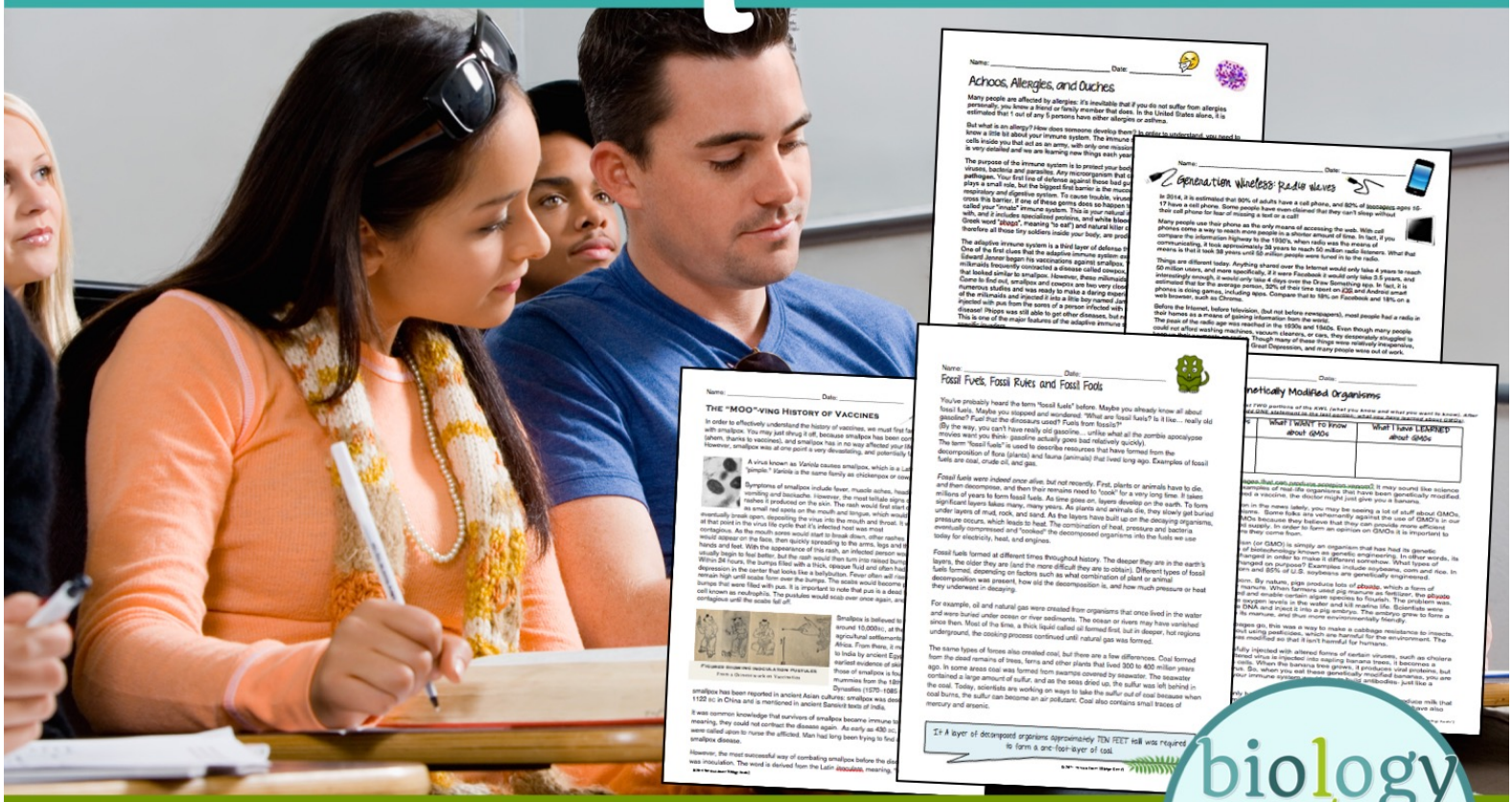
# emergency sub plans




## VOLUME II F-J
## 5 ENGAGING SCIENCE SUB PLANS

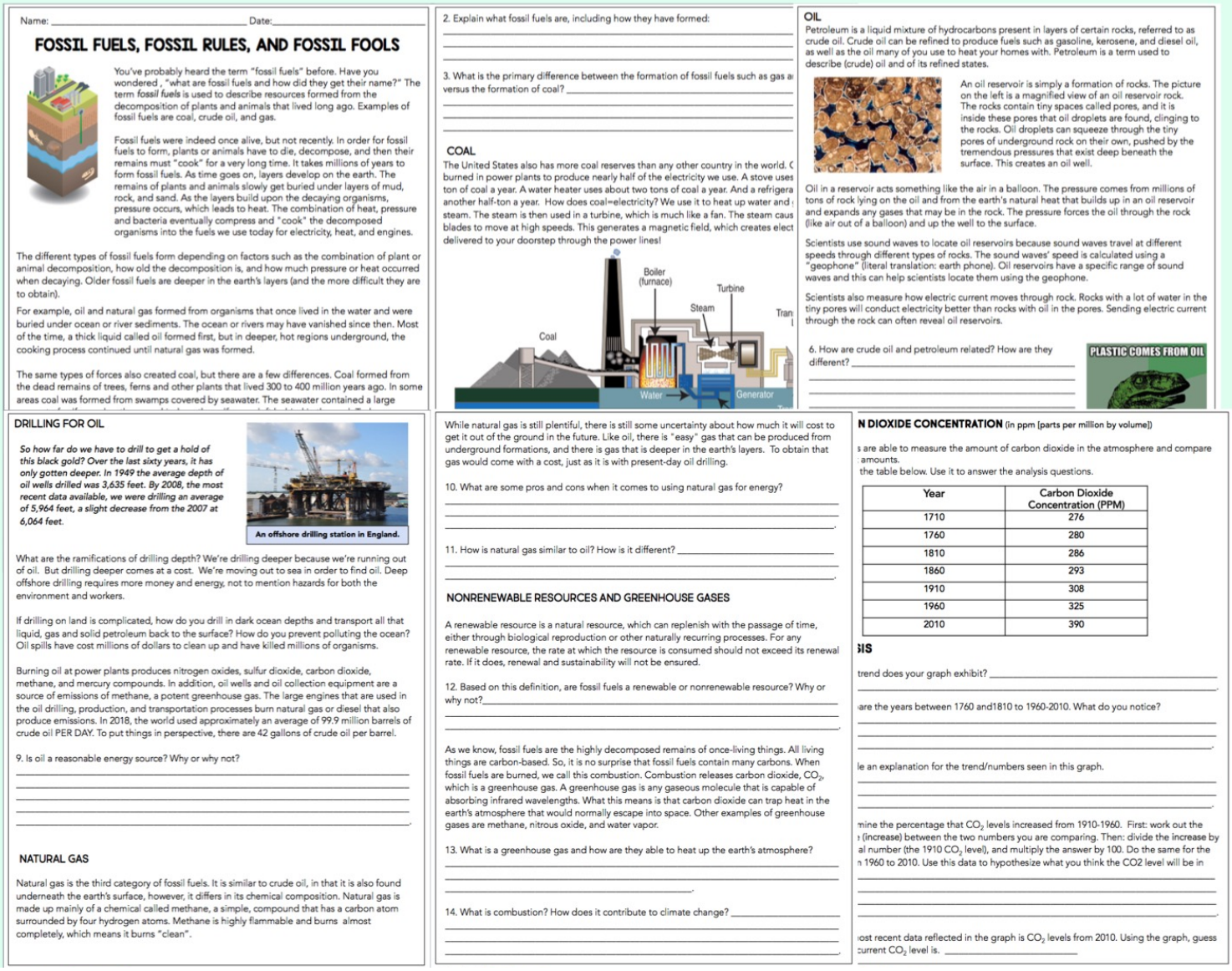
biology roots

- ★ Sub plans are long enough to last the entire class
- ★ Relevant topics that relate to students
- ★ CCSS aligned for literacy in science

# PLAN "F": FOSSIL FUELS

## Plan F: Fossil Fuels, Fossil Rules, and Fossil Fools

- A brief history of the oil and gasoline industry leading back to Rockefeller.
- Explores different types of fuels and what we use them for.
- Explains how each fuel is extracted and the ramifications of their use.



Name: _____ Date: _____

**FOSSIL FUELS, FOSSIL RULES, AND FOSSIL FOOLS**

You've probably heard the term "fossil fuels" before. Have you wondered , "what are fossil fuels and how did they get their name?" The term *fossil fuels* is used to describe resources formed from the decomposition of plants and animals that lived long ago. Examples of fossil fuels are coal, crude oil, and gas.

Fossil fuels were indeed once alive, but not recently. In order for fossil fuels to form, plants or animals have to die, decompose, and then their remains must "cook" for a very long time. It takes millions of years to form fossil fuels. As time goes on, layers develop on the earth. The remains of plants and animals slowly get buried under layers of mud, rock, and sand. As the layers build upon the decaying organisms, pressure occurs, which leads to heat. The combination of heat, pressure and bacteria eventually compress and "cook" the decomposed organisms into the fuels we use today for electricity, heat, and engines.

