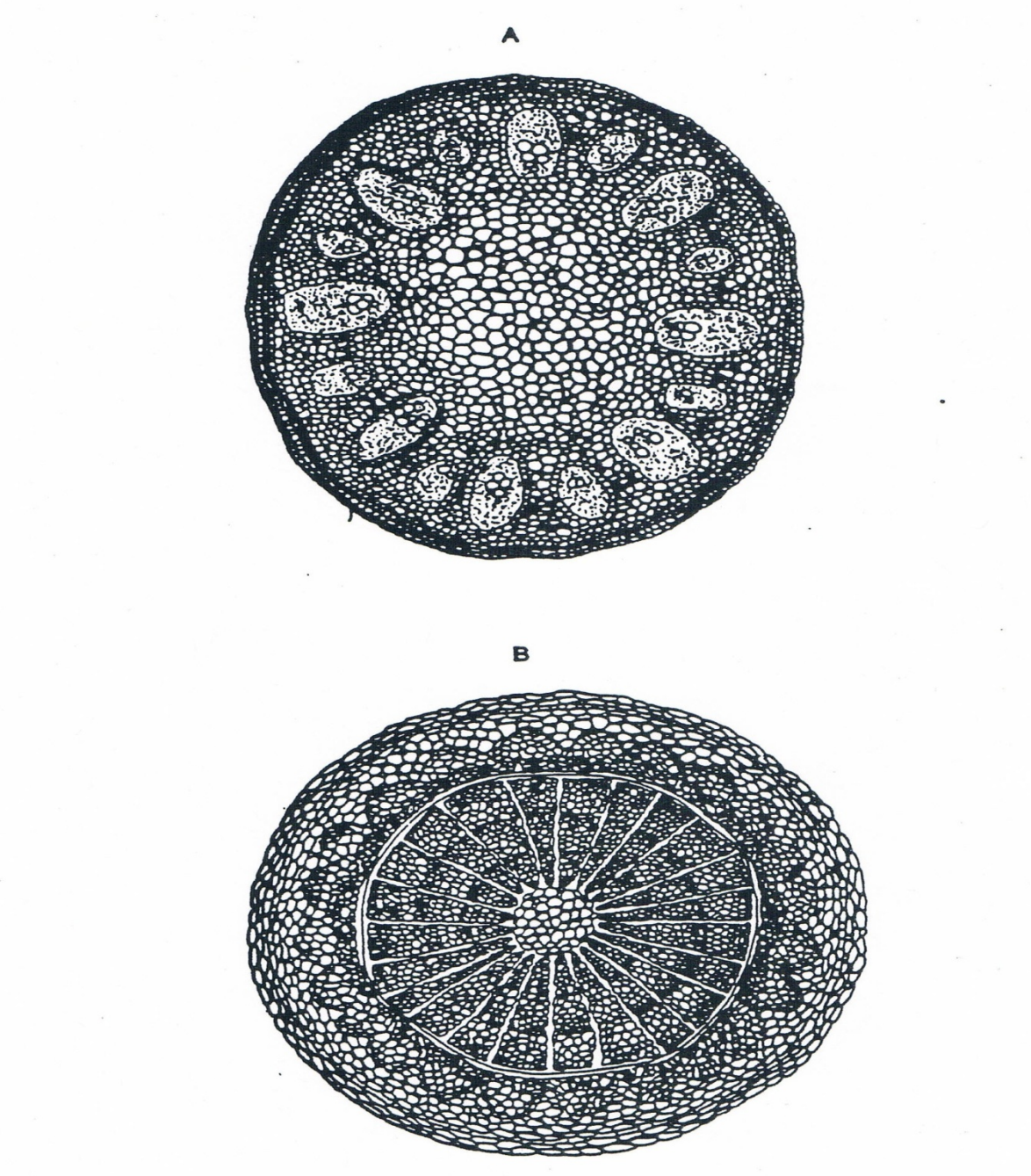
1. Find Diagram A in this lab and look at it closely. This is an herbaceous stem. All herbaceous stems have the same design.
2. The first layer of cells found on the outside of an herbaceous stem is called the *Epidermis.* This is a layer of cells to help protect the plant from loss of water and infection. It is usually 2 cells thick. Label and color the *Epidermis* yellow on your diagram.
3. As we look deeper into the center of the stem, the next layer of cells is called the *Cortex*. This is usually 4 or 5 layers thick and helps protect the stem from structural damage. It is hard and spongy. Label and color the *Cortex* blue.
4. The next layer of cells is the most important in the stem. They are found in groups of cells that are in a circle along the edge of the stem. These round structures are called *Vascular Bundles*. They help to transport water and food in the plant. Label the *Vascular Bundles*.
5. There are 2 kinds of cells in the Vascular Bundles. The smaller is called the *Phloem*. These tubular cells carry the food produced by the plant. Label the *Phloem* and color these cells brown.
6. The other kind of cells found in the Vascular Bundles is called *Xylem*. These cells carry water in the plant. They are larger and thicker walled. Label the *Xylem* and color them red.
7. The cells between each of the Vascular Bundles are small and look like a line connecting these bundles. These cells are called the *Cambium*. They are the dividing place between Xylem and Phloem. Notice that the Xylem is on the inside and the Phloem is on the outside. Label the *Cambium*.
8. The middle of the herbaceous stem is called the *Pith*. This is the filling of the stem which gives support. Label and color the *Pith* orange.
9. Obtain the prepared slide of the herbaceous stem from your instructor and find the following parts: epidermis, cortex, vascular bundles, xylem, phloem, cambium, and pith.

Examining the woody dicot stem:

1. Find diagram B. This is a woody stem. All woody stems have the same basic design.
2. The first kind of cell is called the *Cork*. This layer is the first defense against disease and destruction. Label and color the layer of 3 cells that make up the *Cork* yellow.
3. The next layer of cells found is a 2 or 3 celled layer called *Cork Cambium.* This is where new cork is made when needed. Label and color the *Cork Cambium* blue.
4. The next group of cells makes up the *Cortex,* a protective layer between the cork cambium and the next kind of cells. Label and color the *Cortex* green.
5. The wavy group of cells that go all the way to the inside circular bundle are called *Phloem*. These cells carry food in the plant. Label and color the *Phloem* brown.
6. The line that forms a circle next to the phloem is called the *Vascular Cambium*. This layer makes new phloem and xylem as the stem grows. Label the *Vascular Cambium*.
7. The cells found inside the pie-like shapes are called Xylem. As water changes during the season, new xylem is made causing the stem to grow. The newest xylem is next to the vascular cambium. Old xylem is called wood. Label and color the xylem cells red.
8. The very center of the stem has a group of cells called the *Pith*. The *Pith* is the core of the stem and provides structure. Label and color the *Pith* orange.
9. Obtain the prepared slide of a woody dicot stem and find the following parts: cork, cork cambium, cortex, phloem, vascular cambium, xylem and pith.

Observations

1. Label and color all parts as directed above.



Conclusions

1. What is the function of the cambium?

2. What is the function of the xylem?

3. What is the function of the phloem?

4. How is the woody stem better designed for growing from year to year than the herbaceous stem?

5. What is another name for old xylem that no longer transports water?

6. By what process are new cells made as the stem grows? Explain.

[i] Agricultural Biology Curriculum Lesson Plans. Sacramento: California State Department of Education, Agriculture Education Unit, 1990.

Biology/Life Sciences Standards	• (BLS) 1.a.
Agriculture Standards	• (AG) C 5.4. • (Foundation) 1.2 Science, Specific Applications of Investigation and Experimentation: (1.a) and (1.d).

Name_____

Date_____

The Cell

Purpose

The purpose of this exercise is to study and compare the structures of several different animal and plant cells; to be able to identify the common parts of a cell; to be able to see that plants and animals are composed of cells.[i]

Procedure:

Materials

1. Microscope
2. Glass slides & cover slips
3. Forceps/Tweezers
4. Medicine droppers
5. Scissors
6. Toothpicks
7. Methyl blue die
8. Iodine
9. Onion
10. Elodea
11. Pond water or trough water
12. Assorted prepared slides if available

Sequence of Steps

1. Cheek Cells (animal cells)
   a. Place a small drop of water in the center of a clean glass slide.
   b. Touch the tip of the medicine dropper from the methyl blue bottle to this drop of water.
   c. With a clean toothpick, gently scrape the inside lining of your cheek. Stir this into the water on the slide.
   d. Place a cover slip on the slide and place the slide on the stage of the microscope. View under low power.
   e. Switch to high power. Under "observations" draw 2 or 3 of the cheek cells you observe and label the following parts: cell membrane, cytoplasm, nucleus, vacuoles, and mitochondria.

2. Onion Cells (plant cells)
   a. Place a small drop of iodine on the center of a clean glass slide.
   b. Use the forceps to peel a small (1-2mm) piece of the onion skin from the inside of a section of the onion.
   c. Place the onion specimen in the iodine on the slide and cover with a cover slip.
   d. View under low power and switch to high power. Make drawings of 2-3 onion skin cells and label the following parts: cell wall, cell membrane, cytoplasm, nucleus, and vacuoles.

3. Elodea Leaf (plant cells)
    a. Place a drop of water on a clean glass slide.
    b. Cut a small section of leaf from the Elodea plant and place it in the water on the slide. Cover with a cover slip.
    c. View under low power then switch to high power.
    d. Make a record of any activity you observe. Look for movement of cytoplasm with chloroplasts in it. Record what you see in "observations".
    e. Make drawings of 2-3 Elodea cells and label the following: cell wall, cell membrane, cytoplasm, nucleus, chloroplasts.

4. Pond Water (various kinds of cells)
    a. Place a drop of pond water on the center of a clean glass slide.
    b. Place several strands of cotton on the water in a criss cross pattern. This will act as a net to catch fast swimming organisms!
    c. Place a cover slip over the pond water. View under low power, then switch to high power.
    d. Make drawings of at least 4 different kinds of cells or organisms you observe under the microscope.
    e. Using references available from the teacher, try to identify the organisms you observed.

5. Assorted Prepared Slides
    a. Select 2 prepared slides to view.
    b. View the slide under low power, then switch to high power.
    c. Make drawings of the 2 organisms or cell types in "observations", and place their names below the drawings

Observations

1. Cheek Cells: Magnification = _____
   Illustrate:

2. Onion Cells: Magnification = _____
   Illustrate:

3. Elodea Cells: Magnification = _____
   Illustrate & describe the movement you observed:

4. Pond Water: Magnification = _____
   Illustrate and identify:

5. Assorted Slides: Magnification = _____

Conclusions:

1. Compare and contrast the cells you observed.
   What are the similarities? What are the differences?

2. What differences did you see between cheek and onion cells?

3. What differences did you see between cheek and Elodea cells?

4. What differences did you see between onion and Elodea cells?

5. Why do you believe there are differences between the onion and cheek cells?

[i] Agricultural Biology Curriculum Lesson Plans. Sacramento: California State Department of Education, Agriculture Education Unit, 1990.

Biology/Life Sciences Standards	• (BLS) 1.b.
Agriculture Standards	• (AG) C 3.2. • (Foundation) 1.2 Science, Specific Applications of Investigation and Experimentation: (1.a) and (1.d).

Name_____

Date_____

Apple Browning

Purpose

The purpose of this exercise is to evaluate the rate of fruit browning with emphasis on quality for commercial resale.[i]

Procedure:

Materials

1. Browning Scale (Generated by students 1 day prior to lab.)
2. Apple (1 per student/group)
3. Knife
4. 2-3 plastic (Ziploc) bags (per student/group)
5. Digital Camera and printer

Sequence of Steps

1. Review support article provided entitled "Twelve Easy Pieces"[ii].
2. Slice an apple.
3. Do not treat the apple in any way.
4. Divide slices into 2-3 Ziploc bags.
5. Every 10 minutes take a photo of the apple.
6. Print the photos. Use the photos to decide (as a class) the amount of browning on a scale from 1-5. Anything greater than 3 cannot be sold commercially.
7. Place photos and scale in a binder or another easily accessible area in the classroom.
8. Record observations and complete review questions.

Observations

1. Describe your observations, clearly stating what you saw during this experiment.

2. Why were several bags/samples used for this experiment?

3. Based on your background knowledge, what causes browning in apples?

4. Describe the role played by enzymes in the process of apple browning.

5. What are some methods or new technology which may be employed to prevent browning in the food science sector of the agriculture industry?

[i] Bottoms, Mandi (2008). No One Likes a Bad Apple. *Student, California Polytechnic State University, San Luis Obispo*.
[ii] Mooallem, J.Twelve easy pieces. (2006, February 12). *New York Times*.

Biology/Life Sciences Standards	• (BLS) 1.b.
Agriculture Standards	• (AG) C 3.2 and C 13.3. • (Foundation) 1.2 Science, Specific Applications of Investigation and Experimentation: (1.a) and (1.d).

Name_____

Date_____

Enzymes: Gelatin Lab

Purpose

The purpose of this exercise is to evaluate the effect of enzymes.[i]

Procedure:

Materials

1. Gelatin dessert
2. Hot water
3. Small dishes
4. Small pieces of fresh pineapple
5. Canned pineapple

Sequence of Steps

1. Prepare a box of gelatin dessert and pour the mixture into small dishes.
2. Label half of the dishes "fresh" and half of the dishes "canned".
3. Add one small piece of freshly cut pineapple to each of the "fresh" dishes.
4. Add one small piece of canned pineapple to each of the "canned" dishes.
5. Place the gelatin dishes in the refrigerator overnight.
6. Observe the dishes and record your observations.

Observations

1. Illustrate your observations after the gelatin has settled overnight.

Fresh

Canned

2. Describe, using complete sentences, your observations. Compare and contrast the gelatin with fresh pineapple and the gelatin with canned pineapple.

3. Explain your observations. Why do you think this happened?

4. Define enzyme:

5. Identify at least two ways enzymes can be beneficial to agricultural producers or processers.

6. Identify at least two ways enzymes can be detrimental (harmful) to agricultural producers or processers.

7. What factors can slow or speed up the activities of enzymes?

Teacher Notes

*****The gelatin with the canned pineapple will be solidified. The gelatin with the raw pineapple will be liquid.

* Enzymes in the canned pineapple were destroyed by heat and could not digest the gelatin. Enzymes in the raw pineapple were intact and digested the gelatin protein.[ii]

[i] Mendes, Laura (2008). Enzymes, Lab. *St. Helena High School Agriculture Department*.
[ii] (2002). *Modern Biology*. Austin, TX: Holt, Rinehart, and Winston.

Biology/Life Sciences Standards	•(BLS) 1.b.
Agriculture Standards	•(AG) C 3.2 and C 13.3. •(Foundation) 1.2 Science, Specific Applications of Investigation and Experimentation: (1.a) and (1.d).

Name_____

Date_____

Enzymes: Meat Tenderizer

Purpose

The purpose of this exercise is to evaluate the effect of enzymes on meat.[i]

Procedure:

Materials

1. Meat samples (beef)
2. Tenderizer - dry
3. Scissors/knife
4. Paper towels or plates
5. Container to boil water
6. Water
7. Incubator (capable of holding temperature at 32˚ C / 90˚F)

Sequence of Steps

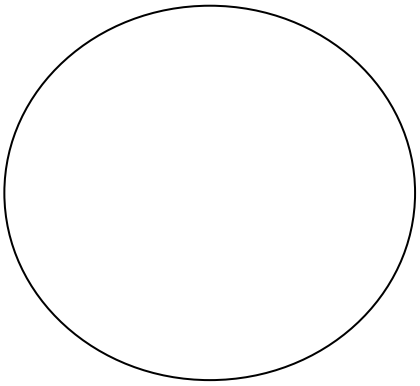
1. Cut fibrous meat into four one inch cubes.
2. Place each cube on a separate towel/plate.
3. Sprinkle three of the cubes with equal amounts of the tenderizer, which contains a protein-splitting enzyme called papain.
4. Label the samples as follows:

Refrigerator	**Room Temperature**
Incubator at 32˚ C	**Boiled Mixture**

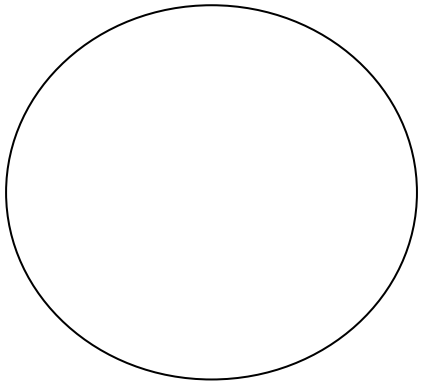
5. According to their labels, place one cube in the refrigerator, leave one at room temperature, and place one in an incubator at 32˚C.
6. For the fourth cube, place the same amount of meat tenderizer and a few tablespoons of water in a container. Boil the mixture for three minutes. Pour the boiled mixture on the meat.
7. After at least three hours, observe the texture of the four meat samples and record observations.

Observations

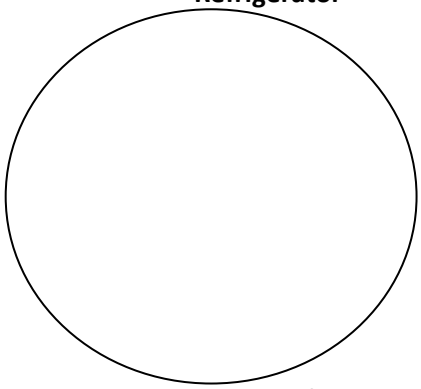
1. Illustrate your observations after the samples have set for at least 3 hours.



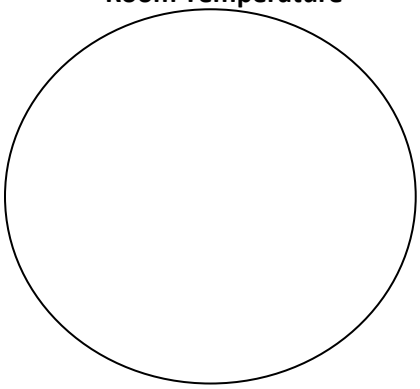
Refrigerator



Room Temperature



Incubator at 32˚ C



Boiled Mixture

2. Describe, using complete sentences, your observations. Compare and contrast the samples.

3. Explain your observations. Why do you think this happened?

4. Define enzyme:

5. Identify at least two ways enzymes can be beneficial to agricultural producers or processers.

6. Identify at least two ways enzymes can be detrimental (harmful) to agricultural producers or processers.

7. What factors can slow or speed up the activities of enzymes?

[i] Mendes, Laura (2008). Meat Tenderizer, Lab. *St. Helena High School Agriculture Department*.

Biology/Life Sciences Standards	•(BLS) 1.b.
Agriculture Standards	•(AG) C 5.2 and C 5.3. •(Foundation) 1.2 Science, Specific Applications of Investigation and Experimentation: (1.a) and (1.d).

Name_____

Date_____

Pickle Fermentation: Desired Microbial Growth in Foods

Purpose

This lab introduces students to the important food science sector connected to pickling vegetables. Organisms which produce lactic acid are used to ferment the vegetables. This experiment takes several weeks to complete. The purpose of this exercise is to demonstrate how changing one or more factors affects pickle fermentation.[i]

Procedure:

Materials

1. 30 small unwaxed cucumbers
2. Noncorrosive 5L containers
3. Noncorrosive weights (stones, plastic or wood to keep cucumbers submerged in brine.)
4. Lightweight plastic film for covering brine.
5. Salt (NaCl) not iodized
6. Bacteriological stains (Crystal violet, Gram's iodine, Safranin, methylene blue, etc.)
7. pH meter or paper
8. 1,000 x microscope with oil immersion lens
9. 50mL burette
10. 20mL pipettes
11. 200mL beakers
12. 1% phenolphthalein indicator in water
13. 500 mL 0.1 N NaOH
14. Glass slides and cover slips.

Sequence of Steps

Preparing Pickles

1. Prepare brine solutions by dissolving the following amounts of salt in 5L of water.

0%	1.5%	2.5%	10%	15%
0g	75g	125g	500g	750g

2. Fill your container 1/2 to 2/3 full of cucumbers and add the brine.
3. Submerge the cucumbers in the brine by placing a grate over them and weighting it down. (Figure 1)
4. Leave the pickles in the brine at room temperature and observe periodically for several weeks. Record your observations.
5. Measure the pH and acidity of the brine every 2 days and record results in Table 1. When taking samples, replace the plastic cover as soon as possible to maintain anaerobic conditions. Total acidity measures the total amount of acid that is in the solution, whereas pH measures the

hydrogen ion concentration of the solution, which is related to how strong the acid concentration is. Measure the total acidity by either titration or use of a pH meter as described below.

Titration Method

1. In this method, brine is titrated with phenolphthalein until the endpoint (a faint pink color which remains for 15 sec) is reached.
2. Pipette 18mL of brine into a 100mL glass beaker.
3. Add 0.5mL of a 1% phenolphthalein solution (1-2 drops).
4. Titrate with 0.1 N NaOH until the endpoint is reached.
5. Record the number of mL of 0.1 N NaOH required.
6. Then calculate the total acidity (as acetic acid) as follows

$$\% \text{ acidity} = \frac{(\text{mL of NaOH}) \times 0.009}{\text{Sample weight in g}} \times 100$$

Since we use an 18g sample, this can be simplified to:
% acidity = (mL of NaOH) / 20

pH Method

1. In this method, pH is measured using a pH meter or pH paper.
2. Standardize pH meter using pH 7 and pH 11 buffer standards.
3. Place 50mL of brine in a 200mL beaker.
4. Place a stirring bar gently into the beaker and place it on an automatic stirrer or manually stir with a rod.
5. Titrate with 0.1 N NaOH to pH 8.1 using the pH meter.
6. Record data as mL of 0.1 N NaOH added.
7. Calculate the total acidity using the equation used in the titration method.

Microbial Analysis

1. Make visual and microbial observations every 5 days and record the results in Table 1.
2. Follow the presence and succession of various types of microorganisms (molds, yeast, spherical bacteria in chains, rod-shaped bacteria, rod shaped bacteria in chains, etc.) by taking samples of the brine, staining them, and viewing the sample under a microscope.

Preparation of Smears

1. Pure cultures of bacteria can ordinarily be prepared for staining by the simple process of making an aqueous suspension and drying a drop of it on a slide or cover glass.
2. To prepare a bacterial smear, remove a small amount of surface growth from the brine and mix it with distilled water.
3. The suspension used should always be sufficiently dilute. (If a smear does not show well separated bacteria, a more dilute smear should be made.)
4. Fix the suspension to the slide by drying it on a hot plate and then passing it rapidly through a Bunsen flame 2 or 3 times.

Staining Procedure

1. Bacteria can be differentiated into Gram-positive bacteria and Gram-negative bacteria by the using this procedure.
2. Fix the dilute brine solution onto a clean slide as described above.

3. Place a few drops of Crystal Violet Stain on the slide and let it stand for 60 seconds. Drain the extra stain from the slide.
4. Place a few drops of Iodine Stain on the slide and let it stand for 60 seconds.
5. Drain the extra stain and wash with water until no free stain appears in the wash.
6. Gently wash with 95% alcohol until no free stain appears in the wash.
7. Place a few drops of Safranin on the slide and let it stand for 45 seconds.
8. Drain the extra stain from the slide and wash with water until no free stain appears in the wash.
9. Air dry the slide and examine it under the microscope.
10. Gram-positive bacteria have the ability to retain Crystal Violet stain and will appear dark purple under the microscope.
11. Gram negative bacteria lose their ability to retain Crystal Violet stain when rinsed with alcohol. They are made visible by the Safranin and will appear pink.

Caution! Do not eat the pickles you produced in this experiment! Control of or elimination of pathogenic bacteria cannot be guaranteed by these processing techniques!*

Figure 1

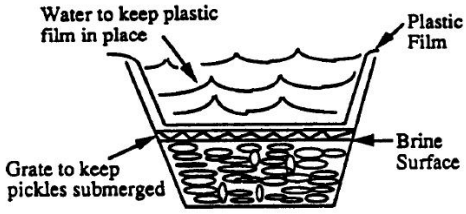


Table 1

	Date:		Date:		Date:		Date:	Date:
Sample	pH	Acidity	pH	Acidity	pH	Acidity	Microbial	Visual
0% Salt								
1.5% Salt								
2.5% Salt								
10% Salt								
15% Salt								

Observations

Keep track of notable observations (not recorded in the table) below:

Questions

1. Do the same types of microorganisms appear (predominate) in all containers?

2. Are some groups present only in one container? Why or why not?

3. Were you able to absolutely exclude the growth of microorganisms using very high levels of salt? Why or why not?

4. Why are fermented pickles desalted before packaging for consumers?

5. What is the role of salt in food preservation?

6. How do the two methods for producing pickles (the brine process and the fresh-pack process) differ?

Notes for the Teacher

1. Do the same types of microorganisms appear (predominate) in all containers?
   A particular organism will predominate throughout the fermentation process. However, which organisms predominates will depend on the stage of the fermentation process. As different carbohydrates become available or unavailable, the predominating organism will change.
2. Are some groups present only in one container? Why or why not?
   Yes, some bacteria are more salt tolerant than others. Bacteria differ as to the type of carbohydrates they use as food, and their populations will therefore change as the food supply changes during the fermentation process.
3. Were you able to absolutely exclude the growth of microorganisms using very high levels of salt? Why or why not?
   Probably not, since some bacteria are extremely salt tolerant and will still survive at high levels of salt.
4. Why are fermented pickles desalted before packaging for consumers?
   The high salt content of the brine and pickles would probably be offensive to most people.
5. What is the role of salt in food preservation?
   Salt preserves food by lowering the amount of "free" water molecules. Without enough free water, microorganisms cannot grow well.
6. How do the two methods for producing pickles (the brine process and the fresh-pack process) differ?
   In the brine process, pickles are immersed in brine for several weeks. Fermentation is accomplished by lactic acid bacteria. The process provides a characteristic flavor. The high salt content of the brine and the use of a cover to keep air out of the container reduce undesirable microbial growth. In the fresh-pack process, the pickles are in brine for only several hours, and heat treatment (immersion in a boiling solution of vinegar and pickling spices) preserves the product and imparts flavor.

[i] Dalmasso, Dr. Joseph (2001).Desirable Microbial Growth in Foods: Pickle Fermentation. *Institute of Food Technologists; The Society for Food Science and Technology*

Biology/Life Sciences Standards	• (BLS) 1.g.
Agriculture Standards	• (AG) C 5.2, C 11.6, and C 13.3. • (Foundation) 1.2 Science, Specific Applications of Investigation and Experimentation: (1.a) and (1.d).

Name_____

Date_____

Root Beer

Purpose

The purpose of this exercise is to produce a root beer by controlling the fermentation of sugar.[i]

Procedure:

Materials

1. 500 ml bottle of spring water
2. 1 weigh boat (coffee filter)
3. Drinking cup, marked with two lines
   Measure:
   30 ml mark = _____cm
   3-4 ml mark = _____cm
4. Root beer extract
5. Sugar
6. Plastic Spoon
7. Baker's yeast
8. Raisin

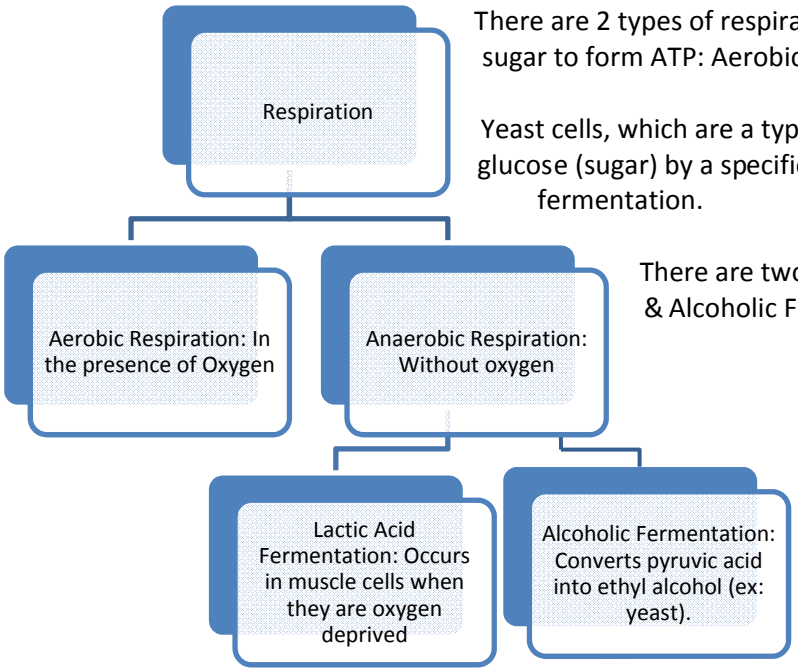
Sequence of Steps

1. Read history and background information.
2. Obtain a 500 ml bottle and label it with your name.
3. Weigh 75 grams of sugar in your weigh boat.
4. Discard 75 ml of water from the plastic bottle.
5. Obtain 3-4 ml of root beer extract and pour into the 500 ml bottle. Swirl gently until mixed.
6. Rinse cup with tap water.
7. Measure 30 ml of lukewarm water (97-112 F) into your cup from equipment station.
8. Transfer a ½ tsp of sugar from your weigh boat to the 30 ml of warm water.
9. Using a funnel, pour the remaining portion of your sugar into your bottle.
10. Weigh .07g of yeast into your weigh boat and pour into the 30ml mixture in your cup. Stir gently until mixed and let set for 5 minutes. This will activate (bring alive) the yeast.
11. Swirl gently the sugar extract and water mix in your bottle until sugar is completely mixed.
12. After 5 minutes, pour yeast solution into your bottle.
13. Use cup to obtain warm water as needed and fill bottle until there is a 5cm space left at the top of the bottle.
14. Optional step: If you would like more "fizz" in your root beer, place 1 raisin in your bottle.
15. Be sure to twist cap on your bottle securely.
16. Place bottle in dark space, undisturbed for 2 days.
17. After day two, refrigerate for 1-2 days before testing.
18. When pouring the root beer, tilt bottle slowly so as not to disturb the yeast that has settled on the bottom.
19. Clean up your work area and complete questions.

History

Root beer was made by our forefathers by soaking Sassafras (a type of tree root) in water, and adding sugar and yeast (yeast for carbonation). In the early 1900's however, scientists discovered that safrole, a chemical found in Sassafras root, was a carcinogen. Now, a mixture of other herbs and spices makes up "root beer extract" which is what we now use to make homemade root beer.

Background Information



There are 2 types of respiration, which is the breakdown of sugar to form ATP: Aerobic & Anaerobic

Yeast cells, which are a type of fungus, obtain energy from glucose (sugar) by a specific anaerobic process called fermentation.

There are two types of fermentation: Lactic Acid & Alcoholic Fermentation.

Alcoholic fermentation is involved in the making of food products such as bread, cheese, soy sauce, tofu, vinegar, wine, and yogurt. In order to make these foods, bacteria or fungi break down complex sugars into simpler substances like carbon dioxide and alcohol. Alcoholic fermentation begins after glucose diffuses into the yeast cell. The glucose is broken down into two, three carbon molecules called pyruvic acid. The pyruvic acid is then converted to CO_2, ethanol, and energy for the yeast cell.

It is the carbon dioxide produced through fermentation by the thriving yeast cells that give root beer its "fizz". This fizz is produced in store bought root beer by a carbonation machine that forces carbon dioxide into the root beer mixture, without the aid of yeast. When you make root beer, you are creating a very friendly environment for yeast to grow and multiply – by adding sugar (food) and cutting off the oxygen supply. Yeast, like many microbes, is anaerobic. This means they grow best without oxygen.

Observations

1. Describe the appearance of the root beer during the bottling process.

2. Describe the appearance of the root beer after fermentation. How is it different from what you saw during the bottling process in question #1?

3. Why were the yeast cells necessary in this experiment?

4. Why was the sugar necessary in this experiment?

5. Explain how the root beer came to be carbonated.

6. Explain how commercial (store bought) root beer is carbonated.

7. What is safrole? Why do we not use it anymore?

8. List the needed ingredients to make root beer.

9. Why did we put the yeast in the warm water for 5 minutes?

10. What is fermentation?

[i] Goehring, JessaLee (2008). Root Beer, Lab. *Lodi High School Agriculture Department*.

Biology/Life Sciences Standards	• (BLS) 1.h.
Agriculture Standards	• (AG) C 3.2 and C 13.3. • (Foundation) 1.2 Science, Specific Applications of Investigation and Experimentation: (1.a) and (1.d).

Name_____

Date_____

Fat Cells: Raw vs. Homogenized Milk

Purpose

The purpose of this exercise is to evaluate the difference in fat cells found in raw vs. homogenized milk.[1]

Background

The diary industry and the processing unit, to be specific, have a vast array of careers in quality control. It is important that the milk sold in grocery stores is always uniform. There are two types of milk that will be compared: raw milk and homogenized milk. If raw milk were left to stand, the fat would rise to the top to form a cream layer. Homogenization is a process that treats the fat globules by passing milk under high pressure through a tiny opening. [2]

Procedure:

Materials

1. Compound microscope with an oil immersion lens.
2. Raw milk from a dairy or a health food store that carries raw milk.
3. Homogenized milk

Sequence of Steps

1. Put a drop of raw milk on one slide.
2. Put a drop of homogenized milk on another slide. Place a cover slip over each.
3. With the oil immersion lens look at the differences in the size of the fat cells.
4. Record your observations and clean your lab station.

[1] Dickson, Chris (2008). Fat Cells, Lab. *North High School, Bakersfield Agriculture Department*.

[2] Homogenization of Milk and Milk Products. Retrieved January 13, 2009, from University of Guelph; Dairy Science and Technology Web site: http://www.foodsci.uoguelph.ca/dairyedu/homogenization.html

Observations

1. Sketch the fat globules of the homogenized milk sample and the fat globules from the raw milk sample.

FAT GLOBULES

Homogenized fat globules

Raw fat globules

2. Explain your observations using complete sentences.

3. Analyze: Why are the globules different?

4. Analyze: What is the purpose of homogenization and how is this beneficial to agriculturists or consumers?

Biology/Life Sciences Standards	• (BLS) 1.h, 4.e, and 4.f.
Agriculture Standards	• (AG) C 8.1 and C 13.3. • (Foundation) 1.2 Science, Specific Applications of Investigation and Experimentation: (1.a), (1.d), and (1.f).

Name_____

Date_____

Identifying Organic Compounds in Food

Purpose

The purpose of this exercise is to identify the major types of organic compounds in common foods.[i]

Background

The most common organic compounds found in living organisms are lipids, carbohydrates, proteins, and nucleic acids. Common foods, which often consist of plant materials or substances derived from animals, are also combinations of these organic compounds. Substances called indicators can be used to test for the presence of organic compounds. An indicator is a substance that changes color in the presence of particular compounds. In this investigation, you will use several indicators to test for the presence of sugars, lipids, carbohydrates, and proteins in various foods.

Procedure:

Materials

1. Honey
2. Egg white
3. Corn oil
4. Lettuce
5. Gelatin
6. Butter
7. Potato
8. Apple Juice
9. Water
10. Mayonnaise
11. (Teacher only) Test tubes (10)
12. (Teacher only) Benedicts solution
13. Iodine
14. Biuret reagent
15. Toothpicks
16. Plastic tray or cups

Sequence of Steps

Develop your hypothesis for each food, hypothesizing whether it will contain the tested compound or not. Record your hypothesis for each food on the tables under “observations”.

<u>Sugar Test – Teacher Demo</u>

1. Fill each test tube with 5 ml of the food indicated on labeled test tubes.
2. Add 10 drops of Benedict’s solution to each test tube.
3. Heat the test tubes in a hot water bath for 3-5 minutes.
4. <u>If the food turns orange, it is positive for sugar.</u>
5. Record Results

Lipid Test

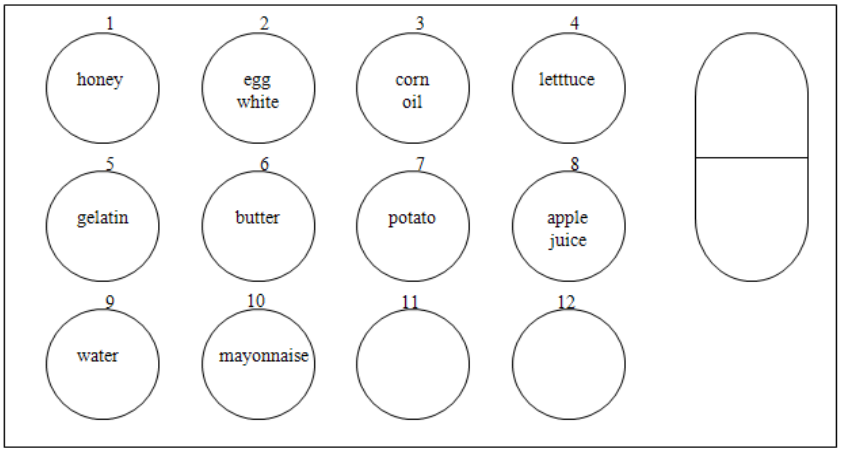
1. Obtain a piece of paper towel. Using a pen or pencil draw a labeled grid on the paper towel as shown below.

Honey	**Egg White**	**Corn Oil**	**Lettuce**	**Gelatin**
Butter	**Potato**	**Apple Juice**	**Water**	**Mayonnaise**

2. Add one drop of each food to the paper towel in the appropriate box.
3. Allow the paper to dry. Hold the paper up to the light. If the paper is translucent, the food is positive for lipids.
4. Record results

Starch Test

1. Obtain a white tray. Add two drops of each food into the given wells. Follow the diagram below so that you will remember which foods are in which wells.



2. Add two drops of iodine to each food. Stir with a toothpick if necessary.
3. If the food turns a very dark color (nearly black), it is positive for starch.
4. Record results
5. Clean out the tray for the next activity.

Protein Test

1. Repeat step one of the starch test.
2. Add two drops of biuret reagent to each food. Stir with a toothpick if necessary.

3. If the food turns violet, it is positive for protein.
4. Record results
5. Clean out the tray.

Observations

Sugar

Food	Hypothesis	Benedict Color	Sugar (+)
Honey			
Egg White			
Corn Oil			
Lettuce			
Gelatin			
Butter			
Potato			
Apple Juice			
Water			
Mayo			

Lipid

Food	Hypothesis	Translucent	Lipid (+)
Honey			
Egg White			
Corn Oil			
Lettuce			
Gelatin			
Butter			
Potato			
Apple Juice			
Water			
Mayo			

Starch

Food	Hypothesis	Iodine Color	Starch (+)
Honey			
Egg White			
Corn Oil			
Lettuce			
Gelatin			
Butter			
Potato			
Apple Juice			
Water			
Mayo			

Protein

Food	Hypothesis	Biuret Color	Protein (+)
Honey			
Egg White			
Corn Oil			
Lettuce			
Gelatin			
Butter			
Potato			
Apple Juice			
Water			
Mayo			

Conclusion:

1. Which foods contain fat?

2. Which foods contain sugar?

3. Which foods contain starch?

4. Which foods contain protein?

Discussion:

1. Which test substance did not test positive for any of the organic compounds?

2. People with diabetes are instructed to avoid foods that are rich in carbohydrates. How could your observations in this investigation help you decide whether a food should be served to a person with diabetes?

3. Your fast food bag has large, translucent spot on the bottom. What explanation could you give for this occurrence?

[i] Knapp, Beth (2008). Identifying Organic Compounds in Food, Lab. *Atwater High School Agriculture Department*.

Biology/Life Sciences Standards	•(BLS) 1.h.
Agriculture Standards	•(AG) C 8.1, C 9.3, C 13.3, D 3.1, and D 3.2. •(Foundation) 1.2 Science, Specific Applications of Investigation and Experimentation: (1.a).

Name_____

Date_____

Macromolecule Lab: A Lesson in Urinalysis

Purpose

The purpose of this exercise is to determine how to use chemical indicators to verify the presence of monosaccharides and polysaccharides, proteins, and lipids in several known substances.[i]

Background

Urine can contain important information about a patient's (human or animal) health status. A test called a urinalysis, or "UA", is done to check for infections of the urinary tract or for the presence of blood, glucose, or protein in the urine.

The composition of urine varies depending on diet and activity. Urine is about 95% water, but it also contains urea and uric acid. Sometimes traces of amino acids can be found in urine, as well as a variety of electrolytes. In this activity, you will be analyzing a "patient's" urine for the presence of carbohydrates, proteins, or lipids.

Procedure:

Materials

- Have biology text books readily available, with reference to section on polysaccharides. The following book references may be of use: *Modern Biology,* Holt (Ch 3); *Biology*, McDougal Littell (Ch 2); *Biology*, Prentice Hall (Ch 2).

Part I

Protein Test Station

1. Test tubes
2. Protein solution
3. Biuret solution
4. Dropper
5. Supplies to clean and dry test tubes

Fat Test Station

1. Test tubes
2. Vegetable oil
3. Sudan III solution
4. Dropper
5. Supplies to clean and dry test tubes

Monosaccharide Test Station

1. Test tubes
2. Monosaccharide solution

3. Benedict's solution
4. Dropper
5. Hot water bath
6. Test tube holder
7. Supplies to clean and dry test tubes

Polysaccharide Test Station

1. Well plate
2. Starch solution
3. Iodine solution
4. Dropper
5. Supplies to clean and dry test tubes

Part II

1. All materials from Step I *except* for known solutions (Protein, lipid, monosaccharide, starch).
2. Urine samples*
   **Teachers refer to "teacher's notes" for urine recipes.*

Sequence of Steps

Complete pre-lab questions below

1. Distinguish between a mono-, di-, and polysaccharide. Provide an example for each.

2. List the four classes of lipids.

3. What are the monomers of protein, and what element do they contain that carbohydrates and lipids do not?

4. Explain why you have to test for the presence of these macromolecules in *known* substances first?

Part I: Testing Known Substances

In the first part of this lab, you will need to determine how to use chemical indicators to verify the presence of monosaccharides and polysaccharides, proteins, and lipids in several known substances. Your results in this section will allow you to carry out tests on a "patient's" urine samples to determine the presence of any of the above known substances.

Visit each of the stations set up in the classroom. Follow all instructions carefully and make detailed observations in the data chart to assist you in Part II.

Macromolecule	Chemical Indicator	Observations for a Positive Test
Monosaccharide		
Polysaccharide		
Protein		
Fat		

Test for Protein Using Biuret Solution

1. Go to the Protein Test station
2. Locate a test tube, the protein solution, and the Biuret solution.
3. Shake the protein solution. Then add 1-2 drops into the test tube.
4. Now, add 2-3 drops of Biuret solution. Swirl the solutions together.
5. Record the change in color that is seen.
6. Replace all materials. Clean out your test tube using soap, water, and a test tube brush. Place your test tube into the rack to dry.

Test for Fat using Sudan III solution

1. Go to the Fat Test station
2. Obtain a test tube, the vegetable oil, and the Sudan III solution.
3. Add 10 drops of vegetable oil to the test tube.
4. Add 10 drops of water to the test tube.
5. Now, add 2-3 drops of Sudan III to the test tube. Swirl the solutions together.
6. The red Sudan III solution should make the fat appear. Record what you see.
7. Replace all materials. Clean out your test tube using soap, water, and a test tube brush. Place your test tube into the rack to dry.

Test for Monosaccharides using Benedict's solution

1. Go to the Monosaccharide Test station.
2. Locate a test tube, a test tube holder, the monosaccharide solution, and the Benedict's solution.
3. Add 4-5 drops of the monosaccharide solution to the test tube.
4. Now, add 4-5 drops of the Benedict's solution. Swirl the solutions together.
5. Carefully place your test tube into the hot water bath using the test tube holder. (Caution: water is HOT!)
6. Record the change in color that is seen (green indicates a low concentration of monosaccharides – brick red indicates a high concentration). Also, note how long it took for the color to change.
7. Replace all materials. Clean out your test tube using soap, water, and a test tube brush. Place your test tube into the rack to dry.

Test for Polysaccharides using Gram's Iodine

1. Go to the polysaccharide test station.
2. Locate a white well plate, the starch solution, and the Iodine solution.
3. Shake the starch solution. Then add 1-2 drops into the well plate.
4. Now, add 1-2 drops of the Iodine solution.
5. Record the change in color that is seen.
6. Replace all materials. Clean out your well plate using soap and water. Place your well plate on the paper towel to dry.

Part II: Testing Urine Samples

Repeat all steps from Part I, only this time use your patient's urine sample instead of the known solutions.

Urine Sample #:		
Macromolecule	Chemical Indicator	Present (+)/Absent (-)
Monosaccharide		
Polysaccharide		
Protein		
Fat		

Post-Lab Questions

1. List the macromolecule(s) present in your patient's urine.

2. Explain why *sucrose* would not test positively with Benedict's solution.

3. Starch and cellulose are examples of polysaccharides. Use your book to find 2 more examples of polysaccharides and their functions.

4. For the following urine samples, evaluate the results and indicate which macromolecules are present.

Patient #5150: Purple-black iodine, green Benedict's solution, blue Biuret, red, oily Sudan.

Patient #0560: Light brown iodine, red Benedict's solution, lavender Biuret, red, watery Sudan.

Teacher's Notes:

Synthetic Urine Recipe
Each student group needs about 10 mL of a sample for testing. These recipes make about 60 mL of each sample.

Stock Urine:

- 160mL water
- Yellow food coloring
- 2g NaCl

Urine from Patient #H 987
(High glucose)

- 40mL apple juice
- 20mL stock urine

Urine from Patient #L 623
(High protein)

- 60mL stock urine
- 5mL egg albumin

Urine from Patient #P 552
(High glucose & protein)

- 40mL apple juice
- 20mL stock urine
- 5mL egg albumin

Urine from Patient #M 340
(High protein & High starch – contaminated sample!)

- 50mL stock urine
- 5mL egg albumin
- 5mL starch

[i] Niesen, Lorilee (2008).Macromolecule Lab; A Lesson in Urinalysis. *Maxwell High School Ag Department*.

Biology/Life Sciences Standards	•(BLS) 1.h.
Agriculture Standards	•(AG) C 3.2. •(Foundation) 1.2 Science, Specific Applications of Investigation and Experimentation: (1.a).

Name_____

Date_____

Sweet Talk

Purpose

The purpose of this exercise is to illustrate the difference between granulated sugar and powdered sugar.[i]

Procedure:

Materials

1. Iced tea (enough for the entire class, or one cup to use as a demonstration)
2. Cups (enough for the entire class, or one cup to use as a demonstration)
3. Plastic spoons
4. Granulated sugar (enough for the entire class, or a teaspoon to use as a demonstration)
5. Powdered sugar (enough for the entire class, or a teaspoon to use as a demonstration)

Sequence of Steps

1. Read background information.
2. Receive a glass/cup of iced tea.
3. Half of class put 1 tsp of granulated sugar in their tea
4. Other half of the class put 1 tsp of powdered sugar in their tea
5. Record observations and respond to questions.

Background information

Our *SENSES* include touch, hearing, sight, smell, and taste. The two senses that are chemical in nature are smell and taste. Those two senses smell (olfactory) and taste (gustatory) can detect actual chemical molecules. The sense of smell can detect only GASEOUS molecules floating around in the air and contributes to about 80% of the flavor of food. (Remember the mouth and nose are connected)! The sense of TASTE can detect only molecules dissolved in water. (Using the food's own liquid or from the saliva in the mouth).

There are five tastes we distinguish. They are sweet, sour, salty, bitter, and umami (glutamate, an amino acid, has its own distinct flavor). Studies have shown that our favorite taste is sweetness.

What is sugar? Sugar is a carbohydrate made up of carbon, hydrogen, and oxygen atoms. All carbohydrate molecules contain glucose (blood sugar). Our bodies metabolize (breakdown) carbohydrates into glucose or a monosaccharide. An example of a monosaccharide that exists in nature is fructose and is found in honey and many fruits. In comparison, a disaccharide is two monosaccharide molecules bonded together. Examples: (SUCROSE from plants like sugar cane and sugar beets, nectar in flowers; MALTOSE from malt sugar; LACTOSE from milk sugar.)

Furthermore a Polysaccharide is a complex carbohydrate made up of many simple sugars – basically starches and fiber – found in foods such as peas, beans, grains, and potatoes.

History - Prior to 3,000 years ago HONEY was the sweetener of choice. It wasn't until 700 A.D. that sugar was used as a sweetener. Today each American eats about 40 pounds of sugar per year!

There are differences in sugars. Raw sugar comes directly from the sugar cane. Brown sugar still has the syrupy liquid, molasses, as part of the sugar. Brown sugar is also called 'raw sugar.' Demerara sugar, made in India, is a dark brown sugar. Jaggery sugar, used in Europe, also is a brown sugar. Refined white sugar is raw sugar with molasses removed. Baker's sugar is super fine granulated refined sugar. Powdered sugar is refined sugar with corn starch added.

Refined white sugar and super-refined (Baker's sugar) are granulated, meaning the sugars consist of individual grains of a single crystal of pure sucrose. By pulverizing the granulated sugar into a fine powder, the sugar picks up moisture in the air. In other words sugar is **hygroscopic** (a substance that has the ability to take up or retain moisture). To prevent powdered sugar from taking up moisture, about 3% of cornstarch is added.

Review Questions

1. What are our senses?

    a. _____

    b. _____

    c. _____

    d. _____

    e. _____

2. The two senses that are chemical in nature are:

    a. _____ also called _____

    b. _____ also called _____

3) There are 5 tastes we can recognize, they are:
   a) _____
   b) _____
   c) _____
   d) _____
   e) _____
4) Americans love the sweetness taste and prove it by consuming _____ pounds of sugar a year.
5) There are 7 kinds of sugar including:
   a) **Raw sugar** comes directly from the _____.
   b) **Brown sugar** still has the syrupy liquid, _____, as part of the sugar. Brown sugar is also called '_____.'
   c) **Demerara** sugar, made in India, is a _____sugar.
   d) **Jaggery** sugar, used in Europe, also is a _____ sugar.
   e) **Refined** white sugar is raw sugar with _____ removed.
   f) **Baker's** sugar is _____ granulated refined sugar.
   g) **Powdered** sugar is refined sugar with _____ added.
6) When a substance has the ability to take up or retain moisture it is referred to as _____.

Observations

1. What happened when you added your sugar to the tea? How does this compare with your classmates who used a different type of sugar?

2. Why is cornstarch added to sugar to make powdered sugar?

3. How does this processing technique of a raw agricultural commodity help the food science industry?

Teacher's Notes

Procedure:

Opening question to the class: "Has anyone ever run out of granulated sugar and used powdered sugar as a substitute? If 'yes' is a response, asked "what happened"; if 'no' is the response use the following procedure so that every member of the class can see the difference between granulated sugar and powdered sugar.

- Separate the class in to two halves.
- Each student receives a glass (plastic cup at school) of iced tea (or at least cold tea).
- Half the class will put a teaspoon of granulated sugar in the tea; the other half will use powdered sugar.
- Results: The powdered sugar will clump instead of dissolving.

Variations of the procedure: You might want to have three groups and also use super-refined (Baker's) sugar. That group should find no granules of sugar at the bottom of the glass, the granulated group may find grains of sugar suspended in the tea or settled at the bottom of the glass.

Student answer sheet:

1. What are our senses?

   a) touch

   b) hearing

   c) sight

   d) smell

   e) taste

2. The two senses that are chemical in nature are:

   a) smell also called olfactory

   b) taste also called gustatory

7) There are 5 tastes we can recognize, they are:

   a) sweet

   b) sour

c) salty

d) bitter

e) umami

8) Americans love the sweetness taste and prove it by consuming 40 pounds of sugar a year.

9) There are 7 kinds of sugar including:

a) **Raw sugar** comes directly from the sugar cane.

b) **Brown sugar** still has the syrupy liquid, molasses, as part of the sugar. Brown sugar is also called 'raw sugar.'

c) **Demerara** sugar, made in India, is a dark brown sugar.

d) **Jaggery** sugar, used in Europe, also is a brown sugar.

e) **Refined** white sugar is raw sugar with molasses removed.

f) **Baker's** sugar is super refined granulated refined sugar.

g) **Powdered** sugar is refined sugar with cornstarch added.

10) When a substance has the ability to take up or retain moisture it is referred to as hygroscopic.

[i] Dickson, Chris (2008). Sweet Talk, Lab. *North High School, Bakersfield Agriculture Department*.

Agriculture Standards

- (Foundation) 1.2 Science, Specific Applications of Investigation and Experimentation: (1.a).
- (Foundation) 4.0 Technology: 4.6.
- (Foundation) 10.0 Technical Knowledge and Skills: 10.4.

Name_____

Date_____

Using the Microscope

Purpose

The purpose of this exercise is to introduce you to the compound microscope and to give you practice in its use. [i]

Procedure:

Materials

1. Compound microscope
2. Lens Paper
3. Microscope slides
4. Cover slips
5. Fine-Print newspaper with the letter "e"
6. Soft cloth
7. Medicine dropper
8. Fibers of cotton, wool, human hair
9. Water
10. Pond water or trough water

Sequence of Steps

1. Evaluate the attached diagram of the microscope. Label the diagram with the names of the following parts and learn their functions:

Eyepiece Magnifying lens at the top of the microscope	**Low Power Objective (LP)** Magnifying lens near the object to be viewed (smallest one)	**High Power Objective (HP)** Larger magnifying lens
Medium Power Objective (MP) Medium magnifying lens	**Base** Bottom of microscope	**Coarse Adjustment Knob** Knob used for beginning to focus a sample
Fine Adjustment Knob Knob used for fine tuned focusing	**Arm** Handle of microscope	**Diaphragm** Controls amount of light that enters the microscope
Stage Platform on which the slide will be placed	**Light Source** Lamp or mirror used to view sample	**Body Tube** Establishes distance between eyepiece and objective
State Clips Metal springs that keep the slide in place	**Revolving Nosepiece** Revolves to allow you to switch objectives	

2. Prepare a dry mount of the letter "e".
   a. Cut a letter "e" out of a newspaper and place it in the center of a glass slide. Place a cover slip over the letter "e".
   b. If your microscope has a lamp, turn it on; if it has a mirror, position the mirror so that light is reflected through the hole on the stage.
   c. The microscope must be adjusted so that the Low Power Objective lens is in place. Turn the lens so that you hear or feel it click into place over the hole in the stage.
   d. Place the prepared slide on the stage with the letter "e" centered over the hole on the stage. You are now ready to view the specimen.

3. Viewing and focusing the microscope
    a. Observe the letter “e” on the slide. Make a drawing of it as it appears on the stage. *Remember to do all drawings in the “Observations” section.*
    b. Focus the microscope by looking through the eyepiece and making sure the letter “e” is centered. Use the Coarse Adjustment Knob to focus by gently turning.
    c. Draw the letter “e” as it now appears.
    d. While looking through the eyepiece, gently move the slide to your left. Under “Observations” record the direction the letter moves.
    e. Move the slide forward on the stage. What direction does the letter “e” move?
    f. Carefully change the LP lens to the H lens. Look through the eye piece and focus with the Fine Adjustment Knob if necessary.
    g. Make a drawing of the letter “e” as you see it under HP.

4. Calculating the magnification
   To know how many times an object is magnified, simply multiply the magnifying power of the objective lens. Usually the eyepiece lens has a magnification of 10X (Ten times). The power is usually indicated by the number of the lens. The objective lenses can have magnification from 5X to 100X. Their power is also located on the lens.
   Example: *If your eyepiece has a power of 10X and the objective lens has a power of 20X, then the total magnification is 10 x 20 or 200X.*

Observations

1. Microscope parts: label the attached diagram
2. Draw a picture of the letter “e” as it appears on the stage without looking through the microscope, and looking through the microscope.

