BLA List in Numerical Order

BLA #	Grade Level	Activity Title	Description
3	K-4	Guest Speaker: Agricultural Professional	Effect of biotechnology on crop yield and selection.
10	K-4	Developing a Biotechnology Bulletin Board	Students create a bulletin board that shows how natural and synthetic fibers and materials relate to biotechnology.
12	K-3	What's in Water	Life and pollution in water.
14	8-12	Backyard Bacteria	Investigating the uses of soil bacteria.
15		Not assigned to a BLA.	
16	2-4	Yogurt with Another Purpose	How antibiotics interfere with yogurt fermentation.
21	10-12	Plastic from Bacteria	Isolation of a plastic from bacteria.
22	10-12	Growing a Hydroponic Plant	Hydroponic vs. traditional plant growth.
23	5-7	Life Cycle of a T-Shirt	Students learn the about the materials, economics, cost/benefit, and decision making process in the manufacturing of a t-shirt.
25	5-7 8-10	Hole – Y Ozone! It's The CFCs	Demonstrates the effects that CFCs are having on the atmosphere.
26	K-4 5-7	Introduction To Adaptation	An introduction to structural adaptation in different organisms.
28	K-4	Soil Stories	Identify components of soil, soil types, and the influence of soils on water filtration.
29	5-7	Biotech Timeline	Events and developments in the history of biotechnology and agriculture. Students create a timeline.
30	K-7	Bubbling Bread	The meaning and purpose of biotechnology. Differences between old and new biotechnology.
31	5-7	Pollen Separation	Separation of different materials and compositions. How flowers distinguish between one pollen and another.
33	K-4	Pollination	How genetic material transfers through pollination.
34	8-9	Pollen Collection	Design and construct a system to remove and collect pollen from various plants.
35	K-4	No Work Leaf Garden	Life cycle of a potato.

37	8-10	Collection and Identification of Bacteria from the Community	Pathogen Location.
38	8-10	Body Fluid Transmission	Transfer of disease in bodily fluids.
40	11-12	Effect of Commercial Soaps	Effectiveness of commercial products controlling bacteria.
41	11-12	Current Event	Choose and research an article related to a technology topic.
42	8-10	Student Self-Design Regulations	Lab Safety Regulation Guidelines for the classroom. Role-play application.
43	K-3	Store Bought vs. Home Made	Compare products for mold resistance.
45	8-10	Enzymes for Communication	How enzymes affect lives and communications.
46	5-10	Trash to Treasure	Recycle trash into something useful.
48	8-10	Thick and Fast	Cellulase preparation in degrading cellulose.
49	5-8	Grease Busters	Investigate the lipolase enzyme in detergent powders. Create a detergent powder with lipolase.
50	5-8	Better Milk for Cats	Immobilize lactose in calcium alginate beads.
51	5-10	More Juice from Apples	Comparing juice yields from different apple pulp samples.
63	3-7	Owl Pellets	Examine pellets to determine eating habits and food sources for owls. Food chain concepts.
64	K-7	As the Cell Turns	Identify and draw cells observed.
66	K-12	Germ Busters	Hand washing, germ spreading.
75	5-7	Toxics Lesson Plan	Identify and substitute toxics in the home.
77	5-7	Lake Benjamin	Pollution's effect on natural resources. Clean up process.
78	11-12	Nuclear Reactor Incident	Effects of nuclear accidents on the environment and community.
82	10-12	Energy Environment Factors	How individuals and organizations affect environment.
84	10-12	pGLO Transformation	Transform a bacterium using sterile technique
85	K-4	Buckle That Seatbelt!	Demonstrate safe and unsafe use of model car's seatbelt. Devise a way to keep the marble in the vehicle. Relate to real life.

86	11-12	How Can You Size Up The Situation?	Understand the use of protein purification and its role in biotechnology. Size exclusion chromatography.
87	11-12	How Can DNA Pattern Help Solve Human Problems?	Basic concepts of DNA fingerprinting
88	K-4	Find The Peanut	Students learn careful observations of living things.

Guest Speaker: Agricultural Professional

BLA#: 3

Strand(s):
Agriculture, Genetic Engineering, Regulation Safety

Standard Statement(s):
3.1.7 A, 3.1.7 B, 3.1.7 C, 3.2.7 C, 3.2.7 D, 3.3.7 C, 3.3.10 C, 3.3.12 C, 3.6.7 A, 3.6.10A, 3.6.12A, 4.3.10 C, 4.4.7 A, 4.4.7 B, 4.4.7 C, 4.4.10 A, 4.4.10 B, 4.4.10 C, 4.4.12 A, 4.4.12 B, 4.4.12 C, 4.5.7 A, 4.5.7 B, 4.5.7 C, 4.5.10 A, 4.5.10 B, 4.5.10 C, 4.5.12 A, 4.5.12 B, 4.5.12 C, 4.7.10 B, 4.7.10 C, 4.8.10 C, 4.8.10 D, 4.9.7 A, 4.9.10 A, 4.9.12 A

Content Objective(s):
After this activity, students will be able to:

1. Develop questions on the effect of biotechnology on crop yield and crop selection to be asked during presentation.
2. List at least one thing learned from biotechnology presentation.

Assessment Strategies:
Student produced:

1. Questions
2. Thank you note listing at least one thing they learned from the presentation.

Procedures:
A speaker (farmer, cooperative extension agent, food processing professional, etc.) will discuss the effect of biotechnology on crop yield and crop selection. Topic depth will be based on the age of audience. Titles based on Standards.

1. Begin with KWL activity to build background and activate prior knowledge.
    - Ask students what they know about biotechnology and the effect it has on crop yield and crop selection.
    - Ask them what they want to know on this topic and have them develop questions to be asked during the speaker presentation.
2. Introduce speaker and have students listen and ask questions. Facilitate discussion during presentation.
2. After the presentation, review discussion of speaker's information
    - Have students share what they learned.
4. Pass out paper and materials for writing and drawing. Have each student write a thank you note, listing at least one statement of information he or she learned from the presentation.

Source:
Amy Alverez (Harpst), Susquehannock High School.

Related Web Sites:
http://www.ase.tufts.edu/biology/bguide/classes/plantbio/assignment.htm
http://www.ag-econ.ncsu.edu/faculty/marra/FirstCrop/tsld001.htm
http://www.extension.uiuc.edu/~vista/html_pubs/irspsm91/future.html

Suggested Level:
Grades 5 - 7, 10 - 12

Standard Category:
Agriculture & Society

Materials:
Guest speaker
Paper
Writing and drawing materials.

Instructional Strategies:

- **Teacher:**
    1. Find and prepare a guest speaker based on the designated learning objectives
    2. Facilitate discussion
- Individual
- Whole class

Developing a Biotechnology Bulletin Board **BLA#: 10**

Content Organizer(s):
Agriculture, Biomaterials

Standard Statement(s):
3.4.4 A, 3.7.4 A, 4.4.4 B

Content Objective(s):
At the conclusion of this activity, students will:

1. List possible locations of samples of natural and synthetic fibers and materials.
2. Collect samples of natural and synthetic fibers and materials.
3. Create a bulletin board project displaying the materials collected with captions explaining their relationship to biotechnology.

Assessment Strategies:
Student's completion of:

1. Locations list.
2. Collected samples of natural and synthetic fibers and materials.
3. Bulletin board project display with at least one sample and its caption.

Procedures:
For this activity, students will collect samples of natural and synthetic fibers and materials. They will then create a bulletin board project displaying the materials collected with captions explaining their relationship to biotechnology. This activity will take several periods to complete for introducing the activity, creating the bulletin board and sharing/discussion.

1. Introduce and define natural and synthetic fibers and where they can be found (use of visual aids would be helpful).
2. Have them create a list of locations of where the samples can be found in the form of a homework sheet to be shared at home (use index cards). Have students collect samples of natural and synthetic fibers and materials.
3. Have students examine their samples using the microscopes. Draw and describe what is seen under the microscope. Have them compare and share their findings. Collect samples from students and provide supplies and guidelines for bulletin board creation.
4. Have students create the background, mount samples, attach captions (with descriptions) to samples, and upon completion, create a title for the bulletin board display project. Include a high quality drawing to correspond with what they saw under the microscope.
5. Conclude activity with sharing of displays and a guided class discussion on how these products impact daily life. Students will participate and provide insights into the discussion. The title section may or may not be used as a springboard for this lesson.
6. Extension of this activity may include exploring the strength, water repellency and absorbency of fibers, etc.

Source:
Charles Kessler, Mifflinburg High School.

Related Web Sites:
http://www.clothesline.com/tipsTimeSavers/fibers.html
http://www.fantasyfibers.com/fibers/rayon.htm

Suggested Level:
Grades K-4

Standard Category:
Physical Science
Technological Devices
Inquiry & Design
Agriculture & Society

Materials:

- Visual aides to introduce the concept.
- Index cards (3X5)
- Microscopes (10X)
- Bulletin board supplies (construction paper, lettering materials, thumb tacks, stapler and staples, agricultural/technology /science related magazines, student's fiber samples)

Instructional Strategies:

- Individual
- Whole class
- Community

What's In Water? BLA#: 12

Strand(s):
Agriculture, Regulation and Safety

Standard Statement(s):
3.3.4 A, 3.7.4 A, 3.7.4 B, 4.1.4 C, 3.3.7 A, 3.7.7 A, 3.7.7 B, 3.3.10 A, 3.7.10 A, 3.7.10 B, 4.1.10 C, 4.4.7B

Content Objective(s):
For this activity, students will:

1. Draw pictures of observed life forms in the collected water samples.
2. Describe and relate specimens to the pollution level of water samples.

Assessment Strategies:
Student generated:

1. Drawings.
2. Responses of specimen descriptions and their relationship to the pollution level of water samples.
3. One day activity extension assessment: Identifications to genera using keys (with microscopes).

Procedures:
In this activity, students will discover different forms of life living in water/mud samples. Clean water has a wide variety of visible life forms living within the mud and rocks. Polluted water, however, typically has little or limited variety. This activity needs 2 periods to complete.

1. Give students directions for collecting water samples from area ponds, streams, puddles of standing water, etc. Have them include plant life, mud and/or rocks from the bottom of their water source. (suggestion – ask for "stuff" in water, like pond scum).
2. Provide students with the bottles and grease pens. Have them label jars to include name of location and as good a description of the location as possible.
3. Set-up the discovery part of the activity by putting some of the water (include plant life, mud, and rocks) samples in the shallow pans or meat trays. Have students use hand lens to discover any observable life forms. Have them draw what they see.
4. As a class, have students share drawings, describe the specimens, and relate what they observed to the pollution level of different water samples.
5. Compare samples from different water sources.

Sources:
Mark Temons

Related Web Sites:
http://commtechlab.msu.edu/sites/dlc-me/zoo/zwmain.html

Suggested Level:
Grades K-4, 5-7, 8-10

Standard Category:
Biological Sciences
Technological Devices
Watersheds & Wetlands

Materials:

- Bottles w/screw-on tops
- Grease pens
- Hand lens
- Shallow pans or meat trays
- Paper
- Microscopes

Instructional Strategies:

- Individual
- Whole class
- Community

Investigating the Uses of Backyard Bacteria **BLA#: 14**

Content Organizer(s):
Biomaterials, Regulation Safety, Resource Recovery

Standard Statement(s):
3.2.10 C, 3.3.10 A, 3.3.10 D, 3.6.10 A, 3.8.10 A, 3.8.10 B, 4.2.10 D, 4.3.10 A, 4.8.10 C, 3.2.12 C, 3.3.12 A, 3.3.12 D, 3.6.12 A, 3.8.12 A, 3.8.12 B, 4.2.12 D, 4.3.12 A, 4.8.12 B, 4.8.12 C

Content Objective(s):
After the completion of this lab, students will be able to:
1. Select protein-digesting bacteria from various soil samples.
2. Investigate ways to test the effectiveness of their specimens in breaking down protein stains on clothing.
3. Determine a method to be used to isolate oil-degrading bacteria.

Assessment Strategies:
Student's completed formal lab report addressing essential questions.

Procedures:
Biotechnology in resource recovery goes well beyond the traditional composting and sewage treatment process. Today biotechnology is being used as a method of treating industrial waste in a number of areas: to reduce pollution, improve crop production, rectify harmful spills, and turn wastes into fuel.

This activity involves sampling bacterial activity in various soils in the study of waste and clean-up problems through bacterial protein digestion. After teaching materials preparation, class work involves one period for petri dish inoculation followed by one-half period for colony observation.

- **Teacher Preparation** (Preparing the skim milk agar)
  1. Add 30g nutrient agar to 1L of distilled water in a flask. Drop in a magnetic stirrer.
  2. Insert a nonabsorbent cotton plug and autoclave the mixture for 20 minutes.
  3. Remove from autoclave and allow flask to cool for 5 minutes.
  4. Add one carton of "Parmalat" brand skim milk (approx. 1L) to the agar flask (not too soon or the milk will curdle).
  5. Stir on stirring plate for 1 to 2 minutes (too much stirring will cause bubbles).
  6. Using aseptic technique, pour out the plates for all of the groups.
  7. Autoclave all glassware and enough sterilized water for all lab groups.

Alternative to preparing the agar

Suggested Level:
Grades 8-10, 10-12

Standard Category:
Biological Sciences
Technology Education
Inquiry & Design
Science, Technology & Human Endeavors
Renewable & Nonrenewable Resources
Environmental Health
Humans & the Environment

Materials:
For teacher preparation:
- Autoclave (*if not available, see alternative lab preparation)
- 30g nutrient agar
- 1 L flask
- 1 L distilled water
- 1 box "Parmalat" brand skim milk (can be found on grocery store shelves, is basically sterile)
- Nonabsorbent cotton
- Magnetic stirrer
- Sterilized Petri dishes
- Stirring plate

Entire class
- Balances
- Bunsen burner

For each lab group
- 95% ethanol
- 3 sterilized Petri dishes prepared with skim milk agar
- Spreading rods
- 3 sterile 1mL pipettes
- 3 sterile test tubes with nonabsorbent cotton plugs
- 3 sterile jars
- Sterile water
- Tape

Instructional Strategies:
- Individual
- Small group
- Whole class

Sterile agar can be purchased from supply companies, and the milk then added to the melted agar. Sterile skim milk agar can be purchased from Carolina Biological Supply Company's microbiology department. It is sold in bottles so it would have to be melted down, then poured into plates.

1. Each group should start off with three samples of soil collected from different environments (a meadow, a wooded lot, etc.). For the first sample, weigh out 1 gram of the soil and add it to 99 mL of sterile distilled water in a jar. Further dilute this mixture by removing 1 mL of the mixture and adding it to a test tube containing 9 mL of sterile distilled water. Mix thoroughly by swirling. Be sure to keep all tubes capped and employ sterile techniques at all times.
2. Use the pipette to remove 0.1 mL of this dilute soil mixture and put it on a Petri dish containing skim milk agar. Dip a spreading rod in the alcohol, hold it over a flame and cool it off by pressing it gently into the agar off to the side of the mixture. Use this to spread the diluted soil sample evenly onto the plate. Flame the rod when finished.
3. Label this plate with the names of group members, date of inoculation, and soil source. Repeat procedure 1 and 2 with the two other soil samples. Stack the three dishes, tape them together, and store them upside down overnight at room temperature.
4. The next day, check to see if there are any clear "halos" developing around the bacterial colonies. If so, record the number and position of such colonies in each dish (sketches could accompany data chart).
5. If no colonies are visible, record observations on the second day, etc.
6. Your teacher will give you instructions for disposal after the activity is completed.
7. This lab could be organized into a formal lab report. Possible questions to be answered as part of the experimental analysis could include:
    - Was there varying success in isolating colonies from the different samples and if so what might account for the differences?
    - Why did it take some groups several days to develop protein digesting colonies while others may have noticed them after 24 hours?
    - What did the clear "halo" indicate? Why didn't all the bacteria have halos?
    - What do the bacteria contain that allow them to digest the proteins?
    - What are some of the protein sources that stain clothing and contact lenses? How can these bacteria be used in the cleaning industry?
    - What method could be used to isolate oil-degrading bacteria?

