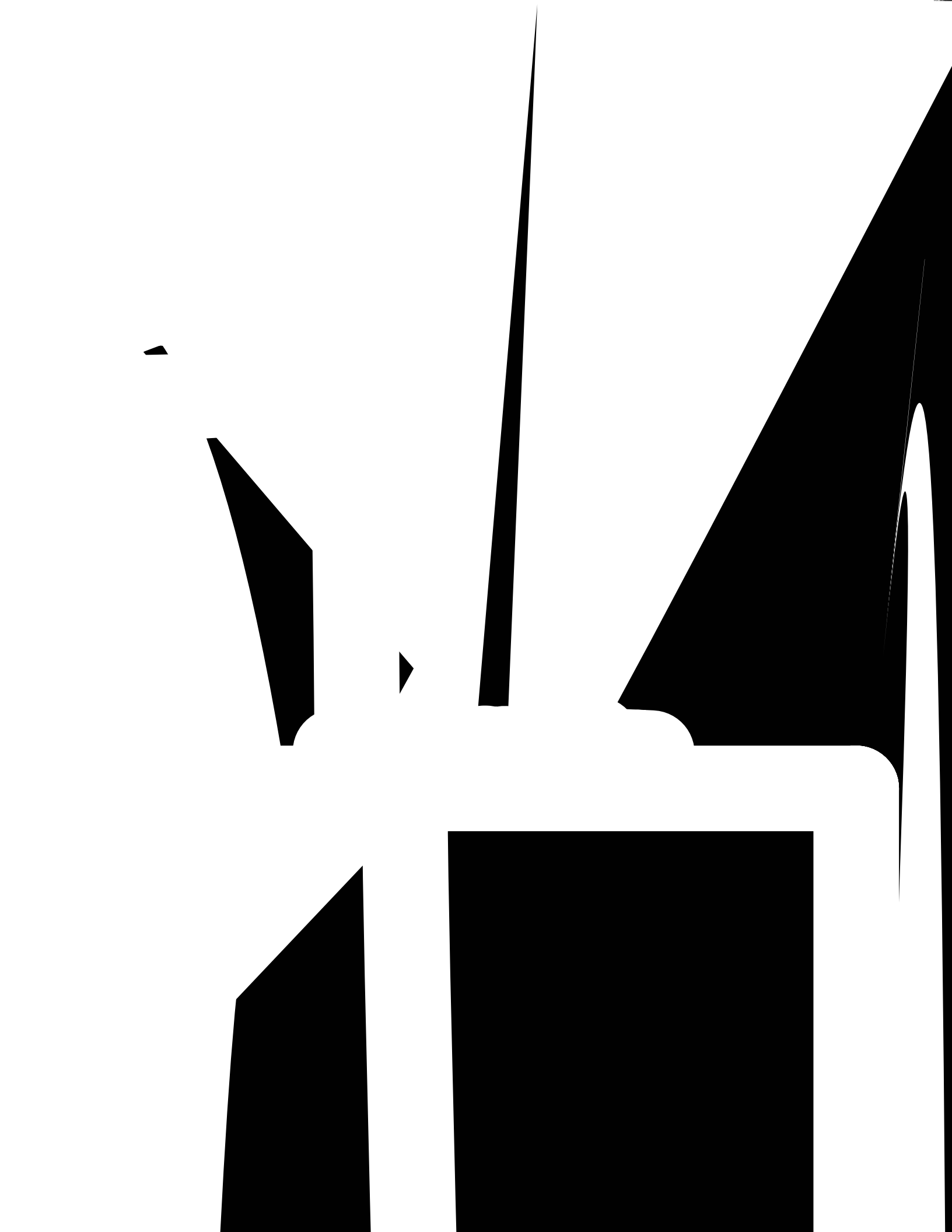

Lesson title: Introduction to Genetic Engineering

Abstract: The teacher will demonstrate an activity called “Earth - the Apple of our Eyes,” which points to the limited resources available to mankind for the production of enough food to feed the world population. Next, students will complete a worksheet while viewing a video presentation that further defines biotechnology. Before a definition of genetic engineering is given, the teacher will assess prior student knowledge using a KWL chart.

