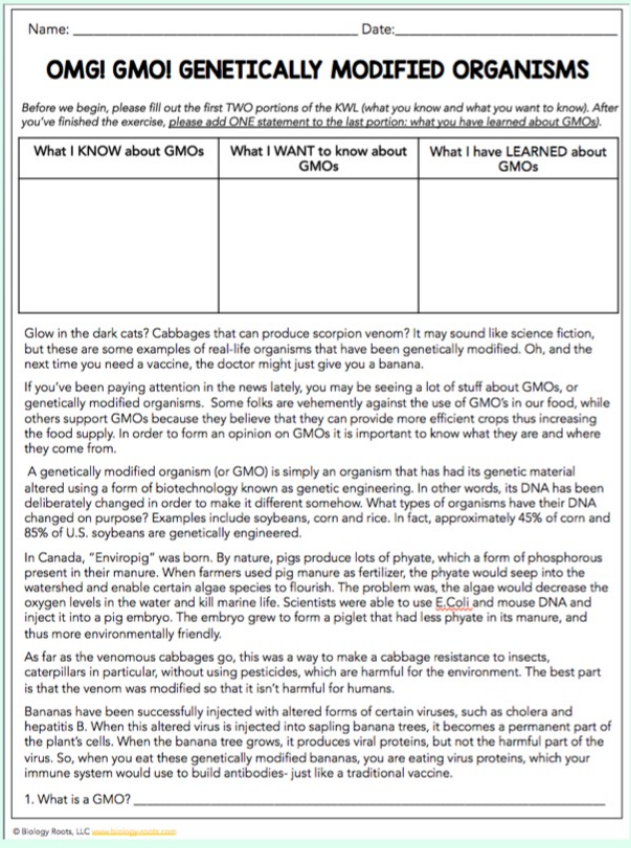
# PLAN "J": GENETICALLY MODIFIED ORGANISMS

## OMG! GMO! Genetically Modified Organisms

- What is a GMO?
- Are GMOs harmful or helpful?
- When might we use a GMO?
- Are GMOs ethical?
- How are GMOs produced (genetic engineering)



Name: _____ Date: _____

**OMG! GMO! GENETICALLY MODIFIED ORGANISMS**

*Before we begin, please fill out the first TWO portions of the KWL (what you know and what you want to know). After you've finished the exercise, please add ONE statement to the last portion: what you have learned about GMOs).*

| What I KNOW about GMOs | What I WANT to know about GMOs | What I have LEARNED about GMOs |
|---|---|---|
| | | |

Glow in the dark cats? Cabbages that can produce scorpion venom? It may sound like science fiction, but these are some examples of real-life organisms that have been genetically modified. Oh, and the next time you need a vaccine, the doctor might just give you a banana.

If you've been paying attention in the news lately, you may be seeing a lot of stuff about GMOs, or genetically modified organisms. Some folks are vehemently against the use of GMO's in our food, while others support GMOs because they believe that they can provide more efficient crops thus increasing the food supply. In order to form an opinion on GMOs it is important to know what they are and where they come from.

A genetically modified organism (or GMO) is simply an organism that has had its genetic material altered using a form of biotechnology known as genetic engineering. In other words, its DNA has been deliberately changed in order to make it different somehow. What types of organisms have their DNA changed on purpose? Examples include soybeans, corn and rice. In fact, approximately 45% of corn and 85% of U.S. soybeans are genetically engineered.

