What is a GMO Student Sheet

Name: _____

1. Define *Genetically Modified Organism* in your own words. (Write big, you will be marking this up later.)

2. Pair or group up! Look at your individual definitions, underline anything you have in common with your partner(s).

3. Look at the non-underlined parts of your definition. Why did you include that information? Is it critically important or can it be eliminated? If it can be eliminated, cross it out (with one single line so you can still see the words).

4. Work together as a team to create a shared definition. It must include all of the important elements you have underlined already in each individual definition. Make sure everyone can defend your definition. (You all must agree on the definition!)

5. As a class, repeat #2-4. What is your agreed upon definition?

6. The answer for #5 above represents an operational definition; meaning it's a definition all agree upon for the purposes of discussion and/or research. Why are operational definitions so important?

7. Would it be possible for you to collaborate or even discuss issues, especially controversial ones, without using operational definitions? How might your collaboration be affected?

8. In the Jimmy Kimmel video, are all of the people using the same definition? Do you think their answers might change if they were all using the same operational definition?

What is a GMO Student Sheet (Continued)

Transgenic Speed Dating Reflection:

1. What organisms are involved in your match/group?

2. Who is the donor? What are they giving in your match/group?

3. Who is the recipient in your match/group?

4. In your match/group, are these the same type of organism?

5. What problem is being addressed in your match/group? (For example: pest resistance, medical treatments, etc.)

6. Now look at all the matches/groups for the whole class. Which overall match or pair do you think is the most unusual? Why?

7. Which overall match of pair do you feel has to most potential to help people?

Breeding and Domestication Graphic Organizer Cards

MUTAGENESIS

Description: Using chemicals or radiation to change the DNA and occasionally produce a favorable trait.

Genes: 10,000 to 300,000+

SIMPLE SELECTION

Description: Choosing to plant seed from the healthiest plants available.

Genes: 10,000 to 300,000+

INTERSPECIES CROSSES/ HYBRIDIZATION

Description: Breeding techniques that permit genetic exchange between plants not crossing naturally.

Genes: 10,000 to 300,000+

SELECTIVE BREEDING

Description: Combining traits through intentional breeding, from similar and dissimilar plants by crossing into one genetic background with improved traits.

Genes: 10,000 to 300,000+

TRANSGENESIS

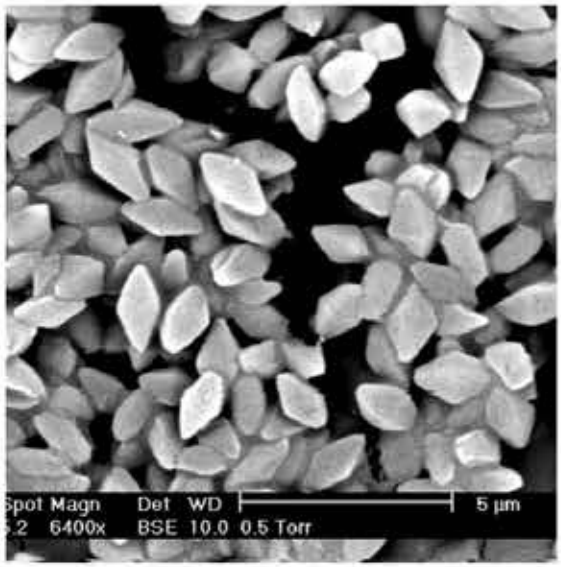
Description: Adding a specific well-characterized gene, from another organism into a new organism, to transfer a specific trait.

Genes: 1 or a Few

GENOME EDITING

Description: Specific changes to the DNA. An Enzyme cuts the DNA at a specific sequence; when repaired by the cell, an edit of change can be made.