➢ **Extension/Reinforcement/Additional Ideas**

Since the procedure employed in no way harms the bacteria, individual protein-digesting colonies could be re-cultured onto a new Petri dish and studied. Students could also perform a Gram stain on the colonies to determine some of their characteristics. They could test the efficiency of the bacteria in dissolving a protein stain on a cloth. (Albumin could be a possible protein source, and there are many indicator tests that could be used to test for the digestion of the protein). A comparison study could be done with some name brand laundry detergents. Motivated students could contact the manufactures of various laundry detergents and contact-lens cleaners to determine their enzyme source. In addition, student could devise various lab protocols for isolating colonies that can digest oil, starch, etc. and then test their effectiveness.

Source:

"Investigating the Uses of Backyard Bacteria." By Elisa Brake, Access Excellence – Activities Exchange.

Related Web Sites:

http://www.gene.com/ae/AE/AEC/AEF/1996/brako_bacteria.html

Yogurt With a Difference **BLA#: 15**

Content Organizer(s):
Biomaterials

Standard Statement(s):
3.2.12B, 3.2.12C, 3.6.12A, 3.3.12B

Content Objective(s):
At the conclusion of this activity students will be able to:

1 Make yogurt from milk with reduced lactose content using enzyme B-galactase (lactase) to hydrolyze its lactose to glucose and galactose to normal milk.
2 Understand that lactose content can be controlled.

Assessment Strategies:

1. Students can explain test strip assay for glucose and why lactose concentration is 1.92 times glucose (lactose is a disaccharide of glucose).
2. Students can rank concentrations of lactose in different samples.
3. Students should be able to describe enzyme-substrate interaction with accurate models that illustrate enzyme-substrate complex and lock-key model.
4. Students should be able to compare pretreated milk with normal milk using descriptive observations, pH comparisons, % glucose, and possibly taste.

Procedures:
A common practice in yogurt manufacturing is the addition of skimmed milk powder to improve the yogurt's nutritional status and to thicken it. This also increases the lactose content of the yogurt and may be unsuitable for those who are lactose intolerant. Food technologists have therefore investigated the possibility of making yogurt from milk with a reduced lactose content. In this activity, students will compare the production of yogurt using pretreated milk (with the enzyme B-galactase lactase to hydrolyze its lactose to glucose and galactose) to normal milk.

- **The day before the investigation:**
  1. Inject 0.5 cm of lactase enzyme into 500 ml milk.
  2. Leave the milk in a refrigerator for 24 hours, so that the enzyme can hydrolyze the lactose the milk contains.
- **Alternatively**
  1. Buy a carton of 'Lactose-reduced milk' e.g. Lactolite
- **On the day of the investigation:**
  1. Dispense 10ml of enzyme-treated milk into one of the boiling tubes, and 10 ml of normal milk into the other.
  2. Add 1 ml of yogurt starter culture to each tube.
  3. Stir the tubes' contents gently. Do not shake.
  4. Seal the tubes with plastic wrap.
  5. Incubate the tubes in a water bath at 43.0^0C for up to 5 hours (it will actually take far less time with this proportion of starter culture).

Suggested Level:
Grades 10-12

Standard Category:
Biological Sciences
Physical Science,
Chemistry, & Physics
Inquiry & Design

Materials:

- Milk, 500 ml, x 2
- Natural yogurt starter culture
- Lactase,
- 0.5 ml (available from the NCBE)
- plastic wrap
- Glass stirring rod
- 1 ml syringes (for measuring out enzyme)
- 10ml syringes (for measuring out milk)
- Boiling tubes
- Stop watch
- Water bath, set at 43.0^0C
- pH probe (optional) or pH paper may be used

Instructional Strategies:

- Groups
- Whole class

6. Observe the pH and appearance of the yogurt (a data logger may be used if available).

- **Safety**

  Although the work is done using food handling equipment (not boiling tubes as specified above) in a food preparation area, the product of this investigation may not be eaten.

- **Further activities**

1. Compare the production of yogurt using different types of milk e.g. ewe's milk (4.91% lactose); goat's milk (4.46% lactose) and cow's milk (4.7% lactose).
2. The glucose concentration of lactose- hydrolyzed milk is readily assessed using semi-quantitative glucose test strips. Lactose concentrations can be estimated by multiplying the glucose measurement by 1.92. Yogurts can be made with milks containing different proportions of lactose and compared. **NOTE**. *It is important to denature the enzyme by heat treatment once the desired glucose level has been reached.*
3. Compare the following production processes (all three are used commercially):
   - **Method A**
     Add the enzyme to cold milk (<10.0^{0}C). Leave overnight, then make yogurt as usual.
   - **Method B**
     Warm the milk to 30.0—35.0^{0}C. Add the enzyme. The hydrolysis treatment may vary from 1/2 —2 hours depending upon the degree of hydrolysis required, (30-100%), enzyme activity and dosage rate. Make the yogurt as usual.
   - **Method C**
     Pre-warm the milk to 30.0^{0}C. Add the enzyme and starter culture together. Incubate overnight for 1 6—18 hours at 30.0^{0}C.

Source:
Any standard biology or biotech catalog.

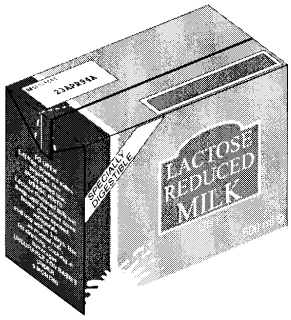
Related Web Sites:

Yogurt with a Difference

You can make your own lactose-reduced milk by adding lactase enzyme to ordinary milk

1

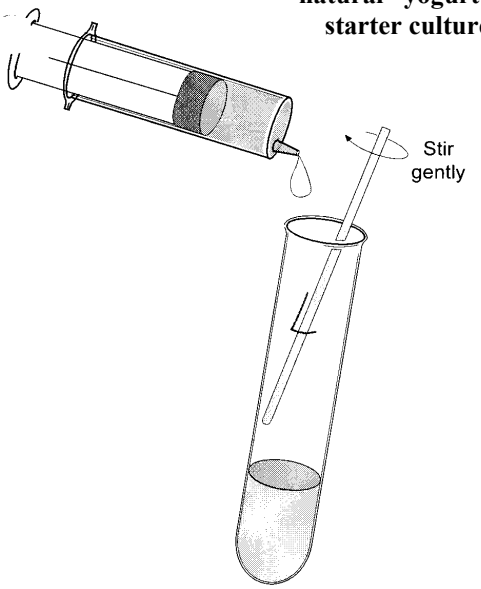
Compare yogurts made with either enzyme-treated or "normal" milks



2

Put 10 cm^3 of milk into a boiling tube

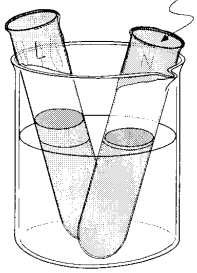
Add 1 cm^3 of "natural" yogurt as a starter culture



Stir gently

3

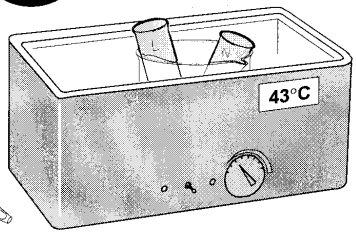
Seal top with *Cling film*



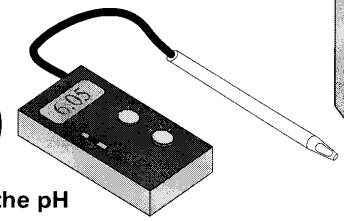
Set up two tubes, one with 'normal' milk, the other with enzyme-treated milk

4

Incubate both tubes at 43°C in a water bath



5



Measure the pH

Yogurt With Another Difference **BLA#: 16**

Content Organize(s):
Biomaterials

Standard Statement(s):
3.1.12A, 3.2.12B, 3.2.12C, 3.3.12B, 3.6.12A

Content Objective(s):
At the conclusion of this activity the students will be able to:
1. Understand that yogurt is made of live bacteria. The growth of bacteria may be inhibited using penicillin G (antibiotic)
2. Understand light microscopy and gram staining.

Assessment Strategies:
1. The student will demonstrate an understanding of how to handle a light microscope, its parts and preparation of slides, and will describe why are we staining the smears.
2. The student will demonstrate how to count bacteria from three slides and make an average. They will compare and find different bacteria density between yogurts with penicillin G and without penicillin G, OR difference between yogurt from lactose digested milk and undigested milk
3. The student will demonstrate how to calculate the number of organisms in a cm^2 and number of organisms in a ml of yogurt.

Procedures:
Milk is routinely tested for residual antibiotics – not because these pose any health risk, but because antibiotic presence may prevent the growth of starter culture organisms used in, for example, the manufacture of cheese or yogurt. The way in which Penicillin G interferes with cell division can easily be demonstrated in the school laboratory, using Lactobacilli and Streptococci from yogurt. This work provides a stimulating context for carrying out some basic microbiological techniques: Gram's staining and direct cell counts. In this activity students will see how antibiotics interfere with yogurt fermentation with two different substances.

- **Note:** This lesson can be used as an advanced extension of **BLA# 15**, Yogurt With a Difference, or some other activity introducing yogurt.

- **Note: <u>Safety--</u>Do not overheat or the glass will shatter. Do not touch the hot part of the slide. Use safety goggles and clothing prior to handling slide.**

- **Practical Details:**
  Making the Yogurt:
  1. Warm the milk to about 40°C (+/-2°C).
  2. Add penicillin G discs to the milk (up to 8 per 500ml of milk).
  3. (Always have a control without penicillin)
  4. Stir in 2% v/v starter culture.
  5. Incubate for 4 – 6 hours without stirring at 40°C (+/-2°C).

Suggested Level:
Grades 10-12

Standard Category:
Biological Sciences
Physical Science, Chemistry, and Physics
Inquiry & Design

Materials:
- Penicillin G discs (from the usual school science suppliers)
- Milk
- Non-Pasteurized plain natural yogurt suitable for use as a starter culture (different supermarket brands seem to vary considerably, so trials might be needed to determine the best type to use)
- Microscope slide
- Grease pencil
- Crystal violet solution, made up as follows: Add 2g of crystal violet to 100mL absolute alcohol. Make up a second solution of 1g of ammonium oxalate in 100mL of distilled water. Add 25mL of the first solution to 100mL of the second.
- Iodine solution, made up with 1g of iodine and 2g of potassium iodide in 300mL of distilled water
- Ethanol (95%) –laboratory IMS will do
- 1% safranin solution, aqueous
- Microscope with oil immersion objective (optional)
- Stage micrometer (optional)
- Incubator or water bath at 40°C

Continued:

- **Preparing a heat-fixed slide of bacteria from the yogurt:**

1. Pass a dry slide through a Bunsen burner flame to remove any grease (Use alcohol flame).
2. Place the slide over a sheet of graph paper marked in square centimeters. With a well-sharpened grease pencil mark out on the slide two squares of 1cm^2 each.
3. Mix the suspension of yogurt thoroughly and use the micropipette to transfer exactly 0.01mL of suspension into the center of each marked area.
4. Using a sterile straight wire spread the suspension evenly over the marked areas.
5. Keeping the slide horizontal, dry the film rapidly in the air near the flame, then heat fix the bacteria onto the slide by heating it momentarily in the Bunsen flame.

- Home-made micropipette to dispense 0.01mL liquid

Instructional Strategies:
- Group Work
- Whole class

- **Staining the bacteria on the slide (Gram's stain):**
  1. Cover the heat-fixed film on the slide with ammonium oxalate crystal violet solution and stain for 30 seconds.
  2. Rinse off the stain with tap water.
  3. Wash off the water using iodine solution. Cover the film with the iodine solution for 30 seconds.
  4. Rinse off the iodine solution with tap water.
  5. Wash away the water with ethanol and decolorize the slide until the washings are pale violet – do not over decolorize.
  6. Stain with 1% Safranin solution for two minutes and wash with water.
  7. Wash away the ethanol with tap water. Gently blot or air-dry the slide.

- **Examining and counting the bacteria on the slide:**
  1. Set up the microscope and use the x100 oil immersion objective (prefer highest power available). Count the number of organisms (bacteria) in the field of view or use a stage micrometer to calculate field of view (if available), and hence the number of fields in 1cm2.
  2. Examine the slide under an oil immersion lens and count individual organisms, pair chains and clumps. Any organisms that are aggregated should be counted as one clump; organisms that are more than the length of one bacterium away from the clump should be counted as individuals. The number of fields to be counted depend on the number of organisms present in each field:

Average number of clumps Or organisms per field	Number of fields to be counted
0 – 3	64
4 – 6	32
7 – 12	16
13 – 25	8
26 – 50	4
51 – 100	2
> 100	1

  3. Count the organisms present in both marked areas on the slide and determine the average number of organisms and clumps per field. Let the average count per field = N. Let the number of fields in 1 cm^2 = A.

     No. of organisms in 1cm^2 (i.e. 0.01 ml) = N x A
     No. of organisms per ml of yogurt = N x A x 100
     Should the suspension be too dense to count directly, dilute it as necessary (1:10 or 1:100).

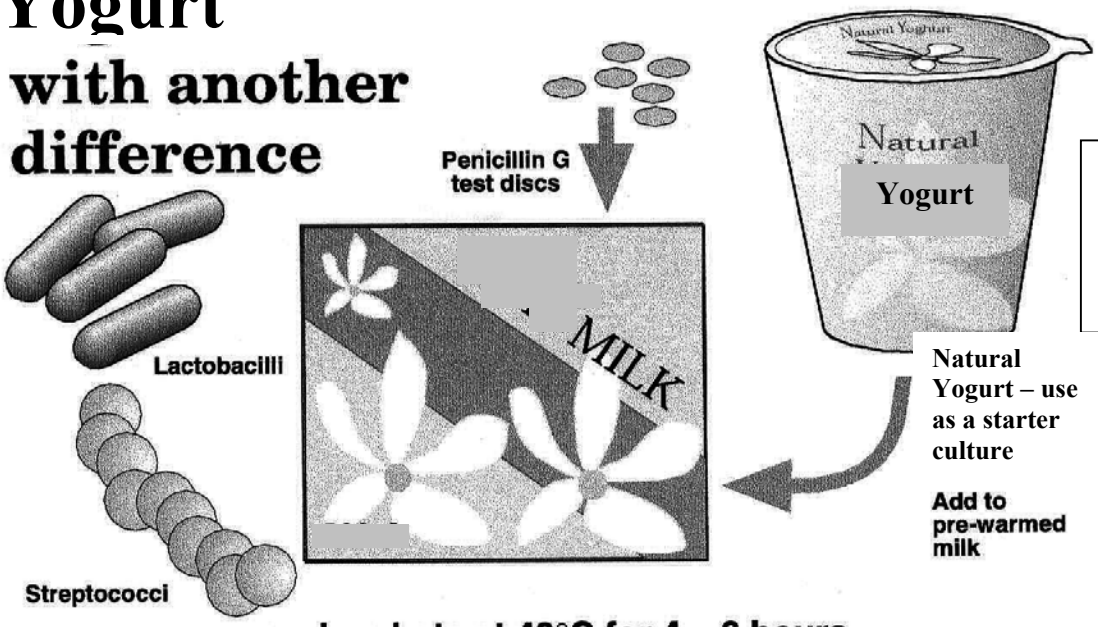
- **Safety Note:**
  The yogurt produced in this way *should not be tasted*. Caution should be exercised when handling ethanol (keep away from flames!) or the stains e.g. crystal violet.

- **Further activities:**
  Yogurt bacteria can also be stained using methylene blue solution. The dye should be left on the slide for 2 minutes, and then gently rinsed off with water. The slide should be air dried (without blotting) before examination.