The different types of fossil fuels form depending on factors such as the combination of plant or animal decomposition, how old the decomposition is, and how much pressure or heat occurred when decaying. Older fossil fuels are deeper in the earth's layers (and the more difficult they are to obtain).

For example, oil and natural gas formed from organisms that once lived in the water and were buried under ocean or river sediments. The ocean or rivers may have vanished since then. Most of the time, a thick liquid called oil formed first, but in deeper, hot regions underground, the cooking process continued until natural gas was formed.

The same types of forces also created coal, but there are a few differences. Coal formed from the dead remains of trees, ferns and other plants that lived 300 to 400 million years ago. In some areas coal was formed from swamps covered by seawater. The seawater contained a large

2. Explain what fossil fuels are, including how they have formed:

3. What is the primary difference between the formation of fossil fuels such as gas a versus the formation of coal?

**COAL**

The United States also has more coal reserves than any other country in the world. C burned in power plants to produce nearly half of the electricity we use. A stove uses ton of coal a year. A water heater uses about two tons of coal a year. And a refrigera another half-ton a year. How does coal=electricity? We use it to heat up water and steam. The steam is then used in a turbine, which is much like a fan. The steam caus blades to move at high speeds. This generates a magnetic field, which creates elect delivered to your doorstep through the power lines!




**OIL**

Petroleum is a liquid mixture of hydrocarbons present in layers of certain rocks, referred to as crude oil. Crude oil can be refined to produce fuels such as gasoline, kerosene, and diesel oil, as well as the oil many of you use to heat your homes with. Petroleum is a term used to describe (crude) oil and of its refined states.



An oil reservoir is simply a formation of rocks. The picture on the left is a magnified view of an oil reservoir rock. The rocks contain tiny spaces called pores, and it is inside these pores that oil droplets are found, clinging to the rocks. Oil droplets can squeeze through the tiny pores of underground rock on their own, pushed by the tremendous pressures that exist deep beneath the surface. This creates an oil well.

Oil in a reservoir acts something like the air in a balloon. The pressure comes from millions of tons of rock lying on the oil and from the earth's natural heat that builds up in an oil reservoir and expands any gases that may be in the rock. The pressure forces the oil through the rock (like air out of a balloon) and up the well to the surface.

Scientists use sound waves to locate oil reservoirs because sound waves travel at different speeds through different types of rocks. The sound waves' speed is calculated using a "geophone" (literal translation: earth phone). Oil reservoirs have a specific range of sound waves and this can help scientists locate them using the geophone.

Scientists also measure how electric current moves through rock. Rocks with a lot of water in the tiny pores will conduct electricity better than rocks with oil in the pores. Sending electric current through the rock can often reveal oil reservoirs.

6. How are crude oil and petroleum related? How are they different? _____




**DRILLING FOR OIL**

***So how far do we have to drill to get a hold of this black gold? Over the last sixty years, it has only gotten deeper. In 1949 the average depth of oil wells drilled was 3,635 feet. By 2008, the most recent data available, we were drilling an average of 5,964 feet, a slight decrease from the 2007 at 6,064 feet.***



**An offshore drilling station in England.**

What are the ramifications of drilling depth? We're drilling deeper because we're running out of oil. But drilling deeper comes at a cost. We're moving out to sea in order to find oil. Deep offshore drilling requires more money and energy, not to mention hazards for both the environment and workers.

If drilling on land is complicated, how do you drill in dark ocean depths and transport all that liquid, gas and solid petroleum back to the surface? How do you prevent polluting the ocean? Oil spills have cost millions of dollars to clean up and have killed millions of organisms.

Burning oil at power plants produces nitrogen oxides, sulfur dioxide, carbon dioxide, methane, and mercury compounds. In addition, oil wells and oil collection equipment are a source of emissions of methane, a potent greenhouse gas. The large engines that are used in the oil drilling, production, and transportation processes burn natural gas or diesel that also produce emissions. In 2018, the world used approximately an average of 99.9 million barrels of crude oil PER DAY. To put things in perspective, there are 42 gallons of crude oil per barrel.

9. Is oil a reasonable energy source? Why or why not?

**NATURAL GAS**

Natural gas is the third category of fossil fuels. It is similar to crude oil, in that it is also found underneath the earth's surface, however, it differs in its chemical composition. Natural gas is made up mainly of a chemical called methane, a simple, compound that has a carbon atom surrounded by four hydrogen atoms. Methane is highly flammable and burns almost completely, which means it burns "clean".

While natural gas is still plentiful, there is still some uncertainty about how much it will cost to get it out of the ground in the future. Like oil, there is "easy" gas that can be produced from underground formations, and there is gas that is deeper in the earth's layers. To obtain that gas would come with a cost, just as it is with present-day oil drilling.

10. What are some pros and cons when it comes to using natural gas for energy?

11. How is natural gas similar to oil? How is it different?

**NONRENEWABLE RESOURCES AND GREENHOUSE GASES**

A renewable resource is a natural resource, which can replenish with the passage of time, either through biological reproduction or other naturally recurring processes. For any renewable resource, the rate at which the resource is consumed should not exceed its renewal rate. If it does, renewal and sustainability will not be ensured.

12. Based on this definition, are fossil fuels a renewable or nonrenewable resource? Why or why not?

As we know, fossil fuels are the highly decomposed remains of once-living things. All living things are carbon-based. So, it is no surprise that fossil fuels contain many carbons. When fossil fuels are burned, we call this combustion. Combustion releases carbon dioxide, $CO_2$, which is a greenhouse gas. A greenhouse gas is any gaseous molecule that is capable of absorbing infrared wavelengths. What this means is that carbon dioxide can trap heat in the earth's atmosphere that would normally escape into space. Other examples of greenhouse gases are methane, nitrous oxide, and water vapor.

13. What is a greenhouse gas and how are they able to heat up the earth's atmosphere?

14. What is combustion? How does it contribute to climate change?

**N DIOXIDE CONCENTRATION** (in ppm [parts per million by volume])

s are able to measure the amount of carbon dioxide in the atmosphere and compare amounts.
the table below. Use it to answer the analysis questions.

| Year | Carbon Dioxide Concentration (PPM) |
|---|---|
| 1710 | 276 |
| 1760 | 280 |
| 1810 | 286 |
| 1860 | 293 |
| 1910 | 308 |
| 1960 | 325 |
| 2010 | 390 |

**IS**

trend does your graph exhibit? _____

are the years between 1760 and1810 to 1960-2010. What do you notice?

le an explanation for the trend/numbers seen in this graph.

mine the percentage that $CO_2$ levels increased from 1910-1960. First: work out the (increase) between the two numbers you are comparing. Then: divide the increase by al number (the 1910 $CO_2$ level), and multiply the answer by 100. Do the same for the n 1960 to 2010. Use this data to hypothesize what you think the CO2 level will be in

ost recent data reflected in the graph is $CO_2$ levels from 2010. Using the graph, guess current $CO_2$ level is. _____

Name: _____ Date: _____

# FOSSIL FUELS, FOSSIL RULES, AND FOSSIL FOOLS



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For example, oil and natural gas formed from organisms that once lived in the water and were buried under ocean or river sediments. The ocean or rivers may have vanished since then. Most of the time, a thick liquid called oil formed first, but in deeper, hot regions underground, the cooking process continued until natural gas was formed.

The same types of forces also created coal, but there are a few differences. Coal formed from the dead remains of trees, ferns and other plants that lived 300 to 400 million years ago. In some areas coal was formed from swamps covered by seawater. The seawater contained a large amount of sulfur, and as the seas dried up, the sulfur was left behind in the coal. Today, scientists are working on ways to take the sulfur out of coal because when coal burns, the sulfur can become an air pollutant. Coal also contains small traces of mercury and arsenic.

*Fun Fact:*
***A layer of decomposed organisms TEN FEET tall was required to form a one-foot tall layer of coal.***

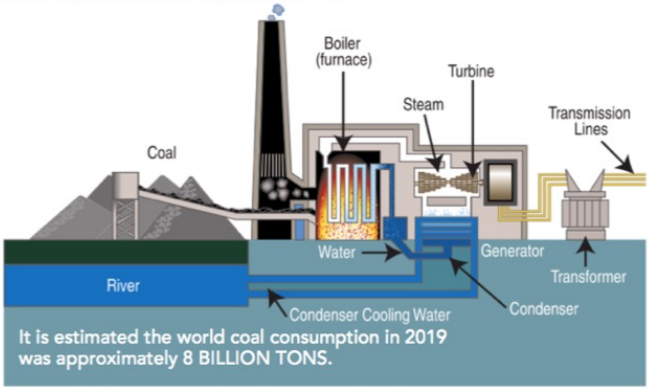
1. List the three types of fossil fuels: _____
_____.