Without Microscope | With Microscope

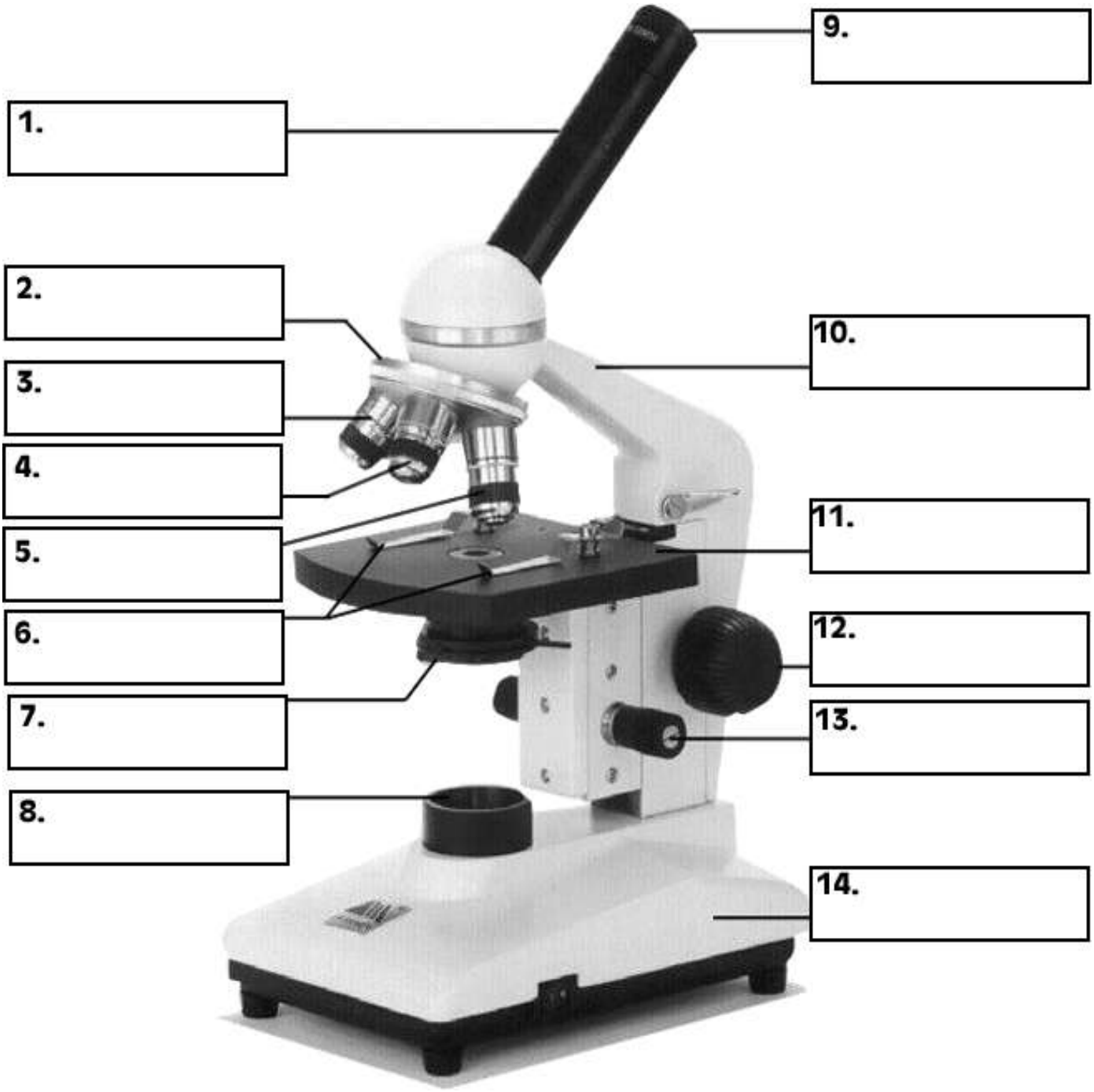
3. When you moved the slide to the left, which way did the letter “e” appear to move? _____
4. When you moved it forward, which way did it appear to move? _____
5. Magnification Practice
   If the eyepiece lens has a magnification of 10X, give the total magnification for the following objective lenses.

   25X = _____ 30X = _____ 40X = _____ 45X = _____

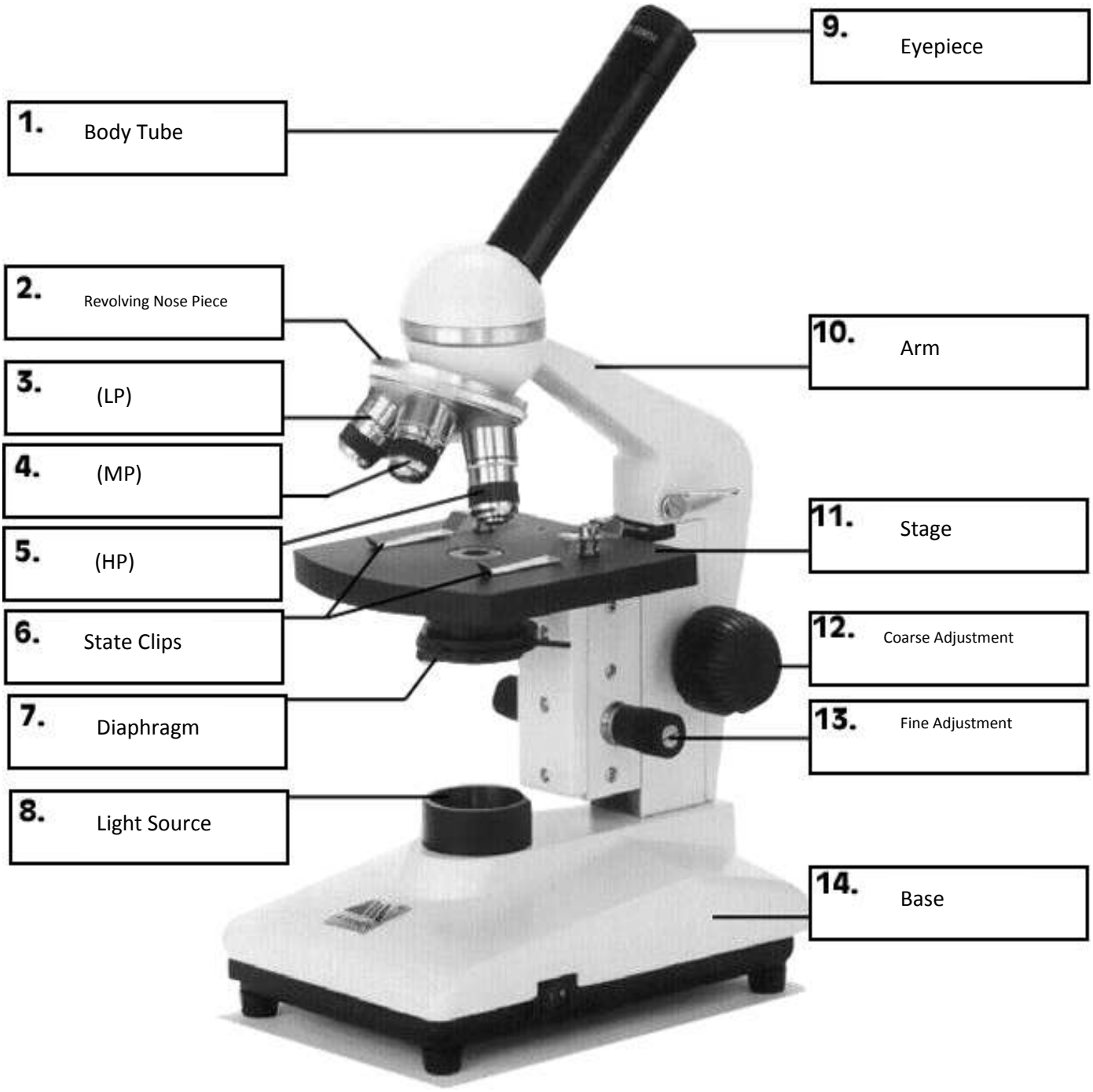
Conclusion:

Compare and contrast the image you see through the microscope compared to the same object viewed without a microscope.

Student Copy[ii]



Key



[i] Agricultural Biology Curriculum Lesson Plans. Sacramento: California State Department of Education, Agriculture Education Unit, 1990.

[ii] "Microscope Parts Identification." Dive Into Science. Woodford Science. 3 Oct 2008 <http://www.woodfordscience.com/microscope_parts_identification>.

Biology/Life Sciences Standards	• (BLS) 1.a, 1.c, 2.a, 2.b, 2.c, 2.d, and 2.e.
Agriculture Standards	• (AG) C 5.1, C 5.2, C 5.3, C 5.4, C 11.1, C 11.4, and C 13.3. • (Foundation) 1.2 Science, Specific Applications of Investigation and Experimentation: (1.a) and (1.d).

Name_____

Date_____

Mitosis

Purpose

The purpose of this exercise is to observe plant and animal cells that are undergoing mitosis and to learn to recognize and illustrate the 4 major phases of mitosis.[i]

Procedure:

Materials

1. Microscopes
2. Prepared slides of plant mitosis (onion root tip) & animal mitosis
   **Great resource "Home Science Tools" www.hometrainingtools.com "Biology Microscope Slide Set". Inexpensive and useful for many labs!*

Sequence of Steps

Plant Mitosis

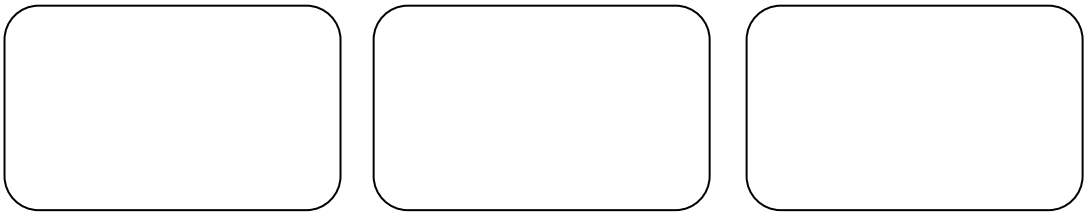
a. Select a prepared slide of onion root tip. Place it on the microscope stage under low power.
b. Focus the microscope to see cells in the onion root tip, and then change to high power objective.
c. Search over the cells by moving the slide back and forth, left and right, to find cells in various phases of mitosis.
d. First find a "normal" cell. This is called an interphase cell. Make a drawing of this interphase in "observations". Label the following parts: cell wall, cytoplasm, nuclear membrane, nucleus, chromosomes.
e. Again search the cells to find a cell in prophase, metaphase, anaphase, and telophase. Make drawings of each phase in the appropriate spaces provided. Label the following parts: cell wall, cytoplasm, nuclear membrane, chromosomes, spindle fibers, cell plate.

Animal Mitosis

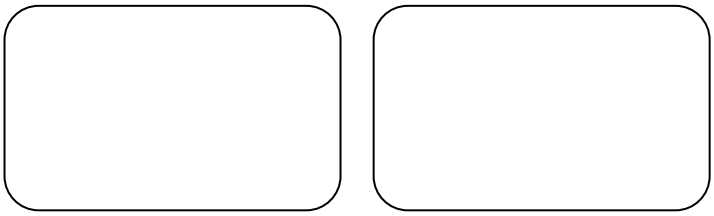
a. Select a prepared slide of the animal cells. Place it on the microscope stage under low power.
b. Focus the microscope to see cells on the slide, and then change to high power objective.
c. Search over the cells by moving the slide back and forth, left and right, to find cells in various phases of mitosis.
d. First find a "normal" non-dividing cell (interphase). Make a drawing of this cell in "observations". Label the following parts: cell membrane, cytoplasm, nuclear membrane, nucleus, chromosomes.
e. Again search the cells for prophase, metaphase, anaphase and telophase cells. Make drawings of each in the appropriate spaces provided. Label the following parts: cell membrane, cytoplasm, centrioles, spindle fibers, nuclear membrane.

Observations

1. Plant Mitosis



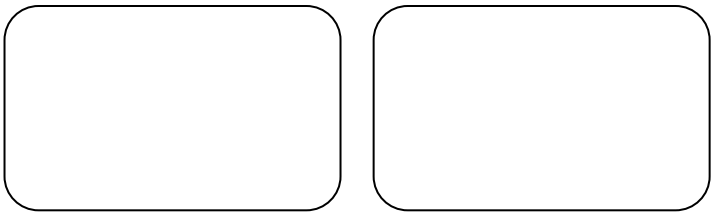
Interphase | Prophase | Metaphase



Anaphase | Telophase

2. Animal Mitosis

Interphase | Prophase | Metaphase



Anaphase | Telophase

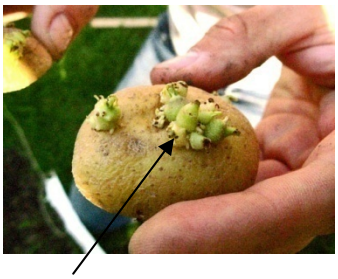
Conclusions:

1. Why is mitosis important to living organisms?

2. How does mitosis insure that each new cell has the same kind of DNA?

3. What kind of cells go through mitosis?

4. Agriculture Application: Potatoes are grown by taking an existing potato, cutting it into chunks and planting the chunks with eyes. These chunks grow into new potato plants. Explain how mitosis is at work in this situation.



Potato Eye

[i] Agricultural Biology Curriculum Lesson Plans. Sacramento: California State Department of Education, Agriculture Education Unit, 1990.

Biology/Life Sciences Standards	•(BLS) 1.b.
Agriculture Standards	•(AG) C 10.2. •(Foundation) 1.2 Science, Specific Applications of Investigation and Experimentation: (1.a), (1.c), (1.d), and (1.f).

Name_____

Date_____

Curds and Whey

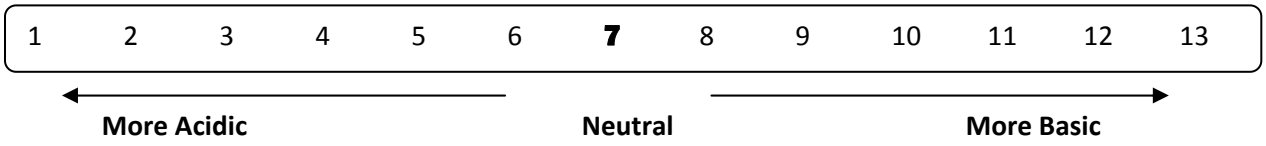
Purpose

The purpose of this exercise is to demonstrate knowledge of pH while observing what happens when different substances are added to milk. In addition, students will determine how to create curds as a common agricultural product. [i]

Background

The pH scale is a measure of how acidic or basic a substance is. The pH value can determine whether a chemical reaction will occur. For example, the pH of milk determines whether curds will form, as in the production of cottage cheese.

The pH of a substance can be measured with pH paper. This method can determine whether a solution is acidic or basic. Acids have a pH of less than 7, and bases have a pH of more than 7. Pure water is neutral and has a pH of 7. Milk curdles when the pH approaches 4.6. The remaining liquid is called whey.



Procedure:

Materials

1. pH paper
2. Lemon juice
3. Diluted chocolate syrup
4. Graduated cylinder
5. Stirring rod
6. Vinegar
7. Tea
8. Milk (whole or cream)
9. Plastic cups (4)

Sequence of Steps

1. Read the problem under "observations" and form your hypothesis.
2. **Safety:** Use care when handling vinegar and lemon juice. Don't get it in your eyes!! Do not eat or drink any of the materials. Wash your hands as necessary.
3. Develop a step-by-step procedure to test your hypothesis using the materials given to you in this lab. Write the steps you will follow in your procedure clearly under "observations".
4. Gather your supplies from the front of the classroom.
5. Using the pH paper, determine pH of the vinegar, lemon juice, tea and diluted chocolate syrup.

6. Record the results in the Data table.
7. Add the vinegar to one cup of milk and stir.
8. Observe and record your observations.
9. Add the lemon juice to another cup of milk and stir.
10. Observe and record your observations.
11. Add the tea to another cup of milk and stir.
12. Observe and record your observations.
13. Add the diluted chocolate syrup to the last cup of milk and stir.
14. Observe and record your observations.
15. Answer the questions below.

Observations

1. Problem: Which of the following substances will cause milk to curdle?

__Lemon juice __ Tea __ Vinegar __ Chocolate syrup

2. Hypothesis: Form a hypothesis below to answer your problem.

3. Describe the procedure, step-by-step, you will use to test each substance in milk:

Data/Results:

SUBSTANCE	**pH**	**OBSERVATIONS** (when added to milk)
Vinegar		
Lemon juice		
Tea		
Chocolate syrup		

Conclusion:

1. Which substance had the greatest effect on the milk? Why?

2. Which substance had the least effect on the milk? Why?

3. What was the common factor that caused some solutions to curdle? How do you know?

4. Define the term "enzyme" and predict how enzymes can be used to impact the process of curdling milk.

5. Was your hypothesis supported? Why or Why not?

6. What might have been a source of error in your experiment?

[i] (2008).Curds and Whey. *Atwater High School Ag Department*.

Biology/Life Sciences Standards	•(BLS) 1.b.
Agriculture Standards	•(AG) C 10.2, C 13.1, and C 13.3. •(Foundation) 1.2 Science, Specific Applications of Investigation and Experimentation: (1.a), (1.d), and (1.f).

Name_____

Date_____

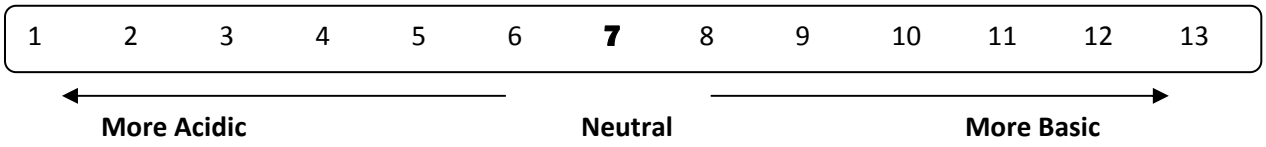
Environmental pH

Purpose

The purpose of this exercise is to determine the pH of various substances and how these substances can affect the environment. [i]

Background

A liquid may be an acid, base, or neutral. The degree of acidity or the strength of a base can be measured by using the pH scale. The scale is divided into three areas: Acid (readings below 7), neutral (reading of 7), and basic (readings above 7). Each division either increases or decreases the pH of a substance 10 times. The pH of 5 is ten times more acidic than a pH of 6. Water has a pH of 7 but when it mixes with air the suspended materials will either raise or lower its pH. Acid Rain is an example of this type of reaction.



Procedure:

Materials

1. pH paper and chart
2. Forceps/tweezers
3. Masking tape
4. Paper towels
5. Depression slides (10)
6. Lemon juice
7. Cola
8. Ammonia
9. Detergent
10. Pond Water
11. Distilled Water
12. Salt Water
13. Tap Water
14. Baking Soda
15. Additional Samples (3)

Sequence of Steps

1. Label a paper towel from A through N. Leave space between each label so that you may place a glass slide above the label.
2. Put a drop of liquid on each slide as listed below: **Caution do not allow any of the materials to come in contact with your skin. If contact is made wash it off under running water and notify the instructor immediately**.

A – Lemon Juice	B – Distilled Water	C – Pond Water	D –Tap Water
E – Salt Water	F – Ammonia	G – Baking Soda	H – Cola
I – Detergent	J -	K -	L -

3. Hypothesize whether the liquid would be acid or base and record in “observations”.
4. Pick up a piece of pH paper with the forceps.
5. Touch the pH paper to the liquid in slide A and remove it. Compare the color of the paper with that on the pH chart. Record your observation on Table 1.
6. Repeat the procedure with the rest of the slides.

Observations

Table. 1

Slide	Hypothesis	pH	Acidic	Basic	Neutral
A					
B					
C					
D					
E					
F					
G					
H					
I					
J					
K					
L					

Analysis:

1. Which of the liquids had the lowest pH?

Is it acidic, basic or neutral? _____

2. Which of the liquids had the highest pH?

Is it acidic, basic or neutral? _____

3. Which of the liquids were closest to being neutral?

4. If the pH of a sample was 3 how many times more acidic is it than a solution with a pH of 6?

5. Agriculture Application: The ideal soil pH for several vegetables is listed below. Use the table to answer the following questions.

a) Which vegetable can handle the most acidic soil?

b) Which vegetable can handle the most basic soil?

c) What is one generalization you can make about the pH that all of these vegetables need?

Vegetables:	Ideal pH
Artichoke	6.5 - 7.5
Asparagus	6.0 - 8.0
Broccoli	6.0 - 7.0
Corn	5.5 - 7.0
Cucumber	5.5 - 7.5
Lettuce	6.0 - 7.0
Peanut	5.0 - 6.5
Pepper	5.5 - 7.0
Potato	4.5 - 6.0
Watermelon	5.5 - 6.5

[i] Galan, Daniel (2008).Environmental pH Lab. *Calexico High School Ag Department*.

Biology/Life Sciences Standards	•(BLS) 1.f.
Agriculture Standards	•(AG) C 11.5 and G 2.6. •(Foundation) 1.2 Science, Specific Applications of Investigation and Experimentation: (1.d).

Name_____

Date_____

A Scientific Play Starring…..Photosynthesis!

Purpose

The purpose of this exercise is to act out the process of photosynthesis. [i]

Procedure:

Materials

1. Cardboard sun
2. Cardboard leaf
3. Construction paper name tags (Light, CO_2, H_2O , O_2 , $C_6H_{12}O_6$)

Sequence of Steps

1. Complete the Content Review at the end of this lab.
2. Your teacher will guide you to break into groups of approximately 7 students.
3. Gather or create the necessary materials listed above.
4. Your challenge: Create a short play starring the roles listed below. Identify who will play each role.
   - Sun _____
   - Leaf _____
   - Light _____
   - CO_2 _____
   - H_2O _____
   - O_2 _____
   - $C_6H_{12}O_6$ _____
5. Your play should involve each member and clearly illustrate the flow of resources and compounds during photosynthesis.
6. After each group has presented their play, illustrate the process of photosynthesis under observations.

Content Review

1. What is Photosynthesis?

2. Write the equation for Photosynthesis.

3. What are the reactants involved in Photosynthesis?

4. What are the products involved in Photosynthesis?

5. What needs to be present in order for Photosynthesis to occur?

Observations:

Illustrate the process of photosynthesis below.

[i] Knapp, Beth (2008).Photosynthesis Products. *Atwater High School Ag Department*.

Biology/Life Sciences Standards	•(BLS) 1.f.
Agriculture Standards	•(AG) C 11.5. •(Foundation) 1.2 Science, Specific Applications of Investigation and Experimentation: (1.d).

Name_____

Date_____

Photosynthesis Graphic Organizer

Purpose

The purpose of this exercise is to create a photosynthesis graphic organizer.[i]

Procedure:

Materials

1. sheet of blank paper
2. Colored pens, pencils
3. Notes/text book

Sequence of Steps

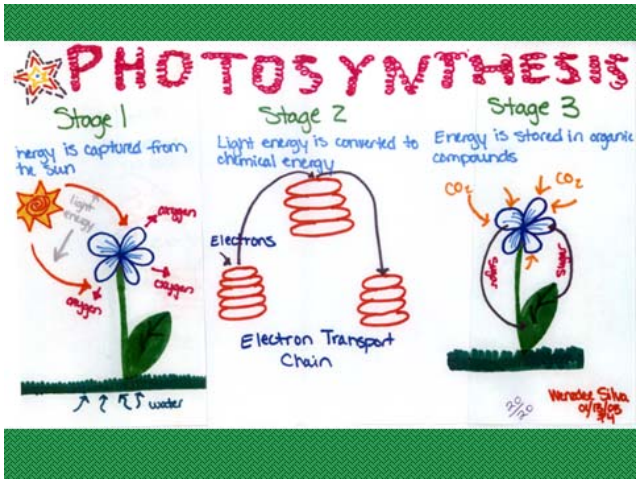
1. Divide a piece of paper into 3 sections.
2. Use pictures, words, etc. to graphically show what happens during each of the three stages of photosynthesis.
3. Put a title on your project.
4. Include name, date, and period on the front of your project.
5. Neatness and creativity count!

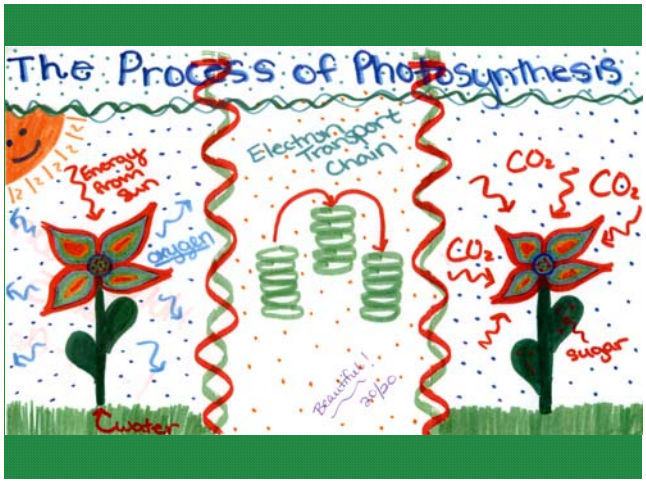
Stages of Photosynthesis Rubric

GENERAL APPEARANCE	POINTS POSSIBLE	POINTS EARNED
• Name, date, period • Title • Overall effort	3 2 5	
STAGE 1		
• Sun's energy being absorbed by plant • Water being taken into plant • Water molecules splitting to produce oxygen (which is released into atmosphere)	5 5 5	
STAGE 2		
• Light energy converted to chemical energy -- Electron transport chain	5	
STAGE 3		
• Carbon dioxide from atmosphere absorbed by plant • Sugars produced through Calvin Cycle	5 5	

Teacher Notes:

Below are 2 samples of student work for reference.





[i] Sperling, Jill (2008). Photsynthesis, Lab. *Kingsburg High School Agriculture Department*.

Biology/Life Sciences Standards	•(BLS) 1.f.
Agriculture Standards	•(AG) C 11.5. •(Foundation) 1.2 Science, Specific Applications of Investigation and Experimentation: (1.a) and (1.d).

Name_____

Date_____

Photosynthesis Products

Purpose

The purpose of this exercise is to investigate the products of photosynthesis. [i]

Background

Starch is produced during the process of photosynthesis. Starch is a form of cellular energy which is consumed during respiration. A leaf that has been in the dark for a long period of time will have less starch present. This is because the process of respiration during the dark phase consumes starch. To observe this physiological process, we will compare the starch content of leaves that have been in the dark for 24-48 hours with those that have been exposed to light.

Procedure:

Materials

1. Leaves (*Geranium, Coleus, Phaseolus*)
2. Isopropyl alcohol
3. Iodine solution
4. Beaker
5. Shallow dish
6. Hot plate
7. Tongs

Sequence of Steps

1. Place a leaf into boiling water for about 5 minutes. (This causes the cells to break down.)
2. Place the leaf in hot alcohol. Chlorophyll is soluble in alcohol and most of the chlorophyll should be removed in 5 minutes. This process may take longer for thicker leaves.
3. Repeat procedure for leaf left in dark.
4. Record your observations.

<u>Testing for starch</u>

1. Place a leaf from which chlorophyll has been removed in a shallow dish.
2. Flood the dish with iodine solution. Wait two minutes and then rinse off the excess iodine. Presence of starch is indicated by a blue-black color.
3. Repeat procedure for leaf left in dark.
4. Record your observations.

Observations

1. Record your observations after removing chlorophyll from each leaf.

2. Record your observations after testing for starch.

Data/Results:

Leaf in sun		Leaf in dark	
Color with iodine		Color with iodine	
Presence of starch?		Presence of starch?	

Conclusion:

1. Why do plants use starch in the dark?

2. Where does the starch come from? When is it produced?

[i] (2008).Photosynthesis Products. *Atwater High School Ag Department*.

Biology/Life Sciences Standards	•(BLS) 1.f.
Agriculture Standards	•(AG) C 11.5 and C 11.6. •(Foundation) 1.2 Science, Specific Applications of Investigation and Experimentation: (1.a) and (1.d).

Name_____

Date_____

Plant and Animal Relationships: Snail Lab

Purpose

In this lab you will set up closed ecosystems containing plants and animals and observe interrelationships. [i]

Background

Oxygen and carbon dioxide are gases used and released by living organisms. Animals and plants use oxygen for cellular respiration and give off carbon dioxide as a waste product.

Indicators are substances that show the presence of certain chemicals by changing color. Bromothymol blue (BTB) is an indicator that turns green or yellow in the presence of a weak acid. Carbon Dioxide (CO_2) reacts with water, forming a weak acid, so bromothymol blue can indicate the presence of CO_2 in water.

Procedure:

Materials

1. Glass tubes with cork stoppers (8)
2. Wax marking pencil (1)
3. Container of dechlorinated water (1)
4. Dropper filled with BTB solution (1)
5. Pieces of *Elodea* plant (4)
6. Small water snails (4)

Sequence of Steps

<u>Part 1: The Set-up</u>

1. Label 8 glass tubes with your marking pencil
   Set 1: 1A, 1B, 1C, 1D
   Set 2: 2A, 2B, 2C, 2D

2. Add dechlorinated water to each of the 8 test tubes, leaving some space at the top. Add 4 drops of BTB solution to each glass tube. Put a cork stopper in 1A and 2A. These test tubes are complete, set them aside.

What is the color of the water in each container?

_____

3. Add 1 snail to container 1B and 2B. These test tubes are now complete. Set aside.

4. Add one piece of *Elodea* plant to containers 1C and 2C. Put a cork stopper on them and set them aside, they are now complete.

5. Add one snail and one piece of *Elodea* plant to each container 1D and 2D. Place cork stoppers to close the container and set them aside, they are now complete.

Which container in each set is the control? Why do you think that?

_____

_____

Would you predict a color change in the control containers? Why?

_____

_____

6. Place set 1 (1A-1D) in a place it will be able to get a good amount of light over the next few days. Find a lab station where you can put your samples.

7. Place set 2 (2A-2D) in the cabinet where it will be dark for the next few days.

8. Clean up your work area and wash your hands before you return to your seats.

Part 2: Observations on Day 2

1. Observe both sets of containers. In order to see the true color, you may want to put a piece of white paper behind the container. Record the color of the water and the condition of the organisms in the table below. *(Notice the BTB Solution color)*

Table 1

Set 1 (in light)			**Set 2 (in Dark)**		
container	color	organisms	container	color	organisms
1A			2A		
1B			2B		
1C			2C		

1D			2D		

Do corresponding containers (1A and 2A, 1B and 2B, etc.) from the two sets show the same color change?

_____

_____

What caused the color change in some of the containers?

_____

_____

2. Put your containers back after recording your observations (set 1 in the light, set 2 in the dark).

Part 3: Observations on Day 3

1. On Day 3, observe both sets of containers. Record your observations in the data table below. *(Notice the BTB Solution color)*

Table 2

Set 1 (in light)			**Set 2 (in Dark)**		
container	color	organisms	container	color	organisms
1A			2A		
1B			2B		
1C			2C		
1D			2D		

Which set of containers showed the greatest change with regard to plant and animal life?

_____

_____

_____

2. Dispose of your materials. Put the snails and plant material in the trash or outside in the dirt. Dump the water and solution down the sink and rinse them out. Be sure the glass containers, stoppers, and all other materials are clean! Use a paper towel to wipe off the writing on the glass containers. Put all items away in their designated area.

3. Clean up your work area and wash your hands before leaving class.

Why were containers 1A and 2A used even though no organisms were placed in them?

_____

_____

_____

If the indicator had changed color in containers 1A and 2A, how would you explain it?

_____

_____

_____

Both Elodea and snails live well in a fish tank. Explain what occurred in container 1D.

_____

_____

_____

_____

_____

_____

Explain how the process of cellular respiration and photosynthesis are dependent on each other.

_____

_____

_____

_____

_____

_____

[i] Jill, Sperling (2008).Plant and animal relationships, lab. *Kingsburg High School Ag Department*.

Biology/Life Sciences Standards	• (BLS) 1.f.
Agriculture Standards	• (AG) C 11.2. • (Foundation) 5.0 Problem Solving and Critical Thinking: 5.3.

Name_____

Date_____

Ag Sudoku

Purpose

The purpose of this exercise is to apply critical thinking skills to a science concept with 4 or more parts. In this lab, students will memorize the four growth requirements for plants: water, air, soil, and sunlight.[i]

Procedure:

Materials

1. Blank Sudoku grid

Sequence of Steps

1. It is game time! The goal of Ag Sudoku is to use one of the words (or numbers) in each row and each column once. The challenge is to make sure that no item appears more than once in any row or column.
2. Your task is to complete your Ag Sudoku board using the four plant growth requirements. When you are done, have your instructor check your work, then illustrate each box.

Sudoku Grid

Notes: From one teacher to another –

I used this for the growing needs of plants: Water, Air, Soil and Sunlight. Making the board is easy and the students used a pencil to fill in the answers then drew in the pictures once they had the sequences correct. I was able to easily check for each requirement in each column and row and corner box. When I pointed out where a mistake occurred it helped them understand. For example, "This plant has too much water and no sunlight," Or "This one has no air and too much soil." They were able to visually see the error and correct the mistake. I am planning to do something similar with the 5 parts of the FFA emblem and possibly the photosynthesis process.

[i] Vannest, Krista (2008).Ag Sudoku. *Pitman High School Agriculture Department*.

Biology/Life Sciences Standards	• (BLS) 1.a.
Agriculture Standards	• (AG) C 11.2 and C 11.6. • (Foundation) 1.2 Science, Specific Applications of Investigation and Experimentation: (1.a) and (1.d).

Name_____

Date_____

Transpiration

Purpose

The purpose of this exercise is to evaluate transpiration and osmosis in a geranium leaf.[i]

Procedure:

Materials

1. 2 geranium leaves
2. 2 small jars (baby food or Mason jars, or 2 beakers)
3. Cardboard (10cm square with a hole about the size of a hole-punch in center)
4. Clay or petroleum jelly

Sequence of Steps

1. Place a geranium leaf in the hole of the cardboard square. (Roll the geranium leaf to fit through the hole). Seal the hole with clay, Silly Putty or petroleum jelly.
2. Fill one small jar with water.
3. Place the cardboard with the leaf over the jar of water. Make sure most of the leaf is in the water, but not so much that the cardboard comes into contact with the water.
4. Cover the leaf with a second jar. Place the leaf in a well-lighted area.
5. Observe the inside of the top jar after 24 hours and record your observations.

Observations

1. Described what you observed in the top jar after 24 hours:

2. Define equilibrium:

3. What is osmosis?

4. How is this experiment related to osmotic force or turgor?

5. What is transpiration and how was it demonstrated in this lab?

6. How does the cell membrane of plant cells allow it to interact with the environment in this way?

[i] Dickson, Chris (2008). Transpiration, Lab. *North High School, Bakersfield Agriculture Department*.

Biology/Life Sciences Standards	•(BLS) 1.a.
Agriculture Standards	•(AG) C 5.3 and C 13.3. •(Foundation) 1.2 Science, Specific Applications of Investigation and Experimentation: (1.a) and (1.d).

Name_____

Date_____

Osmosis

Purpose

The purpose of this exercise is to observe the osmosis using eggs.[i]

Background

Osmosis governs the uptake of water in plant cells. Wilting and the restoration of turgor in plants are due to osmotic processes. Osmosis allows germinating seeds to absorb moisture, a critical first step in the seed germination process. Current practices for extending the shelf life of cut flowers and fresh produce depend upon osmosis.

Procedure:

Materials

1. 3 beakers, 400 ml or wide mouthed jars
2. Water
3. Graduated Cylinder
4. White Vinegar
5. Clear Corn Syrup
6. 4 Raw Eggs (in shell)
7. Balance

Sequence of Steps

1. Label three jars as vinegar, syrup, and water.
2. Weigh the eggs and record in “observations”.
3. Put 250 ml of vinegar into the ‘vinegar’ jar and place two eggs in the vinegar. (Note: Eggs should be completely covered.)
4. Cover the jar and leave undisturbed for two to three days.
5. After at least two days, remove the egg from the jar. Record the volume of the vinegar in a graduated cylinder, and weigh the eggs.
6. Put 250 ml of syrup in a second container and add one whole (weighed) egg.
7. Put 250 ml of water in the third jar and add one (weighed) egg.
8. Cover both jar and leave undisturbed for one day.
9. After one day, remove the eggs from both the syrup and water. Measure the liquids and weigh the eggs.

Observations

Table 1.

Liquid Tested	Weight of Eggs		Gain or	Amount of Liquid		Gain or
	Beginning	Ending	Loss	Beginning	Ending	Loss
Vinegar						
Syrup						
Water						

ANALYSIS

1. Vinegar

Calcium carbonate in the shell reacts with vinegar (acetic acid) and _____ _____ is formed. Calcium acetate is _____ soluble, so the shell disappears leaving the membrane surrounding the egg intact. The egg contents become _____ because the acid denatures the protein.

2. Syrup

The egg placed in the syrup became _____ and _____ as the water moved _____ the egg into the sugar solution. This produced a _____ volume of solution in the jar after the egg was immersed for one or more days.

3. Water

The egg placed in water has _____, becoming _____ and _____ as the water diffuses through the membrane. This has left a _____ volume of water in the jar after the egg was removed following one or two days of immersion.

4. Define osmosis and how it was demonstrated in this lab:

5. Plants require osmosis for growth. Explain how osmosis plays a role in plant growth.

Teacher's Notes

Osmosis

Background:
Osmosis governs the uptake of water in plant cells. Wilting and the restoration of turgor in plants are due to osmotic processes. Osmosis allows germinating seeds to absorb moisture, a critical first step in the seed germination process. Current practices for extending the shelf life of cut flowers and fresh produce depend upon osmosis.

ANALYSIS

Data obtained in these experiments are both qualitative and quantitative in nature. Thus, students should record their observations on the days indicated by simply describing the appearance of the eggs in each of the three jars. In addition, the amount of liquid should be measured at the beginning and end of the osmosis experiment. Each of the eggs should also be weighed before and after the experiment.

ANTICIPATED FINDINGS
Vinegar
Calcium carbonate in the shell reacts with vinegar (acetic acid) and calcium acetate is formed.
Calcium acetate is water soluble, so shell disappears leaving the membrane surrounding the egg intact.
The egg contents become hard because the acid denatures the protein.
Please note: This experiment does not demonstrate the process of diffusion or osmosis, but rather serves as model for discussing cells and semi permeable membranes.

Syrup
The egg placed in the syrup became smaller and lighter as the water moved from the egg into the sugar solution.
This produced a larger volume of solution in the jar after the egg was immersed for one or more days.
Please note: The egg can be examined as soon as 60 minutes following the immersion with obvious changes in the weight.

Water
The egg placed in water swelled, becoming larger and heavier as the water diffused through the membrane.
This left a smaller volume of water in the jar after the egg was removed following one or two days of immersion.

[i] Dickson, Chris (2008). Osmosis, Lab. *North High School, Bakersfield Agriculture Department*.

Biology/Life Sciences Standards	•(BLS) 1.a.
Agriculture Standards	•(AG) C 5.3 and C 13.3. •(Foundation) 1.2 Science, Specific Applications of Investigation and Experimentation: (1.a) and (1.d).

Name_____

Date_____

Passive Transport

Purpose

The purpose of this exercise is to demonstrate the processes of diffusion, selective permeability, and osmosis.[i]

Procedure:

Materials

Part 1	Part 2	Part 3	Part 4
Celery	Plastic bags (2)	Plastic cup	Potato cores (cut like French fries)
Styrofoam cups (2)	Styrofoam cups (2)	Mountain Dew	Styrofoam cups(5)
Food coloring	Yarn	Raisin	Sugar
Hot water	Starch Solution (1 cup of water, ½ Tsp Corn starch)	Graduated Cylinder (50ml)	Scale
Ice water	Iodine solution (1 cup of water, 20 drops of Iodine)		Graduated Cylinder (50 ml)
Graduated Cylinder (50 ml)	Graduated Cylinder (50 ml)		

Sequence of Steps

Part 1: Diffusion

1. Put 50 mL of hot water in a cup and place 2 drops of food coloring into it. Record how long it takes to diffuse so that a homogenous mixture is reached.
2. Put 50 mL of ice water in a cup and place 2 drops of food coloring into it. Record how long it takes to diffuse so that a homogenous mixture is reached.
3. Obtain 2 pieces of celery and place one piece of celery into each cup of food coloring. Set aside so that they are not disturbed.
4. After 20 minutes determine how far the food coloring has traveled up the piece of celery. To do this, cut off the top of the celery in small increments until you run into the food coloring. Measure distance traveled. Record data.
5. Answer analysis questions 1-3.

Part 2: Selective Permeability

1. Obtain 2 plastic bags. Label bags as 1 & 2.
2. Bag 1: add 10 mL of iodine to 10 mL of water. Carefully seal and tie the bag shut.

3. Bag 2: add 20 mL of starch solution. Carefully seal and tie the bag shut.
4. Place bag 1 into cup A containing 20 mL of starch solution.
5. Place bag 2 into cup B containing 10 mL of iodine and 10 mL of water.
6. Set the cups aside and allow them to sit overnight undisturbed.
7. The next day, record your observations.
8. Carefully remove bag 1 from the cup, pour the contents into a graduated cylinder and record the volume. Discard bag and contents. Clean and dry graduated cylinder.
9. Measure and record the volume of the remaining liquid in cup A.
10. Carefully remove bag 2 from the cup, pour the contents into a graduated cylinder and record volume. Discasrd bag and contents. Clean and dry graduated cylinder.
11. Measure and record the volume of the remaining liquid in beaker B.
12. Answer analysis questions 4-10.

Part 3: Osmosis

1. Place 50 mL of Mountain Dew into a cup. Add two raisins.
2. Set aside undisturbed for 20 minutes.
3. Record your observations.
4. Answer analysis questions 11 & 12.

Part 4: Osmosis

1. Obtain 5 potato cores (cut like French fries) and 5 plastic cups.
2. Label the cups 1-5.
3. Weigh and record weights of potato core. Make sure to note what cup you place that potato into.
4. Into cup 1, add 50 mL of water and one of the weighed potatoes. Set aside until tomorrow.
5. Into cup 2, add 50 mL of water and 5 grams of sugar. Mix solution until all the sugar has dissolved. Add to cup 2 one of the weighed potatoes. Set aside until tomorrow.
6. Into cup 3, add 50 mL of water and 10g of sugar. Mix solution until all the sugar has dissolved. Add to cup 3 one of the weighed potatoes. Set aside until tomorrow.
7. Into cup 4, add 50 mL of water and 15g of sugar. Mix solution until all the sugar has dissolved. Add to cup 4 one of the weighed potatoes. Set aside until tomorrow.
8. Into cup 5, add 50 mL of water and 20g of sugar. Mix solution until all the sugar has dissolved. Add to cup 5 the last weighed potato. Set aside until tomorrow.
9. The next day, remove potato from cup 1, blot dry, weigh and record weight. Make a wet mount and view cells under the microscope on low and high power. Draw the cell under high power.
10. Repeat step 9 for cups 2-5
11. Answer analysis questions 13-17.

Observations & Analysis Questions

1. What is diffusion?

2. In which cup did diffusion occur more rapidly? Explain why.

3. Did diffusion occur more quickly in one celery verses the other? Explain.

4. Define selective permeability.

5. Which way did the iodine molecule move through the bag? Explain how you know this.

6. Did starch molecules pass through the membranes? Explain how you know this.

7. In which direction did water move in cup A and in cup B? Explain how you know this.

8. What can you infer from this experiment about movement of large molecules (starch) through a thin polyethylene membrane?

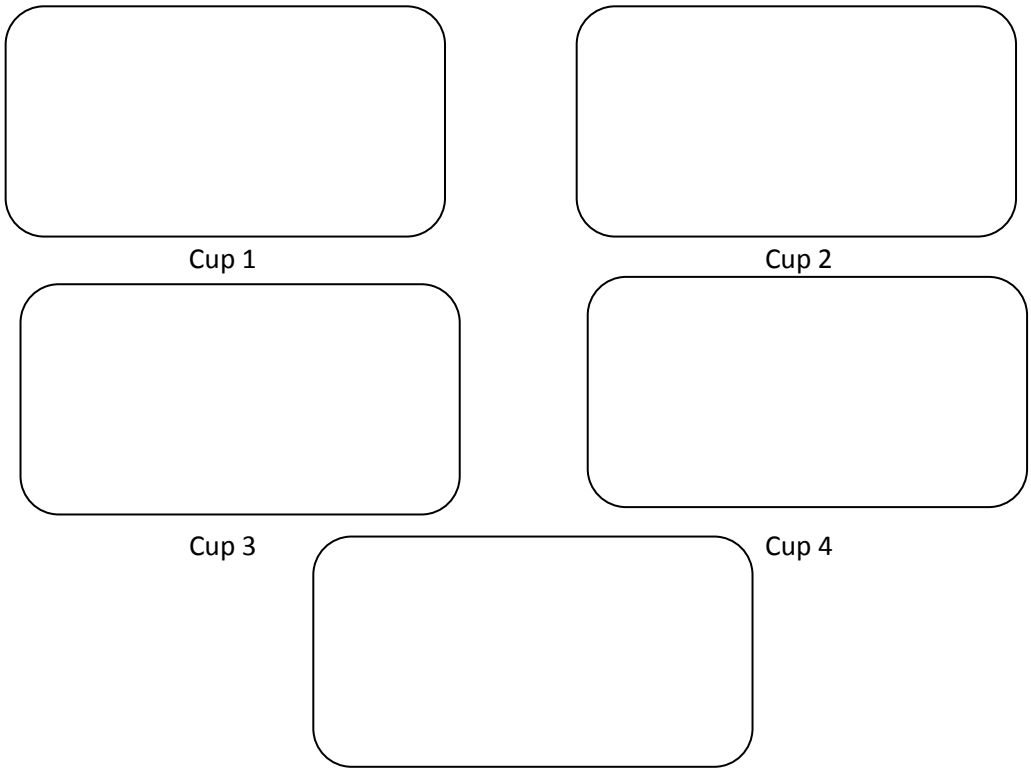
9. Can you call the membrane in this experiment selectively permeable? Explain your answer.

10. Of the molecules tested, which diffused through a polyethylene membrane?

11. Define osmosis.

12. Explain what happened to the raisin.

Illustrations: Draw the potato cell from each up as you observe it under high power.



13. Explain the changes in the masses of the potatoes.

14. Explain the changes in the potato cells.

15. Determine which solutions were hypertonic, hypotonic, and isotonic.

16. Why is it important that an IV is isotonic to blood?

[i] Goehring, JessaLee (2008). Passive Transport, Lab. *Lodi High School Agriculture Department*.

Biology/Life Sciences Standards

2. Mutation and sexual reproduction lead to genetic variation in a population. As a basis for understanding this concept:
    a. Students know meiosis is an early step in sexual reproduction in which the pairs of chromosomes separate and segregate randomly during cell division to produce gametes containing one chromosome of each type.
    b. Students know only certain cells in a multi cellular organism undergo meiosis.
    c. Students know how random chromosome segregation explains the probability that a particular allele will be in a gamete.
    d. Students know new combinations of alleles may be generated in a zygote through the fusion of male and female gametes (fertilization).
    e. Students know why approximately half of an individual's DNA sequence comes from each parent.
    f. Students know the role of chromosomes in determining an individual's sex.
    g. Students know how to predict possible combinations of alleles in a zygote from the genetic makeup of the parents.

3. A multi cellular organism develops from a single zygote, and its phenotype depends on its genotype, which is established at fertilization. As a basis for understanding this concept:
    a. Students know how to predict the probable outcome of phenotypes in a genetic cross from the genotypes of the parents and mode of inheritance (autosomal or X-linked, dominant or recessive).
    b. Students know the genetic basis for Mendel's laws of segregation and independent assortment.
    c. * Students know how to predict the probable mode of inheritance from a pedigree diagram showing phenotypes.
    d. * Students know how to use data on frequency of recombination at meiosis to estimate genetic distances between loci and to interpret genetic maps of chromosomes.

4. Genes are a set of instructions encoded in the DNA sequence of each organism that specify the sequence of amino acids in proteins characteristic of that organism. As a basis for understanding this concept:
    a. Students know the general pathway by which ribosomes synthesize proteins, using tRNAs to translate genetic information in mRNA.
    b. Students know how to apply the genetic coding rules to predict the sequence of amino acids from a sequence of codons in RNA.
    c. Students know how mutations in the DNA sequence of a gene may or may not affect the expression of the gene or the sequence of amino acids in an encoded protein.

d. Students know specialization of cells in multi cellular organisms is usually due to different patterns of gene expression rather than to differences of the genes themselves.
e. Students know proteins can differ from one another in the number and sequence of amino acids.
f. * Students know why proteins having different amino acid sequences typically have different shapes and chemical properties.

5. The genetic composition of cells can be altered by incorporation of exogenous DNA into the cells. As a basis for understanding this concept:
   a. Students know the general structures and functions of DNA, RNA, and protein.
   b. Students know how to apply base-pairing rules to explain precise copying of DNA during semi conservative replication and transcription of information from DNA into mRNA.
   c. Students know how genetic engineering (biotechnology) is used to produce novel biomedical and agricultural products.
   d. * Students know how basic DNA technology (restriction digestion by endonucleases, gel electrophoresis, ligation, and transformation) is used to construct recombinant DNA molecules.
   e. * Students know how exogenous DNA can be inserted into bacterial cells to alter their genetic makeup and support expression of new protein products.

Lab Reference: Genetics

Standards: 2a-g, 3a-d, 4a-f, 5a-e

STANDARD CONCEPT	LAB NAME	LAB NUMBER
Disorders	Genetic Disorder Fact Sheet	B-1
DNA	Codon Bingo	B-2
DNA	DNA Extraction: Strawberry	B-3
DNA	DNA Goes to the Races	B-4
DNA	Edible DNA	B-5
DNA	Find DNA in Your Own Kitchen	B-6
DNA	Gumdrop DNA	B-7
DNA	Simulating Protein Synthesis	B-8
Genetic Engineering	Genetic Engineering Radio Commercial	B-9
Inheritance	Reebop Lab	B-10
Inheritance	Scientific Selection of Agricultural Animals	B-11
Mitosis	Mitosis Drawings	B-12
Probability	Casino Day Probability	B-13
Probability	Chance, Independent Assortment & Results	B-14
Probability	Genetic Problems in Agriculture	B-15
Probability	Predicting Genes of Offspring	B-16
Reproduction	Boar Semen	B-17
Reproduction	Flower Anatomy	B-18
Reproduction	Pollination & Fertilization	B-19

Biology/Life Sciences Standards	•(BLS) 2.d and 4.c.
Agriculture Standards	•(AG) C 7.4. •(Foundation) 2.2 Writing, Specific Applications of Writing Strategies and Applications--Grades 9-10: (1.3) and (2.6).

Name_____

Date_____

Genetic Disorder Fact Sheet

Purpose

The purpose of this exercise is to research a genetic disorder and design an informative "Fact Sheet" which is interesting and educational![i]

Contents

- Name of disorder
- Description
- Symptoms
- Occurrence in general population
- Testing (how is it detected?)
- Informative illustrations
- Prognosis
- Treatment
- Support groups
- References (list all websites that you pulled info from)
- Cause

Grading

Your final grade on this assignment will be based on three areas – (1) the content of the Fact Sheet, (2) the design/layout of the Fact Sheet and (3) participation grade for the time that you spend in the computer lab doing research. This assignment is worth 50 points.

Genetic Disorder Choices

- Albinism
- Cancer
- Cru-du-chat syndrome/Cat Cry syndrome
- Cystic fibrosis
- DiGeorge syndrome
- Down syndrome
- Fragile X syndrome
- Huntington's disease
- Klinefelter syndrome
- Marfan syndrome
- Prader-Willi syndrome
- Peutz-Jeghers syndrome
- Tay-Sachs disease
- Triple X syndrome
- Trisomy 13 syndrome
- Trisomy 18 syndrome
- Tuberous sclerosis
- Turner's syndrome
- Williams syndrome

Useful Websites to Visit

- www.marchofdimes.com/pnhec/4439.asp
- www.noah-health.org/en/genetic/
- http://dir.yahoo.com/Health/Diseases_and_Conditions/Genetic_Disorders/
- http://gslc.genetics.utah.edu/units/disorders/karyotype/
- http://www.ygyh.org/

(Helpful Hint → Use a search engine like Google to find more sites on your disorder.)

Genetic Disorder Grading Rubric

Name: _____

Disorder: _____

FACT SHEET CONTENTS	POINTS POSSIBLE	POINTS EARNED
Name of disorder	3	
Description	5	
Symptoms	5	
Occurrence in general population	3	
Testing (how is it detected?)	4	
Informative illustrations	4	
Prognosis	2	
Treatment	4	
Support groups	5	
References	5	
FACT SHEET DESIGN/LAYOUT	**POINTS POSSIBLE**	**POINTS EARNED**
Page was visually pleasing Appropriate font style & size Minimized "white space"	10	
	POINTS POSSIBLE	**POINTS EARNED**
FINAL ASSIGNMENT GRADE	**50**	

[i] Sperling, Jill (2008).Genetic Disorder Fact Sheet. *Kingsburg High School Agriculture Department*.

Biology/Life Sciences Standards	• (BLS) 4.b.
Agriculture Standards	• (Foundation) 1.2 Science, Specific Applications of Investigation and Experimentation: (1.a).

Name_____

Date_____

Codon Bingo

Purpose

The purpose of this exercise is to practice using a codon table to translate mRNA into its associated amino acids.[i]

Procedure:

Materials

1. Blank Bingo cards
2. Codon table
3. Bingo chips, pennies, or other small marking items.

Sequence of Steps

1. Get one blank bingo card and put your name on it.
2. Fill in each of the blanks with an **amino acid** from the codon table.
3. The teacher will call out three bases (A, T, G, or C)
4. Find the amino acid that is associated with the codon and place a marker on that bingo square.

First Position	Seconed Position								Third Position
	U		C		A		G		
	code	Amino Acid	code	Amino Acid	code	Amino Acid	code	Amino Acid	
U	UUU	phe	UCU	ser	UAU	tyr	UGU	cys	U
	UUC		UCC		UAC		UGC		C
	UUA	leu	UCA		UAA	STOP	UGA	STOP	A
	UUG		UCG		UAG	STOP	UGG	trp	G
C	CUU	leu	CCU	pro	CAU	his	CGU	arg	U
	CUC		CCC		CAC		CGC		C
	CUA		CCA		CAA	gln	CGA		A
	CUG		CCG		CAG		CGG		G
A	AUU	ile	ACU	thr	AAU	asn	AGU	ser	U
	AUC		ACC		AAC		AGC		C
	AUA		ACA		AAA	lys	AGA	arg	A
	AUG	met	ACG		AAG		AGG		G
G	GUU	val	GCU	ala	GAU	asp	GGU	gly	U
	GUC		GCC		GAC		GGC		C
	GUA		GCA		GAA	glu	GGA		A
	GUG		GCG		GAG		GGG		G

BIOLOGY BINGO

[i] Opfergelt, H (2008).Codon Bingo. *Firebaugh High School Agriculture Department*.

Biology/Life Sciences Standards	•(BLS) 5.a.
Agriculture Standards	•(Foundation) 1.2 Science, Specific Applications of Investigation and Experimentation: (1.a), (1.c), and (1.d).

Name_____

Date_____

DNA Extraction - Strawberry

Purpose

The purpose of this exercise is to evaluate DNA through the process of DNA extraction from a strawberry.[i]

Procedure

Materials

1. Zip-lock pint/quart sized baggie
2. Previously frozen strawberry (1)
3. DNA extraction buffer (10 mL)
   Pre-Mixed for class: 50mL dish soap, 15g NaCl (2 tsp plain salt), 900 mL water
4. Filter paper (school paper towels)
5. Ice cold 90% ethanol or Isopropyl alcohol
6. Test tube or champagne flute (1)
7. Funnel (optional)
8. Inoculation loop or coffee stir-straw
   The instructor can melt the end of the coffee stirrer with a match for a couple of seconds to form a scoop.

Sequence of Steps

1. Place 1 thawed strawberry in the Zip-lock bag and squeeze until all lumps are turned into a uniform puree.
2. Add 10 mL of buffer solution. Zip the bag closed.
3. By squeezing the bag, mix the strawberry with the buffer solution completely.
4. Fold filter paper or paper towel into a half circle, then a quarter circle opening it to form a cone.
5. Fill the test tube or champagne flute (approximately 2 inches) with ice-cold alcohol. Place the filter paper cone into the test tube/flute so that half of the cone is on the inside and half is on the outside of the tube/flute.
6. Fill the paper towel cone with the strawberry solution.
7. As the strawberry mixture filters through the cone and comes in contact with the alcohol, the DNA will form ribbons and then coagulate at the top of the alcohol.
8. Use the straw to scoop and retrieve the DNA.
9. Examine the DNA you have extracted and complete the questions below.

Observations

1. Describe the DNA that you extracted from the strawberry.

2. Compare your extraction to the results of the rest of the class. Did you extract more or less DNA than other groups in the class?

