

High School Students Learn about GMOs Using an Inquiry-driven Case Study

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Purpose of Project

A problem-based learning activity was designed to enable high school students to think through the inquiry process for developing a Genetically Modified Organism as a solution to a food security problem.

GMO Facts in Education

- GMOs are a controversial issue prevalent in today's world.
- Much Negativity in the Media
- Because of the issues not many students learn the value (importance) to society

Lesson Development

Case Studies

- Based on Common problems/traits plant breeders encounter
- Each Section of the Case Study was a step in developing a GMO.
- Students were able to be scientists and develop their own research plan
- Picked different genes for each Scenario
- Described the two methods used to inset a gene into a cell and students
- Described selection methods to find what cells have the gene
- Selection of Plants that Survive to maturity
- Choose plants with good qualities and can out perform the original
- Name the Line and write report



GMOs presentation

Powerpoint Presentation

- Comparison of two different plants
- Importance of GMOs
- Current GMOs on the Market
- Conventional Plant Breeding/Why we develop GMOs
- A simplified version of how a GMO is made
- Overview of the Case Studies

3 Phases



Students conduct their inquiry study using case study booklets

Scientific Report

- Students had to report on their GMO
- State their problem and how they plan to fix it
- What gene they used and transformation method
- Explain how they selected the line they did



Student groups report to classmates

Student Scientists

- Urban location
- Chartered High School
- High school Agricultural Education Elective class
- Mixed age and gender
- 17 students in attendance
- Students in casual professional dress
 - Polo shirts and khakis

Scenario 1

The Current World Population is 7 billion and is expected to be 7.6 billion by 2020.

Goal is to develop a plant that can achieve higher yields on less amounts of land so there is enough food to feed the growing population



Scenario 2

Raining Season is Becoming Shorter, Experts Predict
Precipitation Decreases by Half in 5 Years.

**Goal is to develop a crop that can survive drought-
like conditions and produce high yields.**



Scenario 3

A new insect has arrived from overseas and is eating away the foliage of the crops .

Goal is to develop a plant that will reduce the number of harmful insects feeding on it.



Scenario 4

Rainfall continues to increase causing many fields to become flooded. Experts predict the trend to continue in years to come.

Goal is to develop a plant that can survive in flooding conditions and produce high yields



Outline of Steps in Case Study

- Pick a Crop to Improve
- Pick a Gene
- Choose a Transformation Method
- Evaluate the Lines
- Name your Line
- Write the Report



Candidate Genes

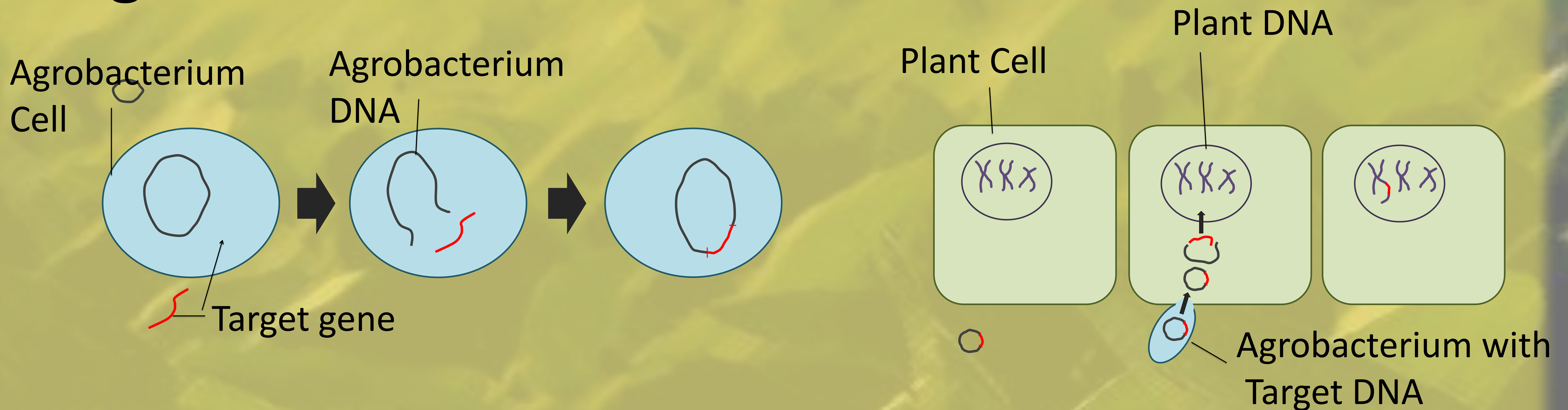
We provided the students a list of genes with a short description of the function.