Genes: 1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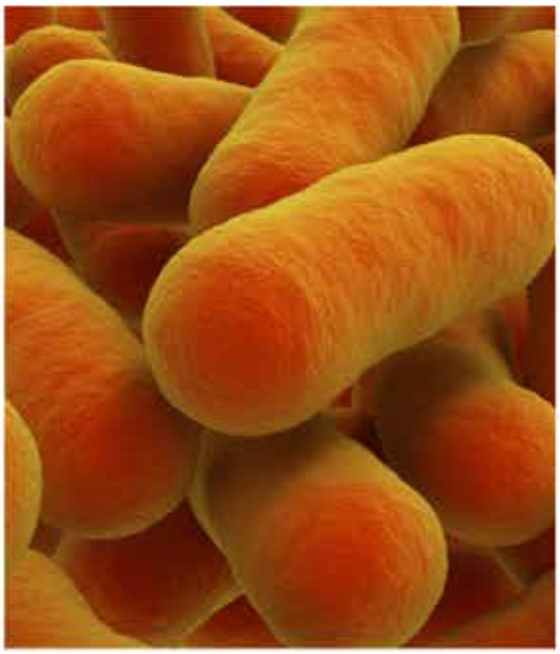


DONOR

Name
Bos primigenius
Cattle

Key gene
Cym

Properties of gene product
Chymosin is a protease enzyme that curdles milk.

GM use
GM bacteria produce the enzyme which is purified and used to make cheese. Previously chymosin was extracted from the stomachs of calves so cheese made in this way was notacceptable to vegetarians. 80-90% of the cheese sold in Britain is made with GM bovine chymosin.

Seed to STEM

DONOR

Name
Phyllomedusa bicolor
Giant Leaf Frog

Key gene
DRS B1

Properties of gene product
B1dermaseptin protein kills bacteria and fungi.

GM use
To prevent blight and bacterial diseases in potato crops.

Seed to STEM

DONOR

Name
Agrobacterium sp
C4 strain

Key gene
C4 EPSPS

Properties of gene product
EPSP synthase performs a crucial metabolic step in plant chloroplasts. The bacterial version is undamaged by glyphosate.

GM use
To make crops resistant to glyphosate so it can be used as a weed killer without harming the maize, cotton or soya bean crops.

Seed to STEM

DONOR

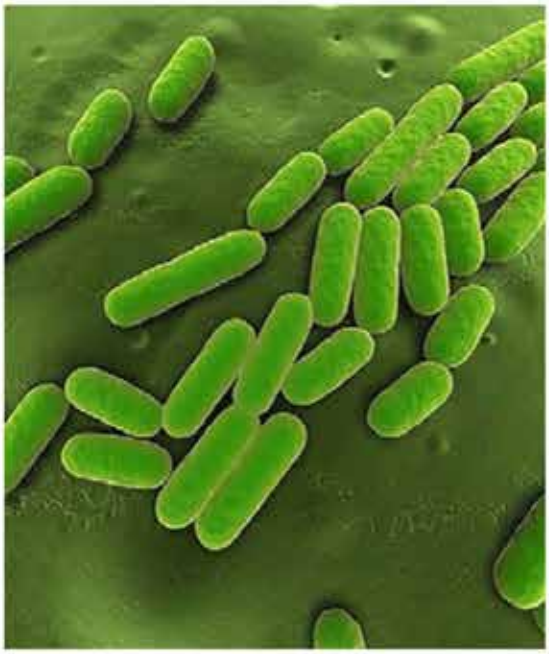
Name
Bacillus thuringensis

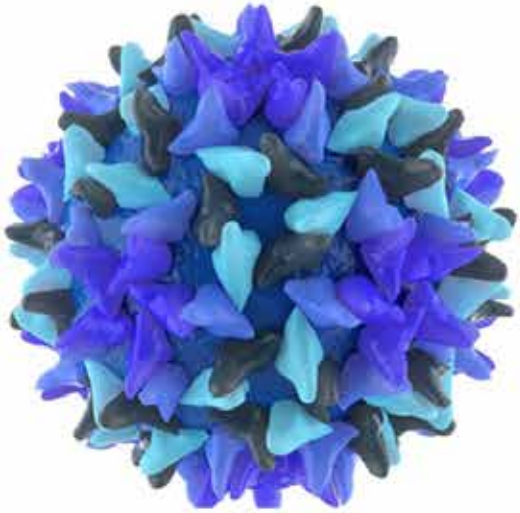
Key gene
Cry

Properties of gene product
Crystal protein kills caterpillars, maggots and beetles that eat the protein.

GM use
To make crops such as maize, cotton and soya bean resistant to herbivorous insects.

Seed to STEM





DONOR

Name
Nephila clavipes
Golden Orb Weaver

Key gene
MaSp

Properties of gene product
High-strength silk fibre for webs.