Teacher information/Situations/Setting/Time:

- Time Frame: One 90-minute bock period
- Materials:

1) Small apple & knife (see “Earth: The Apple of our Eyes”)
2) “A Short Course on Biotechnology” self-running video on disk
   a. Contact Council for Biotechnology & Syngenta Seeds, Inc @ 1-800-478-5428 for a copy of the video
3) “Cinna-Apple” posters (using the “croptechnology” Website as a guide, develop posters to illustrate the 5 steps of GE)
4) Student sheets:
   Video notes
   KWL chart
   GE guided notes

- Teacher Resources:
  http://citnews.unl.edu/hscrop/biotechnology/html/firstPage.html

Technology requirements/Tools/Materials:

Eiki projector w/computer
Computer speakers

Assessment: KWL chart; video questions; discussion

Teacher Instructions/Student Activity/Tasks:

1. Follow the “Earth: The Apple of our Eyes” activity instructions to introduce students to the need for science to advance agriculture. It is important that they understand agricultural concerns are not just the business of farmers. We all need food to survive. In addition, most vaccines and medicines originate from plants.
2. Transition to the video presentation. Students should be instructed to complete the video questions. Differentiation options: Allow students 5 minutes to “pair-share” after the video. A word list might also be provided.
3. After the video, refer back to the concept map (from last period.) Discuss the genetic engineering section, explaining that you would like to know what information they already have about genetic engineering.
4. Handout the KWL chart and instruct students to make a list of everything they already know about GE in the first column, and a list of what they want to learn about GE in the second column. The third column will be completed at a later

date. Collect the charts and save for future use. I usually give a grade based on participation.

5. Encouraging student participation, the teacher should record their responses on the classroom marker board, reminding students that any response is acceptable at this point. The last column will later allow us to correct any misconceptions.
6. Using the GE posters, walk students through the steps of genetically engineering an apple transformed to include the taste of cinnamon. Students should complete their notes page. Note: I made individual posters, laminated them, and then stuck a magnet on the back of each so that I could toss them onto the marker board as I told the story (hypothetical) of how I created an apple to taste like cinnamon. I really get animated with this story—starting with the question: How many of you had Apple-cinnamon Cheerios for breakfast? Then discuss how much of love the taste of cinnamon with my apple, however, I hate the mess that it makes.

EARTH: THE APPLE OF OUR EYES
(adapted from Teachers' Pet Project)

Consider the earth an apple. Carry out the following sequence:

1. Slice an apple into quarters.
   - x Set aside 3 of the quarters.
     What do these represent?
     The represent the oceans of the world.

     What fraction do you have left? 1/4

   - x Slice the ¼ in half and set on piece aside.
     That piece represents the parts of earth that are inhospitable to people: polar regions, deserts, swamps, very high or rocky mountains

     What fraction do you have left? 1/8
     The piece that is left is land area where people live, but do not necessarily grow the foods needed for life.

   - x Slice the 1/8 piece into 4 sections. Set aside 3 of these.
     These 3 pieces represent the areas too rocky, too wet, too cold, too steep, or with too poor soil to actually produce food. They also contain the cities, suburban sprawl, highways, shopping centers, schools, parks, factories, parking lots, and other places where people live but do not necessarily grow food.

     What fraction do you have left? 1/32

   - x Carefully peel the 1/32 slice of the earth.
     This tiny bit of peeling represents the surface, the very thin skin of the earth's crust upon which mankind depends. It is less than five feet deep and is a quite fixed amount of food-producing land.

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Name_____ Period_____

# KWL CHART (Genetic Engineering)

| What I already know about GE | What I would like to learn about GE | What I have learned about GE (end of unit) |
|---|---|---|
| | | |

Combating animal disease
Through recent developments in biotechnology we are able to control "shipping fever," the biggest killer of beef cattle in feed lots.

Increasing yield
In the farm field, herbicide-resistant soybeans improve yield while reducing the need for chemical application, as well as lowering production costs, and reducing the need for soil tillage--which means less soil erosion.

Safer crops
And, insect-protected corn, cotton, and potatoes result in better-quality crops with less reliance on insecticides.

In fact, in 1998, 3.5 million pounds less _____7_____ were applied to American-grown corn and cotton through the use of insect-protected varieties produced through biotechnology.

Why Biotech Products Are Safe
The facts indicate that biotech products are safe, and that the _____8_____ they provide far outweigh the _____9_____.

outweigh the

Let's look at a few examples. . .