2. Explain what fossil fuels are, including how they have formed:
_____
_____
_____.

3. What is the primary difference between the formation of fossil fuels such as gas and oil, versus the formation of coal? _____
_____
_____
_____.

## COAL

The United States also has more coal reserves than any other country in the world. Coal is burned in power plants to produce nearly half of the electricity we use. A stove uses about half a ton of coal a year. A water heater uses about two tons of coal a year. And a refrigerator, that's another half-ton a year. How does coal=electricity? We use it to heat up water and generate steam. The steam is then used in a turbine, which is much like a fan. The steam causes the blades to move at high speeds. This generates a magnetic field, which creates electricity and is delivered to your doorstep through the power lines!




4. How is coal used to generate electricity at power plants?
_____
_____
_____.

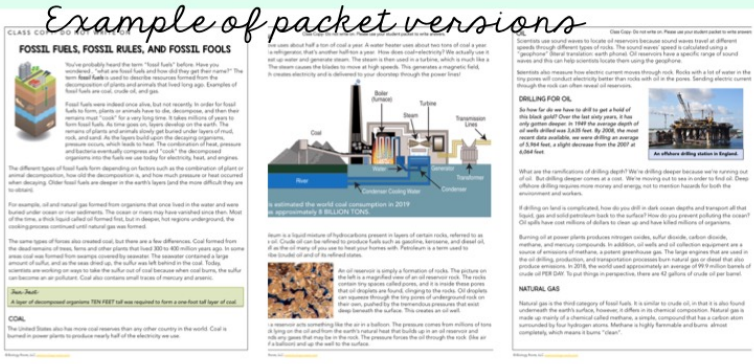
5. How may tons of coal are used each year to generate electricity worldwide?_____

6 pages including analysis of the text and a chart examining carbon dioxide concentrations- students pull information from the text and analyze a chart on carbon dioxide concentrations over time.

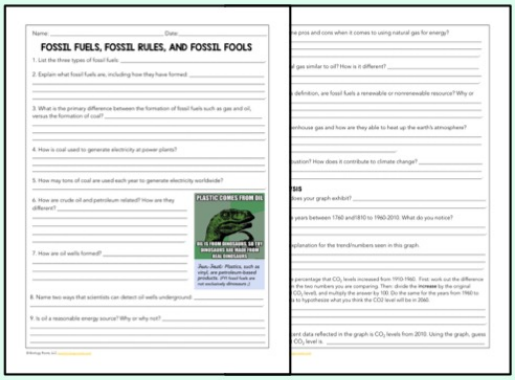
As with many of my sub plans, you can shorten if if necessary. The last page can be omitted and saved for another day.

## ANSWER KEY AND CLASS PACKET VERSION INCLUDED

Example of packet versions



Classroom set (print once)



Student answer sheets

# PLAN "G": HISTORY OF VACCINATIONS

**The "Moo-ving" History of Vaccines**: Explores the fascinating history in making a vaccine for smallpox, courtesy of Edward Jenner and James Phipps. Optional timeline can spread this assignment over 2 days if necessary.

Name: _____ Date: _____

## THE MOO-VING HISTORY OF VACCINES



In order to effectively understand the history of vaccines, we must first familiarize ourselves with smallpox. You may just shrug it off, because smallpox has been completely eradicated (ahem, thanks to vaccines), and smallpox has in no way affected your life or your loved ones. However, smallpox was at one point a very devastating, and potentially fatal disease.

Symptoms of smallpox include fever, muscle aches, headaches, nausea vomiting and backache. However, the most telltale signs of smallpox were the rashes it produced on the skin. The rash would first start off a small red spots on the mouth and tongue, which would eventually bre open, depositing the virus into the mouth and throat. It was at that po in the virus life cycle that it's infected host was most contagious.

As the mouth sores would start to break down, other rashes would appear on the face, then quickly spreading to the arms, legs and then hands and feet. With the appearance of this ra an infected person would usually begin to feel better, but the rash would then turn into raise bumps.

Within 24 hours, the bumps filled with a thick, opaque fluid. Fever often will rise again at th time and remain high until scabs form over the bumps. The scabs would become pustules- meaning bumps that were filled with pus. It is important to note that pus is a dead type of blood cell known as neutrophils. The pustules would scab over once again, and the person remained contagious until the scabs fell off.

Smallpox is believed to have appeared around 10,000BC, at the time of the first agricultural settlements in northeastern Africa. From there, it may have spread from to India by ancient Egyptian merchants. The earliest evidence of skin lesions resembling those of smallpox is found on faces of mummies from the 18th and 20th Egyptian Dynasties (1570–1085 BC). At the same time, smallpox has been reported in ancient Asian cultures; smallpox was described as early as 1122 BC in China and in an Sanskrit texts of India.



FIGURES SHOWING INOCULATION PUST
From a Chinese work on Vaccination

*It was common knowledge that survivors of smallpox became immune to the disease; they could not contract the disease again. As early as 430 BC, survivors of smallpox we upon to nurse the afflicted. Man had long been trying to find a cure for the smallpox d*

However, the most successful way of combating smallpox before the discovery of vaccination was inoculation. The word is derived from the Latin *inoculare*, meaning, "to graft." Inoculation referred to the subcutaneous (meaning under the skin) introduction of the smallpox virus into individuals who have not yet had the virus. The inoculator usually used a sharp lancet dipped in pus taken from a ripe pustule of some person who suffered from smallpox. The person was then pricked with the lancet on arms or legs.

1. What causes smallpox? _____

2. When is smallpox believed to have appeared? When is the earliest known recording of smallpox? _____
_____
_____.

3. During which symptom is the virus the most contagious? _____
_____
_____.

4. What is a pustule? _____

5. What is inoculation? What is its purpose? _____
_____
_____
_____.

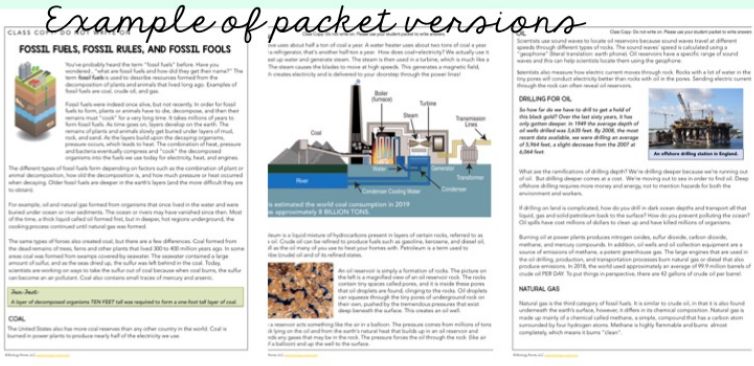
Inoculation was likely practiced in Africa, India, and China before the 18th century, which was when it was introduced to Europe. In 1670, Circassian traders introduced inoculation to the Ottoman Empire in Turkey. Circassian women of the Turkish sultan's harem in Istanbul, because of their legendary beauty, were inoculated as children in parts of their bodies where scars would not be seen. Inoculation came to Europe at the beginning of the 18th century with the arrival of travelers from Istanbul; however, they did not change the ways of the conservative English physicians, who believed that Eastern medicine was inferior and thought inoculation would go the way of bloodletting.

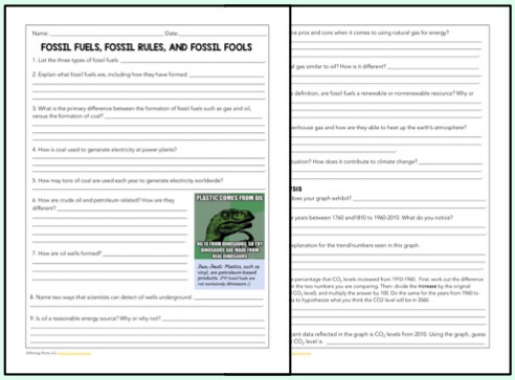
It was the continued advocacy of the English aristocrat Lady Mary Wortley Montague that was responsible for the introduction of inoculation in England. In 1715, Lady Montague suffered from an episode of smallpox, which severely disfigured her face. Her 20-year-old brother died of the illness 18 months later. In 1717, Lady Montague's husband, Edward Wortley Montague, was appointed ambassador to the Sublime Porte of Istanbul. A few weeks after their arrival in Istanbul, Lady Montague wrote to her friend about the method of inoculation. Lady Montague was so determined to prevent smallpox that she ordered the embassy surgeon to inoculate her 5-year-old son.