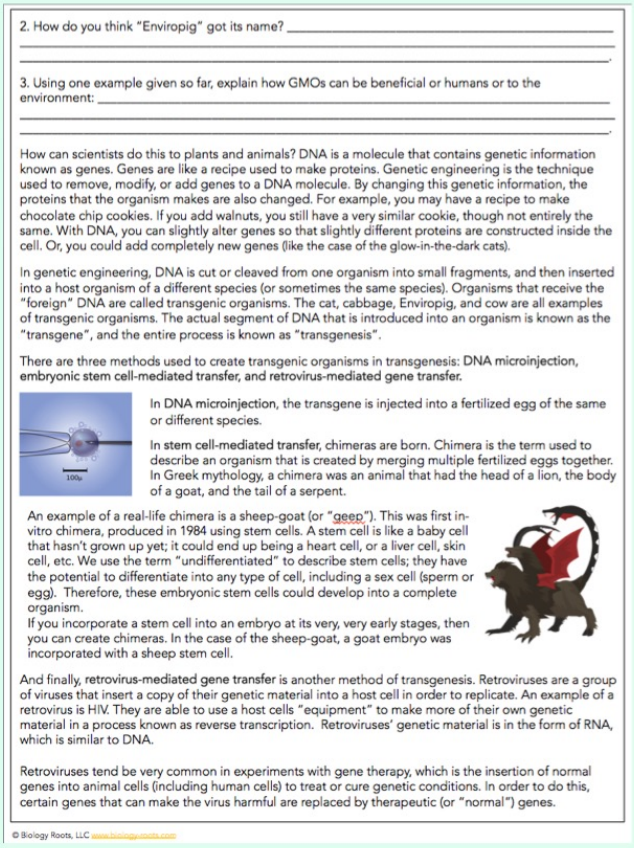
In Canada, "Enviropig" was born. By nature, pigs produce lots of phyate, which a form of phosphorous present in their manure. When farmers used pig manure as fertilizer, the phyate would seep into the watershed and enable certain algae species to flourish. The problem was, the algae would decrease the oxygen levels in the water and kill marine life. Scientists were able to use E.Coli and mouse DNA and inject it into a pig embryo. The embryo grew to form a piglet that had less phyate in its manure, and thus more environmentally friendly.

As far as the venomous cabbages go, this was a way to make a cabbage resistance to insects, caterpillars in particular, without using pesticides, which are harmful for the environment. The best part is that the venom was modified so that it isn't harmful for humans.

Bananas have been successfully injected with altered forms of certain viruses, such as cholera and hepatitis B. When this altered virus is injected into sapling banana trees, it becomes a permanent part of the plant's cells. When the banana tree grows, it produces viral proteins, but not the harmful part of the virus. So, when you eat these genetically modified bananas, you are eating virus proteins, which your immune system would use to build antibodies- just like a traditional vaccine.

1. What is a GMO? _____

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2. How do you think "Enviropig" got its name? _____

3. Using one example given so far, explain how GMOs can be beneficial or humans or to the environment: _____

How can scientists do this to plants and animals? DNA is a molecule that contains genetic information known as genes. Genes are like a recipe used to make proteins. Genetic engineering is the technique used to remove, modify, or add genes to a DNA molecule. By changing this genetic information, the proteins that the organism makes are also changed. For example, you may have a recipe to make chocolate chip cookies. If you add walnuts, you still have a very similar cookie, though not entirely the same. With DNA, you can slightly alter genes so that slightly different proteins are constructed inside the cell. Or, you could add completely new genes (like the case of the glow-in-the-dark cats).

In genetic engineering, DNA is cut or cleaved from one organism into small fragments, and then inserted into a host organism of a different species (or sometimes the same species). Organisms that receive the "foreign" DNA are called transgenic organisms. The cat, cabbage, Enviropig, and cow are all examples of transgenic organisms. The actual segment of DNA that is introduced into an organism is known as the "transgene", and the entire process is known as "transgenesis".

There are three methods used to create transgenic organisms in transgenesis: DNA microinjection, embryonic stem cell-mediated transfer, and retrovirus-mediated gene transfer.



In DNA microinjection, the transgene is injected into a fertilized egg of the same or different species.

In stem cell-mediated transfer, chimeras are born. Chimera is the term used to describe an organism that is created by merging multiple fertilized eggs together. In Greek mythology, a chimera was an animal that had the head of a lion, the body of a goat, and the tail of a serpent.

An example of a real-life chimera is a sheep-goat (or "geep"). This was first in-vitro chimera, produced in 1984 using stem cells. A stem cell is like a baby cell that hasn't grown up yet; it could end up being a heart cell, or a liver cell, skin cell, etc. We use the term "undifferentiated" to describe stem cells; they have the potential to differentiate into any type of cell, including a sex cell (sperm or egg). Therefore, these embryonic stem cells could develop into a complete organism.
If you incorporate a stem cell into an embryo at its very, very early stages, then you can create chimeras. In the case of the sheep-goat, a goat embryo was incorporated with a sheep stem cell.



And finally, retrovirus-mediated gene transfer is another method of transgenesis. Retroviruses are a group of viruses that insert a copy of their genetic material into a host cell in order to replicate. An example of a retrovirus is HIV. They are able to use a host cells "equipment" to make more of their own genetic material in a process known as reverse transcription. Retroviruses' genetic material is in the form of RNA, which is similar to DNA.

Retroviruses tend be very common in experiments with gene therapy, which is the insertion of normal genes into animal cells (including human cells) to treat or cure genetic conditions. In order to do this, certain genes that can make the virus harmful are replaced by therapeutic (or "normal") genes.

