Student Guide

Supermarket Science: Investigating Genetically Modified Organisms (GMOs)

Introduction: Genetically modified organisms (GMOs) are organisms that have DNA that has been altered by the intentional introduction of foreign genes. Food products which contain genetically modified organisms are available in your grocery store. These organisms, mostly plants, have had their DNA manipulated to enhance their growth and nutrition. DNA is a biological nanostructure that measures ~2 nm in width and 2-3 m in length. It is also the organism's genetic blueprint that controls its characteristics, such as height and color.

You are a scientist working at a food science laboratory *SuperGro* and you have been tasked with analyzing several fruit samples to determine if they are genetically modified with the gene *Growfast*. *Growfast* is a 4 base pair gene that is used to replace the plant's normal height growth gene to accelerate its growth.

Pre Activity: Your teacher will direct you to an online simulation/animation on gel electrophoresis. This technique is used to estimate the size and separate DNA using an electric field. This simulation will help you prepare for the analysis of your mock data. In addition, you will review a Polymerase Chain Reaction, or PCR.

Directions for the Activity: Prior to receiving the samples, your assistant extracted the DNA from several fruit samples and amplified the samples using PCR (polymerase chain reaction). PCR is a laboratory technique used to make many copies of a particular region of DNA – it can be any part of the DNA of interest to a scientist. Gel electrophoresis is how the results of a PCR reaction can visualized. It is a technique in which fragments of DNA are pulled through a gel matrix by an electric current that causes the separation of the DNA fragments according to size.

1. Record the samples that you will be testing in the blanks below or in your lab notebook.
    a. Sample 1_____
    b. Sample 2_____
    c. Sample 3_____
    d. Sample 4_____

2. Label your chart paper with the sample names across the top. The sample DNA will be analyzed in the labeled lane. Use Figure 1 as guide for labeling the chart paper.

3. Use the restriction enzyme Cutit to cut your DNA into small fragments. Cutit cuts the DNA sequence after the sequence TAC. Sequence chart below.

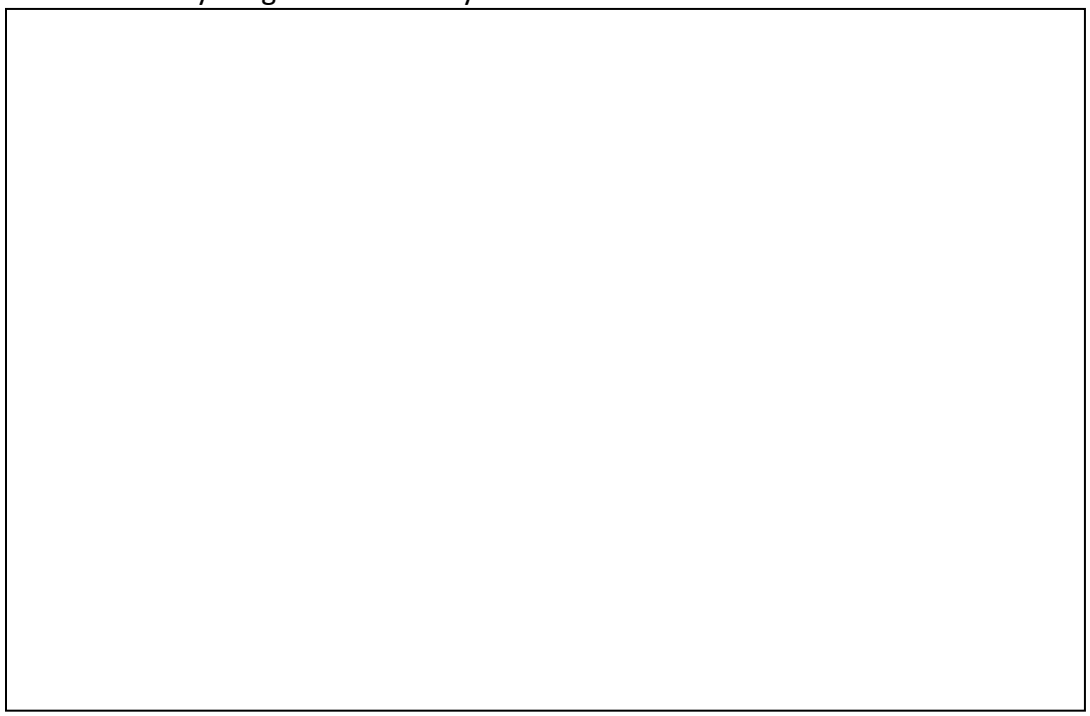
4. Count the number of bases pairs for each fragment.