- **Ex. Gene: Sub1A:**
- This gene is found in Rice. Controls ethylene production and gibberellic acid (plant hormones) responsiveness during submergence, economizing carbohydrate reserves and prolonging endurance. A plant expressing this gene can last up to two weeks completely submerged.

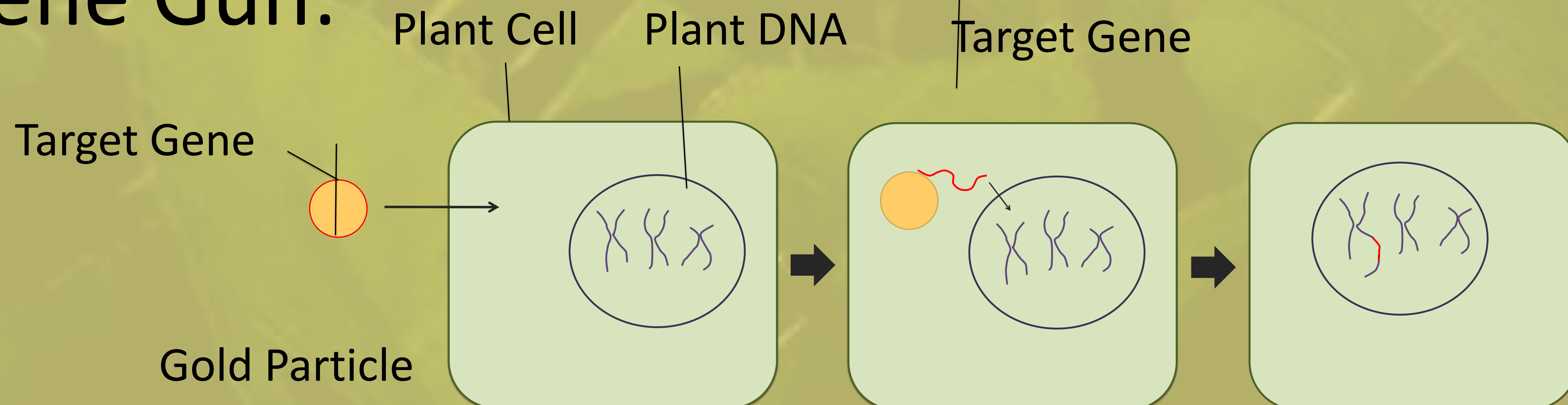
(Fukao, 2011, The Plant Cell 23:412-427)