## ANSWER KEY AND CLASS PACKET VERSION INCLUDED

*Example of packet versions*





*Classroom set (print once)*

*Student answer sheets*

# ANSWER KEY AND CLASS PACKET VERSION INCLUDED

Name: _____ Date: _____

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FIGURES SHOWING INOCULATION
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Upon their return to London in April 1721, Lady Montague had the family physician, Charles Maitland, inoculate her 4-year-old daughter in the presence of physicians of the royal court. Given the success of Lady Montague's children, Charles Maitland was granted a royal license to perform a trial of inoculation on six English prisoners in 1721. Several court physicians, members of the Royal Society, and members of the College of Physicians observed the trial. All prisoners survived the experiment, and those exposed to smallpox later proved to be immune. In the months following this very first trial, Maitland repeated the experiment on orphaned children, again with success. Finally, on April 17, 1722, Maitland successfully treated the two daughters of the Princess of Wales.

Not long after Lady Montague presented inoculation, physicians performed inoculation on a massive scale. Although 2% to 3% of inoculated persons died from disease, inoculation rapidly gained popularity among both aristocratic and common people in Europe. The case-fatality rate associated with inoculation was 10 times lower than that associated with naturally occurring smallpox. In fact, many European princes and princesses were died of smallpox in the 1750s, causing even more royal families to inoculate.

6. During the 18th century, what was England's view on inoculations? _____

7. Who is Lady Montague and why is she is a historic figure in inoculations? _____

8. When and how did inoculation finally become acceptable in England? _____

9. The fatality risk of inoculation was _____ times lower than the fatality risk of naturally occurring smallpox.

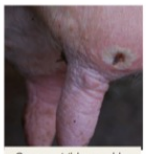


Edward Jenner was born on May 17, 1749, in Berkeley, Gloucestershire. During his early school years, Edward developed a strong interest in science and nature that continued throughout his life. At age 13 he was apprenticed to a country surgeon, where Jenner heard a dairymaid say, "I shall never have smallpox for I have had cowpox. I shall never have an ugly pockmarked face." In fact, it was a common belief that dairymaids were in some way protected from smallpox.

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While Jenner's interest in the protective effects of cowpox began during his apprenticeship in school, it was in 1796 when he made the first step in eradicating smallpox. For many years, Jenner had heard the tales that dairymaids were protected from smallpox naturally after having suffered from cowpox. Cowpox is similar to smallpox, but it is a much more mild disease. Pondering this, Jenner concluded that cowpox not only protected against smallpox but also could be transmitted from one person to another as a deliberate mechanism of protection.



Cowpox visible on udder of a sow

In May 1796, Edward Jenner found a dairymaid named Sarah Nelms, who had fresh cowpox lesions on her hands and arms. On May 14, 1796, using fluid from Nelms' lesions, he inoculated an 8-year-old boy, James Phipps. Subsequently, the boy developed mild fever and discomfort. Nine days after the procedure he felt cold and had lost his appetite- common symptoms of cowpox, but felt much better the next day. In July 1796, Jenner inoculated the boy again, this time with fluid from a fresh smallpox lesion. No disease developed, and Jenner concluded that protection was complete.



Medical drawing of Sarah Nelms' hand

In 1797, Jenner sent a short communication to the Royal Society describing his experiment and observations. However, the paper was rejected. Then in 1798, having added a few more cases to his initial experiment, Jenner privately published a small booklet entitled *An Inquiry into the Causes and Effects of the Variolae Vaccinae, a disease discovered in some of the western counties of England, particularly Gloucestershire and Known by the Name of Cow Pox.* The Latin word for cow is *vacca*, and cowpox is *vaccinia*; Jenner decided to call this new procedure *vaccination.*

Eventually, vaccination became popular through the activities of others, particularly the surgeon Henry Cline, to whom Jenner had given some of the inoculant. Later in 1799, Drs. George Pearson and William Woodville began to support vaccination among their patients. By 1800 the use of vaccination spread rapidly in European countries.

Dr. John Haygarth received the vaccine from Jenner in 1800 and sent some to Benjamin Waterhouse, a professor at Harvard University. Waterhouse introduced vaccination in New England and then persuaded Thomas Jefferson to try it in Virginia. Waterhouse received great support from Jefferson, who appointed him to the National Vaccine Institute, an organization set up to implement a national vaccination program in the United States. Although he received worldwide recognition and many honors, Jenner made no attempt to enrich himself through his discovery. Gradually, vaccination replaced inoculation, which became prohibited in England in 1840.

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10. How did vaccinations get their name? _____

11. What was the procedure during the first successful vaccination? _____

12. Why was Jenner's vaccination a more ideal way to prevent smallpox than traditional inoculation? _____

13. Hypothesize a reason as to why vaccinations were successful in immunizing an individual for the smallpox virus. _____

14. Name two interesting facts that you learned during this article: _____

15. How has the term "vaccination" changed over time? Thanks to Edward Jenner, what other diseases can be prevented with vaccines? _____

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5 pages plus optional timeline. Use of the text and timeline is perfect for a two-day absence!

This is a fascinating read and it helps students to appreciate the medical phenomena of today!



Name: _____

TIMELINE: THE HISTORY OF VACCINES

*Directions:* INCLUDE ALL DATES AND FIGURES FROM THE TEXT TO COMPOSE A GRAPHIC TIMELINE. A ROUGH DRAFT IS ENCOURAGED.

JENNER

LADY MONTAGUE

# PLAN "H": RADIO WAVES

## Generation Wireless (Radio Waves):

- History of radio and how fast news could travel
- Why did video kill the radio star?
- How radios work; frequency, FM, AM, oscillation, etc.
- Why are they called "cell" phones and how do they work?



Name: _____ Date: _____

**GENERATION WIRELESS: RADIO WAVES**

In 2019, it is estimated that 96% of adults have a cell phone, and 88% of teenagers ages 13-17 have a cell phone. Some people have even claimed that they can't sleep without their cell phone for fear of missing a text or a call!

Most people use their phone as the only means of accessing the web. With cell phones comes a way to reach more people in a shorter amount of time. In fact, if you compare the information highway to the 1930's, when radio was the means of communicating, it would have taken approximately 38 years to reach 50 million radio listeners. Meaning that information shared on the radio would eventually reach 50 million people (mostly by word of mouth), but it would take 38 years for this information to circulate.

Today, information is shared much faster. Anything shared over the Internet would only take 4 years to reach 50 million users, and more specifically, if it were Facebook it would only take 3.25 years.

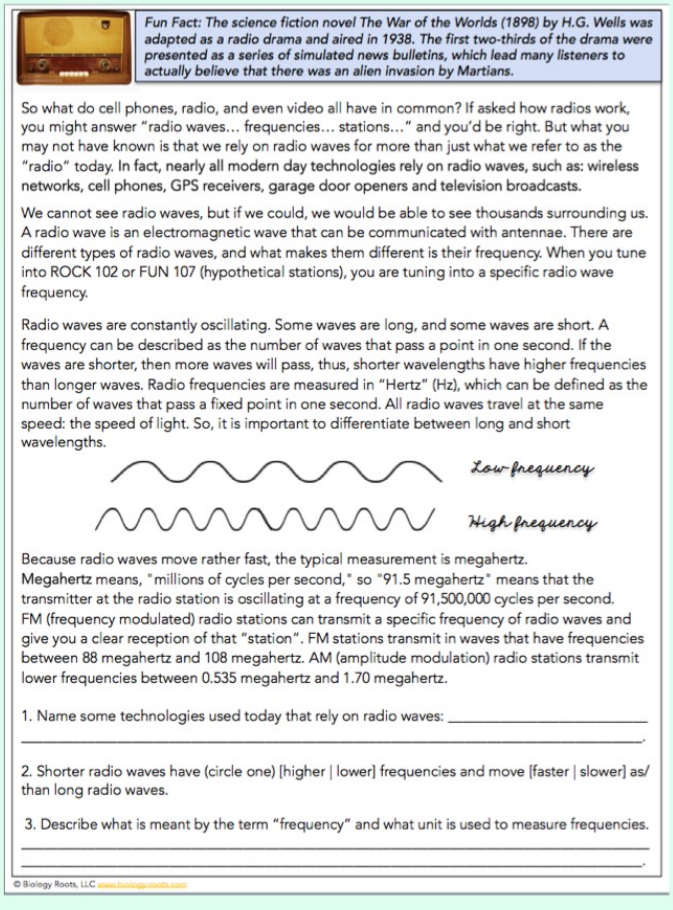
Before the Internet and television, most people had a radio in their homes as a means of gaining information from the world. The peak of the radio age was reached in the 1940s. Even though many people could not afford washing machines, vacuum cleaners, or cars, they desperately struggled to keep up their payments on radios. Though many of these things were relatively inexpensive, the radio age was shortly after the Great Depression, and many people were out of work. Radios were how they received news and entertainment.

**Photograph of a young girl listening to a radio during the Great Depression. From 1920 through the end of World War 2, a period called the Golden age of radio.**

By 1935, more than 22 million Americans had radios in their homes, and at this time, cars were being sold with factory-installed radios. Radios were the television, the Facebook and the newspaper of long ago. Families sat around the radio and listened to shows like "Amos n' Andy", "Gunsmoke", "Superman", "Dick Tracey", and the "Sixty-Four Dollar Question" (and yes, $64.00 was the top prize!). Families would sit around the radio, and much like reading a book, use their imaginations as they listened to the radio shows.