5. "Run" your gel by organizing your DNA according to size on the chart paper. Remember that short fragments run faster on the gel. Label the number base pairs along the length of the paper. Make sure you keep each sample in the appropriate lane on the gel.

6. Compare the bands of your samples with the controls and determine if your item is genetically modified.

Results

Draw the results of your gel below or in your lab notebook.



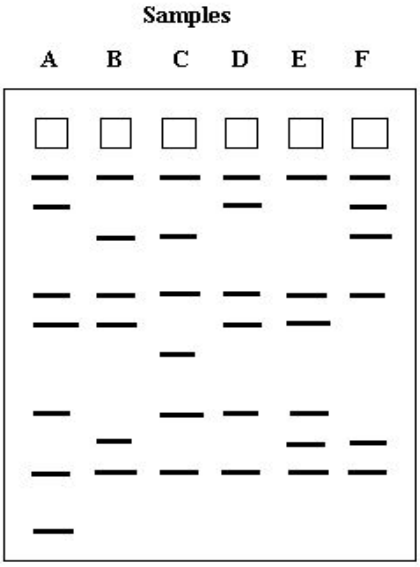


Figure 1: Gel electrophoresis results. The bands represent DNA fragments

Cleanup: Discard chart paper and return supplies

Assessment:

1. Was your organism genetically modified? If so how did you know?
2. What were the controls for the experiment?
3. What are the benefits of creating and using GMOs?
4. Why is this lesson connected to nanotechnology?
5. What are some ethical concerns about using GMOs?
6. Other than plants, what other organisms are manipulated using genetic engineering?
7. Using the internet or other references explain the steps that a nanobiologist would have to take to insert foreign genes in another organism. References:
   http://biology.kenyon.edu/courses/biol114/Chap08/Chapter_08a.html
   http://www.rpi.edu/dept/chem-eng/Biotech-Environ/Projects00/rdna/rdna.html

DNA Samples The gel with the results is shown on the next page.

Papaya DNA Papaya DNA Papaya DNA Papaya DNA Papaya DNA
TACTAGGATCTACTAGGCCTATAAGCCTATACCGGTGCCTATACCAGC
ATGATCCTAGATGATCCGGATATTCGGATATGGCCACGGATATGGTCG

Organic papaya DNA Organic papaya DNA Organic papaya DNA
TACTAGGATCTACTAGGCCTATAAGCCTATACCGGTGCTTAGCTACAC
ATGATCCTAGATGATCCGGATATTCGGATATGGCCACGAATGGATGTG

Corn DNA Corn DNA Corn DNA Corn DNA Corn DNA Corn DNA
AGCTACCTAGCGTGCCTATACTAGGATCTTACAGGCCTATATACCAGC
TCGATGGATCGCACGGATATGATCCTAGAATGTCCGGATATATGGTCG

Organic corn DNA Organic corn DNA Organic corn DNA Organic corn
AGCTACCTAGGGTGCCTATACTAGGATCTTACTAGGCCGTGCAGCTAT
TCGATGGATCCCACGGATATGATCCTAGAATGATCCGGCACGTCGATA

Strawberry DNA Strawberry DNA Strawberry DNA Strawberry DNA
AGCCTACTACGGTGCCTATAGGATCTTACAATAGGTTGCATACGCTGG
TCGGATGATGCCACGGATATCCTAGAATGTTATCCAACGTATGCGACC

Banana DNA Banana DNA Banana DNA Banana DNA Banana DNA
AGCTACAGGTTACGGTGCCTTACTGCAGCTGGGTACTAGGATCTAATG
TCGATGTCCAATGCCACGGTATGACGTCGACCCATGATCCTAGATTAC

GMO Control GMO Control GMO Control GMO Control GMO Control
AGCTACCTCTGG TTACGCC TATAGGATCTACTAGGCCT ATATACCAGC
TCGATGGAGACCAATGCGGATATCC TAGATGATCCGGATATATGGTCG

non-GMO control non-GMO control non-GMO control non-GMO control
CGGTGAGCTACCTATCTATACTAGATAGATCTACTAGGCCGTGCAGCT
GCCACTCGATGGATAGATATGATCTATCTAGATGATCCGGCACGTCGA