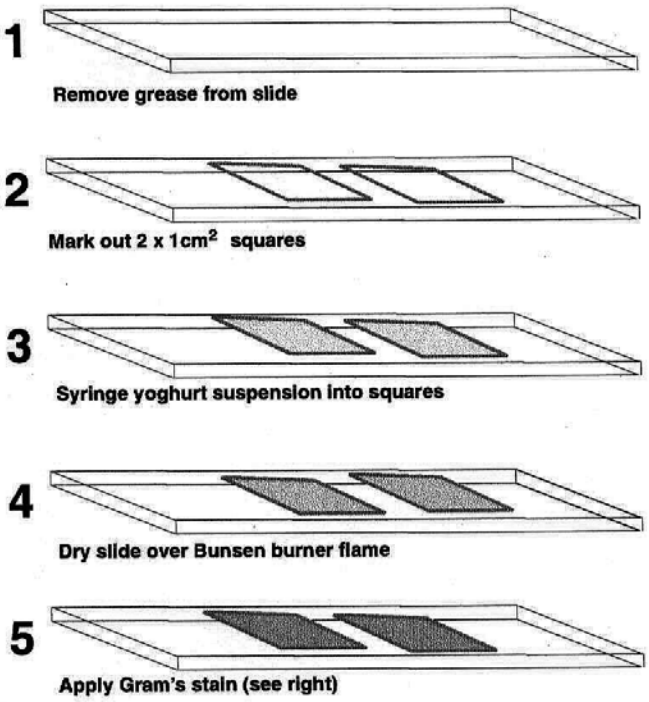
Source:
Any biology or biotech catalog.

Related Web Sites:
www.ncbe.reading.ac.uk/NCBE/PROTOCOLS

Yogurt with another difference



Gram's stain



Cover slide with **crystal violet** solution and stain for 30 seconds. Rinse stain off with tap water or distilled water from a wash bottle.

Cover slide with **iodine solution** and stain for 30 seconds. Rinse stain off with tap water or distilled water from a wash bottle.

Decolorize slide with **ethanol (IMS) until the washings are a very pale violet.** Rinse with tap water or distilled water from a wash bottle.

Counter stain with **safranin solution** for 2 minutes. Rinse stain off with tap water or distilled water from a wash bottle.

Blot or air dry. Examine under a microscope fitted with an oil immersion lens.

Standard Statement(s):
3.6.10A, 3.6.12A, 4.2.10A, 4.2.12A

Content Objective(s):
During this activity, students will:
1. Record and apply the scientific method in a lab report.
2. Draw what they observed from the microscope.

Assessment Strategies:
Student produced:
1. Lab report.
2. Lab drawing.

Procedures:
In this activity, students will isolate poly-B-hydroxybutyrate (a plastic) from *Alacaligenes eutrophus.*

- **Growing the Bacteria**

After complete utilization of the nitrogen in the nutrient broth, the bacteria can no longer grow and energy derived from the sugar in the medium is used for the production of the reserve material, PHB. Sufficient bacteria for staining may be conveniently cultured in McCartney bottles or in an NCBE Bioreactor.

1. Aseptically transfer a loopful of *Alcaligenes eutrophus* from a slope to a Universal Bottle containing 20 cm^3 of half-strength nutrient broth. Alternatively, prepare an inoculum and fermenter for larger scale cultivation.
2. Incubate the bacteria at 25^oC for 48 hours.

- **Staining for PHB**

1. Flame the loop and allow it to cool. Remove the cap from the culture bottle, flame the neck, remove a loopful of broth, flame the neck again and replace the cap.
2. Spread the culture on a clean, grease-free slide, using the loop. The smear should cover an area about 10mm x 30mm. Flame the loop. Allow the smear to dry in the air.
3. Fix the smear by holding the slide with forceps and passing it horizontally through a small Bunsen flame 2-3 times. Do not overheat the slide. Fixing kills the bacteria by coagulating the cytoplasm. It also sticks them to the slide.
4. Place a few drops of Sudan Black solution on the fixed preparation.
5. After 5-10 minutes the ethanol in the stain should have evaporated. Any excess liquid can be carefully drawn off using the edge of a piece of filter paper.
6. Immerse the slide in xylene until it is completely decolorized (this takes about 10 seconds). Allow the slide to dry.
7. Flood the slide with the counterstain, Safranine solution.
8. After 10 seconds, gently rinse the slide with running water and allow it to dry again.
9. When the slide is completely dry add a drop of immersion oil directly to the slide (no cover slip is needed). Examine with an oil immersion lens. The PHB can be seen as very dark granules inside pink cells.

Suggested Level:
Grades 10 - 12

Standard Category:
Biotechnology
Renewable resources

Materials:
- Culture of *Alcaligenes eutrophus* (available from Philip Harris Limited)
- Half strength nutrient broth
- Sudan Black B stain (0.3% in 70% ethanol)
- Safranine stain (0.5% in water)
- Xylene (dimethylbenzene – see safety note below)
- Universal bottle and incubation facilities (25^oC) or a fermenter e.g. *NCBE Bioreactor* in which to culture microbes)
- Microscope with oil immersion objective (at least x100)
- Forceps
- Inoculating loop
- Bunsen burner

Instructional Strategies:
- Individual
- Small group

Students should complete a lab report, applying the scientific method, and a lab drawing of what they observed through the microscope.

- **Safety**

Standard microbiological safety procedures, including aseptic techniques, **must** be observed by teachers, technicians and students when carrying out this work.

- **Source:**

Practical Biotechnology
www.ncbe.reading.ac.uk/NCBE/PROTOCOLS

Related Web Sites:
http://www.mtholyoke.edu/offices/comm/csj/970124/bacteria.html
http://www.wiley.com/products/subject/life/cytometry/ISAC98/5MELGros.htm

Growing a Hydroponic Plant and a Soil Based Plant for Comparison

BLA#: 22

Content Organizer(s)
Agriculture

Standard Statement(s):
3.2.4 C, 3.3.4A, 3.6.4 A, 3.7.4 A, 4.4.4 B, 4.6.4 B

Content Objective(s):
At the completion of this lesson students will be able to:

1. Compare and contrast the theory surrounding hydroponic and traditional plant growth.
2. Record daily observations and measurements of changes in plant growth.

Assessment Strategies:
Students' responses:

1. During discussion.
2. In their daily student updated growth and observation journals.

Procedures:
In this learning activity, students will plant seeds in a hydroponic and a conventional growth media. Next, students will record daily observations of changes in growth, while caring for the growing plants. The suggested teaching time consists of two 30 minute periods and three –28 periods, with about 15 minutes for each period.

1. Introduce the class to the theory surrounding hydroponics and traditional plant growth. Have them participate in a compare and contrast discussion.
2. Provide lab supplies, planting instructions and support. Have the students plant the seeds in both the traditional and hydroponic media. Have them record observations in journals.
3. For the next three -28 periods, provide students with rulers and basic instruction on measurement techniques. Have students observe and measure plant growth and record these findings in the daily journals.

   - **Note:** This procedure should be performed in the beginning of the school year (September) to allow sufficient time for plant growth. Kits and other background aids can be found at the referenced Carolina web site.

Source:
Amy Alvarez (Harpst), Susquehannock High School.

Related Web Sites:
http://www.carolina.com
http://ag.arizona.edu/hydroponictomatoes/

Suggested Level:
Grades K-4

Standard Category:
Biological Sciences
Technology Education
Technological Devices
Inquiry & Design
Agriculture & Society
Ecosystems & Their Interactions

Materials:

- Hydroponic Kit (Carolina Biological)
- Soil
- Pots
- Seeds
- Complete fertilizer
- Rulers
- Daily journals

Instructional Strategies:

- Individual
- Whole class

Life Cycle Analysis of a T-Shirt **BLA#: 23**

Content Organizer(s):
Biomaterials, Regulation Safety, Agriculture, Resource Recovery

Standard Statement(s):
3.6.7A, 3.6.7C, 3.2.7C, 3.2.7B, 3.8.7A, 3.8.7B, 3.8.7C, 4.2.7A, 4.2.7B, 4.2.7D, 4.8.7B

Content Objective(s):
After the completion of this activity, students will be able to:

1. Research/analyze the "hidden costs" of t-shirts.
2. Debate the value of product vs. impact and personal actions.
3. Present/display their findings.
4. Design an environmentally friendly product.

Assessment Strategies:
Student generated products and responses.

Procedures:
This is an interdisciplinary activity that includes the study of materials, economics (cost vs. benefits), environmental impact, geography, and decision-making. It integrates information in the areas of science, technology and society, along with the concept of green design. In this activity students research the "hidden costs" of a t-shirt by finding out the materials involved in the entire life cycle of the t-shirt (the original material used, refining/manufacturing process, packaging, distribution, sales, consumer use, waste). Teachers will need one period to plan and develop the forms and materials needed. One period is suggested for the introduction and concept mapping in the focus area and several weeks for students to research/complete the activity.

1. Provide students with the appropriate background information and introduction of the activity.
2. Guide the class through concept mapping in the focus area.
3. students will research and design their product as a homework assignment (allow at least one week).
   - **Note:** Teacher may divide class into groups with each group researching a different consumer material or process as suggested by the students.
4. Students will build a prototype in the Technology Education laboratory of a specific process involved in the production and / or produce a printed t-shirt**.**

Source:
"It Costs What." Lyle Prescott. Ranger Rick Magazine, December 1997, vol. 31, no. 12, Pages 16 – 19.

Related Web Sites:
http://www.nwf.org/nwf/rrick/
http://www.greenseal.org/index.asp
http://www.nwf.org/

Suggested Level:
Grades 5-7

Standard Category:
Technology Education
Inquiry & Design
Science, technology & Human Endeavors
Renewable & Nonrenewable Resources
Humans & the Environment

Materials:

- Trifolds
- Markers
- Glue
- Additional materials and tools may be required based on student design.
- As needed for the prototype and / or t-shirt

Instructional Strategies:

- Individual
- Groups
- Whole class

"Hole-Y Ozone! It's the CFCs" **BLA#: 25**

Strand(s):
Regulation and Safety, Resource Recovery

Standard Statement(s):
3.1.7A, 3.1.7B, 3.1.10B, 3.2.7A, 3.2.7C, 3.2.10A, 3.2.10C, 3.4.7A, 3.4.7B, 3.4.10A, 3.8.7C, 4.3.7A, 4.3.7B, 4.3.10A, 4.3.10B, 4.8.7C 4.8.10C, 4.9.7A, 4.9.10A

Content Objective(s):
To complete this activity, students will:

1. Identify the major subdivisions of the atmosphere, including the stratospheric ozone layer, and explain why the stratospheric ozone layer is important.
2. Participate in a simulation of how chlorofluorocarbons (CFCs) are creating a hole in the stratospheric ozone layer.
3. List various sources of CFCs in their daily lives.
4. Develop a personal action plan to reduce his/her contribution to the CFC problem.

Assessment Strategies:
Student generated work and responses:

Student drawing of atmospheric layers depicting the action of CFCs on the ozone.

Student generated model using marshmallows and gum drops to model the effect of CFCs (marshmallow) on ozone (three gum drops held by a tooth picks.

Student action plan that illustrates sources of CFC in their home and community along with alternative sources.

Procedures:
This activity focuses on the atmospheric subdivision; atoms/molecules; carbon, oxygen, chlorine, fluorine; chemical; reactions, sun's radiation, health risks, and economics. The suggested teaching time to complete this activity requires a minimum of two class periods.

- **Setting the Stage** –
  1. Share with students the background information and use the student sheets "Major Subdivisions of the Atmosphere" and "How Ozone is Destroyed" to enhance their understanding.
  2. Explain to the students that CFCs have two serious environmental effects. The first and major concern with CFCs is the depletion of the

Suggested Level:
Grades 5-7, 8-10

Standard Category:
Chemistry
Physics
Inquiry
Systems Approaches
Science, Technology & Human Endeavors
Environmental Health
Humans & the Environment
Environmental Laws & Regulations

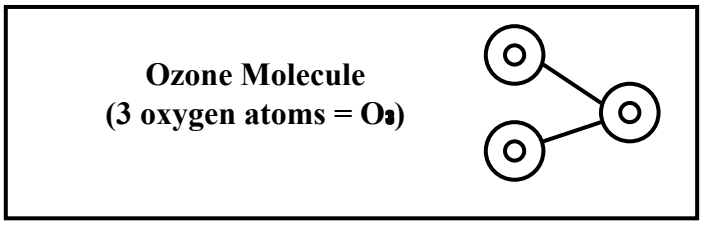
Materials:
- Large marshmallows or gumdrops
- Coffee stirrers
- Food coloring
- Small paint brush
- Scissors
- 5-6 food sheets of newsprint
- Felt-tip markers
- Glue sticks
- Selection of magazines and newspapers
- Masking tape or tacks
- Student handouts

Instructional Strategies:
- Individual
- Whole class

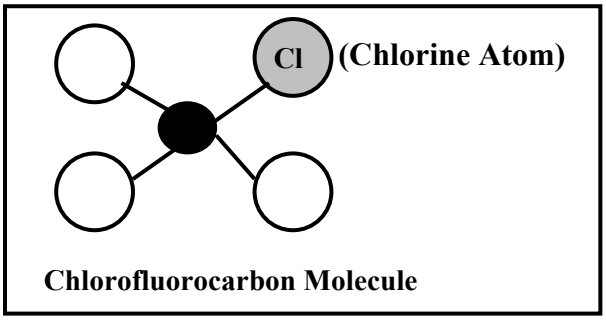
Related Concepts:

ozone layer. The ozone layer screens out most of the cancer-causing ultraviolet light from the sun. When the ozone layer is depleted by one percent, there is a two percent increase in the incidence of human skin cancer. The secondary problem is the greenhouse effect. Although carbon dioxide is largely responsible for the problem, CFCs now comprise 10 – 20 percent of greenhouse gases.

- **Activity – Conduct a simulation with the class to demonstrate how CFCs destroy the ozone layer**.
  1. Explain to the students that the simulation will demonstrate how CFCs can deplete the ozone layer in the stratosphere. Move all the chairs and other items out of the center of the room so you will have room to conduct the simulation. Form a circle of chairs around the room on which students will sit after they participate. This is important because it will illustrate the making of an ozone hole during the simulation.
  2. Tell the class that all but one of them are going to start out playing the roles of ozone molecules. Each ozone student should make one ozone molecule model out of three marshmallows and three coffee stirrers, attaching them as shown:

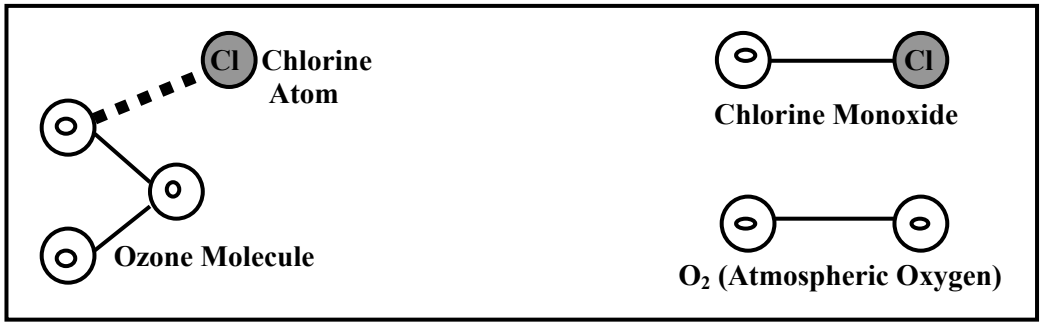


  3. The one remaining student should construct a chlorofluorocarbon molecule model as shown below. To emphasize that this molecule is a CFC, color one marshmallow, using a paintbrush to apply food coloring, to represent the chlorine atom. Color the other marshmallows a different color to distinguish the fluorocarbon group. NOTE: Color these ahead of time so the colors can dry. Green is often used to denote chlorine.