Transformation Options

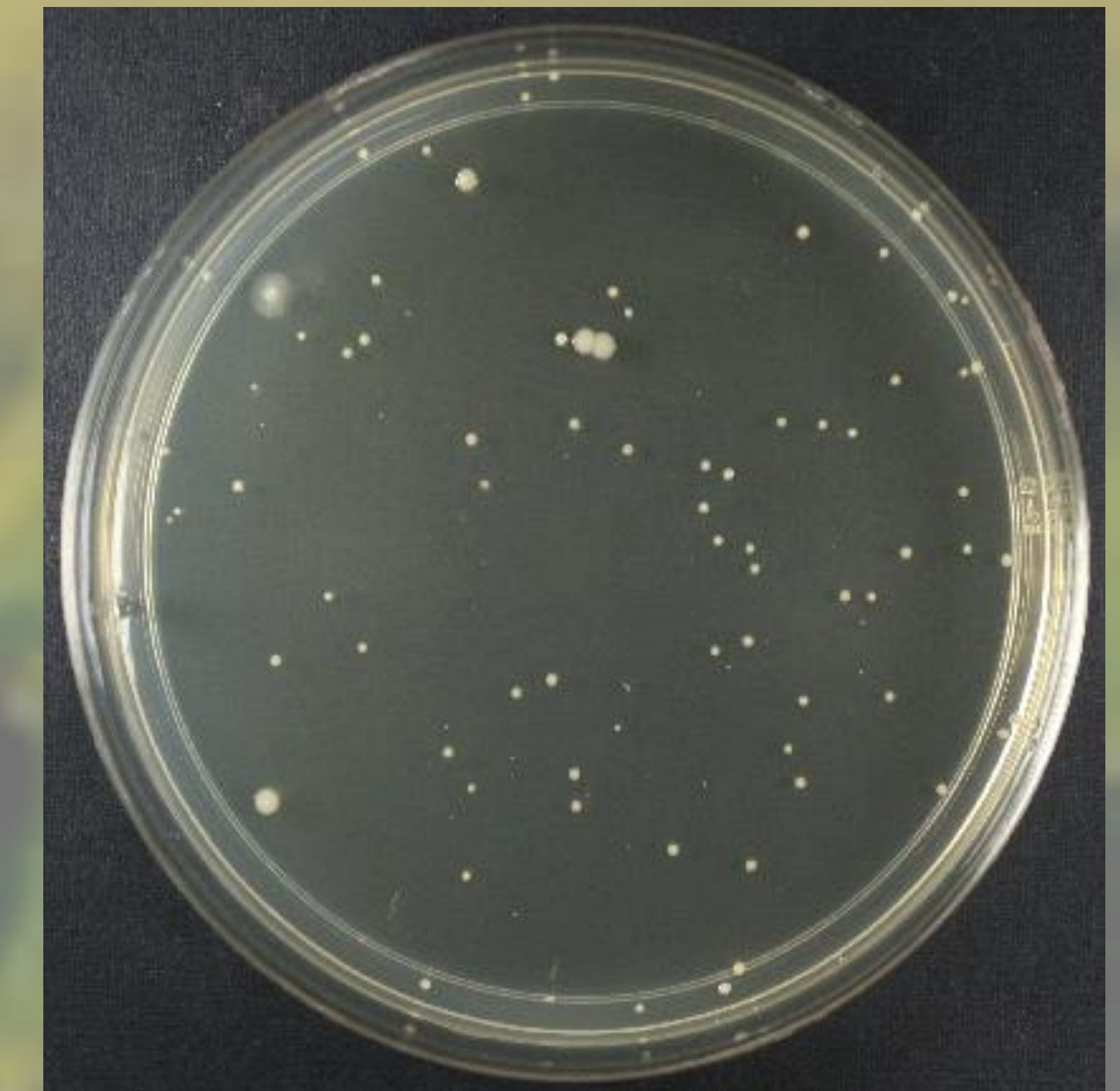