3. What factors could affect your results?

4. Recall: What are the three components of DNA?

5. Were these components visible in this lab? Why or why not?

6. Critical Thinking: How could you design this experiment to show that only living (or once living) organisms have DNA?

7. Agriculture Application: DNA determines the traits, such as eye or flower color, animals and plants possess. Brainstorm at least 3 different traits that would be desirable (good) in plants or animals.

[i] Dickson, Chris (2008).DNA Extraction. *North High School, Bakersfield, Agriculture Department*.

Biology/Life Sciences Standards	• (BLS) 5.a.
Agriculture Standards	• (Foundation) 1.2 Science, Specific Applications of Investigation and Experimentation: (1.a).

Name_____

Date_____

DNA Goes to the Races

Purpose

The purpose of this lab is to simulate the digestion of the DNA with each of the three enzymes, then simulate agarose gel electrophoresis of the restriction fragments.[1]

Background Information

You have already learned about restriction enzymes and how they cut DNA into fragments. You may have even looked at some DNA restriction maps and figured out how many pieces a particular enzyme would produce from that DNA. But when you actually perform a restriction digest, you put the DNA and the enzyme into a small tube and let the enzyme do its work. Before the reaction starts, the mixture in the tube looks like a clear fluid. Guess what! After the reaction is finished, it still looks like a clear fluid! Just by looking at it, you can't tell that anything happened.

In order for restriction digestion to mean much, you have to be able to see the different DNA fragments that are produced. There are chemical dyes that stain DNA, but obviously it doesn't do much good to add them to the mixture in the test tube. In the laboratory, scientists separate DNA fragments so that they can look at the results of restriction digests (and other procedures) by a process called *gel electrophoresis*.

Gel electrophoresis takes advantage of the chemistry of DNA to separate fragments. Under normal circumstances, the phosphate groups in the backbone of DNA are negatively charged. In electrical society, opposites do attract, so DNA molecules are very much attracted to anything that is positively charged. In gel electrophoresis, DNA molecules are placed in an electric field (which has a positive and a negative pole) so that they will migrate towards the positive pole.

The electric field makes the DNA molecules move, but to cause them to separate and be easy to look at later on, the whole process is carried out in a gel (obviously the source of the name *gel* electrophoresis). If you have ever eaten Jell-O®, you have had experience with a gel. The gel material in Jell-O® is gelatin; different gel materials are used to separate DNA. One gel material often used for electrophoresis of DNA is called *agarose*, and it behaves much like Jell-O® but lacks the sugar and color. To make a gel for DNA (called *pouring* or *casting* a gel), you dissolve agarose powder in boiling water, pour it into the desired dish, and let it cool. As it cools, it hardens (sound familiar?).

Since the plan for agarose gels is usually to add DNA to them, scientists place a device called a comb in the liquid agarose after it has been poured into the desired dish, and let the agarose harden around the comb. Imagine what would happen if you stuck the teeth of a comb into liquid Jell-O® and let it harden. Afterwards, when you pulled the comb out, you would have row of tiny holes in the solid Jell-O® where the teeth had been.

[1] Knapp, Beth (2008).DNA Goes to the Races. *Atwater High School Agriculture Department*.

This is exactly what happens with laboratory combs. When the comb is removed from the hardened agarose gel, it leaves a row of holes in the gel. The holes are *sample wells*. DNA samples are placed into the wells before electrophoresis is begun.

For electrophoresis, the entire gel is placed in a tank of salt water (not table salt). An electric current is applied across the tank, so that it flows through the salt water and the gel. When the current is applied, the DNA molecules begin to migrate through the gel towards the positive pole of the electric field.

At this point, the gel does its most important work. All of the DNA in the gel migrates through the gel towards the positive pole, but the gel material makes it more difficult for larger DNA molecules to move than smaller ones. So in the same amount of time, a small DNA fragment can migrate much further than a large one. You can therefore think of gel electrophoresis like a DNA footrace, where the "runners" (the molecules being separated) separate just like runners in a real race. The smaller the molecule, the faster it runs. Two molecules the same size run exactly together.

After a time, the electric current is turned off and the entire gel is placed into a DNA staining solution. After staining, the DNA can be seen. The resulting pattern looks like a series of stripes in the gel called *bands*, where each separate band is composed of one size of DNA molecule. There are millions of actual molecules in the band, but they are all the same size (or very close to it). At any rate, after a restriction digest, there should be one band in the gel for each different size fragment produced in the digest. The smallest fragment will be the one that has migrated furthest from the sample well, and the largest will be closest to the well.

Procedure

Materials:

1. Scissors

Sequence of Steps

You have three representations of a DNA molecule and an outline of an electrophoresis gel. The representations show the cut sites of three different restriction enzymes on the same DNA molecule. You will simulate the digestion of the DNA with each of the three enzymes, and then simulate agarose gel electrophoresis of the restriction fragments.

1. Cut out the three pictures of the DNA molecule.
2. Simulate the activity of the restriction enzyme *Eco*RI sites by cutting across the strip at the vertical lines representing *Eco*RI sites. You have now digested the molecule with *Eco*RI. Put your "restriction fragments" in a pile apart from the other two DNA strips.
3. "Digest" the second DNA strip with *Bam*HI. Put the *Bam*HI fragments in a separate pile.
4. Now digest the remaining DNA molecule with *Hin*dIII. Put these fragments in a third pile.
5. In our imaginary gel electrophoresis, you will separate the *Eco*RI, *Bam*HI, and *Hin*dIII fragments as if you loaded the three sets of fragments into separate but adjacent sample wells. Arrange your fragments, as they would be separated by agarose gel electrophoresis. Designate an area on your desk as the end of the gel with the sample wells. Starting with the *Eco*RI fragments, arrange them from longest to shortest, with the longest one closest to the well.
6. Next, separate the *Bam*HI fragments adjacent to the *Eco*RI fragments. Be sure to order the fragments correctly by size with respect to the other *Bam*HI fragments and to the *Eco*RI fragments you have already laid out.
7. Repeat the same procedure for the *Hin*dIII fragments. You should now have all three of your sets of fragments arranged in order in front of you.
8. Look at the outline of the electrophoresis gel. Notice that it has a size scale in base pairs on the left-hand side, and that sample wells are drawn in. Use the outline and draw the pattern your restriction

digest would make in the gel, using the size scale as a guide for where to draw your fragments, and so on.

9. After you draw the bands representing the restriction fragments, use the size information on the paper DNA strips to label the bands on the gel with the sizes of the fragments in base pairs.
10. Use the actual fragment sizes as a check for your work.

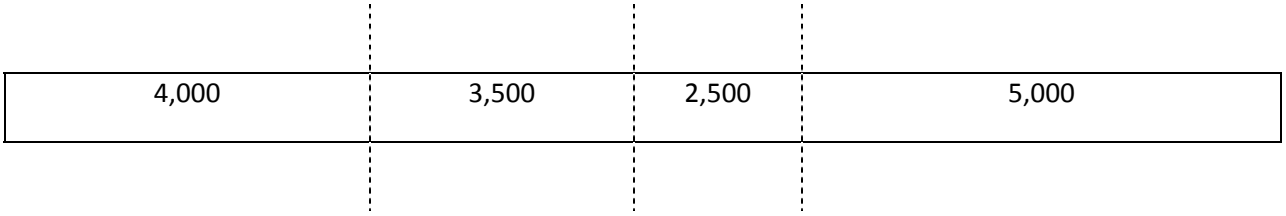
Are all the smaller fragments across all the gel "lanes" in front of all the larger fragments?

Did you notice that the size scale doesn't seem to have regular intervals? The size scale looks the way it does because agarose gels separate fragments that way.

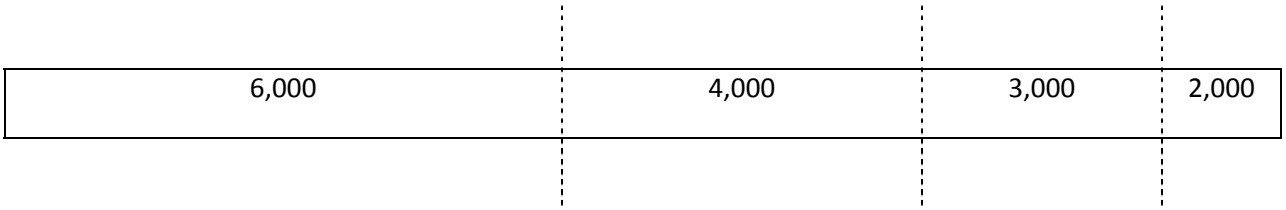
Restriction Maps for DNA Goes to the Races

Below are three representations of a 15,000 base pair DNA molecule. Each representation shows the locations of different types of restriction site, with vertical lines representing the cut sites. The numbers between the cut sites show the sizes (in base pairs) of the fragments that would be generated by digesting the DNA with that enzyme.

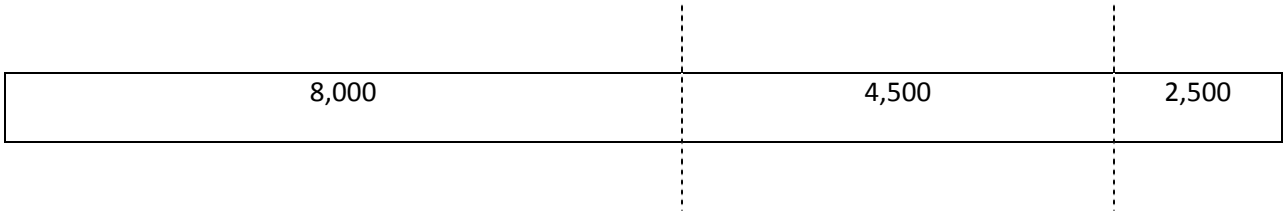
*Eco*RI sites



*Bam*HI sites

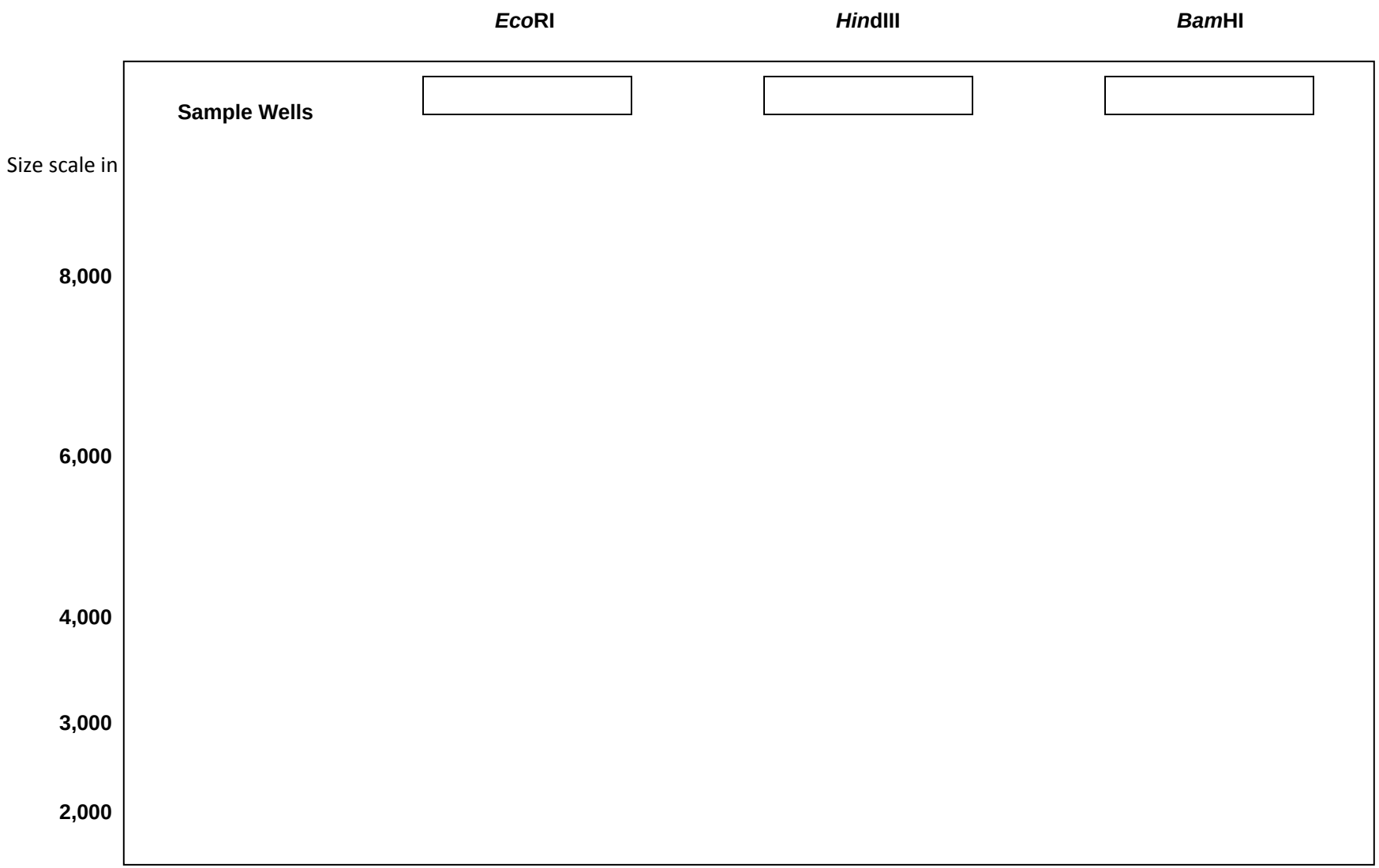


*Hin*dIII sites



Gel Outline for *DNA Goes to the Races*

Name _____ Period _____



Biology/Life Sciences Standards	• (BLS) 5.a.
Agriculture Standards	• (Foundation) 1.2 Science, Specific Applications of Investigation and Experimentation: (1.a).

Name_____

Date_____

Edible DNA

Purpose

The purpose of this exercise is to build and manipulate a model of DNA in order to investigate structure and replication.[i] [ii]

Procedure:

Materials

1. Spice gum drops (four colors minimum)
2. Orange slices (candy type or some other soft candy larger than gum drops)
3. Plain flat toothpicks
4. Paper towels

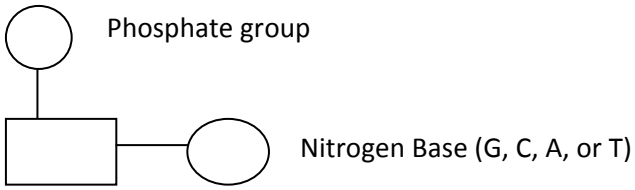
Sequence of Steps

Part I: Building a DNA Model

1. Use a diagram of DNA and the key below to build four different nucleotides (Figure 1): See below

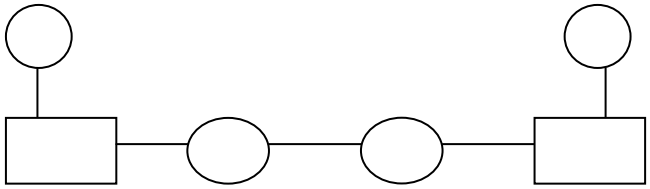
   Orange slice = deoxyribose sugar
   White gum drop = phosphate group
   Plain toothpicks = chemical bonds
   Green gum drop = Guanine nitrogen base
   Purple gum drop = Thymine nitrogen base
   Yellow gum drop = Cytosine nitrogen base
   Red gum drop = Adenine nitrogen base

   Figure 1: A DNA nucleotide



2. Repeat step 1. Now, combine the nucleotides to start forming a DNA molecule. DNA has the shape of a twisted ladder or spiral staircase. The geometric shape is called a **double helix**. You will make a "ladder" that has 4 "rungs" or steps. Remember, Adenine combines with Thymine and Guanine combines with Cytosine. Combine the nucleotides using the example below (figure 2): See below

Figure 2: Two nucleotides bonded together between the nitrogen bases (a "step")



3. Continue to build the "ladder" combing nucleotides as in step 3.
4. Once you have built the "ladder" that has used all 8 nucleotides made in steps 1 and 2, show the DNA molecule to the teacher.

Part II: DNA Replication (copying)

1. DNA must make a copy of itself before one cell splits into two cells. Special molecules called enzymes help DNA replicate or copy itself. First, an enzyme "unzips" DNA as if it were a zipper. Use your hands to pull apart the toothpicks that hold together your nucleotides (right up the middle like a zipper).
2. Next, an enzyme attaches new nucleotides to the two original strands that were separated. You will have to make 8 new nucleotides that pair up to the nucleotides on the original strands. Remember the nitrogen base pairing rules, A with T and G with C!
3. When you are finished, you should have two DNA molecules that are identical. Show your results to the teacher and ask him/her if you can eat your results!
4. Clean up your work area.

[i] Opfergelt, H (2008).Edible DNA. *Firebaugh High School Agriculture Department*.
[ii] Edible DNA! Retrieved January 19, 2009, from Power to Learn Web site: http://www.powertolearn.com/teachers/lesson_activities/index.shtml

Biology/Life Sciences Standards	• (BLS) 5.a.
Agriculture Standards	• (AG) G 2.4 and G 2.5. • (Foundation) 1.2 Science, Specific Applications of Investigation and Experimentation: (1.a).

Name_____

Date_____

Find DNA in your own Kitchen

Purpose

The purpose of this exercise is to isolate and evaluate onion DNA.[i]

Background

All the necessary instructions for making an organism are found in its DNA. In addition, DNA is used throughout the life of an organism to provide instructions for the millions of cellular processes that occur daily. Scientists study how DNA instructions are communicated to other parts of the cell. To do this, scientists isolate (separate) DNA from the cellular parts and examine how DNA interacts with RNA to do its job. To isolate DNA, scientists have to separate it from the other components of the cell. Cells are broken open and the DNA is separated from the lipid-containing membranes of the cell and its organelles.

*As you work through the lab, think about how the things we are using (blender, detergent, meat tenderizer, and alcohol) are tools for breaking apart the organelles and then spooling it.

Procedure

Materials

1. Onion (1)
2. Knife (1)
3. Measuring cup & spoons
4. Warm water (1/4 c)
5. Salt (1 tsp)
6. Stir rod or spoon
7. Blender (1)
8. Dish detergent (3-5ml)
9. Container s/beakers (2)
10. Coffee filter (1)
11. Meat tenderizer (1/8 tsp)

Sequence of Steps

1. Peel and cut the onion into very small pieces.
2. Measure out ¼ cup of warm water and add 1 tsp of salt. Stir until the salt is dissolved.
3. Put the onion pieces and the salt water in the blender and chop for just a couple seconds. The mixture should still be lumpy, containing small pieces of onion.
4. Gently mix the onion and water from the blender with 3-5ml of soap in a new container. Mix for about 5 minutes.
5. Put the coffee filter over an empty beaker and pour in the onion mixture. Allow the liquid to filter into the beaker.
6. Add approximately 1/8 tsp of the meat tenderizer and gently stir the mixture with a toothpick. Stir approximately 5 minutes.
7. Place the beaker on the table. Slowly pour alcohol into the mixture.

8. The alcohol will form a layer on the top of the cell debris.
9. Watch carefully as the DNA precipitates through the alcohol. The DNA is clear. Small bubbles will attach to the strands as they migrate up through the alcohol. Use a stir rod or toothpick to gently stir the alcohol layer. Notice how those strands move like snot. The snotty substance is DNA.
10. Respond to questions under "observations" and clean up your lab area.

Observations

1. Describe, in complete sentences, your observations at the conclusion of this lab.

2. In humans, plants and animals, where is DNA located?

3. Where does the DNA in an individual come from? Why?

4. Describe the pathway by which ribosomes synthesize proteins using RNA.

5. Draw a DNA molecule, showing basic structure including:
   Deoxyribose (sugar), Phosphate, Nitrogen Base (A, G, C, and T).

[i] Goehring, JessaLee (2008).Find DNA in your own Kitchen. *Lodi High School, Agriculture Department*.

Biology/Life Sciences Standards	• (BLS) 5.a.
Agriculture Standards	• (AG) G 2.5. • (Foundation) 1.2 Science, Specific Applications of Investigation and Experimentation: (1.d).

Name_____

Date_____

Gum Drop DNA

Purpose

The purpose of this exercise is to re-create the structure of a DNA molecule using candy. [i]

Procedure

Materials:

1. Toothpicks
2. Pipe cleaners
3. Red & black licorice
4. Gumdrops
5. Ruler

Sequence of Steps

1. Cut the red licorice into ¾ inch pieces and the black licorice into ½ inch pieces.

2. Put together two chains using the licorice and pipe cleaners to create the "backbone" of the DNA structure. The chains should be 12 inches long, alternating red licorice (deoxyribose sugar) and black licorice (phosphate).

3. Assign a gumdrop color to each of the four nucleotide bases.

    a. Adenine = _____
    b. Thymine = _____
    c. Cytosine = _____
    d. Guanine = _____

4. Assemble the DNA molecule by creating the "rungs" of the DNA structure using the gumdrops and toothpicks. These should connect to the deoxyribose sugar molecule (red licorice).

5. One side of the DNA molecule model should follow the pattern below:

    A T G C C A T G

6. Remember that the complimentary base must occupy the same position on the other side of the DNA chain. The base pairs should be joined by the toothpicks but not touch. The exposed toothpick represents the hydrogen bonds.

7. After the teacher has checked off your model, disassemble your DNA molecule and clean-up according to teacher's instructions.


8. Complete the review questions below.

Observations

1. Explain in your own words, using complete sentences, how you assembled your DNA model.

2. Where is DNA located? Be specific.

3. Why does approximately half of an individual's DNA sequence come from each parent?

3. What are the main components of a DNA molecule?

4. How have agriculturists used knowledge of DNA structure to improve plants and animals in a production setting? Give at least 2 examples.

[i] Sperling, Jill (2008).Gum Drop DNA. *Kingsburg High School Agriculture Department*.

Biology/Life Sciences Standards	• (BLS) 4.a and 4.b.
Agriculture Standards	• (AG) C 7.5. • (Foundation) 1.2 Science, Specific Applications of Investigation and Experimentation: (1.a) and (1.d).

Name_____

Date_____

Simulating Protein Synthesis

Purpose

The purpose of this exercise is to investigate how the traits on a particular chromosome are determined, and how these traits determine characteristics of an organism.[i]

Background

Genes are the units that determine inherited characteristics, such as hair color and blood type. Genes are lengths of DNA molecules that determine the structure of polypeptides (the building blocks of proteins) that our cells make. The sequence of nucleotides in DNA determines the sequence of amino acids in polypeptides, and thus the structure of proteins.

In a process called *transcription*, which takes place in the nucleus of the cell, messenger RNA (mRNA) reads and copies the DNA's nucleotide sequences in the form of a complementary RNA molecule. Then the mRNA carries this information in the form of a code to the ribosomes, where protein synthesis takes place. The code, in DNA or mRNA, specifies the order in which the amino acids are joined together to form a polypeptide. The code words in mRNA, however, are not directly recognized by the corresponding amino acids. Another type of RNA called transfer RNA (tRNA) is needed to bring the mRNA and amino acids together. As the code carried by mRNA is "read" on a ribosome, the proper tRNA's arrive in turn and give up the amino acids they carry to the growing polypeptide chain. The process by which the information from DNA is transferred in to the language of proteins is known as *translation*.

In this investigation, you will simulate the mechanism of protein synthesis and thereby determine the traits inherited by a fictitious organism called CHNOPS. CHNOPS, whose cells contain only one chromosome, are members of the kingdom Animalia. A CHNOPS chromosome is made up of six genes (A, B, C, D, E, and F), each of which is responsible for a certain trait.

Procedure:

Materials

1. Colored Pencil #1: _____
2. Colored Pencil #2: _____

Sequence of Steps

1. To determine the trait for Gene A of your CHNOPS, fill in the information in the box labeled Gene A in the Data Table. Notice the sequence of nucleotides in DNA. On the line provided, write the sequence of nucleotides of mRNA that are complementary to DNA. Then, on the line provided, write the sequence of nucleotides of tRNA that are complementary to mRNA.

2. In order to determine the sequence of amino acids, match each tRNA triplet with the specific amino acid in Figure 1. Using a – (dash) to separate each amino acid number, record this information in the appropriate place in the Data Table.
3. Using Figure 2, find the trait that matches the amino acid sequence. Record this information in the appropriate place in the Data Table.
4. Repeat steps 1 through 3 for the remaining genes (B through F).
5. Using all the inherited traits, sketch your CHNOPS in the space provided.

Figure 1

tRNA Triplet	Amino Acid Number
ACC	20
AGC	16
CGA	2
AAC	4
CGC	3
GGG	5
AGG	7
AAA	8
UUU	9
GGU	12
UAU	13
CCC	1
AUC	6
CUA	10
GGA	11

Figure 2

Amino Acid Sequence	Trait
20-11-13	Hairless
20-12-13	Hairy
20-21-21	Plump
13-14-15	Skinny
16-2	Four-legged
12-7-8-1	Long nose
5-7-8-1	Short nose
9-8	No freckles
9-4	Freckles
11-3-2	(Color #1) skin
11-3-3	(Color #2) skin
6-6-10	Male
6-6-14	Female

Data & Results

Gene A **DNA** ACC GGT TAT **mRNA** _____ **tRNA** _____ **Amino acid sequence:** _____ **Trait** _____	**Gene B** **DNA** AGC CGA **mRNA** _____ **tRNA** _____ **Amino acid sequence:** _____ **Trait** _____	**Gene C** **DNA** TTT AAC **mRNA** _____ **tRNA** _____ **Amino acid sequence:** _____ **Trait** _____
Gene D **DNA** GGA CGC CGA **mRNA** _____ **tRNA** _____ **Amino acid sequence:** _____ **Trait** _____	**Gene E** **DNA** GGG AGG AAA CCC **mRNA** _____ **tRNA** _____ **Amino acid sequence:** _____ **Trait** _____	**Gene F** **DNA** ATC ATC CTA **mRNA** _____ **tRNA** _____ **Amino acid sequence:** _____ **Trait** _____

Now draw the best representation of your CHNOPS in the box below. Make sure you pay attention to the traits of your CHNOPS that you determined from the DNA!!

Analysis & Conclusions

1. What are the differences between translation and transcription?

2. What are the specific sites for transcription and translation in the cell?

3. How many tRNA nucleotides form an anticodon that will attach to the mRNA codon?

4. What information do you need to have to show how transcription works? (What must be given to you in a problem?)

5. What information do you need to have to show how translation works? (What must be given to you in a problem?)

[i] (2008).Simulating Protein Synthesis. *Atwater High School Agriculture Department*.

Biology/Life Sciences Standards	• (BLS) 5.c, 5.d, and 5.e.
Agriculture Standards	• (AG) C 3.3. • (Foundation) 2.2 Writing, Specific Applications of Writing Strategies and Applications--Grades 9-10: (1.3). • (Foundation) 2.4 Listening and Speaking, Specific Applications of Listening and Speaking Strategies and Applications--Grades 9-10: (1.1), (1.7), (2.2a), and (2.2b).

Name_____

Date_____

Genetic Engineering Radio Commercial/Pod Cast

Purpose

The purpose of this exercise is to research a topic related to genetic engineering and produce a commercial or pod cast to educate the public. [i]

Procedure

During the next three days you and your group members will be researching a topic related to genetic engineering and writing a commercial to inform the public of your very important topic. Your group will be assigned to either the pro side or the con side of your chosen topic. Your commercial will be recorded using Garage Band in the MAC lab. Your commercial must be three minutes in length and everyone in your group must have a speaking part. Your group must also turn in a typed script of your commercial.

Group Members: (4 maximum)

_____ _____ _____ _____

Topics: Mark your 1st choice, 2nd choice and 3rd choice topic.

The use of cloning livestock for human consumption. **Pro** _____ **Con** _____

The use of transgenic crops for human consumption. **Pro** _____ **Con** _____

Genetic Engineering for medical use. **Pro** _____ **Con** _____

The use of transgenic animals for human consumption. **Pro** _____ **Con** _____

Labeling Genetically Modified Foods **Pro** _____ **Con** _____

Rubric:

Background Information on Topic		_____/10 Points
Persuasive arguments used (Pro/Con)		_____/ 10
3 Minutes in Length		_____/ 5
Typed Commercial Script		_____/ 5
Overall Content		_____/ 5
Voice / Quality of Pod Cast		_____/ 5
	Total Project	_____/ 40 Points
	Extra Credit	_____/ 5

Helpful Web Resources:

- http://www.time.com/time/magazine/article/0,9171,979547,00.html
- http://timesunion.com/AspStories/story.asp?storyID=660691
- http://filebox.vt.edu/cals/cses/chagedor/crops.html
- http://cls.casa.colostate.edu/TransgenicCrops/what.html
- http://www.ctahr.hawaii.edu/gmo/risks/
- http://daltonator.net/durandal/life/cloning.shtml
- http://users.rcn.com/jkimball.ma.ultranet/BiologyPages/T/TransgenicAnimals.html
- http://www.actionbioscience.org/biotech/margawati.html
- http://photoscience.la.asu.edu/photosyn/courses/BIO_343/lecture/transan.html
- http://www.ag.org/top/Beliefs/contempissues_14_genetics.cfm

Written Commercial Script

Opening Attention Getting Statement:

Background Information:

Persuasive Information (Pro / Con):

Closing Statement:

[i] Knapp, Beth (2008).Radio Commercial. *Atwater High School Agriculture Department*.

Biology/Life Sciences Standards	• (BLS) 2.c, 2.e, and 2.g.
Agriculture Standards	• (AG) C 7.1 and 7.3. • (Foundation) 1.2 Science, Specific Applications of Investigation and Experimentation: (1.d). • (Foundation) 1.1 Mathematics, Specific Applications of Probability and Statistics: (8.0).

Name_____

Date_____

Reebop

Purpose

The purpose of this exercise is to simulate fertilization for sexual reproduction. Variation is high during this process and so your zygote (fertilized egg) will have many possible genotypes.[i]

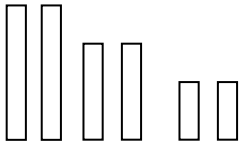
Procedure

Materials

1. Reebop chromosome boy envelope (1/pair)
2. Reebop chromosome girl envelope (1/pair)
3. Beaker (1/pair)
4. Supply Table (Thumbtacks, small marshmallows, push pins, large marshmallows, pipe cleaners, toothpicks)

Sequence of Steps

1. You will work in pairs. One person is mom; one person is dad. You should have 2 envelopes, one labeled male and one labeled female.
2. You and your partner should take out the paper strips (chromosomes) and turn them over so the letters aren't showing. Pair them according to length. You will have 8 pairs. (Remember a girl has XX and a boy has XY!)



3. When all of the chromosomes are paired, each person should pick one chromosome of each length and put it into a beaker. This beaker is your "Baby". Put the left over "chromosomes" back in the male and female envelope.
4. Now find out what your baby looks like. Turn over the chromosomes and decode the genes using the "Key to Reebop traits" (you will need to complete the genotypes before you use it). Write your answers on the data table.
5. Place all paper strips from your baby (chromosomes) back in the correct envelope. Go to the supply table at the front of the room to get your supplies.
6. Construct your baby. Draw a picture of your baby in the box under observations.
7. Draw a picture of another baby at your table in the other box. Write 3 sentences (under the picture) describing how it is similar and/or different from your baby.
8. Label a ½ sheet of paper with your names and you baby's name. Place the baby on the paper and put it in the "nursery".

Observations

Data Table

	Genotype	Phenotype
Antenna		
Nose		
Eyes		
Humps		
Tail		
Legs		
Segments		

Your baby

Another baby

Conclusions/Questions:

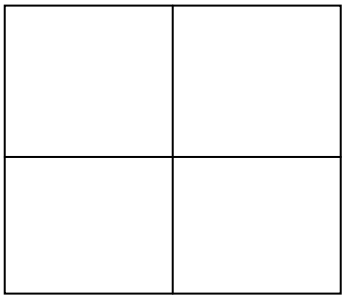
Use the "Key to Reebop traits" to help you answer these questions.

1. What are the phenotypes for these genes?
   a. Aa *b. EE* *c. ll* *d. Nn*

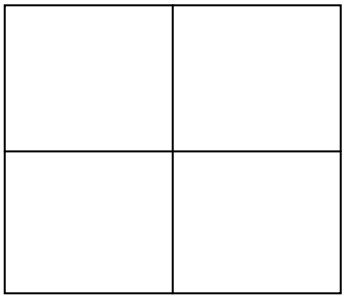
   _____ _____ _____ _____

2. Which of these traits are due to hybrid (heterozygous) genes? _____
   3 antenna *3 eyes curly tail*

3. What is the recessive trait for tail shape (2 small letters)? _____
4. What is the dominant trait for body segments (2 large letters)? _____
5. Make a Punnett square. Cross a green-nosed female with a pink-nosed male.



6. Make a Punnett square. Cross a 3-eyed creature with a 1 eyed creature.

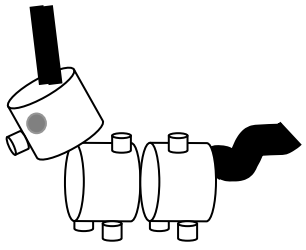


7. What percent of #6 are hybrids?

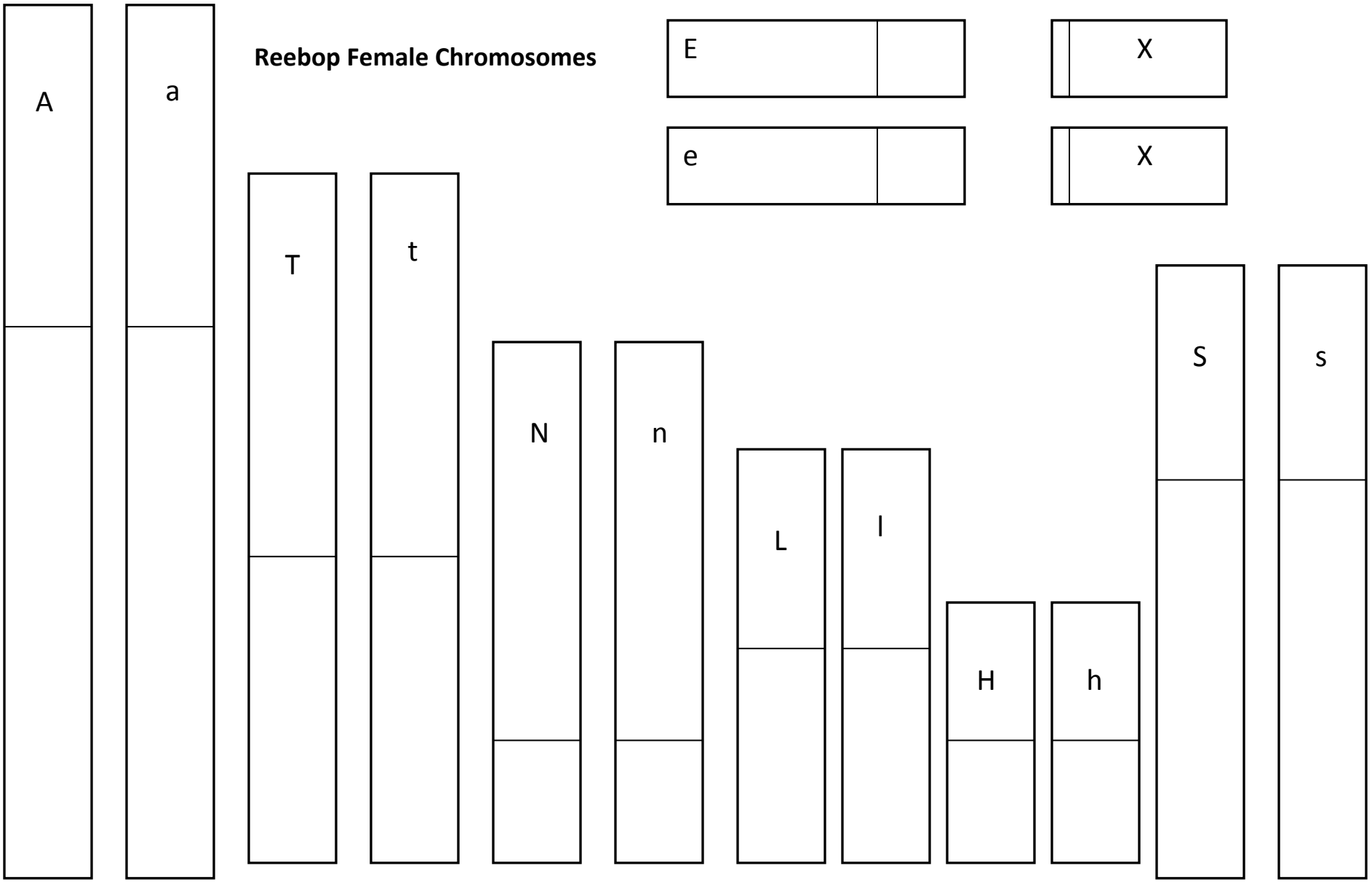
Key to Reebop Traits

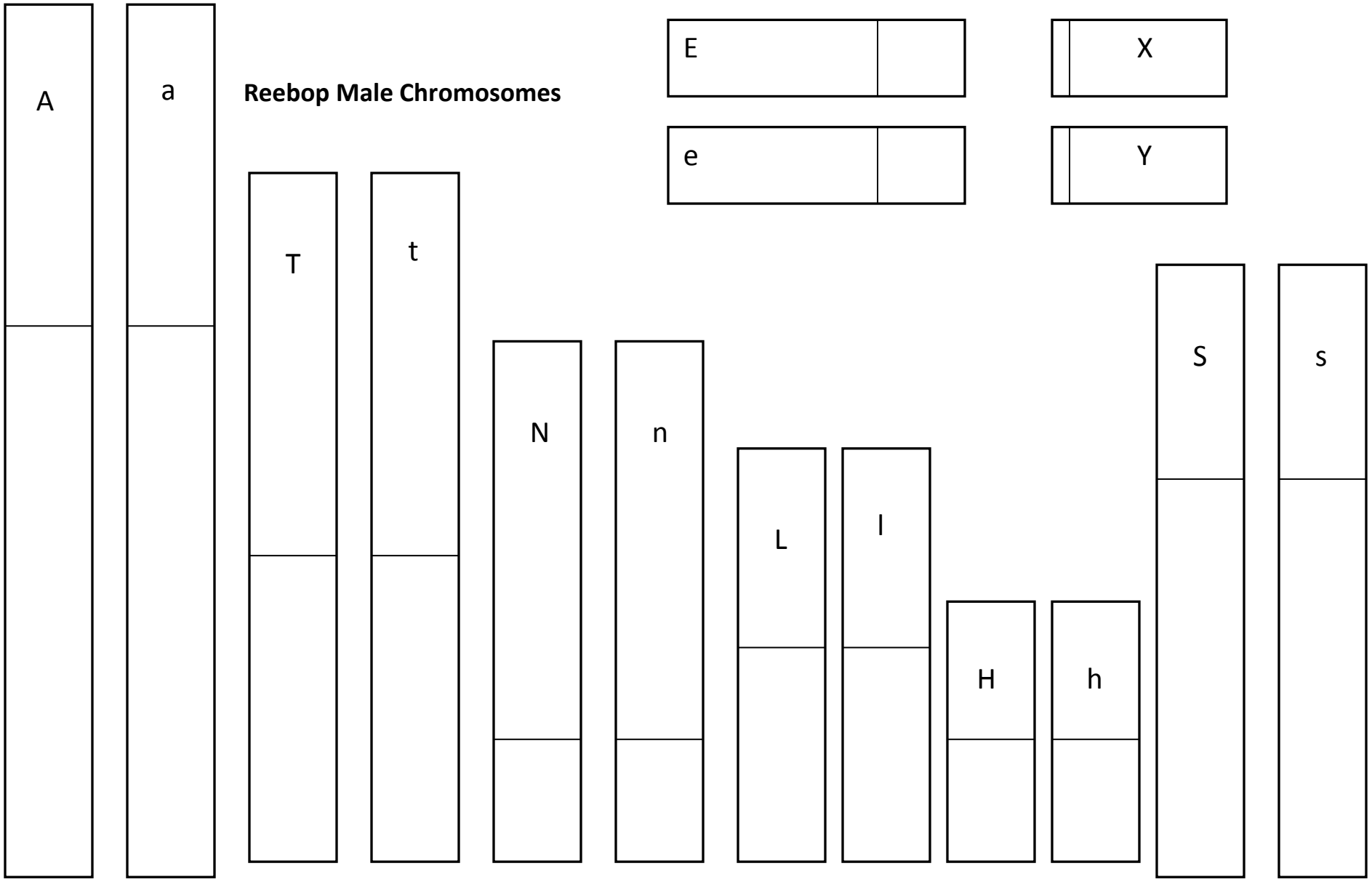
Genotype	Phenotype	Alleles	Supply
Antennae	(A = dominant allele)		
_____	= one antennae	(Homozygous D)	toothpick
_____	= two antenna	(Heterozygous)	
_____	= three antenna	(Homozygous R)	
Tail	(T = dominant allele)		
_____	= straight tail	(Homozygous D)	pipe cleaner
_____	= straight tail	(Heterozygous)	
_____	= curly tail	(Homozygous R)	
Segments	(S = dominant allele)		
_____	= two body segments	(Homozygous D)	large marshmallow
_____	= two body segments	(Heterozygous)	
_____	= three body segments	(Homozygous R)	
Nose	(N = dominant allele)		
_____	= green nose	(Homozygous D)	small marshmallow
_____	= pink nose	(Heterozygous)	
_____	= yellow nose	(Homozygous R)	
Legs	(L = dominant allele)		
_____	= yellow legs	(Homozygous D)	push pins
_____	= green legs	(Heterozygous)	
_____	= orange legs	(Homozygous R)	
Humps	(H = dominant allele)		
_____	= 2 pink humps	(Homozygous D)	small marshmallow
_____	= 2 pink humps	(Heterozygous)	
_____	= 1 yellow hump	(Homozygous R)	
Eyes	(E = dominant allele)		
_____	= two eyes	(Homozygous D)	thumbtack
_____	= three eyes	(Heterozygous)	
_____	= one eye	(Homozygous R)	

Use extra toothpicks as tendons and ligaments to connect your baby's body parts.



Reebop Female Chromosomes





[i] (2008).Reebop. *Atwater High School Agriculture Department*.

Biology/Life Sciences Standards	•(BLS) 3.a.
Agriculture Standards	•(AG) C 4.2, D 5.1, and D 5.2. •(Foundation) 5.0 Problem Solving and Critical Thinking: 5.3.

Name_____

Date_____

Scientific Selection of Agricultural Animals

Purpose

The purpose of this exercise is to demonstrate knowledge of how to predict the probable outcome of phenotypes in a genetic cross, through selective breeding. You are to develop an animal with a solid white hair coat through selective breeding. **20 white beans = solid white coat.** The first person in the class to obtain a solid white coat wins! [i]

Procedure

Materials

1. White beans
2. Speckled beans/dark beans
3. Cups (1 per student)

Sequence of Steps

1. Obtain ten each of white and speckled beans, and a cup to hold them.
2. "Breed" your animal to a neighbor's by pouring your beans into his/her cup. Gently shake the beans to get a good mix.
3. Pour the beans into your hand. Close your hand, and without looking, count out 20 beans into your classmate's cup.
4. Pour the remaining twenty beans into your own cup.
5. Record the new genotype on Table 1. This will simulate record keeping by the producer.
6. Continue to "breed" your animal to others in the class. You will naturally want to breed your animal to one that has more white color than yours. You may ask the classmate for his/her records and to examine his/her animal before committing to breed.
7. Conversely it's not in your interest to breed with an animal that has fewer white beans than yours.
8. The more breedings you have with animals better than yours, the better chance you have to obtain a pure white coat.
9. After a member of the class has reached the objective or the teacher calls time, return the beans to the source and complete the worksheet.

Observations

Table 1. Selective Breeding Record

	Number of White Beans	Number of Speckled Beans
Initial gene pool	10	10
Gene pool after breeding 1		
Breeding 2		
Breeding 3		
Breeding 4		
Breeding 5		
Breeding 6		
Breeding 7		
Breeding 8		
Breeding 9		
Breeding 10		
Breeding 11		
Breeding 12		
Breeding 13		
Breeding 14		
Breeding 15		

Analysis

1. If you were not able to develop a pure animal in the above exercise, how many more breedings do you think it would take to develop a pure animal?

2. Suppose the animals in this exercise are cattle, and it takes you 18 breedings to develop a pure white animal. How many years of development would this represent? (It takes 9 months for a cow to have a calf, and a cow must be one year of age before they can breed.)

3. Suppose the gene pool was much larger for the above exercise – maybe 200 white and 200 speckled. How many breedings would it take to develop a pure animal?

4. Suppose you wanted to start a new breed of animal. How would you go about it and how long do you think it would take?

5. Why is it important to keep records on animals?

6. Why is this exercise called selective breeding? Compare this lab with selective breeding in real life.

7. Compare and contrast natural selection vs. selective breeding.

[i] Goehring, JessaLee (2008).Scientific Selection of Agricultural Animals. *Lodi High School, Agriculture Department*.

Agriculture Standards	• (AG) 5.3. • (Foundation) 2.2 Writing, Specific Applications of Writing Strategies and Applications--Grades 9-10: (2.6).

Name_____

Date_____

Mitosis Drawings

Purpose

The purpose of this exercise is to illustrate and explain the stages of mitosis. [i]

Procedure

Materials:

1. 8 ½ x 11 inch sheet of paper
2. Colored pencils or pens
3. Notes/text book

Sequence of Steps

1. Separate an 8 ½ x 11" sheet of paper into 4 sections.
2. Using colored pencils, draw a cell as it goes through each of the 4 stages of mitosis. *(This is not art class; however, you need to put forth some effort so that you have a visual of the mitosis process.)*
3. Label each stage
4. Briefly explain what occurs in each stage.
5. Make sure to include your name, date and period.
6. When your drawings are complete, answer the review questions below.

Review Questions

1. What are the four stages of mitosis? Explain briefly what happens at each stage.

2. In plants and animals, which cells go through the process of mitosis?

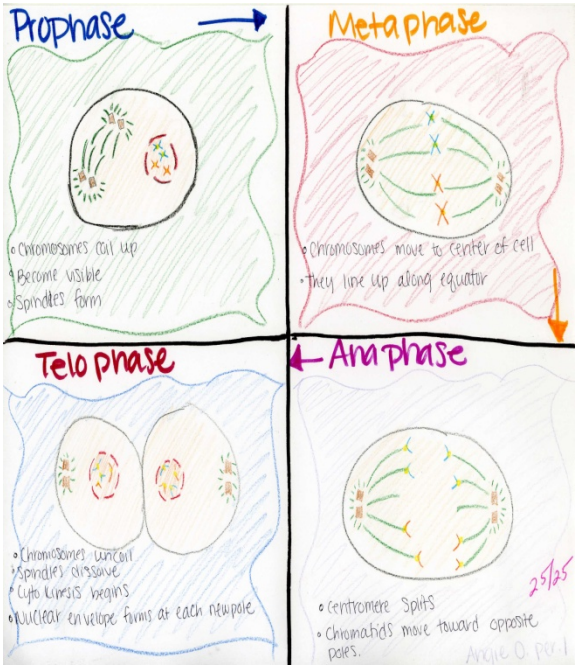
3. What is the purpose of mitosis? What does it produce?

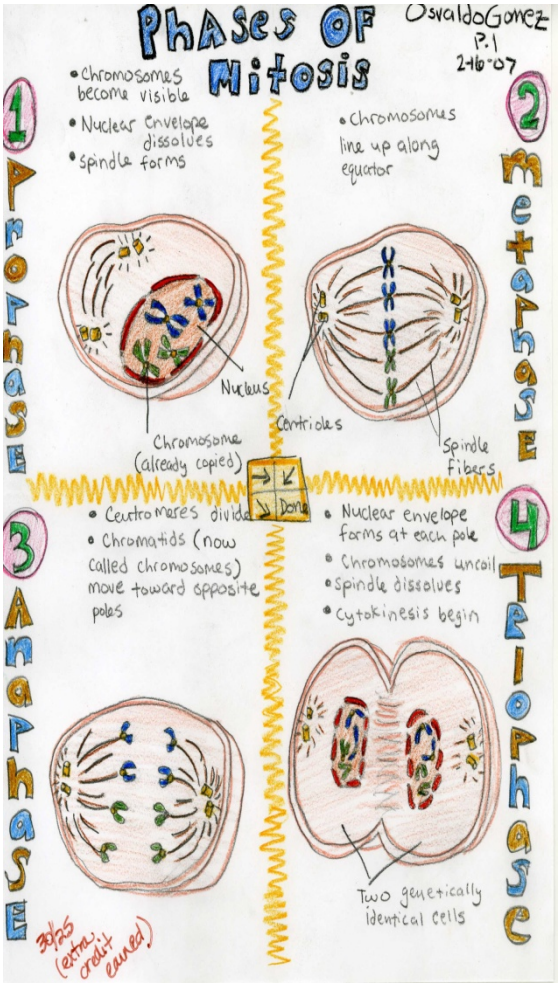
4. Animals are continuously going through mitosis at different places in their body. Identify two areas where mitosis could be taking place in an animal.

5. Plants go through mitosis continuously as well. Identify a reason that plants go through mitosis. What does mitosis produce in plants?

Teacher Notes:

Below are student samples for your reference.





[i] Sperling, Jill (2008).Mitosis Drawings. *Kingsburg High School Agriculture Department*.

Name_____

Date_____

Casino Day Probability

Purpose

In genetics, scientists use probability problems to estimate the genetic outcomes of mating two individuals. To become familiar with the concept of probability, we will examine how this concept relates to many of the games featured in casinos.[i]

Procedure

Materials:

1. Decks of cards (4)
2. Quarters (8)
3. Dice (8)

Sequence of Steps

1. Answer pre-lab questions.
2. During this lab, you will need to remain with your lab group.
3. You will work in partners at each station.
4. You will move through the stations in order of 1-4 or 5-8.
5. When directed, move to your assigned station (1 through 8)
6. Follow the procedure for the station at which you are located. You will have 10 minutes.
7. When the instructor calls time, please rotate to the next station in numerical order.
8. Again you will have 10 minutes.
9. Continue this process until you have completed the four different stations (either 1 through 4 or 5 through 8).

Pre-Lab Questions

1. How does probability relate to shuffling and playing cards?

2. How can you relate probability to the flip of a coin?

3. Explain how probability is seen in tossing dice?

4. Give another example in everyday life of how probability is seen.

Station 1 or 5: Deck of Cards

1. How many cards are in the deck?

2. How many clubs are in the deck?

   Hearts?

   Diamonds?

   Spades?

3. How many aces are in the deck?

4. Separate out all of the aces. What is the probability of picking out the ace of diamonds?

5. Add the jacks. What is the probability of picking out the ace of diamonds now?

6. What do you think is the probability of picking out a diamond on any given turn? Test this by doing the following: Shuffle the deck of cards and randomly pick a card 40 successive times. Record your results in the chart below:

# of diamonds	# of hearts	# of spades	# of clubs

7. Is this what you expected to happen? Explain.

Station 2 or 6: Stack of Coins

1. What is the probability of flipping a 'head'? A 'tail'?

2. If you flip a coin ten times, how many heads would you expect to get?

   How many tails would you expect?

   Why?

   Test this by flipping a coin ten times and record your results:

# of heads	# of tails

3. Now take two coins, call one "A" and the other one "B". What are the possible combinations you can get when you flip "A" and "B"?

	Coin A	Coin B
1)		
2)		
3)		
4)		

4. Flip the coins 40 times. Record in the table below how many times each combination happens. *[For example, if you get heads and then tails, count it in the second box.]*

Tails/Tails	Heads/Tails	Tails/Heads	Heads/Heads

5. Is this what you expected to happen? Explain.

Station 3 or 7: Roll of the Dice

1. Take a die and place it in front of you. How many sides are there?

2. What is the probability of rolling a 'three' on the first try?

3. What is the probability of rolling a 'three' on the second try? (No matter if you got a three on the first try or not.)

4. Using two die, what is the probability of rolling two 'threes' in a row?

5. Now return to using one die only. What is the probability of rolling an even number?

6. An odd number?

7. Take two dice in your hand and roll them simultaneously. What is the probability of rolling at least one 'six'?

8. Now, take two die and place one in each hand. Name the die in your left hand Mr. Curly. Name the die in your right hand Ms. Wrinkled. Now roll the two die simultaneously. Record whether Mr. Curly is an odd or even number. Record whether Ms. Wrinkled is an odd or even number. Repeat 40 times. Enter your results into the following table:

Mr. Curly	Ms. Wrinkled	# of occurrences
odd	odd	
odd	even	
even	odd	
even	even	

Station 4 or 8: Lottery Questions

1. You are more likely to be struck by lightning than to win the lottery. Discuss, and explain why this is true.

2. What is the chance that your ticket will be drawn in the lottery drawing? Explain how you arrived at your conclusion.

[i] Knapp, Beth (2008).Casino Day Probability. *Atwater High School Agriculture Department*.

Biology/Life Sciences Standards	•(BLS) 2.c.
Agriculture Standards	•(AG) C 7.1 and D 5.4. •(Foundation) 1.1 Mathematics, Specific Applications of Probability and Statistics: (8.0). •(Foundation) 1.1 Mathematics, Specific Applications of Algebra I: (10.0), (13.0), and (15.0).

Name_____

Date_____

Chance Independent Assortment and Results

Purpose

The purpose of this exercise is to demonstrate the process of chance and independent assortment in genetics, while calculating probability and ratios.[i]

Procedure

Materials

1. coin (1 per student)

Sequence of Steps

1. If you were to flip a coin ten times:
   a) How many times would you expect to get heads? _____
   b) How many times would you expect to get tails? _____
   c) By yourself, flip a coin 10 times and record the results below:
      Number of times for heads: _____
      Number of times for tails: _____
   d) Compare your results with other students. Are they similar or different?

2. With a partner, flip a pair of coins 100 times and record the outcome of each pair of tosses. Enter the results here and calculate the percentage of the whole for each of the three categories.

Toss Combinations (of 100)	Outcome	Percentage of the Whole
2 heads		
1 head & 1 tail		
2 tails		

3. Describe how dominant and recessive genes function.

4. Assume you have a cow that is black with genotype BB. She is mated to a white male, genotype bb). Black color is Dominant over white color.

a. What is the genotype of the male? _____
b. What is the genotype of the offspring?_____

c. What are the possible phenotypes of the offspring?_____
d. What would you expect the ratio of different genotypes to be? _____
e. What would you expect the ratio of the different phenotypes to be? _____

5. Assume you have a horned Hereford bull, with genotype pp. He is mated to a polled Hereford female that is polled (no horns), with genotype Pp. Polled is dominant and horned is recessive.

a. What is the genotype of the male? _____
b. What is the genotype of the offspring?_____

c. What are the possible phenotypes of the offspring? _____
d. What would you expect the ratio of different genotypes to be? _____
e. What would you expect the ratio of the different phenotypes to be? _____

[i] Goehring, JessaLee (2008).Chance, Independent Assortment, and Predictable Results. *Lodi High School Agriculture Department*.

Biology/Life Sciences Standards	•(BLS) 3.a.
Agriculture Standards	•(AG) C 7.3. •(Foundation) 1.2 Science, Specific Applications of Investigation and Experimentation: (1.d).

Name_____

Date_____

Genetics Problems in Agriculture[i]

Monohybrid Cross

1. Holsteins being black and white is dominant over being red and white. What are the chances of a homozygous dominant bull and a heterozygous cow having a calf that is red?

_____x_____

Phenotype:

Genotype:

2. Angus cattle being black is dominant over being red. What are the chances of a heterozygous bull and a heterozygous cow having a calf that is black?

_____x_____

Phenotype:

Genotype:

3. Curly Calf Syndrome is a lethal genetic defect found in Angus cattle caused by a recessive allele. Calves born with this syndrome are born dead with bent and twisted spines. What would be the likelihood that a carrier bull (Cc) mated to a carrier cow (Cc) produced a calf that did not carry the gene.

_____x_____

Phenotype:

Genotype:

Test Cross

4. Woolly coat (W) in sheep is dominant over straight-haired coat. How would a sheep farmer find out if the ram he bought at the auction was homozygous dominant for the woolly coat trait?

_____x_____ Phenotype:

Genotype:

Codominance

5.Coat color in Herford cattle is a codominant trait. Red coat (R) and white coat (W) alleles blend in the heterozygous condition to produce a roan or red-and-white spotted coat (RW). If a bull with a red coat and a cow with a roan coat are mated, what will be the coat color of their calves?