GM use
Gene is switched on in mammary glands of GM goats to mass-produce the silk fibre for artificial tendons and ligaments and for bullet-proof vests and parachutes.

Seed to STEM

DONOR

Name
Bacillus subtilis

Key gene
cspB

Properties of gene products
Cold shock protein B helps organisms metabolise normally during abiotic stress.

GM use
To produce higher yields for maize crops and produce a higher yield under drought conditions.

Seed to STEM

DONOR

Name
Aequorea Victoria
Jellyfish

Key genes
GFP

Properties of gene products
Green Fluorescent Protein glows under UV light.

GM use
The gene is extensively used as a marker to reveal which organisms have taken up a foreign gene and in which tissues the gene is switched on. Spin-offs include Glo-Fish™ and NeonMice sold as pets in the USA.

Seed to STEM

DONOR

Name
Hepatitis B virus

Key gene
HBsAg

Properties of gene product
Surface antigen of virus stimulates an immune response in humans if injected or given orally.

GM use
GM potatoes eaten raw in small quantities boost immunity to hepatitis B. This is an inexpensive and efficient way to deliver vaccines in developing countries.

Seed to STEM

DONOR

Name
Homo sapiens
Human

Key genes
Normal alleles coding for insulin, lactoferrin, Factor IX, anti-thrombin III and glucosidase.

Properties of gene products
Insulin controls blood glucose concentration.
Lactoferrin is an antimicrobial found in colostrum and milk.
Factor IX helps blood clot.
Anti-thrombin III stops blood clotting.
Glucosidase in lysosome function.

GM use
Pharmaceutical drugs
Insulin from GM bacteria treats diabetics.
Lactoferrin in GM rice treats diarrhoea in children.
Factor IX from GM sheep's milk treats people with haemophilia B.
Anti-thrombin III from GM goats' milk is used as an anti-coagulant in surgical procedures. Glucosidase from GM carrot cells in culture treats people with Gaucher's disease.

DONOR

Name
Homo sapiens
Human

Key genes
Mutated version of *BRCA1* and activated *Ras* oncogene.

Properties of gene products
Cause cancer. The products of the normal versions of the genes repair DNA mutations and suppress tumours.

GM use
Creating cancer research models
GM mice engineered to carry the mutant alleles are used to study cancer and treatments for cancer.

DONOR

Name
Androctonus australis hector
Scorpion

Key genes
AaHIT1

Properties of gene products
Toxic to insects but not harmful to mammals.

GM use
To kill insects on GM cotton crops.