Interestingly enough, when some of the radio shows eventually made the transition to television, audiences were…disappointed. The images of the people and surroundings that listeners had imagined could not measure up to what they were seeing on television. Also not helping this transition was the fact that some radio personalities did NOT make good television personalities. As comes the phrase, "video killed the radio star."

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*Fun Fact: The science fiction novel The War of the Worlds (1898) by H.G. Wells was adapted as a radio drama and aired in 1938. The first two-thirds of the drama were presented as a series of simulated news bulletins, which lead many listeners to actually believe that there was an alien invasion by Martians.*

So what do cell phones, radio, and even video all have in common? If asked how radios work, you might answer "radio waves… frequencies… stations…" and you'd be right. But what you may not have known is that we rely on radio waves for more than just what we refer to as the "radio" today. In fact, nearly all modern day technologies rely on radio waves, such as: wireless networks, cell phones, GPS receivers, garage door openers and television broadcasts.

We cannot see radio waves, but if we could, we would be able to see thousands surrounding us. A radio wave is an electromagnetic wave that can be communicated with antennae. There are different types of radio waves, and what makes them different is their frequency. When you tune into ROCK 102 or FUN 107 (hypothetical stations), you are tuning into a specific radio wave frequency.

Radio waves are constantly oscillating. Some waves are long, and some waves are short. A frequency can be described as the number of waves that pass a point in one second. If the waves are shorter, then more waves will pass, thus, shorter wavelengths have higher frequencies than longer waves. Radio frequencies are measured in "Hertz" (Hz), which can be defined as the number of waves that pass a fixed point in one second. All radio waves travel at the same speed: the speed of light. So, it is important to differentiate between long and short wavelengths.




Because radio waves move rather fast, the typical measurement is megahertz. Megahertz means, "millions of cycles per second," so "91.5 megahertz" means that the transmitter at the radio station is oscillating at a frequency of 91,500,000 cycles per second. FM (frequency modulated) radio stations can transmit a specific frequency of radio waves and give you a clear reception of that "station". FM stations transmit in waves that have frequencies between 88 megahertz and 108 megahertz. AM (amplitude modulation) radio stations transmit lower frequencies between 0.535 megahertz and 1.70 megahertz.

1. Name some technologies used today that rely on radio waves: _____
_____.

2. Shorter radio waves have (circle one) [higher | lower] frequencies and move [faster | slower] as/ than long radio waves.

3. Describe what is meant by the term "frequency" and what unit is used to measure frequencies.
_____
_____.

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Name: _____ Date: _____

## GENERATION WIRELESS: RADIO WAVES



In 2019, it is estimated that 96% of adults have a cell phone, and 88% of teenagers ages 13-17 have a cell phone. Some people have even claimed that they can't sleep without their cell phone for fear of missing a text or a call!

Most people use their phone as the only means of accessing the web. With cell phones comes a way to reach more people in a shorter amount of time. In fact, if you compare the information highway to the 1930's, when radio was the means of communicating, it would have taken approximately 38 years to reach 50 million radio listeners. Meaning that information shared on the radio would eventually reach 50 million people (mostly by word of mouth), but it would take 38 years for this information to circulate.

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4. Why do you think that there are more FM stations available on the radio than AM stations?

Though it may not seem like it at first, radio waves are actually a quite simple way of communication. Any radio setup has two basic parts: the transmitter and the receiver. By "radio setup" we mean anything: baby monitors, cell phones, Wi-Fi, remote controls.
The transmitter takes some sort of message (examples include an image or sound) and encodes it onto a radio wave. The receiver receives the wave and decodes the message.
In order to encode a radio wave, you need to modulate it. The simplest form of modulation is pulse modulation. Recall that a radio wave is simply an electromagnetic wave. You can create electromagnetic fields, thus creating radio waves. PM (pulse modulation) is exactly how Morse code works- you simply turn the wave on and off, by turning an electromagnetic field on and off.

A basic transmitter can be created by rapidly changing electric current in a wire. The simplest way to do this is to rapidly connect and disconnect a battery.



**This is a simple transmitter that was built using a battery. An antenna could pick up its signal. This is much like the first wireless transmission using Morse code.**

A "sine" wave is a smooth, continuous wave, which is more ideal for sending radio signals (Morse code does not use sine waves, for example). To create a sine wave, you would create varying currents within a battery, rather than disconnecting it completely.

Amplitude modulation (AM) is used when broadcasting AM radio stations as well as the picture part of television broadcasting (not sound). *Amplitude refers to the height of the wave.* In amplitude modulation, the amplitude of the sine wave is changed, or in other words, the voltage of the wave changes.

As more voltage is added, the height of the wave increases. For example, a person's voice is introduced to the transmitter's sine wave, and that changes the amplitude. (You may be asking how your voice could possibly change the amplitude, but that is done using a converter, which is another story).

FM radio stations and hundreds of other wireless technologies (including the sound portion of a television broadcast, cordless phones, cell phones, etc.) use frequency modulation. The advantage to FM is that it is largely immune to static. In FM, the transmitter's sine wave frequency changes very slightly based on the information signal.

5. What are the two basic parts of a radio? _____

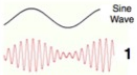
6. What is a sine wave? _____

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7. What does the term "amplitude" refer to? _____

8. What does "AM" stand for? _____

9. What does "FM" stand for? _____










10. Assign each numbered wave in the picture at left as an AM or FM radio wave.

#1=_____

#2=_____

11. Name two things that use AM waves: _____

12. Name two things that use FM waves: _____

13. Do you think a TV remote control is a transmitter or a receiver? Why? _____

When you are tuning the radio, you may be listening to station 146 AM. What that means is that the transmitter's sine wave is transmitting at 146,000 hertz. Simply put, this means that the wave repeats 146,000 times per second— and just think, some radio stations, such as 650 AM are repeating waves at 650,000 times per second!)

The voice of the radio host or DJ is modulated onto a carrier wave by changing the amplitude of the transmitter's sine wave. An amplifier will adds more power to the signal, and then an antenna sends the signal to space. So, how does your car pick up the signal? You guessed it, an antenna.

Your car radio's receiver needs an antenna to pick up radio waves. Antennas aren't fancy; they are simply a metal stick or wire that can interact with the radio waves. However, the antenna will pick up hundreds, if not thousands, of radio waves. That's where your radio's tuner comes in. The tuner can separate one sine wave from the other signals. If the tuner is tuned to receive the 146,000-hertz signal, it will resonate (or oscillate) at that particular frequency, so that only that one particular sine wave will be received.

14. Explain how your typical car radio would be able to pick up a signal from a radio station:

So, if you haven't heard, there are these things called cell phones. As mentioned previously, they also use radio waves. At its most basic, a cell phone is a radio, a very sophisticated radio, but a radio nonetheless.



The first cell phone went on sale for the first time in 1983, and cost almost $4,000.

Believe it or not, it was in 1978 that cell phone systems were first developed. Called "AMPS" (advanced mobile phone systems), it was a genius idea. Instead of requiring a powerful transmitter to talk, the cell city or area is divided into cells and each cell phone can operating within an individual cell and switch cells as they move around. Therefore, cell phones have incredible range.
With the city split into cells, there comes a requirement for a large number of "base stations", which are transceivers. Well, that's a new word. Transmitter? Receiver? The answer is both, but you commonly know them as "cell towers". The cell tower is essentially what creates the "cell" of your city or town. If you are in a small city, you may only have a few. The further you are from the tower, the less "service" you get!

So, what happens when you make a call, or a text? First, a cell phone radios the nearest cell tower. In other words, your phone sends a radio wave frequency that is picked up by the tower's antennae. Once the signal reaches the base station, it is transmitted to the main telephone network, either by cables (wires) or by another radio link at a different frequency. The nearest base station to the person you are trying to reach sends the signal to their cell phone. Incoming calls have different frequencies than outgoing calls, so they will never interfere with one another (which is why you can still receive a call when talking on the phone). The base stations will continuously transmit radio waves to your cell phone, but your cell phone only transmits radio waves to the base stations when making an outgoing call or text.

15. Why are they called "cell" phones? _____

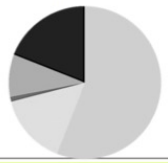
16. Why can you hold a conversation on your cell phone over long distances? _____

17. What is a cell tower? What does it do? _____

18. Name one additional piece of information you read in the article that you found to be interesting: _____

19. In 2018, data pertaining to the use of cell phones was released. The time spent on a user's cell phone was broken down into five categories: phone calls; email and text messaging; web browsing; camera use; and applications. Using the blank pie chart below, predict which of the activities belong in which "slice" of the pie; the bigger the slice, the more time is spent doing that particular activity.

My prediction...