- One of the first major biotech products made available to farmers was Bt [17].
- Greater efficiency
  The farmer spends less time and uses less [18] driving his equipment back and forth, and back and forth, and back and forth across his fields.
- Income spent on food
  Farming efficiencies like that--as well as modern food production efficiencies in this country--help keep what North American families spend on food to just 10% of disposable household income versus the 20% spent by European families.
- Another example: Tacos!
  The shredded cheddar cheese that we put on tacos is a product of biotechnology.

  The food enzyme [19] is used to curdle milk in the production of cheeses. Historically, rennet has been taken from the stomach linings of calves.

  Some years ago however, by isolating the gene that produces rennet, researchers found a way of having common bacteria generate the enzyme. This lets us produce rennet through a much simpler fermentation process.

Name_____ Period____

DNA Extraction Pre-lab Investigation

## How can we make DNA visible?

To work with DNA, scientists usually take it out of the cell and gently separate it from the other substances around it. This activity is a procedure for extracting DNA from banana cells. It is imperative that you read the lab protocol prior to the activity. Then, you should answer the questions below to help you process the lab concepts.

Step 1-4: Collect cells

To see the DNA, you will collect banana cells by breaking down tissue through the process of smashing. You will then break

Steps 5 & 6: Break open (lyse) the cells

Once you have collected the cells, the cells need to be broken open to release the DNA. Detergent, or shampoo, will dissolve the membranes of your cells, just like dishwashing detergent dissolves fats and proteins from a greasy pan, because cell and nuclear membranes are composed of fats and proteins. Dissolving the membrane results in the release of the DNA. The process of breaking open the cell is called lysis. Once the DNA has been released, it must be dissolved so it can be separated from the substances around it through a filtration process. Another important step is to neutralize the negative ends of the DNA so that it will eventually clump together during the last steps of the lab.

Focus question:

3. Do you think your DNA will be visible after you have broken open your cells? Why or why not?

4. Explain the purpose of the following steps:
    a. Smashing the banana

    b. Adding the shampoo

    c. Adding the water

    d. Adding the salt

Steps 7-10: Remove proteins & other substances

DNA is packaged tightly around proteins. Like spools for thread, these proteins keep the DNA tightly wound and organized so that it doesn't get tangled inside the nucleus. For you to see the DNA, it helps to remove the proteins so that the DNA can first loosen and expand, then collect into a mass with the DNA from all the other cells. You will submerge your lysed cells into a hot bath, which breaks down proteins so that they can no longer bind DNA.

Focus question:

5. When washing dishes, what works better, warm or cold water? Which do you think will help the detergent break open the cell, warm or cold temperatures?

Steps 11 & 12: Condense the DNA

Strands of DNA are so thin that it is not possible to see them when they are dissolved in solution. Think of the long, thin strands of DNA as fine cotton thread. If one long piece of thread were stretched across the room, it would be difficult to see. To make the thread more visible, you could collect it all together and pile it on the floor. In this laboratory experiment, you will use a cold liquid to bring the DNA out of solution or precipitate it. The liquid creates a condition in which DNA doesn't stay in solution, so the DNA clumps together and becomes a solid mass that you can see.

Focus question:

6. What liquid is used to precipitate the DNA? (Hint: DNA is insoluble in this liquid.)

What does precipitated DNA look like?

Lab Observations:

1) Use observation terms to describe what you see in the test tube.

2) Use observation terms to describe what the spooled DNA looks like.

3) What pH reading did you get? _____ Is DNA an acid or a base?_____

12.

Lesson title: Introduction to Biotechnology

Abstract: An initial engagement activity is intended to illicit “excited” reactions from students based on news of a dangerous chemical (DHMO) that exists in our environment. The activity is designed to promote open-mindedness and to encourage students to become more informed citizens, especially considering the vast media influence in our society. Students then enjoy “DNA smoot

Teacher Instructions/Student Activity/Tasks:

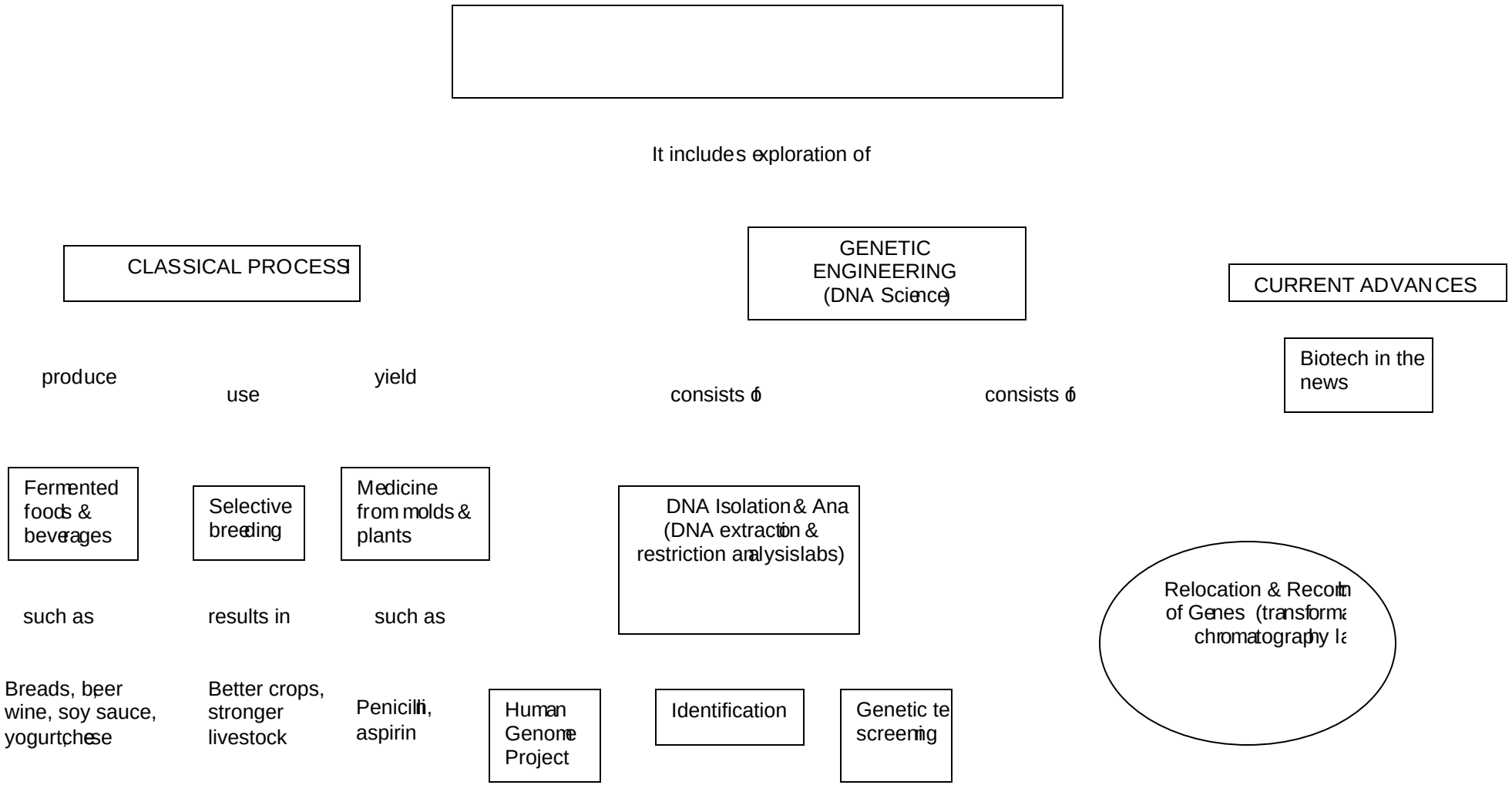
1. Begin class with the DHMO manipulation activity. The teacher must be really "pumped up" and animated while engaging students in the exploration of the dangers of DHMO. After explaining to the students that you recently stumbled across an alarming Website, share the site with them. As you navigate the "Ban" and "Facts" sites, attempt to illicit excited responses from the students. Allow opportunity for student discussion. Point out that it is always important to look for other perspectives when exploring issues. Take them to the "Friends" site. Finally, inform the students that there is even a song about the dangers of DHMO. Encourage students to sing along as you slowly scroll through the verses. As you come to the verse that actually quantifies DHMO as $CO_2$, be prepared for mayhem!
2. Point out that all information presented was true! Press the fact that often the way information is presented influences our thinking. Ask students if they have ever been influenced by negative rumors and avoided someone they did not yet know, only to later realize they really liked the person. This would be a good opportunity to make the connection between misinformation and prejudice.
3. Move to a discussion about how important it is to look at many perspectives, and to become knowledgeable before judging an issue. That is a constant role in science! Scientists must continually search for answers to improve our quality of life, based on a diverse group of interests, ethics; and on scientific research. Discuss the dangers of automobiles. Ask if our society could easily eliminate cars because of their danger. Of course not! Therefore, scientists and technologists have worked together in order to make automobile travel as safe as possible.
4. 5(tsnswersial.h the veblepeopTd Tw 16ific rese7tant )]TJ 0.0011