_____x_____ Phenotype:

Genotype:

6. Sickle-cell anemia is a disorder inherited by a homozygous recessive genotype (ss). Afflicted individuals have abnormal hemoglobin pigments in their red blood cells, causing the RBCs to be misshapen or sickled. Carriers of this trait (Ss) are partially affected as half of their hemoglobin is abnormal and may suffer some symptoms. What are the chances that two carriers will produce a child who is afflicted with the disorder (ss)?_____

_____x_____ Phenotype:

Genotype

Sex Determination

7. Your award winning cow and bull have had 10 calves, 3 bulls and 7 heifers. What is the probability that they will have a bull for their eleventh calf? (Male genotype is XY and female genotype is XX)

_____x_____ Phenotype:

Genotype:

x-Linked

8. In chickens, a dominant gene (F) on the X chromosome results in silver feathers. Its recessive allele results in gold feathers.

a. What are the two possible genotypes of a silver hen?_____ & _____
b. What are the 2 possible F_1 generations that would result from a cross between a golden rooster and a silver hen?

_____x_____

_____x_____

9. Hemophilia or the "bleeder's disease" is a genetic disorder in which blood does not clot. In the past, hemophiliacs died at a young age. Today, afflicted individuals can have their life expectancy increased by having transfusions of clotting factor. This disorder is carried as a recessive allele (h) on the X chromosome.

a. If a normal male and a woman who is a carrier for the trait produce offspring, what are the chances of having a male child with hemophilia?_____
b. A female child with hemophilia?_____

_____x_____

Dihybrid Cross – assume the two traits are on different chromosomes

10. In some dogs, barking (B) when trailing a scent is due to a dominant allele. Other dogs are silent when trailing. Erect ears (E) are dominant to floppy ears. If two heterozygous erect-eared barkers (BbEe X BbEe) produce puppies, what traits would you expect to see in their offspring? (Possible phenotypes are erect ear barker, erect ear silent, floppy ear barker, and floppy ear silent)

Erect Ear Barkers:_____, Erect Ear Silent:_____, Floppy Ear Barker:_____, Floppy Ear Silent:_____

11. In race horses, black hair (F) and a trotting gait (G) are dominant traits. Recessive traits are chestnut hair (f) and a pacing gait (g). Determine the possible offspring from a cross between 2 heterozygous black trotters (FfGg)

Black Hair Trotter:_____, _____:_____,

_____:_____, _____:_____

[i] Madlem, Amber (2008).Ag Genetics Problems. *Central Valley High School Agriculture Department*.

Biology/Life Sciences Standards	•(BLS) 2.c, 2.e, and 2.g.
Agriculture Standards	•(AG) C 7.1 and C 7.3. •(Foundation) 1.1 Mathematics, Specific Applications of Probability and Statistics: (8.0).

Name_____

Date_____

Predicting Genes of Offspring

Purpose

The purpose of this exercise is to compare expected and observed results and predict genes in sheep offspring.[i]

Background

The Punnett square can be used to predict expected results from a genetic cross. In mice black coat (B) is dominant over white coat color (b). If two heterozygous parents are crossed, we would expect 3 black to every 1 white offspring. The Punnett square shows the expected results of the Bb x Bb cross.

You know observed results do not always agree with expected results. Four offspring of the Bb x Bb parents may really all be white. That is, the *observed results* may all be white. These results are not what would be expected. Of what good are *expected results*? The expected results help us determine what the observed results will *likely* be.

Procedure

Materials

1. 2 pennies
2. Masking tape

Sequence of Steps

Part A: Calculating Expected Results

Assume that a female mouse has several litters of young in one year. She is heterozygous (Bb) for coat color and mates with a male that is also heterozygous (Bb) for coat color. You can predict what kind of offspring she will have by constructing a Punnett square as shown in Figure 1. Results from mating two mice can be shown by tossing and reading coins.

Figure 1. Punnett Square

	B	b
B	BB Black	Bb Black
b	Bb Black	bb White

1. Place 2 coins in your cupped hands and shake the coins. Drop the coins on a desktop.
2. Examine the coins and determine whether you have 2 heads, 2 tails, or a head and a tail.
3. Make a mark (/) in Table 1 under the correct combination of genes.
4. Repeat shaking and reading the coins for a total of 40 times. These 40 shakes will represent the combination of genes you might have observed in the offspring of several litters.
5. Count the marks for each gene combination and write the total observed in Table 1.

6. Calculate the expected number for each gene combination by using the Punnett square in Figure 1.
    a. First divide the number of BB squares in Figure 1 by 4; multiply that number (a percentage) by 40. Record this number as the expected number for the gene combination of BB genes in Table 1.
    b. Repeat these calculations for Bb and bb squares. Record your values for each gene combination in Table 1.
    c. Record the colors (phenotypes) in the last row of Table 1.

Table 1. Results of Coin Tosses (Coat Color in Mice Bb x Bb)

Coin Combinations	Head-Head	Head-Tail	Tail-Tail
Gene Combinations	BB	Bb	bb
Observed results (/)			
Total observed in 40 tosses			
Total expected in 40 tosses			
Coat color in mice (phenotype)			

Part B: Predicting Mouse Offspring

Suppose you mate a female mouse that is heterozygous (Bb) with a male that is pure recessive (bb). Predict what kind of offspring she will have by completing a Punnett square in Figure 2.

Figure 2. Predicting Bb x bb

	B	b
b		
b		

1. Place tape on both sides of the two coins and mark both sides of one coin with a “b”. Mark one side of the other coin with a “b” and the other side with a “B”.
2. Place the two coins in your cupped hands and shake the coins. Drop the coins on a desktop.
3. Examine the coins and determine whether the offspring are heterozygous (Bb) or pure recessive (bb).
4. Make a mark (/) in Table 2 under the correct combination of genes.
5. Repeat shaking and reading the coins a total of 40 times. The 40 shakes will show the combination of genes you observed in the offspring of several litters.
6. Count the marks for each gene combination and write the total observed in Table 2.
7. Use the method of calculating expected numbers for each gene combination as in Part A, step 6, by using the Punnett square in Figure 2.

8. Determine the coat color of the offspring by using the Punnett square in Figure 2. Record the color in the proper part of Table 2.

Table 2. Results of Coin Tosses (Coat Color in Mice Bb x bb)

Coin Combinations	B-b	b-b
Gene Combinations	Bb	bb
Observed results (/)		
Total observed in 40 tosses		
Total expected in 40 tosses		
Coat color in mice (phenotype)		

Questions

1. How often do you expect a tossed coin to land on heads? _____
2. How often do you expect a tossed coin to land on tails? _____
3. When 2 coins are tossed, how often do you expect to get the following combinations?
   a. heads/heads _____
   b. heads/tails _____
   c. tails/tails _____

4. What gene combinations and features (coat color) do the following coin tosses produce?

	Gene Combinations	Features
Heads/heads		
Heads/tails		
Tails/tails		

5. What gene combinations and features (coat color) do the following marked coin tosses produce:

	Gene Combinations	Features
B/b		
b/b		

6. How close were your observed results to what you expected to get?

7. When will the observed results be close to the expected?

8. What is the expected result of a cross BB x bb? Draw a Punnett square below to show your solution.

9. Suppose you mated 2 other mice and expected 1 black mouse for each white mouse. How many of the following mice would you expect to observe out of 100 offspring?
   a. black mice _____ b. white mice _____

10. A scientist made a cross between 2 black mice. The cross was repeated between the same 2 mice several times. The data chart showed the color of all 42 offspring to be black. Use the Punnett squares below to show what you think the gene combinations were of both parents.

	B	_____
B	BB	B___
____	B___	____ ____

	B	_____
B	BB	B___
____	B___	B ___

[i] Goehring, JessaLee (2008).How can the genes of offspring be predicted?. *Lodi High School Agriculture Department*.

Agriculture Standards

- (AG) C 7.4, C 13.3, D 4.1, and D 4.4.
- (Foundation) 1.2 Science, Specific Applications of Investigation and Experimentation: (1.a) and (1.d).
- (Foundation) 1.1 Mathematics, Specific Applications of Probability and Statistics: (8.0).

Name_____

Date_____

Boar Semen: Who's the Better Daddy?

Purpose

The purpose of this lab is to evaluate boar semen and determine the performance ability in the areas of motility, morphology and acrosome integrity.[i]

Procedure

Materials

1. Boar semen (2 different samples)
2. Pipettes
3. Slides
4. Slide covers
5. Microscopes (must be capable of 100x and 400x)
6. Eosin-nigrosin stain
7. Acrosome stain
8. Saline
9. Microscope immersion oil
10. Clean Dry beakers of test tubes

Sequence of Steps

1. Define the following terms prior to starting this lab:
   a. Motility:

   b. Morphology

   c. Acrosome Integrity

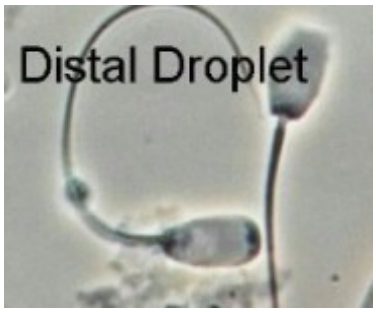
2. *Your Dilemma:* You are a supplier of boar semen to be distributed for AI (artificial insemination). The problem is that you just bought three big time champion boars and you only have room for two of them. You decide that there are two boars that you may be able to part with but you are unsure of which one you should send down the river. One thing that you pride yourself in is the quality of product that you distribute, so you decide the boar that is producing the best quality of semen is the boar that you will keep.
3. Review the examples of visual abnormalities. Follow the procedures and record your data for each sample. Then you will have to decide who the better producer is.
4. Begin by filling in the sire names across the top of the Data Table.
5. Observe the ejaculate and record observations.
6. Determine the volume of the semen.

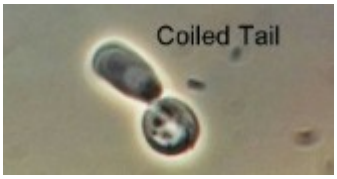
7. **Motility**
    a. Prepare a 1:10 dilution of semen with semen extender (not needed if using bottled semen).
    b. Gently rotate the semen.
    c. Remove a small sample (5 to 10 ml) and place in a clean glass test tube.
    d. If, necessary, warm it to 36 to 37 degrees centigrade (body temperature).
    e. Place a small drop on a pre-warmed slide and gently place a cover slip over the drop.
    f. Immediately examine the sample at 100x and then at 400x.
    g. Count the # of sperm in each field that are progressively moving forward. Count the number of sperm found in each cell for 10 cells in 5 different fields. Record each count in the chart.
    h. Determine the average number of sperm with good motility in each sample and record.
8. **Morphology**
    a. After the motility estimate is complete, allow the slide to cool. Motility will slow or stop and individual sperm cells can be observed. OR Prepare a stained semen sample-using step 9a, with a mixture (1:1) of morphology stain (Eosin-nigrosin stain) and formal saline.
    b. Switch to the 400x objective and observe individual cells in 5 fields.
    c. Determine the percentage of "normal" cells. *HINT: It is usually easier to count the # of abnormal sperm.*

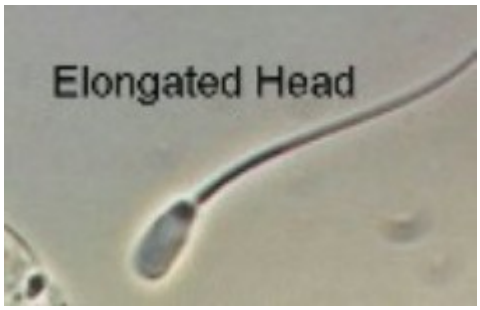
% of normal cells = # of normal cells/ total # of cells

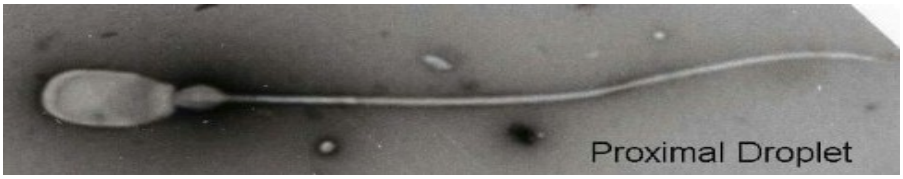
9. **Acrosome Integrity**
    a. Prepare a 1:1 dilution of semen and a mixture (1:1) of formal saline and Acrosome stain on a glass slide.
    b. Place 1-2 drops of semen and 1-2 drops of the stain mixture on a glass slide and mix gently with the tip of the pipette. Use the edge of a second slide to draw the mixture across the flat slide to produce a thin layer. Allow the slide to air dry.
    c. Place a drop of microscope immersion oil under the slide and view first at 10x to focus, and then switch to either 40x or 100x and view individual cells. (Be sure that you don't get oil on non-oil lens)
    d. Repeat step 8c to determine the percentage of cells that are "normal". (see example pictures for normal vs. abnormal)
10. Review ideal values for boar semen and answer observation questions.

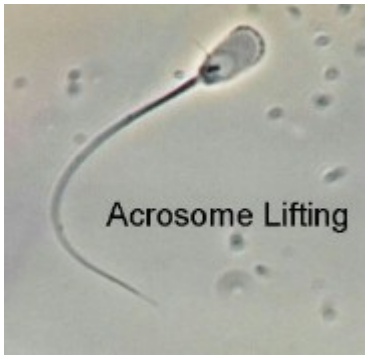
Examples of Visual Abnormalities

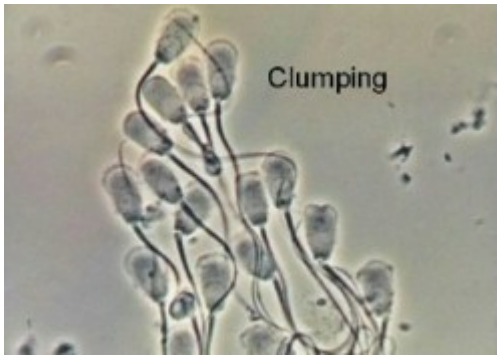












Ideal Values for Boar Semen

Ejaculate Characteristic[1 2 3]	Normal Value	Limit Value
Ejaculate Volume	100-500ml	50ml
Total Sperm per Ejaculate (x 10^9)	10-100	10
Progressive Motility	70-95%	62%
Clumping (% coverage of microscopic field)	0-10%	25%
Curled Tails	1-2%	10%
Morphological Abnormalities	5-10%	30%
Acrosome Abnormalities	5-10%	49%
Cytoplasmic Droplets	<5%	15%

[1] Data from Larsson K: Current Therapy in Theriogenology, 2nd ed. P.972.
[2] Pork Industry Handbook no. 136. Semen collection, evaluation, and processing in the boar.
[3] Flowers, 1998.

Data Table

Sire Name		
Visual of ejaculate (evaluate color, and consistency)		
Determine semen volume		
Motility		
# of sperm in each field progressively moving forward.		
Average sperm count with good motility.		
Morphology		
% of normal sperm cells.		
Acrosome Integrity		
% of normal sperm cells.		

Observations

1. Did sire A meet the limit requirements? If not which values did it not pass? (Use the chart on the previous.)

2. Did sire B meet the limit requirements? If not which values did it not pass?

3. Was sire A in the normal range? If not which values were out of the range?

4. Was sire B in the normal range? If not which values were out of the range?

5. Which boar did you cull from your herd? WHY?

Teacher Notes

For those who do not have a boar to collect semen from, it is fairly inexpensive to buy semen from a distributor. This could be an advantage for class as it is already extended and you could get a sample from more than one boar. Differences can be studied between breeds, boars, ages, etc. One dose should be more than enough for about 4 groups to do all three of the evaluation procedures. You can purchase one dose of boar semen for as little as $15. Top Cut Showpig Sires http://www.topcutsires.com/ is just one possible supplier for boar semen. Do some research online as most genetics companies offer inexpensive sires.

[i] Severtson, M. (2008). Boar Semen. *Student, California Polytechnic State University, San Luis Obispo*.

Agriculture Standards

- (AG) C 11.1.
- (Foundation) 1.2 Science, Specific Applications of Investigation and Experimentation: (1.a).

Name_____

Date_____

Flower Anatomy

Purpose

The purpose of this exercise is to locate and label the parts of a flower on the diagram provided. You will describe the function of each of the parts. You will identify these parts on actual flowers that you bring to class. [i]

Procedure

Materials:

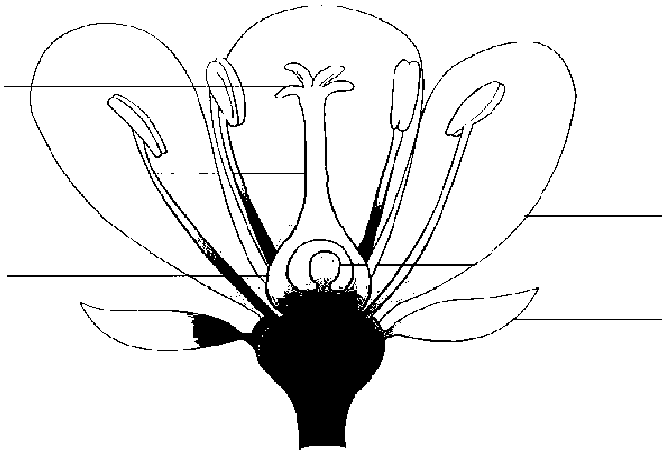
1. Diagrams/models of flowers
2. Hand lens/magnifying glass
3. Colored pencils
4. Construction paper
5. Student collected flowers
6. Microscope
7. Dissecting Blade or scissors

Sequence of Steps

1. Using the diagrams and models of flowers, find the various structures indicated below on your specimen.
2. Label and color the following parts on the flower in "observations":
   a. Sepal – green
   b. Stem – light green
   c. Petals – pink
   d. Filaments – dark blue
   e. Anthers – light blue
   f. Stigma – bright red
   g. Ovary – orange
   h. Ovule – brown
   i. Pollen tube- yellow
   j. Style – purple
3. Gently pull your flower apart.
   a. Separate each part of the flower.
   b. Use a blade or scissors to carefully open the ovary to view the ovules.
   c. Use the microscope to closely view each part of the flower.
   d. Lay the separated parts of the flower out on the construction paper and label the parts. The parts should be arranged so that they look like a flower.

Observations

1. Label and color the diagram using the directions above.[ii]



Conclusions:

1. Fill in the chart below with the functions of the listed parts and whether the part is associated with the male or female function of the flower.

Part	Function	Male/Female/Neither
Sepal		
Petal		
Pistil		
Stamen		
Filament		
Anther		
Stigma		
Style		
Ovary		
Pollen		
Ovule		

2. What factors can affect asexual plant reproduction?

3. What cell(s) in the flower go through Meiosis? How do you know?

4. How did Mendel use his knowledge of the flower parts to develop his laws of segregation and independent assortment?

[i] Agricultural Biology Curriculum Lesson Plans. Sacramento: California State Department of Education, Agriculture Education Unit, 1990.

[ii] "How to Grow a Flower." The Kaleidoscope of Life. 2002. Program for Interdisciplinary Learning Through the Arts. 3 Oct 2008 <teachart.msu.edu/pila/images/flower.jpg>.

Biology/Life Sciences Standards	•(BLS) 2.b, 2.d, and 2.e.
Agriculture Standards	•(AG) C 11.1 and C 11.4. •(Foundation) 1.2 Science, Specific Applications of Investigation and Experimentation: (1.a).

Name_____

Date_____

Pollination and Fertilization

Purpose

The purpose of this exercise is to study pollen grains, ovules and fertilization.[i]

Procedure

Materials

1. Samples of pollen collected from several flowers
2. Microscope
3. Slides & cover slips
4. Pistils of flowers
5. Razor blade
6. Hand lens
7. Forceps/tweezers
8. Red & blue pencils
9. Envelopes

Sequence of Steps

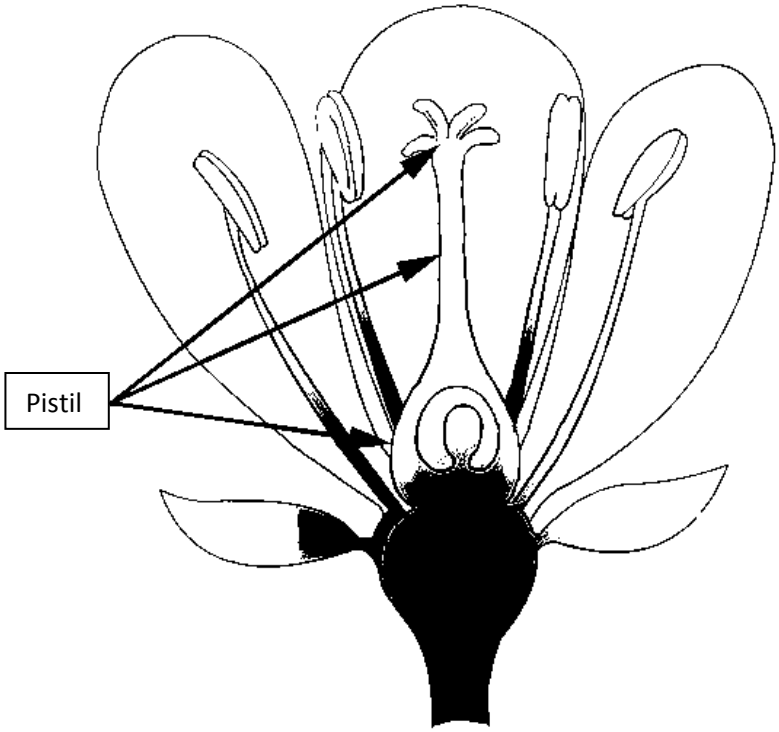
1. Pollen grains
    a. Collect samples of pollen from different flowers by shaking the flower in an envelope, using a different envelope for each flower. Label the envelope.
    b. Dust a little of the pollen in a drop of water on a slide and cover with a slip. Locate the pollen grains under low power and focus under high power. Make a drawing in "observations".
2. Ovules
    a. Locate the pistil of a flower and remove with forceps, being sure that the ovary is not broken off.
    b. Using a sharp razor, make a lengthwise cut into the ovary. The ovules should be seen in one of the two halves.
    c. Study with a hand lens and make an outline drawing of the sectioned ovary in "observations".
3. Pollination and fertilization
    a. The growth of the pollen tube through the tissues of the style and ovary to the micropyle of the ovule are similar to the growth of a young root through the soil.
    b. Upon reaching the micropyle, the pollen tube passes through to the embryo sac.
    c. Two sperm are discharged from the tube into the embryo sac. One unites with the egg. The other unites with the endosperm nucleus.
    d. In "observations", draw several pollen grains on the stigma of the pistil and how they move toward the ovule.One grain should have reached the ovule, entered the micropyle and discharged the sperm into the embryo sac. Indicate fertilization is complete by shading half of the egg and endosperm nucleus red; the other half blue.

Observations

1. Pollen grain drawing: *Label the flowers from which they came.*

2. Ovule drawing: *Draw the ovules as they are attached to the placenta in the ovary. Label ovary, ovules, and placenta.*

3. Pistil section at fertilization: *Illustrate and color the section according to the directions above.*[ii]



Conclusions:

1. Define self-pollination:

2. What is cross-pollination?

3. Where in the flower is meiosis occurring?

4. Compare and contrast sexual vs. asexual reproduction in plants:

5. What is the name given to the fertilized egg?

6. Explain why approximately half of an individual plant's DNA sequence comes from each parent plant.

7. Study the following flower characteristics and indicate which modifications are for insect, and which are for wind pollination:
    a. Brightly colored petals –
    b. Perfume glands –
    c. Long, protruding stamens –
    d. Nectar glands –
    e. Pistils with lengthened styles –
    f. Flowers lacking petals –

8. In the flower, which cell(s) undergo meiosis?

9. What are the male and female gametes in a flower?

[i] Agricultural Biology Curriculum Lesson Plans. Sacramento: California State Department of Education, Agriculture Education Unit, 1990.
[ii] "How to Grow a Flower." The Kaleidoscope of Life. 2002. Program for Interdisciplinary Learning Through the Arts. 3 Oct 2008 <teachart.msu.edu/pila/images/flower.jpg>.

Biology/Life Sciences Standards

6. Stability in an ecosystem is a balance between competing effects. As a basis for understanding this concept:
    a. Students know bio diversity is the sum total of different kinds of organisms and is affected by alterations of habitats.
    b. Students know how to analyze changes in an ecosystem resulting from changes in climate, human activity, introduction of nonnative species, or changes in population size.
    c. Students kno*w* how fluctuations in population size in an ecosystem are determined by the relative rates of birth, immigration, emigration, and death.
    d. Students know how water, carbon, and nitrogen cycle between abiotic resources and organic matter in the ecosystem and how oxygen cycles through photosynthesis and respiration.
    e. Students know a vital part of an ecosystem is the stability of its producers and decomposers.
    f. Students know at each link in a food web some energy is stored in newly made structures but much energy is dissipated into the environment as heat. This dissipation may be represented in an energy pyramid.
    g. * Students know how to distinguish between the accommodation of an individual organism to its environment and the gradual adaptation of a lineage of organisms through genetic change.

Lab Reference: Ecology

Standards: 6a-g

STANDARD CONCEPT	LAB NAME	LAB NUMBER
Cycles	Respiration in Roots	C-1
Cycles	Transpiration	C-2
Decomposers	Decomposers in Soil	C-3
Ecosystem Change	A Snail's Pace	C-4
Ecosystem Change	Biome Project	C-5
Ecosystem Change	Every Plant for Itself	C-6
Ecosystem Change	Let's Go Fishing	C-7
Ecosystem Change	Plant Reactions to Environment	C-8
Ecosystem Change	Soil Media Propagation	C-9
Ecosystem Change	Using a Mini-Ecosystem	C-10
Food Web	Accumulation of Toxins in a Food Web	C-11
Pollution	Interspecific Competition	C-12
Pollution	Maintaining Air Quality	C-13
Pollution	Thermal Pollution	C-14
Population	Making Casts of Animal Tracks	C-15
Population	Mites on Cotton	C-16
Population	Population Pressures and Succession	C-17
Population	Presence/Absence Sampling	C-18
Population	Sweep Method	C-19
Succession	Ecological Succession	C-20
Water	Comparing Water-holding Capacities	C-21
Water	Water Conservation	C-22

Biology/Life Sciences Standards	• (BLS) 6.d.
Agriculture Standards	• (AG) C 11.1, C 11.6, C 13.3, and G 3.1. • (Foundation) 1.2 Science, Specific Applications of Investigation and Experimentation: (1.a) and (1.d). • (Foundation) 5.0 Problem Solving and Critical Thinking: (5.3).

Name_____

Date_____

Respiration in Roots

Purpose

Many organisms in the soil produce carbon dioxide. Roots of plants go through the process of respiration, and may also add carbon dioxide to the soil. The purpose of this lab is to investigate the claim that roots contribute carbon dioxide to the soil. [i]

Procedure

Materials

1. Seedlings (3)
2. Cotton balls
3. Test tubes (3)
4. Test tube rack
5. Bromthymol blue indicator solution
6. Graduated cylinder (1)
7. Water

Sequence of Steps

1. Put 10 to 15 mL of tap water in each of 3 test tubes.
2. Add 3 to 4 drops of Bromthymol blue indicator solution.
3. Insert the seedlings into the test tubes so that the roots are immersed in the dilute indicator solution.
4. Wet the cotton and use it to support the seedlings.
5. Observe the test tubes over the next 2 to 4 days. Record your results.

Observations

1. Why is an indicator solution, which shows the presence or absence of acid, used to demonstrate the production of carbon dioxide?

2. Repeat this exercise using other types of seedlings. Does the indicator solution change color at a different rate? Why?

3. Does the size or nature of the root system appear to have any effect on the amount of carbon dioxide produced? Why?

4. Based on your observations, do roots contribute to carbon dioxide in soil?

5. Describe the carbon cycle and how soil organisms play a role in this cycle.

[i] (2008).Respiration in Roots. *Prentice Hall, Inc.*

Biology/Life Sciences Standards	• (BLS) 6.d.
Agriculture Standards	• (AG) C 11.2, C 11.6, C 13.3, F 2.1, and G 3.1. • (Foundation) 1.2 Science, Specific Applications of Investigation and Experimentation: (1.a) and (1.d). • (Foundation) 5.0 Problem Solving and Critical Thinking: (5.3).

Name_____

Date_____

Transpiration

Purpose

The purpose of this lab is to demonstrate the process of transpiration using geranium leaves.[i]

Procedure

Materials

1. 1 geranium leaf (per student)
2. 2 small jars (baby food or Mason jars, or 2 beakers per student)
3. Cardboard (10cm square with a hole about the size of a hole-punch in center per student)
4. Clay or petroleum jelly

Sequence of Steps

1. Place a geranium leaf in the hole of the cardboard square. (Roll the geranium leaf to fit through the hole). Seal the hole with clay or Silly Putty or petroleum jelly.
2. Fill one small jar with water.
3. Place the cardboard with the leaf over the jar of water. Make sure most of the leaf is in the water, but not so much that the cardboard comes into contact with the water.
4. Cover the leaf with a second jar. Place the leaf in a well-lighted area.
5. Observe the inside of the top jar after 24 hours. Record your observations.

Observations

1. Describe your observations using complete sentences.

2. Define equilibrium:

3. What is osmosis?

4. How is this experiment related to osmotic force or turgor?

5. Describe how transpiration plays an important role in the water and oxygen cycles.

[i] Dickson, Chris (2008). Transpiration. *North High School, Bakersfield, Agriculture Department*

Biology/Life Sciences Standards	• (BLS) 6.e.
Agriculture Standards	• (AG) C 10.2, C 13.3, and G 6.2. • (Foundation) 1.2 Science, Specific Applications of Investigation and Experimentation: (1.a) and (1.d). • (Foundation) 5.0 Problem Solving and Critical Thinking: (5.3).

Name_____

Date_____

Decomposers in Soil

Purpose

Decomposition of materials is essential to provide a sufficient supply of nutrients in the soil. Most of the decomposing action is carried out by microorganisms in the soil. Two groups of soil microorganisms that carry out this necessary task are bacteria and fungi. All objects do not decompose at the same rate. The rate depends partially on the soil in which the objects are found and on the substance of which they are made. The purpose of this lab is to examine the effects of these factors on decomposition. [i]

Procedure

Materials

1. Sand
2. Soil rich in organic material
3. Gravel
4. Material samples:
    a. Dead plant material (leaves, grass)
    b. Dead animal material (household meat, dead insects)
    c. Processed foodstuff (dry cereal)
    d. Natural fibers (wool or cotton)
    e. Synthetic fibers (polyester or nylon cloth)
    f. Styrofoam cup fragments
    g. Clay flowerpots, 5 cm in diameter (12)
    h. Petri dishes and lids, 4 cm in diameter (6)
    i. Large tray, approx. 30x20x5cm

Sequence of Steps

1. Place a small amount of gravel in the base of each pot.
2. Fill six of the flowerpots with sand up to 2 cm from the top. Be sure to pack the sand in the pot.
3. Similarly, fill the remaining pots with the soil rich in organic material.
4. Place dead plant material on one pot filled with sand and on one filled with rich soil.
5. Cover each of these two pots with an upside down petri dish or lid. Press them tightly into the soil.
6. Repeat steps 4 and 5 using the other five material samples.
7. Place all twelve pots in the large tray. Add water to the tray to a depth of at least 3 cm. Maintain this depth throughout the observation period.
8. Keep the tray and its contents in a darkened area at room temperature.
9. Observe the pots every 5 days for up to 8 weeks, until changes are obvious in most of the pots. Be sure to test the strength of the cloth fibers from time to time. Record your results.

Observations

1. Describe your observations using complete sentences below.

2. Which materials decomposed most quickly?

3. Are there any materials that appear not to have decomposed?

4. How is the soil organic content related to the decomposed rate? Explain.

5. Based on this knowledge, what advice can you give the following groups of people?
   a. Production agriculturists needing to breakdown waste:

   b. People who have a tendency to litter.

6. Define the following terms:
   a. producer

   b. consumer

7. “A vital part of an ecosystem is the stability of its producers and decomposers.” Explain the meaning of this statement.

[i] (2008).Decomposers in Soil. *Prentice Hall, Inc.*

Biology/Life Sciences Standards	• (BLS) 6.b.
Agriculture Standards	• (AG) C 13.3 and E 5.2. • (Foundation) 1.2 Science, Specific Applications of Investigation and Experimentation: (1.a), (1.d), and (1.f). • (Foundation) 1.1 Mathematics, Specific Applications of Probability and Statistics: (8.0).

Name_____

Date_____

A Snail's Pace

Purpose

Living organisms respond to a multitude of diverse ways to the environment. The specific responses depend on the type of stimuli which can be perceived as well as the structure and physiology of the animal itself. The purpose of this lab is to observe the common garden snail which will provide a specific example of an organism's response to its environment.

The common garden snail of the Bay Area is an import from Europe where it is eaten with gusto (called escargots). In order to recall what you already might know about snails, answer the pre-lab questions. After observing the snail, come back to these questions to consider revisions, additions or continued confusion. [i]

Procedure

Materials

1. Common garden snail
2. Ruler
3. Sandpaper
4.

Sequence of Steps

1. Answer the pre-lab questions.
2. Acquire 1 common garden snail. If your snail is inactive, place it briefly in a dish of cool water.
3. Take a few minutes to observe your snail. Record your observations.
4. Investigation #1: Do snails move at different speeds over different types of surfaces? Write your hypothesis here: _____
5. Have your snail move over a plastic surface. Measure how far it moves in one minute. (centimeters/minute). DO this three times and record each distance in the chart below. Find the average.
6. Have your snail move over sandpaper and repeat the procedure above and record your results in the chart below. Find the average.
7. Repeat the procedure above on a third surface and record your results in Table 1. Find the average.
8. Investigation #2: Do different size snails move at different rates? Write your hypothesis here: _____
9. Obtain 2 snails of different sizes.
10. Weigh and record the weights of each snail in Table 2.

11. Measure the distance in centimeters that each snail travels in one minute on the same surface. Repeat this procedure three times and find an average of the differences for each snail. Record your results in Table 2.

Pre-lab Questions

1. In what kinds of places would you expect to find snails?

2. Are snails more abundant in one season over another?

3. Are snails more active during certain times of the day and night?

4. During periods of their inactivity, where would you find them?

5. What kinds of food have you seen snails eating?

Observations

1. Describe your snail:

2. Where are the eyes located?

3. Where is the mouth?

4. Find the tentacles. What are their functions?

5. What happens when you gently touch the tentacles?

6. Place the snail on a piece of glass. How does it move?

7. Is there a slime trail?

8. What is the function of the slime trail?

Table 1. Investigation #1*: Do snails move at different speeds over different types of surfaces?*

Surface Type	Trial #1	Time	Distance Traveled	Rate of Movement
Glass	1			
Glass	2			
Glass	3			
	Average			
Sandpaper	1			
Sandpaper	2			
Sandpaper	3			
	Average			
Other	1			
Other	2			
Other	3			
	Average			

- Rate= $\frac{\text{Distance (centimeters)}}{\text{Time (minutes)}}$

Analyze your data and make a conclusion that would support or disprove your hypothesis:

Table 2. Investigation #2: *Do different size snails move at different rates?*

	Snail #1	**Snail #2**
	Weight: _____	**Weight: _____**
Trial #1	_____ cm/min	_____ cm/min
Trial #2	_____ cm/min	_____ cm/min
Trial #3	_____ cm/min	_____ cm/min
Average:	_____ cm/min	_____ cm/min

Results:

Prepare a line graph for each snail on the graph below:

Analyze your data and make a conclusion which would support or disprove your hypothesis:

Teacher Background Information: Snail Lab

The Genus ***Helix*** belongs to the Family Helicidae. The most well known species are: ***Helix aspersa*** (Brown Garden Snail), ***Helix pomatia*** (Roman Snail, Burgundy Snail, or Edible Snail).

Where snails are naturally found

Snails prefer cool, damp environments, as they easily suffer from moisture loss. Snails are most active at night and after rainfall. During unfavorable conditions, a snail will remain inside its shell, usually under rocks or other hiding places to avoid being discovered by predators. In dry climates snails will naturally congregate near water sources, including artificial sources such as waste-water outlets of air conditioners.

What snails eat and who eats snails

The common garden snail (*Helix aspersa*) is herbivorous. They are able to digest most vegetation such as carrots and lettuce. They also have a specialized crop of symbiotic bacteria in their intestine which is used to digest cellulose.

There are many predators that prey upon snails. Some animals such as the song thrush break the shell of the snail by hammering it against a stone to get at its soft insides, some, like frogs, even eat the whole snail, shell and all. There are even some snails such as the Decollate snail that prey upon other snails.

Many Europeans enjoy eating snails. *Helix pomatia* is the one of the best known edible snails. In addition to the excellent taste of the snails, they have many nutrients and are very rich in calcium and also contain vitamin B1 and E. They also supply various kinds of essential amino acids. Also, they are low in calories and fat.

External features

Common snail (*Helix aspersa*)

In addition to the hard calcareous shell that covers and protects the internal organs, the head and foot region can be observed when the snails are fully extended. When they are active, the organs such as the lung, heart, kidney and intestines remain inside the shell, only the head and foot emerge.

The head of the snail has two pairs of tentacles, the upper and larger pair contain the eyes, the lower pair are used to feel the ground in front. The mouth is located just underneath the head. The tentacles can be withdrawn or extended depending on the situation. The mouth has unique tongue called a "radula" that is composed of many fine chitinous teeth. This serves for rasping and cutting food.

From April and throughout the summer, the number of snails copulating increases due to the high temperature and humidity which enhances the possibility of oviposition. The Pulmonate snails are hermaphrodite, meaning that both female and male sexual organs are present in the same individual.

The snails produce both eggs and sperm in the ovotetis called the hermaphrodite gland, but it is later separated into two divisions, a sperm duct and oviduct, respectively.

Mating takes several hours, sometimes a day. A few days later, the eggs are laid in the soil. They are usually 4-6 mm in diameter.

After snails are hatched from the egg, they mature through one or more years. It depends on where the organism lives. Maturity takes two years in Southern California, while it takes only ten months in South Africa.

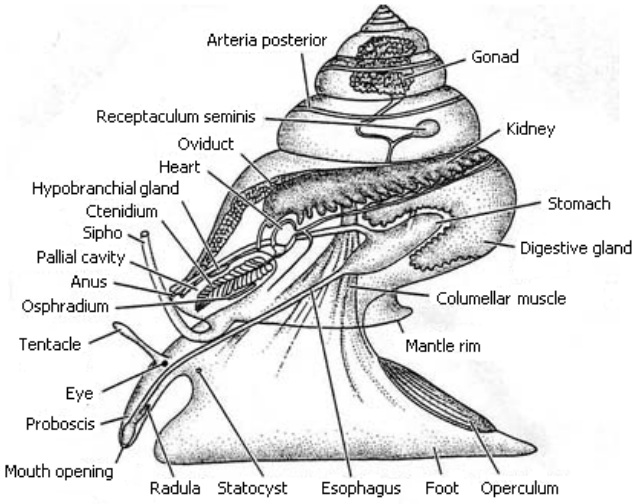
The size of the adult snails slightly varies with species. *H. aspersa* grows up to 35 mm in height and width, whereas *H. pomatia* grows up to 45 mm. The life span of the snails in the wild is on average two or three years.

Some snails may live longer, perhaps even 30 years or older in the case of the Roman snail [1] but most live less than 8 years. Many deaths are due to predators and parasites.

Respiration

Since snails in the Helix genus are terrestrial rather than fresh-water or marine, they have developed a simple lung for respiration. Many other snails that belong to the class Gastropoda have gills instead.

Oxygen is carried by the blood pigment hemocyanin. Both oxygen and carbon dioxide diffuse in and out of blood through the capillaries. A muscular valve regulates the process of opening and closing the entrance of the lung. When the valve opens, the air can either leave or come into the lung. The valve plays an important role in reducing water loss and preventing drowning.



[i] (2008).Making Casts of Animal Tracks. *Prentice Hall, Inc.*

Biology/Life Sciences Standards	• (BLS) 6.a.
Agriculture Standards	• (AG) C 2.1. • (Foundation) 2.1 Reading, Specific Applications of Reading Comprehension--Grades 9-10: (2.3). • (Foundation) 2.2 Writing, Specific Applications of Writing Strategies and Applications--Grades 9-10: (2.6a), (2.6b), and (2.6c). • (Foundation) 2.4 Listening and Speaking, Specific Applications of Listening and Speaking Strategies and Applications--Grades 9-10: (1.7), (2.2a), (2.2b), (2.2d), and (2.2f). • (Foundation) 9.0 Leadership and Teamwork: (9.3).

Name_____

Date_____

Biome Project

Purpose

The Biomes Project is an opportunity for you to do your own research on a particular biome. Your group will be assigned a specific biome. You will work in teams to research critical issues of your biome from different points of view. After your research, you will create a project to teach your classmates about the critical issues surrounding your biome.[i]

Background Information

Every biome of the world is a truly magical place. Its structure is complex, consisting of many levels, each with its characteristic plants and animals. Each organism has its own niche in the biome.

What is the importance of understanding the interdependent roles of plants, animals, the physical landscape and the influence of humans on the biomes of the world? How can you come to understand how the balance of each biome affects our global ecosystem? Can you think critically about global issues? Think about the following questions: *What would happen if something were to change the landscape of a particular biome? What if the temperature were to raise or lower significantly? What if a developer wants to build on the land? What if an animal becomes extinct? What if a plant were destroyed, or if the rainfall greatly increases or decreases?*

Some terms you should become familiar with before you start are:

- Climate _____
- Biome _____
- Biodiversity _____
- Ecology _____

Procedure

Each member of your group will research a particular area of your biome. Areas include: Animal, plant, physical landscape, and human influences.

<u>Report and Presentation Elements – 100 points</u>

Your report and presentation will need to include the following items. As a group, create the following:

- ✓ **Title and authors** (all group members)
- ✓ **Table of contents** or a menu showing where all the relevant information can be found
- ✓ **Introduction**: overview of your biome

- ✓ **Description:** Describe all animal life, physical landscape/habitat and weather, plant life and human influences that affect and make up your assigned biome.
- ✓ **A map of the world** with your biome clearly identified with proper nouns (i.e. if you are in the desert group, the Sahara Desert should be listed) Include a definition of your biome. (What characteristics does your biome have?)
- ✓ **Glossary of terms** that pertain to your biome with definitions
- ✓ **Presentation** Your presentation should be 5 minutes long. Every group member should speak during the presentation. The presentation should cover animal life, physical landscape/habitat and weather, plant life and human influences.

Team Responsibilities

Each individual group member is responsible for one of the following:

Animal life
Background information
Examples with pictures/illustrations
2 questions that can be answered from your research

Physical landscape/habitat & weather
Background information
Examples with pictures/illustrations
2 questions that can be answered from your research

Plant life
Background information
Examples with pictures/illustrations
2 questions that can be answered from your research

Human influences
Background information
Examples with pictures/illustrations
2 questions that can be answered from your research

Diorama – 100 points

Your group should create a three dimensional diorama of your assigned biome. It should include examples of the physical landscape, plant life and animal life. The diorama should look like a miniature example of your assigned biome.

[i] Opfergelt, Heather (2008). Biome Project. *Firebaugh High School Agriculture Department*

Biology/Life Sciences Standards	• (BLS) 6.b.
Agriculture Standards	• (AG) C 11.2, C 13.3, F 2.4, and G 3.4. • (Foundation) 5.0 Problem Solving and Critical Thinking: (5.3). • (Foundation) 1.2 Science, Specific Applications of Investigation and Experimentation: (1.a) and (1.d).

Name_____

Date_____

Every Plant for Itself

Purpose

The purpose of this exercise is to reinforce understanding of the three key requirements for plant growth; sunlight, water and nutrients. In addition, students will demonstrate plant survival through a hands-on role-play activity. [i]

Procedure

Materials

1. 60 white poker chips
2. 60 blue poker chips
3. 60 red poker chips
4. 1 bucket
5. Boundary markers

Sequence of Steps

1. The teacher will choose a location for the activity and then set boundaries and scatter poker chips around area.
2. Recall: What are the requirements for plant growth? Capture these below.

   _____ _____ _____
3. The colored poker chips represent these growth requirements.
   a. White = sunlight
   b. Blue = water
   c. Red = nutrients
4. Each student is going to pretend to be a plant. Each plant needs a specific amount of each resource to survive through the growing season.
5. When instructed by your teacher, place yourself around the designated activity area. Stand close together to demonstrate competition! Remember, plants may **NOT** move. You may plant one foot to act as the taproot and you may only pivot during the activity. Your reach, while keeping your taproot planted, is your drip line. Plants usually have access to whatever resources which are within their drip line.

Round 1: (Optimal Conditions)

6. Your teacher will tell you when to begin Round 1. You will have 15 seconds (a growing season) to grab as many poker chips (resources) as you can.
7. Count up your chips. Record your count in Data Table 1.
8. In order to SURVIVE this particular growing season, each plant needed to capture at least 2 of each color resource!
9. You needed to capture 3 of each color resource to REPRODUCE or set seed.
10. Complete “Round 1 Observation Questions”.

Round 2: (Drought)

11. The teacher will collect all chips and remove 20 blue chips from the bucket. There is going to be a drought in this next growing season!
12. The teacher will scatter the chips around the area. Replant yourself if you have moved. When your teacher tells you to begin, you will have 15 seconds (a growing season) to grab as many poker chips (resources) as you can.
13. Count your chips. Record your count in Data Table 1.
14. In order to survive this particular growing season each plant needed to capture at least 2 of each color resource.
15. In order to reproduce you needed to capture at least 3 of each color resource.
16. Complete "Round 2 Observation Questions".

Round 3: (Limited Nutrients in Crop Field): – OPTIONAL if time is limited

17. The teacher will collect all chips and replace the 20 blue chips in the bucket. The teacher will then remove 20 red chips from the bucket.
18. The teacher will scatter the chips around the area.
19. Students will be "planted" in 4 rows of 5, drip line to drip line, in the area.
20. When your teacher says to begin, you will have 15 seconds (a growing season) to grab as many poker chips (resources) as you can.
21. Count up your chips. Record your count in Data Table 1.
22. In order to survive this particular growing season each plant needed to capture at least 2 of each color resource.
23. In order to reproduce you needed to capture at least 3 of each color resource.

Observations

Data Table 1

	# White Chips - Sunlight	# Blue Chips – Water	# Red Chips – Nutrients	Survive? Y/N	Reproduce? Y/N
Round 1					
Round 2					
Round 3					

Round 1 Observation Questions

1. What happened to plants on the edge of the growing area?

2. What happened to plants in the center?

3. Did any plants compete for resources? In the agricultural environment what would we think of as competing plants?

Round 2 Observation Questions

1. How many plants survived?

2. How many plants were able to set seed?

3. Did any plants have more resources than they needed?

Round 3 Observation Questions

1. You were placed in equal rows. What do you think this placement simulates?

2. How does this placement help the plants?

3. How many plants survived?

4. Did any plants have more resources than they needed?

5. Did you notice that it was harder to find nutrients (red chips)?

6. Can you think of a real world example of when nutrients might be lacking in a farm field?

7. How is this problem addressed in traditional Western farming?

[i] Sakugawa, J. (2008). Every plant for itself. *Mt. San Antonio College.*

Biology/Life Sciences Standards	• (BLS) 1.a, 6.b, and 8.a.
Agriculture Standards	• (AG) C 9.2 and D 3.2. • (Foundation) 1.2 Science, Specific Applications of Investigation and Experimentation: (1.a) and (1.d). • (Foundation) 5.0 Problem Solving and Critical Thinking: (5.3).

Name_____

Date_____

Let's Go Fishing!

Purpose

The purpose of this lab is to evaluate the effect of temperature change on goldfish. [i]

Procedure

Materials

1. Live goldfish
2. Paper towels
3. Petri dish
4. Microscopes
5. Microscope slides
6. Warm water
7. Ice
8. Medicine dropper
9. Thermometer

Sequence of Steps

1. Remove a goldfish from an aquarium that has been kept at room temperature and gently lay on a microscope slide. Wrap the fish and slide together with wet paper towels. Leave the head and tail fin of the fish uncovered.
2. Place the wrapped fish in a petri dish, spread the tail fin and place a slide over it to hold it down.
3. Position the petri dish on a microscope and focus on the tail membrane.
4. Observe the blood vessels in the tail and record observations.
5. Add water to the paper towel to keep the skin and tail moist.
6. Replace the slide covering the tail with an ice cube for about one minute.
7. Remove the ice cube, replace the slide, and observe the tail of the fish through the microscope. Record observations.
8. Replace the slide covering the tail with a piece of cotton that has been soaking in warm water. Leave the warm cotton covering the tail for about 1 minute.
9. Remove the cotton, replace the slide, and observe the tail of the fish through the microscope. Record observations.
10. Return fish to aquarium.

Summary of Data Collected

Water Temperature	Arteries Size (small, medium, large, enormous)	Rate of Blood Flow (increased or decreased)
Room Temperature		
Cold		
Warm		

Analysis

1. How does cold temperature affect the rate of blood flow?

2. How does warm temperature affect the rate of blood flow?

3. What other body activity of a fish could be affected by temperature changes and how?

4. How does natural selection determine the survival of groups of fish in different water temperatures?

5. How does homeostasis help fish adapt to minor temperature changes?

6. During the stages of human hypothermia your arms will burn and become numb and you will lose function. Why might our bodies do this?

7. Why might the fish growth rate be manipulated by temperature changes and yet as humans Californians (warmer climate) are not larger people than Nevadans (cooler climate)?

8. Suppose our school wanted to start an aquaculture program. With our agriculture dept aquaculture tank, what conditions can we control to ensure rapid growth of our trout farm? How can we (LIST) control these factors? (Be creative, we need good ideas!)

[i] Albisu, A. (2008).Let's go fishing. *Spring Creek High School, Spring Creek, NV*

Biology/Life Sciences Standards	• (BLS) 6.b.
Agriculture Standards	• (AG) C 11.1, C 11.5, C 13.3, F 2.2, F 2.4, F 2.6, G 3.2, G 3.4, and G 3.6. • (Foundation) 1.2 Science, Specific Applications of Investigation and Experimentation: (1.a) and (1.d). • (Foundation) 5.0 Problem Solving and Critical Thinking: (5.3).

Name_____

Date_____

Plant Reactions to Environment

Purpose

The purpose of this exercise is to determine how a seed manages to send the shoot up and the root down, and to determine the effect of light on the growth of plants. [i]

Procedure

Materials

1. Petri Dishes (6)
2. Soaked corn grains
3. Paper Towel
4. Cotton
5. Wax pencil
6. Tape
7. Four boxes (3 constructed to provide 1-side illumination)
8. Blue & red cellophane or floral plastic (available at florist/craft store)
9. Four flower pots planted with radish seeds
10. Three artificial lights (available at hardware store)

Sequence of Steps

1. Response to Gravity
   a. Select 4 plump, soaked corn grains and place them on the bottom of the empty petri dish. Place the 4 grains horizontally with pointed ends directed toward the center, 1 grain at each point of the compass (North, South, East, West).

   b. Cut a piece of paper towel to fit tightly inside the bottom half of a petri dish. Cover the corn grains in the dish with the paper towel. Pack the rest of the dish tightly with cotton so that when the cover is placed on the dish, the corn stays in place.
   c. Once seeds are in place, open the dish and wet the paper towel.
   d. Put the dish on its side with one grain at the top position. Mark the dish with the word "top" and let the grains germinate without changing the position of the plate.

   e. After seeds germinate (3 days), open the dish and record observations.

2. Response to light
   a. Plant and water 4 pots of radish seeds and place each one directly into one of the boxes.
   b. Prepare the boxes as follows:
      - Box #1 - Seal the box to make it light-tight
      - Box #2 - Let the opening on this box remain uncovered so seeds receive white light.
      - Box #3 - Cover the opening of this box with the red cellophane.
      - Box #4 - Cover the opening of this box with blue cellophane.

   c. After about 5 days, remove the plants and record observations.

Observations

1. After removing the cover, draw what your seeds look like in the petri dishes after germination has occurred.

2. Compare the plants in the 3 boxes with 1-sided illumination.
   a. Which ones show the most obvious change in direction of growth?

   b. Is there any difference in the reactions of the plant to blue light and to red light?

   c. Compare the size and color of the plants.

Conclusions:

1. In what direction did the root and shoot grow out from each of the corn seeds?

2. To what factor of the environment do the root and shoot respond?

3. Are the red & blue light wavelengths equally effective in stimulating plants to bend toward light?

4. What is the general effect on stem elongation of white light vs. no light? How might you account for the difference?

5. What is the general effect of red light versus blue light on stem elongations?

6. How can this information be used to improve production in the agriculture industry?

7. Define phototropism:

[i] Agricultural Biology Curriculum Lesson Plans. Sacramento: California State Department of Education, Agriculture Education Unit, 1990.

Biology/Life Sciences Standards	• (BLS) 6.b.
Agriculture Standards	• (AG) C 11.1, C 11.4, C 13.3, F 2.4, F 3.1, G 3.4, and G 4.1. • (Foundation) 1.2 Science, Specific Applications of Investigation and Experimentation: (1.a) and (1.d). • (Foundation) 5.0 Problem Solving and Critical Thinking: (5.3).

Name_____

Date_____

Soil Media Propagation

Purpose

The purpose of this exercise is to discover which media type is better for the starting of plant material from asexual propagation. Students will be utilizing six various media and one plant material per group to discover which media is better to start cuttings in. Students will be observing the root development of plant cuttings over a four week period. A control group will be set aside in which no observations will be made until after the time frame has been completed. [i]

Procedure

Materials

Jumbo 6-pack pots	50% mixture of Perlite & Vermiculite
Perlite	SuperSoil potting soil or another high quality soil
Vermiculite	Peat moss & sand mixture (50% of each one)
Plant markers	Greenhouse or mist bed
Dirt (regular material found outside)	4 oz jar of water (baby food jars are good to use)
Popsicle sticks (tongue depressors)	6 oz Styrofoam or plastic cups
Sharpie marking pen	Long-nose clippers or other hand shears

Suitable plant material: aptenia, pathos, ivy, geranium, marguerite daisy, arrow head, creeping charlie or other herbaceous plants

Sequence of Steps

Students will be working in groups of three. Each group will receive materials as listed above. The perlite/vermiculite mixture will be mixed by the instructor. The other media will be in 5-gallon containers properly labeled. The instructor will demonstrate the correct process and steps by completing the control set of plants. Each group will receive a different plant so that the groups can report their findings to the class.

1. Complete pre-lab questions.
2. Using a Sharpie write the group name and soil media on two plant markers which will be used to identify each group's plants.
3. Fill each cell of the 6-pack with a different media to about a half inch from the top. Label each cell with a plant marker or masking tape along the bottom. Use the 6 oz cup as your measuring device.
4. Taking the 4 oz jar, fill it with water almost to the top. You will place one cutting in the water.
5. Place a marker in the jar and into the front right cell of the 6-pack.

6. Your instructor will give your group a set of plant material in which to do your cuttings.
7. Your instructor will demonstrate how to cut the plant material, the proper length required and removal of extra leaves (to reduce transpiration loss) and place it in the media.
8. Place the 6-packs and jars under the mist system.
9. Once a week, observe the root development of your cuttings. Using the Popsicle stick, carefully dig out the plant by loosening up the media and pushing up from the bottom of the stem. Be careful NOT to pull off any young roots.
10. Complete post lab observations and report.

Pre-lab Questions

1. On the back of this sheet, draw a diagram of a root and label all parts per the picture. Use this terminology in your discussion/report.

2. Which media do you expect to be the best rooting mixture? Why?

3. What do you expect to happen with the plant growing in water?

4. How much new growth would you expect from the cuttings because they don't have a root system to supply nutrients?

5. Why is the mist system required for the cuttings?

6. What causes the roots to adhere to the media so tightly?

7. Why should any flower buds be removed from the cuttings?

Data Collection & Observations

Observe and record your findings on the number of roots, any secondary shoots and color of the developing roots of each media. Also note how hard it is to remove the media from the developing roots. You are encouraged to take pictures of the developing roots for presentations. You will be able to 'wash off' your cuttings in water for better observations after the second week.