  4. Spread newspaper in the center of the room. On the papers, place a single marshmallow with a coffee stirrer attached for each ozone molecule (all the students except one). These single marshmallows represent free oxygen (O). Free oxygen is produced when ultraviolet rays in the upper atmosphere break apart atmospheric oxygen (O_2) molecules. One free oxygen atom joins with O_2 to form ozone.
  5. Have all the ozone molecules (students) spread out in the room. They represent the ozone layer. When the activity starts, they should start moving around, since the gases in the atmosphere drift freely. Explain to

the class that a CFC molecule is going to be introduced. The CFC student, carrying the CFC molecule model, is to run into the room from the hallway. Have student with flashlight simulate "sunlight." CFC stays stable until the UV rays from the sun (flashlight) strike. Ultraviolet rays in the upper atmosphere split the CFC atom apart, leaving a free chlorine (the colored marshmallow and its coffee stirrer) from the CFC molecule. The student will hold the chlorine atom and drop the rest of the molecule (the fluorocarbon group) on the newspaper.



6. Free chlorine atoms are very unstable and will immediately react with the first ozone molecules they find. Have the student playing the chlorine atom (formerly the CFC) catch an ozone atom and insert the chlorine atom into an oxygen atom on the ozone molecule below. When this happens, the ozone (O_3) is destroyed. The chlorine becomes chlorine monoxide (ClO), which is also unstable, and O_2 which is stable. Have the student who represented the ozone put the stable O_2 molecule on the floor (newspaper) and take a seat on the sidelines.
7. The chlorine monoxide (formerly the CFC) will immediately react with a free oxygen atom (single marshmallows on the newspaper).Have the student remove the oxygen from ClO and attach it to the free oxygen he/she has picked up. Make sure the coffee stirrer is still attached to the Cl atom.

8. When the CFC – ozone-free oxygen reactions have been completed, the chlorine atom student should repeat the same process with another ozone molecule. The whole sequence should be repeated in this way until all the ozone molecules are gone.
9. When the reaction is completed, the newspapers on the floor will be covered with atmospheric oxygen (O_2) models; the free chlorine atom student will be left in the middle of the room; and the other students will be sitting in the chairs around the room. There should be no free oxygen models left on the floor.

- **Discuss the results of the simulation with the students**
  1. Point out that although in this simulation the chlorine atom reacted with 20-25 (or more) ozone molecules, scientists believe a single atom of chlorine can destroy more than 10,000 ozone molecules. Note that this

exercise demonstrated how an ozone hole is formed. The ozone hole allows harmful ultraviolet rays to pass through the upper atmosphere and reach the earth's surface.

2. Point out that chlorine monoxide, like carbon dioxide, is a gas which contributes to the greenhouse effect. This gas, like carbon dioxide, traps heat energy in the atmosphere resulting in a gradual warming of the earth. ClO, CO2 and other gases form a barrier around the earth, similar to the glass in a greenhouse, that allows solar energy to pass through but doesn't allow heat to escape.

- **Follow-up**
  - Have the students identify sources of CFCs in their lives.
    1. Have the students make a list of all the items in their homes or cars that require CFCs. This list should include refrigerators, home and car air conditioners, foam products such as styrofoam containers and egg cartons, fire extinguishers, and cleaning solvents.
    2. Have them cut out pictures of these items from magazines or newspaper ads.
    3. Spread out a large sheet (5-6 feet long) of newsprint onto a table or the floor. Divide the sheet into halves and label the left "Sources of CFCs" and the other side "What Can we Do to Reduce this Source?" On one half of the newsprint, paste pictures of the items from their home or cars that use CFCs. Affix the chart to a wall or bulletin board.
    4. Next, assign each student or group of students one source CFCs and have them do library research to find out what is being done or could be done to reduce or eliminate this source. You might also have them write letters to various companies or manufacturers for information.
    5. When the students find the information, have them add it to the right half of the poster across from the source.
    6. When all the information has been added, display the poster in a prominent place. You might arrange to display it in a school hallway, the library, or the cafeteria.

  - Ask the students to develop their own personal action plans to reduce CFCs by looking at what CFC products they use and how they can eliminate, change, or modify their uses.

  - Have the students research to determine which companies have not complied with the Montreal protocol. Students could also determine which countries have not complied.

- **Extension:**

Have students predict outcomes if more CFCs are added, then model and graph results. Were we right?

Source:

Related Web Sites:

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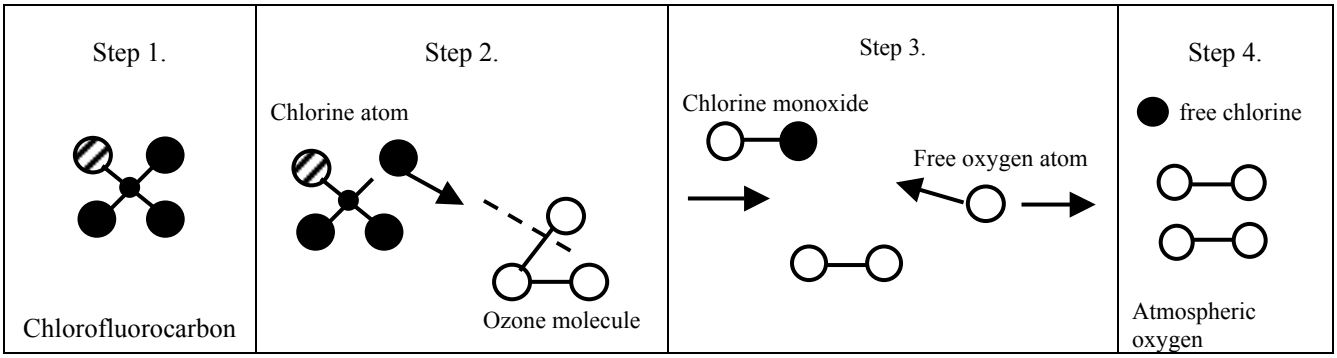
HOW OZONE IS DESTROYED

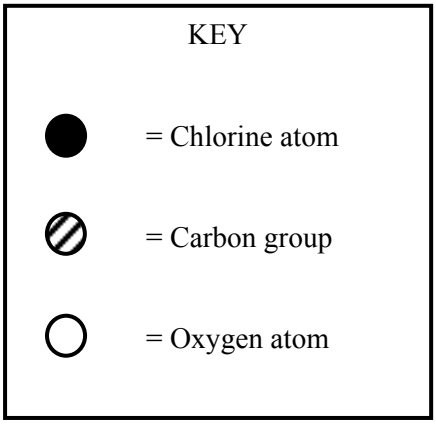


Step 1
Chloroflourocarbon emitted into the atmosphere.

Step 2
Chloroflourocarbon reacts with ozone in the upper atmosphere to form chlorine monoxide.

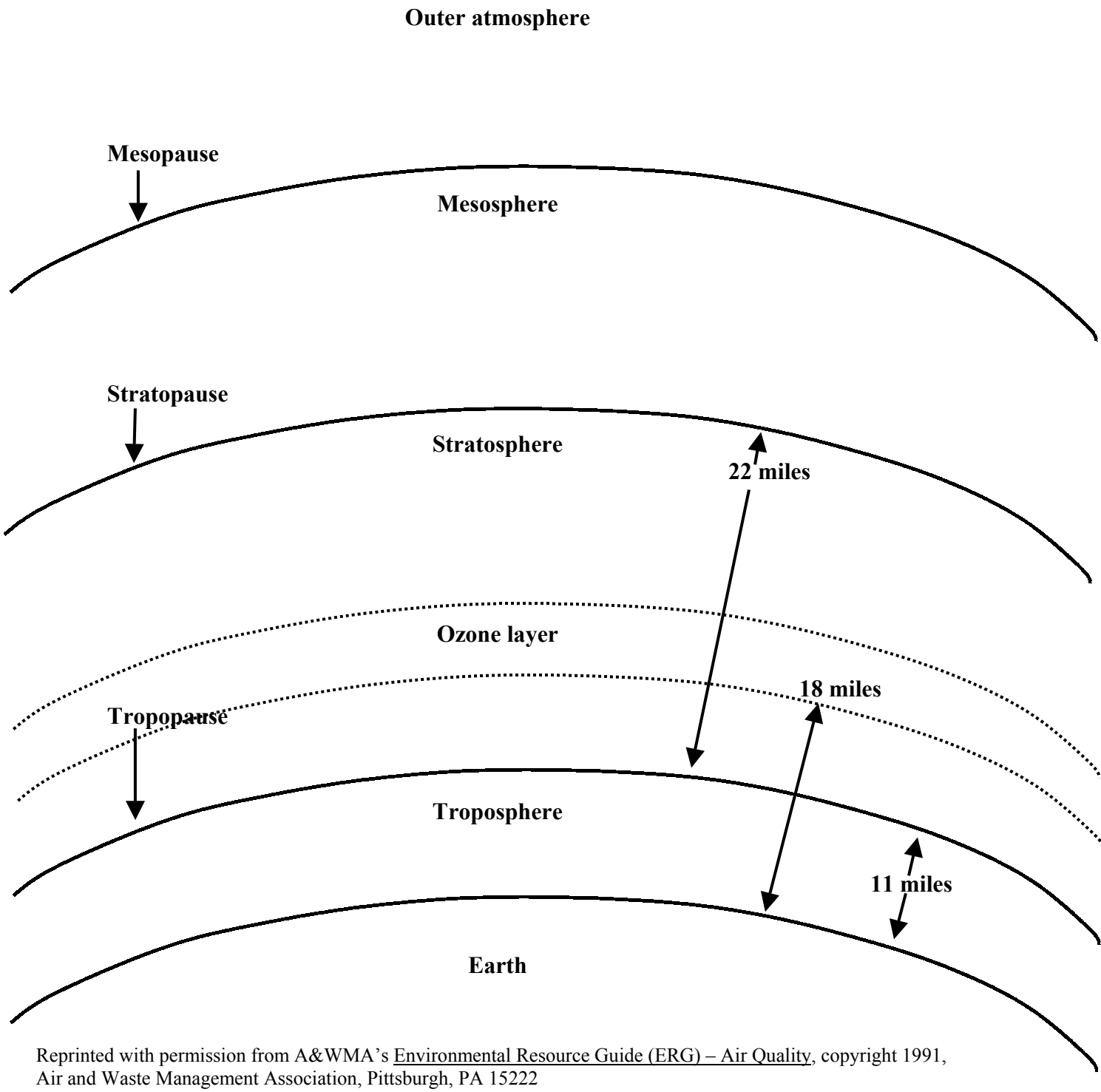
Step 3
Free oxygen reacts with chlorine monoxide to form a free chlorine and an atmospheric oxygen molecule.

Step 4
Free chlorine will continue to react with up to 10,000 more ozone molecules before entering the troposphere.



Student Handout

MAJOR SUBDIVISIONS OF THE ATMOSPHERE



Introduction to Adaptation **BLA#: 26**

Content Organizer(s):
Biomaterials, Agriculture

Standard Statement(s):
3.3.4 A, 3.3.7 A, 4.7.4 A, 4.7.4 B, 4.7.7 B, 4.7.10 A

Content Objective(s):
After completing this activity, students will be able to:

1. Make observations and comparisons of organisms.
2. Discuss answers to open-ended questions in a cooperative learning format.
3. Have students teach the class about one aspect they learned.

Assessment Strategies:
Teacher observation and student generated responses (Lab activity questions and team report to class).

Procedures:
The purpose of this hands-on, inquiry activity is to introduce the students to structural adaptations of different organisms and the concepts used in adaptations, by making observations and comparisons of organisms. Students observe collections of specimens and discuss answers to open-ended questions in a cooperative learning situation. Students learn about the concepts of common ancestry, homology, analogy, adaptive radiation and evolution, while formulating creative answers based on their observations. **Note:** *Grade level will be determined by complexity of questions developed by the teacher. The same materials can be used at all levels.*

- **LABORATORY / ROOM SET-UP:**

The classroom should be set up with 6 lab tables (or desks pushed together), each containing a group of specimens and a list of questions.

Table 1: Bat wing, bird wing, large moth, and dragonfly.

Table 2: Specimens of vertebrate hind feet, turtle, cat, human (picture), frog, etc.

Table 3: Skulls with beaks and taxidermied birds, owl, chicken, duck, pigeon, robin.

Table 4: Hands, forelimbs of cat, human (picture or use your own hand), frog, bat.

Table 5: Skulls of human (picture), dog, cat, sheep, rabbit.

Suggested Level:
Grades K-4, 5-7

Standard Category:
Biological Sciences
Threatened, Endangered & Extinct Species

Materials:

- Textbook (for student reference)
- Notebook paper
- Various specimens
  1. Wings (bat, bird, large moth, dragonfly)
  2. Vertebrate hind feet (turtle, cat, human, frog, etc.)
  3. Skulls with beaks (owl, chicken, duck, pigeon, robin, etc.)
  4. Hands/forelimbs of cat, human (picture), frog, bat
  5. Skulls of human (picture), dog, cat, sheep, rabbit
  6. Branches of assorted conifers
- Table questions
- Plastimounts or Photographs for some of the difficult to reach or "sensitive" materials. Have students use their own hands.

Instructional Strategies:

- Individual
- Groups
- Whole class

Table 6: Branches of assorted conifers.

Note: Modify the table contents to what you actually have in the classroom (you may actually find use for some of those "things" you've inherited when you first got your job). Some other specimens which could be used are exoskeletons, shells, leaves, fruits, insect or leaf collections.

- **PROCEDURE**:
  1. Have the tables set up with the specimens and questions when the students enter the room. It generates curiosity if they see the specimens when they enter.
  2. Divide the class into groups of four or five. If the class is too small to have a group at each table, it is better to have empty tables than to have the groups too small to generate ideas.
  3. Student groups can be seated at any table and can progress to any table in any order, as space becomes available. Each group will have a person who acts as a recorder to write the group's answers. (You may also want all students to record answers.) The recorder should write the names of the students in the group at the top of a sheet of paper and label each set of answers with the appropriate table number. As each group finishes a table, they should move on.
  4. It is very important that the teacher allows the students to generate their own answers to the questions. A textbook is available to each group for checking definitions, but most answers rely on the creative thinking and observations of the group. If students are permitted to arrive at their own answers, they often think of things that the teacher might not anticipate.
  5. Depending on the size of the class and their rate of the activity, the teacher may wish to set a time limit at each table and have all tables switch at the same time. It is probably best to allow groups to work at their own pace and handle stragglers individually.
  6. When all groups have completed all tables (usually 1-2 class periods), students should give class reports. Each group chooses a member to act as a reporter and the group is assigned to a table. The reporter describes the group's answers for their assigned table to the rest of the class. The reporter then leads a class discussion and calls on other students to add ideas. When each group has reported about their table, collect the group answer sheets.

1. SUGGESTED QUESTIONS FOR STUDENTS (BY TABLE):

- **TABLE 1 Grade K-4: FLIGHT STRUCTURES**
  1. The structures on this table are all used for flight. How are they different?

- **TABLE 1 Grade 5-7: FLIGHT STRUCTURES**

  The structures on this table are all used for flight and are analogous.
  1. Define analogous.
  2. Which animals have an internal skeleton in their wings?
  3. Which animals seem most closely related?
  4. For each animal wing, list a feature which is characteristic of only that wing.
  5. Choose a wing. Explain the advantages of that wing over the others.

- **TABLE 2 Grade K-4: HIND FEET**
  1. The structures are all hind feet. How are they similar?

- **TABLE 2 Grade 5-7: HIND FEET**

  The structures on this table are hind feet and they are homologous.
  1. Define homologous.
  2. For each animal, list the main function that the hind foot serves.
  3. For each foot, describe the special features that suit the form to its function.
  4. List 3 similarities and 3 differences between ~he skeleton of the frog foot and the human foot.

- **TABLE 3 GRADE K-4: BEAKS**
  1. The structures here are all bird beaks. Why are they different?

- **TABLE 3 Grade 5-7: BEAKS**

  The structures here are all bird beaks and exhibit adaptive radiation.
  1. Define adaptive radiation.
  2. For each bird, describe the structure of its beak.
  3. Relate the size and shape of each beak to the type of food each bird would eat.
  4. How do differences in beak structure limit competition for food among birds?