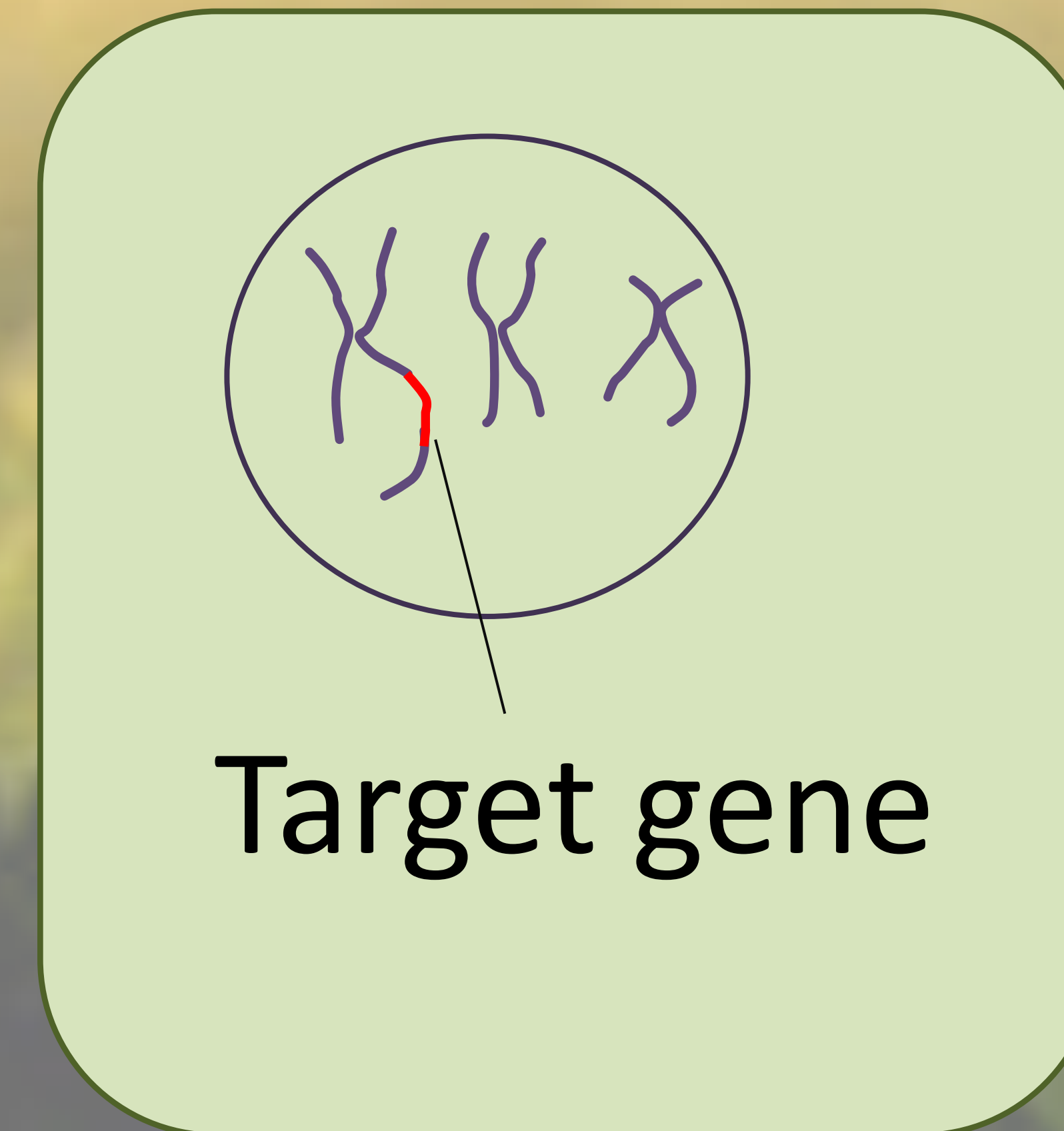
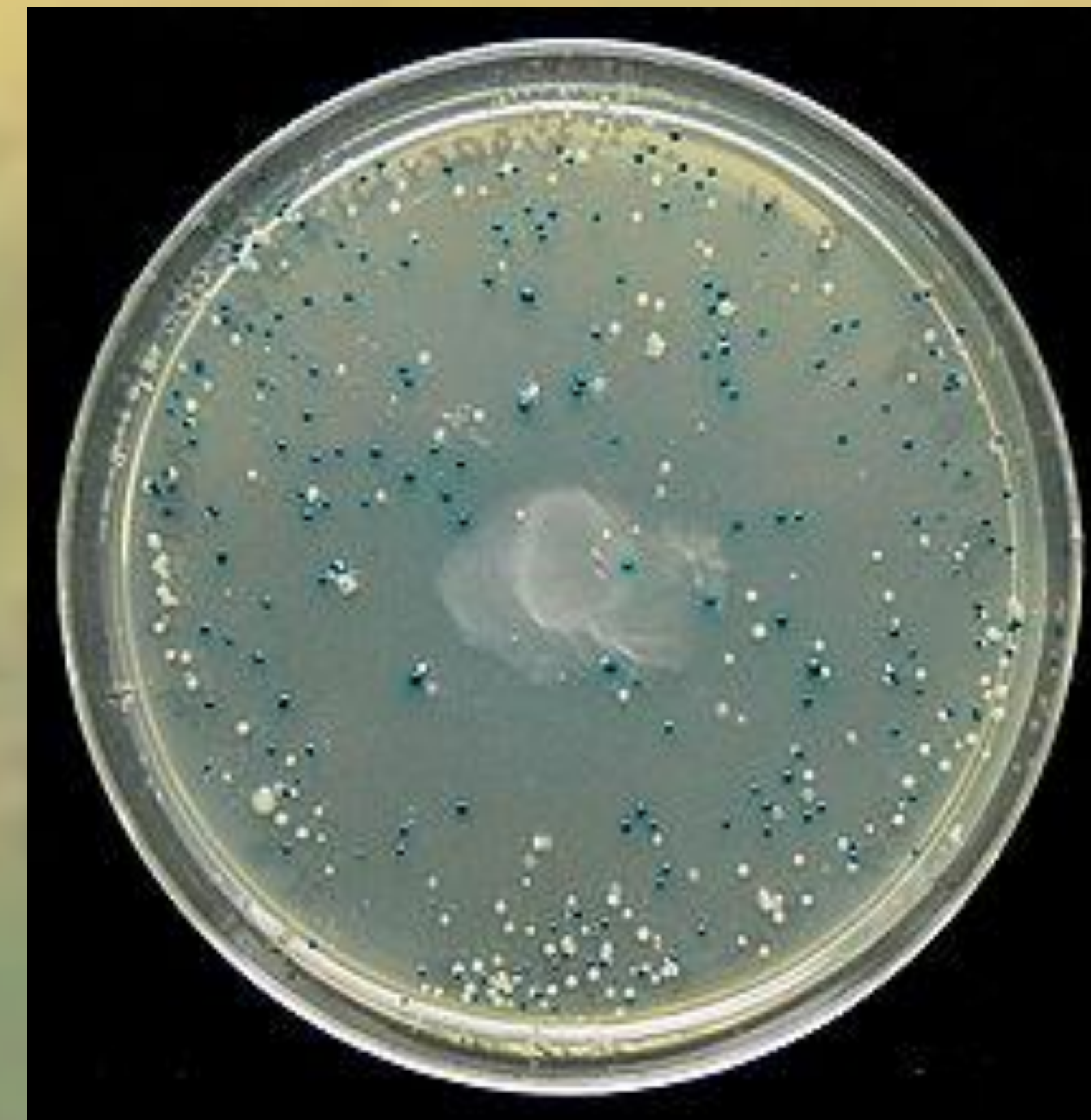