Each group will record their observations in a notebook, which will be turned in at the end of the assignment. In the final report, which is to be typed, you will evaluate which media was the best for root development and give your recommendation for its use in plant propagation. The report will need to compare the root and plant growth between the various media. Details should be noted as to color and vigor of the plant along its advancement. An oral presentation will be given to the class about each groups' results from their plants. There should be varying results between some of the experiments. Your findings and observation report will be typed in 12 point, 1.5 spacing using Arial or New Times Roman fonts.

[i] Sa, Ron. (2008). Soil media propagation. *Reedley High School.*

Biology/Life Sciences Standards	• (BLS) 6.a and 6.b.
Agriculture Standards	• (AG) C 2.1, C 13.3, E 2.2, and E 6.4. • (Foundation) 1.2 Science, Specific Applications of Investigation and Experimentation: (1.a), (1.d), and (1.f). • (Foundation) 5.0 Problem Solving and Critical Thinking: (5.3).

Name_____

Date_____

Using a Mini-Ecosystem to Study Pollution

Purpose

The purpose of this lab is to evaluate pollution in a mini-ecosystem by using pond water samples and selected pollutants. [i]

Procedure

Materials

1. Pond water (several liters)
    a. Surface water (include duckweed and the organisms that may reside in it)
    b. Water from varying depths
    c. Water from the space just above the bottom detritus
    d. Bottom detritus (3-4 cups)
    e. *Do not include any macroscopic animals like fish or frogs.
2. Containers (2 Liter)

Sequence of Steps

1. Divide the water and its contents as equally as you can among several containers.
2. Select one container and label it as the control.
3. Duplicate in this container as many of the features of the natural pond as you can. For example, it should not be aerated. The light quality and intensity should correspond to the average light conditions in the natural setting.
4. Examine the life in this control every few days. Record observations of the species present and the relative sizes of the populations of various organisms.
5. For each of the remaining containers of pond water, change one environmental factor, as listed below. Monitor the effects that this change has on the life in the water.
    a. Change in light intensity
    b. Change in dissolved oxygen concentration (achieved by aerating the water with a pump)
    c. Increase in the concentration of a plant nutrient such as phosphorus or nitrogen
    d. Addition of lawn fertilizer
    e. Addition of various types of detergents
    f. Increase in average temperature
    g. Addition of organic matter
6. In some cases no obvious changes will occur for several weeks or even for several months. This is a long term experiment. Try to predict in advance the effects of the changes that you impose on the environment.

Observations

1. Describe below the treatment you selected for each water sample. (Ex. Added 1 tbs of lawn fertilizer). Hypothesize the effect you believe this treatment will have on the mini-ecosystem.
    - Control

    Hypothesis:

    - Treatment Group 1

    Hypothesis:

    - Treatment Group 2

    Hypothesis:

    - Treatment Group 3

    Hypothesis:

    - Treatment Group 4

    Hypothesis:

2. Record your observations in Table 1.

Date	Control	Treatment 1	Treatment 2	Treatment 3	Treatment 4

3. Describe the observations you noted using complete sentences.

4. Based on this information, do you accept or reject each of your hypotheses?

5. Agricultural application: Managing water quality efficiently is an important job of agriculturists. Whether water is used for animals or plants, agriculturists work hard to ensure that they do not pollute their natural water source. Below, brainstorm ways that agriculturists work to make sure water is not polluted.

[i] (2008).Using a Mini-Ecosystem to Study Pollution. *Prentice Hall, Inc.*

Biology/Life Sciences Standards	• (BLS) 6.a.
Agriculture Standards	• (AG) C 13.3 and E 6.4. • (Foundation) 1.2 Science, Specific Applications of Investigation and Experimentation: (1.a) and (1.d). • (Foundation) 5.0 Problem Solving and Critical Thinking: (5.3).

Name_____

Date_____

Accumulation of Toxins in a Food Web

Purpose

The purpose of this lab is to understand the concept of an ecosystem, energy transfer through the aquatic food chain, and how toxic materials can enter the food chain. You should learn to appreciate the delicate balance of nature.[i]

Background Information

Water quality problems have plagued California since the days of its early settlers. Our state's massive water transportation and storage systems are testimony to the fact that California's water supplies quite often do not occur where and when they are needed most. Our water supply is sometimes a case of glut of famine, flood or drought. But all the water in the world – in the right place at the right time – won't do a drop of good if it isn't fit to use!!

True, our domestic water supplies have come a long way since the days when a glass of water might carry with it the threat of cholera or typhoid. But almost daily, the news media carry alarming stories of toxic substances threatening our ground water supplies.

Procedure

Materials

1. Plastic bag representing your stomach
2. Card representing either a daphnia, mayfly larvae, or fish
3. M & Ms

Sequence of Steps

1. This lab will explain the aquatic food chain. Please define a food chain below:

2. The class will be divided into three groups based on the organism- 30 students
    a. Water daphnia (a small fresh water animal)- about 20 students
    b. Mayfly larvae who prey on the daphnia- about 7 students
    c. Small mouth bass who prey on the mayfly larvae- about 3 students
3. Each "Daphnia" will receive a small plastic bag. The bag represents the food container to hold food energy. In other words, it is your stomach!!
4. The "food" represented by M & Ms will be scattered on a table. NOTE: you cannot leave the established boundaries of the pond.

5. The “Daphnia” will be instructed to go looking for food, gathering the “food” and placing it in their stomach. You eat by picking up one M & M at a time. You will have 30 seconds for your feeding.
6. “Mayfly larvae” will prey on the “Daphnia” by tagging them and “eat” (collect the “Daphnia” stomachs) as many as possible in 20 seconds. Any daphnia caught must give up its stomach to the mayfly larvae and move to the sidelines.
7. “Small mouth bass” are now permitted to prey on the mayfly larvae for 10 seconds. The same rules apply.
8. Go back to the classroom. The live animals are to empty their stomach(s) and separate the colors of M & Ms.
9. There is a toxic chemical loose in the water environment. It is poisonous, accumulates in the food chain and stays in the environment for a long time! All of the _____ M & Ms represent the poison. Calculate the number of toxic M & Ms and the number of ‘safe’ M & Ms you ate and enter it in the data table.
10. All of the “Daphnia” that were not eaten by the mayfly larvae may now be considered dead if they have any of the toxic M & Ms in their food supply. Check your stomachs!!
11. Any mayfly larvae with a food supply that exceeds 40% of toxic M & Ms will also be considered dead.
12. Any fish with a concentration of 50% or over of toxic M & Ms may be able to survive, but its ability to ward off disease, produce offspring, and find or catch food may be limited. Your life expectancy is very unstable!!
13. Record your data and results.

Data and Results

SPECIES	TOTAL M&Ms	# OF SAFE M&Ms	# OF TOXIC M&Ms	% OF FOOD SUPPLY
Daphnia				
Mayfly Larvae				
Bass				

Analysis & Conclusions

1. What is the aquatic food chain represented here?

2. Which species accumulated the most toxic M & Ms?

3. What is biological magnification?

4. What is bioaccumulation?

5. Which level of the food chain is most affected by biological magnification?

6. Name three ways these species may be affected by biological magnification.

7. Can you name another toxin or chemical that has affected food chains with biological magnification?

[i] Knapp, Elizabeth (2008). Accumulation of Toxins in a Food Web. *Atwater High School Agriculture Department*

Biology/Life Sciences Standards	• (BLS) 6.b and 8.a.
Agriculture Standards	• (AG) C 11.1, C 11.2, F 2.6, G 3.4, and G 3.6. • (Foundation) 1.2 Science, Specific Applications of Investigation and Experimentation: (1.a) and (1.d). • (Foundation) 5.0 Problem Solving and Critical Thinking: (5.3).

Name_____

Date_____

Interspecific Competition and Chemical Warfare

Purpose

Water, minerals, space and sunlight are important for plants to grow. Often plants must compete for these resources in a given environment. It may be challenging for a plant to establish a strong root system if minerals and space are lacking, just as it may be challenging for a young plant to grow if it is shaded by taller plants.

Scientists have revealed fascinating information! Some plants are able to manufacture and secrete chemicals into the soil around their roots, which slows or stops the germination of other plants that would compete for resources. The black walnut is one of the plants that is able to secrete these chemicals. The purpose of this lab is to evaluate interspecific competition with chemicals. [i]

Procedure

Materials

1. Planting boxes (2)
2. Potting soil
3. Walnut hulls (preferred) or walnuts
4. Sunflower seeds
5. Metric ruler
6. String and tacks (optional)
7. Hammer
8. Balance

Sequence of Steps

1. Grind up or smash the hulls of 10 or more walnuts. Make a powder of them, if possible. If hulls are not available, use walnuts instead.
2. Place soil to a depth of at least 5 cm in boxes. Sprinkle the powdered walnut over the soil in one planting box. Mix it thoroughly with the soil. Smooth and gently pack the surface of the soil in both boxes.
3. Using a ruler and the point of a pencil gently lay out a grid system in the two boxes, crisscrossing the surface of the soil 8 cm apart. If the lines do not show up well, use the string and tacks to mark the grid system.
4. Make small holes 1 cm deep at the centers of all the squares marked off by the grid systems.
5. Plant 3 seeds of about the same size in each hole.
6. Water the soil and place the boxes in a warm, bright location. Both boxes must be exposed to the same conditions of light and temperature, and should always be watered with the same amount of water.
7. After the sunflowers have sprouted, select the best seedling at each site. Kill the others by pinching off the growing tip.

8. Continue the investigation until the results of competition are obvious. Then make the measurements and observation necessary to complete Table 1.

Observations

Table 1.

	Box 1	Box 2
Percentage of plants surviving.		
Average height of plants.		
Average width of leaves at widest location.		
Average length of roots.		
Total weight of plant tissue.		
Average weight of plant tissue.		

1. Summarize the effects that the walnut powder had on sunflowers.

2. Some aspects of this investigation are obviously not equivalent to natural conditions. How do you think the process works in nature? (Note: the roots of walnut plants give off the same chemical as the hulls.)

3. According to the theory of natural selection, what types of species would survive around a black walnut tree?

4. What can we, as agriculturists, do to effectively manage this scenario to cause beneficial results?

[i] (2008).Interspecific Competition and Chemical Warfare. *Prentice Hall, Inc.*

Biology/Life Sciences Standards	• (BLS) 6.b and 6.d.
Agriculture Standards	• (AG) D 6.3 and E 2.2. • (Foundation) 5.0 Problem Solving and Critical Thinking: (5.3).

Name_____

Date_____

Maintaining Air Quality

Purpose

This lab is to observe how percentages of elements in the air can be altered. This activity is being accomplished by comparing the Mycoplasma bacterial growth in an anaerobic environment to the bacterial growth in an aerobic environment. The anaerobic environment is made by evacuating the oxygen in a closed chamber. In this demonstration the objective is to lower the percent of oxygen to enhance the growth of the anaerobic bacteria, *Mycoplasma mastitis*. [i]

Procedure

Materials

(The instructor will demonstrate this lab). Your responsibility is to observe and record your observations.

1. Stop watch or second hand
2. Pen or pencil

Sequence of Steps

1. Read background information and answer questions prior to the lab.
2. Watch carefully as your teacher demonstrates this lab. Record your observations.

Background Information

There are many ways our atmosphere is altered. Most often we think that any change in the percent of the elements that make up 'air' is a negative activity. Many organisms require an atmosphere different than the macro-atmosphere we use to breathe. Examples include certain bacteria such as botulism and tetanus.

The first human to modify the air was an Arab nomad who inadvertently made cheese when he filled his saddlebag with milk to feed himself during a journey across the desert. The movement of the horse separated the curds and whey in the milk. The desert sun provided the heat (incubation) and rennin (an enzyme) was readily available from the saddlebag (made from the stomach of a young animal). Historians believe this first processing of food occurred at the time animals began being domesticated by man (circa 9,000 B.C.).

1. Key words to know:

Anaerobic _____

Aerobic _____

2. Background information:
   Percent nitrogen in the air _____%
   Percent oxygen in the air _____%
   Examples of two bacteria that live in anaerobic environments:
   _____
   _____
3. Examples of food processed in anaerobic environments:
   _____
   _____
4. What is Mycoplasma mastitis?

Observations

1. What size jar was used in this demonstration? _____
2. How many seconds did it take for the flame to use the oxygen in the sealed chamber? _____ seconds
3. How many colonies of Mycoplasma could be observed before incubation?
   a. In the sealed chamber (anaerobic environment) _____
   b. In the open chamber aerobic environment) _____
4. How many colonies of Mycoplasma could be observed 24-hours after incubation?
   a. In the sealed chamber (anaerobic environment) _____
   b. In the open chamber aerobic environment) _____
5. 5. How many colonies of Mycoplasma could be observed 48-hours after incubation?
   a. In the sealed chamber (anaerobic environment) _____
   b. In the open chamber aerobic environment) _____
6. Did the data support the objective that more colonies would grow in the anaerobic environment? _____ If the data rejected the objective that more colonies would grow in the anaerobic environment, what might be the reason?

Teacher's Notes

SPECIAL SAFETY INSTRUCTIONS
Latex gloves are required to set up the following demonstration. Check with your administration as to their procedures for discarding the milk samples after the completion of the demonstration.

TIME REQUIRED FOR THIS DEMONSTRATION
The set up time will take about 5 minutes to streak the plates (Petri dishes). If you are using frozen milk samples, allow time for them to thaw prior to streaking. Class time for the demonstration will take about 5 minutes. The student background questions can take up to 30 minutes prior to actually showing how oxygen is removed from the air. 2nd and 3rd day observations will take about 10 minutes

PROCEDURE

- Streak the Petri dishes (plates) using inoculating loops just prior to the beginning of class. (Students will be focused on streaking techniques instead of evacuating oxygen if you streak the plates as part of the class demonstration).
- To attain an oxygen-free (or almost oxygen-free) environment, place one of the streaked Petri dishes in one of the glass gallon jars, the second dish in the other jar.
- Place a 2 inch candle in one of the jars.
- Light the candle and seal the jar with the plastic or metal lid.
- Students should observe the lighted candle extinguish itself once the oxygen in the air in the environment of the sealed jar is used. (The question may be asked, 'what takes the place of the 21% of the air that was just burned?' *Suggested answer*: An actual vacuum was formed, although very small because of the size of the container.
- The second jar is not sealed.
- Place the two jars in an incubator at 90°F for 24-48 hours (or oven, or wrap the jar in a blanket and put in a box and leave it in the sun).
- The colonies of *Mycoplasma* spp. will have a fried-egg appearance.
- Predicted outcome – The sample from the somewhat anaerobic environment should have many more and possible larger colonies than the sample from the aerobic environment.

STUDENT HANDOUT - Background Information
Key words to know:

Anaerobic - in the absence of oxygen
Aerobic - in the presence of oxygen

Background information:

Percent nitrogen in the air 21%
Percent oxygen in the air 78%
Examples of two bacteria that live in anaerobic environments:
Clostridium tetani (tetanus)
Clostridium botulinum (botulism)

Examples of food processed in anaerobic environments:

cheese
sauerkraut

What is Mycoplasma mastitis? *Mycoplasma bovis* is the most common bacteria causing mastitis-like signs. It is highly contagious, and apparently harbors in the respiratory tract of the bovine.

Observations

1. What size jar was used in this demonstration? gallon – quart - pint
2. How many seconds did it take for the flame to use the oxygen in the sealed chamber? varies seconds
3. How many colonies of Mycoplasma could be observed before incubation?
    a. In the sealed chamber (anaerobic environment) 0
    b. In the open chamber aerobic environment) 0
4. How many colonies of Mycoplasma could be observed 24-hours after incubation?
    a. In the sealed chamber (anaerobic environment) _____
    b. In the open chamber aerobic environment) _____
5. How many colonies of Mycoplasma could be observed 48-hours after incubation?
    a. In the sealed chamber (anaerobic environment) _____
    b. In the open chamber (aerobic environment) _____
6. Did the data support the objective that more colonies would grow in the anaerobic environment? _____
7. If the data rejected the objective that more colonies would grow in the anaerobic environment, what might be the reason? Could be that the jar was not sealed tightly enough, could be that we are seeing colonies of aerobic bacteria (some other bacteria growing).

[i] Dickson, Chris (2008). Air Quality. *North High School, Bakersfield, Agriculture Department*

Biology/Life Sciences Standards	• (BLS) 6.a and 6.b.
Agriculture Standards	• (AG) C 2.1, E 2.2, E 6.4, E 8.4, G 3.4, and G 3.6. • (Foundation) 1.2 Science, Specific Applications of Investigation and Experimentation: (1.a) and (1.d). • (Foundation) 1.1 Mathematics, Specific Applications of Probability and Statistics: (8.0).

Name_____

Date_____

How Does Thermal Pollution Effect Living Things?

Purpose

The purpose of this exercise is to determine if heated water can affect the growth of living things. The experiment will specifically determine if yeast cells can live in heated water for a short time.[i]

Procedure

Materials

1. Test tubes
2. Dry yeast grains
3. Droppers
4. Test tube holder
5. Graduated cylinder
6. Test tube rack
7. Clock with second hand
8. Marking pencil
9. Hot plate
10. Blue stain
11. Toothpick
12. Slide & cover slip
13. Light microscope

Sequence of Steps

1. Label 4 test tubes (1-4).
2. Fill each test tube with 4mL of tap water.
3. With a toothpick, add 2 grains of dry yeast to each test tube.
4. Shake the test tubes to break apart the yeast grains.
5. Put each tube in the beaker of boiling water as indicated below:
    - Test tube #1 – Do not place in water
    - Test tube #2 – Place in boiling water for 20 seconds
    - Test tube #3 – Place in boiling water for 40 seconds
    - Test tube #4 - Place in boiling water for 60 seconds
6. After putting each tube in water, return each to the test tube rack.
7. Stir the yeast cells in test tube 1 by filling and squirting dropper-full of yeast mixture 3 times.
8. Place 1 drop of yeast mixture from Test tube #1 on a clean slide.
9. Using a clean dropper, add 1 drop of blue stain to the drop of yeast mixture on the slide.
10. Mix the stain with the yeast cells by gently rotating the slide. Add a cover slip.
11. Locate the yeast cells (small dots) on low power, then on high power. Live yeast cells are round and light blue in color. Dead yeast cells are round and dark blue in color.
12. Count the cells in the field of view. Record the cells as dead or alive in “observations”.
13. Repeat procedure 9-12 with each of the other test tubes.
14. Plot 2 bar graphs showing the number of live and dead cells in each tube.

Observations

1. Chart

Test Tube #	Time in Water	# Cells You Saw	# Dead	# Alive
1	0 sec			
2	20 sec			
3	40 sec			
4	60 sec			

2. Graph

Conclusions:

1. Which tube contained the most live cells? Which contained the most dead cells?

2. Why was test tube 1 not placed in boiling water for this study?

3. Using your results, write 3 statements that will explain thermal pollution:
   a.

   b.

   c.

4. Compare the biodiversity among tubes. Is it the same or different? Why?

5. A new industry wants to move to your town. This industry wants to use water from the local river for its production line. What questions should the townspeople ask the new industry about the water?

6. How do these findings apply to agriculture production? What impact does this information have on agriculture production?

[i] Agricultural Biology Curriculum Lesson Plans. Sacramento: California State Department of Education, Agriculture Education Unit, 1990.

Biology/Life Sciences Standards	• (BLS) 6.b.
Agriculture Standards	• (AG) C 13.3 and E 5.3. • (Foundation) 5.0 Problem Solving and Critical Thinking: (5.3).

Name_____

Date_____

Making Casts of Animal Tracks

Purpose

Direct evidence of the presence of wildlife in natural habitats is sometimes hard to come by. Wild animals do not usually enjoy the presence of people. Thus they take flight or hide at the mere sight, smell, or sound of human beings. Often, all that remains are signs that animals were present at some previous time. It requires great detective skills to find the signs and determine the identity of the animal that was there. Here are the clues that you might look for: [i]

- Evidence that the vegetation has been used as food – twigs browsed by deer, shrubs nibbled by rabbits, and husks of acorns discarded by squirrels.
- The presence of scats (fecal material), which give – through their size, distribution, and composition – an indication of the size of the animals, the time spent in the area, the number of animals, and the nature of their feeding habits (herbivorous or carnivorous).
- Tracks, which are as good as fingerprints in determining the identity of the animal.

Browsing or feeding studies can be carried out by examining the vegetation to determine which species are being used as food and to what extent. This information is useful in managing an area for the production of larger populations of given species.

Fecal material (especially that of herbivores) can be collected in plastic bags and either dried in the laboratory or preserved in a 10% formaldehyde solution. This material can be broken apart and examined under a dissecting microscope to obtain evidence as to the type of foods being eaten.

Tracks made in mud, sand, or snow can be followed to trace some of the animal's activities. For example, they may indicate feeding or bedding sites. Obvious trails are usually better indicators than a single set of tracks. Interspecific and intraspecific interactions can be investigated by observing the relationships between the trails of different animals using the same area. Territorial boundaries can often be estimated using tracks. Of course you must be able to identify the tracks. You may want to carry along a field guide to animal tracks. Alternatively, you can sketch or photograph the tracks and identify them later. Or you can make a permanent record of track impressions in moist clay or mud, as in this lab.

Procedure

Materials

1. Plaster of Paris
2. Mixing container
3. Water container
4. Stirring stick
5. Cardboard strips 2 cm wide and 30-40 cm long (optional)

Sequence of Steps

1. After locating a suitable track, clear away any leaves, grass, or particles that have fallen into the impression.
2. Make a circular wall around the print in 1 of 2 ways: Build a mud barrier by placing the mixing container over the print and packing mud around the base or make a collar from the cardboard strips.
3. Place an appropriate amount of water (enough to nearly fill the impression and surrounding pool) in the mixing cup. Gently sprinkle in an equivalent amount of plaster of Paris.
4. Stir the mixture. Add more plaster or water to get a thickness similar to that of pancake batter.
5. The mixture should flow into the crevices of the print as you fill the pool.
6. Let the cast harden for 20 minutes or more. Then loosen it from the ground. Before removing any soil, wrap it in a newspaper and store it to be returned to the lab.
7. Let the cast dry completely. Then use a brush to remove any clinging soil particles.
8. You are left with a model of the tip of the animal's paw or hoof. It is, of course, a negative cast of the original print. It is a simple matter to get a positive track cast. (Hint: use petroleum jelly, soft soap, or melted paraffin to ensure separation of the positive cast from the negative cast.)
9. Record your observations and complete conclusion questions.

Observations

1. Describe, using complete sentences, the steps you took to complete this lab. Include the location and type of print from which a cast was made. (Be clear enough so that someone could follow your steps to do this lab again.)

2. What signs did you find to indicate that an animal(s) was present in your study site?

3. What type of animal(s) do you think these signs indicated?

4. Is there any evidence that the animal(s) actually lives in your study site? If not, where might the animal(s) live?

5. How can casts be used to analyze changes in an ecosystem? Give at least one example.

[i] (2008).Making Casts of Animal Tracks. *Prentice Hall, Inc.*

Biology/Life Sciences Standards	• (BLS) 6.b.
Agriculture Standards	• (AG) C 12.1, C 12.2, C 12.3, C 13.3, F 4.3, F 4.4, and G 5.1. • (Foundation) 1.2 Science, Specific Applications of Investigation and Experimentation: (1.a) and (1.d). • (Foundation) 5.0 Problem Solving and Critical Thinking: (5.3).

Name_____

Date_____

Mites on Cotton

Purpose

Spider mites (Tetranychus species) are the most damaging foliar pests in most areas and in most crops. Under favorable conditions, their populations can multiply so rapidly that they can injure a large portion of leaf area. The purpose of this lab is to demonstrate sampling procedures to determine the population of Spider mites on roses, cotton and/or almonds. [i]

Procedure

Materials

1. 10 to 30x power hand lens for field classroom/observation
2. Lunch size paper bags

Sequence of Steps

I. Sampling ROSES

Sampling a commercial field:

1. Rose leaves are compound, consisting of 5 to 7 leaflets per leaf.
2. To sample a field of roses, walk 40 to 50 paces from the edge of the field and stop.
3. Turn to the right and at random select a leaf (5 to 7 leaflets) from the bottom third of that bush.
4. The 'sample leaf' is then stored in the lunch bag.
5. Turn left and take a leaf (5 to 7 leaflets) from the middle third of that bush and put the sample into the same bag.
6. Still standing in the same location turn back to the right and take a sample from the top third of the bush.
7. Walk another 40 to 50 paces and repeat the process until 30 to 36 samples have been gathered.

Sampling on a school campus: Describe any changes you will make to the procedure to fit your situation.

_____

_____

_____

II. Sampling COTTON

Walk into a cotton field 50 paces. Each sample in this case is one leaf from the MAINSTEM of the plant. Walk at least 20 paces from the plant-to-plant or sample-to-sample. When plants have less than 9 main stem nodes, pick the lowest leaf. When plants have more than 9 main stem nodes, pick the 8th leaf from the top, counting the newest partly unfurled leaf as number 1. Pick at least 10 samples (leaves) from each growing unit (field). The treatment threshold of 50% of infested leaves is conservative. Some researchers believe that economic injury does not begin in cotton until more than 80% of the samples are infested.

III. Sampling ALMONDS

To sample almond trees, choose 15 leaves at random both around the circumference of the tree and within the tree canopy. Place the leaves from each tree into separate bags and mark the location. At least 5 trees should be sampled form each orchard unit.

A threshold of 22% infested leaves in the absence of predators or 45% in the presence of predators calls for action.

PROCEDURE for INTERPRETING DATA COLLECTED

1. Using a dissecting microscope, zoom power microscopy lens, or a hand lens look for mites. Check for mites on the entire upper and lower surface of the leaf, including near the veins and in folds where mites may be hidden.
2. If one or more LIVE mites or eggs are detected, the leaf is considered infested.
3. If no mites or eggs are found, even if there is mite damage on the leaf, do not count that leaf as being infested. (An absence of mites or eggs usually means predators have eliminated the mites/eggs). The predators of mites include thrips, green lacewing larva, minute pirate bugs, bigeyed bugs, and predatory mites (*Metaseiulus occidenntalis*).
4. Using the table below, calculate the percentage of infested leaves by dividing the number of infested leaves by the number of leaves sampled.
5. Graft the results against the dates of sampling.

Percentage of Mite Infested Leaves			
Date	**# of Leaves Infested**	**# of Leaves Sampled**	**% Infestation**

Sampling usually occurs weekly in commercial fields. If the percentage of infested leaves is increasing rapidly, sampling is increased to more than once a week, but treatment does not occur until the threshold percentage is reached.

- Complete the Table for Thresholds to determine whether the roses, cotton, or almonds sampled are in need of treatment.

Table for Thresholds					
Leaf Number	Mites Present (Check marks)	Talley of Mites Present	Don't Treat	Treat	Predator (Check if Present)
1					
2					
3					
4					
5					
6					
7					
8					
9					
10			3	7	
11			4	7	
12			4	8	
13			4	9	
14			5	9	
15			5	10	
16			6	10	
17			6	11	
18			7	11	
19			7	12	
20			8	12	
21			8	13	
22			9	13	
23			9	14	
24			9	15	
25			10	15	
26			10	16	
27			11	16	
28			11	17	
29			12	17	
30			12	18	

[i] Dickson, Chris (2008). Mites on Cotton. *North High School, Bakersfield, Agriculture Department*

Biology/Life Sciences Standards	• (BLS) 6.a and 6.b.
Agriculture Standards	• (AG) C 2.1, C 9.2, C 13.3, and D 10.1. • (Foundation) 1.2 Science, Specific Applications of Investigation and Experimentation: (1.a) and (1.d).

Name_____

Date_____

Population Pressures and Succession in a Lab Community

Background

Most people in the United States have plenty to eat. In fact, we are confronted with a surplus of food crops. However, in most parts of the world, there is not enough food to support the population. Most people in the United States are not especially crowded by their neighbors. In fact, some states have large areas where settlement is invited because more neighbors would be welcomed. However, the world as a whole is already beginning to feel population pressures for space.

The issues of adequate food supply and living space are among the major problems which world governments must solve in the near future. Scientists believe that among lower organisms, food and space have been major problems for a much longer time than for man.

Purpose

The purpose of this exercise is to:

- Determine whether the number of individuals in a lab community of plants and animals is governed by food supply and living space.
- Determine whether populations will change from one kind of organism to another if competition for limited food and room favors one organism over another. [i]

Procedure

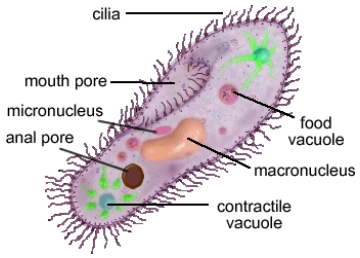
Materials:

1. Battery jar with lid (Large glass jar)
2. Dead grass
3. Water
4. Medicine dropper
5. Microscope
6. Slides & cover slips
7. Quart jars with lids
8. Gelatin
9. Pipette

Sequence of Steps

1. Fill a battery jar about ½ full of dead grass and cover with distilled water. Keep the battery jar covered with a glass plate. In "observations", record what you do and see daily starting with the day you set up the experiment.
2. Examine the jar every class period. Prepare a wet mount of the water by using a medicine dropper to transfer a drop of the culture to a slide and cover with a cover slip. Examine with a microscope, changing the light intensity as you look. View sample twice a week and record your observations.

3. At first you will only see bacteria, if anything at all. The next kind of organism to appear in the infusion will likely be an animal called a paramecium (see picture at right) or other ciliated protozoan. [ii]



4. When the paramecia become abundant, prepare 3 clean quart jars by putting 1 gram of plain gelatin in the first, 3 grams in the second, and 10 grams in the third.


1g Gelatin


3g Gelatin


10g Gelatin

5. Fill the jars with distilled water to an inch from the top and mix well.
6. Withdraw 30ml of liquid from the dead grass infusion. Agitate (shake) it to distribute the organisms evenly and add 10ml of the grass liquid to each gelatin jar.
7. You now have 3 jars with equal quantities of water, living space, bacteria and paramecia, but with different quantities of food (gelatin).
8. Your task: see how food supply affects the number of organisms in a controlled habitat.

Observations

1. Stir the contents of each jar every day and examine a drop of liquid from each with a microscope. Record your observations below:

Date	What did you do?	What did you see?

2. Count the number of organisms in each jar and compare. Record your observations below:

Date	1g Gelatin Jar	3g Gelatin Jar	10g Gelatin Jar

Conclusions:

1. What is the significance of seeing bacteria *first* in the water? Did a lot of bacteria appear suddenly or did their population increase gradually?

2. Did the number of paramecia increase suddenly or slowly?

3. How many days passed before you noticed any life in the grass infusion? How many days passed before the first organisms began to disappear? Would these be replaced by others?

4. Describe the biodiversity in your habitats (jars):

5. What comparison can you make between the relationships of food, bacteria and space for the organisms in your sample and human populations in crowded areas like China and India?

6. What comparisons can you make between this experiment and the demands our population places on California agriculture production?

7. Agriculture Application: Imagine you are a cattle rancher, grazing your cattle on a large pasture. What things must you consider related to population pressure to make sure your cattle are productive on this land?

[i] Agricultural Biology Curriculum Lesson Plans. Sacramento: California State Department of Education, Agriculture Education Unit, 1990.
[ii] "Paramecium Lab." Biology Corner. 3 Oct 2008 <www.biologycorner.com/resources/paramecium.gif>.

Biology/Life Sciences Standards	• (BLS) 6.b.
Agriculture Standards	• (AG) C 12.1, C 12.2, C 12.3, C 13.3, F 4.3, F 4.4, and G 5.1. • (Foundation) 1.2 Science, Specific Applications of Investigation and Experimentation: (1.a) and (1.d). • (Foundation) 5.0 Problem Solving and Critical Thinking: (5.3).

Name_____

Date_____

Presence/Absence Sampling Method for Mites on Roses, Cotton and Almonds

Purpose

Spider mites (Tetranychus species) are the most damaging pests to the foliage (leaves) of plants in many crops. Under good conditions, their populations can multiply quickly injuring a large portion of the leaf area. To make pesticide recommendations a PCA license is required. The purpose of the lab is to demonstrate the presence/absence sampling method to evaluate the population size of mites. [i]

Procedure

Materials

1. Lunch size paper bags
2. Microscope or hand lens

Sequence of Steps

General notes for roses, cotton and almonds:

1. A field of 40-160 acres is called a 'growing unit'. For a classroom setting, just use what rose bushes are around the school.
2. Randomly select bushes and carefully sample (pull off and put in the paper bag) a leaf (with 5-7 leaflets) from the bottom third of a bush, a sample from the middle, and a sample from the top third of the bush.
3. In the lab, remove the leaves from the bag one at a time and, using a microscope or hand lens, look for mites.
4. Check for mites on the entire upper and lower surface of the leaf including near the veins and in folds where mites may be hidden.
5. If you find one or more live mites or eggs, the leaf is infested. If you see no mites, even if there is mite damage on the leaf, do NOT count the leaf. (This usually means predators have gotten to the mites). Predators include thrips, green lacewing larva, minute pirate bugs, bigeyed bugs and predatory mites (Metaseiulus occidentalis).
6. Record your observations in Table 1.
7. To figure the percentage of infested leaves, divide the number of infested by the number of leaves sampled.
8. You should sample your plants weekly. If the percentage of infested leaves increases rapidly, sampling should be increased to more than once a week. However, treatment does not occur until the threshold percentage is reached.

Roses

Rose leaves are compound, consisting of 5-7 leaflets per leaf. To sample a field of roses, walk 40 to 50 paces from the edge of the field and stop. Turn to your right and sample (pull off and put in the paper bag) at random a leaf (with 5-7 leaflets) from the bottom third of that bush. Turn to your left and sample

a leaf from the middle third of that bush and then turn back, still standing at the same location, and sample a leaf from the upper third of that bush. Walk another 40-50 paces. Repeat the process until you have sampled 30-36 leaves. The treatment threshold of 25% infested leaves is most common.

Cotton

Walk in about 50 paces. Each sample in this case is ONE leaf from the MAIN STEM of the plant. Walk at least 20 paces from plant to plant or sample to sample. When plants have less than 9 main stem nodes, pick the lowest leaf. When plants have more than 9 main stem nodes, pick the 8th leaf from the top, counting the newest partly unfurled leaf as number 1. Pick at least 10 samples from each growing unit (field). The treatment threshold of 50% of infested leaves is conservative. Some researchers believe that economic injury does not begin in cotton until more than 80% is reached.

Almonds

To sample almond trees, choose 15 leaves at random both around the circumference of the tree and within the tree canopy above the sprinkler line. Place the leaves from each tree into separate bags and mark the location. At least 5 trees should be sampled from each orchard unit. A threshold of 22% infested leaves in the absence of predators or 45% in the presence of predators calls for action.

Observations

Table 1.

Leaf Number	Check Mites Present	Talley of Checks of Mites Present	Don't Treat	Treat	Predator (Check if present)
1					
2					
3					
4					
5					
6					
7					
8					
9					
10					
11					
12					
13					
14					
15					

1. Describe your observations using complete sentences.

2. Analyze any changes to the plant population you sampled resulting from changes in mite population size.

3. Based on your observations, formulate your recommendations for management of this field.

[i] Dickson, Christine *The inside story: How agriculture uses the microscope*. Bakersfield, CA: North High School Agriculture Department.

Biology/Life Sciences Standards	• (BLS) 6.b.
Agriculture Standards	• (AG) C12.1, C 12.2, C 13.3, G 5.1, and G 5.4. • (Foundation) 1.2 Science, Specific Applications of Investigation and Experimentation: (1.a) and (1.d). • (Foundation) 5.0 Problem Solving and Critical Thinking: (5.3).

Name_____

Date_____

Sweep Method

Purpose

The use of a sweep net is a very common method of monitoring insects in a field. In crops such as alfalfa and cotton, insects are collected and counted to estimate the population levels. Field monitoring is important to determine if treatment is necessary.

In this exercise the use of a sweep net is demonstrated in alfalfa. Insects of concern are the alfalfa weevil larvae (*Hypera postica*) or Egyptian alfalfa weevil (*Hypera brunneipennis*), alfalfa caterpillars (*Colias eurytheme*), beet armyworm (*Spodoptera exigua*) and western yellow-striped armyworm (*Spodoptera praefica*). Other insects, including predators and parasitic wasps (which are the 'good guys' in this case) can also be detected. [i]

Procedure

Materials

1. Hand lens 10-30X power or a dissecting scope
2. Sweep net (can be purchased from any biological educational catalog)
3. Stapler
4. Paper bags (large grocery store size)
5. Glass jars with screw top lids
6. Ethanol or isopropyl alcohol (rubbing alcohol)
7. Use of a freezer (optional)
8. Glass dish or Petri dish

Sequence of Steps

A standard sweep net consists of a cone shaped cloth bag approximately 2 feet deep fitted to a 15-inch wire loop and attached to a 26-inch handle. To sweep, tilt the rim of the net so that the lower edge is 1 to 2 inches ahead of the upper edge of the rim. This allows the net to catch insects falling from the plant. The lower rim of the net should be kept about 10-inches below the top of the plant during sweeping. A single sweep is on a 180-degree arc taken during a step forward. At the end of this sweep raise the net and reverse the direction of the swing. Swing the body from side to side during sweeping, making natural swings. Sweeps may be taken singly or consecutively.

1. To check a field, divide the field into four or more sections depending on the size of the field.
2. Take five sweeps in each section and deposit the contents of the net into a paper bag and staple the bag closed.
3. Place the paper bags from each section of the field into a freezer for 10-minutes.
4. Open the bags and discard the plant material.
5. Pour the insects into the glass jars and add enough alcohol to cover the insects.

6. Seal the jars tightly to prevent the alcohol from evaporating. The alcohol preserves the samples for counting and identification at a later time.
7. To count and identify the insects, carefully pour off as much alcohol as possible without losing any insects.
8. Place the insects in a shallow glass dish or Petri dish. If the insects float, there is too much alcohol remaining in the sample.
9. Put the dish under the microscope and examine the sample.
10. Identify the different insects and count the number of each species. To determine the average number per sweep, add the number of each species from each section of the field and divide by the total number of sweeps taken from the field.

Observations

Average Number Per Sweep				
Insect				
Number per sweep				
Average number per sweep				

Background Information

- The recommended treatment threshold for **weevils** is an average of 20 larvae per sweep.
- **Caterpillars** have a number of predators, parasites, and pathogens that may occur in a field that will keep the populations below economically damaging levels. The treatment threshold for alfalfa caterpillars is an average count of 10 nonparasitized or disease-free caterpillars per sweep.
- **Beet armyworm** or western yellow-stripe armyworm need to be controlled when an average of 15 nonparasitized armyworms of more than ½ inch in length per sweep are found.

Control of these insects could be obtained with early harvest of the hay or with an insecticide. When economically practical, many growers choose to harvest early to minimize the killing of predators and parasites of aphids

Conclusion

1. Based on your observations, describe your findings using complete sentences.

2. Based on your observations, what course of action do you recommend? Are you below the level of threshold for this field?

3. How does population size of a specific pest affect the surrounding ecosystem?

4. Why is effective control of pests an important aspect of production agriculture?

[i] Dickson, Chris (2008). Sweep Method. *North High School, Bakersfield, Agriculture Department*

Biology/Life Sciences Standards	• (BLS) 6.b and 6.e.
Agriculture Standards	• (AG) E 3.3, E 10.6, and G 6.3. • (Foundation) 1.2 Science, Specific Applications of Investigation and Experimentation: (1.a) and (1.d). • (Foundation) 5.0 Problem Solving and Critical Thinking: (5.3).

Name_____

Date_____

Ecological Succession in a Rotten Log

Purpose

After a tree dies, it passes through a number of well-defined stages before it decays completely and becomes part of the soil. Each stage has a microcommunity consisting of characteristic organisms. When the organisms of one stage use up their food supply or otherwise make the microhabitat unsuitable for themselves, they are succeeded by other organisms. Thus a succession of communities occurs in a rotten log in much the same way that a succession of communities occurs on a sand dune or in a vacant lot. [i]

Procedure

Materials

1. *Thermometers (air and soil)
2. *Light meters
3. *Hygrometers (and any other instruments for measuring environmental conditions)
4. Pocket magnifiers
5. Collecting bottles

optional

Sequence of Steps

1. Within a woodlot locate trees of the same species in the following stages of succession:
   - a dead tree that is still standing
   - a tree that has recently fallen
   - a log with a rotten core but firm exterior
   - a totally rotten log
2. Make careful measurements of the environmental factors near each site. If you have the instruments, measure the air and soil temperature, the relative humidity, and the light intensity. If you lack instruments, make qualitative observations of these factors. Note also the condition of the soil – moist or dry, impacted or loose, its color, evidence of organic matter, and its state of decomposition. Record your observations.
3. Identify the plant species that appear close enough to influence the microcommunities at each site.
4. Check the standing tree for evidence of the past activity of vertebrates. Look for woodpecker holes, bird nests, and squirrel nests. Estimate when the activity took place. Note the species and location of any fungi present. Examine the bark remaining on the tree. Note its moisture content. Remove some of the bark and look for invertebrates under the bark and in the wood. Identify as many of these as you can and note their relative abundance. If necessary, collect one of each species and take it back to the laboratory for identification and closer examination. Make accurate notes regarding the habitat of each species.

5. Examine the newly fallen log. Compare the ease with which bark can be removed from it and the standing tree. Note the moisture content and hardness of the wood. Compare these to the standing tree. Check for fungi, mosses, lichens, and herbaceous plants. Study the invertebrates, as in 4. Record your observations.
6. Approach the partially rotten log slowly. Look around and under it for vertebrates like snakes and salamanders. Look for signs of animal life such as tunnels, runways, nesting sites, and food catches. Remove part of the hard outer shell. Break this apart and make observations on the invertebrate population, as in 4. Search through the rotting core for invertebrates, snakes, and salamanders. Note the color, moisture content, and odor of the rotting core. Describe its state of decomposition. Check for fungi, mosses, lichens and herbaceous plants.
7. Examine the totally rotten log as you did the core in 6. Compare the color, moisture content, odor, stage of decomposition, plants, and animals of the two stages.

Observations

Table 1. Observations of woodlot samples

General Observations: Air temperature, soil temperature, humidity, light intensity, etc.				
	Dead tree (still standing)	Recently fallen tree	Log with rotten core but firm exterior	Totally rotten log
Evidence of past vertebrate activity				
Examine Bark				
Observations after bark is removed.				
Observations of invertebrates.				

1. Describe the microsuccession that occurs in a rotten log from the time the tree dies to the time it becomes part of the soil.

2. Which organisms were most abundant at each stage? Why?

3. Which stage had the greatest diversity of life? Why?

4. Account for the succession that occurs by relating the changing biotic factors to the changing abiotic factors.

5. Make up as many food chains as you can for each of the four stages.

6. What organisms are responsible for the odor of a rotting log? What niche do they occupy?

7. What do you think is the most important niche in a fallen log microcommunity? Why?

[i] (2008).Ecological Succession in a Rotten Log. *Prentice Hall, Inc.*

Biology/Life Sciences Standards	• (BLS) 6.a.
Agriculture Standards	• (AG) C 10.2, C 13.3, G 6.2, and F 5.1. • (Foundation) 1.2 Science, Specific Applications of Investigation and Experimentation: (1.a) and (1.d). • (Foundation) 5.0 Problem Solving and Critical Thinking: (5.3).

Name_____

Date_____

Comparing the Water-Holding Capacities of Soils

Purpose

Production agriculturists must know how much water their soil can hold, in order to effectively manage crop production. The amount of water soil can hold is referred to as "water-holding capacity". An alternative to expressing the water-holding capacity of soil as a percentage of its dry weight is to compare the water-holding capacity of two or more soils. These soils may differ in humus content and particle size. The purpose of this lab is to evaluate the water holding capacity of three soil samples. [i]

Procedure

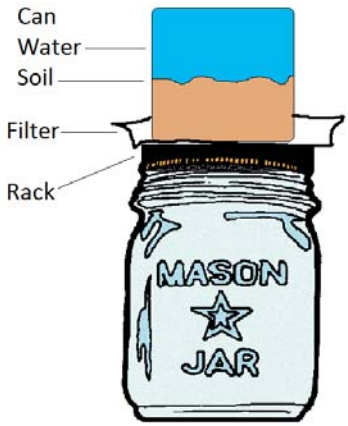
Materials

1. Cans with both ends removed, all cans the same size (3)
2. Filter paper or cloth
3. Rubber bands (3)
4. Racks or screen(3)
5. Large mayonnaise or mason jars; the mouth of the jar must be larger than the base of the can. (3)
6. Soil samples from different areas (3)

Sequence of Steps

1. Using a rubber band, secure a piece of filter paper or cloth to the base of each can.
2. Oven-dry each sample of soil. (Try to get a sample from a field where grasses or legumes have recently been grown, a sample from a field, a sample from a garden, and so on.)
3. Fill each can approximately 2/3rds full of its soil sample.
4. Place the cans on racks/screen over the mouths of the jars. See Figure 1.
5. Pour equal amounts of water into each can.
6. Complete the observation questions and clean your lab area.

Figure 1.



Observations

1. Describe your observations from this lab using complete sentences.

2. Which soil sample absorbed the most water? Why?

3. Why would some soil samples be unable to absorb large amounts of water?

4. How does water naturally cycle through the soil through photosynthesis?

5. Agriculture application: Suppose you talk with a farmer who grows vegetables in the Salinas Valley. He wants you to test his soil for water-holding capacity. Why is this important for the farmer? What decisions will it help him to make?

[i] (2008).Comparing the Water-Holding Capacities of Soils. *Prentice Hall, Inc.*

Biology/Life Sciences Standards	• (BLS) 6.b and 6.d.
Agriculture Standards	• (AG) C 2.3, C 3.2, E 1.1, and E 2.2. • (Foundation) 5.0 Problem Solving and Critical Thinking: (5.3).

Name_____

Date_____

Water Conservation

Purpose

The purpose of this exercise is to study the water cycle and factors which have created water problems. [i]

Procedure

Materials

1. Colored pencils

Sequence of Steps

1. Read the following information about "The Water Cycle"

   Rain, sleet and snow are forms of precipitation. The return of water vapor to the atmosphere is **evaporation**. Together, these processes constitute the **water cycle**. Following precipitation, water may run of the ground and collect in streams, ponds and oceans. This is **surface water**. Some of the water may soak into the ground and reach the water table, enter plant roots, rise through the soil to the surface, or emerge as a spring.

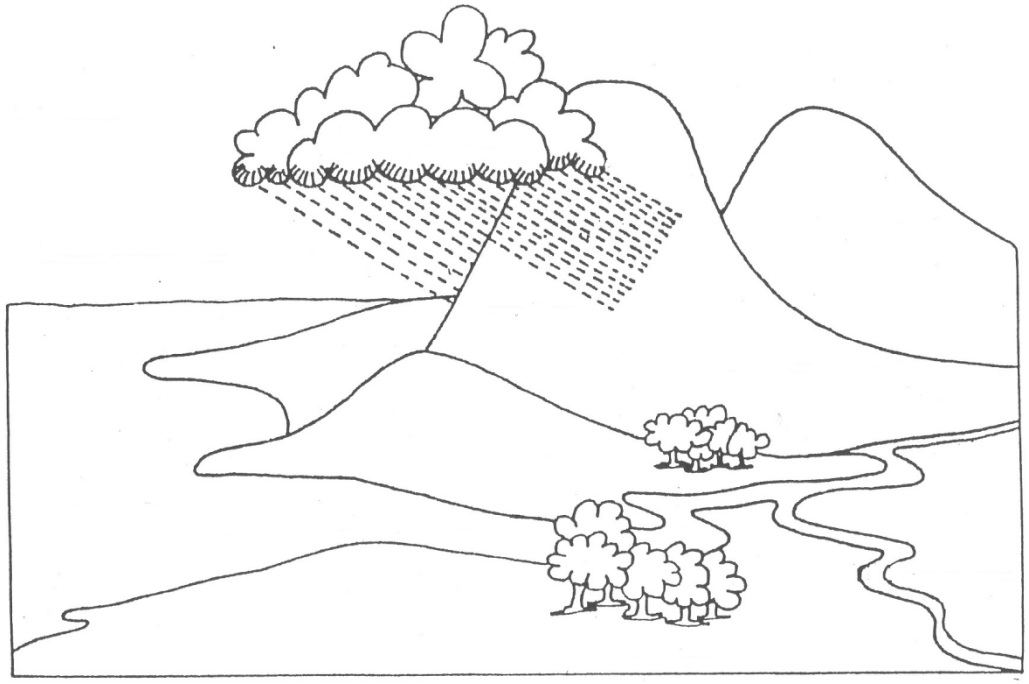
2. The landscape shown in "observations" is a setting for the construction of a diagram of the water cycle. Movement of water will be indicated with arrows; the arrow indicates the direction of movement. The color of the arrow will classify the water as:
   - Precipitation (red)
   - Surface water (blue)
   - Ground water (green)
   - Water evaporating and returning to the atmosphere (yellow)

   Indicate the kind of water with a letter placed on the arrow, according to the description and key below the water cycle.

Observations

1. Use the directions above and the key provided to illustrate the diagram of the water cycle on the next page. [ii]
   a. Precipitation from cloud to earth (red)
   b. Runoff water to pond (blue)
   c. Surface water stored in pond (blue)
   d. Ground water seeping through soil to water table (green)
   e. Ground water stored in water table (green)
   f. Ground water absorbed by plant roots (green)
   g. Water transpired from leaves to atmosphere (yellow)

h. Water evaporating from soil surface into atmosphere (yellow)
i. Water evaporating from surface of pond (yellow)



Conclusions:

Explain the problems created by each of the following practices related to water:

1. Pumping water from deep wells for air-conditioning systems in buildings.

2. Draining swamps and marshes.

3. Cutting forests in watershed (hilly) regions.

4. Cutting bottomlands and flood plains along large rivers.

5. Losing top soil through erosion.

6. Draining fields by means of tile lines and ditches.

7. Water conservation is a major issue in California. Some farmers choose to use drip irrigation instead of sprinkler or flood irrigation. Define these types of irrigation and explain how water is conserved.

8. Farmers also may choose to cover irrigation holding ponds. How will this improve water conservation?

9. Investigate: How has new technology improved water conservation in agriculture?

[i] Agricultural Biology Curriculum Lesson Plans. Sacramento: California State Department of Education, Agriculture Education Unit, 1990.
[ii] "The Water Cycle." Mordialloc Cluster. 3 Oct 2008 <www.mordialloccluster.vic.edu.au>.

Biology/Life Sciences Standards

7. The frequency of an allele in a gene pool of a population depends on many factors and may be stable or unstable over time. As a basis for understanding this concept:
   a. Students know why natural selection acts on the phenotype rather than the genotype of an organism.
   b. Students know why alleles that are lethal in a homozygous individual may be carried in a heterozygote and thus maintained in a gene pool.
   c. Students kno*w* new mutations are constantly being generated in a gene pool.
   d. Students know variation within a species increases the likelihood that at least some members of a species will survive under changed environmental conditions.
   e. * Students know the conditions for Hardy-Weinberg equilibrium in a population and why these conditions are not likely to appear in nature.
   f. * Students know how to solve the Hardy-Weinberg equation to predict the frequency of genotypes in a population, given the frequency of phenotypes.

8. Evolution is the result of genetic changes that occur in constantly changing environments. As a basis for understanding this concept:
   a. Students know how natural selection determines the differential survival of groups of organisms.
   b. Students know a great diversity of species increases the chance that at least some organisms survive major changes in the environment.
   c. Students know the effects of genetic drift on the diversity of organisms in a population.
   d. Students know reproductive or geographic isolation affects speciation.
   e. Students know how to analyze fossil evidence with regard to biological diversity, episodic speciation, and mass extinction.
   f. * Students know how to use comparative embryology, DNA or protein sequence comparisons, and other independent sources of data to create a branching diagram (cladogram) that shows probable evolutionary relationships.
   g. * Students know how several independent molecular clocks, calibrated against each other and combined with evidence from the fossil record, can help to estimate how long ago various groups of organisms diverged evolutionarily from one another.

Lab Reference: Evolution

Standards: 7a-f, 8a-g

STANDARD CONCEPT	LAB NAME	LAB NUMBER
Natural Selection	Bird Beak Adaptation	D-1
Natural Selection	Naked Bunny	D-2
Natural Selection	Natural Selection	D-3
Natural Selection	Natural Selection Limbo	D-4
Natural Selection	Natural Selection: Wooly Worms	D-5
Natural Selection	Survival of the Fittest on Tree Island	D-6
Origin of Species	1000 mm of Time	D-7

Biology/Life Sciences Standards	• (BLS) 8.a.
Agriculture Standards	• (AG) C 4.2, C 7.2, and C 13.3. • (Foundation) 1.2 Science, Specific Applications of Investigation and Experimentation: (1.a), (1.d), and (1.f). • (Foundation) 5.0 Problem Solving and Critical Thinking: (5.3).

Name_____

Date_____

Bird Beak Adaptation

Purpose

In this activity, you and your group will model how competition for food can be a driving force of natural selection. You will witness how certain birds are better adapted to eat specific food sources.

Background Information

On a long voyage around the world, Charles Darwin stopped at the Galapagos Islands. A genius of his time, he noticed there were slight variations in the traits of the animals that lived on each island. Darwin's famous observations were made on finches, a type of bird. Darwin noticed that different species of finches had slightly different beaks, depending on the type of food that was available within the habitat in which they lived. Darwin developed the theory of natural selection based on his observations. In his theory, he stated that only those organisms that are most adapted to their environment would live long enough to produce young. He called this process "survival of the fittest". Thus, these helpful variations are passed from one generation to the next, and with time, this changes the alleles within a gene pool and evolution ultimately occurs.[i]

Procedure

Materials

1. Beak (Scissors, binderclip, spoon or tweezer)
2. Rubberbands
3. Beans
4. Paperclips
5. Macaroni
6. Stomach (bowl/bag)

Sequence of steps

Obtain your assigned beak and your stomach at your designated lab station.

ROUND 1:

1. You will be designated a "beak" and gather as much of one specific type of food as you can in the allowed amount of time.
2. Food only counts when it is picked up and put in the stomach with your beak.
3. Food does not count if your beak is not used properly!
4. Mild competition is normal, but NO pecking!!!

5. Count the amount of the specific food you ingested into your stomach and complete Data Table #1. Fill in the data for each of the other types of birds (group members) in your ecosystem (lab station).
6. Repeat step #1 for each of the four different food types.

ROUND 2:

1. Place the bowl with all the food types in the feeding area (middle of table).
2. In the given amount of time, gather as much of ANY foods of your choice as you can.
3. When time is up, count your ingested good and record on Data Table #2.
4. Record the data of your entire group in Data Table #2.

After Round #1, complete:
Data Table #1

	Scissor Beak	Binderclip Beak	Spoon Beak	Tweezer Beak
Rubberband Worms				
Bean Beetles				
Paperclip Grasshoppers				
Macaroni Snails				

After Round #2, complete:
Data Table #2

	Scissor Beak	Binderclip Beak	Spoon Beak	Tweezer Beak
Rubberband Worms				
Bean Beetles				
Paperclip Grasshoppers				
Macaroni Snails				

Analysis Questions:

1. What was your beak type?

2. During Round #1, what food type was your beak best adapted for according to your data?

3. Was there any beak that was well adapted to all food types? If so, what?

4. If this bird (from question #3) was removed from the ecosystem, what do you think would happen to the other birds?

5. Over a long period of time, what might you hypothesize could happen to your bird species?

6. How might your bird species evolve over time to become better adapted to this environment?

7. What food did you choose to eat most during Round #2? Why?

8. How does this activity demonstrate the idea of natural selection?

9. Describe the type of bird beak that would be best adapted to this ecosystem overall.

10. How do you think the population dynamics of this ecosystem could change over time?

[i] [i] Zallo, Izaskun (2008). Bird Beak Adaptation. *Pleasant Grove High School Agriculture Department*

Biology/Life Sciences Standards	• (BLS) 8.a.
Agriculture Standards	• (AG) C 7.1, C 13.3, and D 5.4. • (Foundation) 1.2 Science, Specific Applications of Investigation and Experimentation: (1.a) and (1.d). • (Foundation) 1.1 Mathematics, Specific Applications of Probability and Statistics: (8.0).