- **TABLE 5 GRADE K-4: SKULLS**
  1. How are all these structures similar and how are they different?

- **TABLE 5 GRADE 5-7: SKULLS**
  1. Are these structures analogous or homologous? Explain your answer.
  2. List 5 functions of a skull.
  3. List 5 ways these skulls differ.
  4. For each skull, list a special feature of the skull and explain how it relates to one of the functions listed in question #2.
  5. Identify the animals

- **TABLE 6 GRADE K-4: CONIFERS**
  1. How are all these structures similar and how are they different? Why are they different?

- **TABLE 6 GRADES 5-7: CONIFERS**

  These plants belong to a group called conifers. They exhibit adaptive radiation.
  1. Describe 5 differences you see among the needles.
  2. How are these plants suited for low temperatures?
  3. Which plant can best withstand harsh winds? Explain your answer.
  4. What is the advantage of long needles? Disadvantage?
  5. How are needles advantageous to broad leaves?

Source: Mary Jo Osborn. Carterville High School. Carterville, IL. aemosborn@aol.com. An **ACCESS EXCELLENCE ACTIVITY**

Related Web Sites:
www.accessexcellence.org

Soil Stories **BLA#: 28**

Content Organizer(s):
Agriculture, Regulation Safety

Standard Statement(s):
3.2.7A, 3.2.7B, 3.1.7B, 3.5.10D, 3.2.10A, 3.2.10B, 3.1.10B, 3.5.7A, 3.5.10A, 4.1.7 B, 4.1.10 B

Content Objective(s):
At the conclusion of this activity, students will be able to:

1. Identify components of soil and how these components determine its function.
2. Explain how different soil types determine the characteristics of ecosystems.
3. Predict the influence of soils on water filtration and on human use of an area.

Assessment Strategies:
Have students imagine they are inspectors for your county's Soil Conservation Service. They must write a letter to Sam and Laticia explaining:

1. What the results of the perk test indicate.
2. The reasons Sam and Laticia cannot build a house on their property because of its present soil conditions.
3. What steps could be taken to prepare the land for building a house, or what alternate uses the land could be prepared for.

Procedures:
Students often wonder why certain plants grow in some places and not in others. In this activity, students will grow plants in different soil types and mixtures in order to conceptualize the value of soil amendments. The suggested teaching time to complete this activity consists of two periods of 50 minutes each.

- **Note:** Refer to BLA# 7 for lead in or for potential scaled down version of this activity.

- **Preparation:**
  1. Have students collect and compare several different soil samples (try for five). Possible collection sites include low or wet spots, baseball fields, garden areas, overgrown fields, lawns, forested areas, or under trees. You may wish to scout around the school to find appropriate areas for digging and removing of soil (about 2 cups or 470 mL).
  2. If five different soils are not available near the school, consider these options:

Suggested Level:
Grades 5-7, 8-10

Standard Category:
Earth Sciences
Inquiry & Design
Unifying Themes
Watersheds & Wetlands

Materials:

- **Part A**

1. Soil Investigation handout (1 for each student), attached

For each team or group

2. Hand lens
3. Small plastic bag
4. Trowel or shovel
5. Beaker or jar
6. Stirring rod or jar lid
7. 100ml graduated beaker
8. Scientific balance scale
9. Water

- **Part B**

For each team or group

1. Soil Percolation Test handout, attached
2. Food can (soup size) with both ends removed
3. Measuring cup
4. Watch that keeps time to the second
5. 20-penny nail
6. Flat board
7. Hammer (optional)
8. Ruler
9. Paper/pencil
10. Water carrying container
11. Water

Instructional Strategies:

- Individual
- Groups
- Whole class
- Community

- Ask students to bring in a plastic bag of soil from different sites around their homes.
- Use only two or three different sites, but obtain different soil types by digging deeper: surface soil, 6" (15 cm) deep, or 12" (30.5 cm) deep.
- Buy sterile sand (for sandboxes or concrete), peat moss (for gardening), and powdered clay (for pottery or sculpture) so you can make your own soil types. Use five different formulas to create variety (equal parts, three times more of one ingredient than the others, and so forth.

- **Part A: Recipe for Soil.**
  1. What do plants get from soil? (air, water, nutrients, structural support) Do different plants have different soil requirements? (Yes. Some require dry soil, others need wet; some require acidic, others need basic.) How does this characteristic of having different requirements benefit plants? (Reduces competition for requirements.)
  2. Tell students that you will divide them into teams, and that each team will analyze a different soil sample. Later they will predict how well plants might grow in each sample and test their predictions (Enrichment for Part A).
  3. Distribute Soil Investigation handout, bags, and digging tools to each team or group.
  4. Divide the class into five groups (or whatever number of different soils they will compare). Ask each group to collect a sample of soil (about 2 cups or 470 mL) from a different location. You can either assign locations or let them choose their own.
  5. Back in the room, designate a study station for each team. Ask teams to examine their soil by answering questions on the handout, and to compare their answers to other teams' answers. Distribute hand lens to help students with their observations and comparisons.
  6. Ask students about the importance of air spaces in soil (space for the air and water that plants need). Tell them they will measure the air space in their sample.
  7. Give each team a beaker or jar. Have students measure 100 mL (6 cu in.) of dry soil (clumps should be broken up) in a graduated cylinder (or measure ½ cup = 118 mL), put the soil in their jar, and record the weight of the jar with the soil. Next, have students pour water into the jar very slowly until water reaches the top edge of soil. By weighing the container again, they can determine the weight of the water that filled up the air spaces in the soil (weight of jar with soil and water minus weight of jar with just soil). Because 1 gram of water displaces one milliliter of air, they can estimate the volume of air (mL) in each soil sample.
  8. Discuss each team's results. What might have caused the difference? Invite students to hypothesize about the ratio of sand or silt to clay in each sample. (The silt and sand particles result in more air space.) The next step will test their hypothesis.
  9. Have students continue to add water until the soil is covered with two inches (5 cm) of water. Cover the jar and shake it for several minutes, or vigorously stir the soil in a beaker. Allow the soil to settle for at least two hours; then observe the layers in each jar. Since larger components settle out first, soil particles will fall out of suspension in layers: Pebbles will fall first; then sand, silt, clay will fall; and some organic matter might float. Clay may make the water cloudy for a long time. Compare the layers in each sample. How do the results compare with their hypothesis?
  10. Each group should prepare a verbal summary of its findings or create a poster that explains the components of the soil. After examining variations in these soils, discuss why vegetation might grow differently on those sites. Lead a discussion comparing the soil samples each team studied.
      - Why did some have more organic matter? (perhaps the area has more vegetation)
      - Which soil will drain water better: sandy loam or clay loam? (sandy loam because it has larger particles and air spaces)
      - In which soil would a plant that needs a lot of water (willow or black spruce) grow best? (silt loam, which has small air spaces to retain water but will still drain fairly)

- **Enrichment for Part A:**
  1. Before the shake test, distribute graph paper and ask students to estimate the portion of each component in their soil sample (how much sand, gravel, clay, or organic matter it contains). Then have them graph the result of the shake test to show a soil profile and to compare it with their original estimate. Compare soil profiles of different samples, and compare each soil profile to the amount of air space calculated for that sample.

- Set up an experiment to determine the "best" soil for young plants. Try sprouting seeds (radishes grow quickly) under several different soil conditions while maintaining equal amounts of sun and water. To grow the seeds, use the following:
- Different soil samples collected in Part A
- Moist paper towels (no soil)
- Sterile sand
- Peat moss

Measure growth until noticeable differences can be detected.

- **Part B: A Soil Mystery.**
  1. Read the following mystery (located at the end of this lesson) to your students and have them discuss it in teams.
  2. Lead a class discussion about the mystery. Help students identify the key questions: What is a perk test? How would it prevent someone from building a house? To find the answer to these questions, each team will perform a percolation (perk) test on soil from different areas.
  3. Divide the class into teams of five. Distribute "Soil Percolation Test" handout (attached) and let your students get started. Circulate among the teams to help answer questions. If this process is too difficult for your students, you may conduct the perk test yourself as a demonstration.
  4. When the groups finish summarizing their data, lead a class discussion about their results. Guide students toward understanding that dense or compacted soil has fewer air passages so that water percolates (drains) through it more slowly, while porous soils drain water very quickly.
  5. Collect all the students' suggestions about the need for soil to drain near houses. Students should understand the needs for soils to drain wastewater (discharged from sinks, showers, washing machines) for houses not connected to a waste water system and the need to prevent flooding from rains. On the other hand, soils that drain too fast may not properly filter impurities out of the water, which may result in contamination of groundwater (for drinking).
  6. To solve the mystery, your students might suggest that the soil on Sam and Laticia's new property drain the wastewater and their house would not be hooked into a waste water system. This problem is not uncommon in more rural areas where the soil has large amounts of clay. What possible solutions might Sam and Laticia pursue to build their dream house? (Some of these are expensive solutions.)
     - Conserve water to produce less wastewater and reduce the burden on the house's septic system.
     - Build a cesspool to hold wastewater.
     - Dig a large, deep pit and fill it with gravel, sand, and soil to increase the drainage ability.

     Students may also have suggested that the soil drained too quickly and might allow contamination of well water. How could this problem be solved? (by installing equipment that filters wastewater before allowing it to enter the groundwater)

- **Enrichment for Part B:**
  1. Ask your state Natural Resources Conservation Service for a copy of your county's soil survey. The book will contain aerial photographs of your county, marked with the different kinds of soil. Soils will be rated by texture (such as sandy loam) and qualified for appropriate uses (such as agriculture, highways, housing, and so forth).

     By matching their knowledge of local areas with the soil survey, students can see how land-use patterns correlate to soil classifications. If a new development is proposed for your county, students can check the soil survey to see if the soil type is suitable for that development.
  2. Here are additional soil mysteries for your students to investigate:
     - A mudslide destroys homes. What soil conditions caused this to happen? (Soils of different textures overlapped, for example, a coarse-textured soil over a fine-textured soil caused moisture to build up at the point of contact, which in turn caused the coarse soil to slide over the fine soil on a slope).
     - A building's foundation cracks as soil subsides. What soil type would cause this to happen? (Soil with a high organic content tends to subside as organic matter is broken down.)
     - A flood in a city is blamed on increased runoff. What caused the runoff? (Soil has been paved over for streets, sidewalks, or parking lots.)

3. To demonstrate the drainage properties of different soil textures, use a flower pot with drainage holes in the bottom. Place different soils in the pot. As a student pours water into the pot, have the class count aloud until water leaks from the bottom. Use gravel, sand, loam, and, finally, clay.
   Explain that some trees need soils that hold a lot of water, while others need drier soils. Here are examples of trees and their preferred soils:
   - Poorly drained soils – cedars, red and silver maples
   - Moderately drained soils – hemlocks, red spruces, balsam firs, aspens
   - Well-drained soils – white pines, white birches

   It is possible to predict the type of soil under your feet by recognizing the kinds of trees growing there. Likewise, you can tell what trees will grow best on a piece of land if you know the soil type.

- **For Teachers to Read: Soil Mystery.**
  Two weeks ago, Laticia and Sam received a phone call from a lawyer who told them that Sam's grandfather, who had recently passed away, had willed a piece of land to them. They now owned the property and could do with it whatever they wished.
  It didn't take long for Sam and Laticia to decide what to do with the land. They had often dreamed of building their own small house. They were both good carpenters and were sure that with some boards and bricks and a lot of work, they could make a fine house for themselves.
  When Sam and Laticia went to visit their new property, their dream seemed as if it would come true. They started right away by filing the proper building permits and having the site tested for a septic system by having a percolation (perk) test done.
  When they received the test results, their hearts sank. The soil on the property had failed the perk test, and they would not be able to build their dream house. Why not? What was wrong with the soil?

Source:
"Agriculture K-12 Curriculum Supplement, Act 26." Pages 87-91. Pennsylvania Department of Education.

Related Web Sites:
http://wwwghcc.msfc.nasa.gov/precisionag/soils.html
http://www.kenyon.edu/projects/farmschool/nature/particle.html
http://www.nhls.com/perctests.html
http://www.thelandman.com/htmlos/start/landman/perc.html
Many sites available. Search: soil composition, soil nutrients, gardening, perc test, etc.

FOR PART A
SOIL INVESTIGATION

Team Members

_____

_____

1. Describe where the soil is from.

- Where was your soil site? Use words or draw a picture.
- What was growing on this site?
- Was it level or on a slope?
- What other things did you notice?

2. Describe the soil.

- What color is it?
- How does it smell?
- How does it feel? Roll some in your fingers.
- What do the largest soil particles look like? The smallest?
- How does your sample compare to the other soil samples?

3. Describe the air space.

- How much does the container with 100 mL of soil in it weigh?
- How much does the container with water to the top of the soil weigh?
- What is the weight of the water added to the container?
- What is the volume of air in this soil sample?
  NOTE – 1 gram of water displaces one milliliter of air.
- Which soil sample has the greatest amount of air space?

4. Describe what is in the soil.

- What are the components of your soil sample after they have settled in the jar? Draw what the layers look like.
- How do they compare to the other samples?

FOR PART B
SOIL PERCOLATION TEST

Getting Ready

1. Within your team, choose a person for each role:
   - Equipment Monitor – collects equipment, keeps track of it, and returns it in good condition.
   - Time Keeper – uses a watch that tells time to the second.
   - Recorder – makes a data chart and records the time for each experiment.
   - Facilitator – reads directions and helps everything get done.
   - Checker – reads directions and makes sure everything is done correctly.
2. Have the Equipment Monitor collect the necessary equipment from the instructor. Have the Facilitator read the instructions out loud to the team and make sure everyone understands

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Team Instructions

1. Choose five different locations outdoors where there is a small patch of ground. Open soil, grass, leaves, or bushes are fine; asphalt, sidewalks, or concrete will not work.
2. At each location, record what is on the ground, and push one end of the can (which has both ends removed) 1" (2.5cm) into the ground. (It may be easier to rest a board with a hammer to push in the can.) Pour one cup (240 ml) of water into the can. Record how long it takes for the water to completely disappear. In some cases, the water will not disappear entirely during the class period. If this occurs, ask students to consider why all of the water does not percolate into the soil. (The soil may already be saturated; the soil may be compacted at the ground surface; or there may be a hardpan layer near the soil surface.)
3. At each site, ask one person in your team to use his or her thumb to push a nail into the soil as far as it will go using moderate force. Then the student should measure the nail's height. Record this number.

NOTE – *Try to use the same amount of force to push in the nail at each site. Do not use excessive force.*

4. Rank your sites by how long it took for water to percolate; then present the data chart from your group. You may have students graph the results and present that data. Is there a relationship between nail heights and the time it took for the water to disappear?
5. What does the data tell you about the soil's ability to filter water, or to percolate? What assumptions can you make about the difference in soil you tested?
6. Why would a percolation test be important before someone builds a house? Why can't Sam and Laticia build their dream house?

Biotechnology Timeline **BLA#: 29**

Content organizer(s):
Meets all Content Organizers and will be determined by teacher with selection of topics.

Standard Statement(s):
4.4.7 A, 4.4.7 B, 4.4.7 C

Content Objective(s):
At the conclusion of this activity, students will be able to:

1. Research and record, on individual note cards, teacher selected individual events or developments throughout the history of biotechnology and agriculture.
2. Create a poster that includes events and developments occurring (as identified by the teacher).

Assessment Strategies:
Finished timeline and class discussion.

Procedures:
Students will develop a poster that will become part of a classroom displaying a timeline of developments throughout the history of biotechnology and agriculture. The teacher will provide students with a hand-out that details the requirements of the poster. The research and poster will be accomplished at home (allow ten days). Assign a specific time period to each student.

- **Note**: Teacher could provide potential topics and research sources. There are many resources, for example:
  - Internet
  - PA Dept. of Agriculture
  - Agriculture Museum
  - Interview a farmer
  - The PA Assoc. of Conservation Districts, Inc.