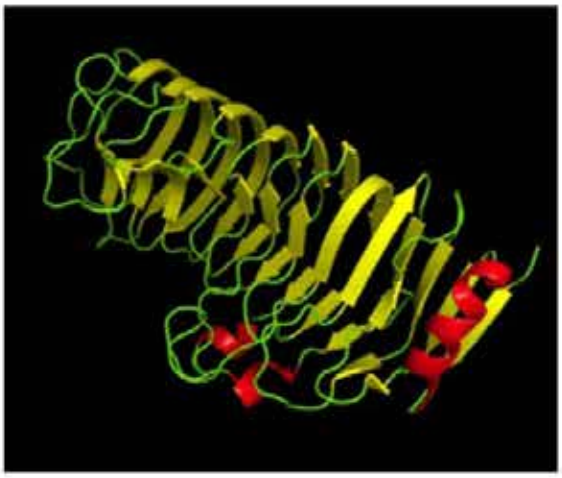
DONOR

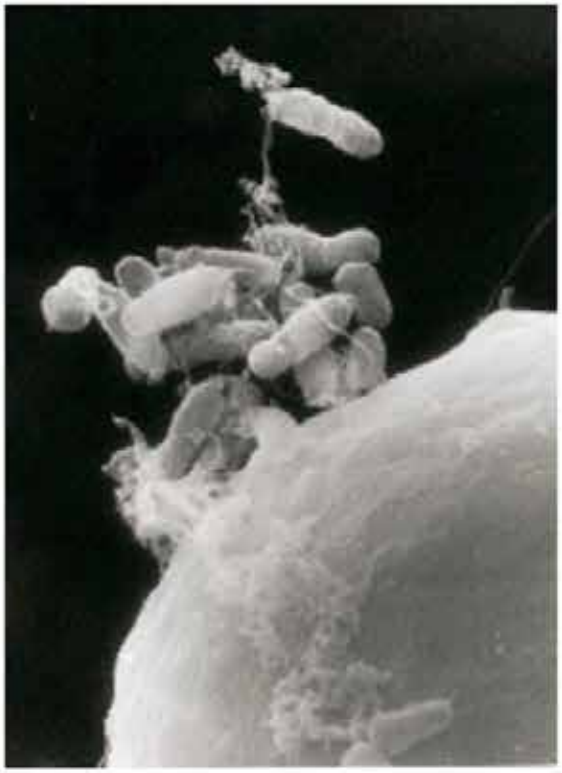
Name
Homo sapiens
Human

Key genes
CFTR
RPE65

Properties of gene products
CFTR protein allows normal mucus production in lungs and gut.
RPE65 protein is needed in rods and cones for normal vision.

GM use
Gene therapy
Normal CFTR allele is introduced into lung epithelial cells of cystic fibrosis patients.
RPE65 inserted into retinal cells of blind patients with Leber's Congenital Amaurosis restored sight.





DONOR

Name
Zoarces americanus
Ocean Pout

Key genes
Antifreeze glycoproteins or AFGP gene

Properties of gene products
Permit survival in subzero environments.

GM use
The promoter for the antifreeze protein gene is used in conjunction with the growth hormone taken from a Chinook salmon, which leads to a higher concentration of the growth hormone in the blood, causing the genetically modified salmon to grow much more rapidly than it would naturally.

Seed to STEM

DONOR

Name
Coat protein (CP) of Papaya Ringspot Virus (PRSV)

Key genes
PRSV HA 5-1

Properties of gene products
Provide resistance to PRSV.

GM use
Confer resistance to PRSV.

Seed to STEM

DONOR

Name
Agrobacterium tumefaciens

Key genes
CaMV 35S

Properties of gene products
Code for the coat protein (CP) encoding sequences from zucchini yellow mosaic virus (ZYMV) and the watermelon mosaic virus (WMV2).

GM use
Provides protection against these viruses.

Seed to STEM

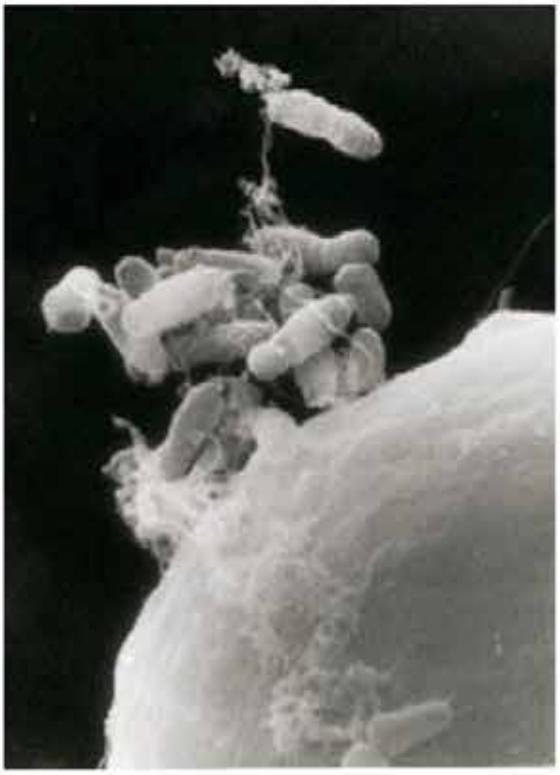
DONOR

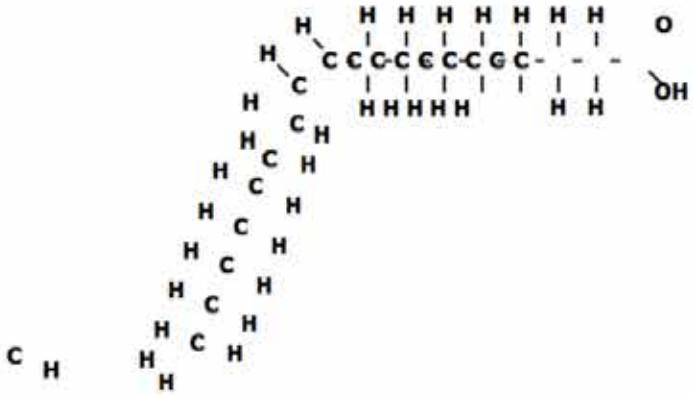
Name
Polygalacturonase (PG)

Properties of gene products
Antisense DNA Keeps Polygalacturonase (PG), the major cell wall degrading enzyme of tomato fruit, from forming.