# Make a DNA Smoothie

To a blender, add the following ingredients and blend until smooth:

- 1 bag frozen strawberries
- 1 banana
- 1 cup orange juice
- 1/2 cup milk
- 8 oz. Yogurt
- 3 Tbs. honey

Serve in small Dixie cups.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Penicillin, aspirin
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Identification
Genetic te screening

# “Biotech in the News”

Name_____ Date_____

Find a biotechnology article that is of interest to you, cut it out (or copy it) and answer the questions below. The article should be attached to the questions and then handed in by _____. You may find an article in the newspaper, a magazine, a science journal, Websites, or any other source that highlights biotechnology.

Why did this article interest you?

Read the biotech article you have chosen and complete the following questions:

1. Title _____

   Author _____

   Source _____Date _____

2. Identify the main ideas of the article. (2-3) Write T.6 (ite s2 0)5(i)5(c)321e009 (C BT /T8 (C BT /2

3. Identify and define at least 5 terms that are either new to you or are related to biotechnology, or biology topics.

| Term | Definition |
| --- | --- |
| A. | |
| B. | |
| C. | |
| D. | |
| E. | |
| F. | |

4. What questions does this article raise? Does the article present differing viewpoints? If so, summarize each point of view.

_____
_____
_____
_____
_____

Lesson title: Welcome to the Wonderful World of Transformation!

Abstract: Completion of this lab allows students to witness genetic transformation as a visible event. After a teacher-led presentation that introduces and explains the process of moving genes from one organism to another, students complete intense pre-lab preparations. Students then explore the mechanisms of gene regulation and genetic selection as they transform bacteria with a gene that codes for GFP, which causes them to glow a brilliant green color, and with a gene that codes for resistance to the antibiotic ampicillin. In addition to providing an excellent example of the central molecular framework of biology in action, this lab allows students an opportunity to practice lab skills and techniques, as well as an opportunity to experience the thought process involved in a lab-based scientific procedure.

Teacher information/Situations/Setting/Time:

- Time Frame: Three 90-minute bock periods
- Materials:
  - Genetic Transformation PowerPoint Presention w/notes (contact leeann.vaughan@ops.org for a copy)
  - pGlo™ Bacterial Transformation Kit (contact BioRad @ 1-800-424-6723)
  - Ice bucket w/crushed ice
  - Thermometer that reads $0^0$-42
  - 1 L flask
  - Distilled water
  - Bleach
- Student sheets
  - Power Point handouts (request attachment from Vaughan)
  - Introduction to Transformation
  - Lab protocol (see BioRad booklet)
  - Focus questerio>>BDC46092 Td 1/MC2DC BP <</MCID 26 >>BDC BT /TT3 1 Tf 11

Teacher Instructions/Student Activity/Tasks:

Note: The kit comes with instruction booklets that include the lab procedures. The student sheets included with this lesson have been modified from the BioRad lessons in order to meet the needs of my own students. The teacher preparations should be carefully followed as directed in the BioRad booklet.

Day One

1) Students fill in blanks on slide show notes as the teacher presents the Genetic Transformation PowerPoint.
2) After slide #16, take a break from the presentation to allow students an opportunity to become more familiar with

Name_____ Period_____

Focus Questions (To be completed prior to lab day)

1) What is the host organism?

2) What two traits are we attempting to change about the host organism?

3) What are the two genes of interest, and what organisms were these genes taken from?

4) How many colonies of bacteria are you going to transfer into the CaCl microtubules?

5) Draw pictures of the four plates you will be using in the lab and label them as shown in step #7 of the lab instructions.

6) Why do some of the plates have ampicillin in the agar?