1. **Period 1** - Introduce agriculture and biotechnology through definitions and examples. Review Pioneers pamphlet and have students participate in discussion. Have students take notes on definitions and assignment goals. Review teacher hand-outs that detail the assignment.
2. **Period 2** – Students display their posters on the wall in correct chronological order and the teacher reviews them with the class to conclude the activity.

Source:
Charles Kessler, Mifflinburg High School.

Related Web Sites:
http://www.pda.state.pa.us/
http://www.pacd.org/

Suggested Level:
Grades 5 - 7

Standard Category:
Inquiry & Design
Agriculture & Society

Materials:

- Pioneers pamphlet
- Encyclopedias
- Internet
- General library resources
- Art supplies
- Note cards

Instructional Strategies:

- Individual
- Whole class

Bubbling Bread **BLA#: 30**

Content Organizer(s):
Agriculture

Standard Statement(s):
3.1.4 D, 3.7.4 B

Content Objective(s):
At the conclusion of this activity, students will be able to:
1. Know the meaning and purpose of biotechnology.
2. Differentiate between old and new biotechnology.
3. Explain that yeast is alive and makes gas.

Assessment Strategies:
Student's oral responses in:
1. Explaining the meaning and purpose of biotechnology.
2. Distinguishing between old and new biotechnology.

Procedures:
Biotechnology uses biological processes to make products. Yeast has been used for centuries to make beer and bread. The suggested time to complete the activity is two hours.
1. Assemble supplies and ingredients before starting. Have students thoroughly wash their hands.
2. Introduce the term biotechnology. You may want to write this word on the chalkboard or flip chart. Explain that biotechnology means using something found in nature to make products. Ask students how long they think humans have been using biotechnology. Five years? Twenty? More? Explain biotechnology has been in use for thousands of years.
3. Explain to the class that they will be using biotechnology to make a secret product. Assemble the class around a central work area and make bread sticks, following the recipe. Explain that yeast is alive and show them how it looks before liquids are added. Liquid and sugar provide the right conditions for the yeast to grow. As the yeast cells grow, they give off carbon dioxide. The carbon dioxide causes the dough to bubble. Yeast, a living thing belonging to the fungi kingdom, has been used to make bread for centuries.
4. Follow the baking procedure on the extension on the next page.

- **Analysis:**
  - What living thing did we add to make the bread? (Yeast.)

Suggested Level:
Grades K-4

Standard Category:
Biological Sciences
Inquiry & Design
Agriculture & Society

Materials:
- Ingredients for breadstick recipe
- Cookie sheets
- Shortening
- Oven
- Bowls
- Mixing spoon
- Measuring cups
- Spoons
- Paper towels
- Optional: flip chart, markers or chalkboard and chalk

Instructional Strategies:
- Individual
- Whole class

- Why did it bubble? (Because we gave it food – sugar – and it started to grow.)
- What does the yeast do for the bread? (It makes it rise, or get bigger. Yeast is a living, microscopic fungus. It is not a plant. It belongs to the fungi kingdom. When yeast grows and starts to digest sugars and starch in bread dough, it releases carbon dioxide. This gas becomes trapped by the dough mixture, and the bread rises. This explains why baked bread has height and many tiny holes.)
- What would happen if we didn't give the yeast water and sugar before we added it in the bread recipe? (It wouldn't grow as well, if at all. The bread wouldn't get big.)

➢ **Extension:**

To expand on this experiment, make one recipe of breadsticks with the yeast, and another without. Let students predict what will happen. Do their predictions match the event? Why or why not? Was their reasoning sound?

Breadsticks

2 (1/4 ounce) packages quick-rise dry yeast
2 teaspoons (10 milliliters) sugar
¾ cup (0.18 liters) warm water
5 cups (1.2 liters) all purpose flour
1 tablespoon water
¾ cup (0.18 liters) vegetable oil
¾ cup (0.18 liters) milk
1 teaspoon (5 milliliters) salt
1 egg, slightly beaten
sesame/poppy seeds, coarse salt or other coatings

Sprinkle yeast and sugar over warm water in a large bowl. Let stand until it starts to bubble. This indicates that the yeast is starting to grow and multiply. After about 10 minutes, stir in the oil, milk, and salt. Beat in about 3 cups flour; stir in the remaining flour to form a soft dough. Turn dough onto a lightly floured surface. Let children take turns kneading the dough. This should take about five minutes. Grease bowl using shortening and paper towels. Place the dough in a greased bowl; turn the dough greased side up. Cover the dough with paper towels and let it rise in a warm place for about 30 minutes.

Grease cookie sheets. Punch dough down and divide it into two parts. Cut each part into 20 pieces (or adjust to your group size). Give each child a piece of dough to roll into a rope. Place dough ropes about one inch apart on greased baking pans. Combine the egg and water and brush the ropes gently. Let children use salt, poppy seeds or other items to decorate their ropes. Let the dough rise for 10 minutes. Bake until brown, about 25-30 minutes, in a 350^0 oven.

Source:
"Field of Genes: Making Sense of Biotechnology in Agriculture" was produced by National 4-H Council.

Related Web Sites:
www.fourcouncil.edu.

Modeling Pollen Separation **BLA#: 31**

Content Organizer(s):
Agriculture

Standard Statement(s):
3.1.7 A, 3.1.7 B, 3.2.7 B, 3.4.7A, 4.4.7 B, 4.4.7 C

Content Objective(s):
At the conclusion of this activity, students will be able to:

1. Explain the separation of different materials and compounds.
2. Relate the explanation to a flower's ability to distinguish one pollen type from another.

Assessment Strategies:
Will be able to explain why only the salt went into solution. The sand and iron filings are insoluble. How is this part of the observation like the pollination story?

Will be able to relate the following:

- ✓ The salt is small and goes through the filter because it is in solution. This is like pollen that is the right size to get to the stigma and made of the right chemical to react with the stigma (it doesn't dissolve, but the pollen recognizes it is on the stigma) and releases its sperm.
- ✓ The magnet attracted the iron filings. How is the observation like the pollination story?

Procedures:
Students will begin with a mixture of sand, salt, and iron filings. They will design and discover a method to separate the three materials through a variety of means. The separation activity will be compared to pollination technique. The suggested teaching time to complete the activity is 1 class period for prep, 1 period for the activity, and 1 period for the conclusion.

1. Add the mixture to warm distilled water to get the salt into solution.
2. Pour the mixture through the filter paper and separate the salt-water from the sand/iron mixture. Continue heating salt-water until water has evaporated, leaving only salt.
3. Use the magnet to attract the iron filings and separate the filings from the sand.

Discussion:
The reproductive part of a plant is the flower. Flowers separate pollen in different ways. Some flowers are shaped to catch wind blown pollen. This means they will only catch a type of pollen that is carried by the wind. Other flowers contain nectar and are shaped or colored in a way that attracts an insect, animal or bird that wants to eat the nectar. For example the insect could be a bee or an ant. An example of a bird could be a hummingbird. Even humans can pollinate flowers. The insect or bird will brush against the anther (male pollen producing part of the plant), where some pollen will stick to it, then drop the pollen on the stigma. The stigma contains a chemical that causes the pollen to grow a long tube down the inside of the style and deposit sperm into the ovary. Fertilization takes place and the ovules become seeds.

Only the salt goes into solution by adding water. Some flowers are not colored or patterned or fragrant, so they attract only wind blown pollen. The filter

Suggested Level:
Grades 5 - 7

Standard Category:
Inquiry & Design
Unifying Themes
Agriculture & Society

Materials:

- Sand
- Salt
- Iron filings
- Distilled Water
- Hotplate
- Magnet
- Filter paper

Instructional Strategies:

- Individual
- Whole class

trapped the bigger iron filings and sand, allowing the water and salt in solution to pass through. Certain flowers attract only certain kinds of insects, animals or birds, which distribute the proper pollen. The magnet attracted only the iron filings, separating the iron from the sand. The stigma contains a chemical which makes the correct pollen grow down the style, so that only the correct pollen for that particular plant will work.

Source: Original

Related Web Sites:
http://prince.thinkquest.org/3715/index.html
http://www.lysands.com/Science/Animals/insectbeehoney_wup_ly.html
http://users.aol.com/pollinator/flwrsex.html
http://pollinator.com

Modeling Pollination **BLA#: 33**

Content Organizer(s):
Agriculture

Standard Statement(s):
3.1.7 B

Content Objective(s):
At the conclusion of this lesson students will be able to:
1. Create a flower with given materials.
2. Mechanically model pollination using colored chalk.

Assessment Strategies:
Student produced:
1. Flower.
2. Mimicry of a bee thorax by using colored chalk to mechanically model pollination.

Procedures:
In this activity, students will make a flower of felt, pipe cleaners, and clay. Students then use a cotton swab to mimic a bee thorax to mechanically model pollination using colored chalk. The suggested teaching time to complete the activity is one period of about 50 minutes.
1. Discuss with class about their knowledge of how a parent plant can produce a seedling and have it resemble the parent. Direct the discussion to the purpose of pollination – the animals and plant parts involved. Explain how nature transfers genetic material through pollination.
2. Show students models/pictures/diagrams of flowers. Discuss the parts and purpose of a flower. How do flowers attract insects/bees? Which part of the flower produces pollen? Explain to students that they will make a flower with the given material and then they will use a cotton swab to mimic a bee thorax to mechanically model pollination using colored chalk.
3. Provide the materials to students to make their flowers. Demonstrate using the cotton swab to mimic a bee thorax to mechanically model pollination using colored chalk and have them work with partners to pollinate each other's flowers. Discuss the activity. Also discuss when and why humans might want to control the process of pollination in plants.

Source:
Original

Related Web Sites:
http://prince.thinkquest.org/3715/index.html
http://www.lysands.com/Science/Animals/insectbeehoney_wup_ly.html
http://users.aol.com/pollinator/flwrsex.html
http://pollinator.com

Suggested Level:
Grades K - 4

Standard Category:
Biological Sciences
Unifying Themes
Integrated Pest Management

Materials:
- Models/pictures or diagrams of plants
- Cotton swabs
- Colored chalk
- Felt
- Paper
- Glue sticks
- Popsicle sticks
- Pipe cleaners
- Clay

Instructional Strategies:
- Individual
- Small group
- Whole class

Pollen Collection **BLA#: 34**

Content Organizer(s):
Agriculture

Standard Statement(s):
3.7.10A

Content Objective(s):
At the conclusion of this lesson students will be able to:
1. Design/construct a system to remove and collect pollen from various plant
2. Apply the use of two or more simple machines in the system.

Assessment Strategies:
1. Student developed models
2. Student presentations

Procedures:
1. Students will design and construct a system to remove and collect pollen from various plants. This will be achieved by incorporating two or more simple machines, which can include, but not be limited to, electrical mechanisms. The suggested teaching time to complete this activity is two weeks.
2. Students will present their solutions.
3. Possible extensions: investigate an electrostatic precipitator.

Source:
Original

Related Web Sites:
http://www.fwkc.com/encyclopedia/low/articles/e/e007000663f.html
http://www.apcnetwork.com/

Suggested Level:
Grades 8 - 10

Standard Category:
Technological Devices

Materials:
- Shop/tech ed lab
- Toothpicks
- Popsicle sticks
- Can lids (common household)
- Tubing and syringes for hydraulics
- DC 12v motors

Instructional Strategies:
- Group Work

Related Concepts:
Mechanical Systems
Electro / magnetic Systems
Control Systems

BLA# 35

No Work Leaf Garden

Content Organizer(s):
Agriculture, Bio-Materials, Resource Recovery

Standard Statement(s):
3.1.4 A 3.1.4 B, 3.1.4 D, 3.3.4A, 3.5.4 A, 3.7.4 A, 4.3.4 A, 4.6.4 B

Content Objective(s):
At the conclusion of this activity, students will be able to:

1. Identify compost components, environmental factors.
2. Draw parts of the potato plant.
3. Sequence stages of growth of the potato.

Assessment Strategies:
Student generated drawings and responses.

Procedures:
This activity addresses the potato plant's life cycle, including plant propagation and compost construction. Students will quantify and record potato growth data (for example type of potato, weight, size, # of "eyes") for graphing, health and print-making. This activity covers more than one school year (see note) and may be done with a team teacher.

1. The teacher should begin with introduction activities, which may vary and be linked with other activities. Time is needed for preparing the compost bed, which may vary depending on the site and help from the school.
2. For one period – students will prepare and plant potatoes. For one period – students will be harvesting the potatoes. Other periods are needed for comparing potatoes – one period for each characteristic. Extension periods may be needed and will vary, depending upon the activities.

Fall:

1. In late fall, have the class identify/construct an area for leaf collection which is several feet deep (grass clippings can also be included). Students note that this site is either packed soil or sod (no tilling of the earth). Measure the depth of the collected leaves.
2. Discuss what happens to the leaves falling from the trees near the school and in the woods. If possible plan a field trip to a woodsy area and explore the build up of soil which has occurred.
3. Explore the concept of decomposers and biodegradation of the leaves (fungi, microorganisms). Link this to the conditions necessary for decomposition (temperature, moisture, pH, etc.). Compare leaf decompositions in various habitats.

Note: If leaves are not available use grass clippings. To shorten the time frame for this activity to one year, the teacher could prepare a compost bed a year in advance of the first lesson, or have the first class prepare two compost beds. Every year the new class could prepare a new compost bed, simultaneously comparing and contrasting to the previous year's compost. Students could plant their potatoes in last year's compost while making a

Suggested Level:
Grades K - 4

Standard Category:
Biological Sciences
Technology Education
Inquiry & Design
Environmental Health
Ecosystems & Their Interactions

Materials:

- Construction of compost bed/site (can be fenced in)
- Leaves
- Potatoes (teacher can cut sections)
- Measuring tapes
- Scales

Instructional Strategies:

- Whole class

compost bed available for next year's class. Teacher should keep the depth of leaves in each year's compost leaves or grass clippings at a consistent depth.

Spring:

1. Measure the compaction of the leaf bed. Determine the amount of soil litter that has occurred. Have class plant sections of the potatoes that contain two eyes in the leaves – not in the ground itself. (Teacher should cut the potatoes into sections.)
2. Over the summer, the plants will sprout, grow, and develop potatoes.

Fall 2:

1. The class "harvests" the potatoes that have developed over the summer.
2. Students count, weigh, measure, and classify the potatoes according to the various characteristics.

- **Extensions:**
  1. Have the potatoes prepared by the cafeteria for a lunch period.
  2. Construct "potato heads/people."
  3. Slice the potatoes in half, carve designs, and use for printing cards/letters/wrapping paper.

Source:
Ms. Jane Konrad, adapted from an early Rotary Club Project.

Related Web Sites:
http://www.dep.state.pa.us/dep/deputate/airwaste/wm/RECYCLE/FACTS/COMPOST.HTML
http://www.compostinfo.com/Default.html

Collection and Identification of Bacteria from Community **BLA#: 37**

Content Organizer(s):
Medical Technology, Regulation Safety

Standard Statement(s):
3.3.10 A, 3.2.10 C, 3.2.10 D, 3.7.10 A, 3.7.10 B, , 4.3.10 A

Content Objective(s):
In this activity, students will record, in a formal lab report, the steps to the scientific method.

Assessment Strategies:
Students' completed lab reports.

Procedures:
For this activity, students will sample common areas of community to determine areas of pathogen location. They will then distinguish between qualitative and quantitative information. The suggested teaching time to complete this activity is a total of 3 periods.

1. **Period 1**: Provide students with appropriate background for the activity. Provide them with the equipment and instructions for collecting the samples in the common areas of their community. Have them label bottles with their location sites and a description of the sites.
2. **Period 2**: Have students swab their petri dishes with samples and have them label their dishes. Have them place the petri dishes in the incubator. Monitor students' procedures.
3. **Period 3**: Provide students with the means to identify the bacterial colonies (chart of common bacteria, gram stain [see BLA #16], and microscope). Have them distinguish between the qualitative and quantitative bacterial information in the determined areas of pathogen location. Have them complete a formal lab report, recording the scientific method steps for the activity.