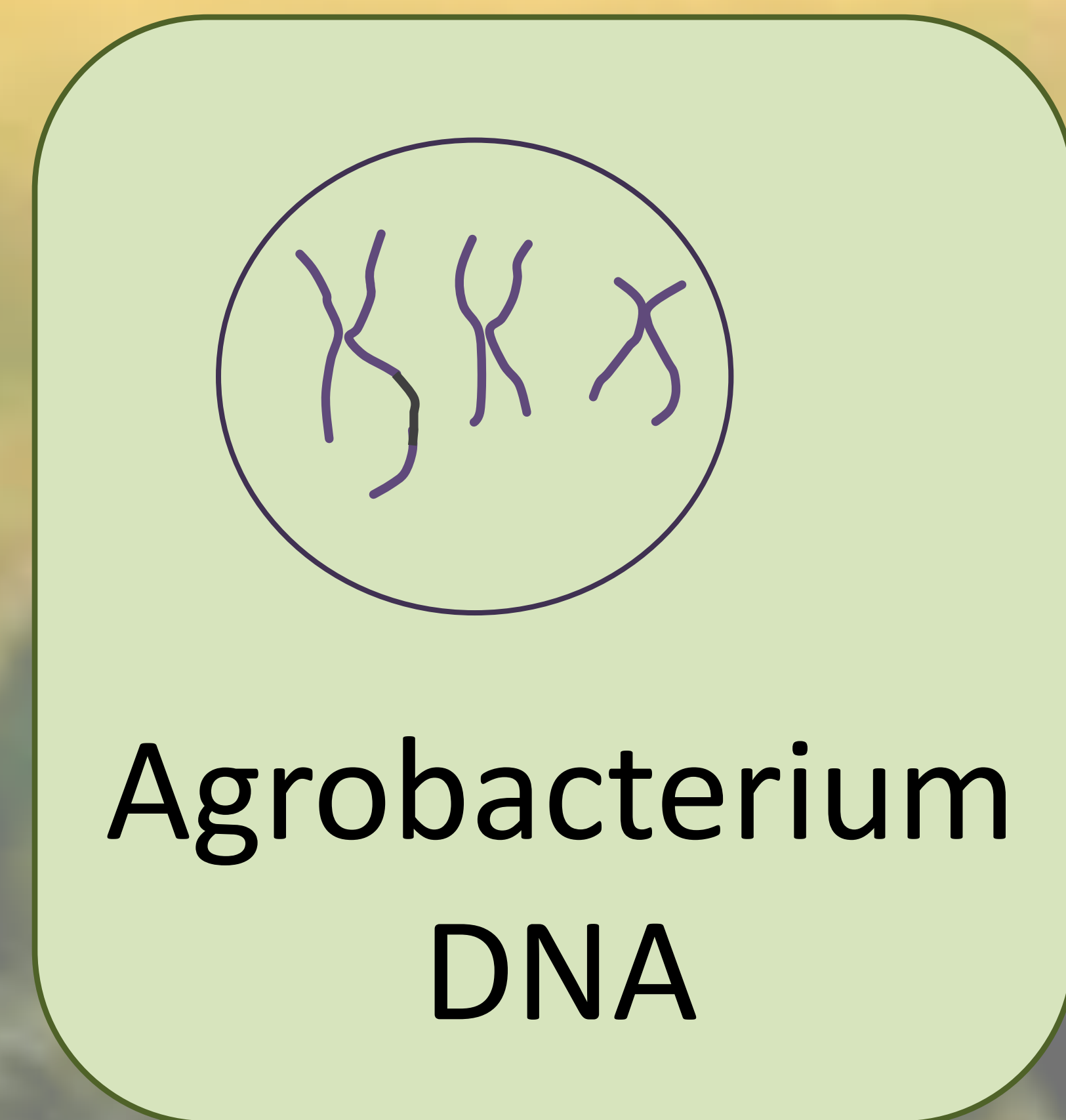
➤ Agrobacterium:



➤ Gene Gun:



Selection



Bock 2001

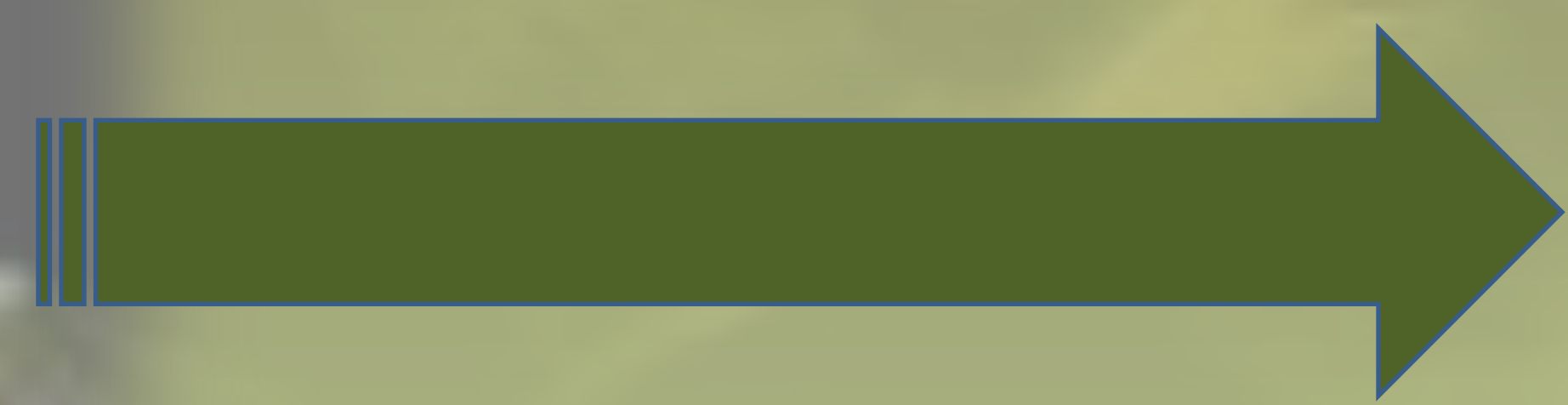
Selection

Select for lines where the performance exceed the Wild Type

	Caloric content of			
Line	Oil	Protein	Carbohydrates	Total
WT	169.1	126.9	559.9	855.9
1	157.6	129.2	617	903.8
2	156.3	149.8	820.6	1126.7
3	133	128.1	619.5	880.6
4	183.3	166.8	789.9	1140
5	140.6	161.6	837.1	1139.3

Inquiry Approach

- Give Students a chance to go through the process themselves and be Scientists



Get students questioning WHY?

- (How, What if)
- What are the components that make a good plant.
- Facilitate them to understand the basic steps of developing a GMO in simple terms

Inquiry Approach

Example of two soybean plants
(internodes)



How are these plants different:

Stems, height, is one plant better than the other, why?

Roundup-ready soybeans.

Why use roundup?



Graduate Teaching Reflections

Initial Challenges

- How to take a complex process and make it simple
- How to keep the students attention and get them involved

Highlights

- Was able to include my research into the lesson
- Rewarding to see the students get involved and interested in the subject
- Was able to Collaborate with another Ph.D. Student from a different department

Teaching Observations

- Urban classrooms require
 - High activity levels of instruction
 - Multiple visual displays
- Stay on task- minimize “story telling”
 - Use white board or note space
 - Classroom teacher vital participant for behavior

Reliable Content Sites

- <http://www.nature.com/scitable/spotlight/gmos-6978241>
- <http://www.hudsonalpha.org/education/kits/gmod/gmos-made>
- <http://www.nepadbiosafety.net/subjects/biotechnology/process-of-developing-genetically-modified-gm-crops>

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QUESTIONS?



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