Name_____

Date_____

Naked Bunny Lab

Purpose

Evolution can be described as the change in allelic frequencies of a gene pool over time. Natural selection can place pressure on specific phenotypes and cause a change in the frequency of the alleles that produce the phenotypes. In this activity, you will simulate the effects of eagle predation on a population of rabbits, where FF represents the homozygous condition for fur, Ff is the heterozygous condition for fur, and ff represents the homozygous condition for lack of fur (naked). The purpose of this lab is to evaluate how natural selection affects allelic frequency. The objectives are to: Simulate natural selection by using beans of two different colors, calculate allelic frequencies over five generations and demonstrate how natural selection can affect allelic frequencies over time. [i]

Procedure

Materials

1. Lab sheet
2. 2 colored pencils
3. Paper bag
4. White beans
5. Black beans

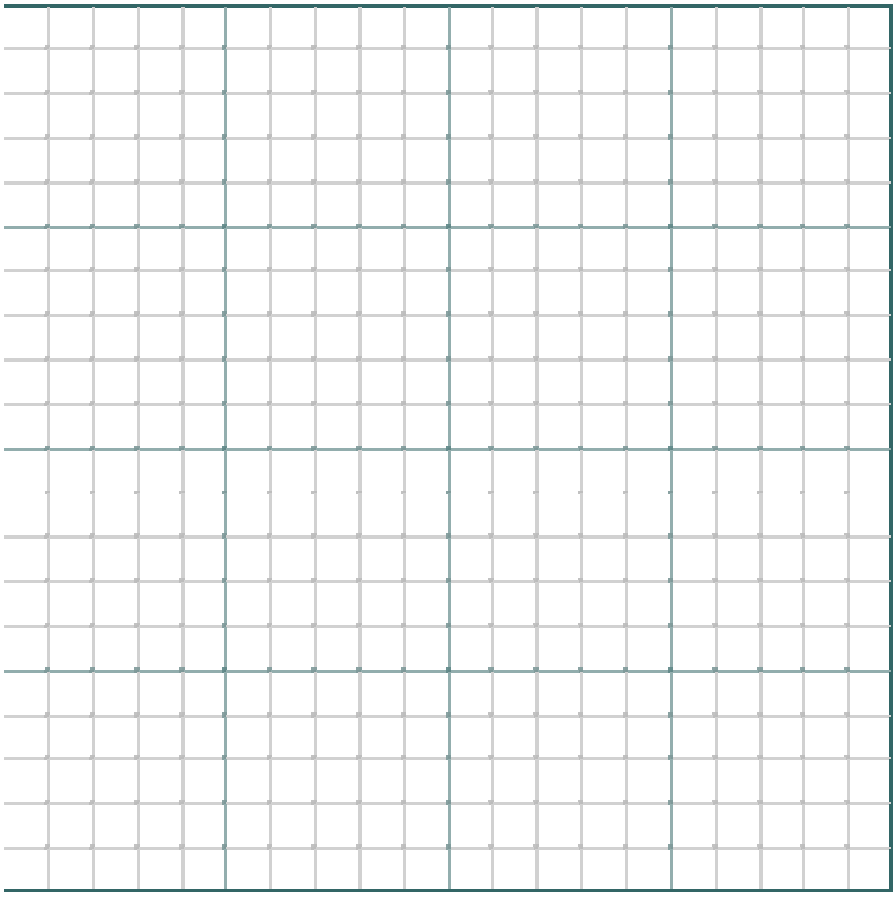
Sequence of steps

1. Place 50 black beans and 50 white beans into the paper bag.
2. Shake the bag. Remove two beans. These represent the genotype of one rabbit. Set the pair aside and continue to remove 49 more pairs.
3. Arrange the beans on the lab station in two columns representing the two possible rabbit phenotypes, with fur (FF or 2 black beans) or (Ff or one black/one white); or without fur (ff or 2 white beans).
4. Examine your columns. Remove 25% of the rabbits WITH fur and 100% of the rabbits WITHOUT fur. These numbers represent a random selection pressure on your rabbit population. If the number you calculate is a fraction, remove a whole rabbit to make whole numbers.
5. Count the number of black and white beans remaining. Record this number in your data table for Generation 1.
6. Calculate the allelic frequencies by dividing the number of beans of one type by 100. Record these numbers in your data table.
7. Begin the next generation by placing 100 beans into the bag. THE PROPORTION OF BLACK AND WHITE BEANS SHOULD BE THE SAME AS THE PERCENTAGES YOU CALCULATED IN STEP #6.
8. Repeat steps #2-7, collecting data for ten generations.
9. Graph the frequencies of each allele over ten generations on the graph paper. Plot the frequency of the allele on the vertical axis and the number of the generation on the horizontal axis. Use a different colored pencil for each allele.
10. Answer the analysis questions.

Data Table:

Generation	*Allele F* Number	*Allele F* Percentage	*Allele F* Frequency	*Allele f* Number	*Allele f* Percentage	*Allele f* Frequency
Start	50	50	0.50	50	50	0.50
1						
2						
3						
4						
5						
6						
7						
8						
9						
10						

Graph your data collected above. Be sure to label the axes according to the directions (step #9) and give your graph an appropriate title.



Analysis Questions:

1. Did either allele disappear? Why or why not?

2. What does your graph show about allelic frequencies and natural selection?

3. What would happen to the allelic frequencies if the number of eagles declined?

[i] Zallo, Izaskun (2008). Naked Bunny Lab. *Pleasant Grove High School Agriculture Department*

Biology/Life Sciences Standards	• (BLS) 7.d, 8.a, and 8.b.
Agriculture Standards	• (AG) C 4.2 and C 13.3. • (Foundation) 1.1 Mathematics, Specific Applications of Probability and Statistics: (8.0).

Name_____

Date_____

Natural Selection

Purpose

The purpose of this exercise is to demonstrate the concept of selection and to observe the role of the environment in determining the direction of selection. [i]

Procedure

Materials

1. 25 colored discs each of the following colors: clear, blue, red, and yellow.
   These "plastic animals" can be any type of penny size plastic objects, markers, etc. Scatter these "plastic animals" on the classroom floor prior to starting lab.
2. Petri dish

Sequence of steps

Variations and Survival

1. At the signal to start, search the floor in the area assigned to you. Collect as many "animals" as possible in 2 minutes.
2. When time is up, count the number of each color that you have collected. Record these numbers in the observations section in Table 1. Collected Animals.

Variations and Inheritance

1. Collect all of the surviving animals (those left on the floor). Place them in the lid of a Petri dish and mix them thoroughly.
2. Draw out mating pairs of animals , 1 at a time, and lay the pairs on a table in columns:
   Clear/clear in one column
   Clear/red in another
   Clear/blue in the third and so on.

Observations

Table 1. Collected Animals

Variety of Animal	Beginning Number (on floor)	Number Collected	Number left on Floor
Clear			
Blue			
Red			
Yellow			
Totals			

Conclusions

1. What are the genotypes of the animals you created from the Petri dish?

2. What is the original frequency of each allele in the gene pool?

3. After foraging, what is the new frequency of each allele (left on the ground) in the gene pool?

4. Which animals were most difficult to find? Explain.

5. Was the difficulty in question 4 reflected in the final frequencies of the various alleles?

6. Which animals are best adapted, and which are more poorly adapted to their environment?

7. Suppose the surviving animals were to mate. How would the success of the best adapted animals be reflected in the offspring?

8. Assume that each mating resulted in a single offspring. How many offspring will be added to the population of plastic animals?

9. Of the number of offspring added, how many will be clear?

10. If this mating procedure were to be carried out over several generations, what would happen to the frequency of the clear allele and the recessive alleles?

11. How do changes in the frequencies of the alleles over several generations affect the predator?

12. For what variation in the predators would the environment select?

13. What was the origin of the variety of colors as seen in these animals?

14. The phrase "survival of the fittest" has been used to describe Darwin's ideas. How has this concept been demonstrated?

15. Would "elimination of the unfit" be more appropriate? Explain.

16. Explain the difference between domestication and natural selection.

[i] Agricultural Biology Curriculum Lesson Plans. Sacramento: California State Department of Education, Agriculture Education Unit, 1990.

Biology/Life Sciences Standards	• (BLS) 7.d, 8.a, and 8.b.
Agriculture Standards	• (AG) C 4.2 and C 13.3. • (Foundation) 1.2 Science, Specific Applications of Investigation and Experimentation: (1.a), (1.d), and (1.f). • (Foundation) 5.0 Problem Solving and Critical Thinking: (5.3).

Name_____

Date_____

Natural Selection Limbo!

Purpose

The purpose of this lab is to evaluate natural selection in action! Nature selects those individual with traits best suited for their environment. An organism's survival is dependent on their phenotype (physical traits), and we all know that your phenotype is determined by your genotype (genes). So, if an organism does not have a trait necessary for survival in their environment, they will never have that trait because it's not in their genes! In other words… you've either got it, or you don't![i]

Procedure

Materials

1. Limbo bar

Sequence of steps

1. Understand the analogy:
   Students = Organisms Limbo Pole = _____
   Good Limbo = You survive & reproduce Bad Limbo = Death & no offspring
2. The problem: Students will pass under a limbo bar continually being lowered. What traits are necessary for survival in this environment?
3. Hypothesis: The top five surviving students will have the following traits –
   1)
   2)
   3)
   4)

4. Students should voluntarily pass under a lowering limbo bar. Record the top five students and indicate the traits they displayed in the data table under observations.

Observations

Data Table: Top 5 students

Circle Displayed Traits

Student Name	Trait			
1.	1	2	3	4
2.	1	2	3	4
3.	1	2	3	4
4.	1	2	3	4
5.	1	2	3	4

Conclusion Questions

1. How does the environment an organism lives in affect its survival?

2. How does natural selection affect single-gene traits?

3. What would happen to the species if none of the organisms were able to limbo under the pole?

[i] (2008).Limbo Lab, Natural Selection in Action. *Atwater High School Agriculture Department*.

Biology/Life Sciences Standards	• (BLS) 8.a.
Agriculture Standards	• (AG) C 7.1 and C 13.3. • (Foundation) 1.2 Science, Specific Applications of Investigation and Experimentation: (1.a) and (1.d). • (Foundation) 1.1 Mathematics, Specific Applications of Algebra I: (15.0).

Name_____

Date_____

Natural Selection: Wooly Worms

Purpose

In this lab, you will play a hungry bird searching for a meal. You diet consists of "wooly worms." The population of wooly worms has been found in five different colors. After a feeding period, you will evaluate how the population and species color will change over time.i

Background

While evaluating your data, consider Darwin's theories about how population is shaped by natural selection. Natural selection is based on the following ideas:

1. More organisms are born than the environment can support.
2. There is competition for limited natural resources (food, water, shelter, space).
3. Variety exists within a species (color, size, speed).
4. Those with the successful variation live to reproduce, thus passing those genes for that favorable variation on to their offspring.

Procedure

Materials

1. "Wooly Worms" (Yarn cut in 1" sections)
    a. Blue (50)
    b. Red (50)
    c. Brown (50)
    d. Green (50)
    e. Yellow (50)

Sequence of steps

1. Your teacher will spread worms out over one eating area (preferably outside).
2. When signaled by your teacher, collect as many worms as possible. It is important that you only pick up one at a time.
3. Stop when your teacher indicates to stop.
4. Record your data below under "First Generation"
5. Now, the number remaining reproduces to create a second generation.
6. Each wooly worm can reproduce and create two new worms. Calculate new population after the remaining population of first generation reproduces.
7. Record your data below under "Second Generation"
8. Answer analysis questions.

Data Table: First Generation

Color of Wooly Worm	*Initial Population*	*No. Eaten*	*No. Remaining to Reproduce*
Blue	**50**		
Red	**50**		
Brown	**50**		
Green	**50**		
Yellow	**50**		

Data Table: Second Generation

Color of Wooly Worm	*Population after the Feeding Period*	*No. Produced by Reproduction*	*New Population*
Blue			
Red			
Brown			
Green			
Yellow			

Analysis Questions:

1. What factor determined who got eaten?

2. What color is dominating in the new population? What influenced this change in the population?

3. In this environment, what will eventually happen to the population of “wooly worms”?

4. In a desert environment, would the same result occur?

5. Compare this lab to real life. Explain how natural selection occurs, using one specific animal as an example.

Teacher Notes:
When you spread the yarn “wooly worms” outside, preferably on a grassy area the more natural colored ones (brown/tan, pale yellow, green) tend to blend in and the kids don't see them as easily. They get the brighter ones right away. Time the students, just giving them a minute or 2 or 3, depending on the size of the plot you used to spread the worms, and then go back inside the classroom to count up the worms. The kids see that the ones that blended into the environment got picked up "eaten" at a lower rate because of the camouflage effect.

[i] Sperling, Jill (2008). Wooly Worms. *Kingsburg High School Agriculture Department*

Biology/Life Sciences Standards	• (BLS) 8.a and 8.b.
Agriculture Standards	• (AG) C 4.2 and C 13.3. • (Foundation) 1.2 Science, Specific Applications of Investigation and Experimentation: (1.a) and (1.d). • (Foundation) 1.1 Mathematics, Specific Applications of Probability and Statistics: (8.0).

Name_____

Date_____

Survival of the Fittest on Tree Island

Purpose

The purpose of this exercise is to test "survival" traits. Will you survive or not? [i]

Procedure

Materials

1. Graph paper (1 per student)
2. Challenge 1: Wall marked with leaves per minute at height increments
3. Challenge 2: Sour candy (1 per student)
4. Challenge 3: Cave opening taped or posted on wall
5. Challenge 4: Disposable cup of water (1 per student), Sharpie

Sequence of steps

1. Your teacher will guide you to assemble in Survivor teams of 4 people.
2. Meet with your Survivor team and select one person to read this overview out loud:
    a. Listen to instructions.
    b. Answer introductory questions.
    c. Perform all 4 challenges.
    d. Graph/answer questions.
3. Background Information: Answer background question under Observations.
4. Determine a name for your Survivor Team. Record on your data sheet.
5. Predict which member(s) of your team will survive the challenges.

Procedure for Challenge #1: Let Us Leaf

Imagine that your survivor team is a group of herbivores living on remote *Tree Island*. Your diet consists entirely of tree leaves. Your favorite leaves used to grow on a stubby tree that was found everywhere on the island, but those trees are gone now. You and the other herbivores ate all the leaves, and the short trees died.

You have no choice now. To live you must eat the leaves from the only kind of tree remaining. But this tree is much taller, and although it has branches near the ground, its upper branches have the most leaves.

A wall in your classroom has been marked to represent the heights of tree branches and labeled with the number of leaves available to one herbivore like you in an hour.

To thrive, you must be able to eat more than 125 leaves per hour.

Directions (each member of your team must perform the challenge)

1. Stand with your feet flat on the floor and your back against the mark on the wall below the "branches" on the tree.
2. Reach above your head as high as you can.
3. Another person on your team will call out the number of leaves per hour that you can reach with your raised hand.
4. Record that number in the Data Sheet.

After completing the challenge:

How many leaves were you able to reach? *Answer in your Data Sheet*
How many group members survived? *Answer in your Data Sheet*
Record this data on the board to share with the class.

Graph the current distribution of reach heights in your class. How might the distribution or reach heights change in future generations of herbivores? *Answer this question on your graph.*

Wait for direction from your teacher to move onto the next challenge!

Procedures for Challenge #2: There's a Fungus Among Us

Some of the leaves are tasty and some are not. Unfortunately, some of the leaves you and your herbivore friends are eating have a fungus growing on them. The fungus is very poisonous—eat too much of it and YOU DIE! But some individuals can taste the fungus. To them it tastes really bad, and they spit out the leaves. That's good, because if the poisonous fungus isn't swallowed, it does no harm!

Directions (each group member must participate in the challenge)

Place the sour candy in your mouth. If you can suck on the candy until it is gone without making a sour face then you pass the fungus test. You many not chew on the candy or make a sour face of any kind.

1. Place a piece of candy in your mouth. If do not make a sour face, you're safe.
2. Record the data for you survivor team on the board.
3. Record the results on your data sheet.

After completing the challenge:

Who survived the poisonous fungus? *Record in your Data Sheet*

Wait for direction from your teacher to move onto the next challenge!

Procedures for Challenge #3: Caveberries

A severe drought has recently struck Tree Island. All of the leaves on the trees that can be reached are GONE! There is another food you can eat though; the fruit of a plant called the *caveberry.* It grows just

inside the island's only cave. The opening to the cave is small and very low to the ground. To get in, the herbivores must kneel down and bend over. They cannot make their bodies any lower than that.

Directions (each group member must participate in the challenge)

1. Kneel next to the cave opening posted on the wall. If you head is lower than the top of the opening, you will survive the drought.
2. Record the information on your data sheet
3. Post the information on the board.

After completing the challenge:
Who survived the drought? *Record in your Data Sheet*

Wait for direction from your teacher to move onto the next challenge!

Procedures for Challenge #4: Slurp and Burp

The ability to roll your tongue into a tube is a genetic trait that some people do not have. Try as they may, they will never be able to roll their tongues. They are not genetically "programmed" to do it.

It has not rained for months on Tree Island, and the lakes and rivers have dried up! Your survivor team of herbivores has found some water trapped in cracks in hard rock. The good news is that the cracks are filled with water, which you can reach with your tongues. The bad news, if you can't roll your tongue, you must try to lap up the water.

Directions (each group member must participate in the challenge)

1. You cannot use your hands.
2. You cannot lift the cup in anyway (remember, the cup represents a water filled crack in a rock).
3. You may use only your tongue to drink. If you can roll your tongue, try to suck water up through your rolled tongue. If you cannot roll your tongue, try to use your tongue to slurp up the water.
4. Before you begin, measure from the top of the cup to the distance to the edge of the water. Mark a line with the sharpie. Record the distance measured.
5. You have 60 seconds to drink as much as you can without spilling any. *Spill any water and you do not survive!*
6. After drinking, again measure from the top of the cup the distance to the water. Record distance measured.
7. The difference between step 4 and step 6 must be greater than half an inch to survive.
8. Pour water out and change water between team members.
9. Record info on data sheet.
10. Post any survivors on the board.

After completing the challenge:
Who survived? *Record in your Data Sheet*

Observations

Background Information: Think about the different features that make some organisms better equipped for the demands of their environment. What features would help humans survive in the wild?_____
_____
_____

Survivor Island Data Sheet

Survivor Team Name:_____

Herbivore Name (team member's name)	# of leaves reached per hour FYI: must eat 125/hr to survive	Check if you CAN taste the sour candy	Check if you can get into Cave	Check if you slurp up more than ½ inch of water.

Analysis & Conclusion Questions:

1. If your team of herbivores survives on Tree Island, does that mean it has adapted to the changes?

2. Do individuals adapt to changes in their environment, or do populations adapt? Explain.

3. What is the vocabulary word for the ability of an individual to survive and reproduce in its specific environment:_____

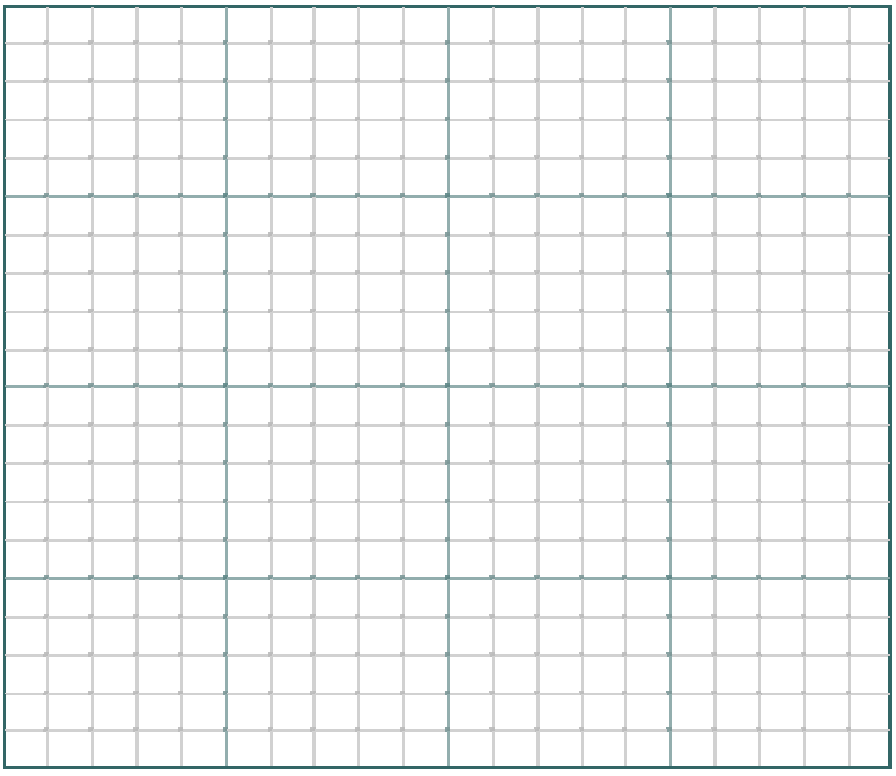
4. What is the definition of adaptation?

5. How does variation within a species increase the likelihood that at least some members of a species will survive under changed environmental conditions?

6. How do the Tree Island challenges relate to the process survival of the fittest?

7. What did Darwin refer to as survival of the fittest?

8. Graph the class herbivore height vs. number of leaves reached per hour.



9. Calculate what percentage of individuals in the class would have survived all of these challenges?

10. How might this population change over time?

[i] (2008).Survival of the Fittest on Tree Island. *Atwater High School Agriculture Department*.

Biology/Life Sciences Standards	• (BLS)8.a and 8.b.
Agriculture Standards	• (AG) C 4.1 and C 4.2. • (Foundation) 1.1 Mathematics, Specific Applications of Algebra I: (15.0).

Name_____

Date_____

1000 Millimeters of Time

Purpose

The purpose of this exercise is to see approximately when primitive organisms inhabited the earth. You will also see when the ancestors of present-day organisms made their appearance.[i]

Recall

Millimeters = Smallest marks on a meter stick (mm)

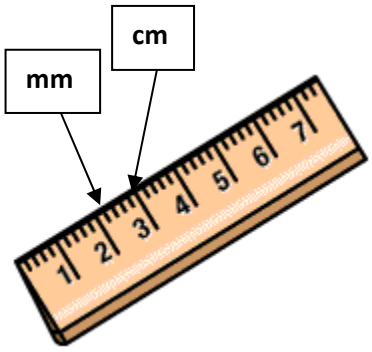
Centimeter = There are 10 millimeters in each centimeter (cm)

Meter = There are 100 centimeters in a meter

Procedure

Materials

1. Paper (1 meter long)
2. Meter stick
3. Ruler



Sequence of Steps

Setting up your chart

1. You will use the centimeter and millimeter to represent units of time in the life of the earth.
2. Lay the piece of paper on a flat surface. Place the meter stick on the paper, with the lowest numbers at the **right** side of the paper.
3. Measure 10 cm from the bottom of the page. Draw a line, 1 meter long, along the bottom of the paper, 10 cm from the bottom edge.
4. Without removing the meter stick from the paper, make a mark on the paper at each of the following centimeter points on the meter stick: **(Moving from right to left.)**
    a. 0cm
    b. Each of the first 12 cm (1-12)
    c. 20 cm
    d. 40 cm
    e. 60 cm
    f. 80 cm
    g. 100 cm
5. Using the ruler, extend these marks to the bottom of the paper.
6. Let 1cm = 50 million years. Therefore, the time represented from 0cm to 1cm represents 50 million years. Write the words “50 Million” on the line you drew at 1cm. Continue across the page, indicating the amount of time represented by each line.
7. Let 1mm = 5 million years. Place the meter stick on the paper again and make a mark at each of the first 10 millimeters on the line, **starting from the right**.

Plotting Events

1. The chart in Figure 1 lists some of the important events and the time in millions of years when they are believed to have occurred. Study the chart.
2. Using the time scale you prepared, locate these points and write the events in the proper places on your paper.

Figure 1

Event	Millions of Years Ago
First flowering plants	150
Great coal forests; reptiles appeared	280
First dinosaurs	200
Dinosaurs extinct	130
Spores- land plants	500
First amphibians	400
Early man	2
Earliest fossils	3,000 million years ago (3 billion)
First primates	65
First primitive fish	480
First mammals and birds	170
First seed plants	300
Conifers & tree ferns; largest dinosaurs	150
Large carnivores	10
Abundant invertebrate fossils	550
Appearance of insects	430

Observations & Conclusions

1. During what part of the earth's history did living organisms first appear? What were they?

2. Which appeared first, animals or green plants?

3. What characteristics of plants enable them to survive without animals?

4. What characteristic or characteristics of animals make them dependent on green plants?

5. Which of the organisms listed in *Figure 1* have been on the earth the shortest period of time?

6. How has natural selection determined the different survival groups of organisms?

7. What evidence do we have to support time period of dinosaurs and their mass extinction?

[i] Agricultural Biology Curriculum Lesson Plans. Sacramento: California State Department of Education, Agriculture Education Unit, 1990.

Biology/Life Sciences Standards

9. As a result of the coordinated structures and functions of organ systems, the internal environment of the human body remains relatively stable (homeostatic) despite changes in the outside environment. As a basis for understanding this concept:
    a. Students know how the complementary activity of major body systems provides cells with oxygen and nutrients and removes toxic waste products such as carbon dioxide.
    b. Students know how the nervous system mediates communication between different parts of the body and the body's interactions with the environment.
    c. Students know how feedback loops in the nervous and endocrine systems regulate conditions in the body.
    d. Students know the functions of the nervous system and the role of neurons in transmitting electrochemical impulses.
    e. Students know the roles of sensory neurons, interneurons, and motor neurons in sensation, thought, and response.
    f. * Students know the individual functions and sites of secretion of digestive enzymes (amylases, proteases, nucleases, lipases), stomach acid, and bile salts.
    g. * Students know the homeostatic role of the kidneys in the removal of nitrogenous wastes and the role of the liver in blood detoxification and glucose balance.
    h. * Students know the cellular and molecular basis of muscle contraction, including the roles of actin, myosin, Ca^{+2} , and ATP.
    i. * Students know how hormones (including digestive, reproductive, osmoregulatory) provide internal feedback mechanisms for homeostasis at the cellular level and in whole organisms.

10. Organisms have a variety of mechanisms to combat disease. As a basis for under-standing the human immune response:
    a. Students know the role of the skin in providing nonspecific defenses against infection.
    b. Students know the role of antibodies in the body's response to infection.
    c. Students know how vaccination protects an individual from infectious diseases.
    d. Students know there are important differences between bacteria and viruses with respect to their requirements for growth and replication, the body's primary defenses against bacterial and viral infections, and effective treatments of these infections.
    e. Students know why an individual with a compromised immune system (for example, a person with AIDS) may be unable to fight off and survive infections by microorganisms that are usually benign.
    f. * Students know the roles of phagocytes, B-lymphocytes, and T-lymphocytes in the immune system.

Lab Reference: Physiology

Standards: 9a-i, 10a-f

STANDARD CONCEPT	LAB NAME	LAB NUMBER
Bacteria	Bactericide	E-1
Digestion	Ruminant Digestion	E-2
Digestion	Simple Digestion	E-3
Disease Control	Fun with Fomites	E-4
Disease Control	Simulating an Epidemic	E-5
Disease Control	Temperature Pulse Respiration	E-6
Nutrients	Nutrients in Feed	E-7
Nutrients	The Great Feed Trial Lab	E-8
Organs	Heart Dissection	E-9
Parasites	External Parasites	E-10
Pathogens	Pathogens	E-11
Tissues	Chicken Wing	E-12

Agriculture Standards

- (AG) C 9.2 and C 13.3.
- (Foundation) 1.2 Science, Specific Applications of Investigation and Experimentation: (1.a) and (1.d).
- (Foundation) 1.1 Mathematics, Specific Applications of Probability and Statistics: (8.0).
- (Foundation) 5.0 Problem Solving and Critical Thinking: (5.3).

Name_____

Date_____

Bactericide

Purpose

The purpose of this exercise is to test the ability of various household cleaners to act as bactericides to inhibit bacterial growth.[i]

Procedure

Materials

1. Permanent marker
2. Un-inoculated agar plate (1 per student or group)
3. Pipette
4. Distilled Water
5. Test tube
6. Inoculated agar plate (1 per class)
7. Q-tip
8. Filter discs (4 per student)
9. Bactericide solutions (Antibacterial household cleaners)
10. Forceps
11. Parafilm (Petri dish tape)
12. Ruler

Sequence of Steps

1. Using a permanent marker, divide the bottom of the **un-inoculated** agar plate into 4 quadrants. Label the quadrants: 1, 2, 3 and C (for control). In the Observations section label the quadrants on the drawing of your petri dish.
2. Take the pipette and fill it with water (one squeeze). Place the water in the small test tube.
3. Go to the teacher's bench and cautiously lift the lid of the **inoculated** agar plate just enough to allow you to scoop up a small amount of a non-shiny bacterial colony with the tip of a pipette. **Do No PENETRATE THE SURFACE**. Stir the pipette in the distilled water in the test tube to dislodge the bacteria.
4. Using the pipette, mix the bacteria and distilled water.
5. Lift the lid of the **un-inoculated** agar plate enough to allow you to place 6-7 drops of bacteria solution on the surface of the agar. Very gently swirl the petri dish to spread the suspension evenly on the surface. Use a sterile Q-tip to spread the bacteria solution evenly. Let the suspension settle for a few minutes before you go on to the next step wait about 3 minutes or until the plate looks dry.
6. Soak a **filter disc** in one of the **bactericide solutions** available. Using **forceps** to handle the disc place it on the surface of the agar in quadrant 1 and very gently press it down. Write the quadrant number and the identity of the bactericide in the data table.
7. Repeat with 2 other discs, soaking them in different bactericides and placing them in quadrant 2 and 3. For quadrant C, soak the disc in **distilled water (control)**. Seal your plate with a strip of Paraflim.
8. Wash all equipment and your lab bench. Lastly, wash your hands.
9. After a few days, examine the agar plate with the bactericide discs. Look for a circular region around each disc where bacterial growth was inhibited (ie. the **zone of inhibition**).

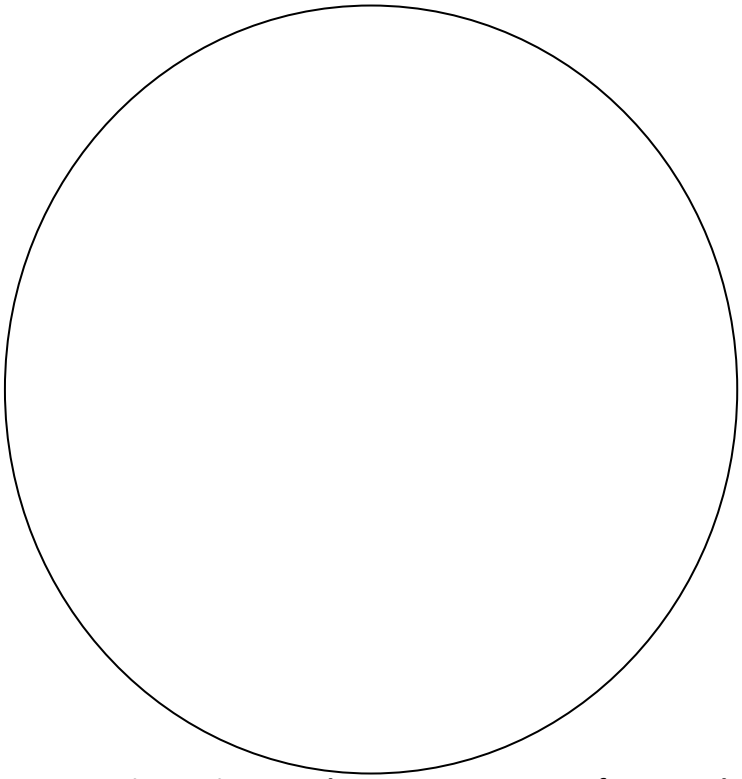
10. Using a ruler, **measure the zone of inhibition** for each disc in millimeters mm. Measure from the center of the disc to the periphery of the inhibition (ie. to where bacterial growth begins again). Record your measurements in a table.
11. In "observations", make a labeled drawing of your petri dish showing: quadrants, filter discs (including the names of all bactericides and control), bacterial colonies, and zones of inhibition.

Observations

Data Table: Effectiveness of Bactericide

Disk	Diameter of zone of inhibition (mm)
1. control	
2.	
3.	
4.	

Labeled drawing of petri dish showing: quadrants, filter discs (including the names of all bactericides and control), bacterial colonies, and zones of inhibition.



Questions: Answer questions using complete sentences except for # 2 and # 8

1. Why was water included in the experiment as the control?

2. Order the bactericides from strongest to weakest based on their zone of inhibition.

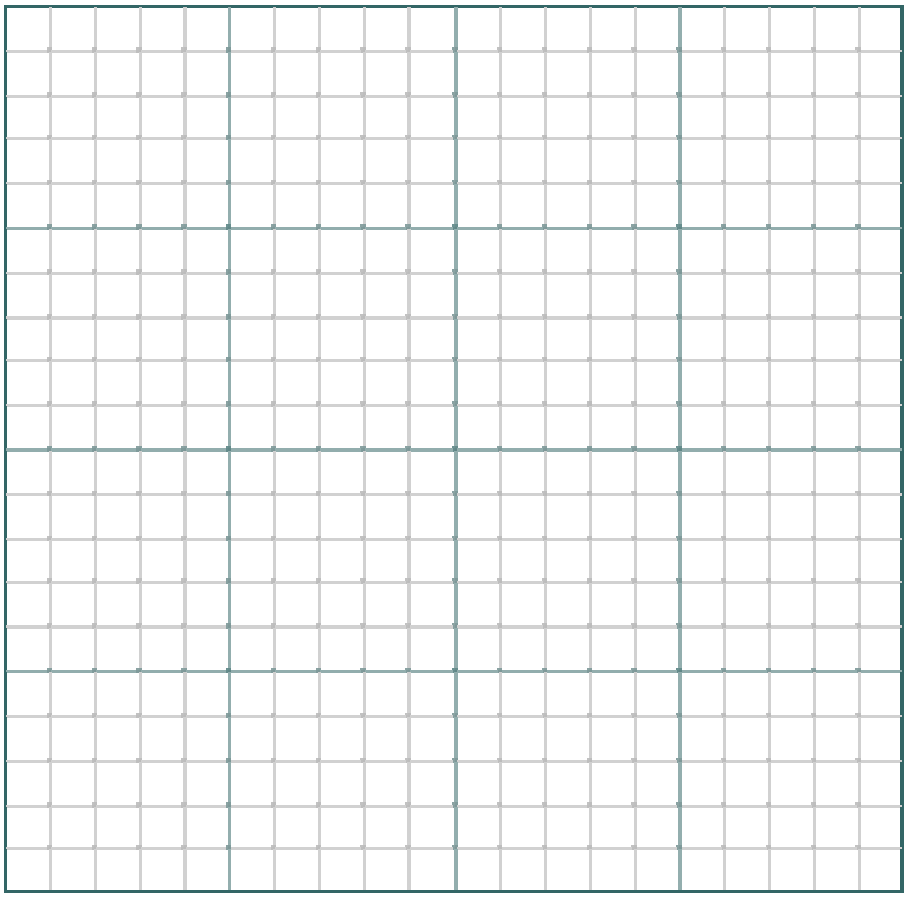
3. If there was a zone of inhibition around the water control disc, what might you conclude?

4. What is the difference between bactericides (antiseptics) and antibiotics?

5. Bactericides are routinely used to clean wounds. Were all the bactericides in your experiment appropriate to use directly on humans? Why or why not?

6. Some people think that over use of bactericides may be harmful. Why? (Hint: think about genetics and evolution)

7. Graph your data below. Be sure to include proper labels of the X-axis and Y-axis and labels. Give the graph a title.



8. In the experiment what is the independent variable? What is the dependent variable?

[i] Zallo, Izaskun (2008).Bacteria Lab: Effect of Bactericides. *Pleasant Grove High School Agriculture Department*.

Biology/Life Sciences Standards	• (BLS) 9.a.
Agriculture Standards	• (AG) C 6.2, C 8.1, C 13.3, D 2.3, and D 2.4. • (Foundation) 1.2 Science, Specific Applications of Investigation and Experimentation: (1.a) and (1.d).

Name_____

Date_____

Ruminant Digestion

Purpose

The purpose of this exercise is to evaluate the ruminant digestive system and familiarize students with the digestive process.[i]

Procedure:

Materials

1. Ruminant digestive systems
2. Sharp knife
3. Pins & labels
4. Jars
5. Dissecting microscope
6. Books with pictures of digestive system

Sequence of Steps

Spread the digestive tract out, so that all parts can be seen easily. Using the pins and tags, read through these steps labeling the digestive parts that are underlined in this lab.

1. The **esophagus** is the tube that carries food stuff from mouth to stomach.
2. There are four parts to the ruminant stomach.
    a. The **rumen** makes up 80% of the stomach. High fiber feed is broken down in the rumen through fermentation.
    b. The **reticulum** makes up approximately 5% of the stomach. The honeycomb shape of the reticulum catches unwanted objects.
    c. The **omasum** makes up 8% of the stomach. Feed passes through the omasum after it leaves the reticulum and rumen. The omasum acts as a filter and a pump.
    d. The **abomasum** makes up 7% of the stomach. This is considered the true stomach and the only part of the ruminant stomach which produces gastric juices. [ii]

Show the digestion that takes place in each stomach.

a. Cut the stomach open and take out some of the contents.
b. Place the contents in a jar and allow classmates to view.
c. Evaluate how much digestion has taken place in each stomach.
d. Obtain a section of the inner lining of each compartment in the stomach and observe under a dissecting microscope. Write your information under observations.

Observations

1. Describe, in your own words, the inner lining of each compartment of the stomach.

Conclusions

1. In which stomach was the food most digested? In which stomach was the food least digested?

2. Using the table below, explain the function of each part of the stomach.

Stomach Compartment	Function
Rumen	
Reticulum	
Omasum	
Abomasum	

3. How does this digestive system compare to that of a pig or human?

4. Explain how the ruminant digestive system provides cells with nutrients while removing toxic waste.

5. How does the diet of ruminant livestock differ from the diet of monogastric livestock? Why?

[i] Agricultural Biology Curriculum Lesson Plans. Sacramento: California State Department of Education, Agriculture Education Unit, 1990.

[ii] "The Digestive System of the Ruminant". Natural Resources, Government of Newfoundland and Labrador Canada. September 27, 2008 <http://www.nr.gov.nl.ca/agric/fact_pubs/pdf/livestock/ruminant/digestivesys.pdf>.

Biology/Life Sciences Standards	• (BLS) 9.f.
Agriculture Standards	• (AG) C 6.2, C 8.1, C 13.3, D 2.3, and D 2.4. • (Foundation) 1.2 Science, Specific Applications of Investigation and Experimentation: (1.a) and (1.d).

Name_____

Date_____

Simple Digestion

Purpose

The purpose of this exercise is to identify the location and function of the organs and systems within the simple digestive tract. [i]

Procedure:

Materials

1. Digestive tract of fetal pig
2. Scalpel
3. Labeling pins & tags
4. Paper
5. Dissecting microscope

Sequence of Steps

Spread the digestive tract out, so that all parts can be seen easily. Using the pins and tags, read through these steps labeling the digestive parts that are underlined in this lab.

1. Find the dark, red-brown organ. It is the **liver**. Notice that the liver is divided into lobes.
2. Raise the right lobe of the liver. Observe the **gall bladder**, a small greenish sac embedded in the underside of this lobe.
3. Immediately under the left lobes of the liver lies the **stomach**. Trace the intestine from the stomach toward the posterior, until it joins the colon, or large intestine. The smaller tubing is the **small intestine**, while the larger tubing is the **large intestine**. Where the small intestine and large intestine join, there is a pouch called the **caecum**. In humans, the tip of the pouch is the appendix. Trace the colon toward the posterior. Just before it reaches the **anus,** there is a slight enlargement, the **rectum**.
4. The **pancreas**, a small pinkish, grainy organ, is also part of the digestive system. It lies just under the stomach, inside the bend made by the first section of intestine.
5. Remove a 3cm section of the small intestine and cut it lengthwise. Wash and examine its lining under a dissection scope. Describe its appearance in the observation section. The projections you see are called **villi**.

Observations

1. Draw the digestive system as you have observed it, and label the parts underlined above.

2. Describe or draw the lining of the small intestine:

Conclusions

1. Fill in the table by listing the part or function of the proper organ.

Part of Digestive Tract	Function
	Controls passage of food from stomach to small intestine
	Chemical digestion and absorption of food
	Stores bile
	Extension of the large intestine that is vestigial in humans
	Storage of undigested food physical mixing of food
Liver	
Villi	

2. How is the pig's digestive system similar to humans?

3. What purpose does the digestive system serve?

4. Why is efficient digestion important when feeding livestock?

[i] Agricultural Biology Curriculum Lesson Plans. Sacramento: California State Department of Education, Agriculture Education Unit, 1990.

Biology/Life Sciences Standards	• (BLS) 10.a.
Agriculture Standards	• (AG) C 9.2 and C 13.3. • (Foundation) 1.2 Science, Specific Applications of Investigation and Experimentation: (1.a), (1.c), and (1.d).

Name_____

Date_____

Fun with Fomites

Purpose

The purpose of this exercise is to test a chosen fomite for the presence of microbes and the effects of a disinfectant by growing colonies of bacteria in a medium on petri plates.

Background

"Fomites? What are fomites? This is a term for any inanimate object that can carry disease-causing organisms. Your cutting board, kitchen sink, the change in your pocket and even that pen you keep putting in your mouth are all fomites. Very few things we encounter in our everyday activities are sterile, or microbe-free, including us. At birth, microbes immediately begin colonizing our bodies as they do most every object in the world. They float around until they come in contact with a surface that offers food and shelter. You are most likely to find microbes in and on dark, moist objects that frequently come into contact with food, dirt or vegetation. Bathroom surfaces, hairbrushes, refrigerators, kitchen sinks and cutting boards often have lots of microbes on them. But doorknobs and walls have fewer because they are nutrient poor and dry.

Most of the microbes on our bodies and other surfaces are harmless, but some are pathogenic or disease causing. For this reason, we want to control the number of microbes around us. The odds of becoming infected increase with the number of microbes on surrounding objects. But what can we do to affect the number of microbes on surfaces around us?

In this activity, you will test a chosen fomite for the presence of microbes and the effects of a disinfectant by growing colonies of bacteria in a medium on petri plates. A medium has food, vitamins and salts that help microbes grow. You usually don't see bacterial colonies like those that form on petri plates on everyday surfaces. That's because there is rarely such a perfect concentration of nutrients on fomites in nature."[i]

Procedure:

Materials

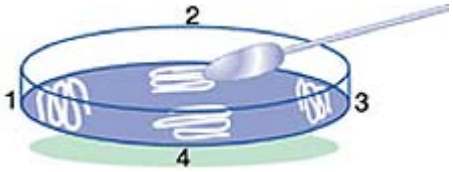
1. 3 sterile petri plates prepared with nutrient agar (can be ordered from Carolina Biological Supply Co. by calling 800-334-5551)
2. unopened box of sterile cotton swabs
3. paper towels
4. cellophane tape
5. permanent marker or grease pencil
6. a disinfectant such as 70% alcohol solution (mix 7 parts alcohol to 3 parts water), 10% bleach solution (mix 1 part bleach to 9 parts water), liquid soap, Lysol® or other household cleanser

Sequence of Steps

1. Clean your work area by dabbing, not pouring, disinfectant solution onto a paper towel and swabbing your area. Set out your petri plates but DO NOT OPEN THE PLATES UNTIL YOU'RE TOLD.

2. Choose an object in the room (doorknob, picture frame, toy, kitchen counter, TV remote control, coin, etc.). Take one unopened petri plate and using your grease pencil or marker, divide the bottom of the plate into four equal sections. Write the object's name across the top and label the sections 1 through 4. Open the box of cotton swabs and select one being careful not to touch the tip. Swab your chosen object with all sides of the swab tip by turning and twisting the swab as you move it across the object's surface.

3. Now open the lid of the plate and GENTLY make four streaks on the plate's surface as shown in the illustration, starting in the section labeled "1" and continuing streaking in order of the sections, making your last streak in section 4. Use firm, but GENTLE pressure and do not retrace your previous streaks. Your streaks should make only very slight impressions in the agar—don't gouge. Close the plate and seal it shut with two pieces of tape placed along the side—don't cover over the top with tape or you won't be able to see the inside of it well.



4. Divide a second unopened petri plate into 4 sections numbered 1 through 4 and label it "Control." Clean half of the object you swabbed with a paper towel dampened with plain water—just wipe a couple of times; don't scrub. Using a new cotton swab, swab the cleaned area for microbes. Open the lid of the second plate and GENTLY make 4 streaks on the plate's surface, following the order of the numbered sections as you did previously. Close the plate and seal it.

5. Divide your third petri plate into 4 numbered sections and label it with the name of the disinfectant you've chosen (e.g. "Bleach"). Use your chosen disinfectant to clean the other half of the object you swabbed. Using another new cotton swab, swab the area for microbes. Repeat the process of streaking the plate. Close and seal the plate.

6. Soak the used cotton swabs in disinfectant and throw them away. Place your plates in an out of the way spot and let them incubate at room temperature for two days. Clean your work area with disinfectant solution. Wash your hands.

7. After two days have passed, look at your initial petri plate. Do not open it. Examine your other petri plates in turn without opening them. Create a table that compares the plates made before and after cleaning the object. Be sure to indicate whether microbes grew in each streak.

8. Very carefully open the petri plates in a sink and flood them with undiluted bleach or alcohol. Let stand for an hour and then rinse them out thoroughly, tie them in a plastic bag and throw them away. Be sure not to touch the plate surfaces when you open them and wash your hands thoroughly after handling the plates. Clean your work area with disinfectant solution.

9. Answer the questions under "observations".

Observations

Table 1

Place an "x" in the growth row under each streak number that showed growth.

	Plate 1				Plate 2				Plate 3			
Streak	1	2	3	4	1	2	3	4	1	2	3	4
Growth												

1. Which plate grew the most and biggest colonies? Why do you think that is?

2. Do you see a pattern in the size and amount of colonies in each plate?

3. How can we control microbial contamination?

4. If you tested more than one fomite, which one grew more microbes? Why is that?

5. Agriculture application: Complete the table below, identifying fomites which can carry disease causing organisms in a production environment.

Scenario: Hog production facility		
	Fomites	Ways to control or sanitize
Housing Facilities		
General Sanitation		
Other		

[i] (2006). Fun with Fomites. Retrieved January 19, 2009, from American Society for Microbiology Web site: http://www.microbeworld.org/resources/experiment/experiment_%20fun_with_fomites.aspx

Agriculture Standards

- (AG) C 13.3.
- (Foundation) 1.2 Science, Specific Applications of Investigation and Experimentation: (1.a) and (1.d).
- (Foundation) 5.0 Problem Solving and Critical Thinking: (5.3).

Name_____

Date_____

Simulating an Epidemic of an Infectious Disease

Purpose

The purpose of this exercise is to simulate an epidemic of an infectious disease.[i]

Background

Epidemiologists study the causes and the spread of diseases through populations. By doing this, they can help to control and prevent diseases. Though epidemiologists may study diseases not caused by microbes, the simulation you will be doing is a simple model of a microbial epidemic. You will be simulating the spread of a microbial disease by using water and a chemical whose presence in the water can be easily shown.

Procedure

Materials

1. Test tubes (1 per student)
2. Water
3. Table salt
4. Silver nitrate

Sequence of Steps

1. Obtain a covered test tube of water from the supply area. All the test tubes for the class have water in them. One of them appears to be water but there is a chemical dissolved in it.
2. Go around the room and exchange liquids from your test tube with three other people. To do this, pour ½ the volume of the liquid in your test tube into the test tube of a classmate. Then that person should pour the same amount of liquid back into your test tube. These actions represent the transfer of microbes between persons.
3. Record the names of the persons with whom you interchange liquid in the order in which you made the exchanges.
4. After you are finished with the exchanges, go to the instructor who will add a chemical to the liquid in your test tube. If the liquid remains clear, then you are not infected. If a white cloudiness appears in the liquid, then you are infected.
5. The problem the class must solve now is the identity of the person who started the infection. It will be like solving a puzzle. You will have to use the lists of contacts to see where each person might have picked up the infection and work backwards until you have determined who the original reservoir of infection is. This is much like the process that the epidemiologist uses to trace the outbreak of a disease.
6. When you have finished your work, answer the discussion questions.

Observations

Order	People with whom I exchanged liquid
1	
2	
3	
My Result Infected Not Infected	

Discussion Questions

1. Did you find the source of the infection? If so, who was it?

2. Describe briefly the process you used to trace the infection back to its source.

3. Was the epidemic a common-source epidemic or was it a propagated epidemic? Explain.

4. In this simulation, what represented the infectious agent?

5. What is the morbidity rate for the infection in this simulation? How did you calculate it?

Teacher Notes:

The chemical used to represent the infection is salt (sodium chloride) and the test chemical is silver nitrate.

To set up this lab, fill one test tube per student with water. Add a teaspoon full of salt to one test tube and dissolve by stirring. Distribute the test tubes without telling students whose sample has salt.

When students bring their test tube to you, add 10-20 drops of silver nitrate. If the sample becomes cloudy, salt is present.

[i] Lord, Richard (2008).Simulating an epidemic of an infectious disease. *Presque Isle High School, Maine.*

Biology/Life Sciences Standards	• (BLS) 9.a and 9.b.
Agriculture Standards	• (AG) C 9.1, C 13.3, D 3.1, and D 6.1. • (Foundation) 1.2 Science, Specific Applications of Investigation and Experimentation: (1.a) and (1.d). • (Foundation) 1.1 Mathematics, Specific Applications of Algebra I: (15.0).

Name_____

Date_____

Temperature, Pulse and Respiration

Purpose

The purpose of this exercise is to determine the normal ranges of temperature, respiration and pulse and analyze those factors which affect these ranges.[i]

Procedure

Materials

1. Animals of the same species (3-4 well socialized dogs or livestock)
2. Thermometers
3. Stethoscope

Sequence of Steps

1. Determine the proper method to measure temperature, pulse, and respiration for the species of animal. Review the procedures at the end of this lab for general recommendations.
2. Write the steps on the lab sheet provided
3. With the lab sheet provided, practice taking your own resting pulse and respiration.
4. With a lab partner, take the temperature, pulse and respiration of one of the animals.
5. Record the information in the table.
6. Trade information with other groups to complete the table.
7. Measure the pulse rates and respiration of the subjects after exercise. (Ask your teacher the proper length of time to exercise the animal.)
8. Record the information in the table
9. Trade information with other groups to finish the table.
10. Calculate the difference in respiration and pulse for one of the animals
11. Complete the Analysis questions

Pre-Lab Questions

1. List the steps to properly take the temperature of an animal.

2. Describe how to properly take the pulse of an animal. (small and larger)

3. Describe how to properly take the respiration of an animal.

Observations

1. Practice taking your own resting Pulse and Respiration.

   Your Pulse: _____ Your Respiration: _____

2. Take the temperature, pulse, and respiration of the provided animals **BEFORE** exercising. Be sure to record units (degrees F, Beats/min., Breaths/min)

Animal	Temperature (˚F)	Pulse (Beats/min)	Respiration (Breaths/min)

3. Measure the pulse and respiration rates of the subjects **AFTER** exercise.

Animal	Minutes Exercised	Pulse (Beats/min)	Respiration (Breaths/min)

4. What is the difference in the pulse rate and respiration of the animals after they have been exercised? (use the resting/exercised information from the same animal)

   Animal Name/ID # _____

   Pulse Rate: Resting _____Bts/min

   Exercised _____Bts/min

   Difference _____Bts/min

   Respiration Rate: Resting _____Breaths/min

   Exercised ____Breaths/min

   Difference _____Breaths/min

   Analysis:

5. Did the animal's pulse rate increase or decrease after exercising?

6. What requirements does that body have that causes the difference in respiration and pulse rates?

7. What factors affect body temperature? Why might animals of the same species and environment have varying temperatures?

Recommended Procedures

Taking the Body Temperature of Animals[ii]

- Control the animal.
- Move the tail to the side.
- Put the thermometer gently into the anus, as far as possible.
- Hold the thermometer at an angle so that it touches the wall of the rectum. Keep a firm grip on the thermometer, if the animal defecates or coughs the thermometer could come out or go into the rectum.
- Hold the thermometer in place for half a minute. If you do not have a watch count slowly up to 30 (one, two, three, ... thirty).
- Remove the thermometer and wipe it if necessary and read it. Do not touch the bulb as this could change the reading.

Normal Body Temperatures of Animals

Animal	Normal Temperature ˚C	Animal	Normal Temperature ˚C
Cattle	38.5	Calf	39.5
Buffalo	38.2	Goat	39.5
Sheep	39	Camel	34.5-41.0
Llama, alpaca	38	Horse	38
Donkey	38.2	Pig	39
Chicken	42	Piglet	39.8

Calculating Pulse Rate

Pulse rate can indicate whether an animal is in distress (rate higher than normal), or if the animal is not getting enough blood flow because an outside agent has caused the heart to beat too slowly. Every time the heart beats it sends a pulse along the arteries. You can feel it at certain points on the body. By feeling the pulse we can count the rate at which the heart beats. Use a stethoscope to listen to the pulse rate of the animal. Compare this to other animals of the same species.

Calculating Respiration Rate

Respiration (breathing) consists of inspiration (breathing in) and expiration (breathing out). When an animal takes a breath, air goes in and out of the lungs. The lungs allow oxygen to pass into the blood stream and carbon dioxide to flow out. Count the number of breaths an animal takes in a 60 second period. Compare this to other animals of the same species. Also indicate other observations, such as sound of breathing and whether extreme effort must be exerted by the animal to breathe.

[i] Parson, Katy (2008). Temperature, Pulse and Respiration Lab. *Golden Valley High School, Bakersfield*

[ii] A Manual for Primary Animal Healthcare Workers. Retrieved July 31, 2009, from FAO Corporate Document Repository Web site: http://www.fao.org/docrep/t0690e/t0690e04.htm .

Biology/Life Sciences Standards	• (BLS) 9.a.
Agriculture Standards	• (AG) C 6.2, C 8.1, C 8.3, C 13.3, and D 2.3. • (Foundation) 1.1 Mathematics, Specific Applications of Probability and Statistics: (8.0). • (Foundation) 5.0 Problem Solving and Critical Thinking: (5.3).

Name_____

Date_____

Nutrients in Feed

Purpose

The purpose of this exercise is to identify nutrients in feed by performing chemical tests.[i]

Procedure

Materials

1. Safety goggles
2. Whole milk
3. Various food/feeds
4. Hot plate
5. Large beaker
6. Biuret reagent (Available through science retailer; light blue solution turns pink in the presence of protein.)
7. Lugol's Iodine (Available through science retailer; dark solution used to test for starch.)
8. Benedict's solution (Available through science retailer; clear blue solution of sodium and copper salts used to test for simple sugars.)
9. Test tube holder & rack
10. Test tubes
11. Ceramic Crucible
12. Brown paper bag

Sequence of Steps

Caution! Follow all lab safety rules when completing this lab. Wear safety goggles and a lab apron. Test small samples at a time and clean materials thoroughly when finished.

1. Test for water
   a. Place the feed samples in a crucible. Using a test tube holder, hold an inverted test tube over the crucible. Heat the food until only a residue remains. Any fluid that condenses on the glass surface is water. Using a scale of 0-10, 0 representing no water and 10 representing a lot of water, record what you see for each feed sample under "observations".

2. Test for sugar
   a. Add 5mL (10 drops) of Benedict's solution to a test tube containing a feed sample. Heat gently in a boiling water bath. The solution will turn green to brick red, depending on the amount of sugar. Using a scale of 0-10, 0 representing no change in color/no sugar and 10 representing a red color/a lot of sugar, record what you see for each feed sample under "observations".

3. Test for starch
   a. Place a drop of Lugol's iodine on a food sample. The drop will turn blue-black if starch is present. Using a scale of 0-10, 0 representing no starch and 10 representing high starch content, record what you see for each feed sample under "observations".

4. Test for Fat
    a. Rub a sample of a solid feed or place a few drops of a liquid feed on brown paper. Hold the paper to light. If the feed contains fat, you will see a translucent spot that will not disappear even when dry. Using a scale of 0-10, 0 representing no fat and 10 representing a high fat content, record what you see for each feed sample under "observations".