Source:
North Carolina Association for Biomedical Research Manual—
Contact 919-785-1304 for information and purchase information

Related Web Sites: For safety issues regarding pathogens:
http://www.enc.org/csss

Suggested Level:
Grades 8 - 10

Standard Category:
Biological Sciences
Technological Devices
Inquiry
Environmental Health

Materials:
- Screw top bottles with distilled water
- Sterile swabs
- Petri dishes with nutrient agar
- Incubator
- Chart of common bacteria
- Gram stain
- Microscope
- Grease pens

Instructional Strategies:
- Individual
- Small group
- Large group
- Community

Body Fluid Transmission Simulation Activity **BLA#: 38**

Content Organizer(s)
Medical Technology, Regulation Safety

Standard Statement(s):
3.2.7 C, 3.2.7 D, 3.2.10 C, 3.2.10 D, 4.3.7 A, 4.3.10 A

Content Objective(s):
At the conclusion of this lesson students will be able to:

1. Follow given procedures to collect laboratory "body fluids" with three other students.
2. Determine from where the disease originated.
3. Explain the implications of the fluid exchanges.

Assessment Strategies:

- Student's ability to follow collection procedure and responses.
- Student's ability to use this modeling to explain how a real disease can be transmitted.

Procedures:
In this activity, students will exchange "body fluids" with three other students. They will then be tested to see if they have been exposed to the disease.

1. Before the class, fill the appropriate number of test tubes (one for each of the students in the class) with water and a few drops of ammonia.
2. For class, provide each student with a test tube and a dropper.
3. Discuss the definition of "body fluids" (liquid components of living organisms**). Have the class identify some human body fluids, and how body fluids can be "exchanged" between people. Ask the students to "exchange" laboratory "body fluids" with three other students by placing a dropper full of their solution into another student's test tube, and then, receiving a dropper full of that same student's fluid into their test tube. (Repeat this twice)
4. The teacher will put 2 drops of phenolphthalein into each student's tube.
5. The student's test tube contents, which were exposed, will turn bright pink. Have the students try to figure out from where the disease originated. Talk about implications of "only 3 exchanges."

Source:
Mark Temons

**http://www.graylab.ac.uk/omd/index.html

Related Web Sites:
http://www.graylab.ac.uk/omd/index.html
http://www.medterms.com
http://www.healthfinder.gov/moretools
http://www.nbci.com/LMOID/resource/0,566,-2248,00.html?st.sn.sr.8.7_2248
http://www.nbci.com/LMOID/resource/0,566,-1051,00.html?st.sn.sr.8.7_1051

Suggested Level:
Grades 5-7, 8 - 10

Standard Category:
Inquiry and Design
Unifying themes
Environmental Health

Materials:

- Test tubes – number varies with the number of students
- NaOH
- Eye droppers (one per student)
- Phenolphthalein

Instructional Strategies:

- Individual
- Whole class

Effectiveness of Commercial Soaps

BLA#: 40

Content Organizer(s):
Medical Technology, Regulation Safety

Standard Statement(s):
3.2.10 A, 3.2.10 C, 3.2.10 D, 3.2.12 A, 3.2.12 C, 3.2.12 D, 3.7.10 A, 3.7.10 B, 3.7.12 A, 3.7.12 B, 3.8.10 A, 3.8.10 B, 3.8.10 C, 3.8.12 B, 3.8.12 C, 4.3.10 A 4.3.12 A

Content Objective(s):
At the conclusion of the lesson students will be able to:

1. Will complete a lab report.
2. Will evaluate the effectiveness of commercial products in controlling bacteria.
3. Will determine the ability of commercial products to help in the development of "super bacteria."

Assessment Strategies:
Student's completed lab report.

Procedures:
For this activity, students will evaluate the effectiveness of commercial products in controlling bacteria. They will also determine the ability of commercial products to help in the development of "super bacteria." The suggested teaching time to complete the activity is two class periods.

1. **Period 1**: Teacher introduces the appropriate background for the activity, provides materials for the lab, and monitors students' procedures. Students pour the nutrient agar into the petri dishes and set the incubator. Then they include commercial soap (be sure to use antibacterial and bacterial products) in some of the dishes and have a control group of dishes without the soap. Label dishes. Next, they streak the dishes with various commercial bacterial strains or streak with bacterial samples from areas in the community. Place the dishes in a 35.0^{o}C incubator.
2. **Period 2**: Have students count and identify the bacterial colonies. Monitor students' procedures. Have them complete their lab reports and discuss the implications of the findings. Guide discussion if needed.
3. **Period 3**: Have students identify bacteria by morphology. An option for upper levels includes gram staining.

Source: Original

Related Web Sites:
http://www.lysands.com/Health/Advice/antibacterialso_sgu_ly.html
http://www.ucmp.berkeley.edu/bacteria/bacteria.html

Suggested Level:
Grades 8-10, 11 - 12

Standard Category:
Technological Devices
Inquiry & Design
Science, Technology & Human Endeavors
Environmental Health

Materials:

- Commercial soaps
- Hand sanitizers
- Other cleansing products
- Petri dishes with nutrient agar
- Incubator
- Bacteria (commercial or collected)

Instructional Strategies:

- Individual
- Small group
- Whole class

Current Event

BLA#: 41

Content Organizer(s)
All strands, depending on articles selected.

Standard Statement(s):
3.2.10 C, 3.2.10 D, 4.3.10 B
3.2.12 C, 3.2.12 D, 3.6.12 B, 4.3.12 A, 4.3.12 B

Content Objective(s):
At the conclusion of this lesson students will be able to:

1. Select and research an article related to a biotechnology topic.
2. Present the biotechnology topic to peers.
3. List reference materials from their research of a biotechnology topic.
4. Display presentation to inform students of other classes about a Biotechnology related topic.

Assessment Strategies:

1. Student developed materials
2. Student presentation

Procedures:
For the activity, each student will choose an article that provides the learner an opportunity to research a technology related topic. Students will then present their topics to the class and display their findings so learners of other classes can be informed. The suggested time to complete the activity is 10 class periods.

1. **Period 1**: Introduce the background and activity to the students.
2. **Period 2,3,4**: Have them choose an appropriate article in order to research the technology related topic. Have them research the topic. Facilitate the learning and research process.
3. **Period 5,6,7,8**: Have students construct their presentations. Facilitate learning and construction.
4. **Period 9, 10**: Have students present their topics to the class. Have them display their presentations in an appropriate area so that they may inform students from other classes about their findings.

Source: Original

Related Web Sites:
Use the Internet as a resource to research the students' article.

Suggested Level:
Grades 8-10, 11 - 12

Standard Category:
Technology Education
Inquiry & Design
Environmental Health
Agriculture & Society
Integrated Pest Management

Materials:

- Computer
- Computer software
- Inter or Intra net
- TV
- Newspaper
- Magazines
- VCR
- Poster boards
- Graphic design materials for presentation

Instructional Strategies:

- Individual
- Whole class

Student Self Design Regulations **BLA#: 42**

Content Organizer(s):
Regulation Safety

Suggested Level:
Grades 8 - 10

Standard Statement(s):
3.2.10 C, 3.2.10 D, 3.6.10 A, 3.7.10 A,

Content Objective(s):
At the conclusion of this lesson students will be able to:

1. Create a list of Laboratory Safety Regulation Guidelines, to be posted in the laboratory.
2. Role-play safety scenarios, while applying their guidelines.

Standard Category:
Technology Education
Technological Devices
Inquiry & Design

Assessment Strategies:

1. Student developed materials
2. Student role – playing performance

Procedures:
In this activity, students will determine appropriate Laboratory Safety Regulation Guidelines to be followed by the class. Then they will role-play four safety scenarios, while applying the guidelines. The suggested teaching time to complete the activity is two class periods.

1. **Period 1**: Introduce appropriate background to students (see websites). Have the class brainstorm and determine what safety regulations should be in place in the laboratory in order to protect the "product" (work) from the student and the student from the "product." Record a list of the regulations and post it in the classroom.
2. **Period 2**: Teacher should design four safety scenarios, which involves procedures and the handling of materials. During the role-play, half of the class performs the work and the other half acts as inspectors. Teacher and students (peer review) will critique the performances according to the Laboratory Safety Regulation Guidelines posted in the classroom.

- **Safety Scenarios**
  1. **The Restaurant:**

Workers	Equipment
• Chefs	Dishes
• Servers	Food
• Bus persons	Server's hands
• Cashier	Utensils
• Dishwashers	

Checklist of Inspectors' Concerns (one for each area)

- Age of Food
- Storage Temperature for food
- Food opened or closed

Materials:

- Materials for role playing the safety scenarios

Instructional Strategies:

- Individual
- Large groups
- Whole class

- Food handlers cleanliness of hands/use of gloves
- Health Badges are current (TB tests negative)
- Dish cleanliness
- Equipment cleanliness

2. Food Production/Packing: Production set-up of an assembly line making 10 peanut butter and jelly sandwiches

Workers	Equipment
• Assemblers	Dishes/utensils
• Servers	Food
	Server's hands
	Plastic wrap
	Paper belt liner

Checklist of Inspectors' Concerns (one for each area)

- Age of Food
- Storage Temperature for food
- Food opened or closed
- Food handlers cleanliness of hands/use of gloves
- Health Badges are current (TB tests negative)
- Dish/utensils cleanliness
- Equipment cleanliness

3. Growing Foods

Workers	Equipment
• Growers	Soil samples (pH)
• Animals	Hormones
• Plants	Pesticides
	Fertilizers
	Removal equipment

Checklist of Inspectors' Concerns (one for each area)

- Analytic testing of plants
- Healthy animals
- Proper cleanliness of equipment
- Proper safety of equipment
- Proper storage of equipment

Source: Original

Related Web Sites: Safety guidelines from different sources can be found at :
http://www.enc.org/csss

Store Bought vs. Home Made

BLA#: 43

Content Organizer(s):
Medical Technology, Regulation Safety

Standard Statement(s):
3.3.4 A, 3.3.4 B, 3.3.4 C, 3.2.4 A, 3.2.4 B

Content Objective(s):
At the conclusion of this lesson students will be able to compare products for mold resistance by:

1. Predicting which products (store bought or home made) will grow mold sooner.
2. Making daily observations of molds (recording size and number of colonies).

Assessment Strategies:

1. Student developed materials

Procedures:
For this activity, students will compare "store bought" to "home made" products for mold resistance. The suggested teaching time will vary, and is dependent on the desire of the teacher.

1. **Period 1**: Introduce background to class, limiting to mold and its growth. Provide students with examples of products (store bought and home made). Possible examples: bread, cookies, cake, butter, and other prepared food products. Set up groups of store bought and home made items in similar ways, for example cookies on an aluminum tray covered with clear wrap (add 5 drops of water to raise moisture level). Have students predict which items will have mold grow sooner. Record the predictions.
2. **Period 2**: Have students make daily observations. Have them determine when the mold is first observed and the measurement of the molds through size and number of colonies. Have them observe which products had mold growth first and which started second. Does mold grow at the same rate? Do the products get the same kinds of molds? Have students record their observations and continue to observe/record daily for changes. Discuss the implications of the findings and the predictions made in previous class period.

Source: Original

Related Web Sites:
http://www.sci.mus.mn.us/sln/tf/b/bread/bread.html

Suggested Level:
Grades K - 4

Standard Category:
Biological Sciences
Inquiry & Design

Materials:

- Chart paper for primary level predictions
- Individual Prediction sheets
- Examples of store bought and home made products (bread, cake, cookies, etc.)
- Plastic bags
- Hand lens
- Rulers for measuring

Instructional Strategies:

- Individual or
- Small groups
- Whole class

Enzymes for Communication **BLA#: 45**

Content Organizer(s)
Biomaterials, Medical Technology

Standard Statement(s):
3.1.10B, 3.3.10B, 3.4.10A, 3.6.10A, 3.6.10B

Content Objective(s):
At the conclusion of this lesson students will be able to:

1. Clearly demonstrate an understanding of activity's concepts of enzymes.
2. Express in writing, three ways enzymes can affect their lives and how enzymes will affect communications in the near future.

Assessment Strategies:
Student produced written responses.

Procedures:
In this activity, a scientist, engineer or technical expert from industry will discuss current problems with communication technology (microchips). He will then discuss how enzymes can change the size limitations of future technology. The suggested teaching time required for the activity consists of: 15 minute teacher prep with speaker, 30 minute preparation time for class, 30 minutes for speaker, and another 30 minutes or more for follow-up with students.

1. **Period 1**: Prepare class for speaker by introducing the appropriate background information. Students participate in discussion.
2. **Period 2**: Speaker discusses the current problems with communication technology and how enzymes and organic material can change the size limitations of future technology. Students participate in discussion and take notes.
3. **Period 3**: Conclude the activity with a follow-up and have students complete their written responses for the 3 ways enzymes can affect their lives and how enzymes will affect communications in the near future.

Source:
Original

Related Web Sites: Several possible businesses are listed:
Bayer.com
Celera.com
Discoverylabs.com
Viropharma.com

Suggested Level:
Grades 8 - 10

Standard Category:
Unifying themes
Biological Sciences
Physical Science,
Chemistry & Physics
Technology Education

Materials:

- Video links
- VCR
- Slide projector

Instructional Strategies:

- Individual
- Whole class

Trash to Treasure

BLA#: 46

Strand(s):
Resource Recovery

Standard Statement(s):
3.6.7 A, 3.6.7 B, 3.6.7 C, 3.5.7 B, 3.7.7 A, 3.7.7 B, 3.7.7 C, 3.7.7 D

Content Objective(s):
For this recycling activity, students will:

1. Level I – Follow directions to create and complete an original useful project while utilizing common household trash.
2. Level II – Utilize computer aided drafting, do an oral presentation of, and record in their journals the process for creating an original useful project out of common household trash.

Assessment Strategies:
Level I: Ability to follow directions and student produced project.
Level II: Utilization of computer aided drafting, oral presentation, and process journal.

Procedures:
In this activity, students will utilize (recycle) common household trash and make it into something useful. The suggested teaching time is about 5 – 6 class periods.

- **Safety:** Care must be used if students are using spoiled biological material or sharp objects. The teacher might describe types of materials to use and not to use in advance.

Period 1 (Levels I and II)

- Teacher introduces activity and appropriate background information. Students participate in a question and answer session.

Periods 2, 3 (Level II), 4, 5 (Level I)

- Teacher is the resource person, while students are working on their projects.

Period 4 (Level II), Periods 6, 7 (Level I)

- Teacher is the resource person, while students are asking questions and conducting trial and error experiments on their projects.

Period 5 (Level II), Periods 8, 9 (Level I)

- Teacher and students are evaluating the completed projects through presentations or sharing of projects.

Period 6 (Level II), Period 10 (Level I)

- Teacher and students summarize the activity. Teacher facilitates discussions and implications for the future of recycling.

Source: Original

Related Web Sites:

Suggested Level:
Grades 5 – 7 (Level I),
8 – 10 (Level II)

Standard Category:
Earth Sciences
Technology
Technological Devices

Materials:

- Household trash
- Adhesives
- Cutting instrument
- Hole punch
- Mechanical fasteners
- Materials for presentation of projects
- Computer drafting program

Instructional Strategies:

- Individual and or
- Small groups
- Whole class

Thick and Fast **BLA#: 48**

Content Organizer(s)
Agriculture

Standard Statement(s):
3.1.10 D, 3.3.10B

Content Objective(s):
At the conclusion of this lesson students will be able to:

1. Assess and record in a formal lab report the effectiveness of a cellulase preparation in degrading cellulose.
2. Properly conduct an experiment.

Assessment Strategies:

1. Student produced lab reports.
2. Student experimental procedures

Procedures:
In many food-processing industries the main operation is one of extraction, for example extraction of juice from fruit pulp. The leftover materials are often cellulosic in nature, and are difficult to remove through pipes either for disposal or breakdown into useful fermentable sugars. In this lab activity, students will assess the effectiveness of a cellulase preparation in degrading cellulose. The suggested teaching time is one class period.