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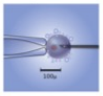
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6. Though the original chimera was found in Greek mythology, what is an example of a chimera in the world of genetic engineering? _____

7. How do retroviruses replicate? _____

8. What is gene therapy? Why is it not widely successful? _____

Match each method of transgenesis with the descriptions below:
A. DNA Microinjection B. Stem Cell Mediated Transfer C. Retrovirus mediated transfer

___ 9. A transgenic chimera is created.
___ 10. Fertilized eggs are injected with foreign genes.
___ 11. Method used to produce normal genes in gene therapy.

### *Using Genetic Engineering to Improve Crops and Livestock*

Recall the cabbage containing scorpion venom. The cabbage plants have been modified to produce scorpion venom that makes them resistant to a specific type of caterpillar that is problematic. However, the venom in its modified form is safe for consumption by humans and animals. The same idea has been introduced to cotton crops: a protein that is toxic to bollworm pests (but safe for animals and plants) was used in pesticides for many years. In order to limit pesticide use, a new variety of cotton was created that makes this protein on its own using a bacterial gene- so the cotton essentially makes its own pesticides.

Aside from built-in pesticides, and resistance against viruses, scientists are also working on a way to make crops more nutritional. Rice is consumed world wide, and some varieties have been genetically modified to produce more Vitamin A and iron. Scientists are also working on ways to reduce allergens in food.

Since the dawn of civilization humans have been selectively breeding livestock. Certain traits are more desirable than others, depending on what the animal is used for. Oxen were bred to be stronger, corn to be sweeter, chickens to lay more eggs. Some might say that genetic engineering is an extension of these agricultural practices. The main goal in livestock modification is to improve them by altering their biochemistry as well as their hormonal balance so that they might grow larger, leaner and faster, or lay more eggs, produce quality wool, etc.

### *Using Genetic Engineering to Help Humans Combat Disease*

Pharming is a transgenic technology in which some valuable pharmaceutical products can be made by mice, rabbits, sheep, goats, pigs and cows by using certain genes. These products include blood-clotting factors, insulin, vaccines (antigens), anticoagulants and treatments for cystic fibrosis. The products can be created using transgenic animals that have been introduced to human DNA, and can produce these products in their blood or milk, which can then be gathered an used for human or animal pharmaceutical purposes.

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Chimeras are being purposefully created in the laboratory using animals with human traits. In 2003, Chinese scientists in Shanghai were able to produce human stem cells by merging rabbit embryos with human skin cells. After the extraction of stem cells, the embryos were destroyed. In that particular case, the rabbit's genetic material was removed from the egg, and then the human DNA was inserted, thus creating an egg that had human and animal origins. Why do this? Because stem cells are valuable and can be used to fight genetic disease or even grow new organs. This could potentially be the cheapest way to produce them.

Another controversial study was conducted at Stanford University: a group of scientists studying stem cells have successfully created mice with brains that are composed of 1% human brain cells. Their goal is to make mice with 100% human brain cells. Why do this? The goal is to study Parkinson's and Alzheimer's diseases by studying brain growth patterns.

How far can this research go? There have already been successful heart transplants that use heart valves from a pig. Sheep have been born with livers that are composed of 80% human liver cells that could be available for organ transplant.

Many ethical questions have been asked pertaining to human-animal chimeras. The Canadian government has already issued the Assisted Human Reproduction Act that prohibits specifically the production of a chimera. In the case of mice with human brain cells, one must ask, could chimeras have human brains? At this point, it is impossible to answer that. There are too many gaps in our knowledge to know for sure if human cells would produce significant changes in non-human brains.

**12. Fill out the table below. You can use the text above as well as some "outside the box" thinking. Try to come up with at least 4 examples of the pros of using GMOs and at least 4 examples of the cons of using GMOs**

| PROS OF GMOS | CONS OF GMOS |
|---|---|
| | |

13. Do you think that GMOs should be limited in our food supply? If not, should they only be implemented into our crops as opposed to livestock? Why or why not? _____

14. If you or a loved one needed an organ transplant, and had the choice of putting your name on a waitlist, or using one from a chimera, what might you choose and why? _____

**OMG! GMO! Genetically Modified Organisms-** This is an article about genetically modified organisms, or GMOs. The article sheds an unbiased light on GMOs; it includes how they are made, what they are used for. Students do a **KWL** as well as an ending statement on where they stand, and some questions on the ethics of chimeras.

***Advanced version included.**

**ANSWER KEY AND CLASS PACKET VERSION INCLUDED**

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