5. Test for Protein
    a. Add 2-3 drops of Biuret reagent to a test tube containing a feed sample. A color change from pink to purple indicates the presence of protein. Using a scale of 0-10, 0 representing no protein and 10 representing high protein content, record what you see for each feed sample under "observations".

Observations

Table 1. Amount of nutrients observed in feed samples.

Feed						
Water						
Sugar						
Starch						
Fat						
Protein						

Conclusions

1. Compare your results with those of other students. Explain any differences?

2. Why do you think milk has long been considered the "almost perfect food"?

3. If you extended this experiment, how could you use the data to help plan a balanced diet? What would you change about the experiment?

4. If a diet is lacking in nutrients, how are major body systems in the animal or human affected? Give 2 examples and explain.

5. How can high energy feeds affect the growth and success of fair project animals (livestock)?

6. Describe how the major body systems remove waste and provide nutrients to the body?

[i] Agricultural Biology Curriculum Lesson Plans. Sacramento: California State Department of Education, Agriculture Education Unit, 1990.

Agriculture Standards

- (AG) C 8.1, C 8.3, C 13.3, D 2.2, and D 6.5.
- (Foundation) 1.2 Science, Specific Applications of Investigation and Experimentation: (1.a), (1.c), and (1.d).
- (Foundation) 1.1 Mathematics, Specific Applications of Algebra I: (15.0).

Name_____

Date_____

The Great Feed Trial Lab

Purpose

The purpose of this exercise is to give students hands on experience handling livestock and how to conduct a multi week lab. Students will have the opportunity to take data and graph the data.[i]

Procedure

Materials

1. 10 chicks (Cornish game hens grow fast and are inexpensive)
2. 2 cages with bottoms
3. 2 water dispensers (with large capacity)
4. 2 feed troughs or dishes
5. Scale
6. Small box for scale
7. 50 lbs of game bird grower feed 22-23% protein (High Protein)
8. 50 lbs of chick grower 18% protein (Low Protein)
9. *Terramycin* soluble powder for disease prevention

Sequence of Steps

1) Mix *Terramycin* in water and prepare the cages.
2) Randomly select five chicks to place in each cage.
3) Pre-weigh the chicks and record initial weight on Data Table 1.
4) Determine the average weight of the 5 chicks in each cage and record.
5) Label the cages “high protein” and “low protein”
6) Pre weigh the feed troughs and then determine the weight of the feed when at a full level. Record on Data Table 2.
7) Record data every week including average chicken weight and weight of feed.

Observations

Data Table 1

Week	High Protein Feed AVERAGE CHICK WEIGHT	Low Protein Feed AVERAGE CHICK WEIGHT
Initial		
1		
2		
3		
4		
5		

Data Table 2

Week	High Protein Feed Feed Weight	Low Protein Feed Feed Weight
Initial		
1		
2		
3		
4		
5		

Conclusions

1. Using complete sentences, describe the data you collected.

2. What conclusions (if any) can be drawn from this experiment?

3. Why is protein an important component of animal feed rations?

4. What medication did you administer to the animals and why?

5. What are some possible errors that could have occurred in this experiment?

6. What specific things could improve this experiment if repeated in the future?

7. Why is this information significant to the agriculture industry?

Teacher Notes:

1) More chicks typically cause problems.
2) Spring is the best time for this lab since chicks require care on Saturdays and I can care for them when I return from a field day.
3) The medication (*Terramycin*) is important because we want to prevent illness.
4) You can compare breeds as well.
5) I don't know why but kids have an attraction to chickens!

[i] Combes, Brian(2008). The Great Feed Trial Lab. *Hanford High School*

Biology/Life Sciences Standards	• (BLS) 9.a and 9.b.
Agriculture Standards	• (AG) C 6.2, C 13.3, and D 3.1. • (Foundation) 1.2 Science, Specific Applications of Investigation and Experimentation: (1.a) and (1.d).

Name_____

Date_____

Heart Dissection

Purpose

The purpose of this exercise is to identify the components of the heart and the flow of blood.[i]

Procedure

Materials

1. Porcine heart(s)
2. Dissection pans and pins
3. Arrows to label direction

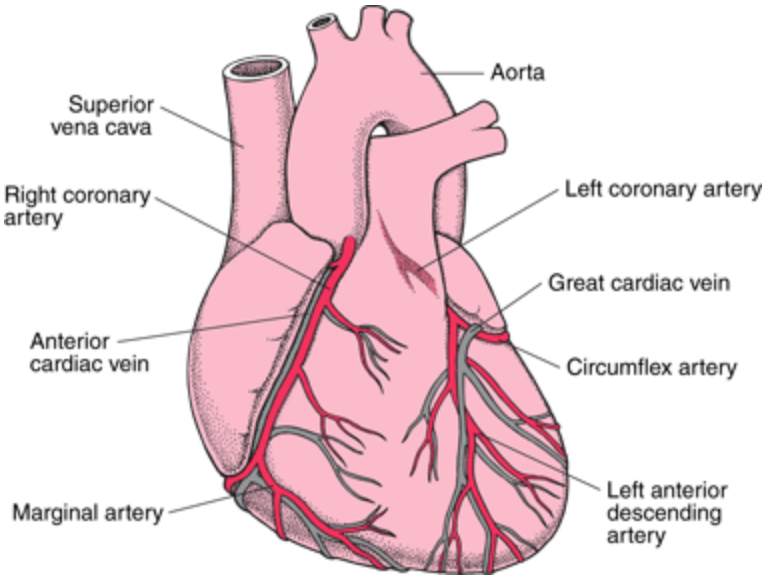
Sequence of Steps

1. Read background information and answer Pre-Lab Questions.
2. Working in a group, gather lab materials including 1 heart.
3. Carefully go through the following steps to dissect your pig heart. [ii]
    a. Make the first incision along the right ventricle, allowing you to see inside the right side of the heart. (You can tell which side is the right ventricle by squeezing the heart. The right side is much softer than the left.) **Label the right ventricle, tricuspid valve, and the right ventricular outflow tract including the pulmonary valve.**
    b. Before you move to the left side of the heart, find the coronary arteries. The coronary arteries are attached to the aorta. Blood that is pumped out of the aorta returns to the heart muscle through the coronary arteries. **Label the coronary arteries.**
    c. Look down at the top of your heart sample. Make a small incision in the Superior vena cava and view this opening. Identify the Pulmonary Artery, which curls around the aorta. It has a thin wall and is less stiff than the aorta. **Label the Superior vena cava and the Pulmonary Artery.**
    d. Make an incision in the left atrium, which stores blood temporarily as it comes back to the heart from the lungs. Carefully look for the left ventricular outflow. Blood moves from the left side of the heart by moving between one of the mitral leaflets and the septum (the part that separates the two sides of the heart.) **Label the left atrium and left ventricular outflow.**
    e. Find the aortic valve, and view from the outflow side. **Label the aortic valve.**
    f. Carefully make 1 incision horizontally, cutting your heart sample in half to view the inner tissues. Use caution! Do not disturb the parts of the heart you have already labeled!
4. Show your labeled heart to the instructor and answer the Observation Questions.
5. Clean your lab area.

Background Information[iii]

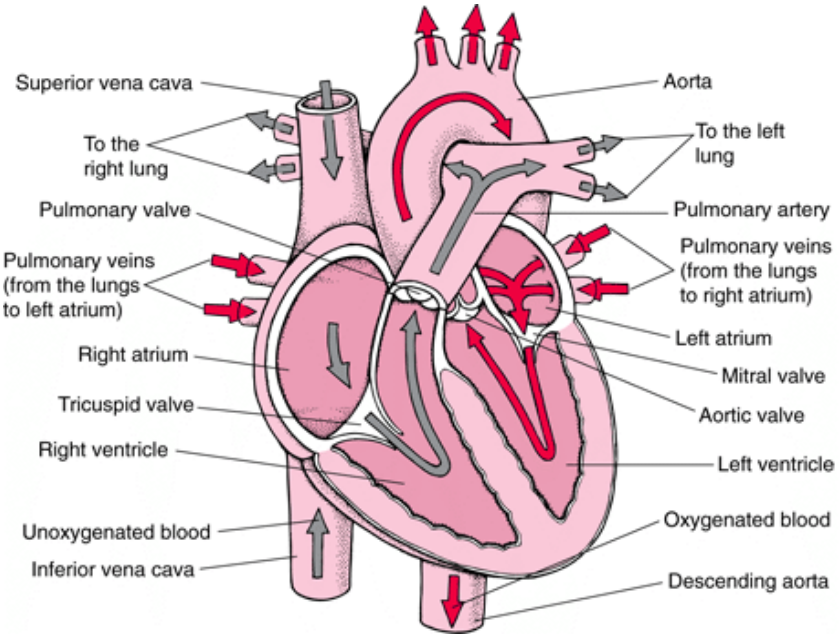
Blood Supply of the Heart

Like all organs, the heart needs a constant supply of oxygen-rich blood. A system of arteries and veins called the coronary circulation supplies the heart muscle (myocardium) with oxygen-rich blood and then returns oxygen-depleted blood to the right atrium. The right coronary artery and the left coronary artery branch off the aorta (just after it leaves the heart) to deliver oxygen-rich blood to the heart muscle. These two arteries branch into other arteries, including the circumflex artery, that also supply blood to the heart. The cardiac veins collect blood from the heart muscle and empty it into a large vein on the back surface of the heart called the coronary sinus, which returns the blood to the right atrium. Because of the great pressure exerted in the heart as it contracts, most blood flows through the coronary circulation only while the heart is relaxing between beats (during diastole).



Supplying the Heart with Blood

Like any other tissue in the body, the muscle of the heart must receive oxygen-rich blood and have waste products removed by the blood. The right coronary artery and the left coronary artery, which branch off the aorta just after it leaves the heart, deliver oxygen-rich blood to the heart muscle. The right coronary artery branches into the marginal artery and the posterior interventricular artery, located on the back surface of the heart. The left coronary artery branches into the circumflex and the left anterior descending artery. The cardiac veins collect blood containing waste products from the heart muscle and empty it into a large vein on the back surface of the heart called the coronary sinus, which returns the blood to the right atrium.



(This cross-sectional view of the heart shows the direction of normal blood flow.)

Pre-Lab Questions

1. Why are pig hearts used to study the anatomy of the human heart?

2. How can you tell which side of the heart is the ventral surface?

3. How many chambers are found in the mammalian heart? What other group of organisms would have this same number of chambers?

4. What is the advantage in having this number of chambers compared to organisms with fewer number of chambers?

5. What is the purpose of heart valves?

6. Name & compare the heart valves found between the upper & lower chambers of the right and left sides of the heart.

7. Vessels that carry blood away from the heart are called _____, while _____ carry blood toward the heart.

8. Which artery is the largest and why?

9. What is the purpose of the coronary artery and what results if there is blockage in this artery?

10. Use the diagram of the heart above to trace blood flow through the heart.

Observations

1. What is the heart?

2. What is the main function of the heart?

3. How does the nervous system affect the rate of the heart?

4. Where does oxygenation occur?

5. What is the medical term for heart?

6. What do the red blood cells carry?

7. What part of the heart does the blood flow to first?

8. Does blood flow in or out of the pulmonary artery?

9. Where does blood from the aorta flow?

10. Can you live without a heart?

11. What is it called when you have to have an organ to live?

Teacher's Notes:

There are great resources on the internet to review prior to doing this lab. Take time to review the porcine heart dissection at http://heartlab.robarts.ca/dissect/dissection.html . This has great pictures as you walk though the dissection step by step. If you have computer access for your students, have them review this site prior to the dissection as well.

[i] Noga, Theresa (2008). Heart Dissection. *Arcata High School*

[ii] Boughner, M.D., PhD, D. (1997, July, 25). University of Western Ontario, The Heart Valve Lab. Retrieved July 31, 2009, from What does a real heart look like? Web site: http://heartlab.robarts.ca/dissect/dissection.html

[iii] Tanser, MD, P (2006). Heart. Retrieved May 14, 2009, from Merck Web site: http://www.merck.com/mmhe/sec03/ch020/ch020b.html

Biology/Life Sciences Standards	• (BLS) 10.a.
Agriculture Standards	• (AG) C 9.1, C 9.2, C 9.4, C 13.3, D 6.1, D 6.3, and D 6.4. • (Foundation) 1.2 Science, Specific Applications of Investigation and Experimentation: (1.a) and (1.d).

Name_____

Date_____

External Parasites

Purpose

There are two types of mites that live on animals. Demodectic mites (Deomodex spp.) are normal skin inhabitants of animals when in small numbers. However, demodectic mites can cause demodectic mange (demodicosis) when in large numbers. The second type, and the most damaging, are the sarcoptic mites (Sarcoptes spp. And Notoedres spp.). These mites burrow into the layers of skin causing a skin disease called scabies or scaroptic mange.

In all animals, demodectic mange or scabies causes intense itching in which the animal will scratch, chew and rub constantly. Unlike demodectic mites, sarcoptic mites are highly contagious even to humans. The purpose of this lab is to evaluate an animal with potential infection, and use the microscope to investigate. [i]

Procedure:

Materials

1. Scalpel
2. Light lubricating oil
3. Microscope slides and cover slips
4. Canvas sheet
5. Cotton swab
6. Black paper
7. Dissecting needle
8. Animal with infection

Sequence of Steps

1. Place a drop of oil on a microscope slide.
2. With a clean scalpel, dip the scalpel blade into the drop of oil on the slide.
3. At the edge of the suspected area of infection, pick up a fold of the animal's skin, pinching it between the index finger and thumb.
4. Scrape the top of the fold several times in the same direction using the oil scalpel blade.
5. The scraping will stick to the blade.
6. Stop scraping when a small amount of blood is detected.
7. Place the tip of the scalpel blade containing the sample into the oil on the slide and with a circular motion transferring the sample to the slide.
8. Apply the cover slip gently without pressing down too hard.
9. Additional oil can be added to the edge of the cover slip so the entire area under the cover slip is filled.
10. Examine the entire area under the cover slip.
11. Low magnification of 100 power should be sufficient to detect the mites.

12. The procedure to detect ear mites in dogs, cats, foxes and rabbits requires the animal to be restrained in a canvas sheet.
13. A cotton swab is placed into the external auditory canal and gently rotated to obtain the mite sample.
14. The swab is placed on a small piece of black paper which can be examined with a hand lens to see the mites.
15. Individual ear mites are transferred from the cotton swab on the tip of a dissecting needle to a drop of oil on a microscope slide.
16. Place a cover slip on top of the oil.

Observations

1. Describe your observations, using complete sentences to describe what you found.

2. Based on your observations, what recommendations would you make for the care of this animal?

3. Describe the role of the skin in providing defenses against infection.

4. How do housing, sanitation, and nutrition influence animal health and behavior?

[i] Dickson, Christine (2008).External Parasites. *The Inside Story: How Agriculture Uses the Microscope*.

Biology/Life Sciences Standards	•(BLS) 10.d and 10.e.
Agriculture Standards	•(AG) C 9.3, C 13.3, and D 6.3. •(Foundation) 1.2 Science, Specific Applications of Investigation and Experimentation: (1.a), (1.c), (1.d), and (1.f).

Name_____

Date_____

Pathogens: Officer Retreat Investigation!

Purpose

The purpose of this exercise is to investigate the cause of a hypothetical outbreak of illnesses.[i]

Scenario

Imagine that the four members of your group are the FFA officers of your Chapter. You organized a weekend retreat to Lake Superior for your 40 Greenhand members. The buses arrived at the cabins in time for dinner on Friday night. On Saturday night, eight of the members became ill. They all had high fevers, chills, severe abdominal pains, vomiting and diarrhea. Within the next 24 hours, four other students had these symptoms. Only the members who went on the retreat became ill. ***Your objective, as the leaders of the trip, is to investigate the cause of this outbreak of illnesses.***

Procedure

Materials

1. Pen/Pencil
2. Handout from your instructor

Sequence of Steps

1. Your class will be organized into groups of four. Each of you will be expected to volunteer as an FFA officer. You will be read a scenario about a Greenhand retreat wherein many of the members fell ill. It is your task as the FFA officers to investigate the cause of the illness. Each of you will be responsible for directing some segment of the investigation. Please follow the format and do not rush through this lab. The president will begin the narrative.

2. Identify the members of your group and determine the office for each team member.
   a. President _____
   b. Vice President _____
   c. Secretary _____
   d. Treasurer _____

Conclusions

1. What are three possible causes of the Greenhand retreat weekend illness?

a. _____

b. _____

c. _____

2. List illnesses that could be ruled out.

a. _____

b. _____

c. _____

d. _____

e. _____

3. What possible causes of illnesses can you probably eliminate?

a. _____

b. _____

4. Why do you think the incubation time for chemicals or poisons is shorter than for bacteria or viruses?

_____

_____

5. For each of the possible causes, what are some ways that the illness could have spread?

a. _____

b. _____

c. _____

d. _____

6. What possible modes of transmission can we eliminate?

a. _____

b. _____

7. Does the pattern in Table III suggest personal contact as the means of disease transmission?

a. The pattern _____ suggest personal contact.

8. Does the pattern in Table IV suggest personal contact as the means of disease transmission? Why or why not?

_____

_____

9. Which method of transmission seems to be the most likely at this point? (look at Table II)

_____

_____

10. What food might have made us ill?

a. _____

b. _____

c. _____

11. Now what food(s) do you suspect?

a. _____

12. Why is the coconut cream pie more suspicious than the roast beef dinner?

_____

_____

13. Is there anything in the dessert data, which contradicts, or makes you uncertain about your conclusion? What?

_____

_____

14. How does this information about Jack and Jill help you interpret the dessert data?

_____

_____

15. Jill ordered pie, but didn't get sick. How could you explain this?

_____

_____

SECRETARY

16. Most high schools have light microscopes. Which are larger a bacterium (singular for bacteria) or virus? Would it be possible to observe a virus using a compound light microscope?

_____

_____

_____

_____

17. Approximately how much bigger is a bacterium than a virus?

a. _____

18. How can we tell if viruses are present or the cause of the illness?

a. Step 1 – _____

_____

b. Step 2 - _____

_____

_____

_____

_____

c. Step 3 – _____

_____

_____

d. Step 4 – _____

_____

_____

19. If the pie contained virus particles, would they be in test tube A or B?

a. _____

20. From Figure II, which mice remained healthy and which became ill?

a. _____

_____

21. How could she find out if something in the pie, other than bacteria or viruses, caused the illness? What is this process called?

a. _____

_____

b. _____

22. What is an experimental control supposed to do?

a. _____

_____

23. In Figure II, what should be drawn in the box labeled 'control' to complete the diagram?

a. _____

24. What can you conclude from this experiment? What are organisms called that cause disease?

a. _____

b. _____

25. Would you expect to find bacteria in food you eat every day? Do all bacteria cause disease? What are bacteria called that do not cause disease?

a. _____

b. _____

c. _____

26. What are some possible ways to distinguish one kind of bacteria from another?

a. _____

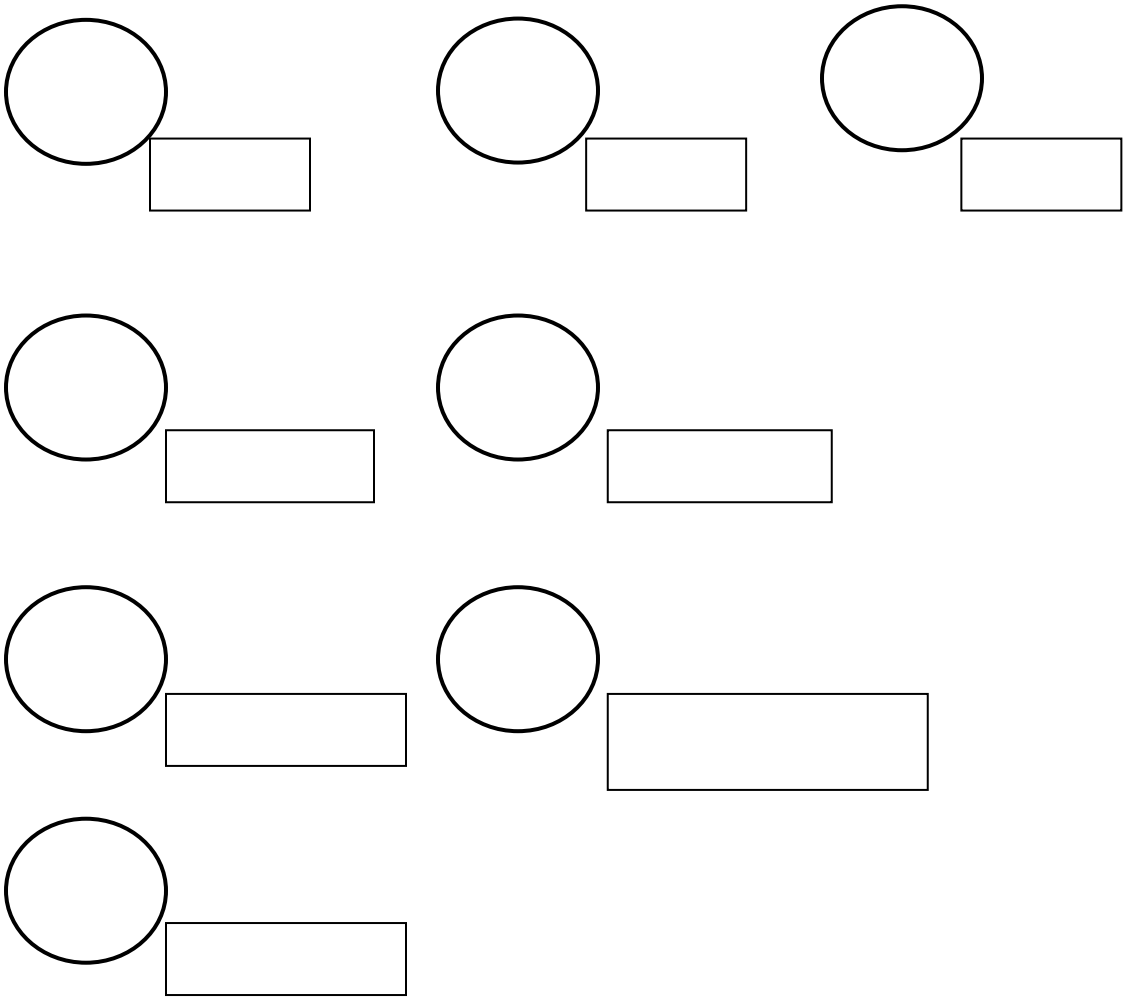
b. _____

c. _____

d. _____

27. How many basic shapes do bacteria have? Draw each shape and label, and then draw each group and label with its prefix.

a. _____



28. Can you tell by the shape or arrangement whether or not all of these bacteria cause disease?

a. _____

TREASURER

29. In steps 1 and 2, why would it be necessary to get a 'pure' culture?

a. _____

_____

_____

30. In steps 3 and 4, the mice given the streptobacillus got sick. The mice given the cocci did not get sick. Can you conclude from this that the streptobacillus made them sick?

a. _____

31. How can you challenge the hypothesis that something else killed them?

a. _____

_____

_____

_____

32. Think about our symptoms we heard about or experience on the Greenhand retreat, the laboratory data, and the health bulletin. What type of bacteria do you think caused our weekend illness?

a. _____

DAY 2 PRESIDENT

1. What should we do first?

a. _____

_____

2. If we used a light microscope, what should make us think we have just one type of bacteria in a blood sample? (It may help to look at Figure III).

a. _____

_____

3. In Figure III, which pictures might represent the blood bacterium?

a. _____

4. By observing with a microscope, how would we know there are many types of bacteria in the feces?

a. _____

_____

5. There are *Diplococci* in the sample of feces. What do *Diplococci* look like?

a. _____

6. We also see *Diplobacilli*. What do they look like?

a. _____

7. There are also *Bacilli*. Can we tell by their size and shape if they are pathogenic?

a. _____

8. Which bacterium from the sick hen is most likely to be the cause of the disease?

a. _____

9. How would we test whether or not the bacterium from the blood is the cause? (Hint-look at Figure IV).

a. _____

_____

DAY 2 VICE PRESIDENT

10. How could we kill a pure sample of the bacteria we found in the chicken blood?

a. _____

11. List two ways to explain the results.

a. _____

_____

_____

b. _____

_____

_____

12. This is why we need a control in the experiment. The control should allow us to rule out the chance that the original bacteria changed. Can you think of a control?

a. _____

_____

13. What can we conclude?

a. _____

_____

14. What was the control in Experiment 2?

a. _____

_____

15. How did it help us with our conclusion?

a. _____

_____

_____

DAY 2 SECRETARY

16. How can cooks at home and in restaurants make food safer to eat? Some ways include:

a. _____

_____

b. _____

_____

c. _____

_____

d. _____

_____

e. _____

_____

f. _____

_____

17. At what temperature do most bacteria multiply fastest? At the temperature of:

a. _____

18. Do boiling temperatures kill all forms of bacteria so they won't grow again? What might be an exception?

a. _____

_____

b. _____

19. Salmonella is killed at high temperatures. And the coconut pie was cooked. How did the Salmonella survive?

a. _____

_____

_____

STUDENT NARRATIVE HANDOUT

Pathogens: Officer Retreat Investigation!

FFA PRESIDENT

- You will begin the lab. Ask your fellow officers the questions below. Questions are written in **bold**; the answers are in *italics*. The underlined parts of the answer of this narrative are the key words or phrases that you and your team will write on your answer sheet.
- After reading the question, discuss the 'guesses' made by each officer. Call on everyone to offer an answer before you read the correct answer.

Read to your group the following question:

1. **What are three possible causes of the Greenhand retreat weekend illness?**
   Read the answer (you also need to write the answer).
   chemical poisoning
   infection with bacteria
   viruses

2. **List illnesses that could be ruled out.**
   Read aloud: *An allergy is an individual reaction to a specific substance. It would not be an 'epidemic' type of reaction in most groups. Car sickness, lack of sleep, homesickness, and over-eating can also cause illness. But they are not likely to affect so many people at one time.*

- Have your officers analyze and discuss Table 1.

3. **What possible causes of illnesses can you probably eliminate?**
   After some discussion read the answer: *You can probably eliminate chemical poisoning because students were not ill until Saturday night. Also, high fevers rarely occur with chemical poisoning. Protozoa can also be ruled out. Symptoms would not occur by Saturday. The time factors and symptoms make bacteria and viruses possible causes.*

- You and your officer team will want to discuss this next question at length before reading the answer.

4. **Why do you think the incubation time for chemicals or poisons is shorter than for bacteria or viruses?**
   It takes a lot of viruses or bacteria to make you sick. Usually only a few viruses or bacteria are taken into the body but they multiply rapidly. A hundred bacteria can become a million in eight hours! The incubation period is the time when the bacteria or viruses are multiplying inside your body until there are enough to make you sick. Bacteria and viruses multiply. Chemicals don't multiply. If you take in enough, they affect the body as soon as they are absorbed in the digestive system. This is why chemicals cause illness faster than bacteria or viruses.

5. **For each of the possible causes, what are some ways that the illness could have spread?**
   'Germs' in the water you drink, the air you breathe, and the food you eat can spread sickness. Personal contact, such as talking with someone at close range; holding hands; kissing; and sharing personal items, can spread germs. Insect bites also can spread germs.

- Have your officers examine table II. Discuss question 6 before answering the question.

6. **What possible modes of transmission can we eliminate?**
   The disease is probably not airborne. Victims did not show any nose or lung symptoms. No mention was made of skin breaks or evidence of insect bites.

- Have your officers examine table III. Discuss question 7 before answering the question.

7. **Does the pattern in Table III suggest personal contact as the means of disease transmission?**
   The pattern does not suggest personal contact. We would have expected many of the roommates to have the disease and not just one or two to of the students in each room.

- Have your officers examine table IV. Discuss question 8 before you answer the question.

8. **Does the pattern in Table IV suggest personal contact as the means of disease transmission? Why or why not?**
   No. In three pairs, only one person was sick.

9. **Which method of transmission seems to be the most likely at this point? (look at table II)**
   Our hypothesis at this time is that viruses or bacteria caused the illness, and these germs were 'caught' when the students ate or drank something.

- Thank you Mr./Mdm. President – You may now turn the meeting over to the Vice President.

FFA VICE PRESIDENT

- You are the FFA Chapter Vice President. You will continue the investigation where the President left off. You will ask questions of the other officers and discuss answers before actually reading the answer.
- Ask your fellow officers the questions below. Questions are written in **bold**; the answers are in *italics*. The underlined parts of the answer of this narrative are the key words or phrases that you and your team will write on your answer sheet.
- After reading the question, discuss the 'guesses' made by each officer. Call on everyone to offer an answer before you read the correct answer.
- Have your officers study Table V. (READ aloud) "Table V is a copy of the dinner menu that the members of our group ate on Friday night. The Treasurer and I were the only ones who became ill. Maybe we can get a clue as to the cause by looking at what we ate".

10. **What food might have made us ill?**
    The fried fish, French fries, and cream pie are suspicious. Both people ate them. The healthy people did not.

- Look at table VI. Table VI has additional information.

11. **Now what food(s) do you suspect?**
    The cream pie looks very suspicious. Almost everyone who ate it became ill.

12. **Why is the coconut cream pie more suspicious than the roast beef dinner?**
    Most of the people who ate the coconut pie got sick. Only a small group of those who ate the roast beef became sick.

13. **Is there anything in the dessert data, which contradicts, or makes you uncertain about your conclusion? What?**
    Yes, one person who ate the cake became sick, and one person who ate the pie did not get sick.

- I got to thinking about this and asked around. We all know that Jack and Jill have been seeing each other for six months. Well, they both had the fish dinner. But Jack ordered chocolate cake and Jill had the coconut cream pie. Then they decided to share. So each had half of each kind of dessert. I couldn't find anyone else who tasted both desserts.

14. **How does this information about Jack and Jill help you interpret the dessert data?**
    This can explain how the one person who ordered the cake became ill. That person was Jack.

15. **Jill ordered pie, but didn't get sick. How could you explain this?**
    Not everyone who is exposed will become ill. People have different levels of resistance to various diseases. Jill could be immune. With disease like mumps, chicken pox, and rubella, you get the disease once and never again. With intestinal viruses and food poisoning bacteria, immunity may last from a month to a year or so. Maybe Jill had the germ before, or maybe she had a cast-iron stomach.

- It is logical to think that a type of bacteria or virus in the coconut cream pie caused the epidemic. Our next detective work is to decide if we had a bacterial or viral infection. I will now pass the chairmanship to the Secretary.

SECRETARY

- You are the class Secretary. You will continue the investigation where the Vice President left off.
- Ask your fellow officers the questions below. Questions are written in **bold**; the answers are in *italics*. The <u>underlined</u> parts of the answer of this narrative are the key words or phrases that you and your team will write on your answer sheet.
- After reading the question, discuss the 'guesses' made by each officer. Call on everyone to offer an answer before you read the correct answer.
- Read to your group the following question:
- "We don't know if bacteria or viruses caused the sickness. So I got some outside help for us. My sister works in a biology laboratory at the university. She examined several samples of the leftover pie under a compound light microscope. She didn't see anything like amoebas, but she did see different types of bacteria".
- Have your officers look at Figure 1.

16. **Most high schools have light microscopes. Which are larger a bacterium (singular for bacteria) or virus? Would it be possible to observe a virus using a compound light microscope?**
No. A light microscope can't even show much detail in bacteria. <u>A virus is much smaller than a bacterium. Viruses can only be seen with an electron microscope.</u>

17. **Approximately how much bigger is a bacterium than a virus?**
There are many sizes of bacteria and viruses. On the average, <u>a bacterium is about 10 times the length of a virus</u>. You can compare the virus and bacterium magnified 7,500 times.

- My sister could observe bacteria from the pie, but she doesn't have access to an electron microscope. She couldn't see viruses even if they were present. What a problem.

18. **How can we tell if viruses are present or the cause of the illness?**
- Have the officers study Figure II.
- Figure II shows the idea of what my sister did. Follow the diagrams as I explain.
    a. *<u>Step 1 – she made an extract from some of the coconut cream pie</u>*
    b. *<u>Step 2 - she poured the extract into a very fine filter, like a coffee filter. Viruses can go through the tiny pores. Bacteria are too big, and they stay on the filter just as coffee grounds do.</u>*
    c. *<u>Step 3 – she poured the material trapped by the filter into test tube A. The substances that drained through the filter paper went into test tube B</u>. (Add step 4 below to your answer sheet)*
    d. *<u>Step 4 – My sister fed material from test tube A to one group of mice. Another group of mice were fed the liquid from test tube B.</u>*

19. **If the pie contained virus particles, would they be in test tube A or B?**
If there were viruses, they would be in <u>test tube B</u>. Small virus particles would pass through the holes in the filter. Bacteria would not.

20. **From Figure II, which mice remained healthy and which became ill?**
<u>Mice fed from test tube A became sick. Mice fed from test tube B remained healthy</u>.

- My sister thought she was close to an answer. But she could not be sure that bacteria were the cause. Maybe something else in the pie, like the coconut, could make mice sick. Pie might make

mice sick even if it didn't contain germs.

21. **How could she find out if something in the pie, other than bacteria or viruses, caused the illness? What is this process called?**
She could feed another group of mice an extract from a fresh coconut cream pie. It would be made from the same recipe as the suspicious pie. This is called a CONTROL in the experiment.

22. **What is an experimental control supposed to do?**
An experimental control is a part of an experiment designed to invalidate one of several possible explanations. From steps 3 and 4 in the experiment, you concluded that something from cream pie extract that couldn't go through the filter caused the illness. This could have been the bacterium, or it could have been something else. The control allows us to rule out the 'something else' from the item in question, like the cream pie.

23. **In Figure II, what should be drawn in the box labeled 'control' to complete the diagram?**
A piece of fresh coconut cream pie.

24. **What can you conclude from this experiment? What are organisms called that cause disease?**
Apparently, bacteria from the pie made the mice ill. We call bacteria and other organisms that cause disease PATHOGENIC. Either there were no pathogenic viruses, or the mice were resistant. The evidence suggests that bacteria in the pie caused the epidemic.

25. **Would you expect to find bacteria in food you eat everyday? Do all bacteria cause disease? What are bacteria called that do not cause disease?**
Yes, very small numbers of bacteria. Bacteria are practically everywhere. Most bacteria do not cause disease and are called non-pathogenic. Large numbers of some kinds of bacteria cause food poisoning. Bacteria can multiply rapidly in cream pie, especially if it's not kept cold. Bacteria multiply faster when they are warmed to room or body temperature. This is why refrigeration is so important.

- So far we know that bacteria probably made the students sick. We don't know what kind of bacteria. Other people in my sister's lab got into the act. They found three different kinds of bacteria in the pie.

26. **What are some possible ways to distinguish one kind of bacteria from another?**
Bacteria differ in shape, grouping of cells, and size. Another way would be to stain them with certain dyes.

27. **How many basic shapes do bacteria have? Draw each shape and label, and then draw each group and label with its prefix.**

- The pie contains one kind of bacteria that has round cells in chains. These are *Stretococcus* because they are arranged in chains. There are two other shapes of bacteria. One is rod-shaped. The rod-shaped bacteria are *Bacilli* (the plural for *Bacillus).* The third is spiral in shape and called *Spirillum*. So, there are three basic shapes of bacteria, some are arranged in pairs, others in clusters, or chains.

28. **Can you tell by the shape or arrangement whether or not all of these bacteria cause disease?**
No. We can look up the names of bacteria when we know their shape, size, arrangement, how they grow, and how they stain. But we can't tell just by size and shape if they are pathogenic.

- I will now turn the meeting over to the Treasurer.

TREASURER

- I really got into this because I wanted to know how much the laboratory work was going to cost us. The money from the last car wash is almost gone. At the lab, I learned about a man named Koch (pronounced 'coke').
- Looking at Figure IV we see that many different types of bacteria can be found in the body of a sick animal or person. Dr. Robert Koch, a German physician, devised a scientific way to find out if particular bacteria caused a specific disease. This happened in the late 1800s. The steps are named after Koch.
- Each one of us will read aloud one of each of the steps. I will begin with number 1.
- In the laboratory, it is possible to separate the different types of bacteria. You can grow each type separately. This provides billions of identical bacteria in one test tube. This test tube then contains what is called a pure culture.

29. **In steps 1 and 2, why would it be necessary to get a 'pure' culture?**
    A mixture of bacteria would show that bacteria caused the disease, but you wouldn't know which type of bacteria was pathogenic. Most bacteria are not harmful. In fact, some types of bacteria live in our intestines and help us digest food. Other bacteria help keep the environment clean by decomposing dead plants and animals.

30. **In steps 3 and 4, the mice given the streptobacillus got sick. The mice given the cocci did not get sick. Can you conclude from this that the streptobacillus made them sick?**
    No. It's possible something else made the mice sick. For example, some other bacteria could have gotten into their food or water.

31. **How can you challenge the hypothesis that something else killed them?**
    In the fourth step you can take the bacteria from the sick animal. Then you show it is the same as the bacteria you took from the pure culture in step 2.

- We have just looked at an example of Koch's postulates. Let's see how we can use them to solve the Greenhand retreat illness outbreak. Look again at Figure III. Three types of bacteria were found in test tube A from the pie. The bacteria were: *Escherichia coli* – a rod (pronounced esh-er-I-she-ah co-lie); *Salmonella* – a rod – (pronounced sal-mow-nell-ah); *Streptococcus faecalis* – a chain of spheres – (pronounced strep-toe-kok-us fee-kal-is). Each bacterium was grown in pure culture and given to healthy mice. Only the mice given the *Salmonella* became ill. *Salmonella* could be re-isolated from the sick mice.
- Let's read the Health bulletin – Figure V.

32. **Think about our symptoms we heard about or experience on the Greenhand retreat, the laboratory data, and the health bulletin. What type of bacteria do you think caused our weekend illness?**
    Salmonella. Diarrhea was a symptom, and eggs and milk products were in the pie. Salmonella made the mice ill.

- I believe we have determined the cause of the weekend retreat illness. And I am happy to report that the lab didn't charge us. They enjoyed working on the mystery and said that both, the FFA and the lab are not-for-profit organizations. Mr./Mdm. President you will begin the second investigation.

DAY 2 PRESIDENT

- The last time we met we solved the question of the Greenhand retreat illness in a very scientific way. Today we will take the ideas a little further. I will begin our discussion. You may not believe it, but I have been thinking a lot about Koch's postulates. I work on my Uncle's poultry ranch as my work experience SAE. He is having a problem with his birds. The chickens in one of his hen houses are dying. They have a disease that produces diarrhea. I think we could use Koch's postulates to find out what is causing the disease. We will first use Figure IV to organize our steps in identifying the cause of the poultry disease.

1. **What should we do first?**
   We need samples of feces and blood from sick and health birds.

- We start with the blood. We don't touch it directly with our hands. We look at it under the microscope. We think we have only one type of bacteria in the sick hen's blood. We don't see any bacteria in the healthy hen's blood.

2. **If we used a light microscope, what should make us thinK we have just one type of bacteria in a blood sample? (it may help to look at Figure III).**
   All the bacteria in the blood would be the same size, shape, and arrangement.
3. **In Figure III, which pictures might represent the blood bacterium?**
   Any of the pictures in Figure III might represent the blood bacterium. Each picture represents a single type of bacteria.

- We think we have many different types of bacteria from the feces of both the healthy and sick hens.

4. **By observing with a microscope, how would we know there are many types of bacteria in the feces?** *We would see bacteria in a variety of sizes, shapes, and arrangements.*

5. **There are *Diplococci* in the sample of feces. What do *Diplococci* look like?**
   Diplo means a group of two; cocci tells the cells, so these are round cells grouped in pairs.
6. **We also see *Diplobacilli*. What do they look like?** *They are pairs of rods.*

7. **There are also *Bacilli*. Can we tell by their size and shape if they are pathogenic?** *No*

8. **Which bacterium from the sick hen is most likely to be the cause of the disease?**
   The bacterium from the sick hen's blood, because it is different from the bacteria in a normal hen's blood.

9. **How would we test whether or not the bacterium from the blood is the cause?** (hint-look at Figure IV).
   Steps 1 and 2, take the bacteria from the blood and grow a pure culture in a test tube. Step 3, feeds this culture to healthy hens and to see if the hens get sick with diarrhea. Step 4, takes blood from these 'sick' hens and sees if blood contains bacteria of the same size, shape, and arrangement as those in the blood of the original sick animal. We then do some chemical tests as well to be sure the bacteria are the same. In essence, we would follow Koch's postulates.

- We follow these steps and discover the culprit. It is the bacteria we found in the sick hen's blood.
- Now let's hear from the Vice President.

DAY 2 VICE PRESIDENT

- What a small world it is! My SAE is to work for an avian veterinarian after school. Dr. Moe is the same veterinarian who is trying to cure the sick hens on the ranch for which you work. I have cleaned the hen houses and the equipment over and over. But the hens are still sick. A famous French scientist, Louis Pasteur (pronounced pas-tour), found that he could prevent infection by giving an injection. He made a pure culture of pathogenic bacteria. Then he killed the culture. Next he injected the dead bacteria into healthy animals. The animals that got the shot were protected from the diseases.
- Maybe we could kill the bacteria from the hen's blood and inject them into our chickens?

10. **How could we kill a pure sample of the bacteria we found in the chicken blood?**
    Boiling kills many bacteria.

- In our Ag Biology class we boiled a pure culture of the hen pathogen. The veterinarian supervised us as we did three experiments to see if the killed bacteria worked like a vaccine. A 'vaccine' is what is injected. It protects an animal or person from a specific disease. For example, most of us have had vaccinations against polio.
- A scientist does a lot of the work before and after he or she actually does an experiment. We did a lot of planning. Then we did the experiment and collected data. Now we have to try to interpret our results.
- I am going to read step 1 on Figure VI, the Secretary will read step 2, the Treasurer will take step 3, and the President will read step 4. Then we will take a look at diagrams of Experiment 1.

11. **List two ways to explain the results.**
    A first thought is that the chickens stayed healthy because we made a good vaccine. But they also could be healthy because the pathogenic bacteria changed in some way. For example, maybe the bacteria died. The experiment isn't designed well enough to let us rule out either explanation.

12. **This is why we need a control in the experiment. The control should allow us to rule out the chance that the original bacteria changed. Can you think of a control?**
    Feed the un-boiled bacteria to normal, unvaccinated hens, and see if they get sick.

- We did experiment 2. This included feeding unboiled bacteria to unvaccinated chickens. This part of the experiment is a control.

13. **What can we conclude?**
    Our vaccine made from boiled bacteria protected the hens from the disease.
14. **What was the control in Experiment 2?**
    Feeding live bacteria to unvaccinated chickens was the control part of the experiment.
15. **How did it help us with our conclusion?**
    The unvaccinated chickens got sick. That means the bacteria were pathogenic. The only difference between the two groups of chickens was the injection of the vaccine. The vaccine must have protected the chickens from the pathogenic bacteria.

- Our use of scientific knowledge and methods has saved the chicken farm. We can also use this scientific method of investigation to make our own lives better. Mr./Mdm. Secretary please take over the rest of this meeting.

SECRETARY

- I was sick on our Greenhand retreat trip. I don't want to be that sick ever again. I've been looking at ways to avoid food poisoning.

16. How can cooks at home and in restaurants make food safer to eat?

Some ways include:

- *Discard food which smells bad or appears discolored;*
- *don't use damaged or swollen canned goods;*
- *wash your hands before preparing food;*
- *use only clean utensils for preparing food;*
- *cook food at recommended temperatures;*
- *keep food refrigerated or frozen;*
- *don't' leave stuffing in a lift-over turkey.*

- We know that bacteria can multiply very quickly. They multiply by dividing in two. How many new bacteria form depends on temperature and food supply. Safe food handling keeps the growth rate of bacteria low.

17. At what temperature do most bacteria multiply fastest? At the temperature of:

A) a refrigerator, 4^{o}C;

B) a room, 22^{o}C;

C) A live human body, 37^{o}C;

D) Boiling water, 100^{o}C.

- At human body temperature bacteria divide rapidly. In a refrigerator they divide slowly.

18. Do boiling temperatures kill all forms of bacteria so they won't grow again? What might be an exception?

Most bacteria are killed at boiling temperature. However, some bacteria make 'spores'. The spores are like seeds. Boiling does not kill spores. When the temperature comes back down, the spores can turn into bacteria and grow again. Botulism food poisoning results from bad canning. It is caused by a spore-forming bacterium. Salmonella food poisoning is caused by a bacterium that can be killed by boiling.

19. Salmonella is killed at high temperatures. And the coconut pie was cooked. How did the Salmonella survive?

In most Salmonella outbreaks, the bacteria are in the cream. The cream is usually added after the other ingredients have been cooked, so its bacteria are not killed. In the refrigerator, bacteria multiply very slowly and usually there aren't enough to cause disease. Bacteria in pies kept at room temperature can multiply enough to make people sick.

- This ends the introduction to pathogens.

TABLES AND FIGURES HANDOUT

Table I
Symptoms Associated with Possible Causes of Illness

Causative Agent	Incubation Time	Vomiting	Nausea	Muscle Weakness	Fever/ Chills
Bacteria	8-48 hrs	yes	yes	Sometimes	Usually
Virus	24-48 hrs	often	often	Sometimes	Usually
Protozoa	6 or more days	often	often	Sometimes	Usually
Chemicals/Poisons	1-6 hrs	yes	usually	Sometimes	Usually

* The incubation time is the time from swallowing the agent (for example, bacteria) until the person starts to feel sick.

Table II
Symptoms Associated with Various modes of Transmission

Airborne	Agents that enter the body through the nose or mouth often causes irritation of the air passageways or lungs.
Skin Lesions	Agents that enter through breaks in the skin (cuts, abrasions) often produce redness, swelling, or pus.
Insect Bites	Itching and swelling often occur at the site of the bite.
Ingested with Food or Water	Agents carried by food or water produce a variety or symptoms such as nausea, vomiting, fever, and chills.
Personal contact	Viruses and bacteria can be spread directly from one person to another and enter body openings. For example, some infections are spread by a sick person who gets viruses on his/her hands while blowing his/her nose or going to the bathroom, then touches someone else's hand. The second person might touch his nose, rub his/her eyes, or put his/her finger in his/her mouth, and infect himself. Cold and flu symptoms result. Sexual contact can directly spread diseases like gonorrhea, syphilis, and AIDS. Symptoms include sores, irritation, and discharge at the point of contact.

Table III **Student Room Assignments**

There were four students assigned to every room.

The rooms were not co-ed.

Room number	Number in each Room	Number who became ill
1	4	0
2	4	1
3	4	1
4	4	0
5	4	3
6	4	1
7	4	2
8	4	1
9	4	2
10	4	1

Table IV **Illness in Boyfriend/Girlfriend Pairs**

Number of girlfriend/boyfriend pairs on the trip	5
Number of pairs in which both were ill	1
Number of pairs in which one was ill	3
Number of pairs in which neither was ill	1

Table V **Dinner Menus of Our Group**

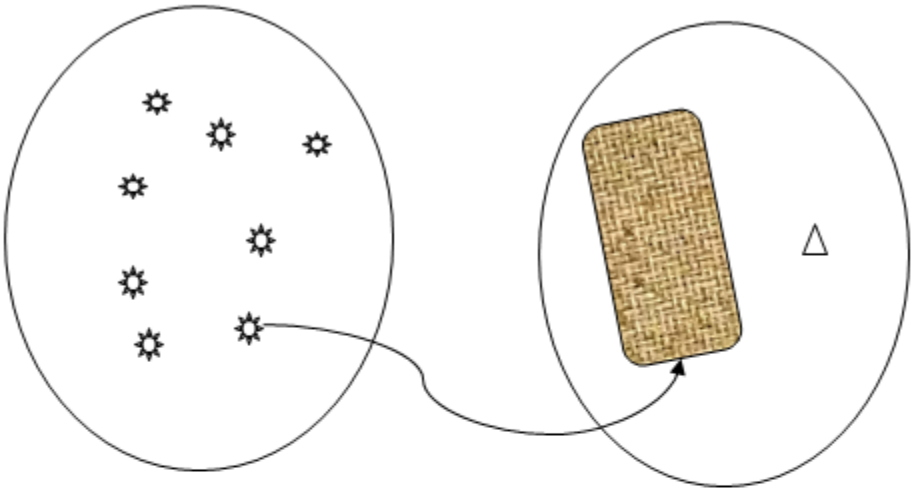
Group Member	Foods Eaten
President	Chicken with rice, green beans, ice cream
Vice President	Fried fish, French fries, green beans, coconut cream pie
Secretary	Roast beef, mashed potatoes, corn, chocolate cake
Treasurer	Fried fish, French fries, cole slaw, coconut cream pie

Table VI **Dinner Foods Eaten By Other 36 Students**

Main Course	# of students ordering	# of students ill
Chicken, rice, green beans	7	2
Roast beef, mashed potatoes, corn	15	4
Fried fish, French fries, cole slaw	14	4
Ice cream	10	0
Coconut cream pie	10	9
Chocolate cake	16	1

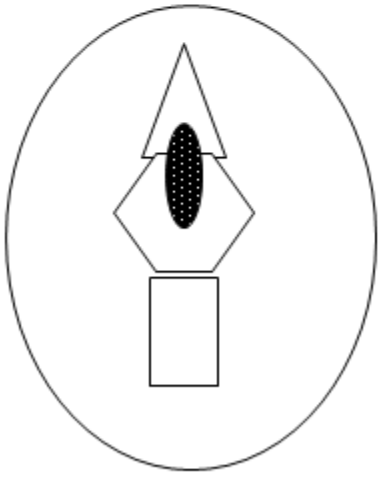
FIGURE I

Relative Size of an Average Bacterial Cell and a Virus



BACTERIA
Light Microscope
Magnified 500X

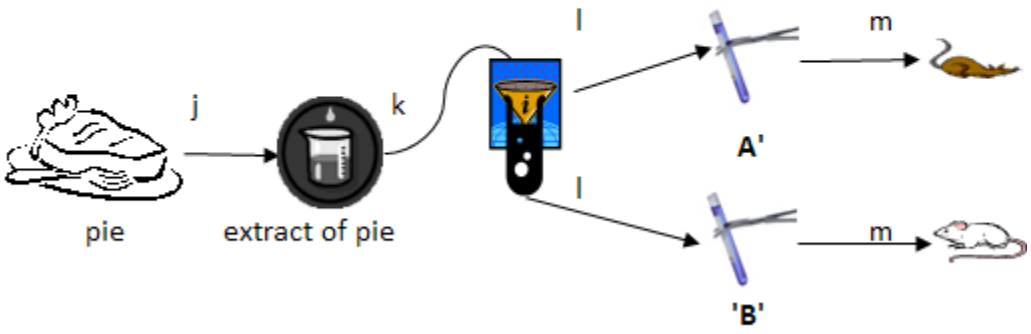
BACTERIUM and VIRUS
Electron microscope
Magnified about 7,500X



DETAILS of ONE TYPE of VIRUS
Electron microscope
Magnified about 200,000X

FIGURE II

Filtering the Pie



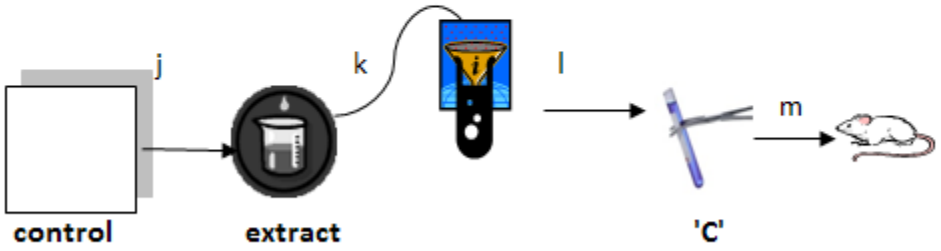


FIGURE III

Types of Bacteria

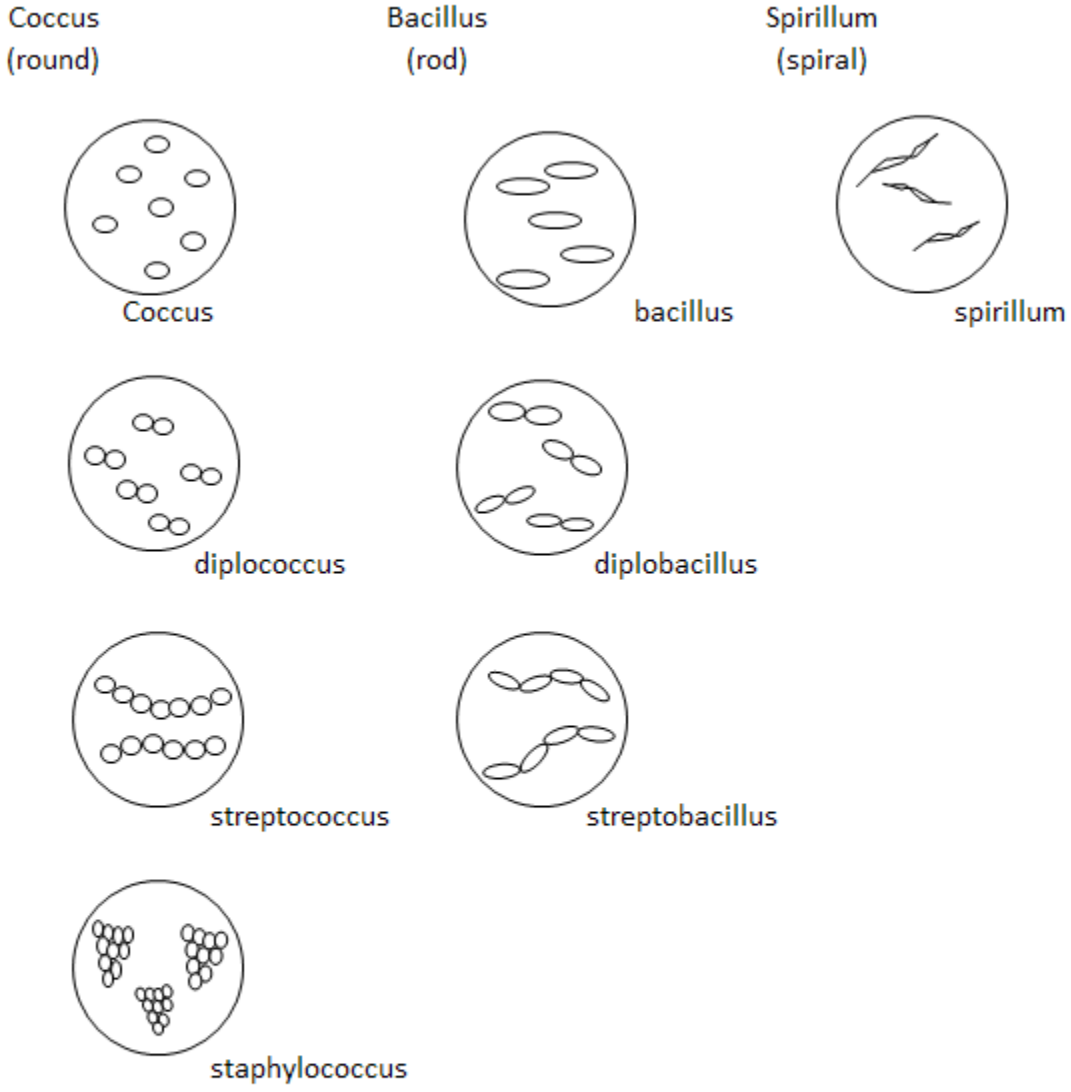


FIGURE IV

Koch's Postulates

Steps to determine if a type of bacteria caused a specific disease.

1. A sample from the sick animal (blood, feces saliva) is taken. There may be more than one type of bacteria.
2. Each type of bacteria is isolated and grown in a pure culture.
3. Once the pure cultures are grown, the 'test' animal is fed or injected with the pure culture to see if the animal becomes sick.
4. If the animal becomes sick, the bacteria is reisolated. The bacteria should be the same as the original pure culture.