GM use
By inhibiting the development of PG, the fruit should stay fresher longer.

Seed to STEM





DONOR

Name
Delta-12 oleate desaturase

Key genes
gm-fad2-1; FAD2-1

Properties of gene products
An antisense RNA strand is created to silence the formation of the enzyme that converts oleic acid into linoleic acid using the omega-6 desaturase encoding gene.

GM use
Inhibits conversion of oleic acid to linoleic acid, keeps oleic acid levels high for healthier oil.

Seed to STEM

DONOR

Name
Agrobacterium tumefaciens

Key genes
CP4 EPSPS (5-enolpyruvylshikimate-3-phosphate synthase) encoding gene.

GM use
Inhibits action of glyphosate, the key ingredient in RoundUp (Monsanto).

Seed to STEM

RECIPIENT

Name
Gossypium hirsutum
Cotton

Suitability as a GM recipient
Important crop for textile fibres but many insect pests attack it and the crop must be kept free of weeds.

Seed to STEM

RECIPIENT

Name
Zea mays
Maize or Sweetcorn

Suitability as a GM recipient
Major food source for animals and humans and as a source of starch and sugars for processed food. Many insects attack the crop, its yield falls in drought conditions and the crop must be kept free of weeds.

Seed to STEM

RECIPIENT

Name
Solanum tuberosum
Potato

Suitability as a GM recipient
Major carbohydrate food source in Europe and America. Potatoes are easy to grow and can give high yields but suffer from many diseases such as blight, which lower yields. They can be engineered to make vaccines, but these must be grown under cover to prevent gene flow to other potatoes and to stop antigenic potatoes accidentally entering the human food chain.

RECIPIENT

Name
Glycine max
Soybean

Suitability as a GM recipient
Major food source for animals and for humans as a source of protein in processed food. Many insects attack the crop and the crop must be kept free of weeds.

RECIPIENT

Name
Oryza sativa
Rice

Suitability as a GM recipient
Major food source in Asia and a suitable vehicle for therapies like treating children with diarrhea (rice enhanced with human lactoferrin) and preventing vitamin A deficiency (genes from maize or daffodil and a soil bacterium).

RECIPIENT

Name
Daucus carota
Carrot

Suitability as a GM recipient
Field-grown crops generally have been found to be unsafe to use as vehicles for production of pharmaceutical drugs, but carrot cells grown in culture in bioreactors are a new 'expression platform' for human proteins that can be used as medical drugs.

RECIPIENT

Name
Ovis aries
Sheep

Suitability as a GM recipient
Female sheep produce plenty of milk.
A gene for a pharmaceutical protein is linked to a promoter to switch the gene on in the mammary glands, so that the protein appears in the milk. Sheep have been used to make factor IX to treat sufferers of haemophilia B.

Seed to STEM

RECIPIENT

Name
Capra aegagrus hircus
Goat

Suitability as a GM recipient
Female goats produce plenty of milk.
A gene is linked to a promoter to switch the gene on in the mammary glands, so that the protein product appears in the milk. So-called 'spider-goats' produce silk in their milk for medical and military applications. Other GM goats produce a drug, human anti-thrombin III, used as an anticoagulant in surgery.

Seed to STEM

RECIPIENT

Name
Homo sapiens
Human

Suitability as a GM recipient
People suffering from genetic diseases caused by two recessive non-functional alleles can be treated with gene therapy. The dominant functional allele is inserted into affected somatic cells. Trials have included treatment of cystic fibrosis and Leber's congenital amaurosis. The limitation on treating a human with another human allele is whether the cells that need the foreign DNA are accessible (e.g. lung epithelium) and stable (not replaced every few days).