7) Why do some of the plates have arabinose in the agar?

8) How will you be able to tell if you are transferring the plasmid DNA into the microtubules that contain the E. coli? (Hint: See step #5.)

Name_____ Period_____

Pre-lab Investigation:

Name_____ Period____

Review Questions

Before collecting data and analyzing your results answer the following questions.

1. On which of the four plates would you expect to find bacteria most like the original non-transformed E. coli colonies you initially observed on the starter plates? Explain your predictions.

2. If there are any genetically transformed bacterial cells, on which plate(s) would they most likely be located? Explain your predictions.

3. What is meant by a control plate? What purpose does a control serve?

4. Which plates should be compared to determine if any genetic transformation has occurred? Why?

Name_____ Period____
Transformation Lab

DATA COLLECTION

| Plate | Colonies (Present or Absent) | Color | |
|---|---|---|---|
| | | Regular Light | UV Light |
| LB | | | |
| LB/AMP | | | |
| LB/AMP | | | |
| LB/AMP/ARA | | | |

Analysis of Results

1. What plates should be compared to best prove changes occurred?

2. Very often an organism's traits are caused by a combination of its genes and its environment. Think about the green color you saw in the genetically transformed bacteria:
    a. What two factors must be present in the bacteria's environment for you to see the green color? (Hint: One factor is in the plate, and the other factor is in how you look at the bacteria.)

## Conclusion

Refer back to the purpose of this lab and write a paragraph (in complete sentences) that addresses the following: Was the purpose accomplished? If not, what could be some possible reasons for lack of successful transformation? Explain what you learned in this lab. What new questions do you have? What new experiments could this experience lead you to?

Unit Title: Genetic Engineering: A Journey into DNA Science

Author: LeeAnn Vaughan
North High School
Omaha, Nebraska
<leeann.vaughan@ops.org>

Unit Overview: An initial engagement activity is intended to illicit "excited" reactions from students based on news of a dangerous chemical (DHMO) that exists in our environment. The activity is designed to promote open-mindedness and to encourage students to become more informed citizens, especially considering the vast media influence in our society. Students then enjoy "DNA smoothies," while a concept map introduces students to the field of biotechnology. A follow-up lesson allows the teacher to demonstrate an activity called, "Earth: The Apple of our Eyes," which points to the limited resources available to mankind for the production of enough food to feed the world population. Students are then introduced to the field of genetic engineering, as they begin their journey into DNA science. The DNA extraction and genetic transformation labs are designed to promote conceptual understanding of genetic engineering. In addition to a focus on conceptual understanding of DNA science, the guided inquiry-based labs aid students in their understanding of scientific processes, and enrich the knowledge gained through the classroom experiences. The lab activities are also designed to develop laboratory skills that are utilized in scientific research.

ABILITIES NECESSARY TODO SCIENTIFIC INQUIRY

- USE TECHNOLOGY AND MATHEMATICS TO IMPROVE INVESTIGATIONS AND COMMUNICATIONS. A variety of technologies, such as hand tools, measuring instruments, and calculators, should be an integral component of scientific investigations. The use of computers for the collection, analysis, and display of data is also a part of this standard. Mathematics plays an essential role in all aspects of inquiry. For example, measurement is used for posing questions, formulas are used for developing explanations, and charts and graphs are used for communicating results.

Components:

- Introduction to Biotechnology: An initial engagement activity is intended to illicit "excited" reactions from students based on news of a dangerous chemical (DHMO) that exists in our environment. The activity is designed to promote open-mindedness and to encourage students to become more informed citizens, especially considering the vast media influence in our society. Students then enjoy "DNA smoothies," while a biotech concept map is introduced to help students visualize the scope of biotechnology. The lesson proceeds with a focus on classical biotechnology, including samples from those processes. Students will also be introduced to a current events assignment that encourages them to recognize biotech in the news, and to make connections with what they are learning in the classroom.
- Introduction to Genetic Engineering: The teacher will demonstrate an activity called "Earth - the Apple of our Eyes," which points to the limited resources available to mankind for the production of enough food to feed the world

and with a gene that codes for resistance to the antibiotic ampicillin. In addition to providing an excellent example of the central molecular framework of biology in action, this lab allows students an opportunity to practice lab skills and techniques, as well as an opportunity to experience the thought process involved in a lab-based scientific procedure.