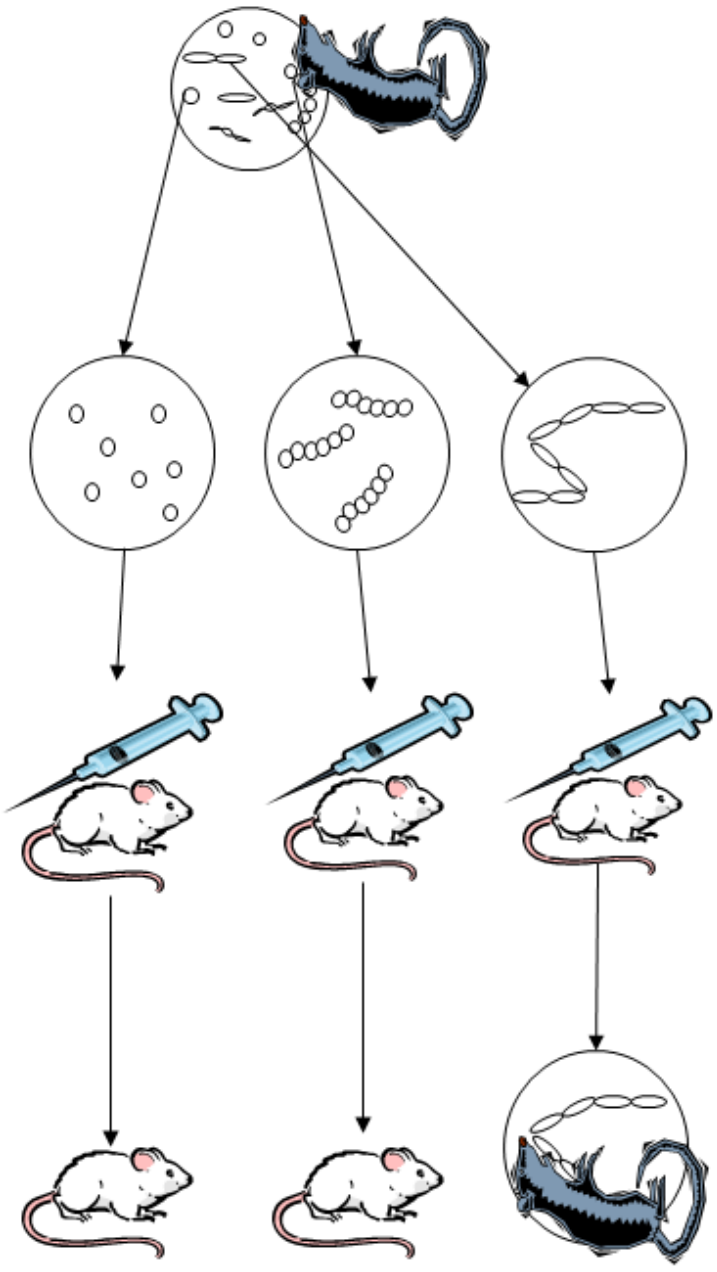


FIGURE V

COUNTY HEALTH BULLETIN #55511

TO: All Commercial Food Establishments

FROM: County Health Department

All food handlers and restaurant employees are required to follow the guidelines regarding health and safety rules. (Sec. 203 – 204, County Health Code, Revised 2005).

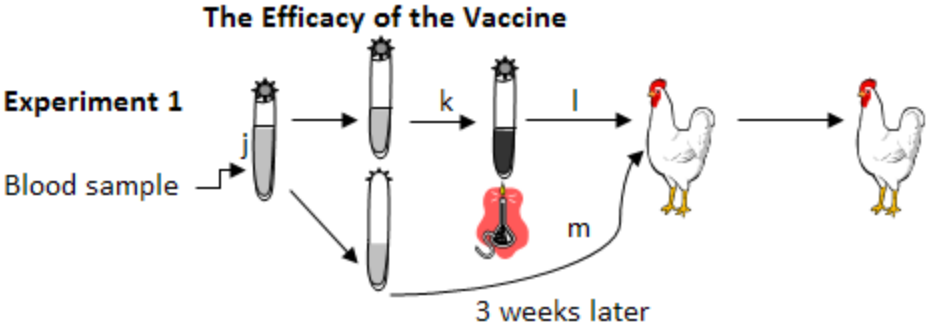
It is mandatory that any suspected food poisoning be reported to the health department within 12 hours to avoid a potential epidemic.

The following are causes and symptoms of reportable types of food poisoning.

BOTULISM: Often caused by improper home or commercial caning methods. Fresh foods rarely contain botulism spores, and cooking above 121oF will destroy the spores. Symptoms generally include fever, weakness of muscles, vomiting, constipation, and sometimes paralysis.

SALMONELLA: Can be associated with a wide variety of foods like poultry and pork; it is often associated with egg and milk products, especially mayonnaise in potato salad and whipped cream in pies. It is usually destroyed by baking and pasteurization. Adding creams after baking, using unclean utensils, or handling food improperly can cause food contamination. Symptoms generally include nausea, vomiting, diarrhea, and fever.

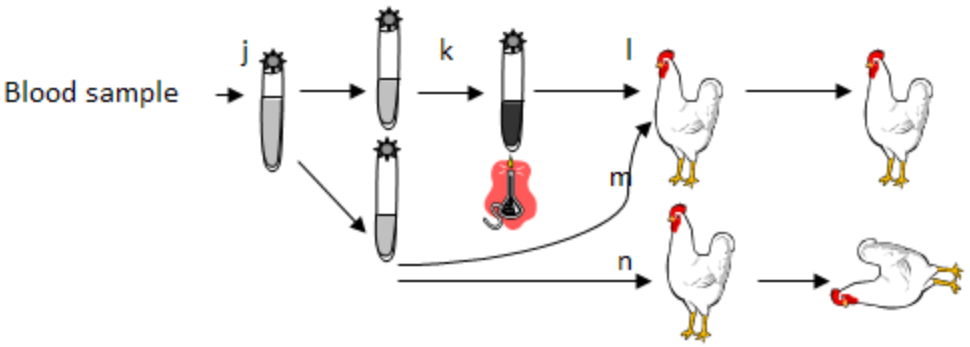
FIGURE VI



1. Isolate the bacterium causing the sickness to the hens.
2. Kill the bacteria by boiling.
3. Inject the boiled bacteria into healthy hens. - VACCINATE
4. Three weeks later feed the hens with unboiled bacteria.

The result should be that ALL vaccinated hens remain healthy.

Experiment 2



1-4. Repeat the steps from Experiment 1.

5. Feed the same culture of unboiled bacteria to healthy, unvaccinated hens.

Results: Vaccinated hens remain healthy, unvaccinated hens become ill.

TEACHERS RESOURCE GUIDE

Pathogens: Officer Retreat Investigation!

Time: 2-3 days

Materials needed:

Pen/pencil
Handouts

Background: This exercise explains the differences between bacteria and viruses and introduces the students to Dr. Robert Koch and Louis Pasteur. The scenario is that the FFA officers have organized a retreat for the Greenhand members. Many of them become ill after eating dinner. Day 2 investigates a disease at a poultry ranch.

The exercises are very self-explanatory. Your job will be to monitor the discussion. Groups of students may find it easier to simply give each other the underlined answers in each narrative instead of discussing what they might know about the question first.

Procedure:

Divide the class into groups of four students. Each student needs to receive a packet with the Tables and Figures and the lab sheet so they can record their answers. Each president needs a copy of his/her narrative; the vice president his/her narrative; the secretary his/her narrative; and the treasurer his/her narrative. Each student will be expected to volunteer for one of the four FFA officer positions. The instructor will read the scenario, which is provided on the lab sheet. The scenario is based on a Greenhand retreat wherein many of the members become ill. It is the task of the FFA officers to investigate the cause of the illness.

Each member of the lab group will be responsible for directing some segment of the investigation. The president will begin the narrative.

Below are the answers to the questions asked in the narrative.

1. What are three possible causes of the Greenhand retreat weekend illness?
    a. chemical poisoning
    b. infection with bacteria
    c. viruses
2. List illnesses that could be ruled out.
    a. an allergy
    b. car sickness
    c. lack of sleep
    d. homesickness
    e. over eating

3. What possible causes of illnesses can you probably eliminate?
    a. chemical poisoning
    b. Protozoa
4. Why do you think the incubation time for chemicals or poisons is shorter than for bacteria or viruses?
    a. Bacteria and viruses multiply. Chemicals don't' multiply
5. For each of the possible causes, what are some ways that the illness could have spread?
    a. Talking with someone at close range.
    b. Holding hands
    c. Kissing
    d. Sharing personal items
6. What possible modes of transmission can we eliminate?
    a. Airborne
    b. Insect bites
7. Does the pattern in Table III suggest personal contact as the means of disease transmission?
    a. The pattern not suggest personal contact.
8. Does the pattern in Table IV suggest personal contact as the means of disease transmission? Why or why not?
    a. No. In three pairs, only one person was sick.
9. Which method of transmission seems to be the most likely at this point? (look at table II)
    a. When the students ate or drank something
10. What food might have made us ill?
    a. Fried fish
    b. French fries
    c. Cream pie
11. Now what food(s) do you suspect?
    a. The cream pie
12. Why is the coconut cream pie more suspicious than the roast beef dinner?
    a. Most of the people who ate the coconut pie got sick. Only a small group of those who ate the roast beef became sick.
13. Is there anything in the dessert data, which contradicts, or makes you uncertain about your conclusion? What?
    a. Yes, one person who ate the cake became sick, and one person who ate the pie did not get sick.
14. How does this information about Jack and Jill help you interpret the dessert data?
    a. This can explain how the one person who ordered the cake became ill.
15. Jill ordered pie, but didn't get sick. How could you explain this?
    a. People have different levels of resistance to various diseases.

SECRETARY

16. Most high schools have light microscopes. Which are larger a bacterium (singular for bacteria) or virus? Would it be possible to observe a virus using a compound light microscope?
    a. A virus is much smaller than a bacterium.
    b. Viruses can only be seen with an electron microscope.
17. Approximately how much bigger is a bacterium than a virus?
    a. a bacterium is about 10 times the length of a virus.

18. How can we tell if viruses are present or the cause of the illness?
   a. Step 1 – she made an extract from some of the coconut cream pie
   b. Step 2 - she poured the extract into a very fine filter, like a coffee filter. Viruses can go through the tiny pores. Bacteria are too big, and they stay on the filter just as coffee grounds do.
   c. Step 3 – she poured the material trapped by the filter into test tube A. The substances that drained through the filter paper went into test tube B. (Add step 4 below to your answer sheet)
   d. Step 4 – My sister fed material from test tube A to one group of mice. Another group of mice were fed the liquid from test tube B.

19. If the pie contained virus particles, would they be in test tube A or B?
   a. Test tube B

20. From Figure II, which mice remained healthy and which became ill?
   a. Mice fed from test tube A became sick. Mice fed from test tube B remained healthy.

21. How could she find out if something in the pie, other than bacteria or viruses, caused the illness? What is this process called?
   a. She could feed another group of mice an extract from a fresh coconut cream pie.
   b. A control in the experiment.

22. What is an experimental control supposed to do?
   a. The control allows us to rule out the 'something else' from the item in question, like the cream pie.

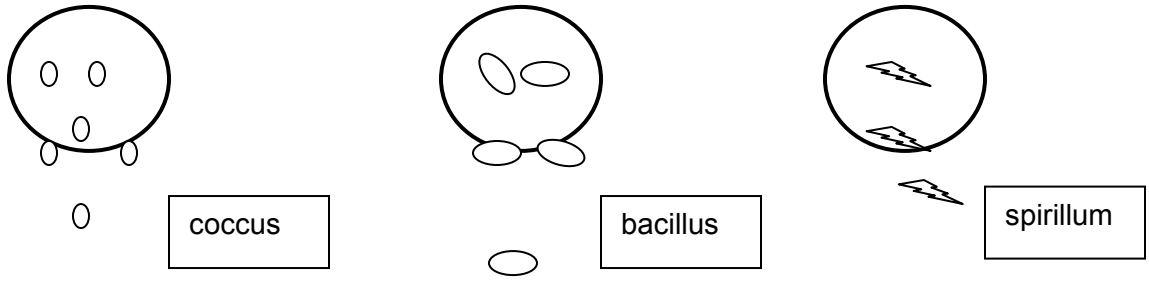
23. In Figure II, what should be drawn in the box labeled 'control' to complete the diagram?
   a. A piece of fresh coconut cream pie.

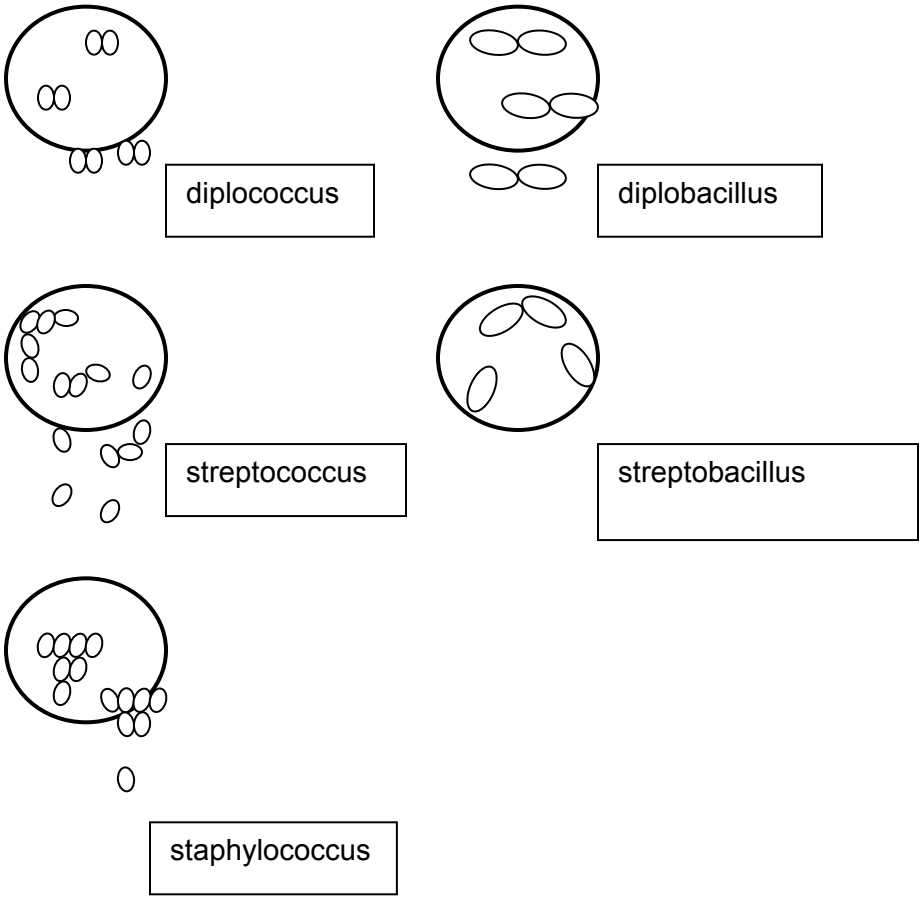
24. What can you conclude from this experiment? What are organisms called that cause disease?
   a. Bacteria from the pie made the mice ill.
   b. PATHOGENIC.

25. Would you expect to find bacteria in food you eat every day? Do all bacteria cause disease? What are bacteria called that do not cause disease?
   a. Yes
   b. Most bacteria do not cause disease
   c. non-pathogenic.

26. What are some possible ways to distinguish one kind of bacteria from another?
   a. Shape
   b. grouping of cells
   c. size
   d. stain them with certain dyes.

27. How many basic shapes do bacteria have? Draw each shape and label, and then draw each group and label with its prefix.
   a. Three





28. Can you tell by the shape or arrangement whether or not all of these bacteria cause disease?
   a. No.

TREASURER

29. In steps 1 and 2, why would it be necessary to get a 'pure' culture?
   a. A mixture of bacteria would show that bacteria caused the disease, but you wouldn't know which type of bacteria was pathogenic.

30. In steps 3 and 4, the mice given the streptobacillus got sick. The mice given the cocci did not get sick. Can you conclude from this that the streptobacillus made them sick?
   a. No.

31. How can you challenge the hypothesis that something else killed them?
   a. In the fourth step you can take the bacteria from the sick animal. Then you show it is the same as the bacteria you took from the pure culture in step 2.

32. Think about our symptoms we heard about or experience on the Greenhand retreat, the laboratory data, and the health bulletin. What type of bacteria do you think caused our weekend illness?
   a. Salmonella

DAY 2 PRESIDENT

1. What should we do first?
   a. We need samples of feces and blood from sick and health birds.

2. If we used a light microscope, what should make us think we have just one type of bacteria in a blood sample? (It may help to look at Figure III).
    a. All the bacteria in the blood would be the same size, shape, and arrangement.
3. In Figure III, which pictures might represent the blood bacterium?
    a. Any
4. By observing with a microscope, how would we know there are many types of bacteria in the feces?
    a. We would see bacteria in a variety of sizes, shapes, and arrangements.
5. There are *Diplococci* in the sample of feces. What do *Diplococci* look like?
    a. round cells grouped in pairs.
6. We also see *Diplobacilli*. What do they look like?
    a. pairs of rods
7. There are also *Bacilli*. Can we tell by their size and shape if they are pathogenic?
    a. No
8. Which bacterium from the sick hen is most likely to be the cause of the disease?
    a. The sick hen's blood
9. How would we test whether or not the bacterium from the blood is the cause? (hint-look at Figure IV).
    a. We would follow Koch's postulates

DAY 2 VICE PRESIDENT

10. How could we kill a pure sample of the bacteria we found in the chicken blood?
    a. Boiling kills many bacteria.
11. List two ways to explain the results.
    a. A first thought is that the chickens stayed healthy because we made a good vaccine. But they also could be healthy because the pathogenic bacteria changed in some way. For example, maybe the bacteria died. The experiment isn't designed well enough to let us rule out either explanation.
12. This is why we need a control in the experiment. The control should allow us to rule out the chance that the original bacteria changed. Can you think of a control?
    a. Feed the unboiled bacteria to normal, unvaccinated hens, and see if they get sick.
13. What can we conclude?
    a. Our vaccine made from boiled bacteria protected the hens from the disease.
14. What was the control in Experiment 2?
    a. Feeding live bacteria to unvaccinated chickens was the control part of the experiment.
15. How did it help us with our conclusion?
    a. The unvaccinated chickens got sick. That means the bacteria were pathogenic. The only difference between the two groups of chickens was the injection of the vaccine. The vaccine must have protected the chickens from the pathogenic bacteria.
16. How can cooks at home and in restaurants make food safer to eat?
    Some ways include:
    - Discard food which smells bad or appears discolored;
    - don't use damaged or swollen canned goods;
    - wash your hands before preparing food;
    - use only clean utensils for preparing food;
    - cook food at recommended temperatures;
    - keep food refrigerated or frozen;

- don't' leave stuffing in a lift-over turkey.

17. At what temperature do most bacteria multiply fastest? At the temperature of:
   a. A live human body, 37°C

18. Do boiling temperatures kill all forms of bacteria so they won't grow again? What might be an exception?
   a. Most bacteria are killed at boiling temperature
   b. Boiling does not kill spores.

19. Salmonella is killed at high temperatures. And the coconut pie was cooked. How did the Salmonella survive?
   a. The cream is usually added after the other ingredients have been cooked, so its bacteria are not killed.

[i] Dickson, Chris (2008).Pathogens. *North High School, Bakersfield, Agriculture Department*.

Biology/Life Sciences Standards	•(BLS) 10.a.
Agriculture Standards	•(AG) C 6.1, C 6.2, and C 13.3. •(Foundation) 1.2 Science, Specific Applications of Investigation and Experimentation: (1.a) and (1.d).

Name_____

Date_____

Chicken Wing: Tissues

Purpose

The purpose of this exercise is to practice manipulating dissecting equipment and become familiar with organs and tissues found throughout the body of animals.[i]

Background Information

A bird's wing is made up of groups of tissues and organs working together to perform a job. Before beginning the dissection, review the functions performed by the tissues and organs.

- Skeletal muscles are attached to bones.
- Skin is the membranous tissue that forms the outer covering of the body that provides a protective barrier from the outside environment.
- Muscle tissue is composed of bundles of skeletal muscle fibers. When these tissues expand and contract they produce motion in the wing.
- Fatty tissue, when stored on the underside of the skin, helps to keep the body warm, cushion and protect other body tissues, and stores vitamins A, D, E, and K.
- Blood vessels are the arteries, veins, and capillaries, which transport blood throughout the body. Capillaries are too small to be seen without a microscope. Arteries have thicker walls than veins.
- Tendons are especially strong connective tissue that attaches skeletal muscle to bones.
- Cartilage helps prevent neighboring bones from grinding against each other.
- Bone provides structural support and manufactures red blood cells.
- Nerves are the bundles of fibers that transmit sensory stimuli and motion impulses.
- Ligaments are strong bands of connective tissue that connect two bones together.

Procedure

Materials

1. One raw chicken wing for each student. Chicken wings can be purchased at the local supermarket in the 'inexpensive' family pack.
2. Scissors
3. Paper plate
4. Tweezers or forceps

Sequence of Steps

Read the description of each of the tissues or organs and then begin the dissection for that particular tissue/organ. In the box provided, sketch an illustration of each tissue/organ listed in this lab.

SKIN – The skin is the external covering of the entire wing. The skin will have a web like appearance between the bones. Look for evidence that the skin was covered with feathers. Cut a slit in the skin covering the largest bone and joint.

SKIN

How does skin provide nonspecific defenses against infection?_____

_____

CONNECTIVE TISSUE – First lift a corner of the skin and, with tweezers or forceps, peel it back gently from the muscle. Notice the shinny, thin, membrane that surrounds the muscle and attaches the muscle to the skin. This is connective tissue.

CONNECTIVE TISSUE

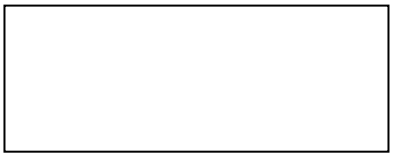
MUSCLE TISSUE – Note the pink-orange bundles of fibers attached to the bone. This is muscle tissue.

MUSCLE TISSUE

FATTY TISSUE – Continue to peel back the skin slowly and gently until you locate a tissue between the skin and muscle that is yellow in color and greasy to the touch. If no fatty tissue can be found there, find a thick piece of skin and proceed to cut through it to see if there is any fatty tissue. If the lab is utilizing store-bought chicken wings, it is possible that little or no fat can be observed.

FATTY TISSUE

BLOOD VESSELS – With the skin peeled back, scan the surface of the skeletal muscles for thin red tubes. These are blood vessels. Arteries and veins might also be located in bundles of connective tissue with nerves.

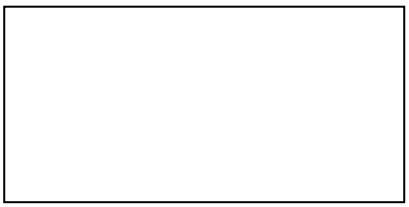


BLOOD VESSELS

TENDONS – Look at the top of the large bone. Notice the shiny white piece of connective tissue that attaches skeletal muscle to bone. These are tendons.

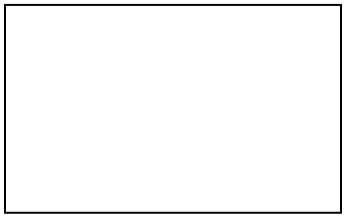
TENDON

CARTILAGE – Examine the top of the large bone. Locate a pearly white hard tissue found at the ends of the long bones. This is cartilage.

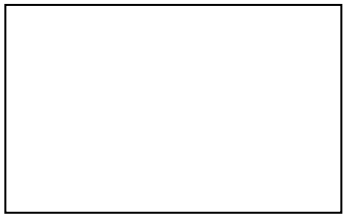


CARTILAGE

BONE – Cut through the muscle with your hard white bone. Bones are hard (but not primarily of calcium and phosphorus. The to cross-sect the bone. Ask the instructor to the cross-section of the bone; the mass of red is the red marrow that manufactures red blood cells. Notice the bone surrounding the red marrow. The bone itself in not solid, but is an asymmetrical lattice work of calcium and phosphorus.



MARROW



CROSS SECTION OF BONE

NERVES – Nerves are usually found buried deep within an organism, often lying close to long bones. Sometimes an artery, vein, and nerve are held together in one bundle of connective tissue. Gently peel the muscle from the long bone and search carefully for a thin white threadlike tissue. This is a nerve. If this does not work, look for a bundle of connective tissue containing blood vessels. Gently pry it apart and search for the nerve.

NERVES

LIGAMENTS – Cut through the skin and muscle down to the joint between the long bone and the center bone. Locate the strong white bands of connective tissue that connect the two bones together at the joint. This is a ligament.

LIGAMENT

Conclusion:

How do the structures of the human and animal body (such as muscle tissue, fatty tissue, skin, etc) help keep the internal environment relatively stable?

_____
_____
_____
_____

[i] Dickson, Chris (2008).Chicken Wing. *North High School, Bakersfield, Agriculture Department*.

Agriculture and Natural Resources Industry Sector Foundation Standards

1.2 Science - Specific applications of Investigation and Experimentation standards (grades nine through twelve):

(1.a) Select and use appropriate tools and technology (such as computer-linked probes, spreadsheets, and graphing calculators) to perform tests, collect data, analyze relationships, and display data.

(1.c) Identify possible reasons for inconsistent results, such as sources of error or uncontrolled conditions.

(1.d) Formulate explanations by using logic and evidence.

(1.f) Distinguish between hypothesis and theory as scientific terms.

(1.j) Recognize the issues of statistical variability and the need for controlled tests.

(1.l) Analyze situations and solve problems that require combining and applying concepts from more than one area of science.

(1.m) Investigate a science-based societal issue by researching the literature, analyzing data, and communicating the findings. Examples of issues include irradiation of food, cloning of animals by somatic cell nuclear transfer, choice of energy sources, and land and water use decisions in California

Lab Reference: Investigation

Standards: Ag Foundation 1.2 Science

STANDARD CONCEPT	LAB NAME	LAB NUMBER
Investigation	Rising Water	F-1
Investigation	Scientific Method	F-2
Experimentation	Virtual Greenhouse Experimentation	F-3

Agriculture Foundation Standards

- (AG) C 13.1.
- (Foundation) 1.2 Science, Specific Applications of Investigation and Experimentation: (1.a), (1.b), (1.c), (1.d), and (1.f).

Name_____

Date_____

Rising Water

Purpose

Often things seem simpler at first glance than they really are. Upon closer examination the complexity and mystery become more apparent. Discovering and solving these mysteries can be enjoyable and more satisfying than looking for answers in books or asking people who claim to know better than you. There is a way to search for your own answers. It is called science and it can be fun! The purpose of this lab is to stimulate curiosity about natural phenomena and to become aware that science is an activity which involves generating alternative hypotheses (possible explanations) and predictions to arrive at explanations. [i]

Procedure:

Materials

1. Aluminum tin
2. Birthday candle
3. Modeling clay
4. Test tube
5. Matches
6. Water

Sequence of Steps

1. Obtain the materials for your lab table.
2. Stick a ball of modeling clay in the center of your pan.
3. Pour some water into the aluminum pan at least 1 inch high.
4. Stand a candle in the modeling clay upright.
5. Light the candle and put your test tub over the candle so that it covers the candle and sits in the water.
6. Record your observations and develop your hypothesis.
7. Re-test based on your hypothesis and evaluate results.

Observations

1. What happened? (What did you see?)

2. What questions could you ask as to how your results might have happened?

3. What possible reasons (hypotheses) can you suggest for what happened?

4. Repeat your experiment to see if you obtain similar or different results. Do your results support or contradict your ideas in #3? Explain.

5. Where might have experimental error taken place?

6. Distinguish between a theory and a hypothesis. What is the difference?

[i] (2008).Rising Water. *Atwater High School Ag Department*.

Name_____

Date_____

Scientific Method with SpongeBob

Purpose

The purpose of this lab is to analyze an experiment and apply the scientific method. [i]

Procedure

Sequence of Steps

I. Write a definition for each of the following terms in YOUR own words. Look them up but don't copy!

- Control –
- Manipulated variable –
- Responding variable –

II. SpongeBob and his Bikini Bottom pals have been busy doing a little research. Read the following description for each of their experiments and answer the questions provided.

Krusty Krabs Breath Mints

Mr. Krabs created a secret ingredient for a breath mint that he thinks will "cure" the bad breath people get from eating crabby patties at the Krusty Krab. He asked 100 customers with a history of bad breath to try his new breath mint. He had 50 customers (Group A) eat a breath mint after they finished eating a crabby patty. The other 50 customers (Group B) also received a breath mint after they finished the sandwich; however, it was just a regular breath mint and did not have the secret ingredient. Both groups were told that they were getting the breath mint that would cure their bad breath. Two hours after eating the crabby patties, 30 customers in Group A and 10 customers in Group B reported having better breath than they normally had after eating crabby patties.

1. Which group of people is in the control group?

2. What is the manipulated variable?

3. What is the responding variable?

4. What do you think Mr. Krabs' conclusion should be?

5. Why do you think 10 people in group B reported fresher breath?

SpongeBob Clean Pants

SpongeBob noticed that his favorite pants were not as clean as they used to be. His friend Sandy told him that he should try using Clean-O detergent, a new laundry soap she found at Sail-Mart. SpongeBob made sure to wash one pair of pants in plain water and another pair in water with the Clean-O detergent. After washing both pairs of pants a total of three times, the pants washed in the Clean –O detergent did not appear to be any cleaner that the pants washed in plain water.

6. What was the problem SpongeBob wanted to investigate?

7. What is the manipulated variable?

8. What is the responding variable?

9. What do you think SpongeBob's conclusion should be?

Squidward's Symphony

Squidward loves playing his clarinet and believes it attracts more jellyfish than any other instrument he has played. In order to test his hypothesis, Squidward played a song on his clarinet for a total of 5 minutes and counted the number of jelly fish he saw in his front yard. He played his song for a total of 3 times on the clarinet then repeated the experiment using a flute and then a guitar. He also recorded the number of jellyfish he observed before he began playing an instrument. The results are shown in the data table below.

10. What is the manipulated variable?

11. What is the responding variable?

12. What do you think Squidward's conclusion should be?

Number of Jellyfish/Instruments

Trials	No Music	Clarinet	Flute	Guitar
1	5	15	5	12
2	3	10	8	18
3	2	12	9	7

13. Are the results reliable? Why or why not?

Super Bubbles

Patrick and SpongeBob love to blow bubbles! Patrick found some Super Bubble Soap at Sail-Mart. The ads claim that Super Bubble Soap will produce bubbles that are twice as big as bubbles made with regular bubble soap. Patrick and SpongeBob made up two samples of bubble solution. One sample was made with 5oz of Super Bubble Soap and 5oz of water, and the other was made with 5oz of regular bubble soap and 5oz of water. Patrick and SpongeBob used their favorite bubble wands to blow 10 different bubbles and did their best to measure the diameter of the bubbles as they popped on the table. The results are shown in the data table below.

Bubble #	Super Bubble	Regular Soap
1	15	10
2	10	5
3	12	16
4	18	14
5	22	11
6	13	12
7	16	11
8	18	15
9	15	15
10	12	6

Diameter in centimeters

14. What did the Super Bubble ads claim?

15. What is the manipulated variable?

16. What is the responding variable?

17. Look at the results in the data table.

- Calculate the average diameter for each bubble solution.

  Super Bubble = _____ cm

  Regular Soap = _____ cm

- What do you think SpongeBob's and Patrick's conclusion should be?

18. Are the results reliable? Why or why not?

[i] (2008).Scientific Method with SpongeBob. *Atwater High School Ag Department*.

Agriculture Foundation Standards

- (AG) C 13.1 and C 13.3.
- (Foundation) 1.2 Science, Specific Applications of Investigation and Experimentation: (1.a), (1.d), and (1.j).

Name_____

Date_____

Virtual Greenhouse Experimentation

Purpose

The purpose of this lab is to design and conduct an experiment using a greenhouse simulator and then compose a laboratory report summarizing the research problem, hypothesis, procedures, findings and conclusions.[i]

Procedure

Sequence of Steps

Write a definition for each of the following terms.

- *Experiment* –
- *Control group* –
- *Control variable* –
- *Dependent variable* –
- *Independent variable* –
- *Random Selection* –
- *Treatment variable* –
- *Validity* –

After a demonstration of the greenhouse simulator by your instructor answer the following questions:

1. In this experiment the manipulation is referred to as the _____.
2. The independent variable in this experiment was _____.
3. Which two variables were controlled?
   a)

   b)
4. The dependent variable in this experiment was _____.

5. What variable was the treatment variable? _____

   a) Describe how the variable was manipulated?

6. Besides the variable described in question #5, what other two variables can be used as treatments in an experiment using the greenhouse simulator? Describe how they can be manipulated.

   a)

   b)

Now it's your turn to design and conduct an experiment using the greenhouse simulator. You will need to use the scientific method to do so. Here are the steps:

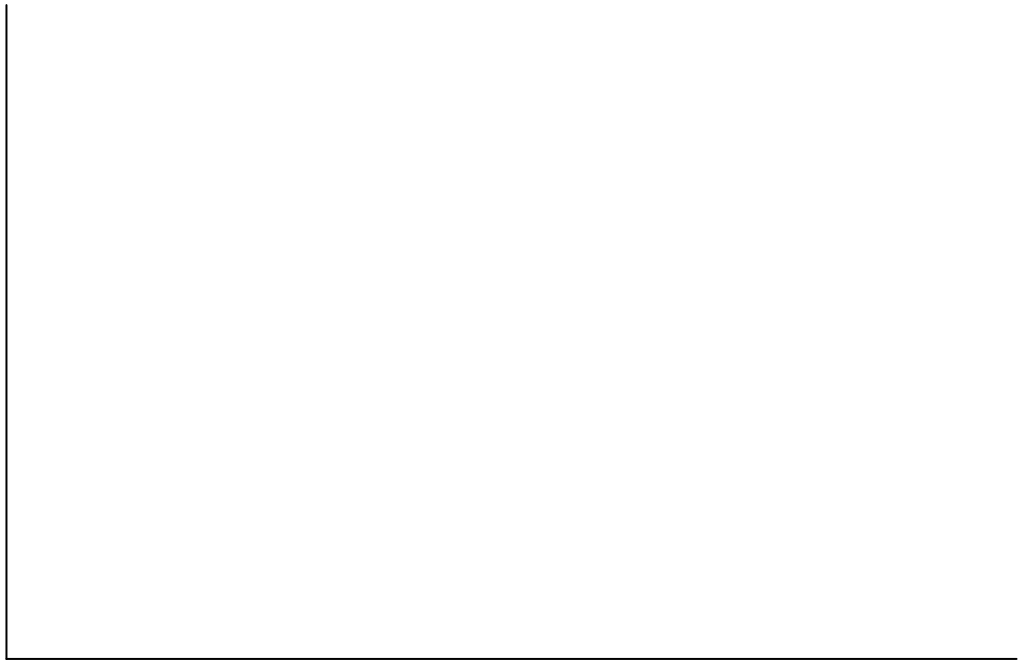
1. Define the problem.
   a) Write a research problem that you want to investigate?

2. Gather information about the problem.
   a) List background information you gather about your research problem?

3. Suggest possible answers or solutions to your problem.
   a) Write a hypothesis predicting the results of an experiment investigating your research problem.

4. Design an experiment and test your hypothesis.
   a) Record the steps followed in conducting your experiment.

   b) Summarize the data you collected from the experiment in a bar graph.



5. Evaluate the results of the experiment.
    a) Based on the results in the bar graph, what conclusions can be made about your findings? Was your hypothesis plausible?

Now that you have completed your experiment, let's share what you have learned with other researchers! Using the information you've recorded in this lab handout or journal, develop a laboratory report which addresses the following parts:

1. Title page – name, class, date, and title of the experiment
2. Introduction – state the need and justification for the experiment and present background information that influenced the research.
3. Research problem – the specific question that was under investigation. All the variables influencing the research should be specified.
4. Research hypothesis – predictions about the effect the treatment would have on the dependent variable.
5. Procedures – summary of the techniques used in designing, treating, and measuring the variables.
6. Findings – summary of the data, include any graphs or charts representing the data.
7. Conclusions – specific statements about the relationships between the variables.
8. Recommendations – suggestions on how the results of the research should be used or recommendations for further experimentation of the problem.
9. References – complete listing of all sources used in designing the experiment and preparing the report.

Teacher Resource Guide

Virtual Greenhouse Experimentation

Student Learning Objectives: Upon completion of this lesson, students will be able to:

1. Understand the functions of the greenhouse simulator.
2. Demonstrate the use of the greenhouse simulator.
3. Design and conduct an experiment using the greenhouse simulator.
4. Compose a laboratory report summarizing the research problem, hypothesis, procedures, findings and conclusions.

List of Resources:

California Core Agriscience Lesson Plan Library. (2005). *Lesson B1.5: Designing and conducting agricultural research*. California Department of Education.

Cooper, E. L. & Burton, L. D. (2004). *Agriscience: Foundations & Applications* (3rd Ed.). Delmar Publishers: Albany, NY

National FFA Organization. *Agriscience handbook: Beginning 2006-2010*. National FFA Organization: Indianapolis, IN

Equipment and Materials:

Computer and LCD projector
Computers for students
Internet access
Lab Handout or research journal

Terms: (Definitions provided in Appendix I)

Control group
Control variable
Dependent variable
Experiment
Independent variable
Random Selection
Treatment variable
Validity

Background Information:

Prior to teaching this lesson, it is suggested that the instructor first present Lesson B1.5 of the California Core Agriscience Lesson Plan Library, entitled Designing and Conducting Agricultural Research. Lesson B1.5 provides students with the requisite information needed to successfully achieve the objectives of this lesson.

Interest Approach:

A local nursery owner has a problem with tomato plants she produces in her greenhouse. The grower plants tomato seeds in January and then sells those plants in April to customers who transplant them into their gardens. Unfortunately, the grower continually finds that the size of her tomato plants is too inconsistent. Some of her plants reach a marketable size by the end of March while others are too small and difficult to sell. The grower needs your assistance in discovering why her tomato plants are not growing at the same rate.

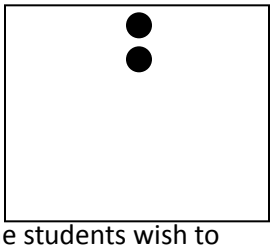
Summary of Contents and Teaching Strategies

Objective 1: Become familiar with the greenhouse simulator and its functions.

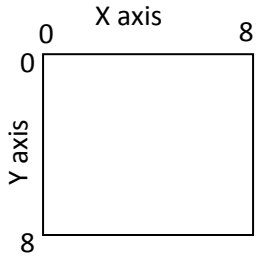
1. Since we cannot go to the actual greenhouse, we are going to use a greenhouse simulator that is available on the Internet. This will allow us to learn about the problems this grower is experiencing and by conducting some experiments we may be able to help solve the grower's problem.
2. The greenhouse simulator is located at: http://www.kuleuven.be/ucs/env2exp/
    a. Click on the Greenhouse icon to start the simulator
3. The square box in the center of your screen represents the virtual greenhouse.
    a. The greenhouse has two possible lighting schemes:
        i. One light tube – located in the center of the greenhouse from left to right.
        ii. Four light bulbs – four light sources, one in each quadrant of the greenhouse.
    b. By default, the one light tube scheme is shown in the greenhouse.
    c. To view the lighting scheme, click on "Options" in the upper left corner of the screen and then select "Visualization Lights".
    d. To change the lighting scheme, click on "Options" and then "Select Light Model". Next select either "1 Light Tube" or "4 Light Bulbs" and then click "Apply".
    e. The greenhouse has two heating sources.
        i. Heaters are located on the left and right sides of the greenhouse.
4. The simulator provides you with twelve trays of tomato plants.
    a. Each tray contains twelve *randomly selected* pots each containing one tomato plant.
    b. The number on each pot indicates the initial size of that tomato plant.
    c. By clicking on the right arrow button, you can view each of the twelve trays of plants.
    d. To select a plant, just click and hold, then drag it into the greenhouse.
        i. The greenhouse has the capacity to hold 144 plants if the pots are placed very close together.
5. By placing plants in different locations in the greenhouse it allows you to manipulate the amount of light and heat that each plant will receive. Let's see if the amount of light received by the tomato plants has an effect on their growth.

Objective 2: Demonstrate the use of the greenhouse simulator.

The instructor should first demonstrate the following procedure while students observe. Following the demonstration, the instructor should repeat these steps leading students through the process on their computers.

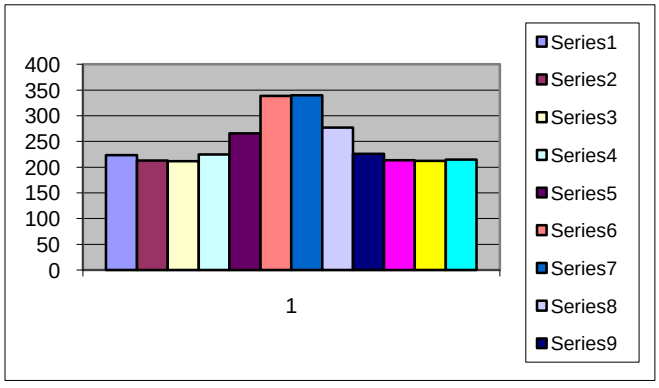


1. Select a plant from Tray 1 and drag it into the greenhouse.
2. Place the plant in the center of the greenhouse at the top of the screen.
3. Select another plant and place it directly below the first plant.
4. Repeat Step 3 until all twelve plants are placed in a line from the top to the bottom of the greenhouse. (Twelve plants will fit if you place them close together).
5. Once the plants are placed in the greenhouse, determine the length of time the students wish to grow their tomato plants. To set the period of time the plants will grow, click on each of the following arrow boxes and then select the appropriate day and month corresponding to the period of time you desire:
    a. Select the beginDate – day of the month to begin plant growth
    b. Select the beginMonth – month of the year to begin plant growth
    c. Select the endDate – day of the month to end plant growth
    d. Select the endMonth – month of the year to end plant growth
6. Once you have properly located your plants and determined the length of growth time you are ready to grow your plants. To do so, simply click the "Grow" button.
7. After clicking "Grow" the next step is to click the "View Output" button. This will provide you with a data set that represents:
    a. Plant ID number – the order in which you placed the plant in the greenhouse
    b. Initial weight – the biomass weight (grams) of the tomato plant prior to beginning the growth period.
    c. Final weight – the biomass weight (grams) of the tomato plant after the completion of the growth period.
    d. Treatment – indicates the treatment level applied to the tomato plants, in this case no treatment was used other than light so disregard this item for now.
    e. Location of the plant – represented by the X coordinate and Y coordinate (see illustration)
        i. The greenhouse is 8 meters x 8 meters
        ii. The X axis extends across the top of the greenhouse from left to right.
        iii. The Y axis extends down the left side of the greenhouse from top to bottom.



8. In order to analyze the data you will need to copy it and paste it into a spreadsheet program, such as Microsoft Excel.
    a. To do so, highlight all of the text and numbers.
    b. Copy the information – done by right clicking and selecting copy.
    c. Open Excel and paste the data into a new document.
9. The column headings and corresponding data may not align properly. You may need to realign some text.
    a. To do so, highlight the text or numbers you wish to move.
    b. Click on the highlighted information and drag it over to the appropriate cells.

10. To measure the actual amount of growth of each plant it is necessary to subtract the plants initial weight from its final weight.
    a. To do so, create a new column, if one is not already available.
        i. In Excel, this can be done by clicking on “Insert” and “Column”
    b. Label the new column by typing in the first row “Difference”.
    c. Now you can use a formula to calculate the difference between the two weights.
        i. To create a formula in a cell, you must first type an equal sign “=”
        ii. Next click on the cell that contains the final weight of the plant in that row.
        iii. Then type a minus sign “-“
        iv. Next click on the cell that contains the initial weight of the plant.
        v. Your formula should look similar to this: =C2-D2
        vi. Once you have done so, press “Enter.
        vii. This should produce a value equal to the difference between the plant’s initial and final weight.
    d. Copy this formula and paste it into the other cells below it, which should produce “Difference” values for all the other plants.
11. In order to analyze this data you will need to first summarize the data. By representing the data in a chart or graph it allows you to better draw conclusions from your findings.
    a. Let’s try representing the data graphically, using a bar graph.
        i. To do so, click on “Insert” and “Chart”
        ii. When asked to select “Chart Type”, click on either “Column” or “Bar”
        iii. Next you are asked to enter the data range.
            1. To do so, highlight all the data in the “Difference” column
            2. Select the button indicating the data is in “Rows”
        iv. Click on “Finish”
        v. A bar graph representing the data should appear on your screen, it should be similar to this:



12. The different colored bars represent the growth of each of the twelve plants in the greenhouse.
13. Ask students a series of analysis questions leading them to the conclusion that greater plant growth was observed in the middle of the greenhouse where the light intensity was greatest.
    a. Analysis questions:
        i. Based on this graph what can we conclude about the effect of light on plant growth?
        ii. Which plants exhibited the greatest amount of growth?
        iii. In which part of the greenhouse was the greatest amount of light?
        iv. What is the relationship between the amount of light and plant growth?

14. Based on the answers to these questions, have students form their own conclusions. Then have students share their conclusions with the class.
15. Now that the instructor has demonstrated the use of the greenhouse simulator, ask each student to repeat these steps using their computer.

Objective 3: Design and conduct an experiment using the greenhouse simulator.

(***Teacher note****: For additional information pertaining to this topic refer to the Agriscience Handbook, available from the National FFA Organization*)

1. An *experiment* is a scientific investigation in which the researcher manipulates one or more independent variables, controls other relevant variables, and then observes the effect of the manipulations on the dependent variable.
2. The manipulation is referred to as a <u>treatment</u>.
3. Using the previous activity as an example:
    a. *Independent variable* – <u>light</u> (also referred to as Treatment variable)
    b. *Control variables* –
        i. <u>Length of time</u> - all plants were grown for an equal amount of time
        ii. <u>Heat</u> - all the plants received the same level of heat since they were aligned down the center of the greenhouse.
    c. *Dependent variable* – <u>growth of the plants</u>
    d. *Treatment variable* – <u>light, due to the location of the plants the amount of light each received was manipulated. Those in the middle of the greenhouse received the most light and those on the ends received the least amount of light.</u>
4. The greenhouse simulator provides three variables that can be manipulated:
    a. <u>Light</u> – manipulated by the location of the plant in the greenhouse
    b. <u>Heat</u> – also manipulated by the location of the plant
    c. <u>Treatment</u> – various doses of a treatment can be applied to plants in the greenhouse.
        i. The treatment refers to no specific substance. It can be any substance you wish, however for our purposes lets say the treatment is nitrogen fertilizer.

        (***Teachers note****: since the treatment has no specific characteristics, by default the effect of the treatment will increase as the dosage level is increased. Suggest to students that they select a treatment that would result in increased plant growth, such as applying nitrogen fertilizer.*)
5. We have discussed how to manipulate light and heat sources by changing the location of our plants, but to apply a treatment it requires additional steps.
    a. On the right side of your screen below the plant tray you should see “Treatment”.
    b. By default all of the plants receive Treatment 1, which is set at Dose 0. This means that currently the plants are not receiving any of the treatment.
    c. To apply a treatment to a group of plants you only need to increase the dosage of Treatment 1. As you will see this process will increase the dosage of every plant in the greenhouse.
    d. In order to conduct an experiment, it is necessary to have a *control group*. This control group would not receive the treatment. This allows the researcher to compare the treatment group with the control group to see if the treatment had an effect on the tomato plants.
        i. To do so, click on the “Add” button next to “Treatment”. This will create “Treatment 2”.

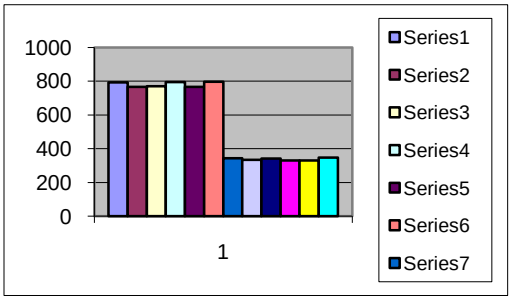
1. You can then change the dosage of Treatment 2 so that it is greater than that of the plants determined to be in the control group.
2. For demonstration purposes set Treatment 1 at dosage 0 and set Treatment 2 at 1 or higher.
3. To apply Treatment 2 to a plant, click and hold on the colored box next to the treatment that indicates the dosage, then drag it over to the plant you want to apply that treatment to and let off your mouse button. If done correctly the circle (plant) should become the color of the treatment you applied to it.
4. Repeat this process until you have applied all the treatments called for in your experiment.

e. In order to identify plants that receive different levels of the treatment variables you will want to use the "Group Factors". These are like marking flags that indicate what group each plant belongs to.
   i. To do so, click on the "Add" button next to "Group Factors".
   ii. "GroupFactor1" should appear in the box
   iii. Double click on "GroupFactor1" and another box should open that says "Groups for: Group Factor 1".
   iv. Click on the "Add" button creating "Group 1"
      1. To label a plant in Group 1, click and hold on the colored box next to Group 1, then drag it over to the plant you want to identify and let off your mouse button. If done correctly a portion of the circle (plant) should become the color of the group.

6. Now let's design an experiment together. Please note these steps since each of you will be asked to design your own experiment following this group activity.
   a. We'll be following the scientific method:
      i. Let's first define the problem.
         1. Ask students to suggest possible problems or questions that pertain to the variables included in the greenhouse simulator. (Example: Does nitrogen fertilizer increase the growth rate of tomato plants?)
         2. Have students record the research problem on notebook paper or in research journals.
      ii. Gather information about the problem.
         1. Based on the research question, ask students questions about the problem or have them gather information to provide background information. (Example: Ask students what effect light, heat, and nitrogen fertilizer have on plant growth. If reliable information isn't provided, have students gather information related to the research question before proceeding.)
         2. Have students record this information in their research journals.
      iii. Suggest possible answers or solutions.
         1. As a class, form a hypothesis predicting the results of an experiment. (Example: Nitrogen fertilizer will have no effect on the tomato plants.)
         2. Have students write their hypothesis in their research journals.
      iv. Test the hypothesis
         1. Lead the class discussion in designing an experiment that will test the hypothesis.

*[**Teachers note**: To test the effect of a treatment like nitrogen fertilizer, you would need to control for light and heat. This would require that all plants receive similar amounts of light and heat, and one group of plants would receive the treatment and the other would receive no treatment (control group). A more complex design would be to have two treatments, like comparing plants with low light and nitrogen fertilizer to plants with low light and no fertilizer, and plants with high light and nitrogen fertilizer with plants with high light and no fertilizer.]*

2. Have students record the procedure followed in designing and conducting the experiment.
3. Summarize the data collected in a bar graph. Follow the same procedure as before, copy and paste the data into Excel and create a graph representing the data.
   (***Teachers note:*** *Make sure to sort the data so that the plants from the control and treatment groups are together on the bar graph. See example bar graph*)



4. Have students sketch the bar graph in their research journals.
   (***Teachers note:*** *For more advanced students an alternative method of analysis using a statistical test has been provided in Appendix II at the end of this lesson.*)

v. Evaluate the results.
   1. Examine the bar graph.
   2. Ask students to draw conclusions based on the findings in the bar graph.
   3. Have students record their conclusions in their research journals.
   4. Ask students to share their conclusions with the class.
   5. Discuss the conclusions and their *validity*.

7. Following the scientific method and the same procedures used in the demonstration, ask students to design and conduct their own experiments using the greenhouse simulator.
   a. Follow these steps:
      i. Define the problem
      ii. Gather information about the problem.
      iii. Suggest possible answers, form a hypothesis
      iv. Test hypothesis by designing and conducting an experiment.
      v. Evaluate your results - copy and paste your data into Excel and create a bar graph, then analyze your data.
   b. As in the previous activity have student record each step of the process in their research journal. This information will be used to accomplish Objective 4, which is to compose a laboratory report.

Objective 4: Compose a laboratory report summarizing the research problem, hypothesis, procedures, findings and conclusions.

1. Utilizing the information contained in their research journals, ask students to develop laboratory reports which address the following parts:
    a. Title page – name, class, date, and title of the experiment
    b. Introduction – states the need and justification for the experiment and presents background information that influenced the research.
    c. Research problem – the specific question that was under investigation. All the variables influencing the research should be specified.
    d. Research hypothesis – predictions about the effect the treatment would have on the dependent variable.
    e. Procedures – summary of the techniques used in designing, treating, and measuring the variables.
    f. Findings – summary of the data, would include any graphs or charts representing the data.
    g. Conclusions – specific statements about the relationships between the variables.
    h. Recommendations are suggestions on how the results of the research should be used or recommendations for further experimentation of the problem.
    i. References – complete listing of all sources used in designing the experiment and preparing the report.

Review/Summary – Once students complete their research reports ask each of them to provide the class with a brief oral summary of their experimental design, findings, and their conclusions.

Evaluation – Students will be assessed on their achievement of the learning objectives.

Appendix I

Definitions of Terms:

Control group – in an experiment, a group of participants who receive no treatment or an alternate treatment.
Control variable – a variable that is held constant so that it will have no effect on the dependent variable.
Dependent variable – a variable that occurred after, and as a result of another variable. In a hypothesized cause-and-effect relationship, the dependent variable is the effect.
Experiment – a research study in which the investigator manipulates one or more independent variables (the treatment) and observes the effect on one or more dependent variables.
Independent variable – a variable that occurred prior in time to and had an influence on the dependent variable. In a hypothesized cause-and-effect relationship, the independent variable is believed to be the cause.|
Random Selection – process of selecting a sample by chance means, so that every member of the population has an equal probability of being selected.

Treatment variable – the variable to be manipulated in order to determine its effect on the dependent variable.

Validity – refers to the degree to which researchers conclusions are justifiable and appropriate.

Appendix II

Rather than summarizing the data using a bar graph, a statistical test called a paired samples t-test can be used to analyze the data. This procedure tests if the statistical mean (average) of one group is significantly different than the mean of another group. Using this procedure would require that the instructor be familiar with this method of statistical testing and capable of explaining the concept to the students. Microsoft Excel does provide a data analysis tool, which is capable of conducting this test. The following instructions explain how to conduct this test using Excel.

Data Analysis using Excel 2003

1. On the menu bar, click on "Tools" and then select "Add-Ins"
2. A window will open with many available chooses, check the box next to "Analysis ToolPak" and then "OK"
3. Click on "Tools" to access the Analysis ToolPak.

Data Analysis using Excel 2007

1. Click on the MS Office button in the upper left corner of your screen and then in the bottom right corner of the menu click on "Excel Options".
2. Along the left side of the menu click on "Add-Ins" then at the bottom of the menu box find the "manage:" box.
3. Select "Excel Add-ins" and click on the "Go" button.
4. A small menu box will display available Add-Ins, select the box for "Analysis ToolPak" and allow Excel time to install the new Add-In.
5. Now when you click on the "Data" tab you should see "Data Analysis" on the right.

Using the t-test

1. *Just as before* - Copy and paste the plant growth data into Excel.
2. Realign the data and the column heading, in a new column create a formula and calculate the difference between the plant's final and initial weights.
3. *New steps* – On the menu bar, click on "Tools" and then "Data Analysis"
4. A new window will appear, scroll down the list of available analysis tools until you find "t-test: Paired Two Sample for Means" click on it and then click "OK"
5. Another window will appear, it will ask you to enter two data ranges. Here you need to enter the data from your first group in the box for "Variable 1 Range". To do so, click on the box, which locates your cursor in the box and then go to your data set and highlight the cells that contain the "Difference" data for your first group only. Once you have done this, the range of cells should appear in the box for "Variable 1 Range".
6. Next click on the box for Variable 2 Range and follow the same procedure mentioned in item 5.
7. If you choose to test whether there is a significant difference between the means of your two groups you will need to enter a zero (0) in the box next to "Hypothesized Mean Difference".
8. Once you have completed these steps, click "OK".
9. Excel will now conduct the t-test and an output will be displayed on a new sheet within your spreadsheet file. This output will display the means for each group and the variance. Towards the bottom you'll find the t statistic (t Stat) and the p-values. If students predict that the treatment group will exhibit greater growth than the control group then the one tail p-value is

the most appropriate statistic to use [P(T<=t) one-tail]. The alpha level is set at .05 by default, so a p-value less than .05 would be considered significant. This would allow the researcher to conclude that two means are significantly different. The one-tail p-value allows the researcher to not only conclude there is a significant difference, but also that the mean of the treatment group is greater than that of the control group.

[i] Rocca, Steven (2005).Virtual Greenhouse Experimentation. *California State University, Fresno*.