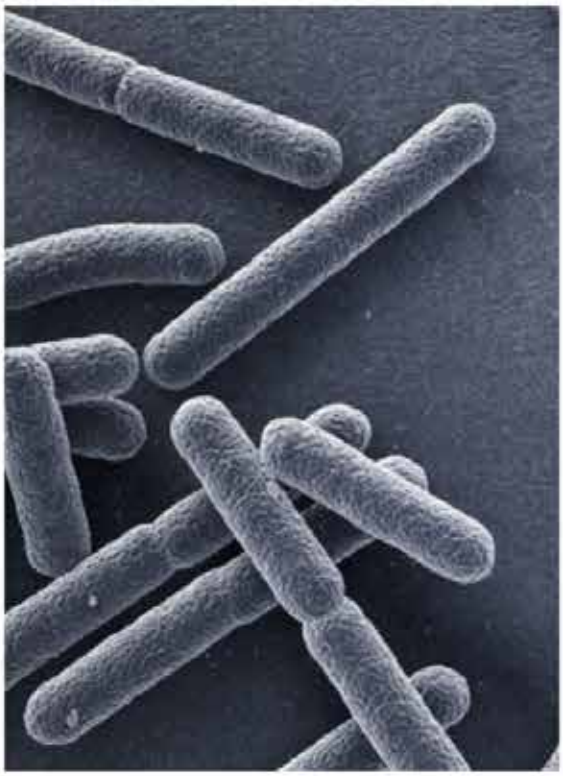
Seed to STEM

RECIPIENT

Name
Mus musculus
Mouse

Suitability as a GM recipient
It is a genetic model organism with a well-known, fully-sequenced genome. As a mammal its genome is very similar to that of humans. Mice are small so are cheap to feed and house. Many GM techniques applicable to humans or farm mammals are first tried on mice. Fluorescent GM NeonMice are sold as pets in the USA.

Seed to STEM



RECIPIENT

Name
Escherichia coli

Suitability as a GM recipient
GM bacteria divide rapidly in a fermenter to produce proteins like human insulin and bovine chymosin for cheese-making.
E. coli is a genetic model organism with a well- known, fully-sequenced genome. Its plasmids are widely used as vectors. However, some strains of *E. coli* are pathogenic, and the GM process may involve inserting antibiotic resistance genes into the bacteria.

RECIPIENT

Name
Rerio danio
Zebrafish

Suitability as a GM recipient
It is a genetic model organism with a well-known, fully-sequenced genome. It is a useful, simple vertebrate for research. GM zebrafish expressing genes for fluorescent proteins are on sale in the pet trade in the USA marketed as Glo-Fish™.

RECIPIENT

Name
Salmo salar
Salmon

Suitability as a GM recipient
Wild salmon disappeared from many rivers during the twentieth century due to overfishing and habitat change.

RECIPIENT

Name
Carica papaya
Papaya

Suitability as a GM recipient
The papaya is cultivated in most tropical countries. However, it is susceptible to the Papaya Ringspot Virus (PRSV). Since 1992, PRSV has destroyed nearly all non-GMO papaya in Hawaii.

RECIPIENT

Name
Solanum lycopersicum
Tomato

Suitability as a GM recipient
Tomatoes are picked as green fruits and artificially ripened by ethylene treatment, which gives a ripe tomato color but not the full vine-ripened tomato flavor.

Seed to STEM

RECIPIENT

Name
Fragaria × ananassa
Strawberry

Suitability as a GM recipient
Strawberries grow in temperate climate regions which are capable of having low temperatures and frost.
Spring frosts cause damage to the flowers of the plant leading to poor yields and erratic fruiting. Frost on average causes millions of dollars in damages and drives up the price of the fruit for the consumer.

Seed to STEM

RECIPIENT

Name
Glycine max
Soybean

Suitability as a GM recipient
Soybean oil is hydrogenated as a preservative to extend shelf life. High oleic oil does not need to be hydrogenated.

Seed to STEM

RECIPIENT

Name
Cucurbita pepo
Summer squash

Suitability as a GM recipient
Viral diseases are a limiting factor to squash production, particularly during summer and fall months. Mosaic viruses include the cucumber mosaic cucumovirus (CMV), zucchini yellow mosaic potyvirus (ZYMV) and watermelon mosaic potyvirus (WMV2).

Seed to STEM

RECIPIENT

Name

Glycine max

Soybean

Suitability as a GM recipient

Soybeans chief rivals in the field are weeds. If the plant can resist herbicide spraying, the control of weeds is much easier.