**COMPARE**

20. The actual results are listed as the number of minutes that the average user spends in each category within a 12-hour period. The 12-hour period reflects the time of day that users were most likely to use their phones. In order to get the percentage, you need to divide the minutes in each activity by the amount of minutes in each 12-hour period (720 minutes). That will give you the overall fraction of time spent in each category. Then, multiply your answer by 100% to get the percentage. For example, if you get 0.13 as your answer, it would equal 13% of the daily minutes spent in that category. The first one has been done for you (108 ÷ 720=0.15 x 100%=15%).

| Activity | Average number of minutes spent in one 12-hour period | Percentage of Daily Use |
|---|---|---|
| Phone calls | 108 | 15% |
| Email and text messages | 138 | |
| Web browsing | 65 | |
| Camera | 9 | |
| Apps | 400 | |

Actual breakdown of mobile activity



*Be sure to include the percentages as well as the label for each chunk of the pie.*

Generation Y has been exposed to radio waves all their life, and some may even say they rely on it. Yet, most of them do not realize their cell phones, Wi-Fi, and video games all operate in the invisible world of radio waves. Explores a brief history of radio, how radios work, how cell phones work, and finally they must analyze a pie chart about cell phone use.

ANSWER KEY AND CLASS PACKET VERSION INCLUDED

# PLAN "I": IMMUNE SYSTEM

## Achoos, Allergies, and Ouches

- Why is there pain and swelling when we skin our knee?
- What causes an allergic response?
- Are allergies on the rise?
- What are the key players in our immune system and how are they so awesome?

Name: _____ Date: _____

### SUB PLAN I: ACHOOS, ALLERGIES, and OUCHES



Allergies are abundant: In the United States alone, it is estimated that 1 out of any 5 persons have either allergies or asthma.

But what is an allergy? How does someone develop them? In order to understand, you need to know a little bit about your immune system. The immune system is quite fascinating; there are cells inside you that act as an army, with only one mission: to protect you.

The purpose of the immune system is to protect your body against foreign invaders such as viruses, bacteria and parasites. Any microorganism that can cause disease is known as a pathogen. Your first line of defense against these bad guys is a physical barrier, where the skin plays a role as well as the mucous membranes that cover your respiratory and digestive system. To cause trouble, viruses, bacteria and parasites must first cross this barrier. If one of these germs does so happen to get through, it is greeted by what is called your "innate" immune system. This is your natural immune system that you were born with, and it includes specialized proteins, and white blood cells, such as phagocytes (from the Greek word "phago", meaning "to eat") and natural killer cells. All white blood cells, and therefore all those tiny soldiers inside your body, are produced in the bone marrow.

The adaptive immune system is a third layer of defense that can actually adapt to protect us. One of the first clues that the adaptive immune system existed came in the 1790's when Edward Jenner began his vaccinations against smallpox. What Jenner realized was that milkmaids frequently contracted a disease called cowpox, which causes lesions on their hands that looked similar to smallpox. However, these milkmaids almost never contracted smallpox. Come to find out, smallpox and cowpox are two very closely related viruses. Jenner had done numerous studies and was ready to make a daring experiment. He collected pus from the sores of the milkmaids and injected it into a little boy named James Phipps. Later, Phipps was injected with pus from the sores of a person infected with smallpox, and he did not contract the disease! Phipps was still able to get other diseases, but not smallpox or closely related viruses. This is one of the major features of the adaptive immune system: it adapts to defend against specific invaders.

1. What is the purpose of your immune system? _____
_____.

2. What is the first line of defense against pathogens? _____
_____.

3. Where are white blood cells produced? _____

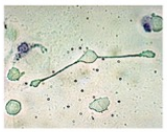
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4. Briefly describe the two branches of immune systems using the chart below:

| Innate | Adaptive |
|---|---|
| | |

Let's say you're playing softball and you slide into home plate and skin your knee. Bacteria and other pathogens now have access to your body. Most bacteria cannot infect healthy skin cells because your outermost skin cells are technically dead. Now that we've scraped off that outer layer, there are lots of cells for the bacteria to invade! After a little while, you may notice that your knee becomes red and swollen. The swelling isn't caused directly by the bacteria, but rather it is a sign that your innate immune system is kicking in!

Within your tissues are white blood cells that defend you against attack. One of the defender cells that are stationed in your tissues is the **macrophage**: the most famous innate phagocyte. Macrophages don't wait until they come in contact with a bacterium, they can reach out and grab it, and then engulf it. They then use lysosomes to destroy the bacteria.



Macrophages can also produce proteins called "cytokines." These are hormone messengers that can communicate between different types of cells in your immune system. Some of the cytokines attract macrophages and other immune cells traveling in nearby blood vessels, the cells then exit the blood vessels to help fight the rapidly multiplying bacteria at the site of infection. This leads to an inflammatory response in your knee.

Another type of phagocyte is the **neutrophil**. Neutrophils make up about 70% of the white blood cells in your blood. Neutrophils are killing machines. In fact, they have short lifespans (~ 5 days) because once they come out of the blood vessel they have one mission: kill. And with that mission comes some destruction of normal tissues. If they were all allowed to live for a long time, we might see more damage from the neutrophils.



Most of the time, neutrophils are dormant. It is indeed the good old macrophage's cytokines that activate the neutrophils. But the macrophages don't get scared easily; in fact they can fight an infection alone for days without calling up the killer cells. It has to be a serious fight for the neutrophils to come along. A sure-sign that neutrophils are involved is pus. Pus is actually a clump or cluster of dead neutrophils.

5. Name the two types of phagocytes that make up an important part of your innate immune system: _____.

6. What are cytokines? _____
_____

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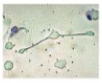
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without calling u
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l neutrophils.

f phagocytes tha

Certain cells, known as "antigen presenting cells" have a type of MHC molecule that bind to antigens. In fact, our trusty macrophages can do this! During a bacterial infection, a macrophage will "eat" some bacteria, and then will load fragments of ingested bacterial proteins onto MHC molecules on their cells. So, picture a macrophage holding up a sign saying, "the bacteria are here!" (*Except really it's just bits of half-eaten bacteria [antigen] that is stuck on MHC molecules).* Something called a "helper T cell" can scan the macrophage's MHC molecules and alert *killer T cells*. The helper T cells then bind to the macrophage, which is displaying the bacterial antigens on its surface.

You can picture the helper T cell as studying the antigen and keeping it in its memory bank. Once it recognizes the antigen as being a bad guy, the helper T cells begin to make copies of itself- so what you are left with is many cells that are all capable of recognizing this specific antigen. Helper T cells can also release cytokines that stimulate the production B cells and killer T cells. Killer T cells release very powerful chemicals. Helper T cells are named after what they do: help. They are very important in facilitating the communications among the immune system. The example of them "talking" to macrophages and "calling for killer T cell backup" is just one of the many communications they perform in helping all the players work together to ensure that you stay healthy. HIV is so devastating because it specifically attacks and kills helper T cells.

10. What is an antibody and what does it do? _____

11. Explain what does antibodies having "specific" antigens mean: _____

12. What are B cells and why are they important? _____

13. How does a macrophage "present" antigen to other cells, such as helper T cells?

14. Why are helper T cells important? _____

15. An individual that has been exposed to chickenpox will usually develop the fever and rash symptoms that the virus causes. However, it most cases, these individuals could not contract the virus a second time, even if they were interacting with individuals that were sick from chickenpox. Provide a hypothesis as to why this may be the case: _____

Allergies are the result of an immune disorder; persons with allergies tend to have hypersensitive immune systems. Allergies are the things that people are allergic to: peanuts, honey, shellfish, pollen, animal dander/hair, eggs etc. Allergies can cause something known as *anaphylactic shock*.

For example, when a bee stings you, its venom enters your bloodstream. Our immune system recognizes the venom antigen (or, if it's your first time being stung, your body will make antibodies). The antibody response will also make histamine. Histamine is a chemical that affects the tissue, blood vessels and nerves surrounding the allergen (or antigen) and makes the area swell. If it's a food allergy, then the swelling will occur in the tongue, lips, mouth and throat. Histamine is present during any immune response, but the body can make too much histamine, which leads to excessive swelling that causes an allergic reaction. If the swelling is severe, it can result in anaphylactic shock, which can be fatal.

Though allergies are not uncommon, it is not entirely understood how they develop. One hypothesis is that they could form when you are introduced to an antigen while you are sick, and your immune system is on "high alert", thus making unnecessary antibodies. Also, some types of allergies are genetic and can be passed on from one generation to the next. If you were not born with allergies, you can develop them later in life.

16. What causes allergies? _____

17. What is histamine and how is it related to anaphylactic shock? _____

18. Hypothesize how many of your classmates have allergies:_____

Allergies have been on the rise for the past twenty years, and there is not a clear answer as to what could be causing this trend. Using the table below, make a line graph to show the trend of allergies from 2000-2019. Label the y-axis as "Percentage of population with allergies", and label the x-axis as "4 year period of time". You will need to make THREE lines on one graph. Use different colors and clearly label each line: food allergy, skin allergy, respiratory allergy.