1. Provide the class with the appropriate introduction and background to the activity. Review with students, lab safety procedures and instructions for the activity (provided below, or you may want to have it written out for them in a lab instruction sheet).
2. Fix both syringes in the clamps and attach them to the stand so that each syringe is about ten centimeters above the bench surface.
3. Add 25 cm^3 of wallpaper paste solution to one of the beakers.
4. Add an equal volume of paste to a second beaker.
5. To the first beaker add 0.1 cm^3 of distilled water and mix it into paste.
6. To the second beaker add 0.1 cm^3 of the Cellulace enzyme and mix it well into the wallpaper paste solution.
7. Carefully but quickly pour the two solutions into the vertically clamped syringes. Ideally, both solutions should be added at the same time. If you do this, it is wise to simply place a finger over each syringe nozzle until both are full.
8. Record the time taken for the solutions to run through the two syringes.
9. Once the wallpaper paste solution with enzyme has run through, run it through again, recording the time taken for this.

Suggested Level:
Grades 8 - 10

Standard Category:
Biological Sciences

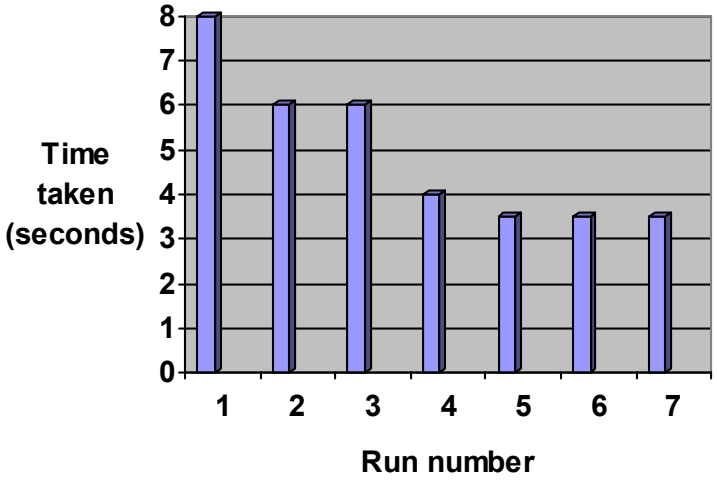
Materials:

- 1% wallpaper paste solution, 50 cm^3 (available from the NCBE Website)
- Cellulace Enzyme
- Glass stirring rods, 2
- Small beakers, 2
- Two 1cc syringes (for measuring out enzyme and water)
  - **NOTE:** 1cc=1cm^3=1mL
- Two 25 cm^3 syringe barrels, (for assaying flow rate)
- Two bosses and clamps
- Retort stand
- Stop watch

Instructional Strategies:

- Individual or
- Small group
- Whole class

10. Continue to run through until three similar time readings are obtained.



11. Use the data to plot a bar chart of the time taken for each run.
12. The decrease in flow rate may be calculated as follows:

$$\text{Flow Rate} = \frac{F - F_t}{F - F_w} \times 100 = \% \text{ Flow Rate}$$

F = flow rate of untreated wallpaper paste
F_t = flow rate of the paste solution after incubation time, t
F_w = flow rate of distilled water

This can be plotted against time of incubation, and the time required for a 50% decrease in flow rate read off the x axis, t50. This is used as a measure of relative cellulase activity:

$$\text{Relative cellulase activity} = \frac{1}{t50} \times 100$$

13. Discuss findings/implications and have students record their assessments in a formal lab report.

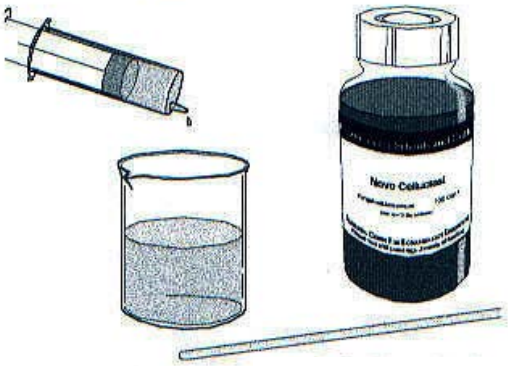
- **Further Activity**
  Incubate 25 cm^3 of 1% wallpaper paste with 1g of soil at 20°C for 24 – 72 hours (the exact time needed varies with the microbial population of the soil). Use the syringe to assay the cellulolytic activity of the soil microflora. (See Diagram) Compare soil samples from different sites.

Source:
Practical Biotechnology. University of Reading. 1995.

Related Web Sites:
http://www.ncbe.reading.ac.uk/
www.ncbe.reading.ac.uk/NCBE/PROTOCOLS/pracbook.html

Thick and fast?

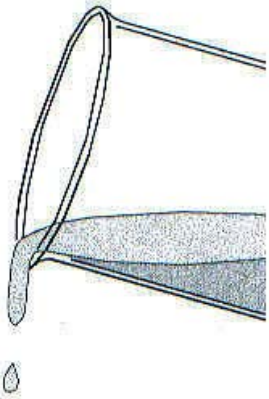
1

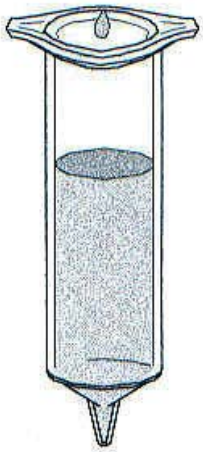


Stir 0.1 cc of cellulase enzyme into 25 cc of cellulose wallpaper paste

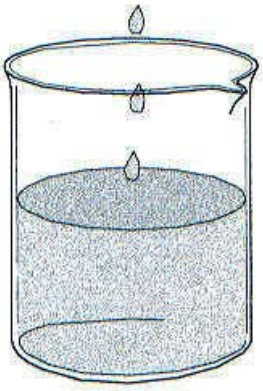
2

Pour the enzyme and paste mixture through a syringe body

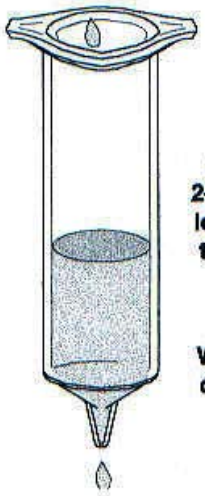




3



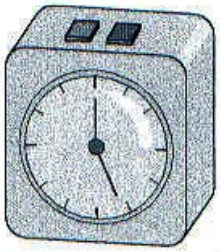
Repeat the process until three similar readings are obtained



4

Repeat Steps 2–3 with another lot of paste, this time with water instead of enzyme

What difference did the enzyme make?



Grease Busters **BLA#: 49**

Content Organizer(s):
Biomaterials

Standard Statement(s):
3.6.7A, 3.8.7

Content Objective(s):
At the conclusion of this lesson students will be able to:

1. Conduct and record an investigation of the enzyme Lipolase in commercial washing powders using the worksheet.
2. Create a washing powder using the lipase enzyme.
3. Relate their design procedure to the universal systems model.

Assessment Strategies:
Student generated investigation and washing powder.

Procedures:
The enzyme Lipolase is now widely used in commercial washing powders to help shift greasy marks such as oil, shoe polish and lipstick at relatively low temperatures. Students will conduct their own investigations to create a washing powder using the lipase enzyme. The suggested teaching time to complete the activity is one class period.

- **Safety:** Include precautions and use of personal protective equipment for lipase enzyme.
- **Safety**
  Lipolase ™ 30T consist of lipase enzyme encapsulated in a low melting point wax, hence it is unlikely to form airborne dust. Lipolase ™ is nontoxic, but it is an active fat decomposing enzyme, so unnecessary contact with the product should be avoided.
  In case of accidental spillage or contact with skin or eyes, rinse by flushing with water.

1. Provide students with appropriate background and introduce activity to the class, giving them the following practical details (you may wish to write this up as a student handout in conjunction with the "Grease Busters!" worksheet).
   - Students should be advised to use realistic amounts of lard to mark the fabric, as no washing powder could be expected to remove very heavy stains.
   - The washing powder solution should typically contain 10g of powder per liter of water (students are often tempted to use far too much).
   - A concentrated enzyme solution may be used to pre-spot stains on the fabric. Washing with conventional, or lipase-augmented solution should then take place.
   - The effectiveness of the enzyme depends greatly on the composition of the detergent used. For example, chlorine bleaches even in small amounts, will inhibit the enzyme.

Suggested Level:
Grades 8-10

Standard Category:
Technology Education
Science, Technology & Human Endeavors

Materials:

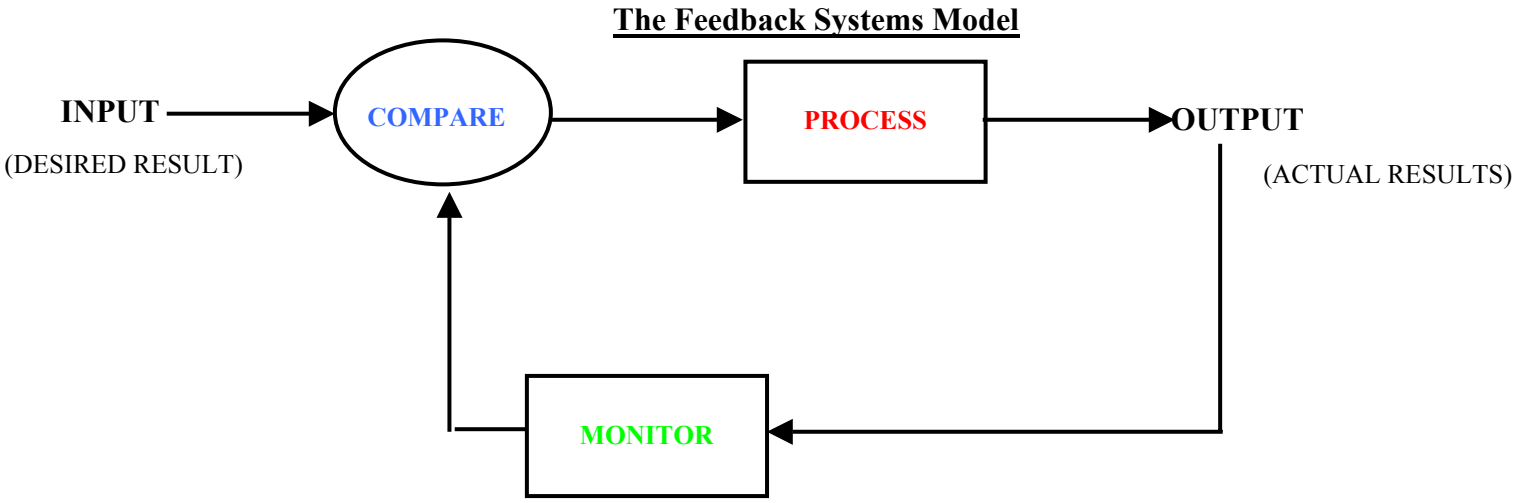
- Lipase enzyme, Novo Nordisk Lipolase ™ 30T (available from the NCBE)
- Enzyme-free washing powder
- Fabric for staining – cotton or polyester/cotton. Alternately, a multi-fiber fabric (normally used for testing dyes) is available from NES Arnold, Ludlow Hill Road, Nottingham. Tel: +44 (0) 1602 452203 (Catalogue No. P3007/2)
- Lard, blended with a small quantity of carbon powder or Sudan III dye (colored red) to make it visible on cloth
- Balance, accurate to 0.1g

Instructional Strategies:

- Individual or
- Small group
- Whole class

- The optimum temperature for the enzyme is 30°C. It may not be necessary to use a water bath to maintain this temperature over the period of the investigation.
- Light lard stains are removed after 40 minutes under the above conditions.

2. Monitor students' procedures, facilitate learning, and have students record their investigations. Have students share their newly produced washing powders and discuss findings and lab activity.



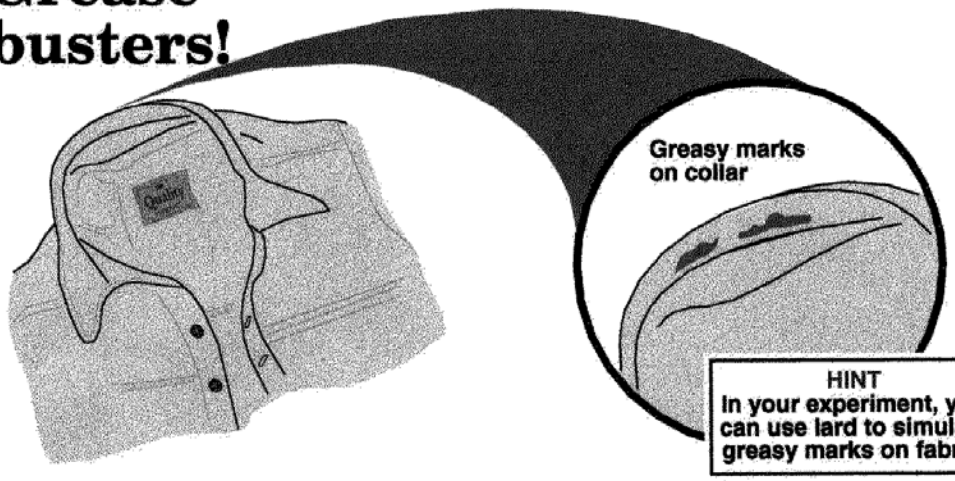
Source:

Practical Biotechnology. University of Reading. 1995.

International Technology Education Association. ***Technology for All Americans: A rationale and Structure for the Study of Technology.*** International Technology Education Association. 1996. Page 20.

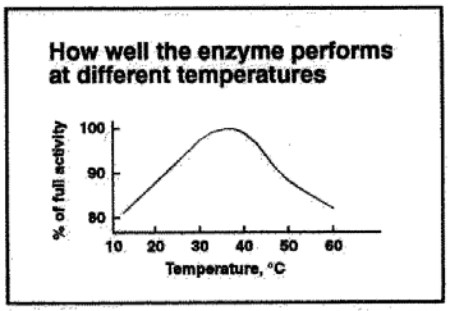
Related Web Sites:
www.ncbe.reading.ac.uk/NCBE/PROTOCOLS/pracbook.html
http://www.ncbe.reading.ac.uk/
itea@tmn.com (email)
http://www.tmn.com/Organizations/Iris/ITEA.html (homepage)

Grease busters!

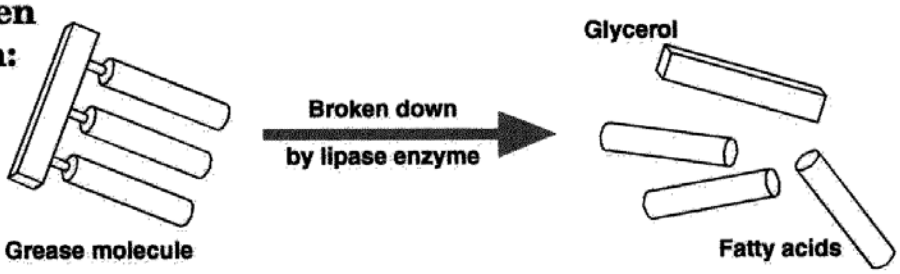


HINT
In your experiment, you can use lard to simulate greasy marks on fabric.

A new lipase enzyme can be used to shift greasy marks at low temperatures.



How grease is broken down:



Making your investigation a 'fair test'

- how much washing powder are you going to use? (1 g per 100 cm^3 of water would be usual)
- how much enzyme are you going to use? (manufacturers use 2 g of enzyme for every 100 g of powder)
- how are you going to put the stain on the cloth?
- at what temperature are you going to keep the solutions?
- will you stir the washing, and if so, how much?
- how will you detect whether the enzyme has worked?

Will your investigation tell you whether it *really is* the *enzyme* which shifts the grease?

What tests could you do to find out

- whether water alone can remove grease?
- whether washing powder solution alone (without lipase enzyme) can remove grease?
- whether washing powder solution with added lipase enzyme can remove grease?