19. On your graph (or the back piece of graph paper), summarize/describe what trends your graph shows.

| Allergy Type | Years (4 year period) | Percentage |
|---|---|---|
| Food allergy | 2000-2003 | 4.5% |
| | 2004-2007 | 5% |
| | 2008-2011 | 6% |
| | 2012-2015 | 6.5% |
| | 2016-2019 | 7% |
| Skin allergy | 2000-2003 | 8% |
| | 2004-2007 | 8.5% |
| | 2008-2011 | 9% |
| | 2012-2015 | 10% |
| | 2016-2019 | 12% |
| Respiratory allergy | 2000-2003 | 17.5% |
| | 2004-2007 | 17.5% |
| | 2008-2011 | 17% |
| | 2012-2015 | 16.5% |
| | 2016-2019 | 17% |

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7. Why could macrophages be considered the "2nd line of defense" (if counting skin and mucous membranes as the 1st line of defense), rather than neutrophils? _____

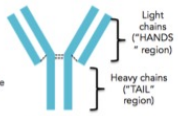
8. After getting injured, like skinning your knee for example, why does the wound appear red and feel sore after a short time? _____

9. Name one way that you might be able to tell neutrophils are fighting an infection (without a microscope): _____

Though the innate immune system can do a fine job, Mother Nature has ensured a way for our immune systems to actually remember certain pathogens so that our bodies can fight them off faster, and kill them off before they cause trouble, all thanks to the **adaptive immune system**. Recall the history of vaccinations: Edward Jenner injected the pus from a milkmaid's cowpox-infected sore into poor little James Phipps. However, this gave Phipps immunity against smallpox, a very close relative of the cowpox virus. We know now that this is because of special proteins that circulate in the blood of immunized individuals called **antibodies**.

Each antibody binds to a specific antigen, which is a protein that can be found on the surface of a foreign invader (e.g., a protein on the surface of the smallpox virus). The antibody-antigen relationship is specific. For example, the smallpox antibody can only bind to the smallpox antigen, it cannot bind to antigens found on other viruses. When an antigen is detected, several types of cells work together to recognize it and respond to it. These cells also trigger some helpful antibody-making cells known as "B cells". B cells can copy themselves VERY quickly and make lots and lots of antibodies in the process. The more antibodies there are, the faster a pathogen can be destroyed. What is especially wonderful about B cells is that they can form memory cells. They can actually remember different types of pathogens that your body has been introduced to before and instantly make more of those specific antibodies.

Though antibodies are very important, they don't actually kill anything. Their job is to place the "kiss of death" on the intruder- to tag it for destruction. Basically, these antibodies attach themselves to the
ds" of the antibody can bind to
ortion of the antibody binds to the
d cells, like macrophages.




i a bridge between the white blood cell and the bacteria. Antibodies and their
gether like a lock and key at one end, and at the other end, antibodies fit with
the surface of a white blood cell. It is important to note that phagocytes do
o engulf an intruder; antibodies simply help to reinforce them.

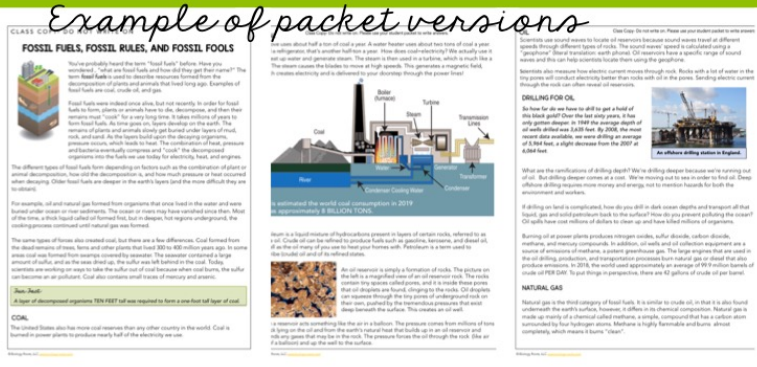
nother member of the adaptive immune system team. In order to understand
need to know a little about major histocompatibility complex proteins, or MHC

Allergies, Achoos, and Ouches- this is a compact introduction to the mysterious world of the immune system. Students read about macrophages, killer T cells, antigens and antibodies and then from there can understand a bit more about allergies. Line graph required (specific directions included).

Can be reduced to 4 pages by omitting the graphing exercise).

## ANSWER KEY AND CLASS PACKET VERSION INCLUDED

*Example of packet versions*



FOSSIL FUELS, FOSSIL RULES, AND FOSSIL FOOLS



You've probably heard the term "fossil fuels" before. Have you wondered... "what are fossil fuels and how did they get their name?" The term **fossil fuels** is used to describe resources formed from the decomposition of plants and animals that lived long ago. Examples of fossil fuels are coal, crude oil, and gas.

Fossil fuels were indeed once alive, but not recently. In order for fossil fuels to form, plants or animals have to die, decompose, and then their remains must "cook" for a very long time. It takes millions of years to form fossil fuels. As time goes on, layers develop on the earth. The remains of plants and animals slowly get buried under layers of mud, rock, and sand. As the layers build upon the decaying organisms, pressure occurs, which leads to heat. The combination of heat, pressure and bacteria eventually compress and "cook" the decomposed organisms into the fuels we use today for electricity, heat, and engines.

The different types of fossil fuels form depending on factors such as the combination of plant or animal decomposition, how old the decomposition is, and how much pressure or heat occurred when decaying. Older fossil fuels are deeper in the earth's layers (and the more difficult they are to obtain).

For example, oil and natural gas formed from organisms that once lived in the water and were buried under ocean or river sediments. The ocean or rivers may have vanished since then. Most of the time, a thick liquid called oil formed first, but in deeper, hot regions underground, the cooking process continued until natural gas was formed.

The same types of forces also created coal, but there are a few differences. Coal formed from the dead remains of trees, ferns and other plants that lived 300 to 400 million years ago. In some areas coal was formed from swamps covered by seawater. The seawater contained a large amount of sulfur, and as the seas dried up, the sulfur was left behind in the coal. Today, scientists are working on ways to take the sulfur out of coal because when coal burns, the sulfur can become an air pollutant. Coal also contains small traces of mercury and arsenic.

Term - Fossil fuels
A layer of decomposed organisms TEN FEET tall was required to form a one-foot tall layer of coal.

**COAL**

The United States also has more coal reserves than any other country in the world. Coal is burned in power plants to produce nearly half of the electricity we use.




is estimated the world coal consumption in 2019
is approximately 8 BILLION TONS.

lleum is a liquid mixture of hydrocarbons present in layers of certain rocks, referred to as
k oil. Crude oil can be refined to produce fuels such as gasoline, kerosene, and diesel oil.
rt as the oil many of you use to heat your homes with. Petroleum is a term used to
the crude oil and of its refined states.



An oil reservoir is simply a formation of rocks. The picture on the left is a magnified view of an oil reservoir rock. The rocks contain tiny spaces called pores, and it is inside these pores that oil droplets are found, clinging to the rocks. Oil droplets can squeeze through the tiny pores of underground rock on their own, pushed by the tremendous pressures that exist deep beneath the surface. This creates an oil well.

a reservoir acts something like the air in a balloon. The pressure comes from millions of tons of rock lying on the earth's surface. Natural heat that builds up in an oil reservoir and forms hot, gassy mist also helps in the push. The pressure forces the oil through the rock (like air if a balloon) and up the well to the surface.

Class Copy- Do not write on. Please use your student packet to write answers.

Scientists use sound waves to locate oil reservoirs because sound waves travel at different speeds through different types of rocks. The sound waves' speed is calculated using a "geophone" (literal translation: earth phone). Oil reservoirs have a specific range of sound waves and this can help scientists locate them using the geophone.

Scientists also measure how electric current moves through rock. Rocks with a lot of water in the tiny pores will conduct electricity better than rocks with oil in the pores. Sending electric current through the rock can often reveal oil reservoirs.

**DRILLING FOR OIL**

*So how far do we have to drill to get a hold of this black gold? Over the last sixty years, it has only gotten deeper: in 1949 the average depth of oil wells drilled was 2,635 feet. By 2008, the most recent data available, we were drilling an average of 5,964 feet, a slight decrease from the 2007 at 6,004 feet.*


An offshore drilling station in England.

What are the ramifications of drilling depth? We're drilling deeper because we're running out of oil. But drilling deeper comes at a cost. We're moving out to sea in order to find oil. Deep offshore drilling requires more money and energy, not to mention hazards for both the environment and workers.

If drilling on land is complicated, how do you drill in dark ocean depths and transport all that liquid, gas and solid petroleum back to the surface? How do you prevent polluting the ocean? Oil spills have cost millions of dollars to clean up and have killed millions of organisms.

Burning oil at power plants produces nitrogen oxides, sulfur dioxide, carbon dioxide, methane, and mercury compounds. In addition, oil wells and oil collection equipment are a source of emissions of methane, a potent greenhouse gas. The large engines that are used in the oil drilling, production, and transportation processes burn natural gas or diesel that also produce emissions. In 2018, the world used approximately an average of 99.9 million barrels of crude oil PER DAY. To put things in perspective, there are 42 gallons of crude oil per barrel.

**NATURAL GAS**

Natural gas is the third category of fossil fuels. It is similar to crude oil, in that it is also found underneath the earth's surface, however, it differs in its chemical composition. Natural gas is made up mainly of a chemical called methane, a simple, compound that has a carbon atom surrounded by four hydrogen atoms. Methane is highly flammable and burns almost completely, which means it burns "clean."

Class Copy- Do not write on. Please use your student packet to write answers.

While natural gas is still plentiful, there is still some uncertainty about how much it will cost to get it out of the ground in the future. Like oil, there is "easy" gas that can be produced from underground formations, and there is gas that is deeper in the earth's layers. To obtain that gas would come with a cost, just as it is with present-day oil drilling.

**NONRENEWABLE RESOURCES AND GREENHOUSE GASES**

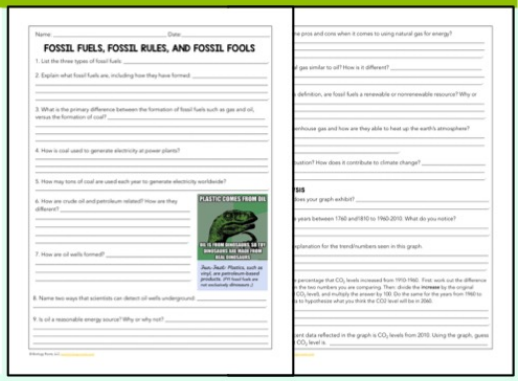
A renewable resource is a natural resource, which can replenish with the passage of time, either through biological reproduction or other naturally recurring processes. For any renewable resource, the rate at which the resource is consumed should not exceed its renewal rate. If it does, renewal and sustainability will not be ensured.

As we know, fossil fuels are the highly decomposed remains of once living things. All living things are carbon-based. So, it is no surprise that fossil fuels contain many carbons. When fossil fuels are burned, we call this combustion. Combustion releases carbon dioxide, $CO_2$, which is a greenhouse gas. A greenhouse gas is any gaseous molecule that is capable of absorbing infrared wavelengths. What this means is that carbon dioxide can trap heat in the earth's atmosphere that would normally escape into space. Other examples of greenhouse gases are methane, nitrous oxide, and water vapor.

**CARBON DIOXIDE CONCENTRATION** (in ppm (parts per million by volume))

Scientists are able to measure the amount of carbon dioxide in the atmosphere and compare it to past amounts.
Examine the table below. Use it to answer the analysis questions.

| Year | Carbon Dioxide Concentration (PPM) |
|---|---|
| 1710 | 276 |
| 1760 | 280 |
| 1810 | 286 |
| 1860 | 293 |
| 1910 | 308 |
| 1960 | 325 |
| 2010 | 390 |



Name: _____ Date: _____

FOSSIL FUELS, FOSSIL RULES, AND FOSSIL FOOLS

1. List the three types of fossil fuels: _____
2. Explain what fossil fuels are, including how they have formed: _____
3. What is the primary difference between the formation of fossil fuels such as gas and oil, versus the formation of coal? _____
4. How is coal used to generate electricity at power plants?
5. How may tons of coal are used each year to generate electricity worldwide?
6. How are crude oil and petroleum related? How are they different? _____
7. How are oil wells formed? _____
8. Name two ways that scientists can detect oil wells underground: _____
9. Is oil a reasonable energy source? Why or why not? _____

PLASTIC COMES FROM OIL

DO YOU THINK DINOSAURS, OR ANY DINOSAURS, ARE MADE FROM FOSSIL DINOSAURS?

Nope. Dead. Plastics, such as those found in consumer products, are not exclusively dinosaurs. :)

the pros and cons when it comes to using natural gas for energy?

gas similar to oil? How is it different? _____

definition, are fossil fuels a renewable or nonrenewable resource? Why or

house gas and how are they able to heat up the earth's atmosphere?

bustion? How does it contribute to climate change? _____

TES

does your graph exhibit? _____

years between 1760 and1810 to 1960-2010. What do you notice?

planation for the trend/numbers seen in this graph.

percentage that $CO_2$ levels increased from 1910-1960. First, work out the difference the two numbers you are comparing. Then, divide the increase by the original $CO_2$ level, and multiply the answer by 100. Do the same for the years from 1960 to to hypothesize what you think the $CO_2$ level will be in 2060.

ant data reflected in the graph is $CO_2$ levels from 2010. Using the graph, guess $CO_2$ level is _____

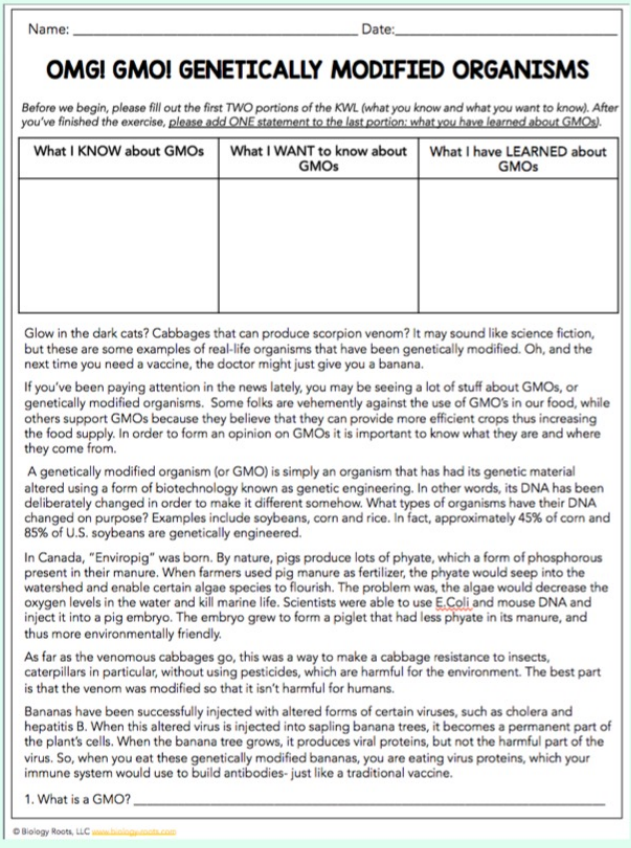
*Classroom set (print once)*

*Student answer sheets*

# 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.

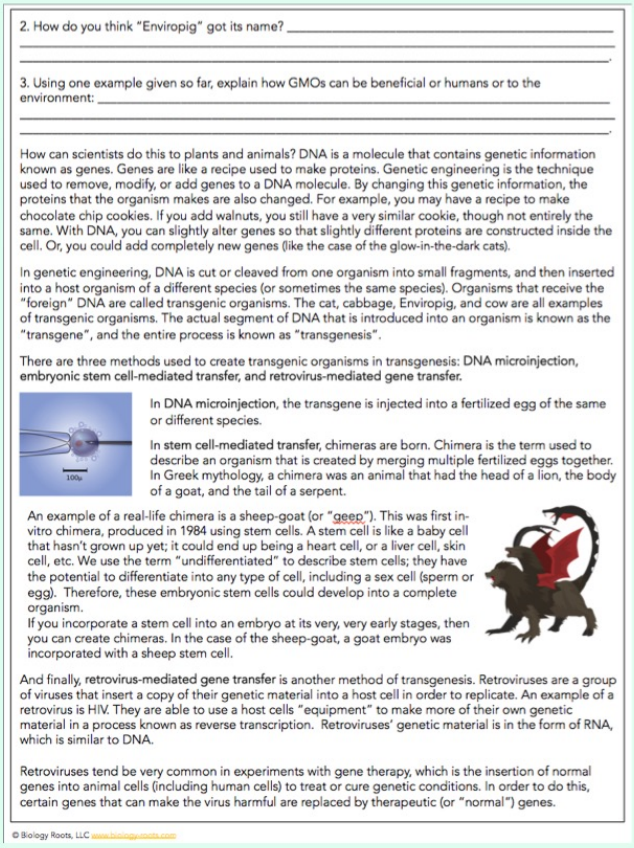
In Canada, "Enviropig" was born. By nature, pigs produce lots of phyate, which a form of phosphorous present in their manure. When farmers used pig manure as fertilizer, the phyate would seep into the watershed and enable certain algae species to flourish. The problem was, the algae would decrease the 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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Name: _____ Date: _____

## OMG! GMO! GENETICALLY MODIFIED ORGANISMS

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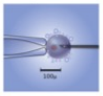
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6. Though the original chimera was found in Greek mythology, what is an example of a chimera in the world of genetic engineering? _____

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**